Sept. 29, 1953 C. N. CAHUSAC ET AL 2,654,082

SMOKE DETECTOR

Filed Sept. 8, 1949 4 Sheets-Sheet 1

Fig. 1.

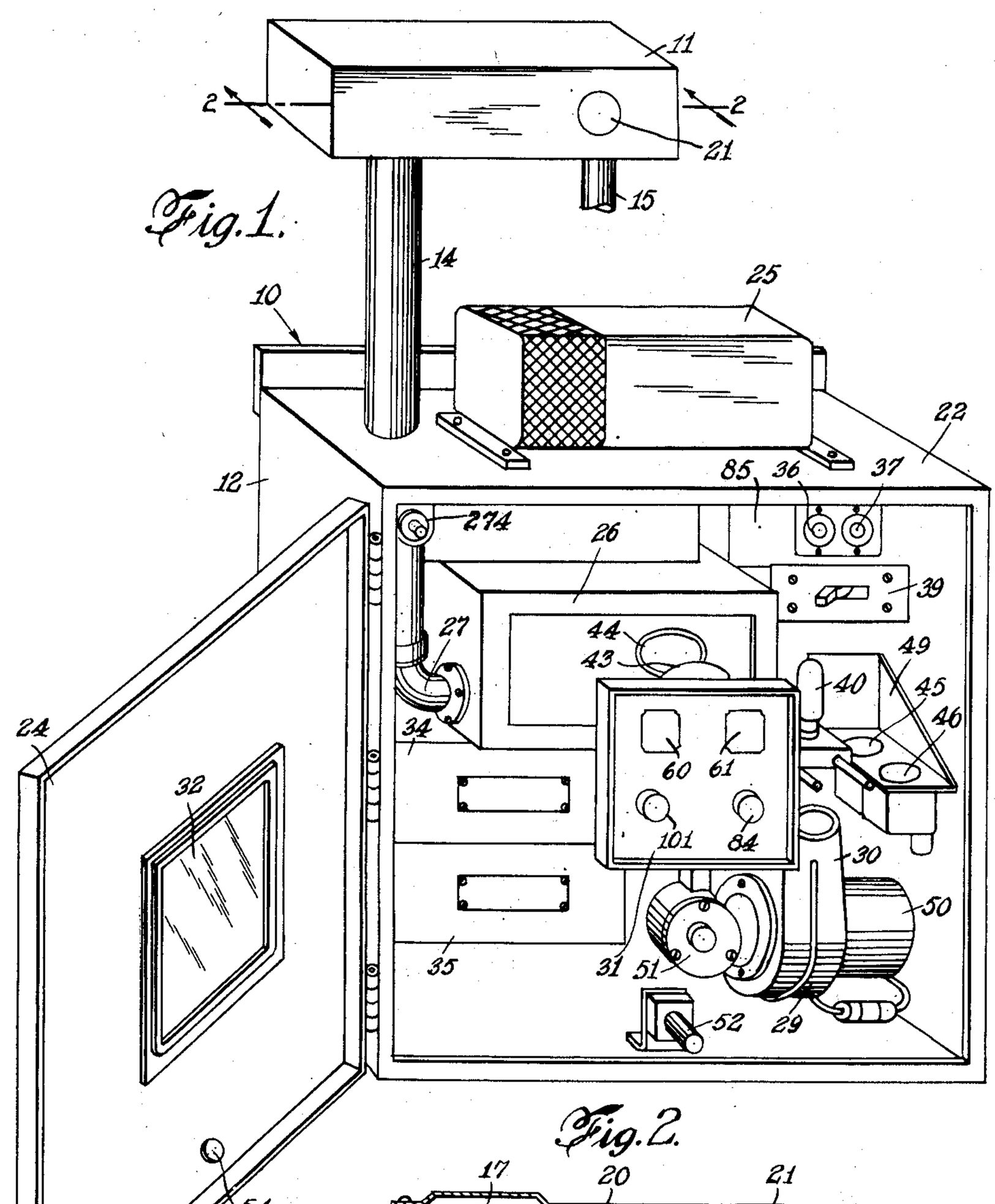
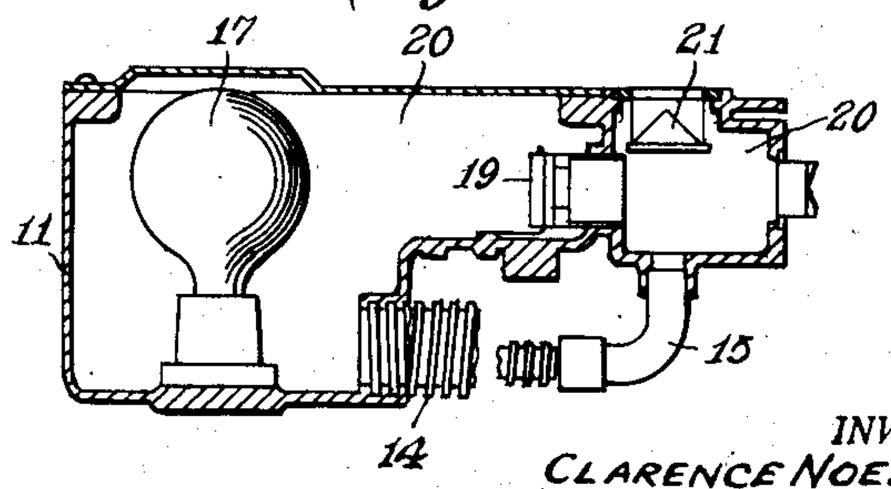


Fig. 2.



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SMOKE DETECTOR

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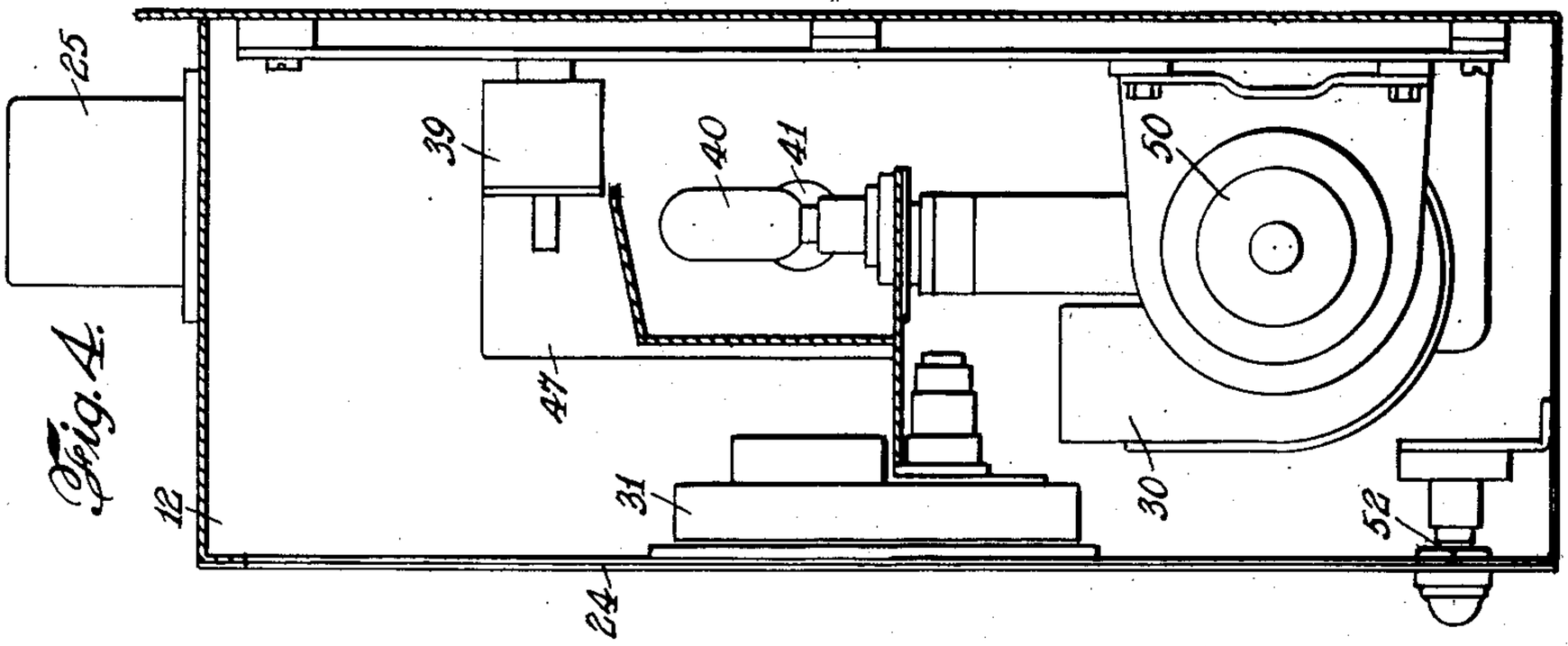

Fig. 4.

