Dec. 8, 1936. J. SIDDALL ET AL 2,063,703

FIRE AND TEMPERATURE ALARM SYSTEM

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Fig. 1

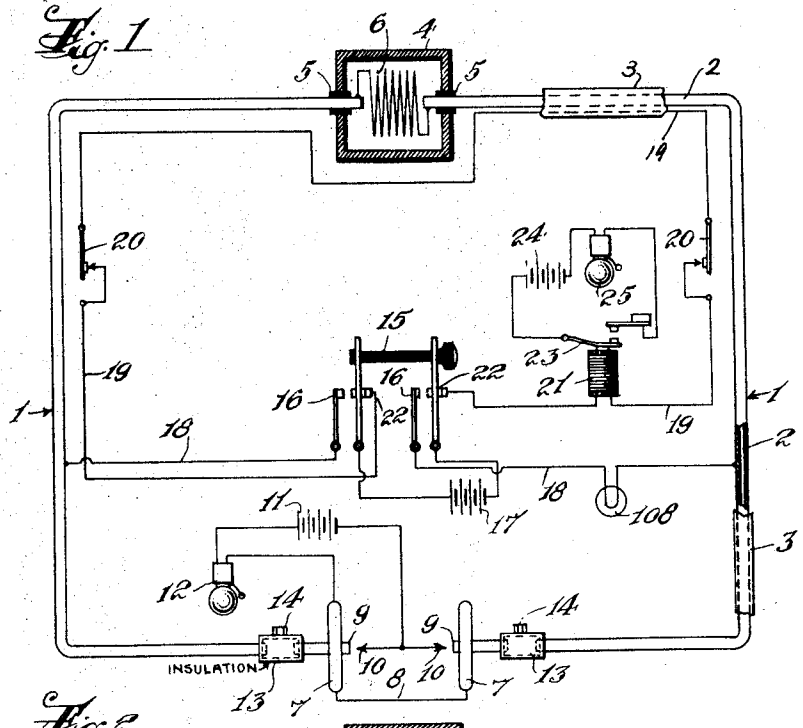
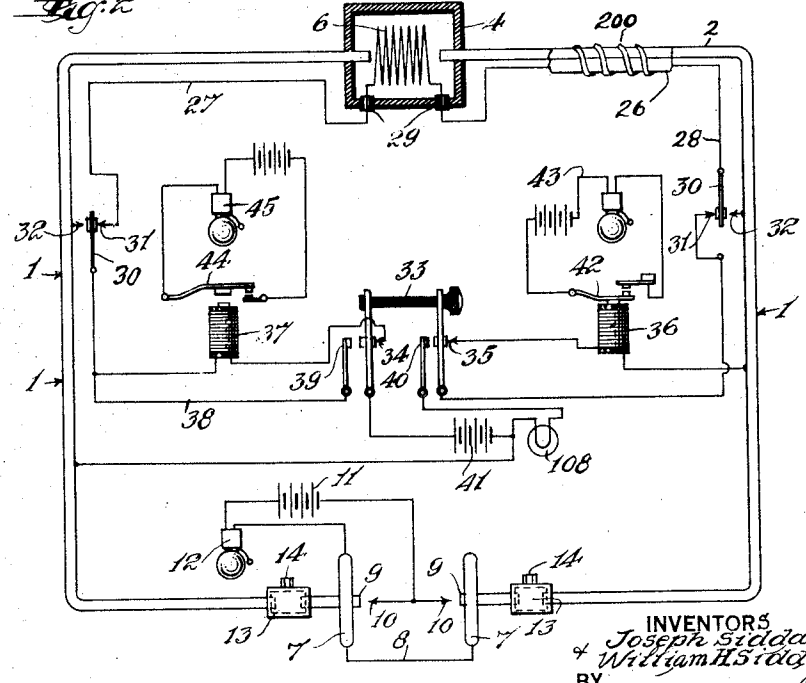


Fig. 2



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FIRE AND TEMPERATURE ALARM SYSTEM

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Fig. 3

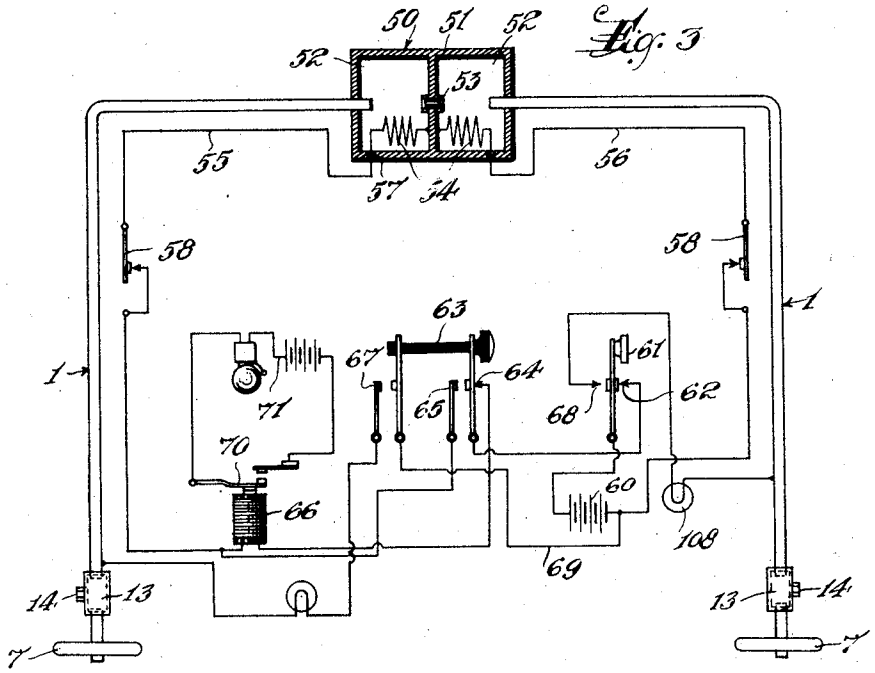
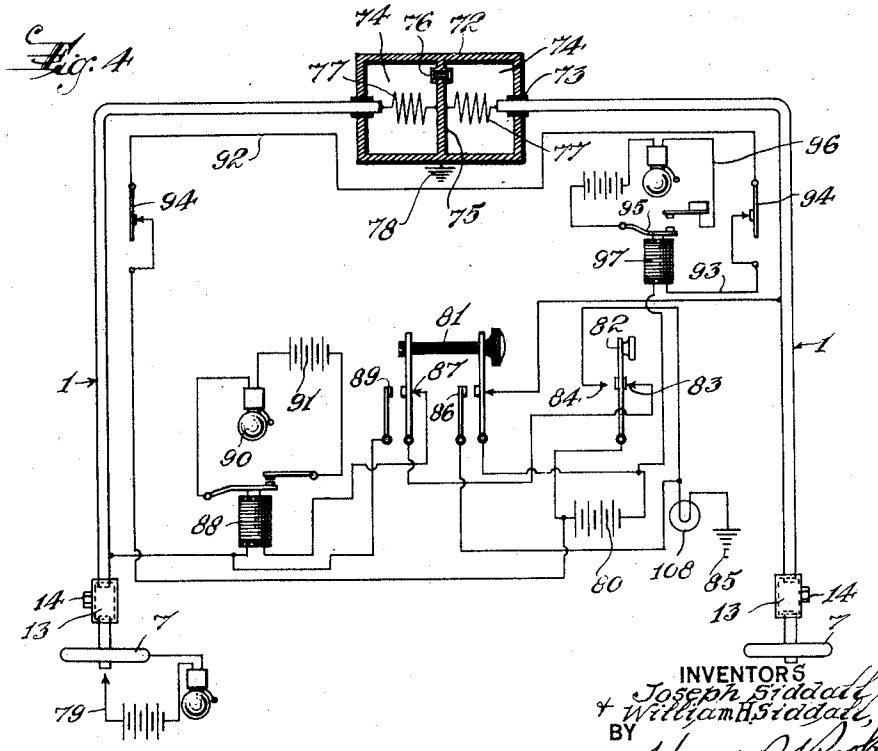


