

Nov. 26, 1963

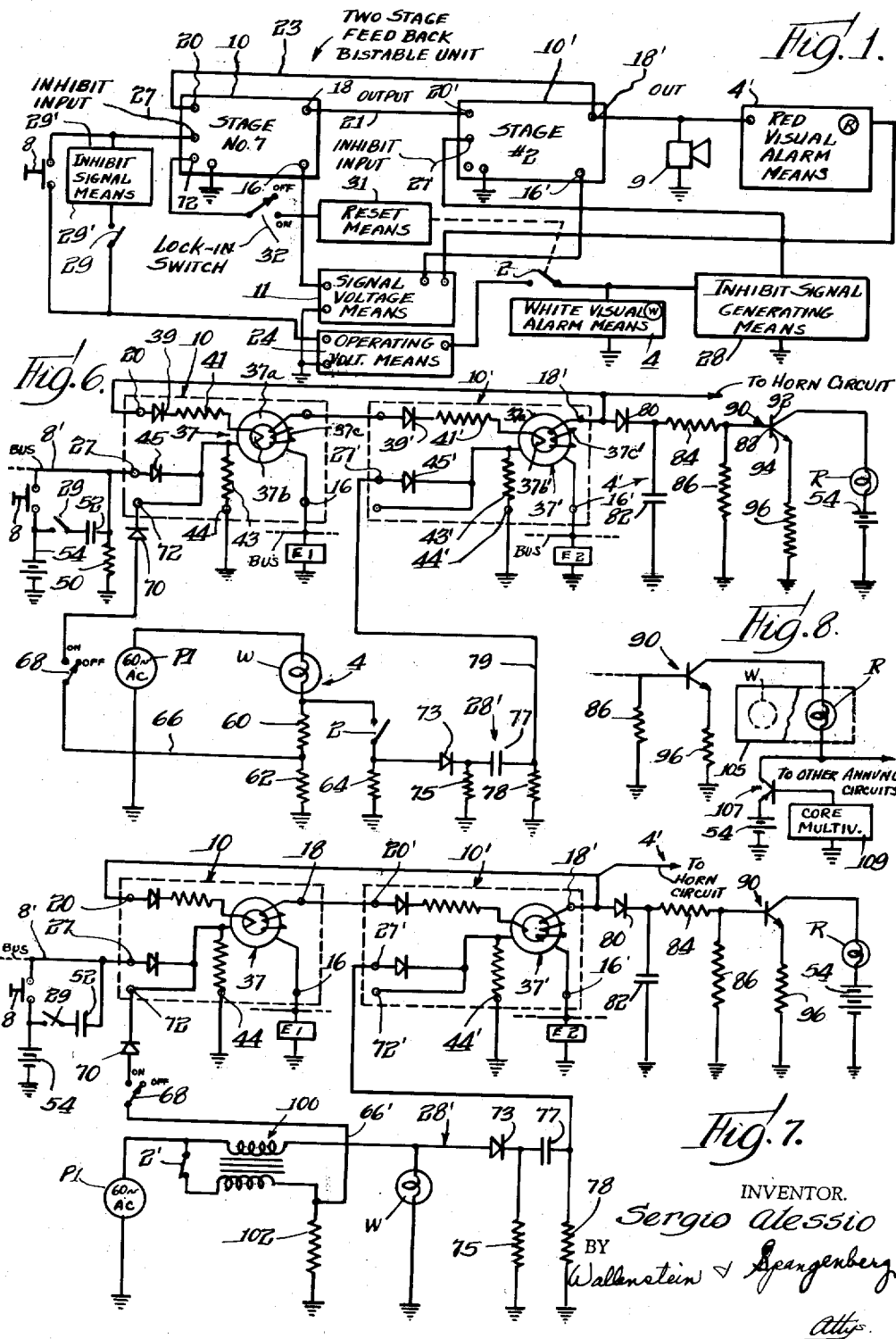
S. ALESSIO

3,111,475

ANNUNCIATOR SYSTEM

Filed Jan. 2, 1958

2 Sheets-Sheet 1



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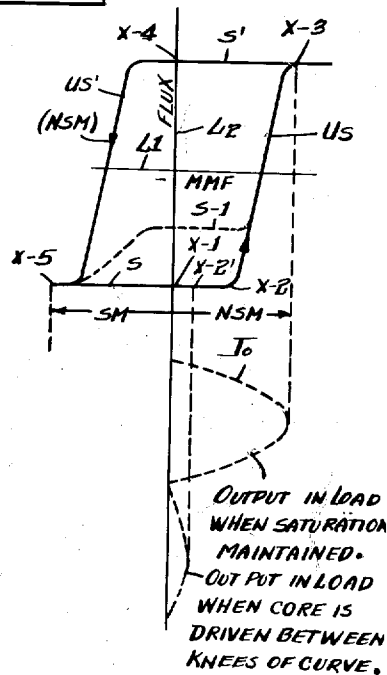
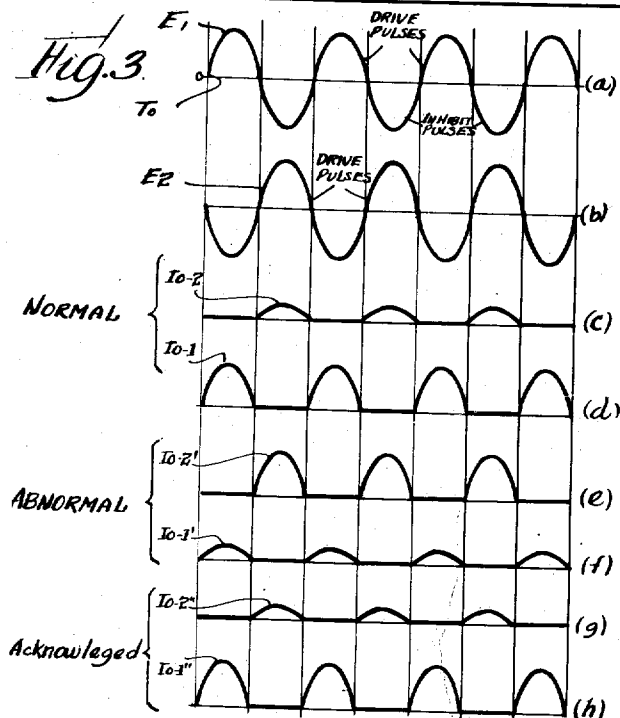
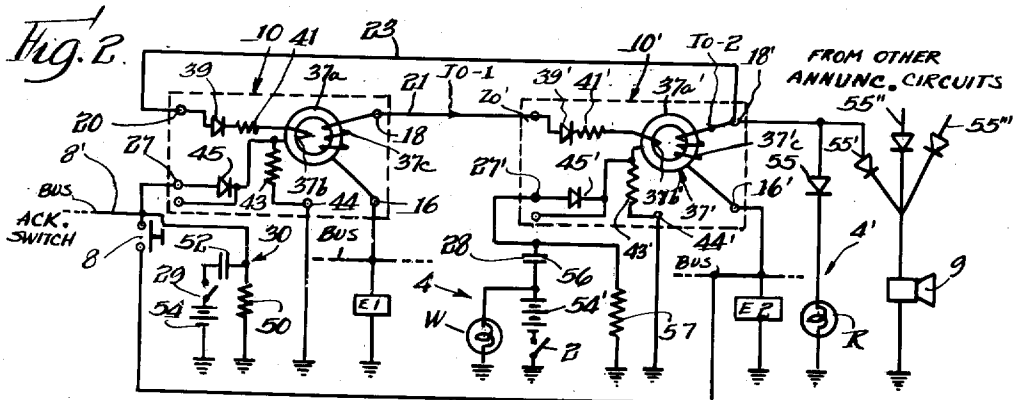
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CIRCUIT CONDITIONS	CORE 37a	E1	CORE 37b	E2	R	W
NORMAL	SM	S	NSM	NS	OFF	OFF
ABNORMAL	NSM	NS	SM	S	ON	ON
RETURN TO NORMAL (BEFORE ACK)	NSM	NS	SM	S	ON	OFF
ACKNOWLEDGE (STILL ABNORMAL)	SM	S	NSM	NS	OFF	ON
RETURN TO NORMAL AFTER ACK.	SM	S	NSM	NS	OFF	OFF

S= SIGNAL PASSES THRU OUTPUT WINDING
 NS= NO SIGNAL PASSES THRU OUTPUT WINDING
 SM= SATURATION OF CORE MAINTAINED
 NSM= CORE DRIVEN BETWEEN OPPOSITE STATES OF SATURATION

Fig. 5.

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3,112,475

ANNUNCIATOR SYSTEM

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14 Claims. (Cl. 340-226)

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, the visual alarm unit provides an indication that the variable has just become abnormal. A manually operable acknowledgement control is 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 provided 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.

Annunciator systems of the kind just described have heretofore been hydraulically or relay controlled systems. Obviously, it is quite important for annunciator systems to be reliable since, otherwise, they could not fulfill their intended purpose. Due to mechanical wear on relay contacts and of the various movable parts in hydraulic systems, the reliability of such annunciator systems left much to be desired.