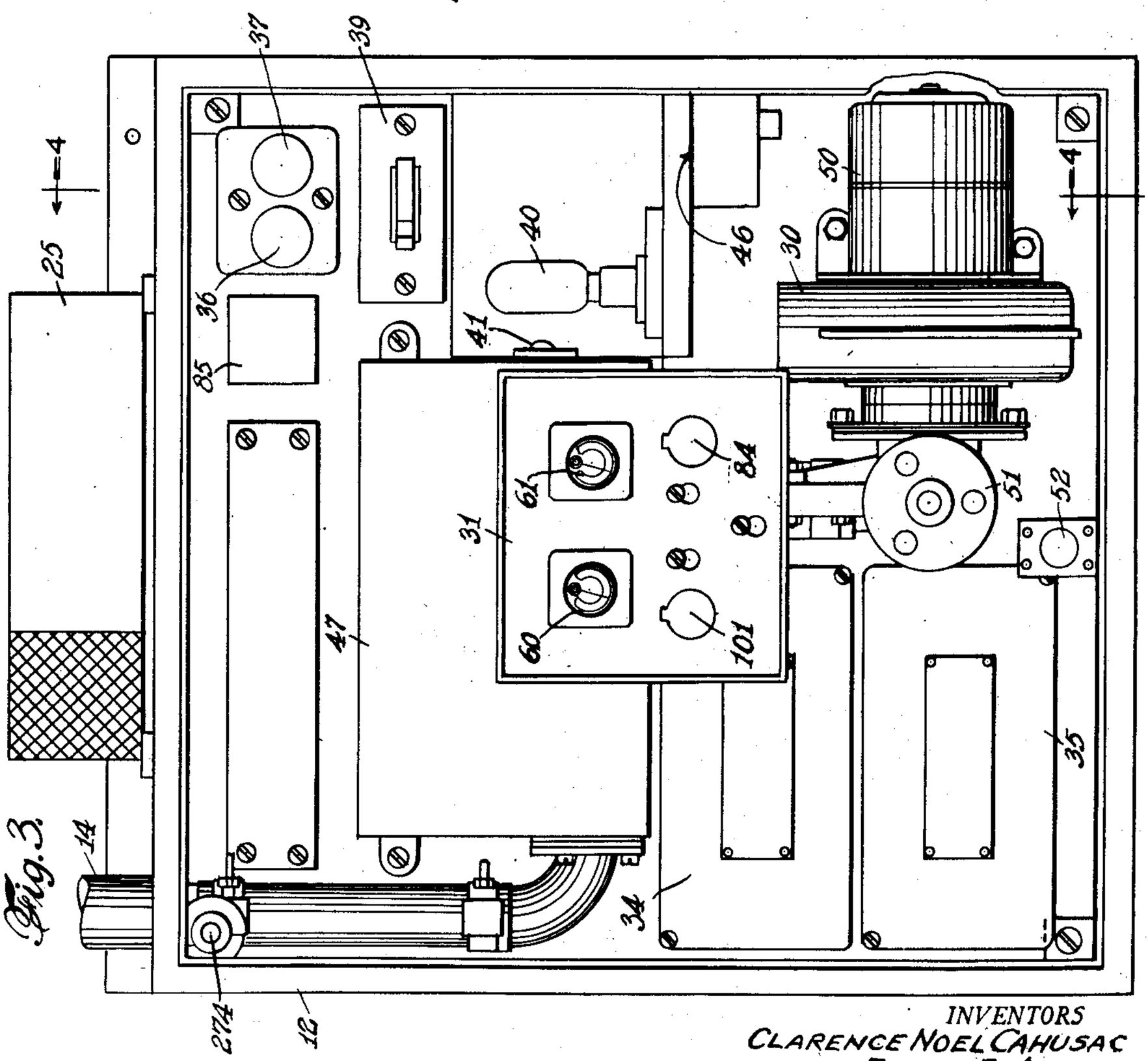

Fig. 3.

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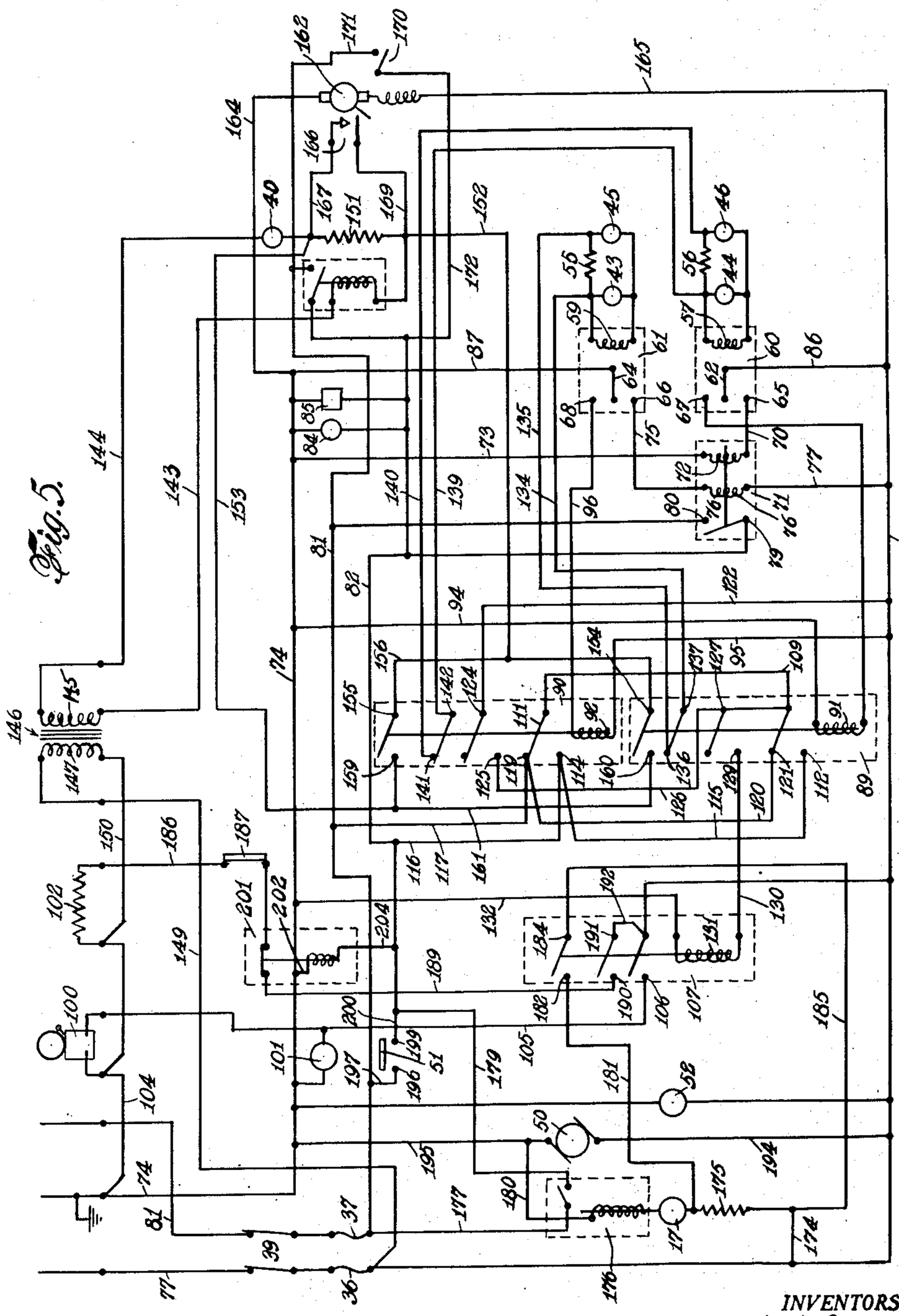
Fig. 5.



