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AMPLIFIER FOR INTERCOMMUNICATION SYSTEM WITH FIRE AND BURGLAR ALARM FEATURES

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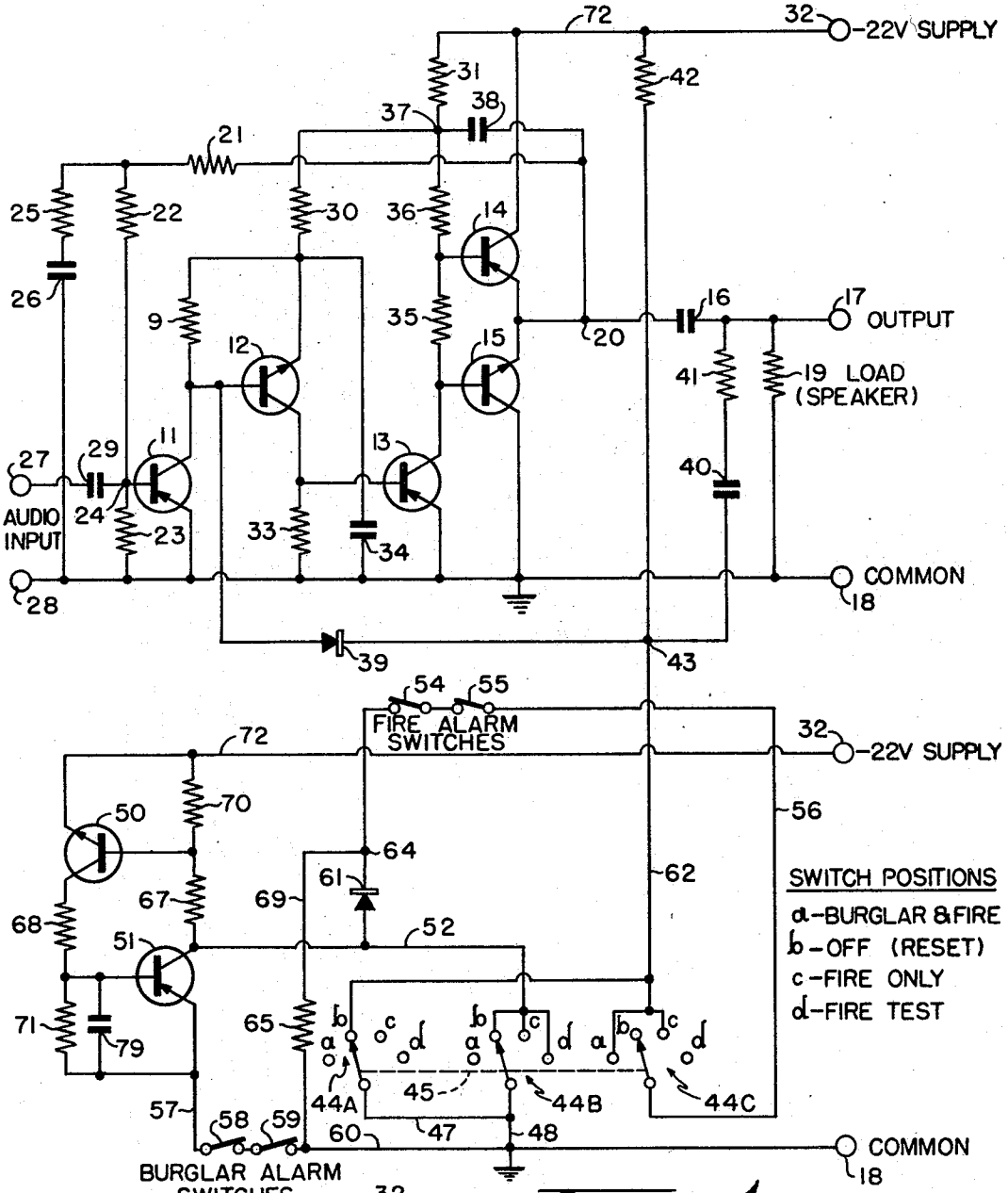



Fig 1

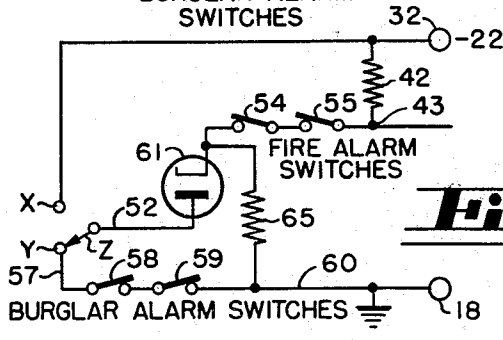



Fig 2

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# AMPLIFIER FOR INTERCOMMUNICATION SYSTEM WITH FIRE AND BURGLAR ALARM FEATURES

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## ABSTRACT OF THE DISCLOSURE

A solid state audio amplifier of the type used in sound intercommunication systems is provided with a feedback network which is adapted either to make the amplifier "howl" with high frequency oscillations, in the event of a fire, or provide low frequency oscillations of the relaxation type, in the event of a burglary.

