F. BAIN.

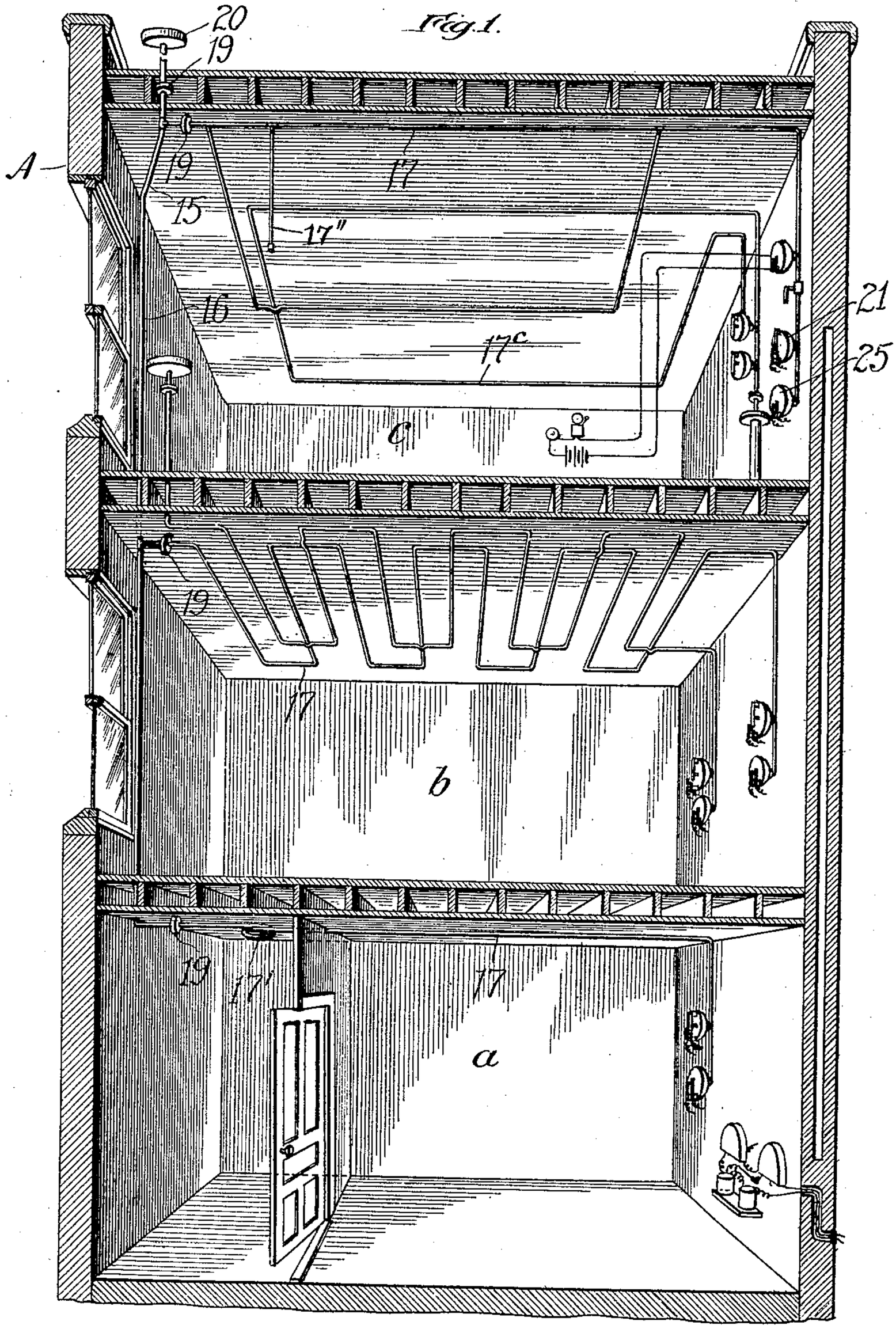
AUTOMATIC FIRE ALARM SYSTEM.

APPLICATION FILED JAN. 13, 1908.

921,660. **Patented May 18, 1909.**

3 SHEETS—SHEET 1.

Fig. 1.



Witnesses
Harry R. Lefaivre
Ray White.

Inventor
Forée Bain
By Forée Bain and May
Attys

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3 SHEETS—SHEET 2.

