April 7, 1964 S. D. SILLIMAN ETAL 3,128,456

ANNUNCIATORS WITH MANUAL RESET

Filed Jan. 22, 1957 2 Sheets-Sheet 1

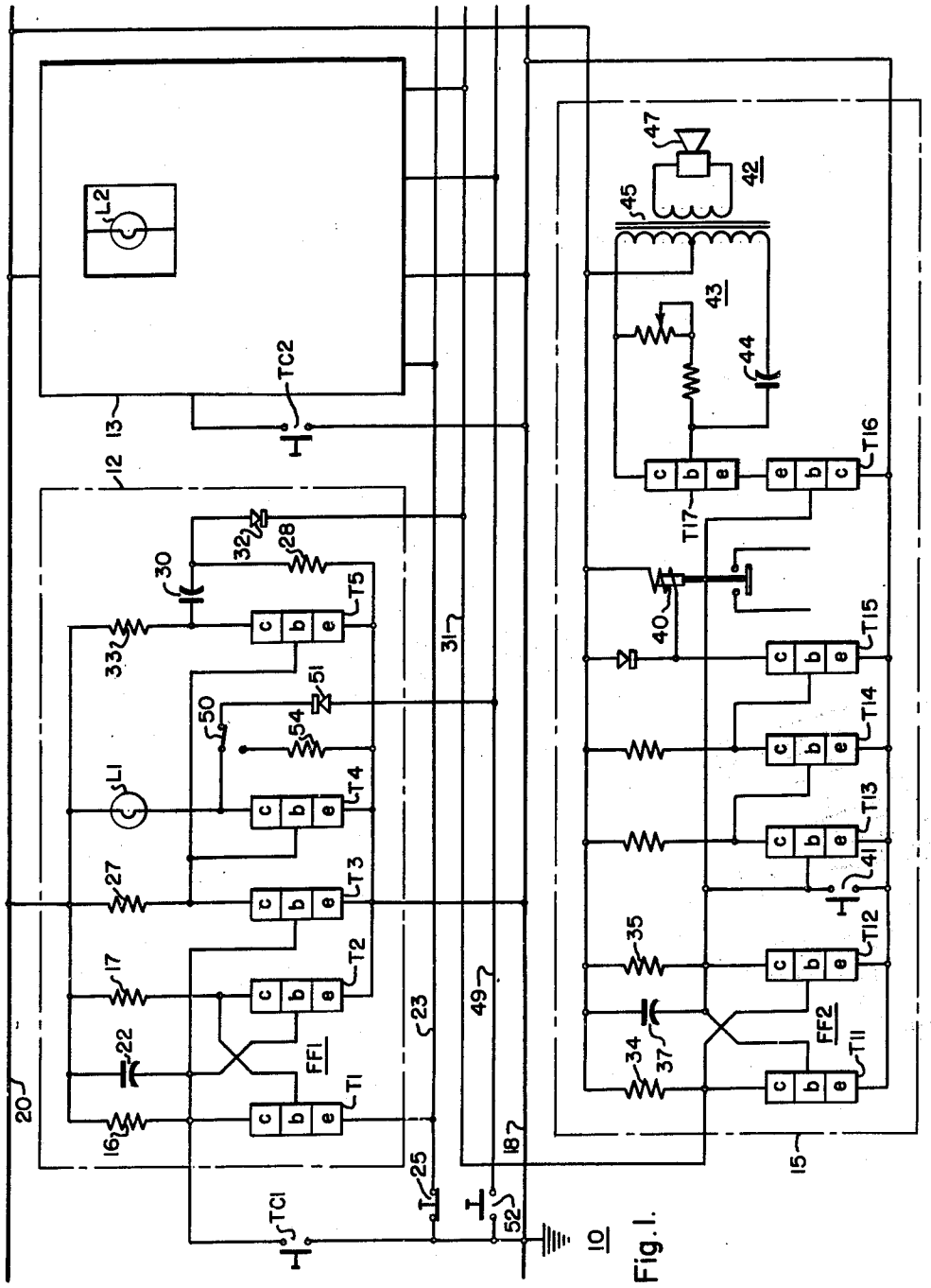

Fig. 1.

