Jan. 26, 1954 A. L. JÖRGENSEN 2,667,630

AUTOMATIC FIRE ALARM SYSTEM

Filed Dec. 21, 1951

Fig. 1.

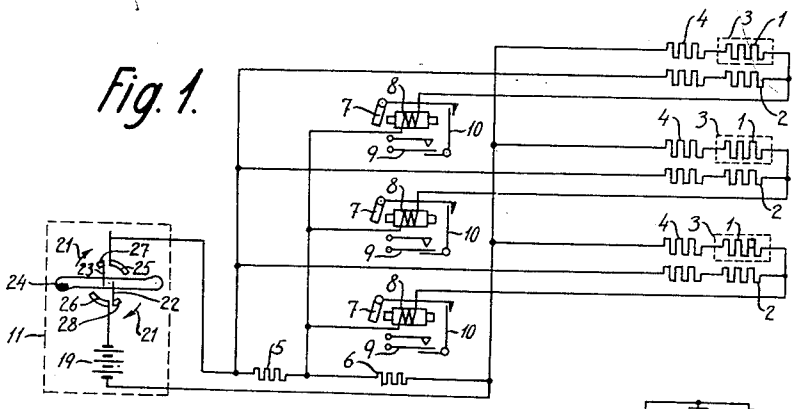


Fig. 2.

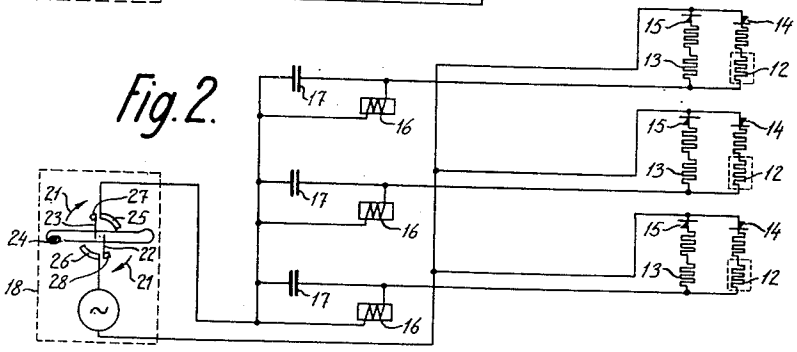
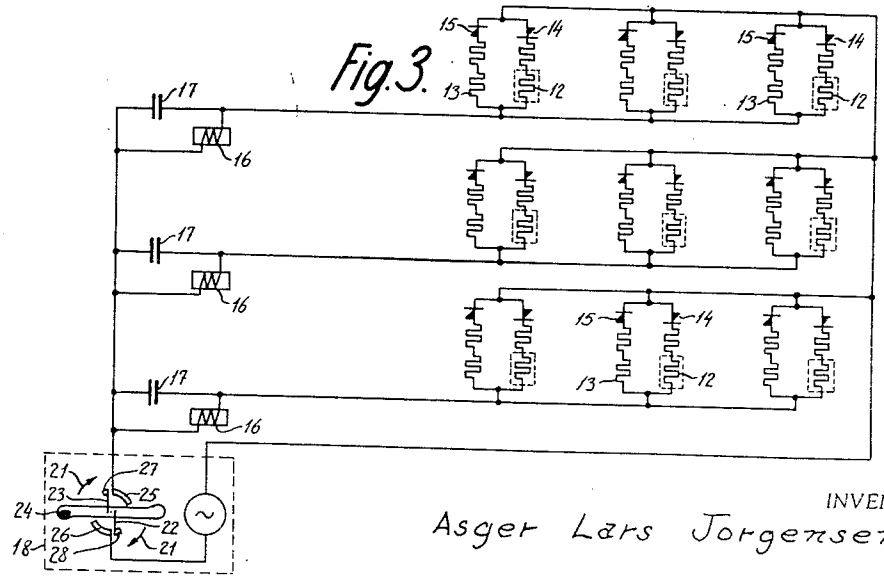


Fig. 3.



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AUTOMATIC FIRE ALARM SYSTEM

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5 Claims. (Cl. 340—227)

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This invention relates to automatic fire alarm systems of the kind comprising fire detectors mounted in positions to be subjected to temperature changes in the case of a fire and included in an electric alarm circuit comprising relays or other suitable means for operating acoustic or visible signal means or similar equipment in response to temperature changes to which any one or more of the fire detectors may be subjected.