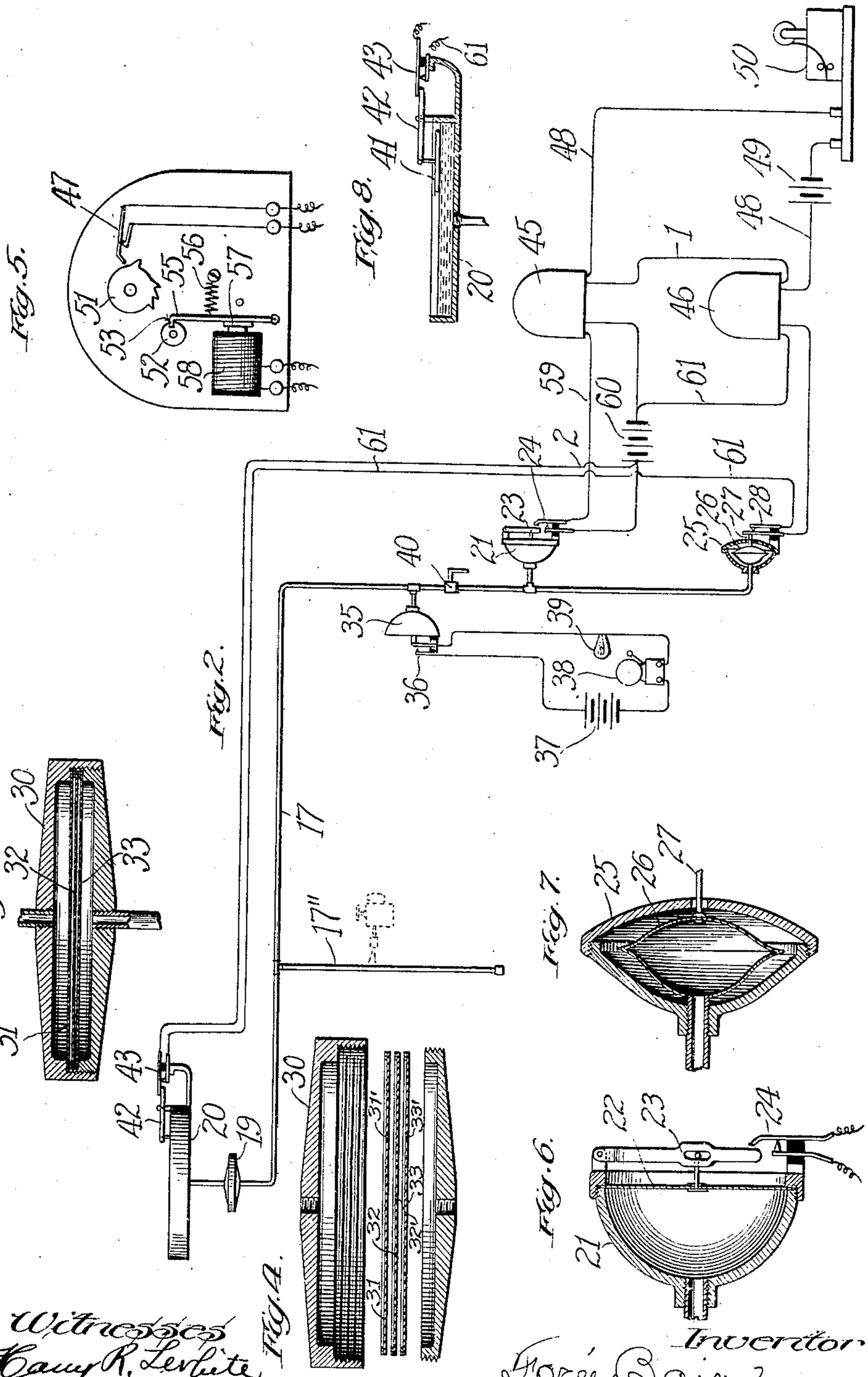

Fig. 2.

Fig. 5.

Fig. 8.

Fig. 3.

Fig. 4.

Fig. 7.

Fig. 6.

Witnesses:
Harry R. Lerbute
Ray White.

Inventor.
Forest Bain
By Forest Bain and May
Attys

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3 SHEETS—SHEET 3.

Fig. 9.

