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C. N. CAHUSAC

2,474,221

SMOKE DETECTOR AND SIGNAL FOR DUCTS

Filed Sept. 28, 1946

3 Sheets-Sheet 1

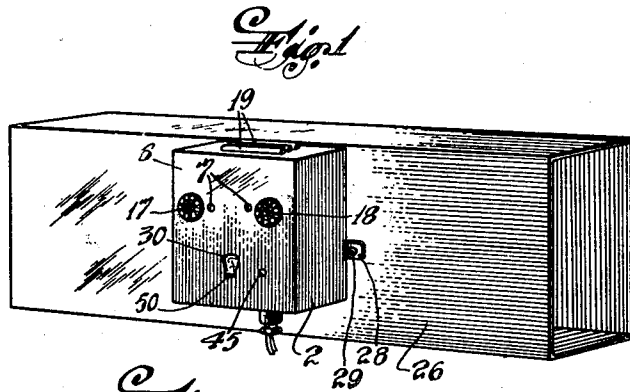


Fig. 2

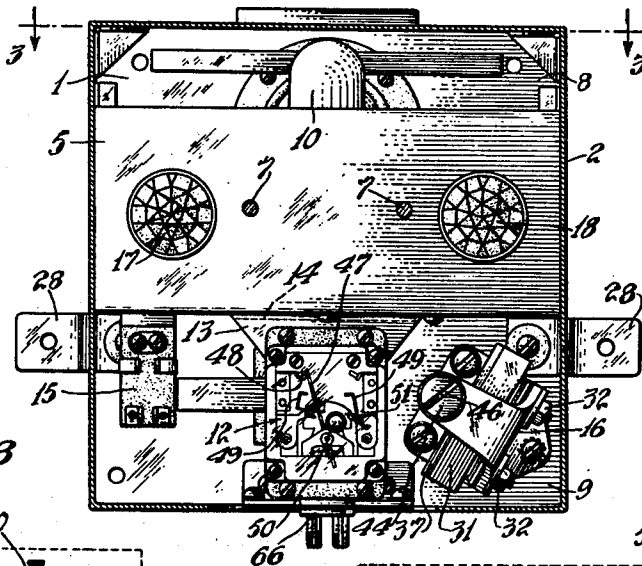
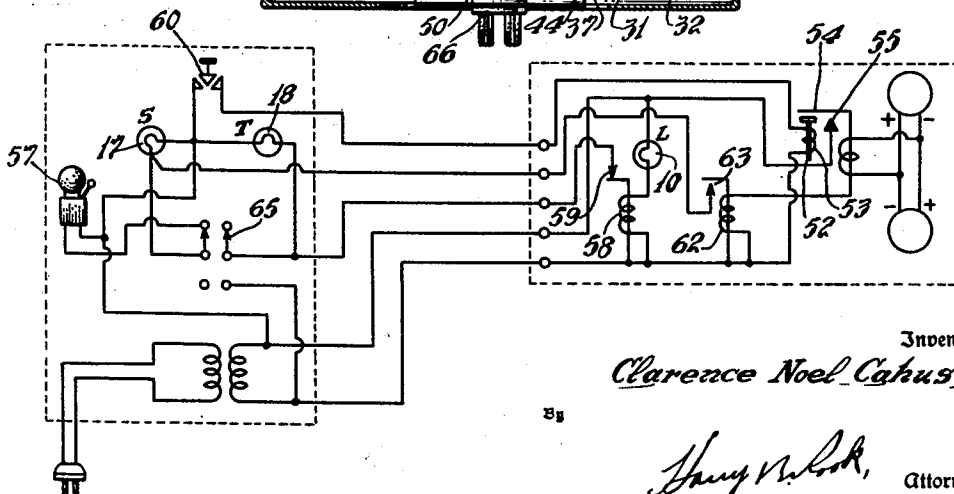


Fig. 3



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June 28, 1949.