In most automatic fire alarm systems, use is made of fire detectors in the form of bimetallic or other temperature sensitive contact making or breaking devices. Such fire detectors suffer from the drawback that they may become inoperative in the course of time owing to the presence of dirt, dust or other surface films on the contacts or by corrosion. Generally, it is therefore necessary to inspect the fire detectors from time to time, which is a rather troublesome amount of work since the fire detectors are usually distributed over a vast area and are frequently located in positions where they are not very easily accessible.

Attempts have also been made at replacing the contact making or breaking fire detectors as described by resistors included in a bridge or balance circuit. Such resistors have the advantage that since they have no movable parts and no contacts they are not likely to become inoperative and can therefore be left without inspection once they have been mounted. However, fire detectors of this type have the disadvantage of being heated by the passage of the necessary electric current in the circuit such heating tending to reduce the sensitivity of the system. Moreover, in order to avoid excessive heating of the fire detectors, it will in most cases be necessary to keep the current in the fire alarm circuit at a value so low that the variations of this current owing to changes of temperature of the fire detectors caused by the outbreak of a fire will be too small to directly operate ordinary relays and the like so that it will be necessary to incorporate electronic amplifiers or the like in the system.

It is an object of the present invention to devise a fire alarm system in which the fire detectors are constructed as resistors, and more specifically as thermo-negative resistors, i. e. resistors having a negative temperature coefficient, but where it is possible, without undue heating of the fire detectors, to employ a considerably higher current in the alarm circuit than in the known systems using fire detectors in the form of resistors.

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With this object in view, according to a principal feature of the invention, a fire alarm system comprises pairs of thermo-negative resistors, one resistor of each pair being more heat insulated from the surroundings than the other, the resistor of each pair being mounted in close proximity in positions to be heated on the occurrence of a fire so as to form a fire detector, an electric circuit in which said resistors are included, means in said circuit responsive to changes of the relative values of the two resistors of any pair when current is flowing in said circuit, and means for intermittently supplying short current pulses to said circuit, the duration of each of said pulses being small as compared with the intervals therebetween.

The invention will now be described in further detail with reference to the accompanying drawings in which Figs. 1–3 show circuit diagrams of three different forms of fire alarm systems according to the invention.

In Fig. 1, 1 and 2 are two thermo-negative resistors of approximately equal value, the resistor 1 being surrounded by a heat insulating enclosure 3 while the resistor 2 is directly exposed to the surroundings. Adjustable resistors 4 may be connected in series with the thermo-negative resistors 1 and 2 in order to permit adjustment of the apparatus. The resistors 1, 2 and 4 combine to form the individual fire detectors which are mounted adjacent to such places where a fire may occur. Thus, three fire detectors in total have been shown in Fig. 1, and each of these fire detectors has been shown as being provided with an individual detector circuit, but it will easily be appreciated that two or more fire detectors might be connected in parallel in each of the detector circuits, if desired.

5 and 6 are two series connected ohmic resistors serving as a voltage divider. In each detector circuit there is provided a relay 7 having a coil 8, a contact 9 and a drop 10. The contact 9, the connections of which are not shown in the figure, may be either a make contact or a break contact and serves in well known manner to operate suitable signal means such as bells or lamps or other acoustic or visible signal means or other fire alarm equipment or circuits of any kind. 11 is a source of voltage which is constructed to periodically supply voltage pulses of relatively short duration at suitable time intervals. The adjustment of the source 11 does not form part of the invention and a multitude of solutions are well known in the art or will readily present themselves to the expert. By way of example the

source of current 11 is shown in Fig. 1 as comprising a D. C. source 19 and a mercury tube 20 adapted to be rotated in the direction of the arrows 21 by means not shown, such as a Ferrari motor working through a worm gear or other suitable gear. The tube 20 is provided near its centre with two contacts 22 and 23, and it will be seen that twice during each revolution of the tube 20 a drop of mercury will run from one end of the tube 20 to the other and during its travel will momentarily bridge the gap between the contacts 22 and 23 to close the circuit by way of contact arcs 25, 26 and brushes 27, 28.