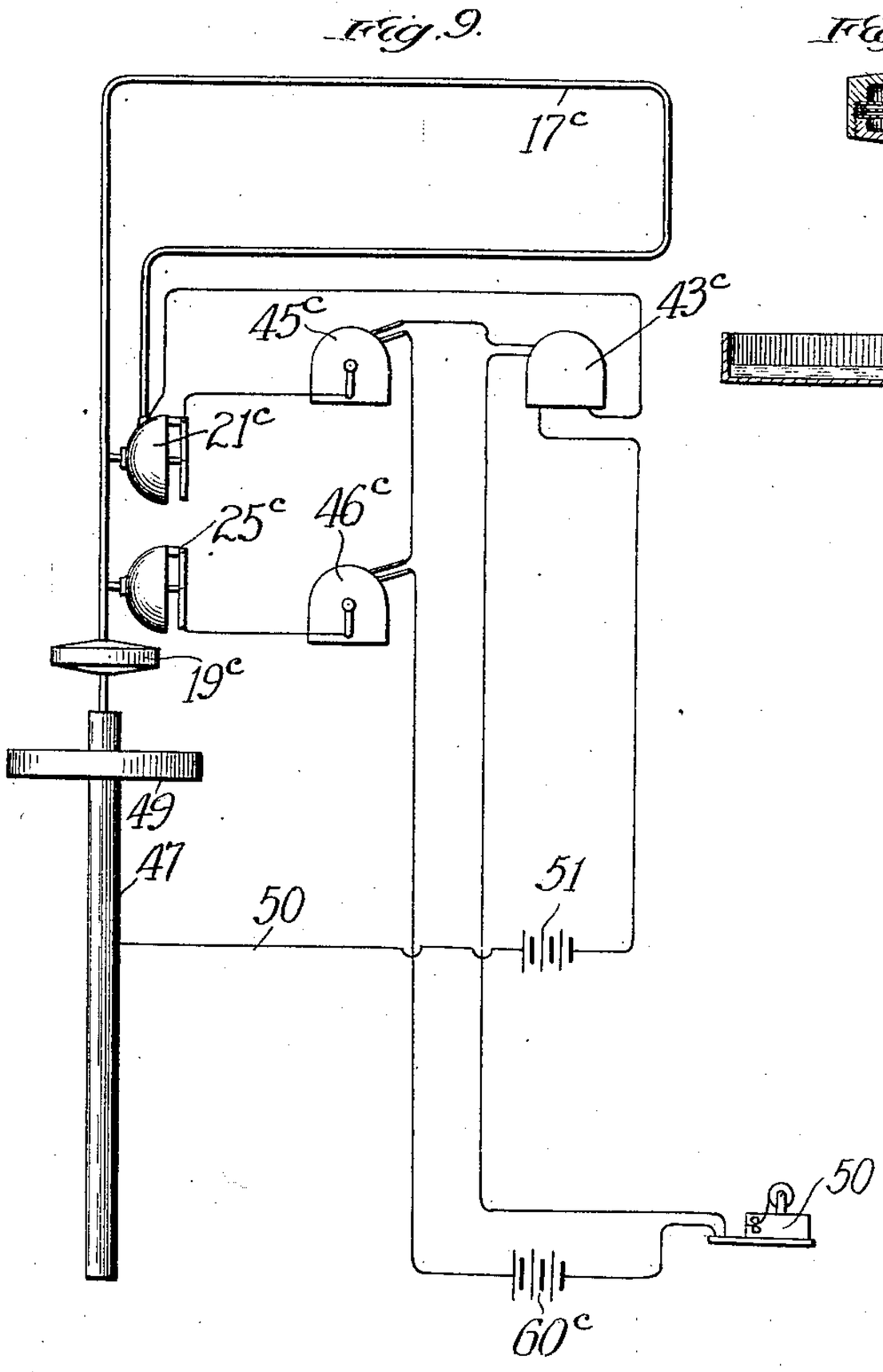
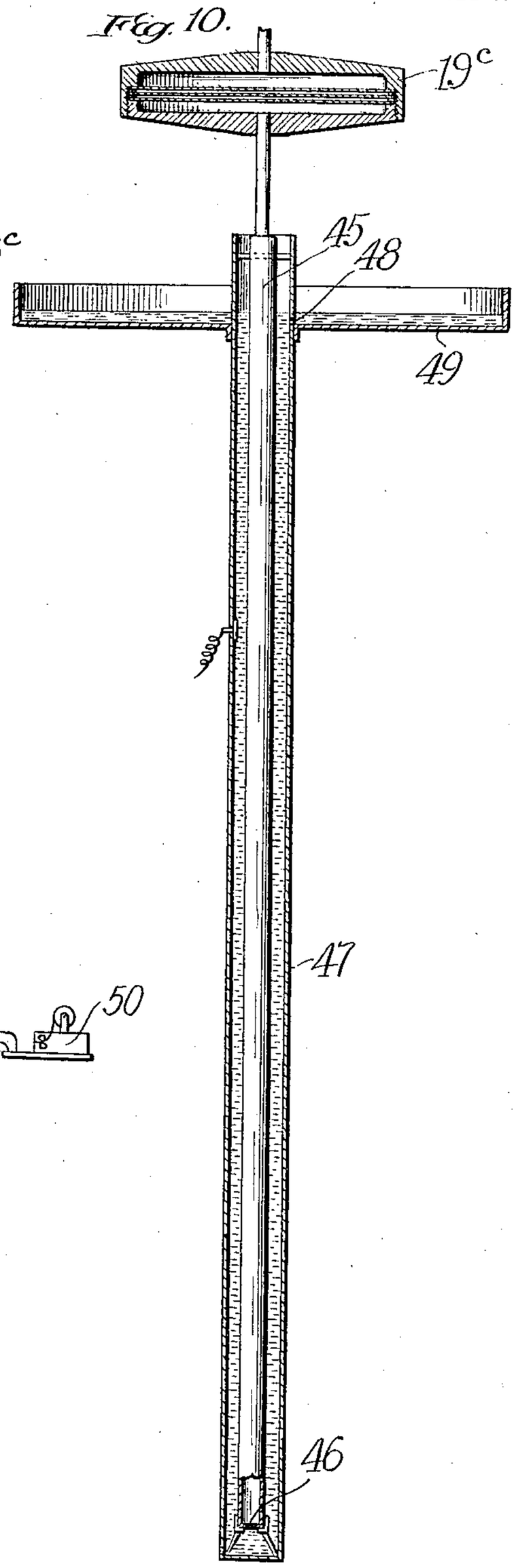


Fig. 10.



