May 9, 1939. P. P. HORNI 2,157,237

FIRE ALARM SIGNALING SYSTEM

Filed April 19, 1938

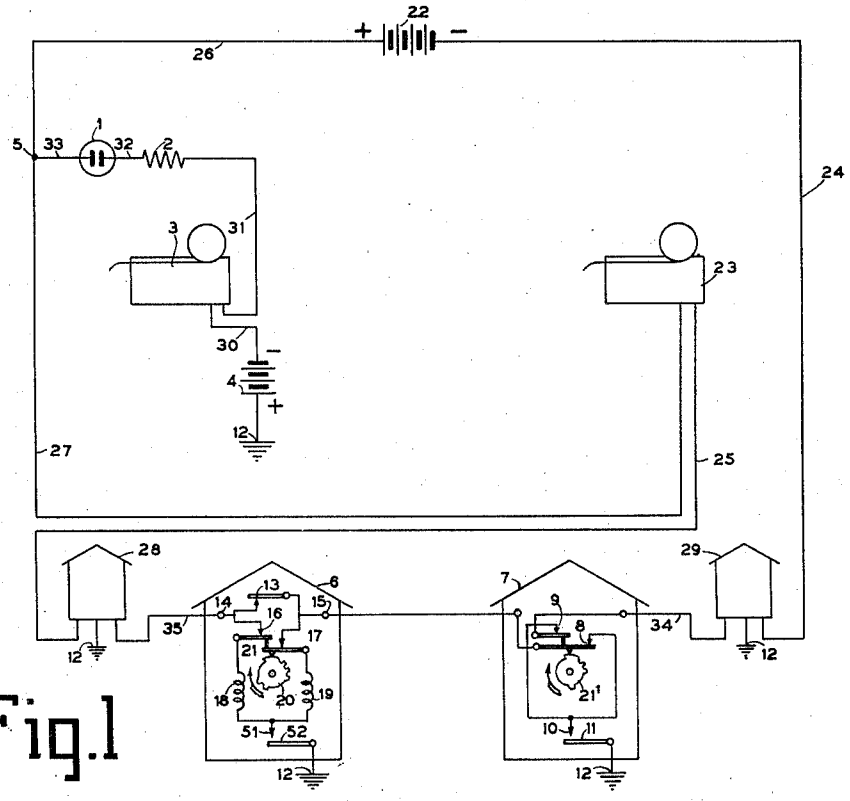


Fig.1

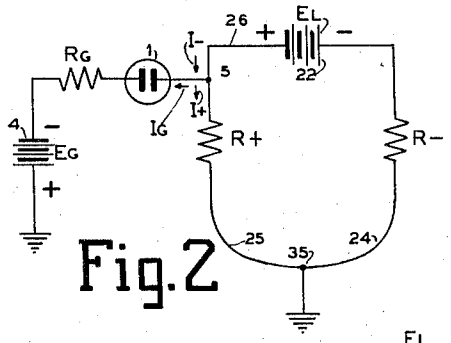


Fig.2

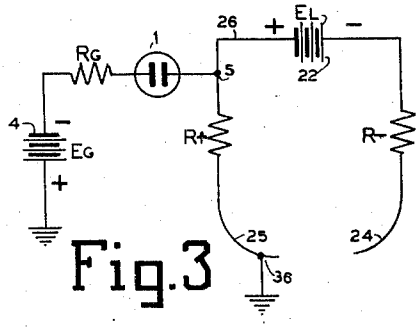


Fig.3

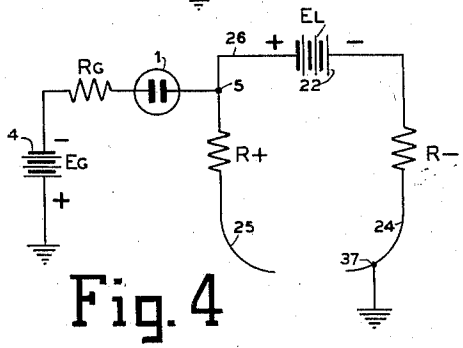


Fig.4

INVENTOR.
PAUL P. HORNI

BY Herbert A. Smith
HIS ATTORNEY.

