

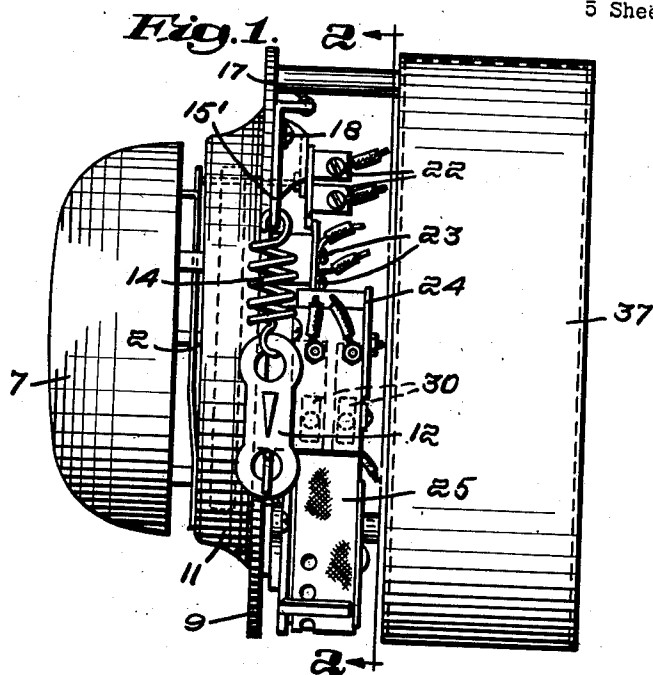
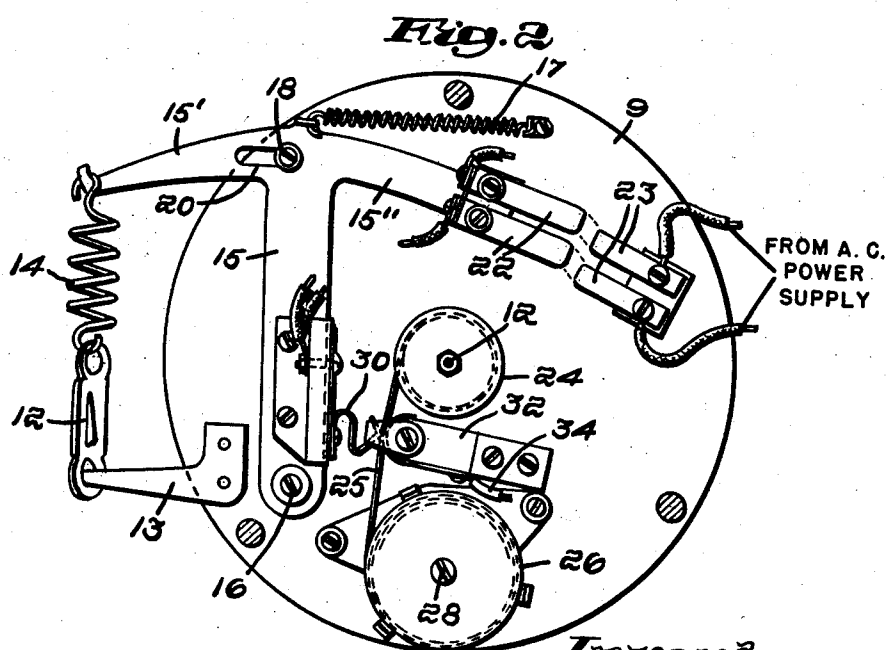
March 30, 1954

J. M. KEARNEY ET AL
FIRE ALARM SYSTEM

2,673,975

Filed Feb. 15, 1949

5 Sheets-Sheet 1



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5 Sheets-Sheet 2

Fig. 3.

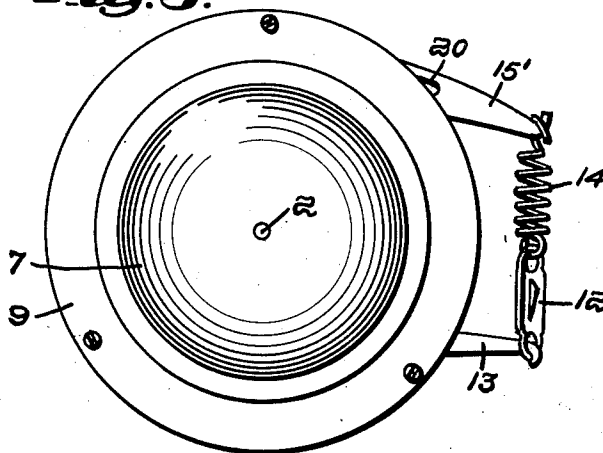


Fig. 4.