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ANNUNCIATORS WITH MANUAL RESET

Filed Jan. 22, 1957 2 Sheets-Sheet 2

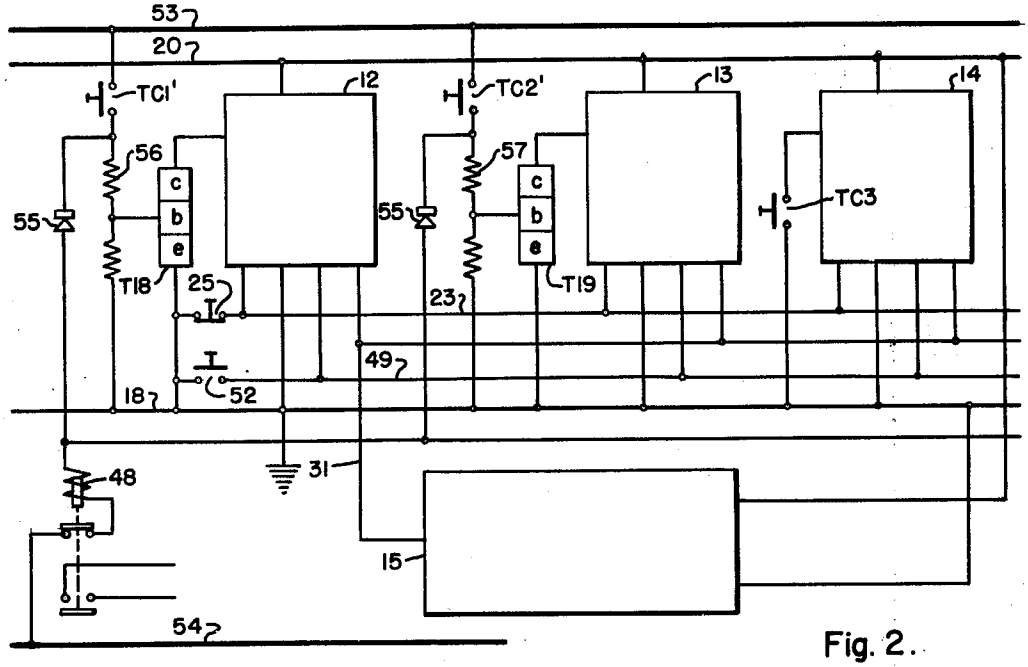

Fig. 2.