Patented May 9, 1939 2,157,237

UNITED STATES PATENT OFFICE

2,157,237

FIRE ALARM SIGNALING SYSTEM

Paul P. Horni, Newark, N. J.

Application April 19, 1938, Serial No. 202,863

3 Claims. (Cl. 177—367)

There have been, in the past, numerous fire alarm systems which have been arranged to transmit and receive signal impulses, normally, over a closed loop circuit, and under certain conditions over an additional or auxiliary circuit. The auxiliary circuit is usually normally open and includes the ground or other common return conductor as one branch, and both sides of the closed loop circuit, or portions thereof as the other branch. It is customary in systems of this type to employ transmitters or signal initiating stations which will not only formulate impulses in the closed loop circuit, but which will also formulate impulses in the auxiliary circuit comprising the ground or common return conductor. In certain instances signals are not formulated in the ground circuit, unless there is a prolonged absence of current in the loop circuit during signaling operation of a transmitter.

Numerous methods of interconnecting the auxiliary circuit and the closed loop have previously been devised. These include the superimposition of an alternating potential between the closed loop and ground. This will ordinarily require the use of coupling devices or their equivalents to establish separate current paths for the direct and alternating currents.

Systems employing direct current exclusively are well known, and generally include a grounded battery at the central office, and a manifesting device in the ground circuit, or controlled by current flow therein.

The present invention contemplates the use of a grounded battery or other source of unidirectional current, but may be used equally well with alternating current. One of the major advantages of this invention is the withholding of substantial circuit continuity in the auxiliary circuit until a signal originates therein. Leakage currents from the loop to the cable sheath or common conductor which common conductor need not necessarily be the sheath of the cable, will flow to cause a deterioration of the cable. In certain instances this condition may require more than the conventional type of apparatus to assist in decreasing the leakage currents which result in electrolysis. The gaseous tube has been found to solve this problem by eliminating leakage currents while permitting the signal transmitter to cause a low resistance ground which will be of a sufficient potential to cause the breakdown of the gaseous tube and permit signal impulses to be truly recorded on the manifestation device connected with the auxiliary conductor. Another advantage is the continuous visual indication of circuit conditions afforded by the use of a gaseous discharge tube in the auxiliary circuit. The presence of conditions involving reduced insulation resistance to the ground or return conductor will be manifested by a glowing of the gaseous discharge tube, the brightness of illumination affording a measure of the seriousness of the insulation fault.

An object of this invention is to provide a means of interconnecting a closed fire alarm circuit of the conventional type and an auxiliary circuit in which substantial circuit continuity of the auxiliary circuit is normally withheld until a signal originates in the auxiliary circuit.

A further object of this invention is to provide a means of interconnecting a closed fire alarm circuit of the conventional type and an auxiliary circuit by including a gaseous discharge device having a pre-determined break-down voltage and being substantially non-conductive until said break-down voltage is reached, whereby current will flow through said auxiliary circuit only when said gaseous discharge device is conductive, whereby the electrolysis produced in the grounded portion of said auxiliary circuit is substantially reduced.

A further object is to provide a means for withholding substantial circuit continuity which will likewise serve as a visual indicator of insulation conditions in the loop circuit associated therewith.

Other and further objects may be or may become apparent from a perusal of the specification and drawing.

Figure 1 shows a schematic circuit drawing of the invention as applied to a single fire alarm loop circuit.

Figures 2, 3, and 4 illustrate the circuit relation under various abnormal conditions of the loop circuit.

Referring to Figure 1, the closed loop circuit comprises conductors **25**, **35**, **34** and **24**. Serially connected in the loop circuit are signal initiating stations or transmitters **28**, **6**, **7**, and **29**. The transmitters may be of any desired type, capable of formulating signals in the closed loop circuit, and in addition, being provided with mechanism for formulating signals in the auxiliary circuit which comprises a common return conductor indicated in Figure 1 by the several ground symbols, **12**.