Fig. 4



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FIRE AND TEMPERATURE ALARM SYSTEM

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Fig. 5

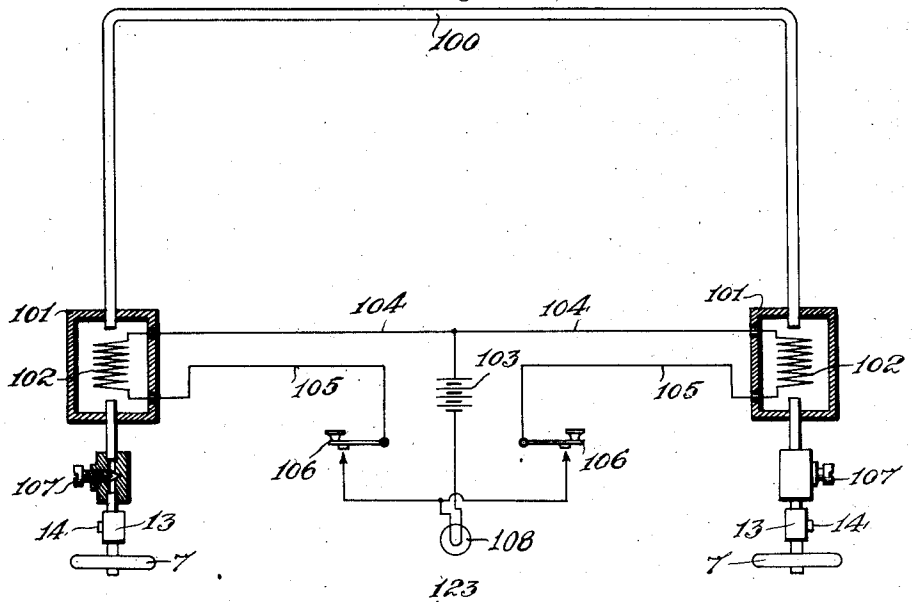
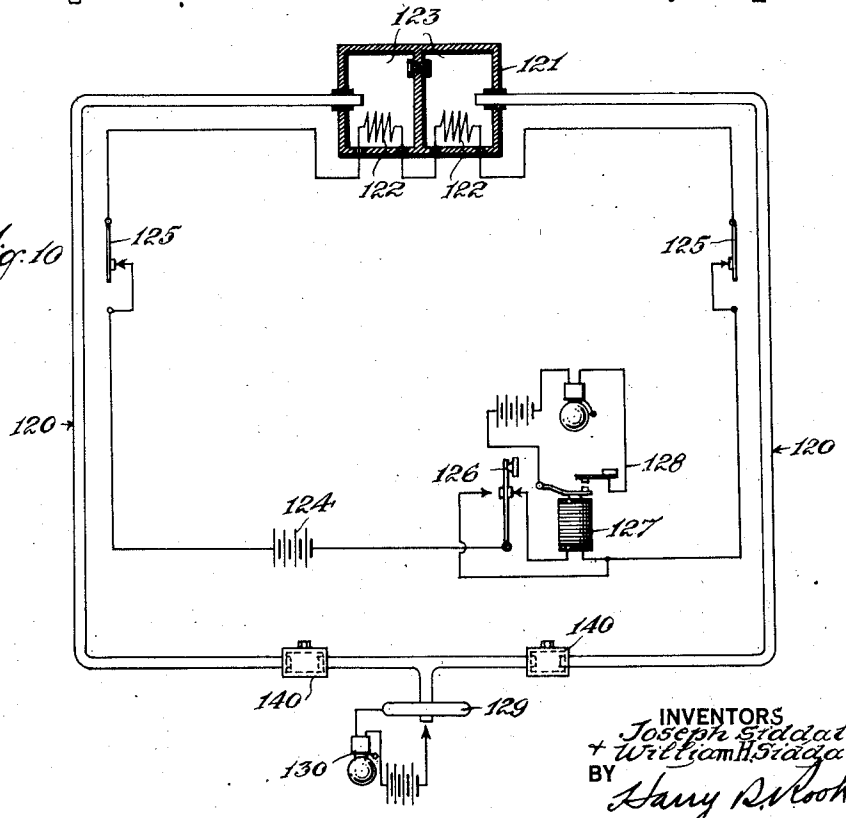


Fig. 10



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FIRE AND TEMPERATURE ALARM SYSTEM

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Fig. 11

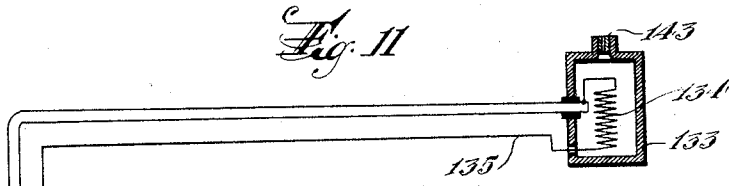


Fig. 6

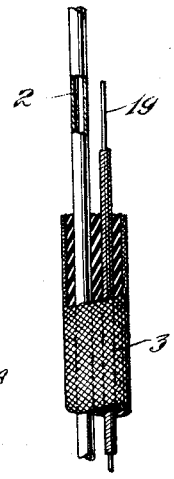
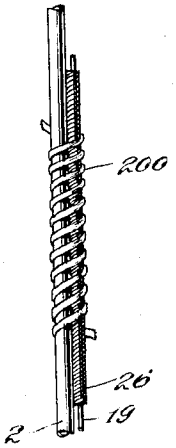