Witnesses
Henry R. Lehnte
Ray White.

Inventor
Forest Bain
By Forest Bain and May
Attys

UNITED STATES PATENT OFFICE.

FOREE BAIN, OF CHICAGO, ILLINOIS.

AUTOMATIC FIRE-ALARM SYSTEM.

No. 921,660. Specification of Letters Patent. Patented May 18, 1909.

Application filed January 13, 1908. Serial No. 410,597.

To all whom it may concern:

Be it known that I, FORÉE BAIN, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Automatic Fire-Alarm Systems, of which the following is a specification.

My invention relates to automatic fire alarm systems, and has for its general object to provide a system for instigating a fire alarm signal, preferably at a supervisory station, promptly upon the occurrence of undue heat conditions within a protected area.

Further my invention has for one of its objects to provide a heat detecting system for fire alarm purposes, of high efficiency, low cost of installation and maintenance, and of such construction as to be not apt to become deranged or get out of order.

A further object of my invention is to provide a signal initiating detector system sensitive to heat conditions in the area supervised, which will be functionally responsive to gradual changes of temperature in the supervised area below a critical temperature; which will be functionally responsive to rapid increases in temperature from any preëxistent normal condition, and which will be likewise responsive to the existence of a critical temperature however gradually attained.

Another object of my invention is to provide a system of the character described, wherein the detector apparatus and the electrical appliances are maintained under constant test to give trouble signals in the event of derangement thereof.

A further object of my invention is to improve generally and in detail systems of the character described, as will become apparent to those skilled in the art from the following description taken in conjunction with the accompanying drawings, wherein;

Figure 1 indicates in diagrammatic fashion a building equipped with protective apparatus embodying my invention; Fig. 2 shows diagrammatically an embodiment of the invention; Fig. 3 is a sectional view showing an automatic valve; Fig. 4 is a view of the valve with its parts in separated relation; Fig. 5 is a diagrammatic illustration of a suitable signal transmitting mechanism; Figs. 6 and 7 are sectional views of pressure responsive devices suitable for employment in the embodiment of the invention, and; Fig. 8 is a sectional view of the reservoir and connected devices; Fig. 9 is a diagrammatic representation of a modified embodiment of my invention, and; Fig. 10 is a sectional elevation of a pressure inducing apparatus.

Throughout the several views like characters of reference refer always to like parts.

Broadly considered my invention contemplates the provision within the area to be protected of a heat detecting, signal initiating system comprising piping containing a fluid expansible under undue heat conditions, and the association with such piping of pressure responsive devices capable of mechanically or electrically initiating signals when actuated to indicate abnormal pressure conditions within the detector system. More specifically I provide piping arranged in communication with pressure responsive devices and containing, preferably, a liquid distributed substantially uniformly throughout the entire extent of the piping, so that the application of heat to any point produces expansion of the liquid, affecting an operative section of the system and so doing away with the necessity for localized thermostatic devices, and enabling the use of uniform, cheap piping throughout comparatively large areas in the protected building. Further my invention contemplates supplying the piping with expansive liquid of a non-inflammable nature, volatilizing at a suitable predetermined temperature above the normal temperature to be maintained in the area protected. Also my invention contemplates the provision of a system in which the liquid is maintained within the piping normally under a suitable pressure sufficient to maintain in potentially active condition a trouble-signal initiator, so that rupture of the piping will be attended with a trouble-signal. Further I provide a construction such that slow changes of pressure within the system may be compensated for by a slight flow of the expansible fluid or medium, to or from a reservoir or other supply source, while sudden increase of pressure within the system may result in actuation of the pressure responsive device, such construction preferably comprising an antomatic valve normally open-

ing an equalizing passage to the reservoir, and self-closing under sudden pressure. I also make provision, which may be used or not as desired, for making a positive test of the integrity of the piping system upon occasions, and I also provide an arrangement for making the system especially sensitive to heat confined to relatively small areas.

In the specific embodiment of my invention shown, A represents a building, shown as a three story structure, divided into stories or spaces *a*, *b* and *c*, and diagrammatically illustrated as equipped with a system embodying my invention.

15 indicates in general a single piping system composed of pipe uniformly infusible at a predetermined critical or danger temperature extending through the protected area for signal initiating purposes, and of character adapted for the reception of expansive fluid. Such piping preferably is black or dark colored thin-walled, highly conductive piping of uniform small diameter and of a practically continuous character, oxidized-brass one-eighth-inch piping being well adapted for the practice of my invention. The single piping system 15 comprises a vertical main or riser 16 filled with the expansible fluid, and having extending therefrom just below the different ceilings branch pipes 17 which may be run in any desired fashion to efficiently serve the area of each floor to be protected. On the upper floor of the building the piping is shown as run in a grille formation; on the middle floor as run in sinuous formation, and on the lower floor the piping is shown as provided in suitable areas with coiled portions 17′ to give a relatively great piping exposure in a relatively small area, such as a small room.