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SMOKE DETECTOR

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Fig. 6.

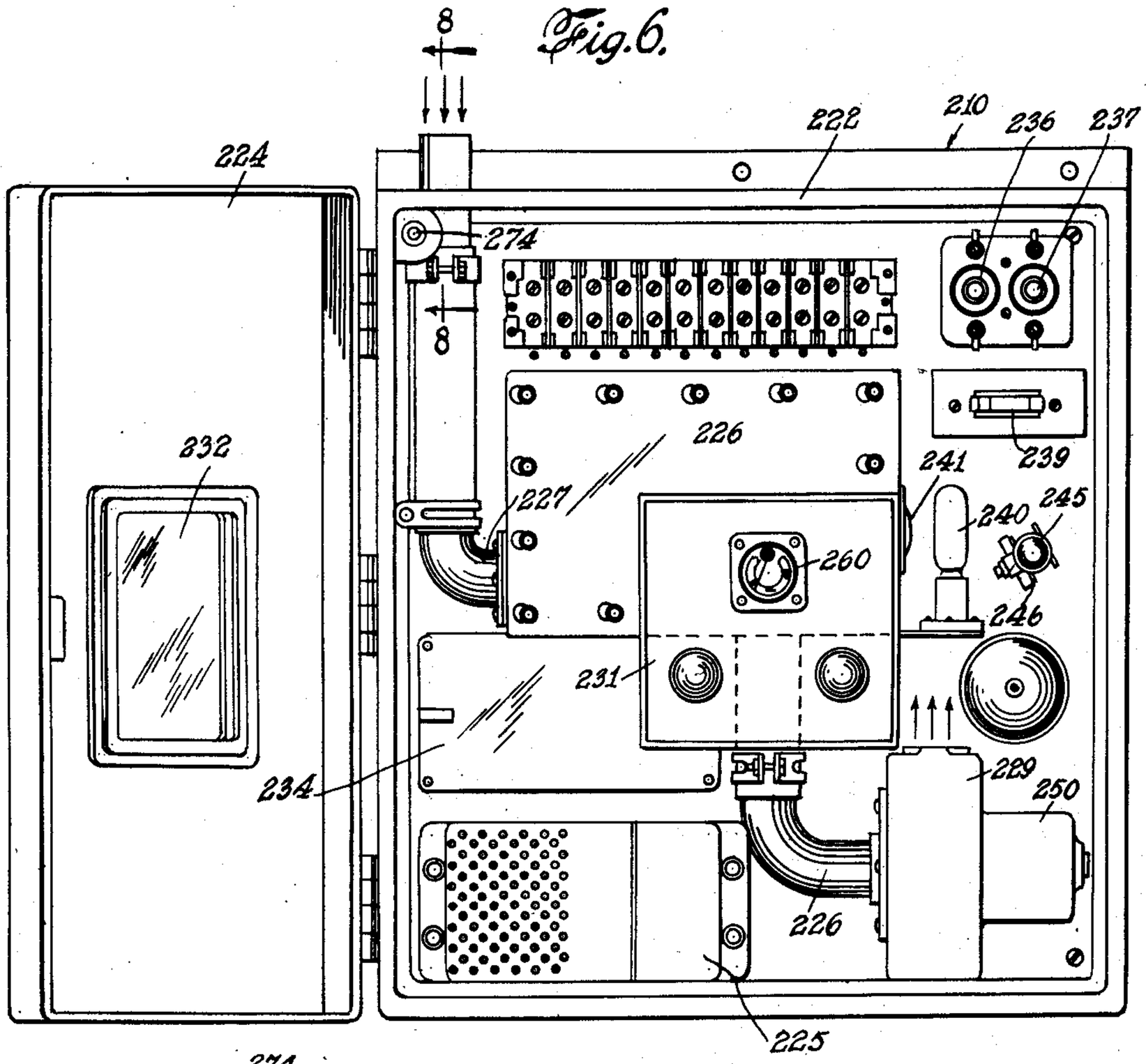


Fig. 7.

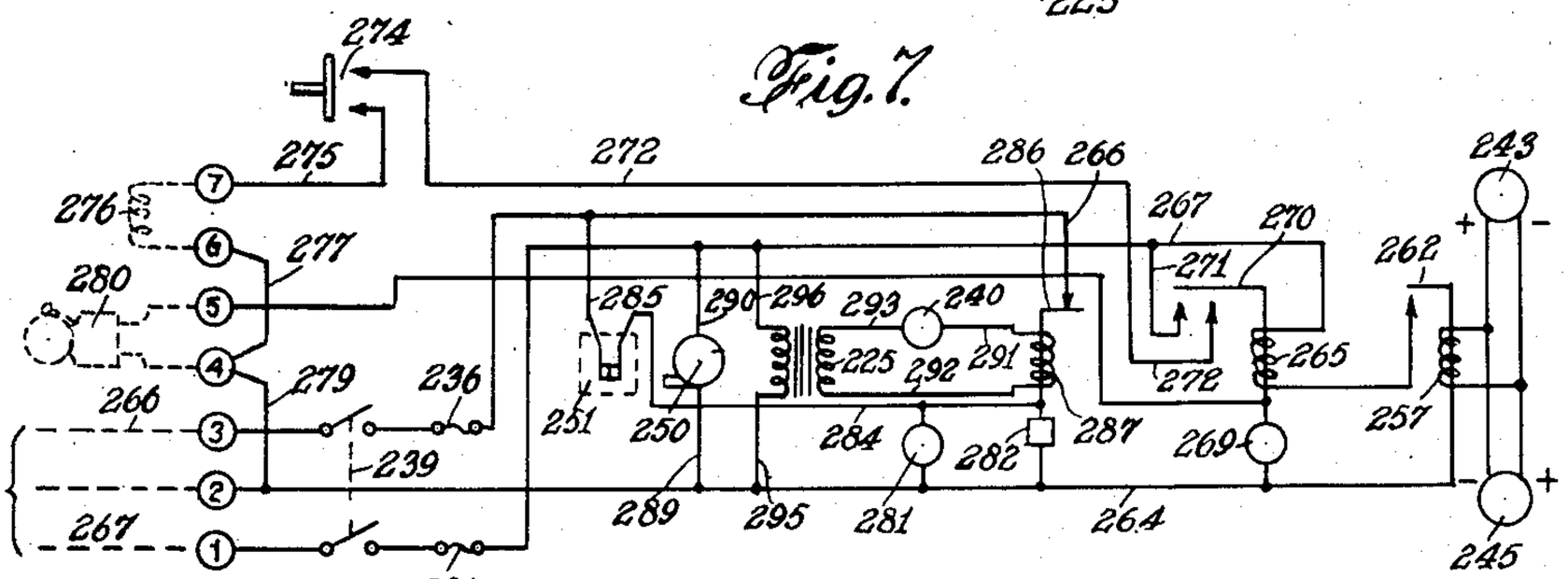
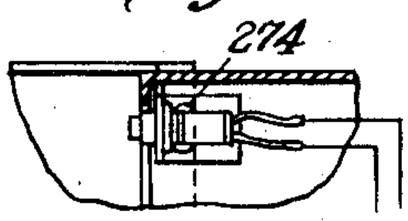


Fig. 8.



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Patented Sept. 29, 1953

2,654,082

UNITED STATES PATENT OFFICE

2,654,082

SMOKE DETECTOR

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Application September 8, 1949, Serial No. 114,611

13 Claims. (Cl. 340—237)

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The present invention relates to apparatus for detecting and indicating the presence of suspended matter in fluids, the apparatus being particularly suitable for detecting the presence of smoke in a fluid stream.