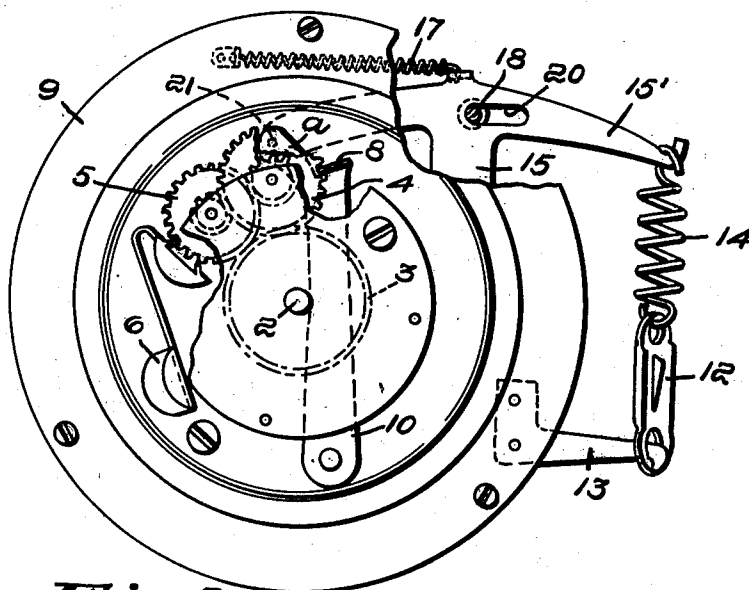
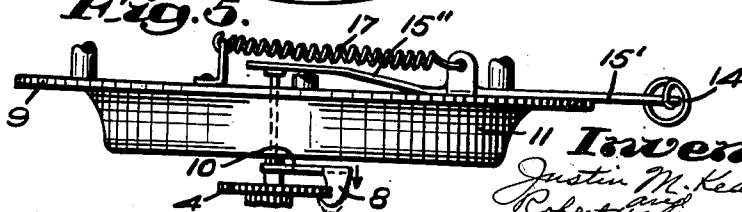


Fig. 5.



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5 Sheets-Sheet 3

Fig. 6.

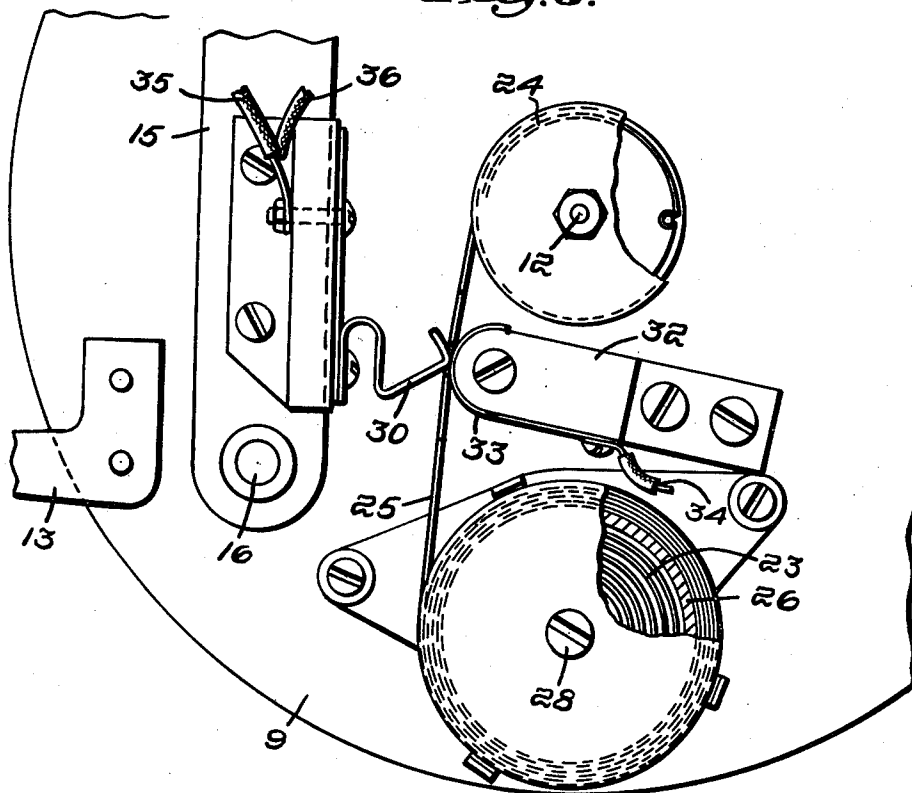
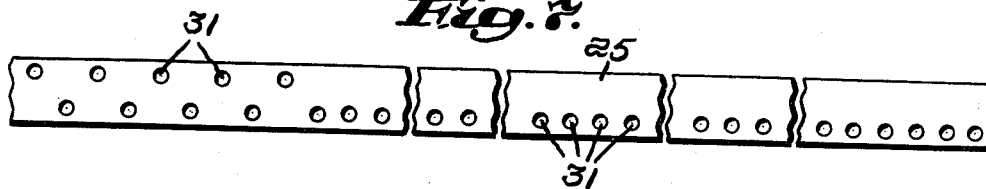


Fig. 7.