Preferably communication between each branch pipe and the riser is controlled by an automatic valve 19, which may be of a construction hereafter described, and the piping main 16 is preferably connected for supply through a similar valve to a reservoir 20 located at a high level to impose a gravity pressure upon the system, such reservoir 20 being preferably of relatively great area in plan, so that the level of the liquid therein will be but little changed by the natural flow of liquid to and from the piping as hereinafter described.

It is my preference that the entire system be filled with an expansion medium in the form of a liquid having an expansion coefficient, at low temperatures, in excess of the expansion coefficient of the piping, and capable of volatilization to an extent sufficient to produce a relatively high pressure at a suitable critical temperature, such as is undesirable in the protected area, and such as is regarded by fire experts as dangerous, say 160° F. Further I prefer that the liquid medium be of a non-inflammable character and one of comparatively high specific gravity, and I have found that these desirable qualities may be secured, for example, by the use of carbon tetrachlorid as a basic liquid ingredient. For modifying the critical point of volatilization and either increasing or decreasing the expansive effect, this ingredient may be mixed with others, but I have found that such liquid may be used alone with excellent effect, as its expansion coefficient is comparatively high, its volatilization point is about 160° F., and its expansion when heated above that point is exceedingly rapid, its specific gravity is sufficiently great for the purpose desired and it is non-inflammable and non-explosive.

With the branch pipes of the single pipe system a suitable number of pressure responsive devices are associated, it being my preference that there be pressure responsive devices associated with each branch of the piping. I deem it desirable that the responsive devices associated with each piping branch shall be of a character to respond to either an increase of pressure within the piping or a substantial decrease in such pressure, and while a single responsive device might be employed for this purpose, I herein show separate pressure gages or responsive devices 21 and 25, adapted to be functionally operated by increase and decrease, respectively, in the pressure, both in open communication with their branch of the piping system 17. In the construction shown the high pressure gage,—that is, the device responsive to increase of pressure,—consists of a chamber having one wall closed by a flexible diaphragm 22, arranged to move outward upon the application of predetermined pressure from the inside of the chamber, and connected by a pin and slot connection with a lever 23, arranged in coaction with the normally closed electric switch 24 to open said switch when the diaphragm is sufficiently bulged outward. The low pressure gage 25, or that responsive to decrease to subnormal pressure, is shown as comprising a shell in which is contained a chamber 26 formed of two diaphragms expanded under the normal pressure existing in the system and sufficiently resilient to contract when the pressure is relieved, the outer diaphragm of the chamber 26 having connected therewith a rod 27, which serves to hold closed a switch 28, so that collapse of the chamber 26 when pressure is relieved permits the switch 28 to open.

The automatic valve 19, heretofore referred to, may be of any construction which will permit gradual flow of liquid therethrough in either direction in response to gradual expansion or contraction of the liquid within

the pipe, but which will close tightly in response to any sudden impulsive expansion or pressure. A construction which I have found well adapted for the purpose is illustrated in Figs. 3 and 4, wherein 30 indicates a shell or casing having its opposite sides connected with the piping in open communication therewith, and having in its interior three parallel diaphragms 31, 32 and 33, tightly packed at their edges, arranged to stand normally in spaced relation, and having therein the non-registering apertures 31′, 32′ and 33′, respectively, the apertures 31′ and 33′ being preferably located at points between the center and periphery of the respective diaphragms, and aperture 32′ being preferably located about the center of the middle diaphragm.

It will be seen that the construction described provides a tortuous passage through the apertures of the diaphragm through which liquid may slowly flow to compensate for expansion or contraction of the liquid within the pipe, but it will be evident that a relatively sudden expansion of the liquid within the piping 17 will force over the diaphragm 33 upon diaphragm 32 and the latter against the diaphragm 31, closing the central aperture 32′ and holding the same closed until the pressure is relieved and the balance restored. Likewise in the event of rupture of one piping branch and sudden decrease in pressure therein, the valve 19 for that branch will close under the unbalanced pressure to prevent the reservoir from being drained, and so localizing the effect of the trouble to the single branch.