Fig. 7



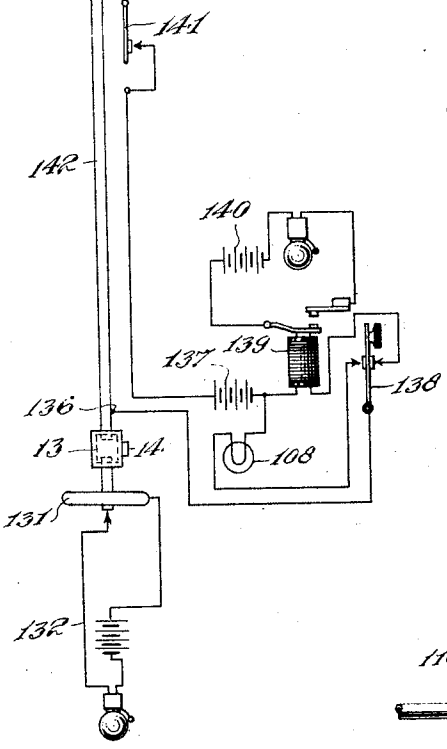
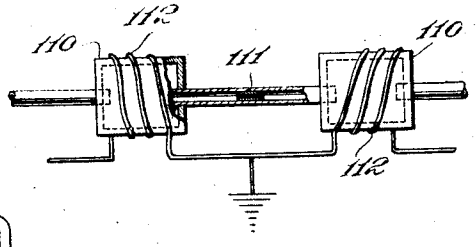


Fig. 8



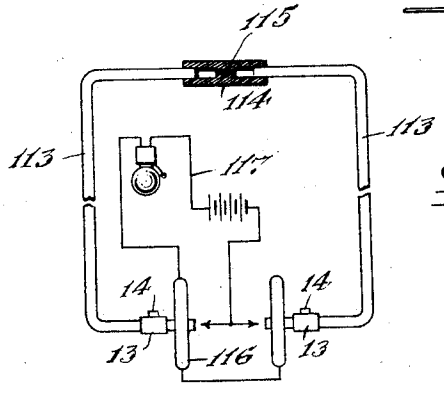


Fig. 9

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UNITED STATES PATENT OFFICE

2,063,703

FIRE AND TEMPERATURE ALARM SYSTEM

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Application April 22, 1933, Serial No. 667,322

13 Claims. (Cl. 177—355)

This invention relates to fire and heat or temperature alarm systems of the fluid pressure type, and more particularly to means for testing such systems to ascertain whether they are in proper operating condition. The invention also relates to a combination of the fluid pressure and thermostatic electrical types of fire alarm systems, and means for testing both of such systems.

The fluid pressure fire alarm system referred to includes a loop of tubing which passes through an area to be protected against fire and has connected at each end thereof, a fluid pressure actuated signal initiating means such as a diaphragm, which is actuated by fluid pressure in said tubing caused by fire or a sudden rise in temperature in the vicinity of any part of said tubing and which controls a signal actuating device so that the latter is actuated upon the occurrence of a fire or a sudden rise in temperature. The electrical fire alarm system above-mentioned, includes a temperature responsive signal initiating device, for example, a temperature responsive circuit changing mechanism which is arranged in the area to be protected against fire and controls an electric circuit which includes means for actuating a signal, whereby said signal is actuated upon the occurrence of a fire or a rise in temperature in the vicinity of said temperature responsive device.

There are many known fluid pressure systems of the general type described including means for testing the systems to ascertain whether they are in proper operating condition, but the known systems are objectionable for various reasons. It will be understood that if there should be a leak or a rupture in the tubing, or if the fluid actuated signal initiating device should be out of the adjustment, the system would not properly operate. In one known system, a test is made by pumping air into the tube with a hand pump so as to increase the pressure in the tube, whereupon if the system is in proper condition the signal is actuated when a certain pressure has been applied for a certain period of time. When greater pressure or more time is required to cause operation of the signal, there is trouble in the system. This method of testing is objectionable in that the fluid pressure actuated signal may be damaged by excessive pressure which may be applied to the system with the pump, and various degrees of pressure may be applied to the system so that the results of the test may be inaccurate. This is possible because the amount of pressure applied and the time during which the pressure is applied are wholly controlled by the operator, who may be careless or unskilled. Furthermore, it is necessary to utilize valves for permitting the connection and disconnection of the pump to and from the tubing, and such valves may leak, or may be inadvertently left open or partially closed after a test has been made, so that the system may be accidentally rendered inoperative as the result of failure of the valves required for testing or by carelessness in the very act of testing.

In the systems, the tube is coiled in such a manner that the full length of the tubing in the coil is equivalent to about fifty feet of the tubing, or a chamber having a capacity equal to about fifty feet of tubing is connected to the tubing, such coil or chamber having a capacity for sufficient air to cause a rise in pressure in the tubing adequate to actuate the signal when the chamber is heated at moderate temperature for a short period of time; and in testing the system a heated iron is inserted into the coil or chamber to raise the pressure of the air in the tubing. These systems are objectionable in that the temperature of the iron may be different at different times, and accordingly the results of the test may be unreliable.

Another system includes a plurality of chambers communicating with the tubing at spaced points in the length thereof, and a cup shaped electrical unit provided to slip over these chambers one at a time for the purpose of heating the air in the tubing to cause operation of the signal and test the condition of the system. This system is objectionable in that the temperature of the heating element as it is carried about may vary, and the results of the test will differ accordingly as the chambers tested are near to or distant from the pressure actuated signal initiating device due to variations in time required for the rise in pressure of air at one point to be transmitted to other points in the tubing.

Another system includes a chamber connected to the tubing through a mercury valve and heated by applying a receptacle containing hot water to the chamber, the air upon expansion in the chamber being forced past the mercury valve into the tubing so as to actuate the signal. Obviously the results of tests are unreliable due to variations in temperature in the water at different times.

Furthermore all of these old systems except the one utilizing the hand air pump, are objectionable because the testing chambers are at points remote from the pressure operated signal initiating device which is generally located on a panel in some accessible position, and generally one man is re-

quired to travel about with the heating unit for heating the testing chamber, while another man must remain at the panel or in proximity to the signal initiating device to see whether or not the signal properly operates, and collaboration between the two inspectors is necessary. Considerable time is therefore required in making tests with all known systems, and due to the variations in pressure which may be applied to the systems by the air pump, or due to variations in temperature of the heating devices, the results of the tests are not accurate.

One object of our invention is to provide a fluid pressure alarm system embodying a novel and improved construction and combination of parts whereby a test of the system can be made from one point in proximity to the signal mechanism and by one operator, and whereby the fluid pressure in the tubing shall be predetermined and danger of injury to the pressure actuated signal initiating device shall be eliminated, tests made at different times shall be uniform, the results of the tests shall be accurate, and the tests shall be simple and may be satisfactorily made by unskilled persons.