It is, accordingly, one of the objects of the present invention to provide an improved annunciator system operating, for the most part, with non-mechanical or static components, such as magnetic core or, perhaps, transistor, elements, arranged to have two stable states of operation which are utilized to control the operation of the alarm units.

Another object of the present invention is to provide an annunciator system as above described wherein the annunciator sequences heretofore provided to identify normal, initial abnormal and acknowledged abnormal conditions are readily possible as, for example, a two alarm light sequence wherein the initial alarm condition is indicated by the energization of one or both alarm lights and the acknowledged alarm and normal conditions are identified by two other different combinations of conditions of the alarm lights. Still another object of the invention is to provide an annunciator system as described wherein the initial alarm indication may be locked in before the alarm condition is acknowledged so that even momentary alarms are sensed by the system.

A further object of the invention is to provide an annunciator system as above described as a control for one of the alarm units, which uses a two stage feedback bistable control circuit where the stages are respectively operated in opposite stable states at all times, particularly such a circuit made of magnetic core elements, wherein the operating states of the stages can be reversed by different operating conditions of the circuit, and further wherein a second alarm unit is controlled directly by the field contacts which are controlled by the variable being monitored. An ancillary object of the invention is to provide an annunciator circuit as just described wherein initial operation of the field contacts triggers one of the bistable stages and thereafter becomes ineffective so that the stage can be returned externally to its original state even though the field contacts remain closed. A further object of the invention is to provide a circuit as just described wherein means are provided for ensuring a given state of operation for the two stages of the feedback bistable circuit when the power is turned on.

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Other objects of the invention are to provide annunciator circuits as above described which may be operated directly from normally-open or normally-closed field contacts, to provide circuits wherein operation of at least one of the alarm lights can be carried out with normally closed field contacts without the interposition of power or current amplifiers and without appreciable power loss during normal operation.

In accordance with one aspect of the invention, the annunciator most advantageously uses two alarm lights, one of which is preferably (but not necessarily) controlled by a set of normally-open or normally-closed field contacts, or other control means, controlled by the variable being monitored. When the variable is normal, the field contacts are open or closed, and when the variable is abnormal, the contacts are in their opposite position. The second alarm light is controlled by a control circuit, preferably a two-stage feedback bistable control circuit, most preferably one comprising only static components, such as magnetic cores or less desirably, transistors. The circuit is preferably arranged so that the operation of the bistable circuit in one state of operation, effected by the movement of the field contacts to their abnormal indicating position, energizes the second alarm light. Most desirably, when the field contacts are moved to their abnormal indicating position, the first alarm light is also lit. A manually operable acknowledgement switch is preferably used providing an acknowledged alarm indication, and this is preferably effected by connecting the acknowledgement switch so that it triggers the bistable control circuit into its other state which de-energizes the above-mentioned second visual alarm light. The acknowledged condition of the variable would, therefore, be indicated by the energized first alarm light. When the variable being monitored returns to normal, the field contacts are returned to their normal indicating position which de-energizes the first alarm light. By incorporating flashing means in the energization circuit of the second visual alarm light and placing the two alarm lights behind a single translucent light panel, it is possible to obtain the conventional flashing annunciating sequence comprising an over-all appearing flashing indication during an initial alarm condition and a steady-light indication for an acknowledged condition.

Particularly where static components are used, particularly although not necessarily magnetic core components, extremely high reliability is obtained using the circuit just described. Since one of the alarm lights is controlled directly by the field contacts and independently of the bistable control circuit, even if the bistable control circuit should become inoperative, there is still a light indication indicating an abnormal condition of the variable being monitored.

The bistable control circuit preferably comprises a two stage bistable feedback circuit, most preferably a magnetic core feedback "not" gate circuit wherein the output of each gate circuit is connected to the "not" input of the other gate circuit. In a "not" gate circuit, when a control signal is fed to the "not" input of the gate circuit, a no-output signal condition exists at the output of the gate circuit, whereas the absence of the signal at the "not" input of the gate circuit results in a signal output condition thereat. Moreover, each gate circuit is preferably arranged with an inhibit input terminal arranged so that the feeding of an inhibit signal of proper phase can inhibit or make ineffective the signal fed to the main "not" input terminal of the gate circuit involved. Thus, if a signal condition exists at the main signal "not" input terminal of a gate circuit which would normally effect a no-signal output condition at that gate circuit, the gate circuit can be triggered into a signal output condition by feeding an inhibit signal to the inhibit signal input ter-

minal of the gate circuit involved. Where a feedback circuit of the type above described is provided, the changing of signal output condition of any one of the circuits will automatically result in a change of the signal output condition of the other gate circuit. Obviously, the two gate circuits must operate in opposite output conditions, that is, only one circuit may have a signal output condition at a time.

When such a circuit is utilized as an element in the combination of the present invention, the operation of the field contacts to their abnormal-indicating position preferably operates an inhibit signal generating circuit which feeds an inhibit signal to the gate circuit which normally has a no-signal output condition. The above-mentioned second visual alarm light may be connected to be controlled by the output condition of the latter gate circuit, so that, when the latter gate circuit has a signal output condition, the second visual alarm light will be energized. The inhibit signal generating circuit is preferably a circuit which generates a single pulse or signal in response to the movement of the field contacts to an abnormal-indicating position. No such signal is generated when the field contacts move from an abnormal-indicating position to a normal-indicating position. With this arrangement, it can be seen that the abnormal signal can be locked in even though the variable is only momentarily abnormal. For example, in the circuit described above, when the field contacts only momentarily move to their abnormal-indicating position, although the first visual alarm light would be de-energized when the field contacts returned to the normal-indicating position, the second visual alarm light would remain on since a return of the field contacts to their normal indicating position need not affect the output states of the two stage feedback "not" gate circuit.

The momentary operation of the above-mentioned acknowledgement switch is preferably arranged to generate an inhibit signal which is fed to the inhibit signal input terminal of the gate circuit which under normal operating conditions is in a signal output condition and which under a condition requiring acknowledgement is in a no-signal output condition. In the latter case, the last mentioned gate circuit would be triggered back to a signal output condition which, in turn would trigger its other gate circuit to a no-signal output condition and extinguish the second visual alarm light.

In accordance with another aspect of the present invention, where an automatic reset or non-lock-in operation is desired a reset signal generating circuit is provided which returns the gate circuits to their normal output conditions when the field contacts are returned from their abnormal-indicating position to their normal-indicating position. By placing an on-off switch in the reset circuit, automatic reset or lock-in type of operation may be selectively obtained.

If desired, the reset circuit could also perform the function of initially setting the bistable control circuit to a given condition of operation when the power to the system is initially turned on. Alternatively, an additional setting circuit may be provided for this purpose where the selective lock-in and non-lock-in operation is desired. The reset circuit may be an inhibit signal generating circuit which is connected to the gate circuit which has a no-signal output condition during abnormal operation.

In connection with the control of the first visual alarm light, it is most advantageous from the standpoint of maximum reliability to control the energization thereof without the use of power or current amplifying means. Where the field contacts are normally open, this may be simply obtained by placing the field contacts in series between the first alarm light and a voltage source. Where normally-closed field contacts are utilized, however, in a circuit wherein the field contacts shunt the first alarm light and are operated in series with a dropping resistor, the problem of power loss and overheating of the com-

ponents would be present. In accordance with another aspect of the present invention, this problem is alleviated by utilizing the operation of the field contacts to control the magnitude of a reactive impedance connected in series between first alarm light and a source of A.C. voltage. During normal operation, where the field contacts are closed, the impedance in series with the alarm light is large thereby minimizing current drain and power loss. When the field contacts are opened, the impedance is reduced to a point where the current flow will be sufficient to light the alarm light involved. The voltage developed across the alarm light, in such case, can be utilized to operate the first-mentioned inhibit signal generating means.

In accordance with still another aspect of the invention, the latter inhibit signal generating means comprises a circuit including a capacitor in series with a resistor and a source of voltage effectively coupled and de-coupled to the circuit by the field contacts. Where a direct current voltage source is involved, when the field contacts are operated to their abnormal-indicating position, the direct current voltage is connected to the capacitor-resistor circuit and a pulse appears across the resistor until the capacitor is fully charged. When the field contacts are moved to their normal indicating position, a pulse may be developed due to the discharge of the capacitor, but this pulse may be removed by a suitable rectifier polarized to pass only a pulse generated during the initial charging of the capacitor.

To avoid the necessity of using high current capacity direct current power supplies, it is desirable to utilize power line alternating current potential for operating at least the first alarm light and the inhibit signal generating circuit. A single pulse generating circuit may be provided in a capacitor-resistor circuit as above described by using a rectifier connected in series with the input to this circuit. With this arrangement, the capacitor may charge fully to the amplitude of the first alternating current pulsation of proper polarity to pass through the rectifier. By preventing substantial discharge of the capacitor between successive pulses of this polarity, further pulsations of a sufficient magnitude to trigger the bistable control circuit will not appear across the resistor output. A relatively long time constant discharge circuit is provided for the capacitor, however, so that it can discharge when the field contacts return to their normal-indicating condition.