Apparatus in accordance with the invention may be used, in addition to other purposes, for the detection of smoke in rooms or sections of industrial buildings, or in the compartments or holds of ships. The apparatus is arranged to actuate a fire extinguishing system and to give a smoke signal when the presence of smoke is indicated, the apparatus also being arranged to actuate a trouble signal in the event of a malfunction of its principal parts. It is generally desirable that the signals be given at a remote location, such as at a central station or control room.

Apparatus of this type generally includes a source of light, means for bringing a stream of fluid such as smoke from the space to be protected into the light beam, means for indicating the presence of the smoke, and electric responsive means such as a relay for controlling the production of an audible or visible warning signal, or for actuating additional apparatus such as the fire extinguishing system.

It is very important that smoke detecting apparatus function properly at all times and that an indication be given if trouble should develop. Further, it is important that the apparatus be constructed so as to minimize the possibility of a false warning being given or that an unnecessary discharge be had of a fire extinguishing system.

The present invention aims to provide smoke detecting apparatus in which means are provided to indicate any condition adversely affecting its proper operation.

Another object of the invention is to provide a smoke detector which is efficient in operation and durable in use.

In accordance with the invention this is accomplished by providing a smoke detector having an improved circuit including means adapted to be actuated upon the occurrence of any condition wherein the apparatus will fail to operate properly.

A feature of the invention is the provision of means whereby the apparatus will give a smoke alarm only if both smoke detecting photoelectric cells and balancing cells operate in a proper manner.

Another feature of the invention is the provision of means to indicate the improper operation of either of the smoke detector photoelectric elements or of either of the balancing photoelectric elements.

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Still another feature of the invention is the provision of means whereby when any of the component parts are in any condition affecting its proper operation, the trouble signal will be given separate and distinct from the alarm signal.

A further feature of the invention is the provision of circuit interrupting means arranged to be actuated by the opening of the door to the cabinet enclosing the apparatus so that there can be no accidental actuation of the central station alarm or accidental discharge of the fire extinguishing system while adjustments are being made on the apparatus.

Other objects and advantages of the invention will be apparent from the following description and from the accompanying drawings which show, by way of examples, embodiments of the invention.

In the drawings:

Figure 1 is a perspective view of an apparatus in accordance with the invention. A visual smoke detecting unit is shown positioned above an audible smoke detecting unit and connected therewith by piping. The inlet pipe for the visual unit is shown broken away and may be extended to a space from which the air is to be tested for smoke. The cover of the audible cabinet is opened and the cover of the smoke detecting compartment removed to expose the smoke detecting photoelectric elements.

Figure 2 is a sectional view taken along the line 2—2 of the visual unit shown in Figure 1.

Figure 3 is a front view of the audible unit of Figure 1.

Figure 4 is a sectional view taken along the line 4—4 of Figure 3.

Figure 5 is a wiring diagram of the apparatus shown in Figure 1.

Figure 6 is a front view of a modified form of the invention utilizing a simplified circuit.

Figure 7 is a wiring diagram of the apparatus shown in Figure 6.

Figure 8 is a detailed sectional view of the door switches shown in Figures 1 and 6.

Referring to the drawings there is shown a smoke detector 10 in accordance with the invention comprising a visual detector 11, and an audible detector 12 connected by a pipe 14. The term visual detector is used herein to distinguish from the audible detector, it being understood that in the visual detector when smoke is present it actually is seen due to light reflected by suspended

smoke particles in the fluid. In the audible detector electro-mechanical means are employed, such as photoelectric cells, to indicate the presence of smoke in the fluid being tested, the indication thereof being given in the form of an alarm as by the sounding of a gong or by the lighting of a signal lamp.

The visual detector 11 has an inlet pipe 15 shown broken away but which may lead to any space to be protected and from which samples of air are to be drawn for testing for smoke. The visual detector 11 may be an individual unit as illustrated, or it may be constructed as a plurality of units each having a pipe 15 leading to a separate space to be protected, the outlets from all of the visual detectors being manifolded to the pipe 14 to the audible detector. As shown, the individual smoke detecting unit 11 comprises a housing enclosing a visual electric light source 17, and a lens 19 used to concentrate and project light from the source 17 through the visual testing compartment 20. The smoke is brought into the visual testing compartment 20 through the pipe 15 and ejected through the pipe 14 into the audible testing detector 12. A viewing window 21 made of a transparent material is positioned in one side of the visual testing compartment 20 at the side of the light beam projected through the lens 19. The inside of the detecting compartment 20 is painted or otherwise covered with a dark non-reflecting material so that normally no light may be seen through the window 21. However, when smoke is present in the detecting chamber, light is reflected from the particles of smoke and may be observed through the window. Because of the concentration of the beam of light by the lens 19, a very small percentage of smoke in the air being tested is readily visible through the window 21.

The audible detector 12 is encased in a cabinet 22 having a swinging door 24 providing easy access to the mechanism within the cabinet. A transformer 25 is mounted on the top of the cabinet and connected to the apparatus in the interior thereof by suitable conduit means. Within the cabinet 22 is an audible smoke detector housing 26 having an inlet 27 connected with the pipe 14. The outlet of the audible smoke detecting compartment 26 leads to the inlet of the suction blower 29 which may have its outlet 30 either within the cabinet 22 or piped to the outside as may be desired. A sensitive relay panel 31 is positioned in front of the smoke detecting cabinet 26 in alignment with a transparent window 32 in the door 24. A pair of boxes 34 and 35 are used to enclose relays to be hereinafter described. An electrical power supply is connected through fuses 36 and 37 to a main switch 39. An audible smoke detector lamp 40 is positioned at one side of the smoke detecting housing 26 to project light therethrough by means of a suitable lens system 41. Within the housing 26 are located a pair of detecting photoelectric elements or cells 43 and 44. A pair of balancing photoelectric elements or cells 45 and 46 is positioned outside the housing 26 and connected in a circuit which will be later described.

The audible detecting housing 26 may be made of any suitable material such as sheet metal and is preferably provided with a removable cover 47 for inspection and cleaning of the interior thereof. The detecting photoelectric cells 43 and 44 located within the housing 26 are positioned at an angle with respect to each other and facing the path of the beam of light projected by the

lens 41 into the smoke detector compartment. The pair of balancing photoelectric cells 45 and 46 are supported by a bracket 49 and are positioned at one side of and below the light 40 to avoid a high concentration of rays of light on the face of the cells. Any suitable means may be used for varying the amount of light received by the cells such as a semi-transparent glass cover, a diaphragm shutter, or the like, so that a balance may be had as will be later described.

The blower 29 is actuated by a motor 50 to produce a negative pressure within the piping system and smoke detector compartment. An indication of a failure of the blower is given by a suction actuated switch 51 inserted ahead of the blower 29.

An indicating light 52 is supported within the cabinet 12 in juxtaposition with a window 54 in the door 24 to indicate the energization of the unit.

The wiring diagram of the smoke detector 10, is shown in Figure 5. A pair of smoke detecting units is formed of the photoelectric cells, one unit comprises the detecting cell 43 connected in opposition with the balancing cell 45 and in series with a resistance 55, while the other unit comprises the detecting cell 44 connected in opposition with the balancing cell 46 and in series with a resistance 56. The outputs of the detecting cells for the two units are respectively connected to coils 57 and 59 of sensitive relays 60 and 61. The sensitive relays include double throw switches having movable elements 62 and 64, trouble signal contacts 65 and 66 and smoke signal contacts 67 and 68.

The trouble contact 65 of the sensitive relay 60 is connected by a wire 70 to one terminal of a double coil detecting cell supervisory relay 71 having a relay coil 72 connected by a wire 73 to a common ground 74. The supervisory relay 71 is adapted to indicate trouble in either or both of the detecting cells 43 and 44. The trouble contact of the sensitive relay 61 is connected by a wire 75 to a second coil 76 of the relay 71. The coil 76 has its other terminal connected by a lead 77 to one side 78 of a power supply protected by the fuse 36. In the event either of the detecting cells become open circuited or for any reason fail to produce normal current output, its corresponding balancing cell causes the sensitive relay moveable contact to go to the trouble position. When either of the coils of the relay 71 are energized its contacts 79 and 80 are closed connecting a second power supply 81 protected by the fuse 37 to a trouble signal bus 82. A trouble signal lamp 84 and a trouble buzzer or gong 85 are connected between the trouble bus 82 and the power supply 81 in order to provide a trouble indication.

