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[54] **COMBUSTION PRODUCTS ALARM**

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[58] **Field of Search** ..... 340/237 S; 250/381, 382, 250/384, 385, 389

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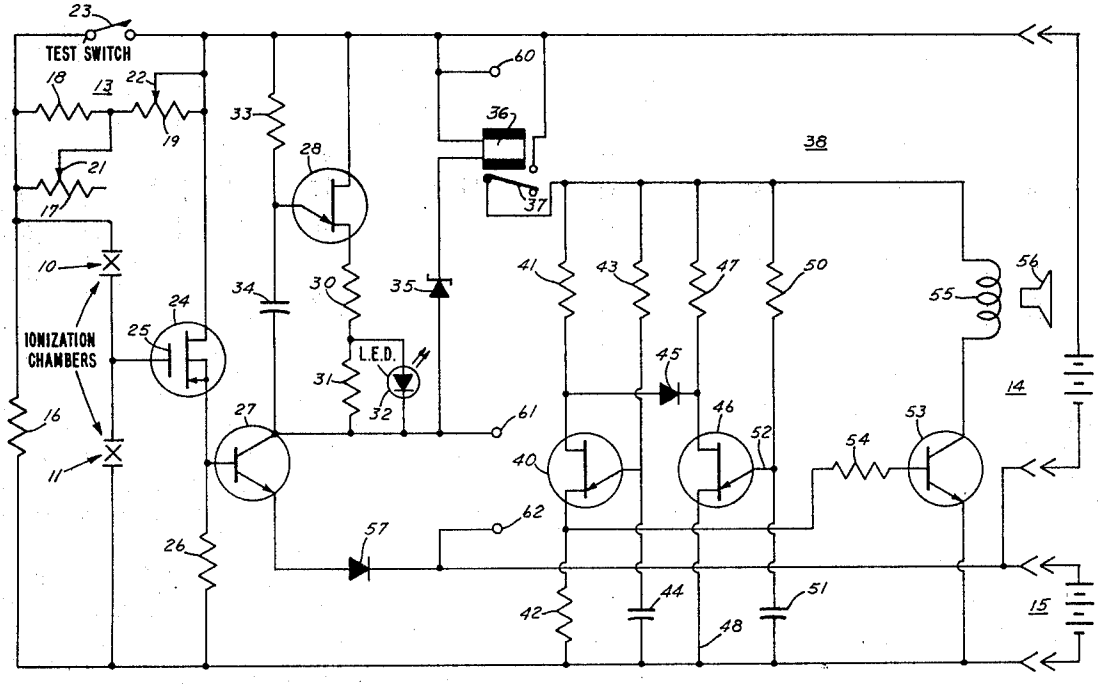
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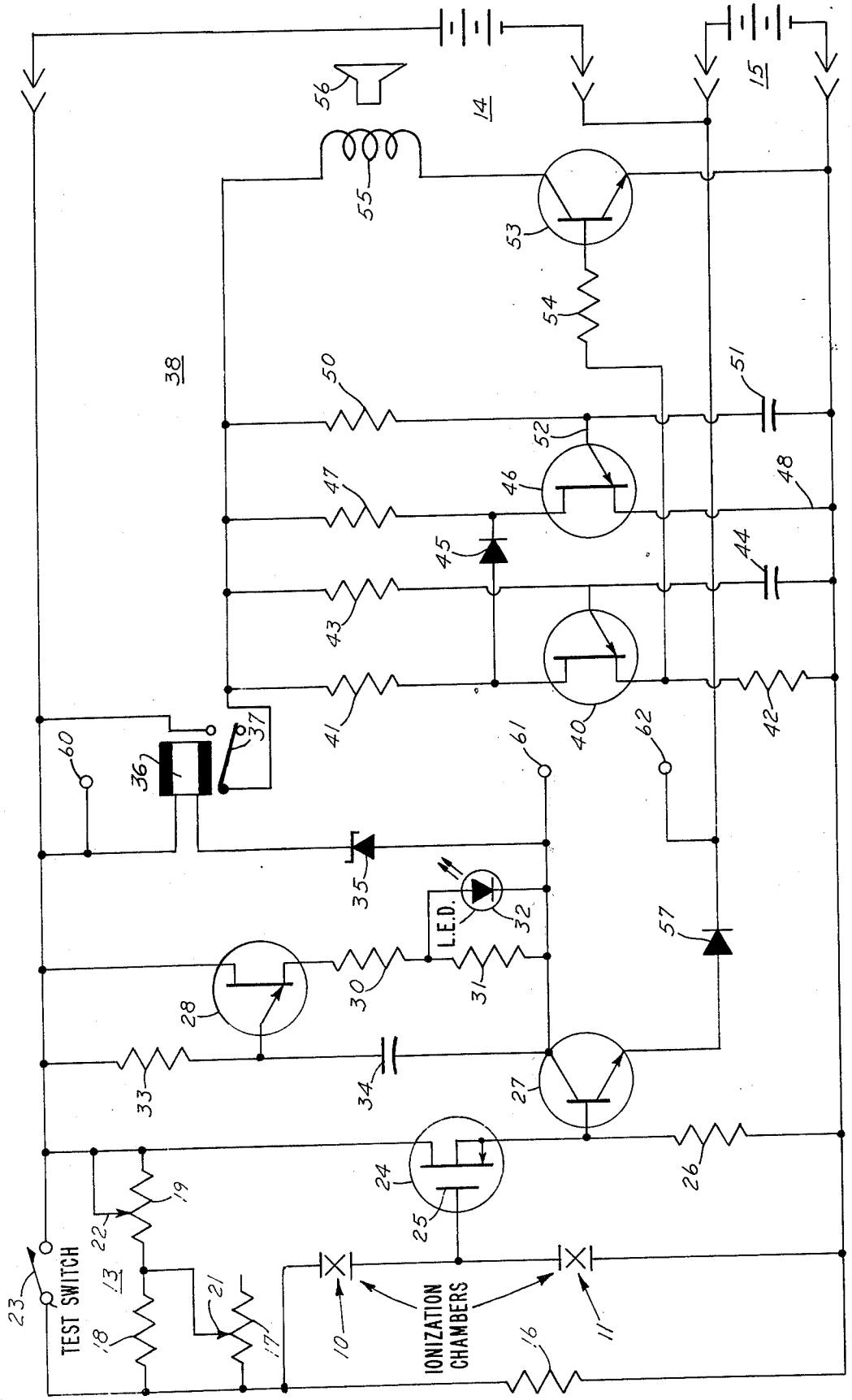
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[57] **ABSTRACT**