Other aspects of the invention relate to specific circuit details which will be described as the specification proceeds. Therefore, other objects, advantages and features of the present invention will become apparent upon making reference to the specification to follow, the claims and the drawings wherein;

FIG. 1 is a simplified box diagram of an annunciator circuit constructed in accordance with the present invention;

FIG. 2 is a detailed circuit diagram of one form of the present invention operated with normally-open field contacts and a magnetic core bistable control circuit;

FIG. 3 shows various current and voltage waveforms in different parts of the circuit of FIG. 2, under various conditions of operation thereof;

FIG. 4 shows a sample hysteresis curve of the core material used in the core unit of the annunciator circuit of FIG. 2;

FIG. 5 is a table of the various operating conditions of the annunciator circuit of FIG. 2;

FIG. 6 shows a modified annunciator circuit operating with normally-open field contacts;

FIG. 7 is an annunciator circuit operating with normally-closed field contacts; and

FIG. 8 shows an alarm light control circuit with a flashing alarm light sequence utilized.

Referring now more particularly to FIG. 1, the annunciator circuit thereshown includes the basic components usually found in annunciator systems including a suitable

condition-responsive means, such as field contacts 2 which have opposite positions of operation representing, respectively, normal and abnormal conditions of the variable being monitored, visual alarm means which may include a pair of visual alarm means 4 and 4', and an acknowledgment switch 8 which, when depressed, changes the visual indication in the manner to be explained. Although a separate two-light system is shown, an apparent one-light system may also be formed by mounting two lights behind a single translucent colored panel and utilizing a flasher for flashing the visual alarm means 4' whenever it is energized. In the explanation to follow, a two-light non-flashing sequence will be assumed with alarm means 4' providing a steady bright red indication and alarm means 4 providing a steady white indication.

In the two-light system, when the field contacts are operated to their abnormal-indicating position, the annunciator apparatus will energize both visual alarm means 4 and 4'. Provision is made for energizing an audible alarm such as a horn 9 simultaneously with the energization of the red visual alarm means 4'. When the acknowledgment switch 8 is momentarily depressed, red visual alarm means 4' may be extinguished leaving only the white visual alarm means 4 brightly lit. (In the one-light visual alarm sequence where flashing means is inserted in the energization circuit of the visual alarm means 4', and the two lights (then preferably of the same color) are mounted behind a common translucent panel, the initial alarm indication will be identified by a flashing light contributed by visual alarm means 4' and an acknowledged alarm condition would be indicated by a steady light provided only by the visual alarm means 4.) When the variable being monitored returns to normal and after an alarm condition has been acknowledged, both visual alarm means 4 and 4' are extinguished.

In accordance with one aspect of the invention, the field contacts 2 and the acknowledgment switch 8 are associated most preferably with a pair of control stages indicated by reference numerals 10 and 10', respectively, arranged so that the two stages have opposite states of operation at any given time and that triggering one stage to an opposite state automatically reverses the state of operation of the other stage. In accordance with a preferred and specific aspect of the invention, each stage 10 and 10' is a "not" gate circuit fed from a source of signal voltage, such as signal voltage means 11. The latter is connected to main signal input terminals 16 and 16' of the gate stages 10 and 10'. Signals of appreciable magnitude from the signal voltage means 11 will appear at a signal output terminal 18 or 18' of the gate circuits or stages in the absence of control signals at a control signal input terminal 20 or 20', each to be referred to as a "not" signal input terminal. When no signal appears at the "not" input terminal 20 or 20', then a signal output appears at the signal output terminal 18 or 18'.

It should be understood that reference to a no-signal condition refers to a condition where the amplitude of the signals present are either zero or so small as to be ineffective in triggering the circuit. Likewise, reference to a signal condition refers to a condition where the signals are of sufficient amplitude to trigger the circuit involved.

The signal output terminal 18 of the "not" gate circuit 10 is connected via a line 21 to the "not" input terminal 20' of the other "not" gate circuit 10' and signal output terminal 18' of the gate circuit 10' is connected via a line 23 to the "not" signal input terminal 20 of the first gate circuit 10, so that a feedback arrangement of gate circuits is provided, wherein the output conditions of each gate circuit controls the output conditions of the other gate circuit. In such case, if one of the gate circuits has a signal output condition, signals fed therefrom to the "not" control input terminal to the other gate circuit will ensure a no-signal output condition of the

latter gate circuit. Likewise, the no-signal condition of the latter gate circuit will ensure a signal output condition of the former gate circuit. The signal output conditions of the two gate circuits may be reversed by any means which even momentarily changes the signal output condition of one of the gate circuits, since this will then result in a reversal of the output condition of the other circuit.

The present invention is useful with field contacts which are normally closed or normally open, although specific circuitry in any given case may be different for these two types of field contacts.

As will be explained, both visual alarm means 4 and 4' are directly or indirectly controlled by the operation of field contacts 2. The visual alarm means 4 is arranged to be controlled by the field contact 2 and independently of the state of operation of the bistable gate circuits or stages 10 and 10'. To this end, the visual alarm means 4 is connected in a first circuit including operating voltage means 24, which may be a source of alternating or direct current voltage, and could even conceivably be the signal generating means 11. When the field contacts are moved to an abnormal-indicating position in response to the abnormal condition of the variable being monitored, the operating voltage means 24 is effective to energize the visual alarm means 4. Conversely, when the field contacts 2 are moved to their normal-indicating position, visual alarm means 4 will not receive an operating magnitude of voltage from the operating voltage means 24, so that it becomes de-energized.

As will be explained, visual alarm means 4', on the other hand, is controlled from the output of one of the bistable gate stages, such as gate 10'. An audible alarm or horn 9 may be controlled also from the output of gate circuit 10'. Through means to be explained, the annunciator circuit is arranged so that when power is initially turned on, and the field contacts are in their normal indicating position, the bistable gate stage 10' will normally have a no-signal output condition and the bistable gate circuit 10 will have a signal output condition. With a no-signal output condition at the output of the bistable gate stage 10', visual alarm means 4' will be assumed to be de-energized. Visual alarm means 4' may include a light bulb energized directly from the output of the bistable gate stage 10', or it may include such an electric light bulb controlled from the output of a current amplifier such as a transistor amplifier. In such case, it doesn't make any difference whether the normal output condition of the bistable stage to which visual alarm means 4' is connected is normally in a signal or no-signal output condition, since the amplifier can be internally or externally gated to operate the light bulb from a no-signal output condition. However, in the explanation to follow, it will be assumed that the bistable gate stage with which the visual alarm means 4' is directly associated normally has a no-signal output condition.

In accordance with the present invention, the field contacts 2 and acknowledgment switch 8 are associated with circuits which generate inhibit signals which are respectively fed to inhibit terminals 27' and 27 associated with, respectively, gate stages 10' and 10. When an inhibit signal appears at these terminals, the effect of any signal condition existing at the associated main signal input terminal 20' or 20 is inhibited or cancelled, which, in case the associated stage was in a no-signal output condition, would trigger the associated stage into a signal output condition. Accordingly, an inhibit signal generating means 28 is connected in circuit between the field contact 2 and inhibit input terminal 27' of the bistable gate stage 10'. The acknowledge switch 8 may be connected between signal voltage means 11, acting as an inhibit signal source, and inhibit input terminal 27 of gate stage 10.

When the field contacts 2 are moved to their abnormal-indicating position, an inhibit pulse generated by the inhibit signal generating means 28 is fed to the inhibit sig-

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nal input terminal 27'. This inhibit action will trigger the bistable gate state 10' from a no-signal output condition to a signal output condition. This signal output condition of the gate stage 10' will, in turn, trigger the first gate stage 10 to a no-signal output condition. This signal output condition of the gate stage 10' will result in the energization of the light bulb associated with the visual alarm means 4' and the energization of the horn 9. If the field contacts 2 only operate momentarily, because the associated variable has been abnormal only momentarily, the circuit thus far described is such that no change in the output conditions of the gate circuits 10 or 10' will be effected and the alarm condition of visual alarm means 4' will remain.

As will appear, it is important that the inhibit signal generating means 28 does not generate a continuous succession of inhibit pulses, but rather only a single effective inhibit pulse upon the movement of the field contacts 2 and the maintenance thereof in an abnormal indicating position. Otherwise it would not be readily possible to reset the bistable gate circuits to effect an acknowledgement operation if the field contacts remain in their abnormal indicating position.

As above indicated, the acknowledgement switch 8 is associated in a circuit such that momentary depression thereof will generate an inhibit signal, which inhibits the signal fed to the "not" signal input terminal 20 of the bistable gate stage 10 from the output of the other gate stage 10'. Where the circuit is arranged to lock-in a momentary abnormal variable, the gate stage 10' will be in a signal-output condition irrespective of the operating position of the field contacts at the instant involved. The inhibit signal generated by the momentary depression of switch 8 will generate a signal output condition in the gate stage 10 which, in turn, triggers the other gate stage 10' into a no-signal output condition. This will de-energize the visual alarm means 4'. If the variable being monitored is still abnormal, wherein the field contacts 2 will remain in an abnormal-indicating position, only the visual alarm means 4 will be energized, which will represent an acknowledged alarm indication. If the variable had returned to normal, then the field contacts would be in their normal indicating position thereby effecting the de-energization of the visual alarm means 4.