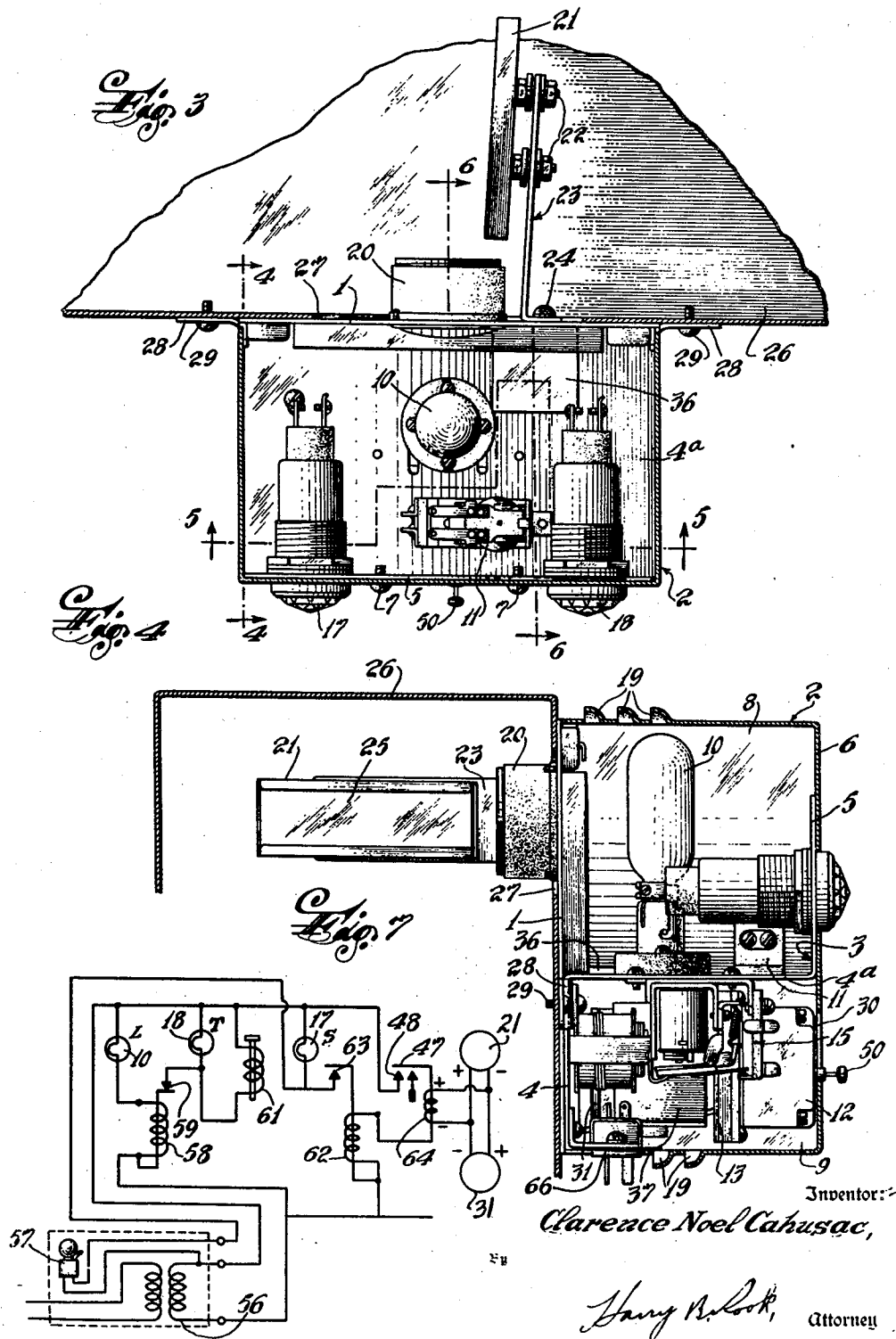
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3 Sheets-Sheet 2