Another object is to provide a novel and improved fluid pressure alarm system of the general character described wherein the pressure in the tubing can be increased for testing purposes by means of an electric heater of predetermined fixed resistance which shall be permanently located in heat exchanging relation to a chamber or other accumulator for containing a large volume of air which communicates with the tubing, and the electric heater can be controlled by a switch or the like from a convenient point, for example, a test panel, whereby a test of the system can be made from one point, that is, the testing panel, and by one operator, the amount of heat applied to the system and consequently the rise in fluid pressure shall be uniform at all times and regardless of the period of time during which the heater is in operation, and therefore the results of the tests shall be accurate and reliable.

In the majority of fluid pressure fire alarm systems now in use a loop of tubing extends through the area to be protected and has a fluid pressure responsive device at each end thereof for actuating a signal. In practice should a break occur in the tubing adjacent one of the fluid pressure responsive devices, and should a fire occur in the vicinity of a portion of the tubing between such break and the other fluid pressure responsive device, the system may fail to operate because the air may escape from the break more easily than it can flow through the tubing to the fluid pressure responsive device, so that there is not sufficient pressure to actuate the signal. Accordingly another object of our invention is to provide a restricted passage in the tubing approximately at the middle of the length thereof so that should the tubing break between said passage and one end and a fire occur between said break and the other end, the signal will be operated, whereby to avoid complete disabling of the system by a break or a large leak.

A further object is to provide a combination of such a restricted passage with a testing chamber of the character described wherein said chamber shall be divided into two compartments communicating with each other through such restricted passage and each communicating with one end portion of the loop of tubing, and each compartment shall have an electrical heater in heat exchanging relation thereto, whereby the two end portions of the tubing loop can be tested independently of each other so that a leak or trouble in one end portion of the tubing or the corresponding pressure responsive signal initiating device, can be quickly discovered without the necessity for inspecting the whole loop of tubing.

Another object is to provide a fluid pressure alarm system wherein the tubing shall be part of the electrical circuit for the electric heater to reduce the amount of wire required and whereby the tubing shall be electrically supervised so that a break in the tubing will interrupt the circuit and the presence of the break will be indicated by the failure of the circuit.

A further object is to provide a novel and improved combination of such a fluid pressure alarm system and a thermostatic electrical alarm system, whereby the tubing may serve as part of the circuit for the electrical system as well as a conductor in the circuit for the electrical heaters, and also both the tubing and the wires of the electrical system shall be electrically supervised so that an impairment of the circuit such as a break in the wires or tubing will be indicated by a signal.

A still further object is to encase or cover the tubing and electric wires of a system of the character described in one and the same electricity insulating casing or cover in insulated relation, whereby the tubing and wires shall be in close proximity to facilitate the connection of thermostatic devices in circuit across the tube and wire, the tube and wires shall be in compact fixed relation to each other so that they can be handled as a unit, and the wire and insulation shall reenforce the tube against tension and crushing during installation.

Other objects, advantages, and results of our invention will more fully appear from the following description.

Referring to the accompanying drawings in which corresponding and like parts are designated throughout the several views by the same reference characters,

Figure 1 is a schematic illustration of an alarm system embodying our invention.

Figure 2 is a similar view of a modified form of the invention.

Figures 3 and 4 are schematic illustrations of further modifications of the invention.

Figure 5 is a schematic illustration of a simple fluid pressure alarm system embodying a modified form of the invention.

Figure 6 is a fragmentary perspective view of a portion of the tubing and wiring used in our alarm system.

Figure 7 is a similar view of a modified combination of the tube and wiring.

Figure 8 is a schematic illustration, partially in section of a heater chamber for a fluid pressure alarm system showing a further modification, and

Figures 9, 10, and 11 are schematic illustrations of other modified forms of the invention.

Specifically describing the embodiment of the invention illustrated in Figure 1, our alarm system includes a fluid conduit located through the area to be protected, which is shown as composed of two sections 1 of electricity conducting tubing 2 which is enclosed in a casing of electrical insulating material 3, such as rubber or fabric.

In accordance with the invention, the two sections 1 of tubing are of substantially the same length and are arranged to form a loop, and one

end of each section is connected to the adjacent end of the other section by an air chamber or accumulator 4 which has a capacity equal to several feet of the tubing, for example, fifty feet. This air chamber or accumulator preferably has a heavy metal case or is heat insulated so as not to be sensitive to external temperatures in the vicinity of the chamber. As shown, the ends of the tubing sections extend into the chamber 4 in spaced relation and are electrically insulated from the chamber as indicated at 5. An electric heating coil or an electrical resistance element 6 is connected across the adjacent ends of the tubing sections so as to be in series with them. This resistance element has a predetermined or fixed resistance so that when current is passed therethrough, it will produce a predetermined temperature.

At the other end of each of the tubing sections 1 is connected a fluid actuated signal initiating device 7, for example a diphragm of known construction, at least one wall of which will be moved or distended by fluid pressure generated in the tubing by heat. These signal initiating devices cooperate with a signal operating mechanism for producing a signal upon increase in pressure in the tube. As shown, the devices 7 are electrically connected by a wire 8 and each of them has an electric switch contact 9 which cooperates with another contact 10 to control a circuit including the signal initiating device, a source of electricity 11, and a signal, for example, a bell 12. The switch contacts 9 and 10 are normally in spaced relation, but upon an increase in pressure in the tubing of a predetermined amount, the contacts 9 and 10 are moved into engagement between devices 7 so as to cause actuation of the signal 12.

The signal initiating devices 7 are connected to the tubing in insulated relation, as by a sleeve 13 of electrical insulating material, and a suitable vent or breathing opening 14 is provided for each signal initiating device to permit the fluid pressure in the tubing to become reduced to atmospheric pressure after such pressure in the tubing has been increased by heat.

In accordance with the invention, in testing the tubing for leaks or breaks, and the fluid actuated signal initiating devices to ascertain whether the system is in proper operating condition, the electrical resistance element 6 is heated so as to heat the air in the chamber 4 and cause expansion thereof, whereby the pressure of the air in the tube is increased so as to actuate the signal initiating device 7. As shown, the resistance element 6 is connected in series circuit with the tubing sections 1, and the tubing sections form a part of an electrical circuit which also includes wires 18, and 19, a double switch or test key 15 which cooperates with contacts 16, and a source of electricity 17. The test key or switch 15 is normally open so that the heating element 6 is normally cold, but when a test is to be made the test key or switch 15 is operated to close the circuit so as to cause the heating element 6 to be heated. With this construction, it will be observed that the test key or the switch 15 may be located in a convenient position, for example at a test panel where the two signal initiating devices 7 are usually located, and the test may be made by one operator at this convenient point. This is an important advantage, since one operator can do the work which usually requires two men, one of whom usually travels to the air chamber for heating it while the other remains at the test panel to see whether the signal operates. In addition, the resistance 6, being of predetermined fixed resistance, the increase in pressure in the tubing will be predetermined so that there is no danger of injury to the device 7 by the application of excessive pressure, and furthermore, the amount of pressure will be the same at different testing periods so as to give uniform results. Furthermore, the tubing being a part of the electrical circuit, a break in the tubing would be indicated by a failure of the circuit.