To provide a source of supply for the actuation of the relay 71 by its coil 72 a wire 86 is connected between the power supply 77 and the movable element 62 of the sensitive relay 60. The relay 71 is actuated by its other coil 76 by making a ground connection through the movable element 64 of the other sensitive relay 61 and a wire 87 to the common ground 74. While the relay 71 has been described as being a two coil relay, it is obvious that in an alternative construction a pair of single coil relays might be used each having their contacts 79 and 80 connected in parallel so that either relay may actuate the trouble signal in the same manner as it is now actuated by one of the coils of the relay 71.

A pair of balancing cell relays are provided for each of the sensitive relays, each balancing cell relay being adapted to actuate a plurality of switching contacts. These relays also cause the actuation of an alarm signal. The balancing cell supervisory relays are indicated by the numerals 89 and 90 and respectively have operating coils 91 and 92. The operating coil 91 is connected to the smoke signal contact 67 of the sensitive relay 60, the operating coil having its other contact connected by a wire 94 to the ground bus 74. The other supervisory relay 90 has one terminal of its coil 92 connected to the power supply 78 by a wire 95 while the other contact of the coil 92 is connected by a wire 96 to the smoke signal contact 68 of the sensitive relay 61.

A smoke signal bell 100 and a smoke signal lamp 101 are connected in parallel across a wire 104 connecting with the ground bus 74, the other sides of these devices are connected in parallel by a wire 105 to contact 106 of a smoke signal relay 107. The smoke signal relay 107 is used to avoid the necessity of providing the contacts of the balancing cell supervisory relays with high capacity current contacts. In an alternative construction the smoke signal bell and lamp might be directly connected to contacts of the balancing cell supervisory relay.

The smoke signal relay 107 is energized only upon the actuation of both of the balancing cell supervisory relays 89 and 90. This is accomplished by providing each of the supervisory relays 89 and 90 with a pair of double throw contacts having their movable elements connected in series and having their double throw contacts arranged in a parallel connection. The connection is so arranged that in the event only one of the relays 89 or 90 are actuated, a connection is made to the trouble signals. This is done by providing a series connection 109 between the movable element for relay 89 and a movable element 111 for the relay 90. Contact 112 of a double throw switch for the relay 89 is connected to a contact 114 of a double throw switch of the relay 90 by a wire 115, in turn, connected to the trouble bus 82 by a wire 116. The power supply 81 is connected by a wire 117 to another contact 119 of the double throw switch for the relay 90, in turn, connected by a wire 120 to the other contact 121 of the relay 89.

The power supply 78 is connected by a wire 122 to the movable element of a normally open single throw contact 124 of a normally open switch having its other contact 125 connected by a wire 126 to a movable element 127 of a single throw switch actuated by the relay 89 and its other contact 129 connected by a wire 130 to one terminal of an operating coil 131 of the smoke signal relay 107, the operating coil 131 having its other terminal connected by a wire 132 to the ground bus 74.

In the connection in which the photoelectric cells are connected in opposition in series with a resistance, the resistances have the effect of increasing the sensitivity of the unit by reducing the effective output of the balancing cells. The detecting cells do not generate excess current unless smoke is present.

If it were possible to provide a detecting cabinet in which no stray light was present it would be unnecessary to use a balancing cell. However, as stray light is always present the balancing cells 45 and 46 are required and are connected in opposition with the detecting cells 43 and 44, and the outputs of the balancing cells 45 and 46 are adjusted so as to counteract the outputs of the detecting cells 43 and 44 under the effects of stray light. In the event smoke is present, the outputs of the detecting cells increase and initiate actuation of the smoke signal through the relays 89, 90 and 107.

The photoelectric elements are inherently of slightly different characteristics thus making it difficult to adjust both units so that they will actuate their smoke signal at practically exactly the same time. This is disadvantageous in that, unless provision is made otherwise, if either of the detecting cells calls for smoke, and the other does not, a trouble signal is given. This difficulty is overcome by providing a normally closed shorting switch for each of the resistances 55 and 56 so connected that the shorting switch for the resistance of one of the units is opened when the detecting cell for the other unit actuates its relay to the smoke signal position.

The resistance tends to effect an increase in the sensitivity of the unit by causing a voltage drop across the balancing cell and resistance in series thus lessening its opposition to the positive action of the circuit. Thus by opening the shorting switch a possible time lag is overcome and a smoke signal is given rather than a trouble alarm signal.

The resistance 55 is connected by a pair of wires 134 and 135 connecting it to a normally closed single throw switch having contacts 136 and 137 and actuated by relay 89, while the resistance 56 has a pair of wires 139 and 140 connecting it to a normally closed single throw switch having contacts 141 and 142 and actuated by the relay 92.

The audible detector is provided with a source of light such as the electric lamp 40 connected by wires 143 and 144 with the secondary 145 of a transformer 146. A primary winding 147 of the transformer 146 is connected by a wire 149 to the power supply 77 and by a wire 150 to the wire 104 connecting, in turn, to the ground bus 74. A resistance 151 is connected in series with the lamp 40 and is adapted to be shorted by single throw switches actuated by either relay 89 or 90. A wire 152 from one side of the resistance 151 is connected to a contact 154 of the relay 89, in turn, connected in a parallel connection with a contact 155 of the relay 90 by a wire 156. The other side of the resistance 151 is connected by a wire 153 to a contact 159 of the relay 90, in turn, connected in a parallel connection with a contact 160 of the relay 89 by a wire 161.

The resistance 151 is normally connected in series with the light 40 to reduce its operating intensity and thus add to its life. In order to increase the intensity of the light at periodic intervals, a timing control 162 energized by a wire 164 connected to the ground bus 74 and by a wire 165 connected to the power supply 78, is adapted to periodically close a shorting switch 166 having one terminal connected to the resistance 151 by a wire 167 and to the other side of the resistance by wire 169. A supervisory relay 170 is connected in series with the timing control unit 162 and has its contacts connected by a wire 171 to the power supply 81 and its other contact connected by a wire 172 to the trouble bus 82.

The visual lamp 17 is connected to the power supply 78 by a lead 174 through a series resistance 175, the other terminal of the visual lamp is connected through the coil of a supervisory relay 176 to the ground bus 74 by a wire 180. The contacts of the supervisory relay 176 are connected to the power supply 81 by a wire 177 and to the trouble bus 82 by a wire 179. The visual

lamp series resistance 175 is connected by a wire 181 to a normally open contact 182 of the smoke signal relay 107, and a corresponding contact 184 of the normally open switch is connected by a wire 185 to the other side of the resistance 175. The electric discharge plug 102 is connected by a wire 186 through a door switch 187 and a wire 189 to a contact 190 of a normally open switch having its other contact 191 connected by a wire 192 to the wire 78. The door switch 187 is normally resiliently urged into the open position and is held closed by the door 24, thus eliminating the possibility of an accidental discharge of the fire extinguishing system while the door is open as for adjustments of the apparatus within the cabinet 22.

The blower 50 has one of its terminals connected with the power supply 78 by a wire 194 while its other terminal is connected by a wire 195 to the ground bus 74. The blower supervisory switch 51 has one of its contacts 136 connected by a wire 197 to the power supply 81 while its other contact 199 is connected by a wire 200 to the trouble bus 82. The blower supervisory switch 51 is normally closed and is adapted to be actuated into the open position upon the cessation of the suction in the blower inlet.

A stop discharge relay 201 has its coil connected with the ground bus by a wire 202 and with the trouble bus by a wire 204, its contacts being connected in series with those of the door switch 187 so that in the event the trouble circuit is energized the electric discharge plug 102 is prevented from becoming energized and thus causing an unnecessary discharge of the system.

In the operation of the system of the smoke detector shown in Figure 5, the main switch 39 is closed energizing the system and causing the pilot indicating lamp 52 to light. The blower 50 is started providing suction to actuate the suction control switch 51 preventing the trouble signal, and at the same time the visual lamp 17 and the audible lamp 40 are lighted. The balancing cells 45 and 46 are adjusted to produce the required output so that the midpoints 62 and 64 of the sensitive relays 60 and 61 are positioned intermediate their contacts. The system is then operating normally, the timing control unit 162 being energized to periodically short the resistance 151 for the audible lamp 40 so that its intensity is periodically increased to increase the sensitivity of the audio-detector.