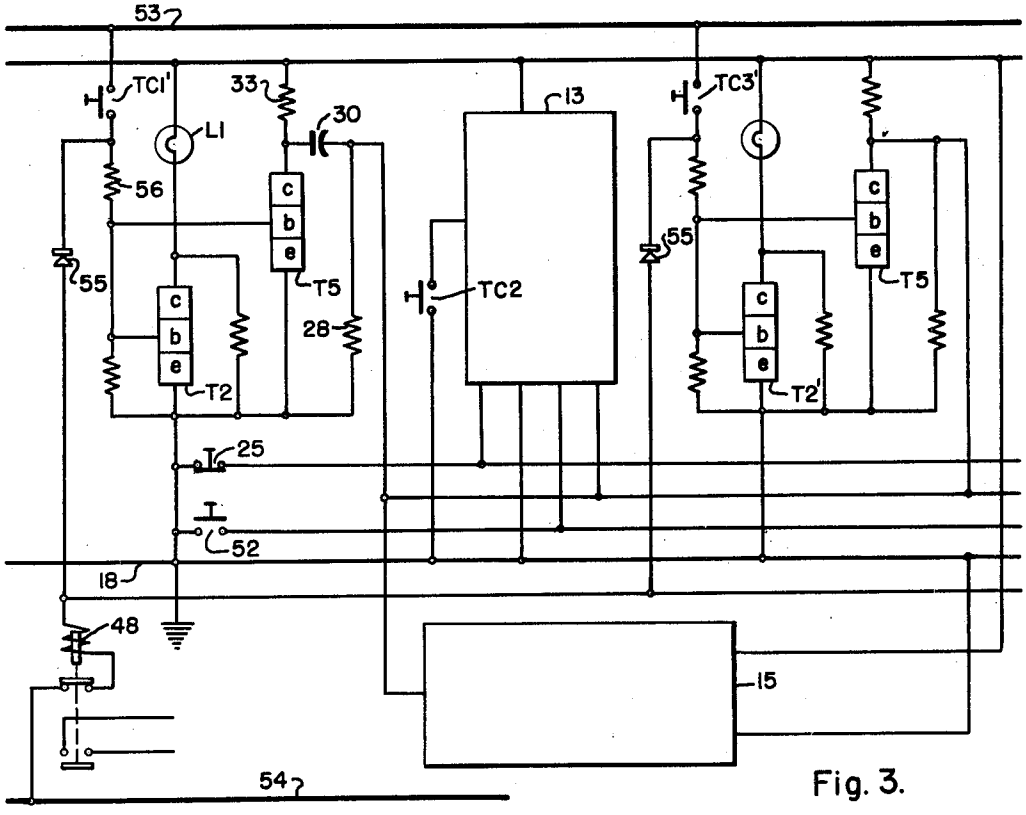

Fig. 3.

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ANNUNCIATORS WITH MANUAL RESET

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Our invention relates generally to alarm and indicating apparatus, and has reference in particular to annunciators.

Generally stated, it is an object of our invention to provide a simple and improved annunciator using static elements.

More specifically, it is an object of our invention to provide an annunciator using semi-conductor logic elements.

Another object of our invention is to provide a static annunciator in which closing of trouble contacts to initiate operation is necessary for no more than a few microseconds.

Yet another object of our invention is to provide in an annunciator for connecting an amplifier to the off output circuit of a flip-flop to obtain an on output signal.

It is also an object of our invention to provide in a multi-drop annunciator for resetting any one of a plurality of transistor flip-flop circuits by interrupting a common emitter circuit thereof instead of grounding the collector of a particular transistor that is cut off.

It is also an important object of our invention to provide in a semiconductor logic element annunciator, an indicating lamp check circuit that is independent of the alarm and annunciator operating conditions.

Another important object of our invention is to provide in a static annunciator, circuits for selectively checking the indicating lamps by providing alternate circuits for normally dark and normally glowing operation.

It is also an important object of our invention to provide a static element annunciator which requires but a single operating voltage.

Other objects will in part be obvious, and will in part be explained hereinafter.

In practicing our invention in accordance with one of its embodiments, each drop of a static annunciator comprises an individual direct-coupled transistor flip-flop circuit which is triggered to the on condition by an associated trouble contact and operates to trigger separate lamp and alarm amplifiers for the drop. A common alarm flip-flop is triggered by the individual alarm amplifier to sound an audible alarm. A common reset circuit interrupts the base circuit of the individual flip-flop to reset it and turn the lamp off. Reset of the common alarm flip-flop is effected by operating a reset switch to ground the base of the saturated transistor thereof.

As used herein, a flip-flop is a circuit which provides an on output signal in response to a first condition, which output signal continues even though said first condition ceases to exist, and terminates said output signal and produces an off output signal in response to a second condition.

A NOT amplifier is an amplifier circuit which produces an amplified output in response to the absence of an input signal.

For a more complete statement of the nature and scope of the invention, reference may be made to the following detailed description which may be read in connection with the accompanying drawings in which:

FIGURE 1 is a schematic diagram of an annunciator system embodying the invention in one of its forms;

FIG. 2 is a schematic diagram of a modification of the invention shown in FIG. 1; and

FIG. 3 is a schematic diagram of yet another modification of the invention shown in FIG. 1.

Referring particularly to FIG. 1, the reference numeral **10** may denote generally an annunciator system wherein a plurality of trouble contacts represented by the contacts TC1 and TC2 are associated with the individual drops **12** and **13** of the annunciator for operating trouble lamps L1 and L2 individual to the drops, as well as effecting operation of a common alarm means **15**.

Since the individual drops **12** and **13** are identical, the drop **13** is shown only in outline form and the description as hereinafter directed in detail to the drop **12** will be understood as applying equally to the drop **13**.