A combustion products detector of the ionization chamber type comprises a reference ionization chamber and a signal chamber arranged in series for connection across a direct current source such as a dry battery. An insulated gate field effect transistor is arranged with its drain electrode for connection to the high side of the source, and with its source electrode to the law side; its gate is connected to the common junction of the chambers; a high resistance is connected across the chambers in parallel. A control amplifier supplies the signal to a circuit for producing a preliminary alarm or proximity signal upon a predetermined increase in combustion product density in the signal chamber and a full alarm upon an additional increase. The alarm may be produced as a throbbing or undulating sound.

3 Claims, 1 Drawing Figure




TEST SWITCH
IONIZATION CHAMBERS
L.E.D.

COMBUSTION PRODUCTS ALARM

This invention relates to combustion product detectors and particularly to an improved detector of the ionization chamber type.

Numerous circuits have been provided heretofore for the purpose of utilizing ionization chamber detectors for actuating fire indicators and alarms. These circuits have proved useful to varying degrees depending upon the conditions prevailing and the nature of the applications of the circuits. Reliability and consistent operation of fire detectors over a wide range of ambient conditions are desired and, accordingly, it is an object of this invention to provide an improved reliable combustion product detector of the ionization chamber type.

It is another object of this invention to provide a combustion product detector of the ion chamber type including an improved circuit for operation from an electric battery as a direct current source.

It is a further object of this invention to provide an improved combustion product detector including an arrangement for providing a preliminary warning before the energization of an alarm.

Briefly, in carrying out the objects of this invention in one embodiment thereof, two ion chambers, one a reference, the other a signal chamber are connected in series with a variable resistance across a D.C. source. An insulated gate field effect transistor is connected across the source with its gate connected to the junction between the chambers. Upon increase in product in the signal chamber a control transistor energizes a unijunction oscillator which actuates a light emitting diode causing it to flash periodically to warn of the proximity of alarm conditions and which upon further increase of product, glows steadily before the circuit activates the alarm.

The features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. The invention itself, however, both as to its organization and its manner of operation, together with further objects and advantages thereof, will best be understood upon reference to the following description taken in connection with the accompanying drawing, the single FIGURE of which is a schematic diagram of a combustion products detector embodying the invention.