In the event smoke is drawn into the housing 26, light from the audible lamp 40 is reflected from the smoke to the surface of the detecting cells 43 and 44. By reason of their inherent differences in characteristics, it is quite possible that one of the detecting units will have a larger output, and assuming this to be the case for the detecting cell 43, the sensitive relay 61 will be operated so that the movable element 64 of the double throw switch is moved to the contact 68 energizing the coil 92 of the relay 90. The contacts of the relay 90 are actuated, contact 155 being connected with contact 159 to short the resistance 151 for the audible lamp therefore increasing its intensity tending to produce a greater output from the detecting cell 44. At the same time, the relay 90 has opened contacts 141 and 142 normally shorting resistance 56 thus giving the effect of further increasing the output of the detecting cell 44, contacts 124 and 125 are connected providing a source of supply to the contact 127 of the relay 89, and the movable element 111 of the double throw switch is actuated from contact 119 to the contact 114.

In the event the system is operating properly, and smoke is present, by this time relay 44 will have actuated its sensitive relay 60 so that its movable element 62 is moved to the contact 67, thereby energizing coil 91 of the relay 89, actuating all of its contacts so that no trouble signal is given, the movable element 110 opening its connection with the contact 121, simultaneously the contact 127 has been connected to the contact 129 energizing the smoke signal relay 107 and actuating its armature to close the contacts 193 and 191 respectively to the contacts 106 and 190, to energize the wires 105 and 189 from the power source 77.

The smoke signal bell 100 and the smoke signal lamp 101 are thus energized to give a signal, and the electric discharge plug 102 is energized to discharge the fire extinguishing medium into the protected space to complete a normal cycle of operation of the apparatus resulting from the presence of smoke. The energization of the smoke signal relay 107 causes the closing of its contacts 182 and 184 shorting the resistance 175 for the visual lamp 17, thereby increasing its intensity and thus giving a better visual indication of the presence of smoke.

Assuming there is no smoke present, and that the operation of the sensitive relay 61 is caused by a defect, for example, in the detecting photoelectric cell 43 causing an increase in its output. In this event, even though the intensity of the visual light 40 is increased and the resistance 56 is cut into the circuit decreasing the effect of the balancing cell 46, the output of the cell 44 is not increased enough to actuate the sensitive relay 60 to move its movable element 62 to its smoke signal contact 67. Thus the supervisory relay 89 is not actuated and its contact 110 remains connected to its contact 121, thereby connecting the power circuit 81 through the wire 109, through the actuated contacts 111 and 114 through the lead 116 to energize the trouble bus 82 to actuate the trouble lamp 84 and the trouble gong 85 to indicate that the system is operating defectively.

In the event either one of the detecting cells is defective in that its output is decreased a trouble signal will also be given. Assuming, for example, that the detecting cell 43 is defective and its output is decreased then its sensitive relay 61 is actuated so that the movable element 64 is connected to the contact 66 energizing the detecting cell supervisory relay 71 to close its contacts to energize the trouble bus 82 from the power circuit 81. It should be noted that the energization of the trouble bus 82 automatically energizes the stop discharge relay 201 so that the electric discharge plug 102 is prevented from becoming energized.

In the event either one of the balancing cells is defective in that its output is decreased a trouble signal will also be given. Assuming, for example, that the balancing cell 45 is to become defective and its output is decreased, then the same effect is produced as if the output of the detecting cell 43 had been increased. The sensitive relay 61 is actuated so that the movable element 64 makes a connection with the contact 68 energizing the relay 90. As the relay 89 is not energized, a trouble signal is given by the completion of the circuit through the contacts 111 and 114.

Referring to the embodiment of the invention shown in Figure 6–8, there is shown a smoke de-

tector **210** which differs from the embodiment shown in Figures 1–5 mainly in that only a single detecting and balancing cell unit is used. The supervision of the circuits is also simplified resulting in a smoke detector which may be produced at a lower cost for installations in which the added safeguards of the first embodiment are not warranted.

The detector **210** is encased in a housing or cabinet **222** having a door **224** providing access to the mechanism within the cabinet. A transformer **225** is mounted within the cabinet **222**, together with an audible smoke detector housing **226** having an inlet **227**. The outlet of the smoke detecting compartment **226** leads to the inlet of a suction blower **229**. A sensitive relay panel **231** is positioned in front of the smoke detecting cabinet **226** and in alignment with a transparent window **232** in the door **224**. A relay box **234** is positioned above the transformer **225**.

A power supply is connected through fuses **236** and **237** to a main switch **239**. An audible lamp **240** is positioned at one side of the smoke detector housing **226** and is adapted to project into the housing through a lens **241**. Within the housing **226** is a detecting photoelectric element **243** connected in opposed relationship with a balancing photoelectric element **245** positioned outside of the housing **226** and in range of the light from the electric lamp **240**. Suitable means are provided for varying the light to the balancing element **245** such as by the use of a shutter **246**.

The blower **229** is actuated by a motor **250** to draw air to be tested for smoke through the smoke detector housing **226**. A suction actuated switch **251** is connected into the inlet piping to the blower **229** at any suitable location, such as in the inlet **227**.

The wiring diagram of the smoke detector **210** is shown in Figure 7. The photoelectric elements **243** and **245** are connected in opposed relationship and in parallel with a coil **257** of a sensitive relay **260**. A movable element **262** of the sensitive relay **260** connects a ground wire **264** through a coil of a smoke signal relay **265** to one of the dual power supplies **266** and **267**. A smoke signal lamp **269** is connected between the ground wire **264** through a movable element **270** of the smoke signal relay **265** to the power supply **267** by a wire **271**. The movable element **270** also connects through a wire **272** to a door switch **274** and a wire **275** to an element **276** of a fire extinguishing discharge plug. A ground connection **277** connects the element **274** with a ground connection **279** of an alarm bell or gong **280** which may be positioned at a remote location if desired.

A trouble lamp **281** and a trouble gong **282** are connected through a trouble bus **284** and the suction switch **251** through a wire **285** to the power supply **266**. The trouble bus **284** is also connected through a movable element **286** of an audible lamp supervisory relay having a coil **287** to the power supply **266**. The blower motor **250** is connected by a wire **289** to the ground bus **264** and by a wire **290** to the power supply **267**.

The audible lamp **240** is connected in the secondary of the transformer **225** in series with the coil **287** of its supervisory relay by wires **291**, **292** and **293**. The transformer **225** is connected with the ground bus **264** by a wire **295** and with the power supply **267** by a wire **296**.

In the operation of the smoke detector **210** it is connected to the electrical power supply by the switch **239**. The sensitive relay **260** is adjusted by the manipulation of the shutter **246** of the balancing cell **245**. In the event the audible lamp **240** is defective a trouble signal is given by the supervisory relay **287**. Likewise, a trouble signal is given if the suction switch **251** indicates a lack of suction in the piping system such as by a failure of the blower **229** or its motor **250**. The door switch **274** is actuated by the closing of the door **224** making the system ready for a discharge of the fire extinguishing system through its actuating element **276** upon the presence of smoke in the housing **226**.

While the invention has been described and illustrated with reference to specific embodiments thereof, it wil lbe understood that other embodiments may be resorted to without departing from the invention. Therefore, the forms of the invention set out above should be considered as illustrative and not as limiting the scope of the following claims.

This application is a continuation-in-part of our co-pending application Serial No. 5,524 filed January 31, 1948.