Under ordinary circumstances, the pulses supplied by the source 11 do not cause any passage of current through the relay coil 8, since the latter is connected between two points at equal potential. The pulse should be selected so short relative to the pauses therebetween that the thermo-negative resistors 1 and 2 are only heated to a very small extent during the pulses and have ample time to be cooled during the pauses.

Supposing now that a fire breaks out in the neighbourhood of one of the fire detectors, then the non-insulated thermo-negative resistor 2 will be heated to a higher temperature than that of the heat insulated thermo-negative resistor 1. The resistance value of the former will accordingly be decreased, and during each pulse supplied by the source 11, a current will flow through the relay coil 8, such current being the higher, the greater the temperature difference between the two thermo-negative resistors 1 and 2. By suitably selecting the resistance values of the resistors and the relay coil, and also the operating voltage, the relay may e. g. be adjusted to operate at a temperature difference of 20° C. when the ambient temperature is 40° C. The sensitivity increases with increasing ambient temperature. Thus, the apparatus may e. g. operate at a temperature difference of 8° at an ambient temperature of 80°.

The values and temperature negative characteristics of the resistors 1 and 2, the periodicity and make-to-break ratio of the source of current 11 and its operating voltage will of course be selected in accordance with the requirements in each individual case. As an example, the thermo-negative resistors may be made from magnesium titanium spinel (a mixture of MgO and TiO_2), one specific form of this material having a temperature coefficient of —74 per cent per °C. The value of the resistors 1 and 2 may be 1500 ohms, and the source 11 may supply one pulse per minute, each pulse having a duration of $\frac{1}{10}$ second. The voltage of the source 11 may be 60 volts.

In the embodiment of Fig. 2, 12 is a heat insulated thermo-negative resistor, 13 a non-insulated thermo-negative resistor, 14 and 15 are rectifier cells, 16 a relay coil and 17 a condenser. In this embodiment, a source of voltage 18 supplies relatively short pulses of alternating current of a suitable frequency at suitable time intervals. As an example, the periodicity and the duration of the pulses may be the same as the embodiment of Fig. 1, and the frequency may be of the size of order of 5000 cycles. The source 18 has been illustrated in Fig. 2 in the same manner as in Fig. 1 with the only difference that the D. C. source 19 has been replaced by an A. C. source 29.

Each pulse supplied by the source 18 comprises several cycles of alternating current, and of each cycle one half will be admitted through the resistor 12 and the other half cycle through the resistor 13, since the two rectifier cells 14 and 15 are arranged to be conductive in opposite directions.

The relay coil 16 is constructed for D. C. operation and has a reactance value of a size such that in ordinary circumstances the alternating current thus admitted through the resistors 12 and 13 in parallel by-passes the coil 16 and flows through the condenser 17.

If a temperature difference between the thermo-negative resistors 12 and 13 occurs in the case of a fire, the half cycles admitted through these two resistors will no longer be equal, and consequently the detector circuit will carry a superposed D. C. which takes its way through the relay coil 16 during the pulse supplied from the source 18 whereby the relay is caused to operate.

It will thus be seen that the main principle of the alarm system of Fig. 2 is the same as that of the alarm system of Fig. 1, and the system of Fig. 2 may be constructed to have the same sensitivity as that of Fig. 1. It is an advantage of the system of Fig. 2 that the detector circuits, that may extend over relatively large distances, are in the form of two-wire circuits as against the three-wire circuits of Fig. 1.

Fig. 3 shows an example of how a plurality of fire detectors of the kind illustrated in Fig. 2 may be connected in parallel in each detector circuit. In this embodiment, one half cycle of the A. C. delivered from the source 18 will be admitted in parallel through all of the resistors 13 of the fire detectors of a circuit, while the other half cycle will similarly be admitted through the corresponding resistors 12. Under ordinary circumstances, the two half cycles will be equal. However, if one or more of the parallel-connected fire detectors are heated, the current will be higher during one half cycle than during the other, and the relay 16 of the relevant detector circuit will operate.

It will be seen that in all of the embodiments described, the only equipment that is distributed over the whole of the building or the like to be protected is the fire detectors, which need not be inspected, because they do not comprise movable parts or contacts that might become deficient in the course of time. All the relays, and if desired also the source of current may be collected at a central control board where inspection and checking may easily be carried out.