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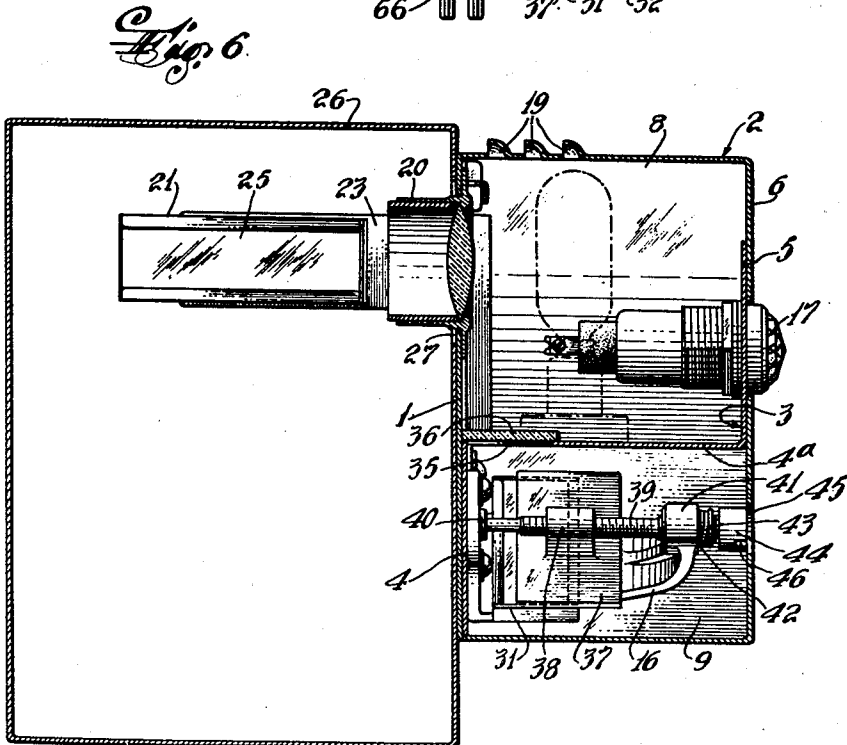
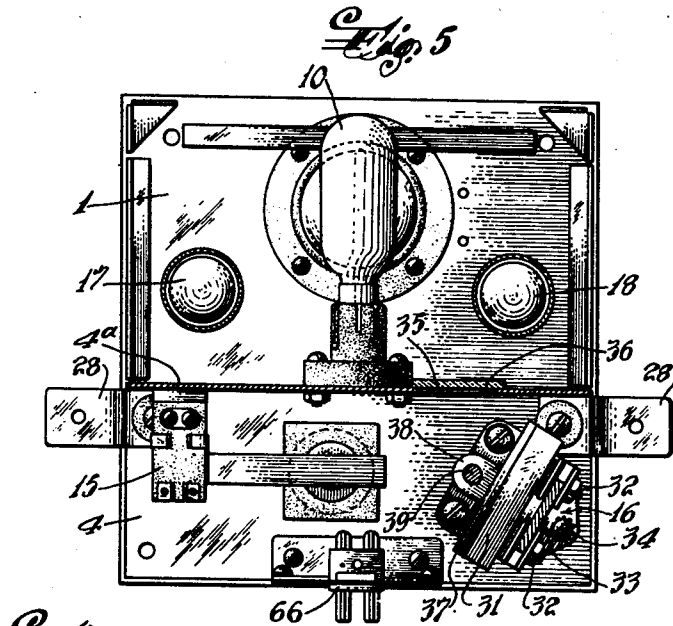
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SMOKE DETECTOR AND SIGNAL FOR DUCTS

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3 Sheets-Sheet 3



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SMOKE DETECTOR AND SIGNAL FOR DUCTS

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8 Claims. (Cl. 177-311)

1

This invention relates in general to apparatus of the general type disclosed in the copending application of Clarence Noel Cahusac and Frank B. Allen, Serial No. 604,892, filed July 13, 1945, now Patent No. 2,464,211, dated March 15, 1949, for detecting and announcing the existence of a fluid having particles of matter such as smoke, suspended therein, but the present invention is directed to apparatus especially adapted to the detection of smoke in ducts and for producing a signal—for example on an instrument board in a control room—to insure immediate warning of fires and prompt action to extinguish them.