It will now be apparent that in the operation of the system as thus far described, the head of liquid in the reservoir 20 and the piping appurtenant thereto, maintains the pressure upon the liquid filling the piping branches, and upon the pressure responsive devices 21 and 25, connected with each such piping branch. Of course in the single piping system 15 the pressure would be different on the several floors, and the pressure devices would be adjusted correspondingly. As slow or gradual changes in temperature take place, such as those due to normal heating up of the building in the day time and its cooling at night, or the changes attendant upon natural climatic conditions, the gradual expansion or contraction of the liquid causes gradual and gentle flow of liquid through the automatic valve, without materially changing the head of liquid in the supply reservoir because of the relatively great superficial area of the pool of liquid within the reservoir, and, therefore, without altering the pressure on the gages. If, however, heat is so applied to the system as to cause relatively sudden expansion of the liquid in the system the automatic valve closes under the relatively rapid change of pressure, which may for comparative purposes be called an impulse, so preventing the dissemination of pressure from the piping system and causing the accumulation of pressure due to the increased temperature to act upon the diaphragm of the high pressure device 21 bulging it outward to initiate a signal through the mechanism controlled by the switch 24. Furthermore, it will be observed that even a very slow or gradual increase of temperature to or above the critical point determined by the character of the liquid within the piping, will occasion the action of the signaling devices for the reason that at such critical points the expansibility of the liquid is so greatly enhanced that its action upon the automatic valve is impulsive rather than slow even where the heating above the critical point is very slow, and the automatic valve is closed by the rapid increase of pressure in the piping due to volatilization of the liquid. Therefore, a dangerously high temperature may not be attained without the initiation of a signal even if the increase tending toward such dangerous heat condition is very slow. Further it will be observed that if for any reason pressure is reduced within the system, for instance by the breaking of a pipe, the relief of the pressure upon the low pressure responsive device 25, occasions the collapse of its diaphragm and operates the switch 28 associated therewith to initiate a signal. For purposes of additional supervision of the integrity of the system I provide refinements which may be employed or not as desired, and to this end is shown the testing structure comprising a test stub-pipe 17″ connected with a suitable part of the piping system 17 for the easy application of heat thereto through the agency of a blow torch or the like, and a test gage 35 connected with the pipe 17 and of construction generally similar to the gage 21, such gage 35 controlling a normally open switch 36 in circuit with a battery 37, audible test bell 38, and visual test lamp 39. A cock 40 is provided in the piping between the test gage 35 and the main gages for preventing the operation of the service gages when the test is being applied to the system. Furthermore supervision of the liquid level in the tank 20 may be effected, as shown in Fig. 8, through the provision of a float 41 connected by a suitable lever 42 to control a normally closed electrical switch 43 so that when the liquid level drops below a predetermined point the switch 43 is opened.

For signaling purposes I have herein shown the pressure responsive devices as arranged to coöperate with electrical fire telegraphic appliances, although obviously the several gages may be made to act to initiate signals in any manner described

whether electrical or otherwise. In the use of such electrical devices, however, I prefer that the circuits thereof shall be under constant test, so that the possibility of failure in this branch of the system shall be reduced to a minimum. In the specific disclosure made 45 is a fire alarm signal transmitter and 46 a trouble alarm signal transmitter, each such transmitter preferably comprising a signaling switch, 47, wired in series in a signaling circuit 48, which contains a suitable source of current supply 49, and at the central station includes a signal register 50. The switch 47 of each transmitter is controlled by a signaling wheel 51, arranged to be driven by a normally wound "clock-work" or otherwise potentially active motor, which in the embodiment shown is illustrated as including a rotating part 52, having therein a notch 53 for normal engagement by a controlling lever 55, provided with a spring 56 which tends to retract it, and carrying the armature 57 for an electro-magnet 58. The magnet 58 for the box 45 is wired in a circuit 59 including a source of current supply 60, and the switch 24, of the high pressure gage 21. The switch 28 and switch 43 are wired in series in a circuit 61 including also said source of current supply 60. Now it will be seen that the rupture of either circuit 59 or 61 by the opening of the switch 24 or either of switches 43 and 28 will deënergize the magnet 58 of the corresponding transmitter 45 or 46, permitting spring 56 to retract the controlling lever 55 and thereby free the motor for active operation during which its wheel 51 coacts with the switch 47 of the main or signaling circuit to transmit a plural impulse signal thereover registrable at the central station on the instrument 50. In some cases it may be desirable to provide double supervision for the area under protection, so that accidental derangement of one system, resulting in the transmission of a trouble or alarm signal may not be treated as serious without the confirmation of a signal from the other signal initiating system and, therefore, on the second and third stories of the building illustrated in Fig. 1, I have indicated convenient arrangements of duplex supervision, wherein two piping elements are run in interlaced relation to serve the same area and be both subjected to the same heat conditions. Furthermore, in some instances it may be impossible to secure a pressure in the piping system by extending the piping to an overhead reservoir, and I have herein shown in Figs. 9 and 10 an application of my invention wherein the pressure is supplied from below by a gravity pressure-maintaining arrangement.