To ensure that the bistable gate stages are in a given initial state of operation when power is initially turned on, a switch 29 is provided which is ganged for operation with the main power on-off switch, not shown, to be utilized with the annunciator. A suitable inhibit signal generating means 29' is provided for generating an inhibit signal which is fed to the inhibit input terminal 27 of the gate stage 10 to ensure initial operation of the gate stage 10 in a signal-output condition. Since the switch 29 may be of a type which is either continuously open or continuously closed, it is important that only a single signal be generated upon the closure of the switch 29. To this end, a signal generating circuit similar to the circuit used in conjunction with inhibit signal generating means 28 may be used. Thus, when the switch 29 is closed, a single inhibit signal is generated which will inhibit the signal at the "not" input terminal 20 to effect the proper initial operation of the gate circuits.

For flexibility purposes, the annunciator circuit may include a circuit enabling selective lock-in and non-lock-in operation of the annunciator. To this end, a reset means 31 is arranged to be operated only by the movement of the field contacts from their abnormal to their normal-indicating position. The reset means 31 may be a pulse generating circuit connected to the alternate inhibit input terminal 72 of the gate stage 10 through an on-off switch 32. When the switch 32 is opened, then the annunciator circuit operates with the lock-in operation above described. When the switch is closed, the reset means 31 is effective to generate an inhibit signal whenever the field contacts return to their normal indicating position. This

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signal will inhibit the signal being fed to the "not" signal input terminal 20 of the gate stage 10 and thereby triggers the bistable stages into respective opposite output condition where the visual alarm means 4' is de-energized even before the acknowledgement switch 8 has been depressed. If a selective lock-in operation of the annunciator is not desired under any circumstances, then the circuit between reset means 31 and an inhibit terminal 27 may be permanently closed. In such case, the reset means 31 and the associated circuit acts as a means for initially setting the bistable gate stages into the aforementioned desired initial stage states of operation when power is turned on, and the circuit including the switch 29 and the signal generating means 30 may be omitted.

In the interests of maximum reliability, it is desired to construct the bistable gate stages 10 and 10' out of magnetic core elements. The forms of the invention utilizing magnetic core units will now be described.

Refer now to the schematic diagram of FIG. 2 which shows one form of annunciator circuit used with normally open field contacts. For the most part, the bistable gate circuits in this and the other illustrated specific embodiments of the invention are identical, and corresponding elements will be similarly numbered, except perhaps for the addition of a prime (') following the reference number of a particular component. Practically all the components utilized exclusively for monitoring a given variable are contained preferably in a pair of standard identical plug-in units forming the respective "not" gate circuits 10 and 10'. The various signal input and output terminals previously described in connection with the box diagram of FIG. 1 may be the prongs of respective male connectors at the bottom of plug-in units, which connectors fit within female connectors secured to a common chassis or mounting base, not shown.

Where large numbers of variables are being monitored, large numbers of annunciator circuits of the kind illustrated would be mounted together on the same or adjacent panels or chassis as would their visual alarm lamps. As will appear, the use of common buses or circuits permit the use of the same acknowledgement switch and start switch 29. Thus, the chassis may carry or are connected to respective power buses carrying signal voltages supplied by signal generating means 11. Signal generating means 11 in the embodiment being described includes two voltage sources designated as E1 and E2 in the circuits to be described. The buses make connection with the plug-in units through said male and female connectors. Voltage sources E1 and E2 may be any suitable alternating voltage sources providing pulses of sinusoidal or other shape, displaced 180° in phase. The alternating pulses of these sources are coincident but are of opposite phase or polarity, as shown by the exemplary sinusoidal voltage waveforms of FIGS. 3a and 3b. The positive pulses of these voltage sources, as will be explained, perform core driving functions and will be referred to as drive pulses, while the negative pulses thereof perform other functions to be explained. A frequency or positive pulse repetition rate of 100 kc. is desirable since it enables the use of relatively small core units.

The signal input terminal 16 associated with the gate circuit 10 is connected to the power bus associated with main signal source E1 and the signal output terminal 18 of gate circuit 10 is connected via the line 21 to the "not" signal input terminal 20' of the gate circuit 10'. The signal output terminal 18' of gate circuit 10' is connected via line 23 to the "not" signal input plug-in terminal 20 of the gate circuit 10.

Each of the plug-in units 10 or 10' has a magnetic core unit 37 or 37' which comprises a ring core 37a or 37a' made of a material having a generally rectangular shaped hysteresis curve shown in FIG. 4. The opposite saturated states of the core are represented by parallel horizontal curve segments S and S' spaced evenly below and above a zero flux line L1, and the unsaturated conditions

of the core are represented by the steep segment lines US and US' similarly located on opposite sides of a zero magnetomotive force (M.M.F.) or ampere turns line L2. Each core 37a or 37a' has an input winding 37b or 37b' and an output winding 37c or 37c'. Most preferably, the output winding has a substantially greater number of turns than the input winding. For a core having knee points x-2 and x-3 located respectively two and three M.M.F. units from the zero M.M.F. line L1, a step-up turns ratio of one to five was found highly satisfactory. Such a step-up ratio insures reliable operation of the circuit, without requiring external biasing means. In such case the no-signal condition of a core unit would drive its load core only to a point x-2' far below the near knee x-2 of the hysteresis curve.

A resistor 41 or 41' and a rectifier 39 or 39' are connected in series between the upper end of the input winding 37b or 37b' and the "not" control signal input terminal 20 or 20' of the gate circuits 10 or 10'. The bottom end of the input winding 37b or 37b' is connected through an input load resistor 43 or 43' to a terminal 44 or 44' which is connected directly to ground. The junction of the input resistor 43 or 43' with the bottom end of the input winding 37b or 37b' is connected to the inhibit signal input terminal 27 or 27' of the gate circuit 10 or 10'. The inhibit signal input plug-in terminal 27 of the gate circuit 10 is connected to an acknowledgment bus 8' to which the inhibit signal input terminals of all of the plug-in units 10 associated with other variables are connected. Pushbutton switch 8 is connected between the bus 8' and an inhibit signal source, which may be the bus connected to voltage source E2, or a separate source of alternating or direct current voltage. The inhibit terminal 27 is also connected via bus 8' to inhibit signal generating means 30 which may comprise a circuit used in common with all annunciator circuits and including a resistor 50 connected to ground, and a capacitor 52 connected between the junction point of the resistor 50 and the bus 8' and the previously mentioned switch 29 which is ganged for operation with the main on-off power switch, not shown, of the annunciator system. With this specific circuit, the switch 29 is connected to the positive terminal of a source 54 of direct current potential forming part of the previously mentioned operating voltage means 24. The time constant of the capacitor 52 and the resistor 50 is such that when the switch 29 is closed, a pulse of proper polarity, magnitude and duration or phase will appear across the resistor 50 of sufficient duration to inhibit or cancel out the effect of any setting signals fed to the "not" input terminal 20 of the gate circuit 10 from the output of the gate circuit 10'. Rectifier 45 in series with inhibit input terminal 27 is so polarized as to pass only positive pulses generated across the resistor 50. As soon as the capacitor 52 charges up to the voltage output of the source 54, then the pulse disappears from the resistor 50. This type of circuit is commonly called a differentiating circuit.

An inhibit pulse so fed to the inhibit terminal 27 is applied to the bottom end of the input winding 37b of the core unit 37 to inhibit current flow therethrough due to the application of a simultaneously applied pulse to the "not" signal input terminal 20. As above explained, such inhibit action will initiate a signal output condition at the signal output terminal 18, which signal output condition creates a no-signal output condition at the output of the gate circuit 10'.

The output circuit of the gate circuit 10' includes a rectifier 55 and the red visual alarm means 4' which comprises a red lamp R. The white visual alarm means 4 comprising a white lamp W is connected between the positive terminal of a direct current voltage source 54' and ground. The negative terminal of the voltage source 54' is connected through a normally open set of condition-responsive field contacts 2 to ground. Thus, as long

as the field contacts are open, the white lamp W will be extinguished.

The positive terminal of the voltage source 54' is connected through a capacitor 56 to the inhibit input terminal 27' of gate circuit 10'. A capacitor discharge resistor 57 is connected between the end of capacitor 56 nearest the inhibit terminal 27' and ground. By a proper proportioning of the capacitor 56 and resistor 57, a suitable time constant will be provided such that closure of the field contacts 2 will result in the generation of a positive inhibit pulse across the resistor 43', which is of sufficient magnitude and duration to inhibit flow of current in the input winding 37b' due to the input signals fed thereto from the output of the gate circuit 10, much in the same way that closure of the power switch 29 provided an inhibit signal which prevented current flow in the input winding 37b of the core unit 37.