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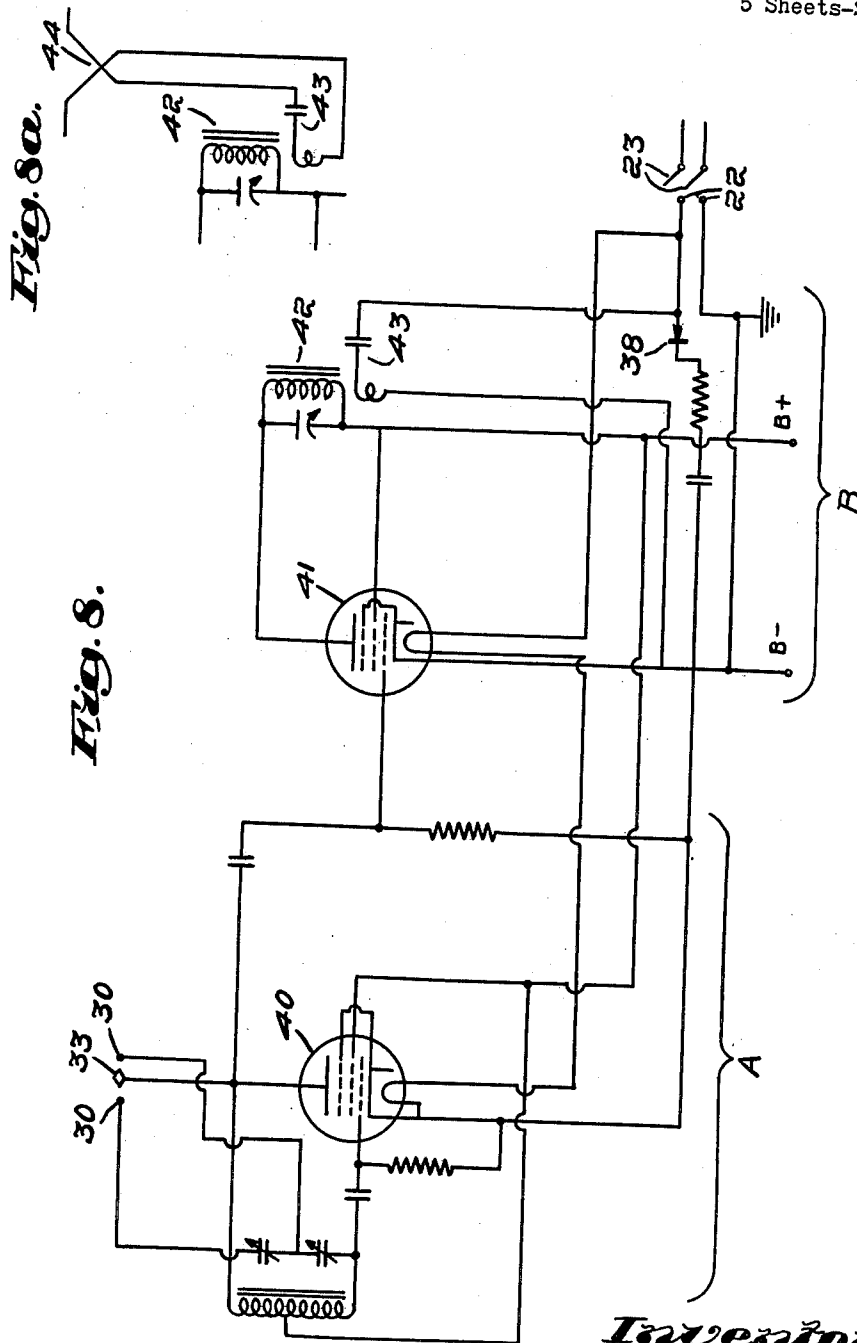
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FIRE ALARM SYSTEM