The drop **12** may comprise a flip-flop FF1 consisting of two transistors T1 and T2 of the fused junction type, which are connected in series with resistors **16** and **17**, respectively, between conductors **18** and **20** of a direct current source. The emitters *e* of the transistors are connected to the conductor **18** which is grounded, and which, in the present instance, is connected to the positive terminal of the source. The resistors **16** and **17** are connected between the conductor **20** and the collectors *c*. The base electrodes *b* and collectors *c* of the transistors T1 and T2 are cross-connected, and the trouble contact TC1 is connected between the ground conductor **18** and the collector *c* of transistor T1 so as to provide for triggering the transistor T1 to a saturated condition. A capacitor **22** is connected in shunt with the resistor **16** so that the charging current thereof, when the flip-flop is connected to the source, provides sufficient base current for the transistor T2 to become saturated. The emitters *e* are connected to ground, the emitter *e* of transistor T1 being connected to a common lamp reset bus **23**, which is connected to the ground conductor **18** through a lamp reset switch **25**, which may be opened to lift the emitters *e* from ground and effect saturation of transistor T2 to trigger the flip-flop FF1 back to its initial condition after it has been triggered to the on condition by the closing of the trouble contact TC1.

The indicating lamp L1 may be connected to the source by a transistor T4 which is connected in series therewith. The base electrode *b* of the transistor T4 is connected to the collector *c* of a NOT amplifier, comprising a transistor T3 which is connected to the source through a resistor **27**. Control of the indicating lamp L1 is effected by connecting the base electrode *b* of the transistor T3 to the collector *c* of transistor T1, so that when the flip-flop FF1 is triggered to the on condition by the closing of the trouble contact TC1, the absence of an off output signal at the collector of transistor T1 will produce an output signal at the collector *c* of transistor T3, so as to effect saturation of the indicating lamp transistor T4. This signal is also applied to the base *b* of an alarm control transistor T5 which is connected to discharge a capacitor **30** and apply a control pulse to an alarm bus **31** through a rectifier device **32** for effecting operation of the alarm means **15**. A resistor **28** connects capacitor **30** to conductor **18** for slowly charging it when transistor T5 is blocked.

The alarm means **15** comprises an alarm flip-flop FF2 consisting of transistors T11 and T12 having cross-connected collectors *c* and base electrodes *b*, and connected to the source through resistors **34** and **35** in a manner similar to that used in the flip-flop FF1. A capacitor **37** is connected in parallel with the resistor **35** so as to render the transistor T11 initially saturated when power is applied. This means that an output signal appears at the collector *c* of transistor T12 which is applied to an alarm relay **40** or other suitable alarm device through transistors T13, T14 and T15 which are connected in cascade and to an audible alarm **42**. The alarm **42** comprises an audio oscillator **43** consisting of a capacitor **44** connected across the primary of an audio transformer **45**

through a transistor T17. A speaker 47 is connected to the secondary winding of transformer 45, and a control transistor T16 connected in an inverted cascade relation to minimize leakage current is used to connect the transistor T17 to the source for applying the signal thereto from the flip-flop FF2.

On first applying power to the annunciator, the indicating lamp flip-flop FF1 goes to the off condition since the capacitor 22 effects saturation of the transistor T2, making the transistor T1 cut off, so that the collector *c* thereof is at the same potential as the base *b* of T2. This voltage is applied to the base *b* of the NOT amplifier T3 to effect saturation thereof. Accordingly, the collector *c* of transistor T3 will be dropped to substantially ground potential so that the base *b* of transistor T4 is grounded, causing transistor T4 to cut off, so that the lamp L1 is deenergized. Transistor T5 is likewise cut off, and the capacitor 30 is slowly charged through a resistor 28 and the collector resistor 33 of the transistor T5.