In the transmitter **6**, contacts **13** normally provide a current path of low resistance around signaling contacts **16** and **17** and noninterference magnets **18** and **19**. In the beginning of opera-

tion of transmitter 6, contacts 13 disengage, and the current in the loop circuit is thereafter subjected to the signal formulating action of contacts 16 and 17 which open and close substantially simultaneously in response to the motion of cam follower 21. The character wheel or code wheel 20 is cut with spaced depressions which allow cam follower 21 to drop therein at intervals, thus periodically opening the loop circuit and creating impulses therein in accordance with the cutting of the code wheel 20.

In the event that the current in the loop circuit is insufficient to operate the non-interference mechanism, and if the current remains at this low value for a predetermined interval longer than the longest normal open period incident to the formulation of any signal, the transmitter will thereafter close ground circuit contacts 51 and 52. With contacts 51 and 52 in engagement, the simultaneous action of contacts 16 and 17 will connect and disconnect terminals 14 and 15 from each other and from ground 12.

The transmitter 7 operates in a manner similar to transmitter 6, except that contacts 10 and 11 are arranged to close, whenever the signaling mechanism is in operation. Signaling contacts 8 and 9 will connect and disconnect the two terminals of the loop circuit from each other and from ground 12.

In each transmitter, in order to avoid an extra unintended signal impulse in the auxiliary circuit, ground contacts 51, 52 and 10, 11 should close shortly before their respective signal contacts 16, 17 and 8, 9 open for the first impulse, and should open during the open period of the final impulse and before final closure of the signaling contacts. If this condition is satisfied, it will be immaterial whether response of manifesting device 3 occurs upon energization or deenergization of its circuit through conductors 30 and 31.

The manner of operation of transmitters 6 and 7, as described above is old in the art and is merely illustrative in connection with the present invention. Numerous types of transmitters suitable for use with the invention are well known, and it is believed that detailed description thereof would be superfluous.

Under normal conditions, unless signals are formulated in the auxiliary signaling circuit through ground 12, only manifesting device 23 will respond. The normal current delivered by battery 22 flows over conductors 26, 27, 25, 35, 34, and 24 energizing manifesting device 23. Interruption of this current by the signaling contacts of the transmitters 28, 6, 7, or 29 will cause operation of manifesting device 23.

If any transmitter formulates a signal in the circuit of ground 12, current will flow over conductor 30, through manifesting device 3, conductor 31, resistor 2, conductor 32, gaseous discharge tube 1 and conductor 33, to junction point 5. From 5, the current will flow over either or both branches of the loop circuit, depending upon circuit conditions, to the transmitter. The negative branch includes conductor 24 and the other or positive branch includes conductor 25. The voltage of battery 4 exceeds the critical voltage of discharge tube 1 by a safe margin, so that breakdown of the tube will always occur upon grounding any portion of the loop circuit. The flow of current from battery 4 will operate manifesting device 3.

If the insulation between the closed loop circuit and ground 12, becomes faulty at any point, a sufficient current may flow from battery 4, through discharge tube 1, to cause a faint glow, the amount of illumination bearing a definite relationship to the seriousness of the insulation fault even though the current may be insufficient to operate manifesting device 3. Thus, discharge tube 1 performs the dual functions of a visual indicator of insulation conditions and of a valve, maintaining an exceedingly high resistance in the circuit of conductors 32, and 33, at least until the voltage across the tube terminals reaches the critical voltage value of the tube 1.