Moreover, it will be seen that since current is supplied to the detector circuit only during short time intervals with ample pauses in between, heating of the thermo-resistors will be reduced to a minimum. Consequently, it is also possible to employ a relatively high current during the pulses, and in fact, it has been found possible to employ a current so high that the variations thereof caused by unequal heating of the thermo-negative resistors in the case of a fire will suffice to operate an ordinary reliable relay of the type used in telephone systems. For all practical purposes the use of periodic pulses instead of a continuous current does not result in any reduction of the reliability of the fire alarm system since a checking of the condition of the fire detectors is effected at intervals so short that the delay of the fire alarm that may theoretically result, will at any rate be negligible.

Considering now again the embodiment of Fig. 1, the current flowing through the relay coil 8 may be directly calculated as the difference between the currents through the resistors 2 and 1.

When the values of these resistors are equal, the currents flowing therethrough will likewise be equal. This will apply as long as the temperatures of the resistors are equal, no matter whether these temperatures are high or low, or in other words no current will flow through the relay coil as long as there is no temperature difference between the resistors 1 and 2. In a modified embodiment, the resistor 2 may be constructed to have a numerically higher temperature coefficient than the resistor 1, whereby a rise of temperature will cause a current to flow through the relay coil 8, even if the temperatures of the two resistors remain equal. Consequently, the relay may be adjusted so as to operate at a predetermined temperature in the room in which the fire detector is mounted even if the rise of temperature in the said room is infinitely slow.

To prevent operation of the relay in the case of decreasing temperature, or particularly low temperature, a rectifier may be connected in series with the relay coil 8. Also in the embodiment of Fig. 2, it will be possible with the same result to employ resistors having different temperature coefficients, and it is likewise possible in this embodiment to connect a rectifier in series with the relay coil 16 in order to eliminate the possibility of improper operation in the case of decreasing temperature or very low temperature.

Resistors having different temperature coefficients may be obtained in various ways. Thus, it is possible to use different thermo-negative resistance materials. According to one specific example, one resistor may be made from magnesium titanium spinel as above described, e. g. having a temperature coefficient of —74 percent per ° C., while the other resistor may be constructed from a mixture of NiO and Mn_2O_3 in proportions such as to obtain a temperature coefficient of —44 percent per ° C. Alternatively, each of the thermo-negative resistors may be produced by connecting ordinary, non-thermo-negative resistors of different values in series or parallel with thermo-negative resistors of one and the same type.

In fire alarm systems having a relatively large number of fire detectors, the two series-connected resistors 5 and 6 of Fig. 1 may be omitted.

The relays of Figs. 1 and 2 are electromagnetic relays. However, it is also possible within the scope of the invention to use other current responsive relay types, and while it has been mentioned above that fire alarm systems according to the invention may be constructed to operate without amplification of the detecting current, it goes without saying that such amplifiers may nevertheless be used if this is found desirable in any particular case.

I claim:

1. An automatic fire alarm system comprising pairs of thermo-negative resistors, one resistor of each pair being more heat insulated from the surroundings than the other, the resistors of each pair being mounted in close proximity in positions to be heated on the occurrence of a fire so as to form a fire detector, an electric circuit in which said resistors are included, means in said circuit responsive to changes of the relative values of the two resistors of any pair when current is flowing in said circuit, and means for intermittently supplying to said circuit, short current pulses of an amplitude high enough to be capable of individually operating said responsive means, and a duration and a make-to-break ratio small enough to substantially avoid heating of said thermo-negative resistors above the surrounding temperature.

2. An automatic fire alarm system as in claim 1, in which said electric circuit is a bridge circuit in which the thermo-negative resistors of a pair are interposed in different branches.

3. An automatic fire alarm system as in claim 1 in which said current supplying means is constructed to supply D. C. pulses.

4. An automatic fire alarm system as in claim 1 in which rectifiers having opposite directions of conductivity are connected in series respectively with the two thermo-negative resistors of a pair, said current supplying means being constructed to supply A. C. pulses.

5. An automatic fire alarm system as in claim 1 in which the two thermo-negative resistors of a pair have mutually different temperature coefficients.

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