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5 Sheets-Sheet 4



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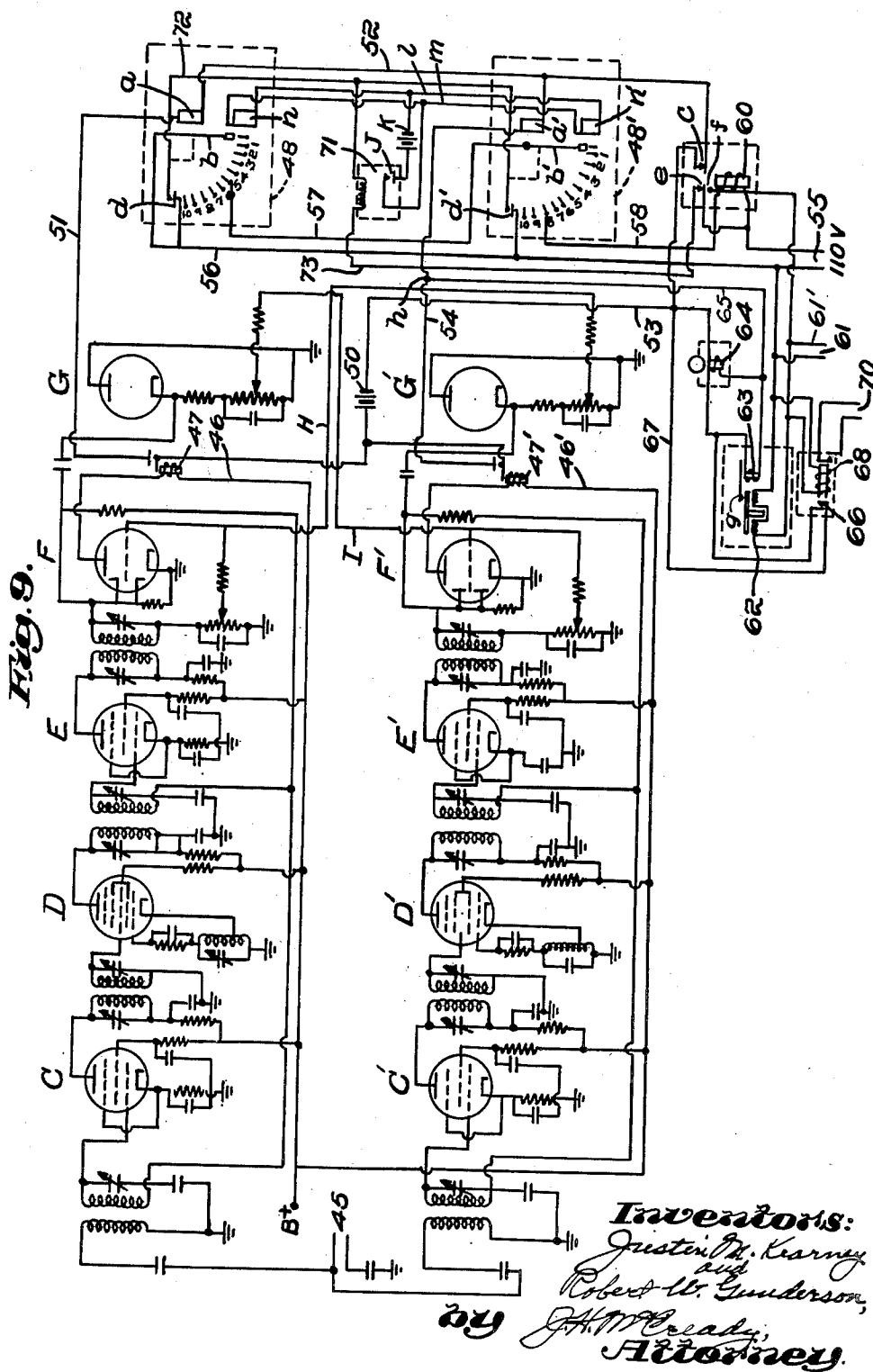
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FIRE ALARM SYSTEM

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5 Sheets-Sheet 5



UNITED STATES PATENT OFFICE

2,673,975

FIRE ALARM SYSTEM

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6 Claims. (Cl. 340-219)

1

In large buildings, such as hospitals, schools, hotels, and others, and also in thickly forested areas, tree farms, coal piles, shipsholds, and the like, where fires can start and acquire considerable momentum without their presence being immediately discovered, the problem of protecting lives and property becomes an exceedingly serious one. While fire alarm systems are available for use in such areas, they are complicated and so expensive that the financial investment required to install them is a serious deterrent to their use.

The present invention is especially concerned with the problem presented by these circumstances and it aims to devise a thoroughly practical solution for that problem. The invention involves both a novel method and also a novel apparatus or system.

The nature of the invention will be readily understood from the following description when read in connection with the accompanying drawings, and the novel features will be particularly pointed out in the appended claims.

In the drawings,

Fig. 1 is a side elevation of a detecting and transmitting unit which forms an important part of this invention;

Fig. 2 is a sectional view taken approximately on the line 2-2, Fig. 1;

Fig. 3 is a left-hand elevation of the apparatus as shown in Fig. 1;

Fig. 4 is a plan view of the unit illustrated in Fig. 2 with the bell removed;

Fig. 5 is an edge view of the apparatus shown in Fig. 4;

Fig. 6 is a view on a larger scale of some of the parts shown in Fig. 2;

Fig. 7 is a plan view of a section of the tape perforated in accordance with a simple code;

Fig. 8 is a diagram of the radio transmitting apparatus;

Fig. 8a is a diagrammatic view of an antenna connection which may be used in the circuit shown in Fig. 8; and

Fig. 9 is a diagram of the apparatus for receiving the transmitted signals and converting them into suitable alarm indications, which may be either audible, visual, or recorded.

Preliminary to a detailed description of the construction shown in the drawings, it may be pointed out that the method provided by this invention consists essentially in detecting the presence or imminence of a fire through the use of some thermo-responsive element; causing the response of that element to the presence of an

2

abnormally high temperature at the area to be protected to release a coded signal which is transmitted by waves of radio frequency to a distant point, at which information as to the fire or the danger of it is desired; and at that point receiving the radio signals and causing them to indicate both the fact of the fire and its location. Such indications may include sounding an alarm of some type, or in any other suitable manner.