The operation of the magnetic core gate circuits 10 and 10' will now be explained. The signal voltage source E1 connected in series with the output winding 37c of the core unit 37 feeds current through a path including signal input terminal 16, output winding 37c, "not" signal input terminal 20' of the core unit 37', rectifier 39', current-limiting resistor 41', input winding 37b' of the core unit 37', input load resistor 43' and the terminal 44 connected to ground. The rectifier 39' is polarized to block current flow resulting from the negative pulses of the output of the alternating main signal source E1. The positive or drive pulses of the signal source E1 are in a direction to drive the core 37a of the core unit 37 into the reference state of saturation represented by the curve segment S in FIG. 4, if the core is not already in such state, or to maintain such state of saturation if the core is already in this state of saturation. Initially, due to the above mentioned inhibit operation effected by closure of the switch 29 when power is initially turned on, which ensures a no-signal input condition to the core unit 37, the core 37 will be continuously initially maintained in the reference state of saturation. In such case, the output winding acts like a practically zero impedance and large positive signal pulsations I_o-1 (FIG. 3) flow as a result of the drive pulses from signal source E1 in the input winding 37a' of the core unit 37'. Gate circuit 10 is thus normally open. The impedance in the aforementioned current path is such that there is sufficient energy in each relatively large current pulsation passing through the output winding 37c of the core unit 37 to the input winding 37a' of the core unit 37' that the core of the latter unit will be driven from point x-1 of its reference state of saturation, represented by the curved segment S in FIG. 4, to the knee point x-3 of its opposite state of saturation represented by the curved segment S'. When the current pulsation ends, the state of operation of the core 37a' is represented by point x-4. The positive current pulsations driving the input winding 37b' are the positive drive pulses from the main signal source E1.

The output winding 37c' of the core unit 37' is in a loop circuit including main voltage source E2, rectifier 39, resistor 41, input winding 37b of the core unit 37, resistor 43 and the field contacts 2. The rectifier 39 is arranged to pass the positive pulses of signal source E2, which occur one-half cycle after the positive drive pulses of signal source E1 and these pulses return the core 37' to the reference state of saturation S. When the states of saturation of a core unit are reversed, its output winding acts like a high impedance so that relatively small pulsations like those shown in FIG. 3f appear in the output winding 37'. This represents a no-signal output condition when the gate circuit 10' is closed. The negative pulses of signal source E2 inhibit or cancel out the effect of the pulses induced into the output winding 37c' of the core unit 37' by the driving of the core 37a' from the reference state of saturation S to the second or opposite state of

saturation S' (FIG. 4) by the drive pulses in input winding 37b'.

When an abnormal condition of the variable being monitored exists, field contacts 2 close to connect the direct current voltage source to the capacitor-resistance network 56—57 which generates an inhibit pulse which prevents the setting of core 37' to saturation state S' . The next positive pulse fed to the output winding 37c' will thus maintain the state of saturation of core 37a' thus producing a large positive output pulse which sets the first core 37a to state S' and creates a no-signal output condition in the output winding thereof. The output state of core 37' energizes the red lamp R and horn 9 through a rectifier 55'. Other rectifiers 55'', 55''', etc., extend from the output circuits of the gate circuits associated with the other annunciator circuits, not shown, so that if any variable in the group being monitored becomes abnormal, the horn 9 common to all of the annunciator circuits will be sounded. Closure of field contacts 2 also energizes white light W since voltage source 54' is connected thereto through field contacts 2.

Although the small current pulsations I_{0-1} passing through the input winding 37b' of the second core unit 37' are in a direction tending to drive the second core 37a' from its operating point $x-1$ on the reference state of saturation curved segment S toward the opposite state of saturation, the small current passing through a small number of turns in the input winding 37b' will be insufficient to reach anywhere near even the nearest knee point $x-2$. The small current pulsations passing through the large number of turns in the output winding 37c, however, can reset the core 37a so that the signal sources E1 and E2 will continue to set and reset the core 37a during alternate half cycles until the acknowledgement pushbutton 8 is momentarily depressed. Waveforms e and f in FIG. 3 illustrate the current flow in the output windings 37c' and 37c of core units 37' and 37 during the initial alarm condition of operation of the annunciator circuit.

If the above-mentioned small current pulsations I_{0-1} were to drive the core 37a' into its unsaturated state, yet to an insufficient degree to completely reverse the state of saturation of the core, difficulty would probably be encountered because the core would then be set to another state of saturation represented by the horizontal dotted line curved segment S-1. During the next half cycle, when the drive pulse of the main signal source E2 would drive the core to the reference state of saturation S, a current pulsation would be generated which would have insufficient energy to trigger the core unit 37a. An inversion of the operations of the two gate circuits 10 and 10' would result, which would completely destroy the proper operation of the annunciator circuit. So, it is important that the relatively small or no-signal positive current pulsations not drive the core through whose input winding it passes beyond the nearest knee point $x-2$.

It should be noted that the re-opening of the field contacts 2 before acknowledgement will not affect the states of operation of the gate circuits 10 and 10', so that a momentary alarm condition before acknowledgement will be locked in and will be indicated by an energized red lamp only and the sounding of the horn 9.

When the operator momentarily depresses the acknowledgement pushbutton 8 used in common with all of the annunciator circuits, an inhibit signal comprising a positive pulsation from voltage source E2 which is in phase with the positive pulse fed to the "not" signal input terminal 20 of the gate circuit 10 is fed to the inhibit input terminal 27 thereof to inhibit the effect of the latter pulse. When current flow is inhibited in the input winding 37b, the core 37a is not driven from its reference state of saturation S to its opposite state of saturation S' , so that the next occurring resetting pulsation fed to the output winding 37c from the main signal source E1 will be in a direction to merely maintain the state of saturation of the

core 37a in the state S. As above explained, in such case the output winding 37c will act as a substantially zero impedance, so that a relatively large current pulsation will flow at such time through the rectifier 39', current-limiting resistor 41', input winding 37b', input resistor 43' and the field contacts 2 extending to ground. This large current pulsation represents a signal output condition of the first gate circuit 10 which is now open, and are represented by a pulsation $I_{0-1''}$ shown in FIG. 3h. This large current flowing through the input winding 37b' will set the second core 37a' from its reference state of saturation S to its opposite state of saturation S' in the same way that the large current pulsations from the output circuit of the gate circuit 10' set the first core 37a from its reference state of saturation S to its opposite state of saturation S' . One-half cycle following each such setting of the magnetic core 37a' to its opposite state of saturation, a positive drive pulse of the main signal source E2 causes a resetting current to flow in the large number of turns of the output winding 37c', a resetting current of relatively small magnitude because of the large impedance offered by the large number of turns of the output winding 37c', so that the current output of the core unit 37' may then be represented by a pulsation of the waveform $I_{0-2''}$ shown in FIG. 3g. The gate 10' is now closed. This small current flowing through the small number of turns in the input winding 37b of the first core 37a will be insufficient to drive the core into its unsaturated state, and certainly to its opposite state of saturation S' , so that the saturation of the core 37a is maintained by the active pulses generated by the main signal source E1. The voltage sources E1 and E2 will continue to set and reset the second core 37a', resulting in a maintenance of a no-signal output condition thereat, and signal source E1 continues to maintain the state of saturation of the core 37a resulting in a signal output condition thereat.

Since relatively little output appears at the signal output terminal 18' of the second core unit 37', insufficient power is available to operate the red lamp R even though the field contacts 2 are still closed. Thus, in the acknowledged state of operation of the annunciator unit, while an abnormal variable still exists the white lamp W will burn brightly and the red lamp R will be extinguished.

As core 37a is triggered back and forth between the opposite states of saturation by the drive current pulses from signal sources E1 and E2 flowing respectively through input and output windings 37b' and 37c' voltage pulses are respectively induced in the windings 37c' and 37b' which are polarized to produce current pulses which can pass through rectifiers 39 and 39'. Flow of such current pulses could adversely affect the operation of the circuit. The negative pulses of the main signal source E1 or E2 which is connected to the winding into which the unwanted voltage pulse is induced will oppose and cancel out the effect of these unwanted induced voltage pulses.

When the variable being monitored returns to normal, the field contacts 2 will open thereby disconnecting the white lamp W from the voltage source 54'.

The invention of FIG. 2 just discussed locks-in momentary alarm conditions. In the interest of flexibility, however, it may be desirable to sell an annunciator circuit which can selectively give a lock-in operation or automatic reset before acknowledgement without any appreciable increase in cost or complexity of the equipment. Such a system is shown in FIG. 6 which differs from the circuit just described in numerous other respects. For example, as will appear, the white lamp W is energized from a 60-cycle, 120 volt power source P1, such as is commonly found in public power systems, so that the direct current voltage source to be described which is used to operate the red lights R need not be designed to carry the extra current carried by all of the white lamps of the annunciator system. Since the inhibit signal generating circuit is controlled from the energization circuit

of the white light, a modified signal generating circuit 28' is needed which produces only a single operative positive pulse from a source of continuous alternating current.