Therefore, it will be observed that our invention is highly advantageous. In operation, under normal conditions the signal initiating device 7 should be operated within a certain period, for example, twenty seconds from the time that the circuit is closed by the test key. Should there be a leak in the tubing allowing the fluid to escape, upon making of the test, a longer period of time would elapse between the closing of the test key and the operation of the signals. This makes it possible to determine the size of the leak to some extent by the variations in length of the period of time which elapses between the operation of the test key and the actuation of the signal.

The pressure alarm system may be combined with the usual thermostatic electrical alarm system which is shown as including the source of electricity 17, the double switch 15, wires 18 and 19, thermostatic devices 20, for example fusible links, fusible wires, liquid bulbs, bimetallic thermostatic switches or other circuit controlling devices operated by heat, which are connected in series circuit, and a high resistance relay coil 21. The double switch 15 cooperates with contacts 22 so as to normally close the circuit through the thermostatic devices and relay coil 21, while the circuit through the tubing is interrupted by the double switch 15. The relay coil 21 controls a switch 23 in the usual manner, and the switch 23 is connected in circuit with a source of electricity 24 and a signal 25, such as a bell. During normal operation of the electrical alarm system, the current passing through the relay coil holds the switch 23 open but upon a break of the circuit, as by an opening of one of the thermostatic devices 20 under heat caused for example, by a fire, the relay coil is deenergized so as to permit the switch 23 to close and cause operation of the signal 25.

Preferably the wires 19 are embedded in or carried by the same insulating material which covers the tubing sections 1, as shown in Figure 6 of the drawings. It may be desirable, in some instances, to connect the wires to the tubing by helical wrappings 200 of metal or fabric, as shown in Figure 7 of the drawings. In this arrangement, the wire will of course be electrically insulated as indicated at 26. Such arrangements of the wires and tubing enables lengths of the wire and tubing to be handled as units, and the wire and tubing are conveniently located with respect to each other to facilitate connecting them in electrical circuits, as will more fully hereinafter appear.

A modification of the invention is shown in Figure 2 of the drawings where the tubing sections 1 are connected to the air chamber 4 in the same way as that shown in Figure 1, excepting that the tubing sections need not be insulated from the air chamber. In this form of the invention,—the electrical heating coil 6 is connected in series with wires 27 and 28 which are insulated from the air chamber at 29. The ends of the tubing sections 1 opposite the air

chamber 4 are connected to the fluid actuated signal initiating devices 7 which control signal actuating mechanism exactly as in the form shown in Figure 1. The tubing sections 1 are connected in circuit with an electrical alarm system which circuit also includes the electrical heater 6. As shown a plurality of thermostatic devices 30 are connected in series circuit with the wires 27 and 28. These thermostatic devices may be bimetallic switches, each cooperating with a contact 31 and another contact 32, the first of which is connected directly to the wire 27 or 28, while the latter is connected to the adjacent tubing section 1. The wire 28 is connected to one terminal of a double switch 33 which cooperates with contacts 34 and 35. The contact 35 is connected through a high resistance relay coil 36 with one of the tubing sections 1 while the other contact 34 is connected through a low resistance relay coil 37 with the wire 27. A shunt wire 38 passes around the relay coil 37 and has a contact 39 to cooperate with the switch 33. Another contact 40 cooperates with the double switch 33 and is connected to the tubing section 1 opposite that to which the relay 36 is connected. A source of electricity 41 has one terminal connected to the double switch 33 and the other terminal connected to the contact 40 and the corresponding tubing section 1. The relay 36 controls a switch 42 which in turn includes a signal circuit 43, while the relay coil 37 controls a switch 44 which in turn controls another signal circuit 45. The signal circuits 43 and 45 are the same as the signal circuit 23—25, shown in Figure 1.

In operation the double switch 33 normally engages the two contacts 34 and 35 and electricity flows through the relay coils 36 and 37 from the source 41, and both switches 42 and 44 are held open. Upon disconnection of the contact 31 of any thermostatic device 30, as under the influence of heat from a fire, the circuit is broken through the relay 36 whereupon the switch 42 is closed so as to actuate the signal in the circuit 43. This may constitute a trouble signal. As the circuit is opened at contact 31 it is closed at contact 32 by reason of which the relay 37 is retained in the circuit. The increase in current through the relay 37 due to the cutting out of the relay 36, causes the relay 37 to close the switch 44 and cause actuation of the signal in the circuit 45. During normal operation of the alarm systems the electricity also passes through the heating element 6, but not sufficient current passes through the heating element to cause appreciable heating thereof. When it is desired to test the fluid pressure system, the double switch 33 is actuated into engagement with the contacts 39 and 40 whereupon the thermostatic alarm system is thrown out of operation and all of the current from the source 41 passes through the heating coil 6. This causes a heating of the air in the chamber 4 and a consequent rise in pressure thereof, which in turn actuates the fluid pressure operated signal initiating devices 7 if the system is in proper condition. If the devices 7 are not actuated, trouble in the system is indicated.

A further modification of the invention is shown in Figure 3 of the drawings where the tubing sections 1 are connected to an air chamber 50 which is somewhat different in structure from the air chamber 4. In this form of the invention the air chamber 50 is divided by a partition 51 into two compartments 52 each of approximately the same capacity as the chamber 4. These two compartments communicate with each other through a restricted passage 53 in the partition 51 having a cross-sectional area less than that of the tubing 2, and each compartment communicates with the end portion of the tubing section between itself and the extremity of the section. A pressure actuated signal initiating device 7 is connected to the other end of each of the tubing sections and controls a signal actuating circuit like that shown in Figure 1.