We claim:

1. In apparatus for detecting smoke in a fluid, a visual light source to provide a visual indication of smoke, a visual light series resistance connected in a circuit with the visual light source to normally decrease the intensity of the visual light source, a trouble signal, a visual light supervisory relay to complete an electrical circuit to the trouble signal for indicating the operability of the visual light source, a suction blower, a suction conduit for conducting a stream of fluid into the apparatus, a suction actuated switch to complete an electrical circuit to the trouble signal for indicating the operability of the suction blower, an audible light source to provide an audible indication of smoke, a series resistance connected in a circuit with the audible light source to decrease the intensity of the audible light source, a timing switch connected across the audible light series resistance for periodically increasing the intensity of the audible light by by-passing the audible light series resistance, an audible light supervisory relay to complete an electrical circuit to the trouble signal to indicate the operability of the audible light source, a timing switch supervisory relay to complete an electrical circuit to the trouble signal for indicating the operability of the timing switch, a pair of detecting photo-electric cells adapted to receive light reflected from smoke in the fluid, a pair of balancing photo-electric cells, a pair of photo-electric cell resistances, each of the detecting and balancing cells connected in opposition and in series with one of the photo-electric cell resistances to form a pair of smoke detecting units, a pair of sensitive relays each electrically connected across one of the detecting cells, a sensitive relay double throw switch actuated by each sensitive relay, balancing means for each of the photo-electric cell units to vary their respective outputs to each of the sensitive relays so that the sensitive relay double throw switches are normally positioned intermediate their contacts, a detecting cell trouble signal supervisory relay for each sensitive relay adapted to complete an electric circuit to the trouble signal from one of the sensitive relay switch contacts, a balancing cell supervisory relay for each sensitive relay adapted to actuate a plurality of switching means, a trouble signal double throw switch for each balancing cell supervisory relay, series connection means between the midpoints of the trouble signal double throw switches of both said relays, connection means from the

contacts of one balancing cell supervisory relay trouble signal double throw switch to the contacts of the other balancing cell supervisory relay trouble signal double throw switch arranged in a reversed connection so that when either one of said relays is actuated a connection is made through the contacts controlled by the other of said relays to the trouble signal while if both of said relays are actuated the trouble circuit is opened, a smoke signal, a smoke signal relay, a normally open smoke signal relay single throw switch actuated by each of the balancing cell supervisory relays, series connection means for the smoke signal relay single throw switches of both relays, the smoke signal relay connected in series with the smoke signal relay single throw switches so that when both balancing cell supervisory relays are actuated the smoke signal relay is actuated, a normally open smoke signal single throw switch actuated by the smoke signal relay to complete an electrical circuit to the smoke signal, a pair of audible light resistance normally open single throw switches each actuated by a balancing cell supervisory relay and both connected across the audible light series resistance, a pair of photo-electric cell resistance single throw normally closed switches each actuated by a balancing cell supervisory relay, one of said last mentioned switches adapted to be actuated by one balancing cell supervisory relay and connected across the photo-electric cell resistance for the other balancing cell supervisory relay, the other of said last mentioned switches adapted to be actuated by the other balancing cell supervisory relay and connected across the photo-electric cell resistance for the one balancing cell supervisory relay, an electrical discharge means for a fire extinguishing system, a normally open single throw fire extinguishing system switch adapted to be actuated by the smoke signal relay to complete an electric circuit to actuate the electrical discharge means, a stop discharge relay connected in parallel with the trouble signal, and a normally closed single throw stop discharge switch actuated by the stop discharge relay to open the electric discharge means circuit when the trouble signal is actuated.

2. In apparatus for detecting smoke in a fluid, a visual light source to provide a visual indication of smoke, a visual light series resistance connected in a circuit with the visual light source to normally decrease the intensity of the visual light source, a trouble signal, a suction blower, a suction conduit for conducting a stream of fluid into the apparatus, an audible light source to provide an audible indication of smoke, a series resistance connected in a circuit with the audible light source to decrease the intensity of the audible light source, a timing switch connected across the audible light series resistance for periodically increasing the intensity of the audible light by by-passing the audible light series resistance, a pair of detecting photo-electric cells adapted to receive light reflected from smoke in the fluid, a pair of balancing photo-electric cells, a pair of photo-electric cell resistances, each of the detecting and balancing cells connected in opposition and in series with one of the photo-electric cell resistances to form a pair of smoke detecting units, a pair of sensitive relays each electrically connected across one of the detecting cells, a sensitive relay double throw switch actuated by each sensitive relay, balancing means for each of the photo-electric cell units to vary their respective outputs to each of the sensitive relays so that the sensitive relay double throw

switches are normally positioned intermediate their contacts, a detecting cell trouble signal supervisory relay for each sensitive relay adapted to complete an electric circuit to the trouble signal from one of the sensitive relay switch contacts, a balancing cell supervisory relay for each sensitive relay adapted to actuate a plurality of switching means, a trouble signal double throw switch for each balancing cell supervisory relay, series connection means between the midpoints of the trouble signal double throw switches of both said relays, connection means from the contacts of one balancing cell supervisory relay trouble signal double throw switch to the contacts of the other balancing cell supervisory relay trouble signal double throw switch arranged in a reversed connection so that when either one of said relays are actuated a connection is made through the contacts controlled by the other of said relays to the trouble signal while if both of said relays are actuated the trouble circuit is opened, a smoke signal, a smoke signal relay, a normally open smoke signal relay single throw switch actuated by each of the balancing cell supervisory relays, series connection means for the smoke signal relay single throw switches of both relays, the smoke signal relay connected in series with the smoke signal relay single throw switches so that when both balancing cell supervisory relays are actuated the smoke signal relay is actuated, a normally open smoke signal single throw switch actuated by the smoke signal relay to complete an electrical circuit to the smoke signal, a pair of audible light resistance normally open single throw switches each actuated by a balancing cell supervisory relay and both connected across the audible light series resistance, a pair of photo-electric cell resistance single throw normally closed switches each actuated by a balancing cell supervisory relay, one of said last mentioned switches adapted to be actuated by one balancing cell supervisory relay and connected across the photo-electric cell resistance for the other balancing cell supervisory relay, the other of said last mentioned switches adapted to be actuated by the other balancing cell supervisory relay and connected across the photo-electric cell resistance for the one balancing cell supervisory relay, an electrical discharge means for a fire extinguishing system, and a normally open single throw fire extinguishing system switch adapted to be actuated by the smoke signal relay to complete an electric circuit to actuate the electrical discharge means, a stop discharge relay connected in parallel with the trouble signal, and a normally closed single throw stop discharge switch actuated by the stop discharge relay to open the electric discharge means circuit when the trouble signal is actuated.

3. In apparatus for detecting smoke in a fluid, a trouble signal, a suction blower, a suction conduit for conducting a stream of fluid into the apparatus, an audible light source to provide an audible indication of smoke, a series resistance connected in a circuit with the audible light source to decrease the intensity of the audible light source, a timing switch connected across the audible light series resistance for periodically increasing the intensity of the audible light by by-passing the audible light series resistance, a pair of detecting photo-electric cells adapted to receive light reflected from smoke in the fluid, a detecting and balancing cells connected in opposition to form a pair of smoke detecting units,

a pair of sensitive relays each electrically connected across one of the detecting cells, a sensitive relay double throw switch actuated by each sensitive relay, balancing means for each of the photo-electric cell units to vary their respective outputs to each of the sensitive relays so that the sensitive relay double throw switches are normally positioned intermediate their contacts, a detecting cell trouble signal supervisory relay for each sensitive relay adapted to complete an electric circuit to the trouble signal from one of the sensitive relay switch contacts, a balancing cell supervisory relay for each sensitive relay adapted to actuate a plurality of switching means, a trouble signal double throw switch for each balancing cell supervisory relay, series connection means between the midpoints of the trouble signal double throw switches of both said relays, connection means from the contacts of one balancing cell supervisory relay trouble signal double throw switch to the contacts of the other balancing cell supervisory relay trouble signal double throw switch arranged in a reversed connection so that when either one of said relays are actuated a connection is made through the contacts controlled by the other of said relays to the trouble signal while if both of said relays are actuated the trouble circuit is opened, a smoke signal, a smoke signal relay, a normally open smoke signal relay single throw switch actuated by each of the balancing cell supervisory relays, series connection means for the smoke signal relay single throw switches of both relays, the smoke signal relay connected in series with the smoke signal relay single throw switches so that when both balancing cell supervisory relays are actuated the smoke signal relay is actuated, a normally open smoke signal single throw switch actuated by the smoke signal relay to complete an electrical circuit to the smoke signal, a pair of audible light resistance normally open single throw switches each actuated by a balancing cell supervisory relay and both connected across the audible light series resistance, an electrical discharge means for a fire extinguishing system, and a normally open single throw fire extinguishing system switch adapted to be actuated by the smoke signal relay to complete an electric circuit to actuate the electrical discharge means.