Referring now to the drawings, two ionization chambers **10** and **11** are connected in series with a dual potentiometer circuit **13** across a direct current source which has been illustrated as a battery comprising two units **14** and **15**. A loading resistor **16** is connected in parallel with the two chambers. The resistance **16** may be of the order of 2 meghohms. The circuit **13** in addition to a resistance **17** includes a fixed resistance **18** and an adjustable resistance **19**. The resistance **17** is connected to the junction of the resistances **18** and **19** by an adjustable contact **21** and the resistance **19** is connected as a potentiometer by an adjustable contact **22** which shorts out a selected portion of the resistance toward the high potential end thereof. The test switch **23** is provided which is normally open and when closed shorts out resistances **17, 18** and **19** and places the chambers **10** and **11** directly across the power supply putting the unit into test alarm condition. This alarm condition provides a 100% component test equal to combustion products alarm. Chamber **10** is a reference chamber and the chamber **11** a sampling or signal chamber responsive to changes in the ambient atmosphere about the detector. The junction of the two chambers is connected to the gate of a field effect transistor **24**, the gate being indicated at **25**. Transistor **24** is of the insulated gate type and is an N-channel depletion mode metal oxide silicon field effect transistor. The transistor is connected across the direct current supply, its drain electrode being connected to the high potential side of the supply and its source electrode being connected to the low side through a resistance **26**. When a change in combustion product density occurs in the ionized chamber **11**, this change in density of the product decreases the current through the circuit of the chambers and increases the potential at the gate **25**; as a result current flows through the transistor **24** and a control transistor **27** which has its base connected to the junction between the source of the transistor **24** and the resistance **26** conducts. The collector of the transistor **27** is connected to a circuit including a unijunction transistor **28** connected as an oscillator having its base-two connected to the high side of the D.C. source and its base-one connected to the collector through resistances **30** and **31** in series. A light emitting diode **32** is connected across the resistor **31**. The emitter of the unijunction **28** is connected to the high side of the source by a resistance **33** and to the collector of the transistor **27** by a capacitance **34** thus completing the oscillator circuit. During operation of the oscillator the light emitting diode **32** flashes and indicates that the combustion product density is approaching alarm condition. As a predetermined further increase of the potential difference between the supply and the transistor **27**, a Zener diode **35**, connected in series with the winding of an alarm relay indicated at **36**, conducts and the diode glows steadily. On a further increase of voltage difference, which in the alarm condition, the winding **36** is energized to actuate the relay and move a switch **37** to its upper position thereby connecting an alarm circuit **38** across the battery comprising the units **14** and **15**. A unijunction transistor **40** is connected as an oscillator across the direct current source by resistances **41** and **42** and with its emitter connected to the common junction of a resistance **43** and capacitance **44**. The base-one terminal of the unijunction **40** is connected through a diode **45** to the base-one terminal of a unijunction **46** which is connected to the high side of the source through a resistance **47**, the base-two terminal being connected to the low side through a line **48**. A resistance **50** and a capacitance **51** connected in series across the source have their common junction connected to the emitter of the unijunction **46**, as indicated at **52**, and complete the oscillator circuit. The unijunction transistor **46** is a lower frequency oscillator which acts as a "warbler" modifying the sound effect produced by the oscillation rate of the unijunction oscillator **40**. The output of the oscillator **40** is supplied to the base of a transistor amplifier **53** through a resistance **54**. The amplifier **53** when conducting energizes a winding **55** of a horn or loudspeaker **56** and the periodic output of the oscillator **40**, modified at the lower rate by the oscillator **46**, is reproduced as the warning sound by the horn **56**.

In order to minimize drain on the battery **14** and **15** a diode **57** is connected in the emitter circuit of the transistor **27** which has been illustrated as connected to the common junction of the two battery sections. The diode **57** prevents reverse flow and drain from the battery **15**.

The circuit of this invention makes it possible to calibrate the detectors by means of a simple D.C. voltmeter. When the transistor **27** is not conducting, the voltage between the test points, indicated at **60** and **61**, is the same, however, when the transistor conducts the voltage increases with increase in the current through the transistor and hence through the resistances **30, 31** and **33** and the unijunction **28.** This voltage varies directly with the density of the combustion product in the chamber **11** and is an indication of that density and may be used to monitor the performance of the detector. The maximum voltage between the test points **60** and **61** immediately prior to energization of the relay winding is an accurate indication of the calibration setting of the detector for alarm operation. This voltage may thus be used for calibrating the detector by adjustment of the potentiometers to obtain alarm operation at a preselected density of product in the chamber **11.**

The alarm actuating voltage across the relay winding **36** and the Zener diode **35** in series is the same for all combustion product densities. The density of product at which the voltage is attained is determined by the setting of the potentiometer **17** which is the sensitivity control of the circuit. With no product in the chamber **11** the voltage across the test points is substantially zero. With a selected setting of the sensitivity potentiometer, the voltage between zero and the alarm voltage indicates the product density in the chamber **11.** A D.C. voltmeter may thus be employed to determine the state of operation of the detector and also to calibrate the detector.

In initial calibration the potentiometers may be set for a fractional portion of the alarm density by subjecting the chamber **11** to product of such density and setting the potentiometer to the corresponding fractional setting of the voltage across the terminals **60** and **61.** The detector will then operate to produce a voltage across the test terminals proportional to whatever density of product is present in the sampling chamber. By following these voltage measuring procedures, a large number of like detectors may be calibrated by calibrating a first detector using product densities in the chamber **11** to obtain the calibrations and corresponding voltages of the first detector, and then setting all other detectors accordingly and using voltages measured at the test terminals for this purpose. Thus, it is not necessary to use the samples of combustion product for calibration of the other detectors of like construction.