Within each compartment 52 is located an electrical heating coil or resistance 54 one terminal of which is grounded on the walls of the chamber 50. The other terminals of the heaters 54 are connected to the respective wires 55 and 56 which are insulated from the chamber 50 at 57. The wires 55 and 56 have connected in series circuit therewith, a plurality of thermostatic devices 58 like the device 20 of Figure 1. The wire 56 is connected to one terminal of a source of electricity 60, the other terminal of which is connected to a test switch or key 61 which cooperates with a contact 62 which is in turn connected to a double switch or key 63. The double switch 63 cooperates with contacts 64 and 65 which are disposed at opposite sides or in shunted relation to a relay coil 66, and said switch 63 also cooperates with a contact 67 which is connected to one of the tubing sections 1. The other tubing section 1 is connected in circuit through a contact 68 with which cooperates the test switch 61. The test switch 61 controls one of the heaters 54 while the test switch 63 controls the other heater, and the latter switch is connected in circuit through a wire 69 to the side of the source of electricity 60 opposite that to which the signal test switch 61 is connected. The relay 66 controls a switch 70 which in turn controls a circuit 71 like the circuit 43 of the system shown in Figure 2.

In operation, the switch 61 normally engages the contact 62, while the switch 63 normally engages the contact 64. Electricity therefore normally passes through said switches, the relay coil 66, the thermostatic devices 58 and the heating coils 54. However, not sufficient current passes through the heating coils to materially heat them. Should one of the thermostatic devices be operated to open the circuit, the relay 66 is deenergized so as to close the switch 70 and cause actuation of the signal in the circuit 71. In operation of the fluid pressure system, should a fire occur in the vicinity of either tubing section 1 the air will be expanded in said tubing section so as to actuate the corresponding signal initiating device 7, but the other device 7 will not be actuated until the fire has continued for sometime due to the restricted passage 53 which prevents a sudden passage of fluid from one tubing section to the other. This passage 53 has a further advantage in that should either tubing section be out of operation, for example, because of a break, and should a fire occur in the vicinity of the other tubing section, a signal would be given. Without the restricted passage 53, and under the same conditions, it is probable that a signal would not be given because the air would escape more rapidly through the break in the tubing than it could flow to the signal initiating device 7 so there would be insufficient pressure to actuate the device 7. Another advantage of this structure is that in case of fire under normal conditions in the tubing, only the air in half of the tubing loop need be expanded to cause operation of the signal whereby a fire

may be detected more quickly than would be the case if the passage through the tubing were not restricted.

When it is desired to test the tubing, the heaters 54 are heated separately and independently of each other. One heater may be heated by throwing the switch 61 into engagement with the contact 68, whereupon the electricity flows from the source 60 through the tubing and the chamber 50 to the right hand heating element 54, through said element back to the source. The air in the corresponding compartment 52 is thereby expanded so as to actuate the right hand fluid pressure operated device 7. Due to the restricted passage 53 between the compartments 52, the other device 7 will not be operated. To test the other side of the tubing loop, the switch 63 is brought into engagement with the contacts 65 and 67, whereupon the other heater 54 is heated. If the signals are operated within a predetermined period of time after the respective switches 61 and 63 are closed, the system is in proper operating condition, while if the signals do not operate at all or if a longer period of time elapses between the closing of the switches and the operation of the signals, trouble in the system is indicated. With this arrangement, trouble in either of the loop sections or signal initiating devices can be quickly ascertained without the necessity for inspection of the whole system as would be necessary without the restricted passage 53.

Another form of the invention is shown in Figure 4 of the drawings wherein the tubing sections 1 are connected to a heater chamber 72 in general similar to the heater chamber 50, but the tubing sections are insulated from the heater chamber 72 as at 73 instead of being electrically connected to the chamber as shown in Figure 3. The heater chamber 72 includes two compartments 74 corresponding to the compartments 52 shown in Figure 3, said compartments 74 being separated by a partition 75 having a restricted passage 76 corresponding to the passage 53, through which the compartments communicate with each other. Within each compartment is an electrically heated coil 77 each of which has one end electrically connected to the adjacent tubing section 1 and its other end electrically connected to the partition 75. As shown, the partition 75 and/or chamber 72 is grounded as at 78. The other end of each tubing section has a signal device 7 which controls a signal circuit 79 like that shown in Figure 1.

For testing the tubing and signal initiating device 7, the tubing is connected in an electrical circuit which also includes the heaters 77. As shown, this circuit comprises a source of electricity 80 one terminal of which is connected through a double switch or key 81 to one of the tubing sections 1, and the other terminal of which is connected to a switch 82 which cooperates with contacts 83 and 84, the latter of which is connected to the ground at 85 and to a contact 86 which also cooperates with the switch 81. The other contact 83 is connected to the double switch 81 which also cooperates with a contact 87 connected in series with a relay coil 88. The double switch 81 also cooperates with a contact 89 which is in shunt relation to the relay coil 88. The relay 88 controls a switch 90 which in turn controls a signal circuit 91.

With this construction and with the switches 81 and 82 in the positions shown in the drawings, the tubing sections and the heaters 77 are constantly electrically supervised or under test so that should any break in the circuit occur, the signal controlled by the relay 88 will be actuated. To test the tubing and signal initiating devices 7 for leaks or mal-adjustments, the heaters 77 are separately and independently heated somewhat in the same manner as are the heaters 54 shown in Figure 3. For testing the right hand tubing section in Figure 4 by heating the right-hand heater 77, the switch 82 is brought into engagement with the contact 84 whereupon the electricity flows from the source 80 through the switch 82 to the ground 85 to 78 thence through the partition 75 of the heater chamber to the heaters 77 and then through the tubing section 1 to the source. During this operation, the source 80 is thrown out of circuit with the other tubing section. To test the latter tubing section, the double switch 81 is actuated into engagement with the contacts 86 and 89, the switch 82 being left in engagement with the contact 83, whereupon the current passes from the source 80 through the switch 82, switch 81 around the relay coil 88 to the left-hand tubing section 1, through the left-hand heater 77 to the ground 78 to 85, thence to the contact 86 through the switch 81 to the source.

If desired, this fluid pressure system may be combined with an electrical thermo-responsive system which includes wires 92 and 93 connected to opposite sides of the source 80 and including in series circuit, thermostatic devices 94 like the devices 20 shown in Figure 1. The circuit also includes a relay 97 which controls a switch 95 which in turn controls a signal circuit 96. In normal operation the current passes from the source 80 through the wires 92 and 93, and the switch 95 is held in open position by the relay coil 97. Upon a break in the circuit, for example, by fusing of one of the thermostatic devices 94, the relay coil 97 is deenergized so as to permit the switch 95 to close and actuate the signal in the circuit 96. It will also be observed that the wires 92 and 93, the devices 94 and the relay coil 97 are constantly electrically supervised, so that a break in the circuit will be indicated by operation of the relay coil 97 and the signal circuit 96 controlled thereby.