An apparatus for performing this method automatically comprises a detector which may or may not control a local alarm, as desired, but which does control the operation of a radio transmitter, together with the circuits necessary to preheat the transmitter and to deliver a coded signal to it. The transmitter sends out the signal pulses at radio frequencies. At a distant point, which may be a fire station, a central power station for a hospital, school, or hotel, or which may be at any other desired location, such signal pulses are utilized to actuate suitable mechanism for indicating the presence of the fire either by sounding an alarm; turning on a signal light; making a suitable record; or by appropriate combinations of such apparatus. It is contemplated that a large number of detector units will be associated with a single receiving set or station.

Detector

Referring to Figs. 1 to 6, the detector unit there shown comprises a spring-actuated gear train of a common form arranged to revolve a shaft 2, Fig. 4. While this mechanism may take various forms, the particular construction shown includes a gear 3 fast on said shaft and meshing with reducing gears including a latch gear 4 and another gear 5 arranged in the usual manner to operate the clapper 6 of a bell 7 which is screw-threaded on to the shaft 2. A latch 8 fast on a lever 10 normally engages the teeth of the gear 4 and prevents rotation of the gear system. A spring (not shown) enclosed in a portion 11, Fig. 5, of the base, operates on the shaft 2 with a strong tendency to rotate it in a counterclockwise direction, and it is pre-tensioned by winding it in the opposite direction, a pawl and ratchet mechanism being provided to hold the power stored in it. This mechanism is of a common form and no novelty is here claimed in it, except that the latch 8 and lever 10 have been provided for the purposes of this invention. When once released the spring 2 unwinds, rotating the shaft 2 with the bell, and the latter sounds until either the latch is man-

3
ually restored to its latching position or the apparatus runs down. It is designed to operate continuously for about five minutes.

The detecting element used in this apparatus consists of a fusible link 12 anchored at one end on a stationary hook 13 which is secured to the base 9 of the bell unit, while its opposite end is connected by a spring 14 with a hook 15' which forms one arm of a T-shaped lever 15 fulcrumed on the base at 16, Fig. 2. A coiled spring 17 acts on this lever with a tendency to swing it toward the right, Fig. 2, and the extent of this swinging movement is limited by the pin 18 extending through a slot 20 in the lever. Another arm 15'' of this lever has an inclined portion shown in Fig. 5 which is adapted to ride over the head of a pin 21. When the lever is swung in a clockwise direction, Fig. 2, sufficiently to bring this inclined surface across the end of the pin 21, where it pushes the pin endwise, the opposite end of this pin then engages an extension a, Fig. 4, of the lever 10 and lifts it far enough to release the latch 8 from the gear 4, as will best be seen from an inspection of Fig. 5.

This arm 15'' of the lever 15 also carries two contacts 22, Fig. 2, of an electric switch, the cooperating contacts of which are shown at 23. It controls the flow of current to the power tubes of the transmitter.

Thus, when the fusible link 12 melts out, the spring 17 swings the lever 15 in a clockwise direction, Fig. 2, and closes the switch 22—23 at the same time that it releases the bell operating mechanism and gives the local alarm.

A further function performed at this time by this mechanism is that of bringing into operation the "key" through which the coded signal is sent.

Referring to Figs. 2 and 3, it will be observed that mounted fast on the lower end portion of the shaft 2 is a drum 24 on which one end of a tape 25 is wound and to which it is secured. The opposite end of this tape is wound on a second drum 26. Inside the latter is a coiled spring 27, one end of which is fastened to a stationary shaft 28, located at the axis of the drum, while the other end is attached to the drum 26 upon which the tape is wound. When the latch 8 is tripped, as above described, and the bell-operating mechanism unwinds, thus rotating the shaft 2, the rotation of the drum 24 so produced winds the tape 25 on it, at the same time winding up the spring 27.

Bearing on this tape are two spring contacts or brushes positioned side by side, one of which is best shown at 30 in Fig. 6. The other is a duplicate of it and they bear on opposite marginal portions of the tape 25. This tape is made of insulating material and, as best shown at 31 in Fig. 7, it is perforated along its margins, in accordance with the nature of the code to be sent out and also to meet the electrical requirements attending the broadcast of the code. Immediately under the tape, and directly opposite the points at which the contacts 30 bear on it, is a guide 32, Fig. 6, having a rounded end which is covered by a metal strip 33. This contact 33 is connected by a conductor 34 to one side of the oscillator tank circuit, while the contacts 30 are connected, respectively, to conductors 35 and 36 which lead to elements of the transmitter, as will later be referred to in connection with Fig. 8.

It will be seen from the foregoing, however, that as the tape passes between the contacts 30 and 33 one or the other of the brushes 30 will

make contact with 33 at points where it drops through the perforations 31. When such a contact occurs, an instantaneous flow or pulse of current passes between the brush making such contact and the contact 33, and these pulses are of predetermined duration and spacing, depending on the size and spacing of the perforations so that they may readily be utilized in sending out a coded signal.