The flip-flop FF2 initially goes to the on condition, since capacitor 37 momentarily provides sufficient base current for the transistor T11 to effect saturation. Accordingly, transistor T12 is cut off, and the collector *c* thereof is at the same potential as base *b* of transistor T11. Accordingly, this voltage is applied to the base *b* of transistor T13, causing it to saturate. This causes transistor T14 to cut off, so that base *b* of transistor T15 is raised to the voltage of the collector *c* of transistor T14 causing transistor T15 to saturate. The alarm relay 40 is thereby connected between the conductors 18 and 20 through the low impedance of the saturated transistor T15, and is operated. Likewise, the signal voltage of flip-flop FF2 is applied to the base *b* of transistor T16 causing it to saturate and connect the audio oscillator 43 across the conductor 18 and 20 to produce an audible alarm. The alarm may be turned off by operating the alarm reset switch 41 which diverts the base current from the transistor T11, so that it changes to the cut off condition, causing transistor T12 to become saturated, dropping its collector *c* to substantially ground potential and removing the output signal from the transistor T13 and T16. Transistor T13 is cut off, raising the base *b* of transistor T14 sufficiently so that transistor T14 saturates and lowers the potental of the base electrode *b* of transistor T15 so that transistor T15 is cut off, and the alarm relay 40 is deenergized.

When trouble contact TC1, for example, closes, the flip-flop FF1 is triggered to the on state or condition, transistor T2 cuts off and transistor T1 saturates, dropping the voltage of its collector *c* to substantially ground potential. This lowers the potential of the base electrode *b* of transistor T3, causing it to cut off and thus, raises the potential of the base electrode *b* of transistor T4, causing it to saturate and light the lamp L1.

At the same time the voltage of the base of transistor T4 is applied to the base electrode *b* of transistor T5, causing it to saturate and connect the capacitor 30 to ground at conductor 18, so that the capacitor voltage is made available at the alarm bus 31 through the rectifier device 32. This applies a positive potentail to the base electrode *b* of transistor T12 of flip-flop FF2, so as to block the flow of base current, thus, causing transistor T12 to cut off and effect saturation of transistor T11. This produces a signal voltage at the collector *c* of transistor T12, which is applied to the base electrode *b* of transistor T16, so as to connect the audio oscillator 43 to the source and produce an audible alarm. At the same time, the signal voltage is applied to the base electrode *b* of transistor T13 causing it to saturate and effect cut-off of transistor T14. This raises the voltage of the collector *c* of transistor T15, and causes transistor T15 to saturate, connecting the alarm relay 40 directly across the source to effect operation thereof.

Should the trouble contact TC1 close only momentarily, the flip-flops FF1 and FF2 will remain in their operated states so that the lamp L1 remains lit and the alarm continues to sound. The alarm may be silenced by pushing the reset button 41, which diverts the base current of the transistor T11 returning it to the cut-off state, causing transistor T12 to saturate and resetting the flip-flop FF2 to the off condition. As hereinbefore explained, this causes transistor T13 to cut off, transistor T14 to saturate, and transistor T15 to cut off, effecting the deenergization of the alarm relay 40. Removal of the signal voltage from the base electrode *b* of transistor T16 disconnects the oscillator 43 from the source and silences the audible alarm 42.

The lamp L1 may be turned off by operating the lamp reset button 25 which opens the common emitter circuit so that the transistor T1 is cut off, and the transistor T2 saturates. If the trouble contact TC1 is open, T2 remains saturated when the push button is released. The capacitor 30 charges and the circuit is reset to its original state.

In order to check the operating condition of the indicating light L1, a lamp check transfer switch 50 is provided for selectively connecting the lamp L1 to the source independently of the transistor T4, either through a rectifier device 51, lamp check bus 49 and a lamp check switch 52 or through the lamp check transfer switch 50 and a resistor 54, which may be connected in parallel with the transistor T4 by operating the transfer switch 50 to its other position, so that the lamp L1 is normally energized sufficiently to glow, and changes to a bright condition when the transistor T4 saturates.