In general, the apparatus comprises means for producing a beam of light, means for conducting a stream of fluid, such as smoke, into said light beam, a photoelectric element of the generative type located with respect to said beam and said fluid stream to receive light rays reflected from suspended matter in said fluid stream, another photoelectric element located to receive light rays transmitted through said fluid stream, means connecting said photoelectric elements in an electric circuit whereby the photoelectric effects of the second-mentioned element oppose the photoelectric effects of the first-mentioned element, and an electrical responsive means, such as a relay or "Sensitrol," in said circuit for controlling the production of an audible or visible signal.

Means also is included for varying at will the extent of exposure of the second-mentioned photoelectric element to the light rays. With this arrangement, by adjustment of the means for varying the extent of exposure of the second-mentioned photoelectric element to the light rays, the effect of the light on the first-mentioned photoelectric element may be balanced by the effect of the light on the second-mentioned photoelectric element whereby a steady and normal setting of the electrical response device or "Sensitrol" may be obtained. This arrangement also obviates the necessity of a voltage regulating apparatus for the light source, because the balance of the photoelectric cell circuit is maintained regardless of the intensity of the light source itself.

In one common type of smoke detector for ducts, a hole is formed in one side of the duct for the projection into the duct of a light beam, and a hole is formed in the opposite side of the duct for the insertion of a photoelectric cell upon which the light beam is projected, so that smoke in the duct will partially block passage of the light to the cell and consequently energize the photoelectric cell circuit.

Systems of this character are complicated to

2

install, requiring two holes in the duct and separate handling and application to the duct of the photoelectric unit and the light source. Furthermore, it is difficult to obtain the desired sensitivity because of the necessity of adjusting the photoelectric cells and the light source relatively to each other at opposite sides of the duct.

Therefore one object of the present invention is to provide a novel and improved smoke detecting unit which can be easily and quickly applied to the duct and in which the photoelectric cell and light source can be relatively adjusted before the unit is mounted on the duct.

Another object is to provide such a unit which shall be uniformly sensitive, regardless of the width or shape of the duct.

A further object is to provide a novel and improved construction and combination of parts whereby the unit shall be compact so as to require a minimum of space and a minimum of handling of separate parts during installation of the duct.

A still further object is to provide in apparatus of this character, a novel and improved construction and combination of light source, photoelectric balancing cell and means whereby the effect of the light from the light source upon the balancing cell shall be capable of easy and accurate adjustment or control from the exterior of the unit and duct.

Other objects are to provide a novel and improved combination of a photoelectric cell, a light shutter or baffle therefor whereby the effect of the light on the cell can be varied, and means for mounting and adjusting the baffle or shutter from the outside of the unit by the simple manipulation of a single element; and to obtain other advantages and results that will be brought out by the following description in conjunction with the accompanying drawings wherein:

Figure 1 is a front perspective view of a smoke detecting unit and signal embodying our invention, showing the unit mounted on a duct which is fragmentarily illustrated.

Figure 2 is an enlarged front elevational view of the smoke detector and signal unit with the front wall of the casing removed.

Figure 3 is a horizontal sectional view approximately on the plane of the line 3-3 of Figure 2.

Figure 4 is a transverse vertical sectional view approximately on the plane of the line 4-4 of Figure 3.

Figure 5 is a longitudinal vertical sectional view approximately on the plane of the line 5-5 of Figure 3.