Thus, when the thermo-responsive element 12 melts out, due to a rise in temperature above a predetermined value at the detector, three things automatically occur:

1. A latch 8 is released which allows the spring-operated alarm bell to ring;
2. A switch is closed which powers the transmitter; and
3. The action of the mechanism which delivers the coded signal to the transmitter is initiated.

Transmitter

The transmitting apparatus preferably is housed in the casing 37, Fig. 1, which is releasably secured to the base 9 of the detecting apparatus. It comprises a master oscillator of the Hartley type indicated, in general, at A, Fig. 8, to which is coupled a power amplifier B. Circuits of this type are well known so that no detailed description of them is deemed necessary. As above indicated, the closing of the switch 22—23 connects the transmitter with a power supply system. Filament heating current is supplied from this power system, the rectifier 38, Fig. 8, furnishing the plate voltage to the two tubes 40 and 41. The coded pulses delivered to the transmitter, as the tape 25 is fed through the key mechanism, is supplied to the two circuits of the oscillator in accordance with the character of the code. It is here assumed that the oscillator is so designed that its frequency will be changed from 140 to 180 kc., as one or the other of the brushes 30 engages the contact 33. The output of the oscillator is fed through the amplifier B and back on to the A. C. power line through the switch 22—23 or, if desired, the output may be fed from the plate tank circuit including the inductance 42 and the condenser 43, to an antenna. Such an arrangement is illustrated in Fig. 8a where suitable circuit connections for producing this result are shown, the antenna being indicated at 44. Whether the radio frequency output of the amplifier B is transmitted by antenna or over an existing power circuit, or any other system of conductors, will depend on the requirements of individual installations. If the distance between the detector and the point of reception of the signals is large, then transmission by ether usually will be employed. In any event, it will be by radio frequencies because they can be transmitted by the metallic circuits in the building; by the metal frame of the building, if it has one; or by the ether. In some of these situations it will be desirable to use a different source of power from that shown for the transmitter such, for example, as batteries or a separate magneto.

Receiver

The receiver, as shown in Fig. 9, comprises two parallel receiver circuits of the superheterodyne type, each including a tuned radio frequency stage C; a mixer D; a stage E of intermediate frequency; a diode F; and an automatic volume control circuit. If the output of the transmitter is delivered through the alternating current sup-

ply circuit, then the input of the receivers comes in on the same circuit at the terminals 45, Fig. 9. And if the output of the transmitter is sent out on the antenna 44, then it is received on suitable antenna connected to the same input terminals 45. Because the organization of these super-heterodyne circuits is well known, no description of them is required.

These two receiver circuits are utilized to bring into operation additional circuits which announce at the detecting station the fact of the fire, or the imminence of a fire and its location. For this purpose the voltage across the diode load resistors is arranged to drive two D. C. amplifiers, the plate circuits 46 and 46' of which include separate, normally closed relays 47 and 47'. With the receiver in an operating condition, no signal being received, these relays 47 and 47' are energized by the current drawn by triodes F and F'. With these relays energized their contacts are in the open position. When an incoming signal is rectified by the diode section of F or F', depending upon frequency, the triode section of F or F' is biased to cut-off, thereby causing relay 47 or 47' to become deenergized, thus closing the contacts.

These two relays control, respectively, the operation of two stepping relays indicated, in general, at 48 and 48', the control current for both being furnished by a battery 50. As an incoming pulse produced initially by a surge of current caused by the contact of one of the brushes 30 with the center contact 33 of the keying device, comes through the receiver and de-energizes relay 47, for example, it closes a circuit as follows: from battery 53, through contacts of relay 47, through conductor 51, through operating coil *a* of stepping relay 48, through conductor 52, through normally closed switch *c*, through conductor 53, to the other side of the battery 50. As this circuit is closed, operating coil *a* causes the arm *b* of the stepping relay 48 to make one step. The other stepping relay 48' is similarly constructed and connected but it does not step at this time because its operating circuit remains closed.

However, this system is so organized that the only way in which the circuit can announce an alarm is by the use of a combination of pulses sent to the two receivers at the respective receiver frequencies in a particular sequence and within a given time. In the particular arrangement shown the detecting and transmitting unit sends out or "keys" the signal back and forth between the two frequencies for which it is designed in an exact combination of 5 and 8, or any other predetermined combination which may be selected. Once this combination has been determined or set, the transmitter circuits are keyed to announce the location of the fire in accordance with the number assigned to the particular room or other location in which the detector unit is installed. For example, receiver No. 1, which may be assumed to be the upper unit in Fig. 9, may receive a pulse which will advance the arm *b* of the stepping relay 48 one step, as above described. Then receiver No. 2 may receive three pulses which will advance its relay arm *b'* up three positions. As additional pulses come in and are transmitted through the respective relays, this stepping operation will continue until the arm *b* has been moved up five steps and the arm *b'* eight steps.