Referring to FIG. 2, it will be seen that a plurality of drops 12, 13 and 14, similar in nature to the drop 12 which is hereinbefore described in detail, may be connected for operating their individual trouble lamps and a common alarm means 15 in a manner similar to that described in connection with FIG. 1. In order to permit the trouble contacts TC1′ and TC2′ to operate a shut down relay 48 or the like for tripping a circuit breaker, etc. provision may be made for connecting the relay to conductors 53 and 54 of a power source through a rectifier device 55 and for connecting the drops 12 and 13 to the conductors 18 and 20 through additional transistors T18 and T19, respectively. The transistors T18 and T19 have their base electrodes *b* arranged for connection to the conductors 53 through resistors 56 and 57 and their respective trouble contacts TC1′ and TC2′. The collectors *c* of the transistors T18 and T19 are connected to the collectors *c* of the transistors T1, instead of connecting the trouble contacts TC1′ and TC2′ directly thereto as in the case of the trouble contact TC3 of drop 14 which may be identical with the drop 12 of FIG. 1.

Whenever the trouble contact TC1′ closes, the shut down relay 48 is connected between the conductors 53 and 54 for operating to open a circuit breaker or the like to shut down a particular piece of equipment. At the same time, the transistor T18 is saturated so as to provide a connection to the conductor 18 similar to that provided by the trouble contact TC1 in FIG. 1. Operation of the annunciator drop 12 in FIG. 2 is thereupon substantially identical with that described in connection with the annunciator with FIG. 1.

If it should be desired to have the trouble lamps L1 and L2 extinguished, when the trouble contacts open, the emitters *e* of transistor T1 and the corresponding transistor of drop 13 of FIG. 1 may be disconnected, so that the flip-flop FF1 is in effect only a single transistor switch instead of a memory circuit, or a circuit may be provided as shown in FIG. 3 wherein the trouble contact TC1′ simply connects the base electrode *b* of transistor T2′ to the conductor 53 through a resistor 56 so to effect saturation of the transistor T2 to light the lamp L1. The same voltage is also applied to the base electrode *b* of transistor T5 to effect discharge of the capacitor 30 to apply an operating signal to the alarm means 15 in the manner hereinbefore described. Operation of the trouble contact TC1′ also connects the shut down relay 48

to the conductors 53 and 54 for effecting operation thereof to open the breaker or shut down a particular piece of equipment. Alarm reset is effected as in FIG. 1.

From the above description and accompanying drawings, it will be apparent that we have provided a static annunciator in which the trouble contacts need be closed only a fraction of a milli-second in order to cause satisfactory operation. Even momentary operation of the trouble contact lights the trouble lamp which remains on until reset. Likewise, only momentary operation of the trouble contact sounds an alarm which is reset by a common reset push button. A check of the operating condition of the lamps may be readily obtained and is entirely independent of the operating circuits. Only a direct current voltage source is necessary and the power consumption is extremely low. Automatic battery supervision is provided in that a momentary interruption of the power source causes the alarm to sound.

Since certain changes may be made in the above-described construction and different embodiments of the invention may be made without departing from the spirit and scope thereof, it is intended that all the matter contained in the above description and shown in the accompanying drawings, shall be considered as illustrative, and not in a limiting sense.

We claim as our invention:

1. In an annunciator, a common alarm device, a common flip-flop operable from one stable condition to another condition to effect energization of the alarm device, a plurality of indicating devices, a flip-flop individual to each indicating device operable from one stable condition to another condition to apply a signal to the indicating device and trigger said first mentioned common flip-flop to said another condition, energy storage means connected in circuit between said individual flip-flops and the common flip-flop, reset means common to the individual flip-flops, and additional reset means individual to the common flip-flop.

2. An annunciator comprising an alarm device, a flip-flop individual to the alarm device, a plurality of indicating devices, a flip-flop individual to each indicating device, switch means effecting operation of each of the individual flip-flops, means for resetting the individual flip-flops, and capacitor means connecting the individual flip-flops to the alarm device flip-flop.

3. In an annunciator, a direct-connected transistor flip-flop having two stable conditions, an indicator, switch means operable to effect energization of the indicator, an alarm, another flip-flop having two stable states operable from one state to another to effect operation of the alarm, switch means operable to effect operation of the other flip-flop, static switch means operable in response to transfer of the first-mentioned flip-flop from one stable condition to the other of its stable conditions to effect operation of both switch means, and alarm switch means operable to effect transfer of the first-mentioned flip-flop from said one stable condition to the other stable condition.