An electronic switch in the form of a bistable device controls the potential of a point on the feedback network in order to establish these two conditions of operation. A control switch establishes a response to the sensing of both burglary and fire or fire only. It also has an "off" position.

## BACKGROUND OF THE INVENTION

The present invention provides control circuitry which, when used in conjunction with an intercommunication system having a sound channel, provides means for detecting such undesired hazards as burglary or fire, and adds these additional functions to the normal function of an intercommunication system.

The prior art includes many arrangements for providing an audio tone in response to the sensing of a fire and coupling that audio tone into the loud speakers of an intercommunication system. Such a system is shown, for example, in the United States patent to Wooten, No. 2,942,245.

The present invention provides an arrangement which furnishes an alarm in the event of either burglary or fire. In the event of fire it furnishes high frequency oscillations in the form of a "howl" and in the event of a burglary it furnishes low frequency audible sounds by relaxation oscillations.

The present invention is an all solid state system, simple and reliable in operation, and it includes a rotary switch device operative to provide the functions mentioned in the abstract set forth above.

## DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention, together with other objects, advantages and capabilities thereof, reference is made to the following description of the accompanying drawings, in which:

FIG. 1 is a circuit schematic of an amplifier and a combined burglar and fire alarm circuit in accordance with the present invention;

FIG. 2 is a circuit schematic showing the switching functions performed with respect to point 43 of the feed back network provided in accordance with the present invention.

## DETAIL DESCRIPTION OF THE INVENTION

In accordance with the present invention, an audio amplifier in an intercommunication system is made to function as an oscillator and to set up a beep or howl in the loud speaker load of the amplifier, in the event of the presence of a burglar or of fire, which presence is appropriately sensed.



Referring now first to the audio amplifier of FIG. 1, it comprises four stages, the first of which is a pre-amplifier stage incorporating a PNP type transistor **11**, the second of which is an intermediate stage incorporating an NPN transistor **12**, the third of which is a driver stage incorporating a PNP type transistor **13** and the fourth of which is a push-pull arranged output network comprising PNP type transistor **14** and NPN type transistor **15**, connected in complementary symmetry. The junction of the emitters of transistors **14** and **15** is coupled by a series capacitor **16** to an output terminal **17**. The other output terminal **18** is grounded. To ground are connected the collector of transistor **15** and the emitters of transistors **11** and **13**. A loud speaker load symbolically indicated by the reference numeral **19** is connected across the output terminals **17** and **18**.

A voltage feedback connection originates at the junction **20** of the emitters of transistors **14** and **15**. For purposes of temperature stabilization the direct current voltage feedback circuit comprises point **20**, series resistor **21**, series resistor **22** and series resistor **23**, the junction **24** of the latter two resistors being connected to the base of transistor **11** and resistors **21–23** forming a voltage divider between point **20** and ground. A portion of the alternating current in the feedback path is bypassed by the series combination of resistor **25** and capacitor **26**, in shunt with **22–23**, some feedback being maintained for purposes of distortion reduction.

The audio input to pre-amplifier transistor **11** is via the input terminals **27** and **28**, terminal **27** being coupled to the base of transistor **11** via capacitor **29**.

A direct current reverse-bias voltage of approximately −18 volts is provided for the collector of pre-amplifier transistor **11** via a series connection of resistors **9**, **30** and **31**, resistor **31** being connected to a −22 volt terminal **32** and resistor **9** being connected to the collector of transistor **11**.

The pre-amplifier transistor **11** is in the common emitter configuration and its collector output is directly connected to the base of transistor **12** and the collector output of transistor **12** is in turn directly connected to the base input of transistor **13**, also in the common emitter configuration. Resistor **33** is the collector load of transistor **12**. Capacitor **34** is an emitter bypass for transistor **12**.

Current in resistor **35**, in series with the collector of transistor **13**, provides turn-on bias for transistors **14** and **15**, resistor **35** being connected between their bases. Resistor **36**, being large with respect to resistor **35**, is the principal collector load for transistor **13**. Resistors **35**, **36** and **31** are in series between the collector of transistor **13** and supply terminal **32**.