At this time a control circuit is completed from the A. C. power supply 55, which is here assumed

to be a 110 volt circuit, the current flowing through the conductor 56 and the relay arm *b* to the No. 5 contact on which it is resting, thence through the conductor 57 to the second relay, through its arm *b'* and the contact 8 on which it bears, to conductor 58, through the relay coil 60 to the opposite side of the line. This opens the relay switch *c* and stops further stepping of the relay 48 and 48'.

The circuit now has been conditioned to receive the code signal and the energizing of the relay 60 closes a switch *f* through the conductors 61 and 61' and the winding of a one R. P. M. motor 62 which slowly revolves the table of a recorder. Positioned immediately above this table is a pencil *g* under the control of a solenoid 63, the pencil normally being held above the record sheet on the table. Both this solenoid and a bell, chime, or the like, operated by another solenoid 64, are connected in parallel with the circuit of the battery 50. Consequently, as each signal impulse produces a momentary closing of one of the switches controlled by the solenoids 47 and 47' in the plate circuits, its arrival is announced by a stroke of the bell and a mark made by the recorder pencil *g* on the record chart.

While the contacts 66 are normally open, their energizing coil is in parallel with the winding of the motor 62 and therefore closed by the solenoid 68 as soon as the recorder motor is energized. Thus the normally closed circuit 70 leading to the fire station also is opened by coil 68 when the motor is energized and gives an alarm at that point. At the same time an electric warning lamp and other indicators can be operated by one or the other of these circuits, either directly or through relays.

In order to avoid the effect of noise bursts on the receivers, each is equipped with an additional diode *G*. While the detector proper operates to provide a negative voltage on the grid of the D. C. amplifier, this noise limiting diode of receiver No. 1 feeds the D. C. amplifier grid of receiver No. 2, and diode for receiver No. 2 feeds the grid of the D. C. amplifier of receiver No. 1, as indicated by the connections H and I in Fig. 9. Because the two receivers are tuned to frequencies differing only by 40 kc., it is reasonable to assume that the noise energy received by each will be about the same. Thus the negative voltage of receiver diode No. 1 will be cancelled out by the positive voltage of the limiting diode of receiver No. 2, and vice versa, so that neither relay 47 or 47' will be opened, due to noise, and neither of the stepping relays connected with the receivers will be operated from this cause.

As an additional safety factor to neutralize the possible effects of stray signals, and the like, a motor-driven time delay relay 71, Fig. 9, is connected into the circuit. As soon as either the stepping relay arm *b* or *b'* begins to move at the initiation of the action of these relays, it closes the small switch *d* or *d'* mechanically connected, respectively, with the arms *b* and *b'* of the stepping relays. This completes a circuit from one side 56 of the alternating current supply circuit 55, through one or both of the switches *d* and *d'*, across to the conductor 72, through the winding of the single revolution motor 71, conductor 73, and the normally closed switch *e* to the opposite side of the A. C. line. This time-delay relay controls a switch *J*, which at certain times can close a circuit through the battery K across two conductors *l* and *m* which connect the relays *n* and *n'* in parallel with that battery.

7
These are the resetting relays for the two stepping relays. When either is energized it will reset its respective stepping arm *b* or *b'* to its zero position. Normally the switch *J* is open, but at times predetermined by the cam driven by the one R. P. M. motor 71 this switch *J* will be closed and will reset both relays. This will occur, for example, if any disturbance should operate either of both of the stepping relays because such operation will close either the switch *d* or *d'*, or both of them. However, this resetting operation requires the lapse of a predetermined time period, usually about 10 seconds, ample to complete the cycle of operations of the alarm system once its action has been initiated. As above pointed out, at a certain time in this cycle after the stepping operation has been completed, and when the 5-3 combination has been established, the solenoid 60 is energized, thus opening the switch *e* and de-energizing the time-delay motor 71. It is at this time that the counting and alarm mechanism of the receiver assembly is brought into operation, as above described.

The operation of the apparatus has been described so fully in connection with the preceding description of structure that no further statement as to operation is believed to be necessary. It may be pointed out, however, that when the operation of the detector has been initiated, and immediately after the switch 22-23 has been closed, the key mechanism revolves for several seconds in the open circuit position in order to give the transmitter time to warm up. It then moves through the alternate closed circuit and open circuit positions corresponding to the coded pulses provided to operate the stepping relays, or in other words, to set up the receiver unit to accept the alarm. These preliminary operations having been completed, the detecting unit then sends out the code impulses. Usually this code will consist of a number, the digits of which will be separated by a pause. That is, if the number of the room or detector where the alarm is initiated is 367, the signals, may, for example, be sent out by so spacing the perforations in the tape 25 that three pulses, each of, say, a half second duration and spaced apart by about a half second interval, will go out. Then a pause of, say, two seconds will occur, after which six pulses will be sent to the transmitter spaced apart by the same half second intervals. This will give the second digit of the code number. After another open circuit interval of, say, two seconds, the third digit, consisting of seven pulses, will be transmitted.