Figure 2 shows a highly simplified circuit drawing of the invention operating under conditions in which the loop circuit is unbroken. E_G represents the voltage of battery 4. R_G represents the total effective resistance in the auxiliary signal circuit, including the resistance of the ground or other conductor included in the common return path, the internal resistance of battery 4, the internal resistance of manifesting device 3, resistor 2, and the internal resistance of gas discharge tube 1. Similarly R_+ represents the total circuit resistance between junction point 5 and the point 35, at which ground is applied. R_+ includes the resistance of manifesting device 23, and the total circuit resistance out to point 35. R_- includes all resistance between point 5 and point 35, considering the path starting at point 5 and passing through battery 22. R_- includes the internal resistance of battery 22 and the resistance of any devices connected in conductor 24 of Fig. 1, and also the circuit resistance to point 35. E_L represents the voltage of battery 22. Let I_G represent the current which will be delivered by battery 4 in Fig. 2. If E_L is zero, I_G will be:

$$\frac{E_G}{R_G+\frac{(R_+)(R_-)}{(R_+)+(R_-)}}$$

If E_G is zero, the ground current I_G will be:

$$\frac{E_L\left[\frac{R_+}{(R_+)+(R_-)}\right]}{R_G+\frac{(R_+)(R_-)}{(R_+)+(R_-)}}$$

The actual current flow will be the sum between the currents due to E_G and E_L and will therefore be:

$$\frac{E_G-E_L\left[\frac{R_+}{(R_+)+(R_-)}\right]}{R_G+\frac{(R_+)(R_-)}{(R_+)+(R_-)}}$$

It will be noted that

$$E_L\left[\frac{R_+}{(R_+)+(R_-)}\right]$$

represents the voltage drop in R_+ due to E_L with the ground circuit opened. The denominator of the expression for

$$I_G: R_G+\frac{(R_+)(R_-)}{(R_+)(R_-)}$$

represents the total resistance opposing the flow of current through ground.

Referring to Fig. 3, it will be noted that the loop has been broken, and that ground is applied to a point 36 connected to R_+. The current I_G will now be:

$$\frac{E_G}{R_G+R_+}$$

Referring to Fig. 4, the loop has been broken, and ground has been applied to a point 37 con-

nected to R–. Because E_G and E_L are cumulative, I_G will now be:

$$\frac{E_G+E_L}{R_G+R_-}$$

In order that the currents in Figs. 2, 3, and 4 may be of the same order of magnitude, the ratio

$$\frac{R_-}{R_+}$$

should be large. In this case, the current in Fig. 2 will become substantially

$$\frac{E_G}{R_G+R_+}$$

which is the value of current in the case of Fig. 3.

In Fig. 4, however, the current will be greater because of the addition of voltage E_L to give

$$\frac{E_G+E_L}{R_G+R_-}$$

Hence if E_G is large with respect to E_L and R_G is large with respect to R– the difference between the expressions

$$\frac{E_G}{R_G+R_+}$$

and

$$\frac{E_G+E_L}{R_G+R_-}$$

may be made sufficiently small so that the range of current values for I_G in Figs. 2, 3, and 4 will not exceed the practical working limits for discharge tube **1**, and manifesting device **3**.

A further reason for having R_G large, is that in Fig. 2, I_G increases as I_+ diminishes. If a balanced condition is reached where $I_+=0$ or substantially zero, then transmitters in the circuit of R_+, between points **5** and **35** will have no current available for signal formulation, and furthermore since I_+ will be zero, all portions of the circuit from point **5** through R_+ to point **35** will be substantially at the same potential as ground, and no effective signal can be formulated in any current path between such equipotential points.

If it is desired to prevent the possibility of occurrence of such a balanced condition, R_G may be made large so that the current in Fig. 2 will be from 10 per cent to 30 or 40 per cent of I_-. In this case, from 60 to 90 per cent of the normal current will be available in R_+ under the conditions of Fig. 2, and devices in the circuit may be selected to respond accordingly. When R_G is thus selected, under the conditions of Fig. 2, there will be from 60 to 90 percent of normal current in R_+ and somewhat more than normal current in R–.

By including the manifesting device **23** as a part of R–, signal impulses formulated in R_+ will cause the current in R– to reverse to 10% to 40% of its normal value. Under these conditions reliable operating adjustment of manifesting device **23** will be easily obtained, since its magnet will be required merely to operate on 50% or more of normal current and not to operate when 10% to 40% of normal current is applied in the reverse direction. It will not be required to release against the latter current. The natural effects of residual magnetism are thus overcome and it is unnecessary to resort to a manifesting device of polarized construction or otherwise capable of discriminating with respect to direction of current flow.