4. In an annunciator, an alarm, a flip-flop having two stable states including an off state during which a voltage is produced at an off terminal and an on state during which no voltage is produced at the off terminal, an indicator, switch means for the indicator, another flip-flop having an off stable state and operable to an on stable state to apply a voltage to effect operation of the alarm, and a NOT amplifier connected to respond to the lack of an off signal at said one flip-flop to effect energization of the alarm flip-flop and the indicator switch means.

5. In an annunciator, a common direct-connected transistor flip-flop having stable on and off states and comprising two transistors with direct-connected emitters and cross-connected collector and base electrodes, means for putting said flip-flop in a stable on state, an alarm controlled by said flip-flop in its on state, reset means operable to trigger the flip-flop to its off state, a plurality of indicating lamps, a flip-flop individual to each lamp having stable on and off states and comprising two transistors with direct connected emitters and cross-connected collector and base electrodes, switch means individual to each of said individual flip-flops connected to trigger said individual flip-flops to their on states, and circuit means connecting the individual flip-flops to energize their associated lights and trigger the common flip-flop to its on state when one of the individual flip-flops is triggered to its on state.

6. In combination, an indicating lamp, a transistor having a base electrode with collector and emitter electrodes connected in series with the lamp and a source, an impedance, an additional transistor having a base electrode with collector and emitter electrodes connected in series with the impedance and the source, circuit means connecting the collector of the additional transistor to the base of the first mentioned transistor, a flip-flop comprising two transistors having base electrodes with emitter and collector electrodes, circuit means cross-connecting the base and collector electrodes, impedance means connecting the collector electrodes to the negative side of the source, additional circuit means connecting the emitter electrodes to the positive side of the source, a capacitor connected in shunt with the impedance means of one of the flip-flop transistors, circuit means connecting the collector electrode of one of said two transistors to the base electrode of the additional transistor, and a switch for connecting the collector and emitter electrodes of said one transistor.

7. In an annunciator, an indicating lamp, an alarm, a flip-flop having two stable states operable in one of said states to effect operation of the alarm, an additional flip-flop having two stable states operable in one of said states to effect energization of the indicating lamp and trigger the first mentioned flip-flop to said one state, a control relay, and contact means operable to simultaneously effect operation of the control relay and the additional flip-flop.

8. In an annunciator, a flip-flop operable from one stable state to another to operate an alarm, indicating means, an additional flip-flop operable from one stable state to another to effect energization of the indicating means and trigger the alarm flip-flop to said another state, said additional flip-flop including two transistors with direct-connected emitters and cross-connected collectors and base electrodes, circuit means connecting the two transistors in common-emitter relationship with a direct current source, switch means connected between the emitter of one of said two transistors and the direct current source operable to reset the additional flip-flop to its one state, and additional reset means to reset the alarm flip-flop to its one stable state.

9. In an annunciator, a flip-flop circuit operable from one stable state to another to operate an alarm, a plurality of indicator means, a plurality of additional flip-flop circuits each operable from one stable state to another to effect energization of one of the indicating means and each connected to trigger the alarm flip-flop to said another state, each additional flip-flop including a pair of transistors with direct-connected emitters and cross-connected collectors and base electrodes, circuit means connecting the collector and emitter of each transistor in common-emitter relationship with a direct current source and including means connecting the emitter of one transistor of each pair of transistors to a common point and including switch means connecting said common point to the direct current source, and additional reset means to change the alarm flip-flop to its one stable state.

10. The combination with a plurality of indicating lamps and a power source for energizing the lamps, of impedance means for limiting the energization of each lamp to a predetermined value, switch means individual to each lamp operated by a fault condition to effect energization of its lamp in excess of said predetermined value of energization, switch means common to all of said

lamps to effect energization thereof independently of the impedance means and first mentioned switch means, and additional manual switch means positionable to be connected to said common switch means to render the impedance means ineffective and the common switch means effective or positionable to be connected to said impedance means to render the impedance means effective and the common switch means ineffective.

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