In the construction described 17^c indicates the piping system, having both ends connected with the pressure responsive device 21^c and having a lead extending thence into connection with the pressure device 25^c and thence to an automatic valve 19^c into a somewhat enlarged tube 45 open at its lower end as at 46 and immersed in an outer shell 47, preferably of glass, having adjacent its upper end communication through an aperture 48 with an overflow reservoir 49, of relatively large area. The reservoir 49 and tube 48 are filled with mercury or other very heavy fluid, which forces its way a suitably short distance up into the tube 45 exerting a determined pressure upon the fluid whether gaseous or liquid, within the detector piping connected with the supply chamber 45. Obviously the action of the system thus equipped will be substantially the same as that heretofore described, the increase or decrease in temperature and corresponding slow expansion or contraction of the fluid within the piping system 17^c forcing more or less of the mercury out of the tube 45 into the tube 48 although hardly perceptibly changing the level of the mercury in the reservoir 49. For maintaining a test upon the mercury and piping in addition to the test afforded by the pressure responsive device 25^c an electric circuit 50 is provided at one end terminating in a contact immersed in the mercury, thence extending to and including a battery 51 and an electro responsive alarm signaling box 43^c, and thence connected to the piping 17^c to include substantially the whole of said piping in the electrical circuit. The signaling circuit of the transmitter 43^c includes also the signaling pen or transmitters 45^c and 46^c which are shown as arranged to be mechanically tripped by the operation of the responsive devices 21^c and 25^c respectively, such main circuit also including the source of current supply 60^c and a signal register 50.

While I have herein described in some detail specific embodiments of my invention for purposes of full disclosure, it will be apparent to those skilled in the art that numerous changes in the construction and arrangement thereof might be made without departure from the spirit and scope of the invention disclosed, and I do not desire, therefore, to be understood as limiting myself to the particular devices electrical or mechanical, herein illustrative, shown further than as specified in the claims.

Having thus described my invention, what I claim and desire to secure by Letters Patent is;

1. In a fire protection system, a signal initiating installation comprising a piping system sufficiently infusible throughout to remain closed at a danger temperature, normally filled with a fluid under pressure above

atmospheric, at any temperature, having a greater expansibility than the piping which contains it, devices associated with said piping system and responsive to abnormal increase in pressure in said system due to increase in temperature of the contained fluid or to decrease in pressure in the piping system below normal, and signaling means arranged for actuation by the said pressure responsive devices when actuated to indicate abnormally high or low pressure.

2. In a fire alarm system, a signal initiating equipment comprising piping having substantially uninterrupted communication throughout a length appropriate for the supervision of a given area, a liquid substantially filling said piping and expansible under the influence of heat to create a pressure in the piping, said liquid having a predetermined volatilization point at which its expansion is greatly enhanced, a pressure responsive device associated with the piping, means controlled by said pressure responsive device, for occasioning a signal, and means for preventing slow expansion of the fluid below volatilization point, from operatively affecting the pressure responsive device.

3. In a fire alarm system, a signal initiating installation comprising piping uniformly infusible at a critical temperature, pressure responsive means for actuation by predetermined abnormal high and low pressures operatively associated with the piping, and a body of liquid substantially filling said pipe, maintaining the pressure responsive means under a normal pressure above atmospheric, expansible under a critical heat to apply the predetermined abnormal high pressure to the pressure responsive means.

4. In a fire protection system, a signal initiating equipment comprising a piping system extending throughout the area to be protected, and divided into sections, a source of fluid supply for said piping system, means permitting ingress of fluid from the reservoir to each section of the piping system but preventing communication of impulsive changes in pressure from said section to the balance of the piping system, pressure responsive devices associated with the several sections of the piping system, and signaling devices arranged for operation by said pressure responsive devices.

5. In a fire alarm system, the combination of a heat responsive, signal-initiating installation, comprising piping uniformly infusible at the danger temperature connected for communication of pressure throughout, a pressure responsive device in open communication with said piping, and a heat expansible liquid substantially filling said piping system and normally constantly exerting a pressure above atmospheric pressure upon the pressure responsive device.

6. In a fire protection system, a signal initiating installation comprising a piping system exposed to action of heat due to fire, said piping system being substantially filled with a volatile, non-inflammable liquid normally under effective pressure above atmospheric, a pressure responsive means operatively associated with the piping system for constant application thereto of the effective fluid pressure, responsive to heat-engendered rise in said pressure, and a signaling means operatively associated with said pressure responsive means.

7. In a fire protection system, a continuous thermostatic piping system comprising communicating piping disposed to be affected by fire within the area protected, the piping being of substantially uniform diameter and uniform infusibility at a critical temperature and filled throughout with a non-inflammable liquid having a volatilization point at the critical temperature below the boiling point of water, a pressure responsive device adapted to be actuated by the pressure engendered by the volatilization of liquid within the piping system, and signaling means associated with the pressure responsive means.

8. In a fire protection system, a piping system containing a liquid under pressure above atmospheric at all temperatures adapted to volatilize at relatively low critical temperature to engender a higher pressure in the system, and pressure responsive devices operatively associated with the piping system, responsive to increase in pressure engendered by volatilization of the liquid, and to decrease in pressure to sub-normal condition.