There is a bootstrap coupling from output point **20** of the push-pull output stage (i.e. the emitters) to the junction **37** between resistors **31** and **36**, via capacitor **38**, and the purpose of this bootstrap connection is to provide a more elevated voltage for the collector of transistor **13** than is available at the source terminal **32**.

In accordance with one aspect of the invention, this amplifier is made to oscillate by close-circuiting of a feedback network between the audio output terminal **17** and the collector of transistor **11**. This network comprises, in series, a series resistor **41**, series capacitor **40**, and series diode **39**. The diode **39** is so arranged that its cathode has a resistive shunt connection **42** to the −22 volt supply terminal **32** whereby, when the cathode of the diode is not grounded the cathode is forward biased and the diode **39** then establishes a conductive path and a feedback connection between point **17** and the collector of transistor **11**, which feedback connection, when closed, causes regenerative reaction and oscillation. The point at which the cathode is connected to resistor **42** is referred to as **43**.

When the point 43 is grounded then the feedback connection is effectively open-circuited and the amplifier circuit functions as an amplifier. On the other hand, when the point 43 is ungrounded then the feedback connection 39, 40, 41 is close-circuited and the amplifier functions as an oscillator.

The broad function of the remaining parts o fthe circuit now described is to cause point 43 to be grounded or ungrounded as desired, grounding being the condition desired for normal operation and a negative potential being the condition desired when a warning or fire is to be furnished. For burglary, point 43 is at a less negative potential.

At this point it is emphasized that when point 43 is grounded the amplifier is in the upper part of FIG. 1 functions as such. Reference is now made to FIG. 2. When point 43 is negative enough to make diode 39 conductive, as when the presence of a fire is detected, then the feedback network 41, 40, 39 functions in such a way as to make the amplifier "howl" at a relatively high but audible frequency. On the other hand, when burglary is detected point 43 is placed at a less negative potential and the feedback network then functions in such a way as to cause the generation of relaxation oscillations which are at a lower frequency and therefore characterize the detection of burglary. In other words, when a fire is detected point 43 is placed at a negative potential. When burglary is detected point 43 is placed at a less negative potential. This switching of point 43 to the desired potential is accomplished by the switching network or bistable device comprising the transistors 50 and 51. Resistors 70 and 67 and the collector-emitter circuit of transistor 51 are in series between high potential supply conductor 72 and conductor 57. The emitter collector circuit of transistor 50, resistor 68 and resistor 71 are also in circuit between conductor 72 and conductor 57. The operation of this switching circuitry is such that when a burglary is detected, removing the ground from 57, then conductor 52 is in effect encircuited with conductor 72 and placed at a minus potential, whereby the diode 61 becomes nonconductive and the potential of point 43 is as determined by the voltage divider which comprises resistor 42 and resistor 65, disposed between conductor 72 and ground, point 43 being effectively the junction of these two resistors.

On the other hand, when a fire is detected the connection between point 43 and ground is simply broken. This will be more readily understood by reference to FIG. 2 in which 61 is a diode and a switch with moving contact Z and fixed contacts X and Y symbolically represents the switch including the transistors 50 and 51 of FIG. 1. It will be seen from FIG. 2 that when one of the burglary sensing switches 58 or 59 is open the moving contact Z moves to X, turning off diode 39 and placing point 43 at a potential determined by the voltage divider 42, 65. On the other hand, when one of the fire alarm switches 54 or 55 is open, point 43 is simply ungrounded. This discussion of FIG. 2 assumes that the switch X, Y, Z operates in such a manner that Z is normally in contact with Y and that when either 58 or 59 is opened that Z will immediately swing over the contact with X.

By analogy, when 58 or 59 in FIG. 1 is open, 57 departs from ground potential and the collector of 51 immediately falls to —22 volts, so that the analog between the bistable switching device of FIG. 1 and the symbolic representation of FIG. 2 is satisfied.

A switch comprising three ganged sections 44A, 44B and 44C, the ganging of the rotary contacts being by a suitable mechanical expedient 45, is so arranged as to provide for four distinct conditions of operation. In the extreme counterclockwise position the rotary contacts are encircuited with the respective fixed contacts designated *a*. In the next position, the rotary contacts are encircuited with the fixed contacts designated *b*. In the third position, the rotary contacts are encircuited with the fixed contacts designated *c*, and in the fourth or extreme clockwise position with those designated *d*. The *b* contact of section 44A is connected to point 43. The *a* and *c* contacts of switch section 44C are connected to each other and point 43. The *b*, *c* and *d* contacts of section 44B are connected to each other and to the collector of transistor 51. The rotary contacts of switches 44A and 44B are connected to ground.