4. In apparatus for detecting smoke in a fluid, a trouble signal, a suction blower, a suction conduit for conducting a stream of fluid into the apparatus, an audible light source to provide an audible indication of smoke, a pair of detecting photo-electric cells adapted to receive light reflected from smoke in the fluid, a pair of balancing photo-electric cells, each of the detecting and balancing cells connected in opposition to form a pair of smoke detecting units, a pair of sensitive relays each electrically connected across one of the detecting cells, a sensitive relay double throw switch actuated by each sensitive relay, balancing means for each of the photo-electric cells units to vary their respective outputs to each of the sensitive relays so that the sensitive relay double throw switches are normally positioned intermediate their contacts, a balancing cell supervisory relay for each sensitive relay adapted to actuate a plurality of switching means, a smoke signal, a normally open smoke signal single throw switch actuated by each of the balancing cell supervisory relays, series connection means for the smoke signal single throw switchs of both relays, the smoke signal connected in series with the smoke signal single throw switches so that when

both balancing cell supervisory relays are actuated the smoke signal is actuated, and a pair of audible light resistance normally open single throw switches each actuated by a balancing cell supervisory relay and both connected across the audible light series resistance.

5. In apparatus for detecting smoke in a fluid, a trouble signal, a suction blower, a suction conduit for conducting a stream of fluid into the apparatus, a light source to provide an indication of smoke, a pair of detecting photo-electric cells adapted to receive light reflected from smoke in the fluid, a pair of balancing photo-electric cells, each of the detecting and balancing cells connected in opposition to form a pair of smoke detecting units, a pair of sensitive relays each electrically connected across one of the detecting cells, a sensitive relay double throw switch actuated by each sensitive relay providing smoke and trouble signal contacts, balancing means for the photo-electric cell units to vary their respective outputs to each of the sensitive relays so that the sensitive relay double throw switches are normally positioned intermediate their contacts, a detecting cell trouble signal supervisory relay for each sensitive relay adapted to complete an electric circuit to the trouble signal from one of the sensitive relay contacts, and a smoke signal, the smoke signal contacts of both of the sensitive relays connected in series with the smoke signal so that when both of the sensitive relays are actuated to their smoke signal contacts a smoke signal is given.

6. In apparatus for detecting smoke in a fluid, a light source, a conduit for conducting a stream of fluid into the apparatus, a trouble signal, a smoke signal, a pair of detecting photo-electric cells adapted to receive light reflected from smoke in the fluid, a pair of balancing photo-electric cells, each of the detecting and balancing cells connected in opposition to form a pair of smoke detecting units, a pair of sensitive relays each electrically connected across one of the detecting cells, a sensitive relay double throw switch actuated by each sensitive relay, balancing means for each of the photo-electric cell units to vary their respective outputs to each of the sensitive relays so that the sensitive relay double throw switches are normally positioned intermediate their contacts, a balancing cell supervisory relay for each sensitive relay adapted to actuate a plurality of switching means, a trouble signal double throw switch for each balancing cell supervisory relay, series connection means between the midpoints of the trouble signal double throw switches of both said relays, connection means from the contacts of one balancing cell supervisory relay trouble signal double throw switch to the contacts of the other balancing cell supervisory relay trouble signal double throw switch arranged in a reversed connection so that when either one of said relays are actuated a connection is made through the contacts controlled by the other of said relays to the trouble signal while if both of said relays are actuated the trouble circuit is opened, a single throw smoke signal switch actuated by each of the balancing cell supervisory relays, and series connection means for the smoke signal single throw switches of both relays, the smoke signal connected in series with the smoke signal single throw switches so that when both balancing cell supervisory relays are actuated the smoke signal is actuated, discharge means for a fire extinguishing system, a normally open single throw fire extinguishing system switch adapted to be actuated by the smoke signal relay to complete an electric circuit

to actuate the electrical discharge means, a stop discharge relay connected in parallel with the trouble signal, and a normally closed single throw stop discharge switch actuated by the stop discharge relay to open the electric discharge means circuit when the trouble signal is actuated.

7. In a smoke detector, a source of electric light, means to conduct a stream of fluid to be tested into the light, supervisory relay means providing trouble indication upon the failure of the electric light, a resistance in series with the electric light to reduce its intensity and with the supervisory relay means completing a circuit therebetween, and switch means to by-pass the resistance to increase the intensity of the light, whereby the electric light may be intermittently energized at full voltage to provide light for the testing and is continuously energized at low current to provide a supervisory indication of its operativeness.

8. In a smoke detector a source of electric light, means to conduct a stream of fluid to be tested into the light, supervisory relay means providing trouble indication upon the failure of the electric light, a resistance in series with the electric light to reduce its intensity and with the supervisory relay means completing a circuit therebetween, switch means to by-pass the resistance to increase the intensity of the light, and timing means to actuate the switch, whereby the light may be intermittently energized at full voltage to provide light for the testing and is continuously energized at low current to provide a supervisory indication of its operativeness.

9. In a smoke detector, a source of light, means to conduct a stream of fluid to be tested for smoke into the light, a pair of detecing photo-electric means responsive to the presence of smoke in the stream of fluid, each operative between trouble and smoke contacts, a trouble signal, a smoke signal, and switching means actuated by the photo-electric means to operate the trouble signal when either or both of the photo-electric means are operative at their trouble contacts, the switching means actuated by the photo-electric means to indicate the smoke signal only when both of the photo-electric means are operative at their smoke contacts.

10. In a smoke detector, a source of light, means to conduct a stream of fluid to be tested for smoke into the light, a pair of detecting photo-electric means responsive to the presence of smoke in the stream of fluid, relay means electrically connected with each of the detecting photo-electric means, smoke signal contacts for each of the relays connected in series, and switching means, whereby a smoke signal is given only when both of the pair of detecting photo-electric means responds to the presence of smoke.

11. In a smoke detector, light source means, fluid conduction means to bring a stream of fluid to be tested for smoke into the light, a pair of detecting photo-electric means responsive to the presence of smoke in the stream of fluid, a pair of balancing photo-electric means to compensate for variations in the light source, means to electrically connect one of the detecting and one of the balancing photo-electric means in opposition in an electric circuit, an electrical resistance in series with the one detecting and one balancing photo-electric means to minimize the effect of the balancing photo-electric means to increase the effectiveness of the detecting photo-electric means a normally closed switch connected across the resistance, the other detecting and balancing cells connected in an opposition circuit, and a relay in said last-mentioned circuit, the relay operatively connected to open the normally closed switch, whereby the one detecting photo-electric means is rendered more effective upon the actuation of the relay by the other detecting photo-electric means.

12. In a smoke detector, a source of light, means to conduct a stream of fluid to be tested for smoke into the light, a pair of detecting photo-electric means responsive to the presence of smoke in the stream of fluid, relay means for the detecting photo-electric means operable between a trouble contact and a smoke contact, a pair of balancing photo-electric means each of which is electrically connected with a detecting photo-electric means and adjusted in the absence of smoke to maintain the relay contacts in a position so that neither trouble nor smoke contacts are completed, switching means adapted to produce a trouble signal when any contact is made, and switching means adapted to nullify the effect of said last-mentioned means when both smoke signal contacts are closed.

13. In a smoke detector, a source of light, means to conduct a stream of fluid to be tested for smoke into the light, a pair of detecting photo-electric means responsive to the presence of smoke in the stream of fluid, relay means for the detecting photo-electric means operable between a trouble contact and a smoke contact, a pair of balancing photo-electric means each of which is electrically connected with a detecting photo-electric means and adjusted in the absence of smoke to maintain the relay contacts in a position so that neither trouble nor smoke contacts are completed, switching means adapted to prdouce a trouble signal when any contact is made, switching means adapted to nullify the effect of said last-mentioned means when both smoke signal contacts are closed, and switching means to produce a smoke signal when both smoke contacts are completed.

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