9. In a fire protection system, piping installations in interspaced relation, separate sources of supply for said two piping installations, fluid of a non-inflammable nature susceptible of volatilization at a relatively low temperature in said piping and supply sources, independent pressure responsive devices for the separate piping installations, and signal initiating devices operatively associated with the pressure responsive devices.

10. The combination with a piping system containing an expansive fluid, pressure responsive devices operatively associated with said piping system, an electric signal transmitter provided with electro responsive controlling means, an electric circuit under test including said transmitter controlling means and controlled by the pressure responsive devices, and an electric signaling circuit under test including the signaling appliances of said transmitter.

11. In a system of the character described, a piping system adapted to contain a fluid susceptible of creating a pressure therein

under the heat of fire, pressure responsive devices associated with said piping, signaling means associated with said pressure responsive device for control thereby, means for interrupting connection with said pressure responsive device and the piping system, a pressure responsive testing device associated with the piping system, and local signaling means connected with said test device, whereby the true signal transmitter may be cut off from communication with the piping system and the system tested through the local test devices.

12. In a fire alarm signaling system, the combination of a piping system, fluid within said system expansible gradually below a critical temperature and more impulsively above said temperature, a pressure responsive device operatively associated with the piping system, and an automatic valve connected in said piping system arranged and adapted to remain open under gradual expansion of the fluid in the piping, and to close upon more impulsive expansion of said fluid.

13. In a fire alarm signaling system, the combination of a piping system, liquid within said system expansible below a critical temperature of volatilization, a pressure responsive signal initiating device operatively associated with the piping system, and an automatic valve connected in said piping system, comprising a normally open passage and means for closing said passage upon sudden increase in pressure in said piping system.

14. In a fire alarm system, the combination of a piping system, a source of liquid supply therefor subject to atmospheric pressure, a liquid practically filling said piping and source of supply, a signal initiating device responsive to change of pressure within the piping, and automatic means for controlling communication between the piping and supply source arranged to substantially interrupt such communication upon sudden variation from normal of the pressure in the piping.

15. In a fire alarm system, the combination of a piping system containing liquid under pressure expansive under heat to create a greater pressure, a reservoir for supplying said liquid and maintaining it under pressure, pressure responsive devices associated with the piping, and means for reducing the communication of abnormal pressure from the piping to the reservoir.

16. In a fire alarm system, the combination of a heat-responsive, signal initiating installation comprising piping uniformly infusible at a critical danger temperature, pressure responsive, signal occasioning means communicating with said piping for actuation by abnormally high or low pressure, a body of heat-expansible liquid substantially filling said piping system, and normally exerting an effective gravity pressure above atmospheric pressure upon the pressure responsive means to maintain a test upon the integrity of the piping, and a reservoir for said liquid normally communicating with the piping system to compensate for slow expansion and contraction of said liquid.

17. In a fire alarm system, piping extending throughout an area to be protected, high and low-pressure responsive means associated with said piping, a body of liquid within said piping exerting normally a pressure above atmospheric upon said pressure responsive means, said liquid being gradually expansible below a critical temperature and rapidly expansible at the critical temperature, and means for preventing slow expansion of the liquid due to slow heating thereof below the critical temperature from functionally affecting the pressure responsive means, incapable of relieving the pressure due to rapid expansion of the liquid due to the heating thereof to the critical temperature or to rapid heating thereof below such critical temperature.

18. In a fire alarm system, the combination of a piping system containing a heat-expansible fluid under a test pressure above atmospheric, and high-and-low-pressure responsive signal-occasioning means for actuation by relief from the test pressure and by increased pressure due to the heating of the fluid.

19. In a fire alarm system, the combination of a piping system containing a heat-expansible fluid under a test pressure above atmospheric pressure, high-and-low-pressure responsive means arranged and adapted for actuation by relief from the test pressure and by increase in pressure due to expansion of the fluid by heat, and electrical signaling means under constant test, arranged for actuation by the functional operation of said pressure responsive means.

20. In a fire alarm system, the combination of a piping system containing a heat expansible fluid under a test pressure above atmospheric, high-and-low-pressure responsive means arranged and adapted for actuation by relief from the test pressure and by increase in pressure due to expansion of the fluid by heat, electric signal transmitting means provided with an electro responsive controlling device, an electric circuit under test including said controlling device and controlled by the pressure responsive means, and an electric signaling circuit under test including the signaling appliances of said transmitting means.

21. In a fire alarm system, piping extending throughout an area to be protected, high and low pressure responsive means associ-

ated with said piping, a body of liquid embodying carbon tetrachlorid as its basic ingredient, within said piping, exerting normally a pressure above atmospheric upon said pressure responsive means, and means for preventing slow expansion of the liquid due to slow heating thereof below its critical temperature of volatilization from functionally affecting the pressure responsive means, incapable of relieving the pressure due to rapid heating or volatilization of said liquid.

In testimony whereof I hereunto set my hand in the presence of two witnesses.

FORÉE BAIN.

In the presence of—
A. P. CRISWELL,
MARY F. ALLEN.