Let it now be assumed that the switch sections are in the "off" position. In this condition there is ground connection, from 43 via conductor 62, the *b* contact of section 44A, conductor 47, and conductor 48 to ground, which open-circuits and disables the feedback connection 39, 40 and 41. This establishes normal amplification of the amplifier.

Parenthetically, for reasons which will appear hereinafter, when the switch sections are in the "off" position it is desired that the bistable device which comprises transistors 50 and 51 be conductive, i.e., that the collector of transistor 51 be at ground potential and this requirement is accomplished by the connection comprising the collector of 51, conductor 52, contact *b* of switch section 44B, conductor 48 and ground 60.

Let use now consider the position "Bulglary-Fire" condition of the switch sections 44A, 44B, and 44C. In this position it is desired that the system be sensitive to the presence either of a burglar or fire. The presence of a fire is indicated by the opening of any one of the serially arranged thermally responsive switches 54, 55, etc., individually staged at the various locations where it is desired that the presence of a fire be sensed. In other words, the presence of a fire is indicated by an open circuit on line 56.

The presence of a burglar is indicated by an open circuit on line 57, by reason of the opening of any one of the switches 58 and 59 which are connected in series and individually located at the various places where security against intrusion is desired.

It will be recalled that the bistable device which comprises the elements 50, 51 is conductive when the switch sections were in the "off" condition. When the switch sections are placed in the "Burglary-Fire" position this bistable device remains conductive, effectively short-circuiting conductor 57 to conductor 52 so that a ground circuit is established from conductor 60, switches 59 and 58, conductor 57, the emitter-collector circuit of transistor 51, and conductor 52, diode 61, switches 54 and 55, conductor 56 and the *a* contact of switch section 44C, conductor 62 and point 43, which point is therefore grounded so that the amplifier functions as an amplifier. Note that the existence of this ground depends on: the closed state of switches 54–55 and 58–59 and the conductivity of transistor 51.

Let there now be considered the events which occur upon opening of any one of the fire alarm switches 54 and 55. This action places point 43 completely off ground because there is an opening in the circuit comprising the elements 62, a contact of 44C, 56 and 55, 54. This action causes a single tone oscillation to be produced by regenerative action of the aforementioned feedback components 39–41.

Now the tone which is characteristic of the burglar alarm is different than that which characterizes a fire alarm.

Let there be considered the events which occur when there is a burglar alarm, causing the opening of one of switches 58 and 59 and ungrounding conductor 57. This action causes interruption of current flow through the bistable circuit comprising transistors 50 and 51, whereby the collector of 51 and the conductor 52 fall to approximately —22 volts, the potential of the collector of 51 rendering diode 61 non-conductive so that point 43 is effectively connected to point 64, via 62, the *a* contact of switch section 44C, conductor 56 and switches 54 and 55. The potential at point 43 is now dependent on the

proportions of the resistors **42** and **65** and is such that the feedback elements **39**, **40** and **41** are causing blocking type oscillations to occur.

The capacitor **40** charges up in a positive direction, periodically cutting off diode **39** and this causes the oscillations to be of the blocking type. Once an oscillation stops, capacitor **40** discharges through **43** and **32**, again rendering diode **39** conductive.

The bistable is a collector to base coupled complementary pair, the collector to base couplings being via resistors **67** and **68**. Capacitor **79** is connected between the emitter and base of transistor **51** for purposes of transient suppression. Appropriate base biases are provided by resistors **70** and **71**.

Let use now consider the events which occur when the switch sections employ the fixed contacts *c* in the "Fire Only" position. Under this condition contact *c* of switch section **44B** short-circuits the collector of transistor **51** to ground. Conductor **52** being at ground potential, switches **58** and **59** are no longer effective. That is, the system does not respond to a burglar alarm when it is set for "fire only." In the absence of a fire, **43** remains connected to ground via **62**, fixed contact *c* of **44C**, **56**, **55**, **54**, **64**, **61**, **52**, *c* contact of **44B**, conductor **48** and ground. In the event of a fire, one of switches **54** or **55** will open, ungrounding point **43**.

The *d* contact-utilization or "Fire Test" condition of the switch sections simulates the conditions of fire only, on the assumption that one of the fire switches is open. That is, it open-circuits line **56**. It also connects the collector of **51** to ground **60**.