The red light circuit also differs from that illustrated in FIG. 2 in that it operates through a transistor amplifier rather than being connected directly to the output of the gate circuit 10'. The gate circuits 10 and 10' used in the embodiment of FIG. 6 are identical in construction and operation to that just described in connection with FIG. 2, so that a further explanation of its construction and operation will not be given thereof.

In the circuit of FIG. 6, the white visual alarm circuit 4 includes a loop circuit comprising the source P1 of 60 cycle, 120 volt, voltage, the white alarm lamp W and a parallel circuit, one branch of which includes series connected resistors 60 and 62 and the other branch of which includes normally-open field contacts 2 and resistor 64. One end each of the voltage source P1 and the parallel circuit are grounded. The value of the resistances 60 and 62 are such that when the field contacts 2 in the other branch are open, insufficient current flows through the alarm lamp W to light the same brightly. The white lamp W, instead, is lit dimly. This corresponds to what will be referred to as de-energized condition of the lamp. When the branch containing the field contacts 2 is closed, resistors 60 and 62 are shunted by resistor 64 which is relatively low resistance to enable a relatively large current to flow through the lamp W to light it brightly.

A reset line 66 extends from the juncture of the resistors 60 and 62 to a two-position manual switch 68 which is open when lock-in operation of the annunciator circuit is desired and which is closed when automatic reset of the circuit is desired. The switch 68 is connected to an isolating rectifier 70 polarized to pass positive voltage pulses. The rectifier in turn, is connected to an alternate inhibit signal input terminal 72 leading to the juncture between the resistor 43 and the bottom terminal of the input winding 37b of the core unit 37. With this circuit arrangement, any positive reset pulses fed to the core unit through the rectifier 70 from the reset circuit are isolated from the common acknowledgement bus 8' associated with all of the annunciator circuits of the system. Thus, it can be seen, that when the switch 68 is closed, and the field contacts 2 are in their normally-open position, positive voltage pulses of appreciable magnitude originating in the 60-cycle power source P1 will be continuously fed to the alternate inhibit input terminal 72 continuously to inhibit the input circuit to the core unit 37, thereby ensuring a signal-output condition of the gate circuit 10. The relative values of the resistors 60 and 62 are, of course, such that the amplitude of the latter positive pulses will be sufficient to obtain the desired inhibit action.

If desired, the switch 68 can be omitted so that the reset circuit is continuously a part of the annunciator circuit. In such case, the reset circuit will be effective initially to set the gate circuits in a proper initial state of operation when the power is initially turned on, thereby making unnecessary the previously described switch 29 and inhibit generating circuit including the capacitor 52 and the resistor 50, which is also shown in the preferred circuit of FIG. 6.

When the field contacts 2 close due to an abnormal condition of operation of the variable being monitored, the reset circuit becomes ineffective because the amplitude of the pulses appearing on the reset line 66 are greatly reduced and are of insufficient amplitude to trigger or inhibit the setting of the gate circuit 10 by the pulses fed to the "not" signal input terminal 20 of the gate circuit 10. As long as the gate circuit 10' is in a no-signal output condition, the small amplitude pulses fed to the input of the gate circuit 10 from the output of the gate circuit 10' will be insufficient to trigger or set the gate circuit 10 in any event. The initial triggering of the gate circuit 10' to a signal output condition is effected by means

of the inhibit signal generating circuit 28' now to be described.

The inhibit signal generating circuit 28' is operated from the 60 cycle voltage source P1 through the energization circuit of the white lamp W. As previously indicated, it is important that closure of the field contacts 2 results in the feeding of only a single inhibit pulse to the input terminal 27' of the gate circuit 10'. To this end, a rectifier 73 polarized to pass positive pulses appearing across the resistor 64 is connected to the ungrounded end of the resistor 64 and to a grounded resistor 75. A capacitor 77 extends from the ungrounded side of resistor 75 to the ungrounded side of a second grounded resistor 78. An inhibit line 79 extends from the ungrounded side of resistor 78 to the inhibit input terminal 27' of the gate circuit 10'. The first positive voltage pulse appearing across the resistor 64 charges the capacitor 77 to the full magnitude of such pulse. During the charging of the capacitor 77, a positive inhibit pulse is generated by the charging current across the resistor 78 which, when applied to the inhibit input terminal 27' of the gate circuit 10', will inhibit or render ineffective a large positive pulsation fed to the "not" input terminal 20' of the gate circuit 10'. This triggers the gate circuit 10' to a signal output condition for reasons apparent from the description of FIG. 2. During the succeeding half cycle, during which the rectifier 73 blocks the negative pulsation appearing across the resistor 64, the capacitor 77 will discharge a small amount due to the relatively long time constant provided by resistor 75. The capacitor will be recharged to the full magnitude of the output of the positive voltage appearing across resistor 64 during the next occurrence of a positive pulse, but the small current flow incident to the small charging current 77 is insufficient to produce a voltage pulse of sufficient magnitude to have any inhibit action on the gate circuit 10'. If such pulses were effective to inhibit the gate circuit 10', then depression of the acknowledgement switch 8 while the field contacts remain closed would not effect a reversal in the states of operation of the gate circuits. Exemplary values for the inhibit signal generating circuit 28' are as follows:

Resistor 75	-----ohms--	4700
Resistor 78	-----do----	500
Capacitor 77	-----microfarads--	10

If the power output of the gate circuit 10' should be insufficient to light brightly the red lamp R of the red visual alarm circuit 4', then a current or power amplifier may be inserted between the output of the gate circuit 10' and the red lamp R.

The red visual alarm circuit comprises an isolating rectifier 80 connected to the signal output terminal 18' of the gate circuit 10' so as to pass only positive pulses. The rectifier 80 is connected to a grounded filter capacitor 82 and a resistor 84 is connected between the ungrounded side of capacitor 82 and the ungrounded end of a grounded resistor 86. The ungrounded end of the resistor 86 is connected to the base electrode 88 of a conventional transistor 90 of the so-called NPN type. The transistor has a collector electrode 92 which is connected through the red lamp R to the positive terminal of a direct current voltage source 54 whose negative terminal is grounded. The transistor has an emitter electrode 94 which is connected to ground through a resistor 96. The transistor 90 acts like a relatively high impedance to current flow in the energizing circuit of the lamp R when the base electrode 88 is at ground or a negative potential. When positive pulses of sufficient magnitude are applied to the base electrode 88, the transistor acts like a relatively low impedance enabling substantially high current flow through the red lamp R so as to light the same brightly. Accordingly, it can be seen that when the field contacts initially close indicating the abnormal condition of a variable, the initially no-signal output condition of the gate circuit 10' ensured by the previously described reset

circuit or the circuit operated by the closure of the contacts 29 when the reset circuit is opened, is changed to a signal-output condition as an inhibit pulse is generated by the inhibit signal generating circuit 28'. High amplitude positive pulsations then appear at the signal output terminal 18' of the gate circuit 10', which positive pulsations pass through the rectifier 80 and charge the capacitor 82. The resistors 84 and 86 offer a discharge path for the filter capacitor 82 when the gate circuit 10' is closed, which maintains positive potential on the base electrode. Thus, while the gate 10' is open, the positive pulses appearing across the resistor 86 generate a high current condition in the output of the transistor circuit including the red lamp R to light the same brightly. At the same time, of course, the white lamp W will be energized as long as the field contacts remain closed.

When the switch 68 in the reset circuit is closed, the momentary closure of the field contacts 2 will result only in the momentary energization of the red lamp R since opening of the field contacts will immediately render effective the reset circuit which inhibits the signal pulses fed to the "not" input terminal 20 of the gate circuit 10, to return the latter gate circuit to a signal-output condition ensuring a no-signal output or closed gate condition of the gate circuit 10'. However, when the switch 68 is open, even momentary closure of the contacts 2 will result in a steady and maintained brightly lit red lamp R until the acknowledgement switch 8 is momentarily depressed. If the field contacts 2 open after acknowledgement, the white light W will of course be extinguished.

Refer now to the circuit shown in FIG. 7 which operates with normally-closed rather than normally-open field contacts. The circuit of FIG. 7 is identical to the circuit of FIG. 6 except for the circuit which generates various inhibit pulses fed to the inhibit input terminals of the gate circuits 10 and 10'. The sequence of operation of the alarm lamps R and W is also identical to that of the embodiment of FIG. 6. One important requirement, however, of the circuit of FIG. 7 using normally-closed field contacts which is not present in the circuit of FIG. 6 using normally-open field contacts is that the problem of power loss and overheating of the equipment is present where normally-closed field contacts are involved. The present invention solves this problem in a highly unique and advantageous manner. In FIG. 7, the energization circuit for the white lamp W includes a grounded 60 cycle power source P1, the primary winding of a transformer 100 and the filament of the white lamp W connected to ground. The secondary winding of the transformer 100 is in a circuit extending from the ungrounded side of the 60 cycle power source P1 and including normally-closed field contacts 2', the secondary winding of the transformer 100 and a grounded resistor 102. The connections to the primary and secondary windings of transformer 100 are such that, when the field contacts 2' are closed thereby connecting the secondary winding of the transformer 100 to the power source P1, the voltage induced into the transformer primary from the transformer secondary adds to the voltage applied thereto by the power source P1. The transformer primary then acts like a high reactive impedance. Accordingly, there is only a small flow of current through the white lamp W. A reset line 66' is connected to the juncture between the resistor 102 and the secondary transformer 100 and the reset line 66' extends through the switch 68, the rectifier 70 and alternate inhibit input terminal 72 to form a reset circuit like that described in connection with the embodiment of FIG. 6. The relatively small voltage appearing across the resistor 102 when the field contacts are closed is sufficient to effect an inhibit action on the gate circuit 10, thereby ensuring a signal output condition of the gate circuit 10. When the variable being monitored goes abnormal and the normally-closed field contacts 2' accordingly open, the transformer primary acts like a relatively low impedance resulting in the application of a relatively

high voltage across the white alarm lamp W to light the same brightly. The inhibit signal generating circuit 28' is coupled across the alarm lamp W and is identical to and operates in the same way as the inhibit signal generating circuit 28' previously described in connection with the embodiment of FIG. 6.