The foregoing is explanatory of the results which may be expected from the present invention, insofar as the relative effect of certain of the circuit constants is concerned. It is to be noted that the resistance relationships recommended are for the purpose of obtaining optimum operating results as indicated, but these results are incidental merely to the invention itself, and many of the benefits of the invention such as a visual indication of current flow may be obtained without adopting the suggested resistance relationships.

It must be noted that auxiliary manifesting device **3** must respond to minimum and maximum current values depending upon the particular conditions in each instance. Similarly, discharge tube **1**, must be so selected that it shall successfully allow passage of the maximum current under conditions in Fig. 4, and correspondingly, source **4** must deliver sufficient voltage to exceed by a safe margin, the critcial voltage of discharge tube **1**, under the conditions in Fig. 2.

All resistors for adjusting the normal line current, millimeter, voltmeters, switches, current supervisory relays, and other devices of like character, have been omitted from the drawing for the sake of simplicity.

Resistor **2** may be omitted entirely, or may have any desired value, as required, to limit the ground current to the desired value. Also, it should be noted that by locating manifesting device **23** between junction **5** and conductor **25**, a small reversed current will flow instead of substantially no current, during signaling under grounded line conditions in Fig. 2 by a transmitter in the negative portion of the loop circuit between the ground fault **35** and conductor **24** and the negative terminal of source **22**. Because the value of the current passing through manifesting device **23** reverses, conditions are more favorable for operation of any magnets of device **23**. If manifesting device **23** were included in conductor **26** or **24** and signals were received from a transmitter in conductor **25**, then a reduced current would flow in the same direction, and manifesting device **23** would be designed for marginal operation.

From the foregoing it will be observed that the gaseous tube may be utilized to test the degree of insulation breakdown on the system, and may also be utilized for the purpose of station identifying signaling by causing manifestation devices at Fire Headquarters to be operated in response to signal impulses from a conventional fire alarm signal initiating station.

While specific details of the system have been herein shown and described, the invention is not confined thereto as changes and alterations may be and may become apparent to those skilled in the art without departing from the spirit thereof as defined by the appended claims.

Having thus described the invention, what I claim as new and desire to secure by Letters Patent of the United States, is:

1. In a fire alarm system having a normally closed, energized loop circuit having fire alarm signal transmitters and a manifestation device serially connected therein, a common return conductor, means in each of said signal transmitters to connect said energized loop to said common return conductor to transmit a station identification signal; an auxiliary source of electrical energy, a gaseous discharge tube and an auxiliary manifestation device connected in series between said loop and said common return conductor, whereby substantial circuit continuity between said loop and said auxiliary conductor will be withheld until a low resistance current path is established between said common return conductor and said loop.

2. In an alarm system having a plurality of signaling stations and a manifestation device connected in a normally closed energized loop circuit, a common return conductor, each signaling station having mechanism to successively open said loop circuit and connect said loop to the common return conductor to transmit an alarm, an auxiliary source of electrical energy and an auxiliary manifestation device in series between said loop circuit and said common return conductor; a gaseous discharge tube in series with said auxiliary source of electrical energy, signaling stations, and loop, whereby small values of leakage current between said loop and said common return conductor are substantially eliminated.

3. In an alarm system having a plurality of transmitting stations, each station having normally closed contact means and a normally open contact means with mechanism to successively open and close said contact means upon operation of a station to transmit a signal, said normally closed contact means being connected in series circuit with a source of electrical energy and a manifestation device, a common return conductor, said normally open contact means being connected in parallel with said series circuit and said common return conductor and an auxiliary manifestation device and source of electrical energy connected in series between said common return conductor and said first named source of electrical energy; a gaseous discharge tube in series with said auxiliary source of energy, manifestation device and common return conductor, whereby substantial circuit continuity between said auxiliary energy source and said common return conductor will be withheld until a low resistance current path is established between said auxiliary conductor and said loop.

PAUL P. HORNI.