The invention provides:

In combination:

An audio amplifier,

A resistance capacitance-feedback network **41**, **40**, **39** in said amplifier which is responsive to a first potential (ground) to cause the amplifier to operate as such, to a second potential (a negative one) to cause the amplifier to oscillate, and to a third potential (a less negative one) to cause the amplifier to relaxation oscillate, said network having a control terminal **43** to which said potentials are applied, and means for applying said potentials to said control terminal comprising:

A source of potential having positive and negative terminals (**32** and **18**),

A voltage divider comprising

a first resistor **42** and

normally closed fire sensing means **54**, **55** and

a second resistor **65** in series between the terminals of said source,

Means comprising a normally enabled diode **61** and normally closed burglary sensing means **58**, **59** in series across the second resistor **65** for normally placing said control terminal **43** at the first potential (ground), and

Means (the bistable device including **50**, **51**) responsive to the opening of the burglary sensing means for disabling said diode to place said control terminal **43** at the third potential (the less negative one),

Said control terminal being connected to the first resistor and the fire sensing means (by **62**, *a* of **44C** and **56**) so that when the fire sensing means is open the control terminal **43** goes to the second potential (the more negative one) by reason of voltage division.

I claim:

**1.** In combination:

an audio amplifier,

a resistance capacitance-feedback network in said amplifier which is responsive to a first potential to cause the amplifier to operate as such, to a second potential to cause the amplifier to oscillate, and to a third potential to cause the amplifier to relaxation oscillate, said network having a control terminal to which said potentials are applied, and means for applying said potentials to said control terminal comprising:

a source of potential having positive and negative terminals,

a voltage divider comprising

a first resistor and

normally closed fire sensing means and

a second resistor in series between the terminals of said source,

means comprising a normally enabled diode and normally closed burglary sensing means in series across the second resistor for normally placing said control terminal at the first potential, and

means responsive to the opening of the burglary sensing means for disabling said diode to place said control terminal at the third potential, by reason of voltage division,

said control terminal being connected to the first resistor and the fire sensing means so that when the fire sensing means is open the control terminal goes to the second potential.

**2.** In combination, an audio amplifier,

a source of potential having positive and negative terminals,

means in said amplifier having a control terminal which is normally at a reference potential but which responds to second and third potentials to cause the amplifier to oscillate in distinct modes,

a normally closed fire sensing means,

a normally closed burglary sensing means,

means responsive to the opening of the fire sensing means for placing said control terminal at the second potential, and

means responsive to the opening of the burglary sensing means for placing said control terminal at the third potential,

the means responsive to the opening of the fire sensing means comprising

a first resistor between one of said source terminals and said control terminal,

the means responsive to the opening of the burglary sensing means comprising

a second resistor in series with the other source terminal and said fire sensing means and said control terminal,

whereby opening of the fire sensing means places said control terminal at the potential of said one source terminal, and closing of the fire sensing means places said control terminal at the potential of the junction between the fire sensing means and said second resistor.

**3.** The combination in accordance with claim **1**,

means for normally holding the control terminal at the reference potential comprising a diode in series combination with said first resistor and said fire sensing means and said burglary sensing means and said other source terminal, and

means for closing this series combination but responsive to opening of the burglary sensing means to disable the diode and to permit the control terminal to assume the third potential determined by said first and second resistors.

**4.** The combination in accordance with claim **3** in which the last-mentioned means is a bistable device comprising two transistors of which one has a collector-emitter circuit in series with said diode and said burglary sensing means, whereby the combination of said other source terminal, which is at the reference potential, and the burglary sensing means and said collector-emitter circuit and said diode and said fire sensing means and said first resistor normally cooperate to hold said control terminal at said reference potential.

**5.** In combination, an audio amplifier,

a source of potential having positive and negative terminals,

means in said amplifier having a control terminal which is normally at a reference potential but which

responds to second and third direct-current biasing potentials to cause the amplifier to oscillate in distinct modes,

a normally closed fire sensing means,

a normally closed burglary sensing means,

means responsive to the opening of the fire sensing means for placing said control terminal at the second direct-current potential and

means responsive to the opening of the burglary sensing means for placing said control terminal at the third direct-current potential,

the means responsive to the opening of the fire sensing means comprising

a first resistor between one of said source terminals and said control terminal,

and the means responsive to the opening of the burglary sensing means comprising

a second resistor in series with the other source terminal and said fire sensing means and said control terminal,



whereby opening of the fire sensing means places said control terminal at the potential of said one source terminal, and closing of the fire sensing means places said control terminal at the potential of the junction between the fire sensing means and said second resistor.

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