These pulses will be accepted by the receiver, indicated by individual strokes on the bell 64, and recorded by marks made by the pencil *g*, separated by spaces corresponding to the time intervals between successive pulses.

After the detector unit has ceased to operate it must be reset by winding the bell 7 and replacing the fusible link 12.

It may here be pointed out that the apparatus shown in Figs. 1 to 5, inclusive, may be used in other fire alarm systems such, for example, as those designed especially for giving a warning and the location of a fire in some part of the hold of a ship, or in a coal pile where fires originate due to spontaneous combustion, or it can be made, when attached to a telephone circuit, to dial the central office and to transmit a code signal to that office.

In the system above described two receiving sets are arranged with their inputs in parallel

and operate at different frequencies. Either system will operate alone to receive signals for which it is tuned, and for many purposes a single receiving set will be satisfactory. Two sets operating in parallel have been shown here for the reason that this arrangement makes the system far more reliable. With a single system there would be times when outside interference would render it inoperative for a short period, and during that period it could not receive and transmit with certainty an alarm coming from a distant detector station. By using two receiving sets in parallel, however, particularly with the precautions above described to take care of noise bursts, and the like, there is no practical danger of the receiving system being rendered inoperative from outside interference for any substantial period of time. As above described, the perforations in the tape transmit signal pulses alternately to the two superheterodyne circuits, but these perforations can be arranged, if desired, to transmit pulses substantially simultaneously so that both superheterodyne circuits will transmit the entire code independently of each other.

While, therefore, we have herein shown and described a preferred embodiment of our invention, it will be evident that the invention may be embodied in other forms without departing from the spirit or scope thereof. For example, the thermo-responsive element may consist of a fusible link, as above described, or numerous other thermo-responsive devices or pieces of apparatus may be used in place of it such, for example, as an ordinary bimetallic thermostat. Also, the various units may be powered in other ways than those shown or described.

Having thus described our invention, what we desire to claim as new is:

40 1. A fire alarm system comprising the combination of an alarm circuit, a radio receiver controlling the operation of said circuit, a radio transmitter distant from said receiver and organized to send out coded radio signals of two different frequencies, said receiver including two receiving sets arranged in parallel and responsive, respectively, to said frequencies sent out by the transmitter, a thermo-responsive element controlling the operation of said transmitter, means connecting elements of said receiving sets in co-operative relationship to cause external disturbances received by both sets to produce effects in each set which neutralize those created in the other set by said disturbances, said means consisting of electrical units located in the respective receivers, each electrical unit capable of reacting to all pulses forwarded by the receiver in which it is located, the circuit control action of each electrical unit being interlaced with the circuit control of the other said electrical unit, and the electrical control units being so connected that any interfering signals being fed to the receivers will be rendered incapable of operating the said alarm circuit.

65 2. A fire alarm system comprising the combination of an alarm circuit, a radio receiver controlling the operation of said circuit, a radio transmitter distant from said receiver and organized to send out coded radio signals of two different frequencies, said receiver including two receiving sets arranged in parallel and responsive, respectively, to said frequencies sent out by the transmitter, a thermo-responsive element controlling the operation of said transmitter, means connecting elements of said receiving sets

75

in cooperative relationship to cause external disturbances received by both sets to produce effects in each set which neutralize those created in the other set by said disturbances, said means consisting of diodes located in the said receiving sets, each diode capable of reacting to all pulses forwarded by the said receiving set in which it is located, the output of each diode being interlaced with the output of the other diode, and the diodes being connected so that the output of each diode may be fed into the opposite receiving set in like voltage but of opposite polarity to produce a cancellation and having a zero voltage condition in each receiving set simultaneously.

3. A structure according to claim 2, and further including two stepping relays, each of which is responsive to a respective receiver.

4. A structure according to claim 2, and further including two stepping relays, each of which is responsive to a respective receiver, said relays being interconnected so that operation of the alarm circuit is dependent upon predetermined positions of both of said relays.

5. A structure according to claim 4, and further including a time delay relay connected into the circuit to provide a time control for the sequence of operation of the said stepping relays.

6. A fire alarm system comprising the combination of an alarm circuit, a radio receiver controlling the operation of said circuit, a radio transmitter distant from said receiver and organized to send out coded radio signals of two different frequencies, said receiver including two receiving sets arranged in parallel and responsive, respectively, to said frequencies sent out by the transmitter, a thermo-responsive element controlling the operation of said transmitter, means connecting elements of said receiving sets in cooperative relationship to cause external disturbances received by both sets to produce effects in each set which neutralize those created in the

other set by said disturbances, said means consisting of noise controlling diode rectifiers located in the said receiving sets, each diode being capable of reacting to all received pulses forwarded to it by the said receiving set from which it is excited, and the output of each diode being interlaced with the output of the diode detector of the opposite receiving set so that the output of each diode may be fed into the opposite receiving set in voltages of like value but of opposite polarity to produce a cancellation and a zero voltage condition at the relay controlled tube of each receiving set simultaneously.

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