Another form of the invention is shown in Figure 5 of the drawings and includes a loop 100 of tubing which need not be insulated since it is not included in an electric circuit. At each end of the loop is a signal initiating device 7 which controls a signal circuit like that shown in Figure 1. Adjacent each signal initiating device is a heater chamber 101 in general similar to the heater chamber 4. Within each heater chamber is an electrical heat coil or resistance element 102, and these heating elements are connected in parallel circuit with a source of electricity 103 by wires 104 and 105 which are insulated from the heater chambers 101. Each heater is controlled by a test switch or key 106, so that the heaters may be independently and separately operated. As will be understood from the foregoing the switches 106 are normally open and when either of them is closed the corresponding heater 102 is heated so as to expand the air in the tubing loop 100 and actuate the signal initiating device 7.

Preferably a valve 107 is arranged in the tubing between each heater chamber 101 and the corresponding signal initiating device 7; these valves are normally open. During test of the system, however, the valve nearest the heater

chamber being heated is closed so as to prevent flow of air into the corresponding signal initiating device and compel the air heated by said heater to flow through the tubing loop to the other signal initiating device. The heaters 102 are alternately heated and the valves 107 are alternately opened and closed.

Preferably electric lamps or other suitable signals 108 are included in the testing circuits for the fluid pressure systems to indicate whether the circuits are in operating condition; obviously if the lamps are not lighted when the testing switches are closed, a break in the testing circuit will be indicated.

In all forms of the invention illustrated in Figures 1 to 4 inclusive, preferably the tubing and the wires are enclosed in the same insulation, as shown in Figure 6 and as described in connection with Figure 1 of the drawings, although the wires and tubing may be combined as shown in Figure 7.

Instead of arranging the heater elements within the heater chambers, we may utilize a construction such as that shown in Figure 8 wherein the heater elements are outside the chamber in heat exchanging relation thereto. Two heater chambers or compartments 110 are shown which communicate with each other by a restricted passage 111, and each of which communicates with the end portion of the tubing between itself and the extremity of the tubing. The compartments 110 are heated by electrical resistance coils 112 on the exterior of the compartments, and these coils may be connected in circuit in the same manner that the coils are shown in circuit in Figures 1 to 5 inclusive, or in any other suitable manner. As shown the connection of the coils in circuit is the same as that shown in Figure 3 of the drawings, one terminal of each heater coil being grounded as upon the tubing, and the other terminals being connected to the source of electricity.

A modification of the fluid pressure system is shown in Figure 9 of the drawings and includes a loop of tubing formed of sections 113—one end of one of which is connected to the adjacent end of the other by a coupling 114 which has a restricted passage 115 between the ends of the tubing sections and of a cross sectional area less than that of the tubing. The other ends of the tubing sections have connected thereto signal initiating devices 116 corresponding to the devices 7 which control a signal circuit 117. The function of the restricted passage 115 is similar to that of the restricted passages 53 and 76 shown in Figures 3 and 4 of the drawings.

A further modification of the invention is shown in Figure 10 wherein the fluid pressure system includes a continuous loop of tubing or an endless fluid conduit formed of tubing sections 120 which are connected at one end to a heater chamber 121 like the chamber 50 which has a heater coil 122 in each compartment 123. The heater coils 122 are insulated from the tubing and chamber and are connected in series circuit with each other, a source of electricity 124, thermostatic devices 125, a test key 126, and a relay 127 which controls a signal circuit 128. The other ends of the tubing sections 120 are connected through electricity insulating nipples 140 to a single pressure actuated signal initiating device 129 which controls a signal circuit 130. In this system the single test switch 126 controls both heater coils so that they are operated simultaneously. Also the pressure in either or both end portions of the tubing loop between the chamber 121 and the pressure actuated device, operates the one pressure actuated device instead of separate devices as shown in for example Figure 3.

In Figure 11 is shown another form of the invention where the system includes a single length of tubing 142 having at one end a pressure actuated signal initiating device 131 like the device 7 which is electrically insulated from the tubing and controls a signal circuit 132. A heater chamber 133 is connected to the other end of the tubing. The heater chamber contains a heater coil 134 which is electrically connected at one end to the tubing and at its other end to a wire 135 insulated from the chamber but connected to the tubing in remote relation to the chamber as at 136. The wire forms with the tubing a circuit which also includes a source of electricity 137, a test key 138, a relay coil 139 which controls a signal circuit 140, and thermostatic devices 141 which control said relay coil. The device 131 is operated by a certain fluid pressure in the tubing to actuate the signal of the circuit 132, while the thermostatic devices 141 operate at a predetermined temperature to cause actuation of the relay 139 and signal circuit 140. The test key 138 controls the heater coil 134 for testing the fluid pressure system, in a manner similar to that hereinbefore described.

In some instances, especially, where the tubing circuit is several hundred feet long, it may be desirable to provide a breather opening 143 at the end of the tubing opposite the pressure actuated signal mechanism so that normal atmospheric pressure in the tubing can be more quickly restored after a fire or test.

Also in some cases, it may be desirable to utilize a tubing loop and a double heating chamber such as the chamber 50 (see Figure 3) but without any communication, such as the restricted passage 53, between the two compartments. Such an arrangement would provide in effect two independent tubing circuits.

While we have shown and described our invention as embodied in certain details of construction, it should be understood that this is primarily for the purpose of illustrating the principles of the invention and that many modifications and changes may be made in the details of construction and the manner of connecting the various parts in electrical circuits without departing from the spirit or scope of the invention. Therefore, we do not desire to be understood as limiting ourselves in the construction and use of the invention except as required by the following claims when construed in the light of the prior art. In said claims the word "chamber" is intended to include chambers such as those illustrated and described, a coil of tubing or any other means in communication with the tubing for accumulating a volume of fluid which when heated at a predetermined moderate temperature for a certain period of time is adequate to actuate fluid pressure signal initiating devices.

Having thus described our invention, what we claim is:

1. An alarm system including a loop of electricity conducting tubing consisting of a plurality of sections, a chamber connected to and communicating with adjacent ends of two sections of said tubing and electrically insulated therefrom, an electrical heater connected in series circuit across the ends of said two sections of tubing within said chamber, a pressure actuated signal

connected to said tubing and actuated by fluid pressure generated in said tubing by heat, and an electrical circuit including said sections of tubing, said heater, a source of electricity and means for controlling operation of said heater at will.

2. An alarm system including a loop of tubing, a chamber communicating with said tubing intermediate the ends of said loop, a pressure actuated signal mechanism connected to each end of said loop to be operated by fluid pressure generated in said tubing by heat, said chamber having two compartments each communicating with the portion of said loop between itself and one end of the loop and said compartments communicating with each other through a restricted passage of less cross-sectional area than said tube, an electrical heater in heat exchanging relation to each of said compartments, and an electric circuit including both of said heaters and means for controlling operation of each of said heaters at will.