As an illustration of a working embodiment of the present invention and for purposes of example and not by way of limitation, a detector having a circuit connected as shown in the drawing and having the component values set forth below, operated successfully over an extended period of time and with a large number of operations due to the presence of combustion product in the test or sampling chamber **11.** The chambers **10** and **11** were cylindrical, the chamber reference having a volume of about 0.8 cubic inches and the sampling chamber being about 25 percent larger.

The transistors were as follows: 24 field effect transistor MU-612, the unijunctions **28, 40** and **46** were all type 2N4871, diode **32** was a light emitting diode type NV10B, the control transistor **27** was a type 2N3643, the transistor **53** type 2N6099, the diodes **35** and **57** were type 1N4148, the Zener diode **35** was type 1N746A, the resistances were as follows:

17 and **19** one megohm
16–2 meghoms
18–390,000 ohms
33 and **43** – 10,000 ohms
26–82,000 ohms
31–1,000 ohms
50–12,000 ohms
30–220 ohms
41 and **47** – 180 ohms
42 and **54** – 150 ohms
The capacitors **35** and **51,** 50 microfarads
44 – one-tenth microfarad

While the invention has been described in connection with a specific embodiment thereof, various modifications and applications will occur to those skilled in the art. Therefore, it is not desired that the invention be limited to the details illustrated and described and it is intended by the appended claims to cover all modifications which fall within the spirit and scope of the invention.

What is claimed is:

1. A combustion product detector of the ionization chamber type comprising:

a. a reference ionization chamber and a sampling ionization chamber connected in series,

b. means including a variable resistor for connecting said chambers in series therewith across circuit terminals for connection to a direct current supply,

c. a field effect transistor having source and drain and gate terminals, said gate terminal being connected to the junction between said chambers, and said source and drain terminals being connected across said circuit terminals in series with an output resistance, said field effect transistor being responsive to potential changes across said sampling chamber for providing a signal in proportion thereto, and

d. means dependent upon a first predetermined signal at the output of said field effect transistor for indicating the approach of an alarm condition, and

e. means dependent upon a second predetermined signal at the output of said field effect transistor for initiating an alarm indication,

said means dependent on a first predetermined signal at the output of said field effect transistor further including a light emitting element and an oscillator for repetitively energizing said element beginning upon occurance of the first predetermined signal at the output of said field effect transistor and continuing through attainment of the second predetermined signal at the output of said field effect transistor,

said detector further including means dependent upon a predetermined signal at the output of said field effect transistor for utilizing said signal to produce an alarm indication, said signal dependent means including a control amplifier comprising a transistor connected in series with a third resistance across said source and having its base connected to the output of said field effect transistor, and wherein:

the oscillator comprises a capacitor connected in series with a portion of said third resistance and said control amplifier across said supply, and a unijunction transistor connected in series with another portion of said third resistance across said first portion and said capacitor and with its emitter connected to the junction of said capacitor and said first portion, and

the light emitting source comprises a light emitting diode connected in parallel with at least a portion of said third resistance between said unijunction transistor and said control amplifier.

2. In a combustion product detector of the ionization chamber type including a sampling chamber and a reference chamber, means for producing an output signal proportional to the density of combustion product in the sampling chamber, means for producing an amplified voltage proportional to said output signal, and means dependent upon a predetermined amplified voltage for actuating an alarm indicator, the method of calibrating the detector for determination of the density of combustion product in said sampling chamber which comprises:

introducing combustion product of a predetermined alarm density in the sampling chamber;

adjusting the voltage across the sampling chamber to produce an amplified voltage sufficient to effect actuation of the alarm indicator; and,

thereafter, determining the density of combustion product in the sampling chamber as the proportion of the predetermined alarm density in the ratio of the amplified voltage resulting from such product to said alarm actuation voltage.

3. The method of calibrating a plurality of like combustion product detectors each of the ionization chamber type including a sampling chamber and a reference chamber, means for producing an output signal proportional to the density of combustion product in the sampling chamber, means for producing an amplified voltage proportional to said output signal and means dependent upon a predetermined amplified voltage for actuating an alarm indicator, comprising the steps of:

providing like means for adjusting the voltage across the sampling chamber of each of said detectors;

providing means for measuring the amplified voltage on each of said detectors;

introducing a density of product to the sampling chamber of one of the detectors, the density being a selected fraction of the alarm density desired,

while the one detector is in operation adjusting the voltage across the sampling chamber to provide an amplified voltage equal to the same fraction of the alarm voltage as the selected fraction of the alarm density, and

calibrating each of the other detectors of said plurality by setting the respective means for adjusting the voltage across the sampling chamber to the same adjustment as that of said one detector.

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