It should be readily understood that the apparently one light flashing annunciator circuit may be obtained by the simple expedient of including some means for pulsing the energization circuit to the alarm lamp R and mounting the lamps R and W behind a common translucent panel for providing an overall indication of only a single color. In such case, it will be noted that the conditions of normal and abnormal and acknowledged abnormal operation will be respectively indicated by de-energized light indications, a flashing bright indication and a steady indication, respectively. Such a circuit is shown in FIG. 8 wherein the common translucent panel is identified by reference numeral 105. The control circuit for the lamp R which is now preferably a white lamp is the same as that previously described except that the load terminals of a PNP type transistor 107 is connected in the circuit branch between the lamp R and the positive terminal of direct current voltage source 54. The output impedance of the transistor 107 is driven between high and low limits at the desired slow flashing rate to flash the lamp R when the transistor 90 receives energizing high amplitude signals from gate circuit 10'. To this end, a suitable oscillator such as a core multivibrator unit 109 is connected between the base electrode of the transistor 107 and ground.

It should be understood that numerous other modifications may be made of the preferred form of the invention above described, without deviating from the broader aspects of the invention.

As an illustrative but not limiting example, in the broad general aspect of the invention, the magnetic core control circuits of the invention need not have a common reference or ground point for the various cascaded magnetic core control circuits illustrated, and the signal source need not be separate sources each having a pair of output terminals, one grounded and the other not, across which a voltage of opposite phase to the voltage across the output terminals of the other signal source appear. Rather, the voltage sources, symbolically shown by the lettered boxes, could be a single source with only two output terminals across which an alternating voltage appears. Each terminal can be said to provide an alternating voltage with respect to a theoretical or phantom ground which is opposite to the voltage between the opposite terminal and phantom ground.

I claim:

1. An annunciator circuit including condition-responsive means having normal and abnormal indicating conditions when the variable being monitored is respectively normal and abnormal, visual alarm means for respectively indicating the normal and abnormal conditions of the variable, bistable control means for operating said visual alarm means to said abnormal indicating condition and having opposite stable states of operation and adapted to be triggered to one of said stable states upon receiving a pulsation of a given polarity and magnitude, said visual alarm means being operated to said alarm indicating conditions when said bistable control means is in said one stable state of operation, a source of pulses having a magnitude which triggers said bistable control means into said one stable state of operation, means forming a circuit with said condition-responsive means and said source of pulses wherein pulses of proper polarity and magnitude are provided across a pair of terminals when said condition-responsive means is in its abnormal indicating position and wherein pulses which are insufficient to operate said control means are provided when said condition-responsive means is in its normal indicating position, pulse-forming means coupled across said terminals providing

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only a single triggering pulse from a series of said pulses fed from said source, and means connecting said triggering pulse to said control means to trigger the same into said one stable state which operates said visual alarm means to its abnormal indicating condition.

2. An annunciator circuit including condition-responsive means having normal and abnormal indicating conditions when the variable being monitored is respectively normal and abnormal, visual alarm means for respectively indicating the normal and abnormal conditions of the variable, bistable control means for operating said visual alarm means to said abnormal indicating condition and having opposite stable states of operation and adapted to be triggered to one of said stable states upon receiving a pulsation of a given polarity and magnitude, said visual alarm means being operated to said alarm indicating condition when said bistable control means is in said one stable state of operation, a source of pulses having a magnitude which triggers said bistable control means into said one stable state of operation, means forming a circuit with said condition-responsive means and said source of pulses wherein pulses of proper polarity and magnitude are provided across a pair of terminals when said condition-responsive means is in its abnormal indicating position and wherein pulses which are insufficient to operate said control means are provided when said condition-responsive means is in its normal indicating position, pulse-forming means coupled across said terminals providing only a single triggering pulse from a series of said pulses fed from said source, said pulse-forming means including rectifier means arranged to pass the triggering pulses and capacitor-discharging resistor means connected in series across said terminals, and capacitor and output resistor means connected in series across said capacitor-discharging resistor means and forming relatively short time constant circuit where the capacitor means charges substantially instantaneously the magnitude of the applied triggering pulses, the discharge circuit for the capacitor including said capacitor-discharging resistor means constituting a relatively long time constant circuit, whereby only a single appreciable triggering pulse appears across the output resistor means when a series of said pulses is fed to said terminals, and means connecting the signal appearing across said output resistor means to said control means to trigger the same into said one stable state which operates said visual alarm means to its abnormal indicating condition.

3. In an annunciator circuit including condition-responsive means having normal and abnormal conditions when the variable being monitored is respectively normal and abnormal, and visual alarm means for respectively indicating the normal and abnormal conditions of the variable, the improvement comprising control means for operating said visual alarm means comprising a first and a second gate circuit each including a main signal input terminal, a "not" control signal input terminal, a signal output terminal, and an inhibit input terminal, main signal voltage means connected to said main signal input terminals of said gate circuits, said gate circuits further including means for providing a signal output condition if a no-signal condition exists at the associated control signal input terminal and a no-signal output condition exists at the associated signal output terminal if an uninhibited signal condition exists at the associated "not" signal input terminal, means connecting the signal output terminal of each gate circuit to the "not" signal input terminal of the other gate circuit, whereby the output conditions of the gate circuits are always opposite, said visual alarm means being connected to the signal output terminal of one of said gate circuits and arranged to provide a normal indicating condition when the gate circuit has one of said signal output conditions and to provide an abnormal indicating condition when the gate circuit is in the other signal output condition, said gate circuits having a definite predetermined initial state of operation

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wherein the output condition of said one gate circuit is such that said visual alarm means is in its normal indicating condition, inhibit pulse generating means connected to the inhibit input terminal of the gate circuit which initially has a no-signal output condition, means connecting said condition-responsive means to said inhibit pulse generating means whereby the latter generates a single inhibit pulse capable of inhibiting the effect of a signal fed to the "not" signal input terminal of said last-mentioned gate circuit when said condition-responsive means is operated to its abnormal indicating condition, to trigger the gate circuit involved into a signal-output condition and effect the operation of said visual alarm means to its abnormal indicating condition, reset circuit means including a continuous source of inhibit pulses whose presence is independent of the output conditions of the gate circuits and means responsive to the operation of said condition-responsive means to its normal indicating position for coupling said inhibit pulses to an output of said reset circuit means, manual selector switch means for selectively coupling and uncoupling said output of said reset means to the inhibit input terminal of the gate circuit which is initially in a signal output condition, whereby a signal output condition of the latter gate circuit may be re-established when the condition-responsive means returns to its normal indicating condition when automatic reset is desired, and the output condition of the latter gate circuit is unaffected during the latter operation of said condition responsive means when lock-in operation of only momentary operation of said condition-responsive means to its abnormal indicating condition is desired, manually operable acknowledgement means, and means responsive to operation of said manually operable acknowledgement means for feeding an inhibit pulse to the inhibit input terminal of said last-mentioned gate circuit to re-establish the signal output condition thereof to change the indication of said visual alarm means when the condition-responsive means remains in its abnormal indicating condition.