3. An alarm system including a loop of tubing, consisting of a plurality of sections of electricity conducting tubing, a chamber connected to adjacent ends of two sections of said tubing and electrically insulated therefrom, and having two compartments which communicate with each other through a restricted passage of less cross-sectional area than said tubing and each of which communicates with the portion of said tubing between itself and one end of the loop, an electrical heater in each compartment and electrically connected to the other heater and one section of said tubing, a pressure actuated signal mechanism connected to each end of said loop of tubing and actuated by fluid pressure generated in said tubing by heat, and an electrical circuit including said two sections of tubing, said heaters, a source of electricity, and means for controlling operation of said heaters.

4. An alarm system including a loop of tubing, a pressure actuated signal connected to each end of said tubing to be actuated by fluid pressure generated in said tubing by heat, a chamber communicating with said tubing adjacent each end of said loop, a valve between said tubing and each of said pressure actuated signals, an electrical heater in heat exchanging relation to each of said chambers, and an electrical circuit including each of said heaters and means for controlling operation of each heater.

5. An alarm system including a loop of tubing, a chamber communicating with said tubing intermediate the ends of said loop, a pressure actuated signal connected to said tubing and actuated by fluid pressure generated in the tubing by heat, an electrical heater permanently arranged in heat exchanging relation to said chamber, an electrical circuit including in series said loop of tubing, said heater, a source of electricity, an electrical signal initiating means operable upon a break in said circuit for controlling an electrical signal, said circuit normally operating without heating said heater, and switch means for at will changing said circuit to increase the current flowing through said heater and cause heating thereof for pneumatically testing said tubing and pressure actuated signal, and an electrical signal controlled by said signal initiating means, whereby said tubing, heater, signal initiating means, source of electricity, and said switch means, are under electrical supervision so that a break in said circuit will be indicated by said electrical signal.

6. As a unit for use in combination fluid pressure and electrical fire alarm systems, a length of tubing and a corresponding length of wire, both embedded and inclosed in a common casing of electricity insulating and heat conducting material in insulated relation to each other.

7. An alarm system including a loop of tubing, a chamber communicating with said tubing intermediate the ends of said loop, a pressure actuated signal connected to said tubing and actuated by fluid pressure generated in the tubing by heat, an electrical heater permanently arranged in heat exchanging relation to said chamber, and an electrical circuit including said heater and means for controlling operation of said heater at will, said tubing being inclosed in a casing of electricity insulating material and said electrical circuit including a wire embedded in said insulating material in insulated relation to said tubing.

8. A combination fluid pressure and electrical fire alarm system, comprising a length of tubing, a fluid pressure actuated signal connected to said tubing, an electrical signal mechanism, and an electrical circuit including wires, said tubing, thermo-responsive circuit changing devices operable at a predetermined temperature, electrical signal initiating means controlled by said thermo-responsive devices for causing operation of said electrical signal mechanism, so that under normal conditions electricity is caused to flow through said tubing, said wires and said thermo-responsive devices and said signal initiating means, and interruption in said circuit through either said tubing or said wires will be indicated by actuation of said electrical signal, a heater chamber communicating with said tubing, an electrical heater in heat exchanging relation to said chamber and connected in said circuit and normally unheated, a test switch and wires connecting it in said circuit, and means controlled by said test switch for changing the flow of current through said circuit to increase the current through said heater so that upon operation of said test switch under normal conditions said chamber will be heated by said heater to expand the air in said tubing and actuate the fluid pressure signal within a certain period and a break or leak in said tubing or inoperativeness of said fluid pressure signal will be indicated by failure of or retarded operation of said fluid pressure signal when said test switch is operated.

9. A combined fluid pressure and electrical fire alarm system, comprising a length of tubing, a pressure actuated signal mechanism connected to said tubing, a casing of electricity insulating material covering said tubing, wire, a thermo-responsive circuit changing device operable under a predetermined temperature and an electrical signal initiating means controlled thereby both connected in electrical circuit with said tubing and wire, and an electrical signal controlled by said signal initiating means and actuated upon occurrence of a predetermined temperature, said wire being embedded in said casing of the tubing in insulated relation to the tubing.

10. A combined fluid pressure and electrical fire alarm system, comprising a length of tubing, a pressure actuated signal mechanism connected to said tubing, a casing of electricity insulating material covering said tubing, a wire, a normally open thermo-responsive circuit closing device closed under a predetermined temperature connected across said wire and said tubing, a signal initiating device connected in series with said tub-

ing and wire and operable upon closing of the circuit by said thermo-responsive device, and an electrical signal controlled by said signal initiating device, said wire being embedded in said casing of the tubing in insulated relation to the tubing.

11. A combined fluid pressure and electrical fire alarm system, comprising a length of tubing, a pressure actuated signal mechanism connected to said tubing, a casing of electricity insulating material covering said tubing, wire, a thermo-responsive circuit changing device operable under a predetermined temperature and an electrical signal initiating means controled thereby both connected in electrical circuit with said tubing and wire, and an electrical signal controlled by said signal initiating means and actuated upon occurrence of a predetermined temperature, and electrical supervisory means for said circuit operable to indicate a break in said tubing or wire, a chamber communicating with said tubing, an electrical heater in heat exchanging relation to said chamber connected in said circuit and normally unheated, a test switch and wires connecting it in said circuit, and means controlled by said test switch for changing the flow of current through said circuit at will to increase the current through said heater and cause heating thereof to pneumatically test said tubing and said pressure actuated signal.

12. A combined fluid pressure and electrical fire alarm system, comprising a length of tubing, a pressure actuated signal mechanism connected to said tubing, a casing of electricity insulating material covering said tubing, a wire, a normally open thermo-responsive circuit closing device closed under a predetermined temperature connected across said wire and said tubing, a signal initiating device connected in series with said tubing and wire and operable upon closing of the circuit by said thermoresponsive device, and an electrical signal controlled by said signal initiating device, a chamber communicating with said tubing, an electrical heater in heat exchanging relation to said chamber connected in said circuit and normally unheated, a test switch and wires connecting it in said circuit, and means controlled by said test switch for changing the flow of current through said circuit at will to increase the current through said heater and cause heating thereof to pneumatically test said tubing and said pressure actuated signal.

13. An alarm system including a length of tubing, a chamber communicating with said tubing, a pressure actuated signal connected to said tubing and actuated by fluid pressure generated in said tubing by heating of the tubing, an electrical heater in heat exchanging relation to said chamber, an electrical circuit including in series said length of tubing, said heater, a source of electricity and an electrical signal initiating means operable upon an impairment of said circuit for controlling a second signal, said circuit normally operating without heating said heater, means including a test switch connected in said circuit for at will changing the flow of current through said circuit to increase the current through said heater and cause heating thereof for pneumatically testing said tubing and said pressure actuated signal, and a second signal controlled by said signal initiating means and actuated upon occurrence of an impairment of said circuit, whereby said tubing, heater, signal initiating means, and source of electricity are under electrical supervision.

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