4. In an annunciator circuit including condition-responsive means having normal and abnormal conditions when the variable being monitored is respectively normal and abnormal, and visual alarm means for respectively indicating the normal and abnormal conditions of the variable, the improvement comprising control means for operating said visual alarm means comprising a first and a second gate circuit each including a main signal input terminal, a "not" control signal input terminal, a signal output terminal, and an inhibit input terminal, main signal voltage means connected to said main signal input terminals of said gate circuits, said gate circuits further including means for providing a signal output condition if a no-signal condition exists at the associated control signal input terminal and a no-signal output condition exists at the associated signal output terminal if an uninhibited signal condition exists at the associated "not" signal input terminal, means connecting the signal output terminal of each gate circuit to the "not" signal input terminal of the other gate circuit, whereby the output conditions of the gate circuits are always opposite, said visual alarm means being connected to the signal output terminal of one of said gate circuits and arranged to provide a normal indicating condition when the gate circuit has one of said signal output conditions and to provide an abnormal indicating condition when the gate circuit is in the other signal output condition, said gate circuits having a definite predetermined initial state of operation wherein the output condition of said one gate circuit is such that said visual alarm means is in its normal indicating condition, inhibit pulse generating means connected to the inhibit input terminal of the gate circuit which initially has a no-signal output condition, means connecting said condition-responsive means to said inhibit pulse generating means whereby the latter generates a single inhibit pulse capable of inhibiting the effect

of a signal fed to the "not" signal input terminal of said last-mentioned gate circuit when said condition-responsive means is operated to its abnormal indicating condition, to trigger the gate circuit involved into a signal-output condition and effect the operation of said visual alarm means to its abnormal indicating condition, reset circuit means including a continuous source of inhibit pulses whose presence is independent of the output conditions of the gate circuits and means responsive to the operation of said condition-responsive means to its normal indicating position for coupling said inhibit pulses to an output of said reset circuit means, means coupling said output of said reset means to the inhibit input terminal of the gate circuit which is initially in a signal output condition, whereby a signal output condition of the latter gate circuit may be re-established when the condition-responsive means returns to its normal indicating condition, manually operable acknowledgement means, and means responsive to operation of said manually operable acknowledgement means for feeding an inhibit pulse to the inhibit input terminal of said last-mentioned gate circuit to re-establish the signal output condition thereof to change the indication of said visual alarm means when the condition-responsive means remains in its abnormal indicating condition.

5. The annunciator circuit as stated in claim 4 wherein there is provided a second visual alarm means, a source of energizing voltage for said second visual alarm means comprising a source of voltage pulses, and first and second circuit branches connected in parallel across said sources of pulses, said second visual alarm means being connected to receive current flowing at least through one of said branch circuits, said condition-responsive means comprising field contacts located in one of said circuit branches and, when operated to its alarm-indicating condition, causing energizing current to flow through said second visual alarm means for energizing the same and when in its normal indicating condition reducing the flow of current flowing through said second visual alarm means to a value insufficient to energize the second visual alarm means.

6. The annunciator circuit as stated in claim 4 wherein there is provided a second visual alarm means, a source of energizing voltage for said second visual alarm means comprising a source of voltage pulses, and first and second circuit branches connected in parallel across said source of pulses, said second visual alarm means being connected to receive current flowing at least through one of said branch circuits, said condition-responsive means comprising field contacts located in one of said circuit branches and, when operated to its alarm-indicating condition, causing energizing current to flow through said second visual alarm means for energizing the same, and, when in its normal indicating condition, reducing the flow of current flowing through said second visual alarm means to a value insufficient to energize the second visual alarm means, said inhibit pulse generating means connected to one of said circuit branches and arranged to receive operating potential from said source of pulses when the condition-responsive means is in its abnormal indicating condition, and said reset means being in the other of said circuit branches and arranged to receive operating potential when said condition-responsive means is in its normal indicating condition.

7. The annunciator circuit as stated in claim 4 wherein there is provided a source of voltage pulses, and first and second circuit branches connected in parallel across said source of pulses, said condition-responsive means comprising field contacts located in one of said circuit branches, said inhibit pulse generating means connected to one of said circuit branches and arranged to receive operating potential from said source of pulses when the condition-responsive means is in its abnormal indicating condition, and said reset means being in the other of said circuit branches and arranged to receive operating poten-

tial when said condition-responsive means is in its normal indicating condition.

8. In an annunciator circuit including condition-responsive field contacts which are closed when the variable being monitored is normal and are opened when the variable is abnormal, and visual alarm means which, when energized, provide an alarm indication, the improvement comprising an energization circuit for said visual alarm means including a source of alternating current energizing voltage, and a transformer having mutually magnetically coupled primary and secondary windings, said secondary winding and said visual alarm means being connected in series across said source of energizing voltage, and said primary winding and field contacts being connected in series across said source of voltage so as to form a circuit branch in parallel with the series connected secondary winding and visual alarm means, the connections to said primary and secondary windings being such that the voltage induced into said secondary winding opposes the flow of current therethrough from said source of voltage, whereby closure of said field contacts makes the transformer primary and secondary windings appear as high reactances, the current then flowing through said visual alarm means being insufficient to operate the same to its alarm indication and the impedance of said primary winding when said field contacts are open being sufficient to provide an energizing current through said visual alarm means.

9. An annunciator comprising condition responsive switch means having normal and abnormal conditions of operation when an associated variable is respectively normal and abnormal, a pair of static elements forming a bistable control circuit having at least one output and two signal inputs and being triggered into a first stable condition providing a first output condition at said output when a first given signal is fed to a first of said inputs and being triggered into a second stable condition providing a second output condition at said output when a second given signal is fed to a second of said inputs, a means independent of the output condition of the bistable control circuit for coupling continuous reset pulses to said first input, each pulse being capable of operating said bistable circuit in said first stable condition when the variable is normal and responsive to the abnormal condition of said condition responsive switch means for feeding said second given signal to said second input and removing said reset pulses from said first input to trip the bistable circuit into said second stable condition when the variable becomes abnormal, and alarm signalling means coupled to said output, said alarm signalling means being energized when said output has said second output condition and being de-energized when said output has said first output condition.

10. An annunciator comprising condition responsive switch means having normal and abnormal conditions of operation when an associated variable is respectively normal and abnormal, a pair of static elements forming a bistable control circuit having at least one output and two signal inputs and being triggered into a first stable condition providing a first output condition at said output when a first given signal is fed to a first one of said inputs and being triggered into a second stable condition providing a second output condition at said output when a second given signal is fed to a second of said inputs, a source of alternating current including current-pulsations of a given polarity each constituting said second given signal, means for passing only the first of said current pulsations received to said second input, means connecting said source of alternating current to said last-mentioned means when said condition-responsive switch means is in its abnormal condition, and manually operable switch means for momentarily feeding said first given signal to said first input to reset said bistable circuit.

11. An annunciator comprising condition responsive switch means having normal and abnormal conditions of

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operation when an associated variable is respectively normal and abnormal, a bistable control circuit having input terminal means and output terminal means and being triggered into a first stable condition providing a first output condition at said output terminal means when a first given signal is fed to said input terminal means and being triggered into a second stable condition providing a second output condition at said output when a second given signal is fed to said input terminal means, a source of continuous reset signals whose presence is independent of the output condition of the bistable control circuit, each constituting said first given signal, manually operable switch means having a first lock-in condition which renders said reset signals ineffective on said circuit and a second automatic reset condition where said reset signals are effective thereon, means responsive to the normal condition of said condition responsive switch when said reset signals are effective on said bistable circuit by feeding said reset signals to said input terminal means to operate said bistable circuit in said first stable condition when the variable is normal, means responsive to the abnormal condition of said condition responsive switch means for feeding said second given signal to said input terminal means independently of the position of said manually operable switch means and removing said reset signals from said input terminal means when the manually operable switch means is in said automatic reset condition to trip the bistable circuit into said second stable condition when the variable becomes abnormal, second manually operable switch means for momentarily feeding said first given signal to said input terminal means to reset the bistable circuit to said first stable condition when the variable has returned to normal, and alarm signalling means coupled to said output terminal means, said alarm signalling means being energized when said output terminal means has said second output condition and being de-energized when said output terminal means has said first output condition.

12. An annunciator comprising condition responsive means having normal and abnormal conditions of operation when an associated variable is respectively normal and abnormal, a bistable control circuit having input terminal means and output terminal means and being triggered into a first stable condition providing a first output condition at said output terminal means when a first given signal pulse is fed to said input terminal means and being triggered into a second stable condition providing a second output condition at said output terminal means when a second signal is fed to said input terminal means, a source of continuous reset pulses

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whose presence is independent of the output condition of the bistable control circuit, each constituting said first given pulse, each pulse constituting said first given pulse to trigger said bistable control circuit into said first condition, means responsive to the abnormal condition of said condition responsive means for feeding said second given signal to said input terminal means of said bistable control circuit to put the bistable circuit into said second stable condition when the variable becomes abnormal, and means responsive to the return of said condition responsive means to said normal condition of operation by coupling said continuous reset pulses each constituting said first given signal pulse to said input terminal means of said bistable control circuit, then to operate the bistable control circuit in said first stable condition and responsive to the abnormal condition of operation of said condition responsive means by rendering said reset pulses ineffective on said bistable control circuit.

13. The annunciator of claim 12 wherein said means for coupling continuous reset pulses to said input terminal means couples said reset pulses to said input terminal means as long as said condition responsive means remains in said normal condition of operation.

14. The annunciator of claim 12 wherein said source of continuous reset pulses are continuously connected to said input terminal means, and said means responsive to the condition responsive means includes signal modifying means for modifying the signal reaching said input terminal means from said source of reset pulses when said variable responsive means is in said normal condition of operation to render the reset pulses ineffective on the bistable control circuit.

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**UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION**

Patent No. 3,112,475

November 26, 1963

Sergio Alessio

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the heading to the drawings, Sheets 1 and 2, for
"3,111,475" read -- 3,112,475 --.

Signed and sealed this 19th day of January 1965.

(SEAL)

Attest:

ERNEST W. SWIDER
Attesting Officer

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Commissioner of Patents