3

Figure 6 is a view similar to Figure 4 approximately on the line 6-6 of Figure 3.

Figure 7 is a wiring diagram of the electrical circuit for the smoke detector and signal including a manual resetting apparatus for the "Sensitrol" or other relay; and

Figure 8 is a similar view showing a modified circuit for use where the signals and resetting switch are to be remotely related to the detector unit.

Specifically describing the illustrated embodiment of the invention, the smoke detector unit comprises a casing which includes a base plate 1 and a removable box-like cover 2 that may be separably connected together in any suitable manner. Preferably, as shown, the base plate has projecting from one side thereof, a Z-shaped frame 3 which comprises a flange 4 secured in any suitable manner to the base plate as by riveting, welding, soldering or the like; an intermediate portion 4a and another flange 5 projecting from said intermediate portion in the opposite direction of the flange 4 and spaced in approximately parallel relation thereto.

The front or top wall 6 of the cover 2 is secured to the flange 5 in any suitable manner as by screws 7. The intermediate portion 4a of the frame also serves as a partition for dividing the casing into upper and lower compartments 8 and 9, and for supporting some of the parts of the unit. As shown, an incandescent lamp 10 is mounted on one side of the intermediate section or partition 4a, as is also a series relay 11 of any suitable construction, the purpose of which will be hereinafter described.

On the opposite side of the partition 4a, is mounted a "Sensitrol" or other suitable relay 12, said relay being mounted on one flange 13 of an L-shaped bracket, the other arm 14 of which is connected to the partition 4a.

Also mounted on the second-mentioned side of the partition 4a, is a power relay 15 of suitable known construction, and a U-shaped bracket 16 for the balancing cell and its shutter mechanism is mounted on the flange 4.

The flange 5 of the frame 3 has mounted therein two signal lamps 17 and 18, one of which serves as a smoke signal, while the other serves to indicate trouble in the system. The cover 2 has suitable ventilating openings or louvres 19 for circulation of air to prevent overheating of the unit from the lamp 10.

In the base plate 1, is a lens system 20 through which the rays from the lamp 10 are directed outwardly from the casing in a substantially parallel beam, and on the side of the base plate opposite the frame 3 is mounted a photoelectric cell 21 at one side of the light beam so as to be sensitive to light rays reflected from suspended matter in a fluid, such as smoke passing through the light beam.

This cell may be mounted in any suitable manner but is shown as supported by screws 22 on one arm of an L-shaped bracket 23, the other arm of which is separably secured as by screws 24 to the base plate. This photoelectric element may be of any suitable type, such as the current generating barrier layer type, and preferably has a large flat rectangular exposed light-sensitive surface 25, and is capable of generating sufficient current to operate a "Sensitrol" without amplification of the electricity. The light-sensitive surface is exposed in close proximity to the outer boundaries of the light beams and is tilted obliquely with respect to the light beam so that

4

said surface is inclined away from the light source as shown in Figure 3, whereby greater sensitivity is obtained and the effect of stray light rays is substantially reduced. By simply bending the bracket 23, the cell 21 may be moved toward and away from the light beam and tilted with respect thereto as desired, the screws 22 also facilitating this adjustment.

In accordance with the invention, the casing is mounted on one wall of a duct 26 which is to be protected by the detector and signal, with the lens system and the photoelectric cell 21 projecting into the duct as best shown in Figures 2 and 4. The duct is formed with a suitable opening 27 through which the lens system and the photoelectric cell may be inserted, and the base plate of the unit may have any suitable means for attaching the casing to the duct, for example arms or ears 28 projecting laterally from the base plate and secured to the duct by screws 29.

The photoelectric element 21 is connected in circuit with any suitable electric responsive device, for example a micro-ammeter or, as shown, a "Sensitrol" 12, the face of which is exposed and visible through an opening 30 in the cover 2 of the casing. This "Sensitrol" controls another circuit which may include any desired electrically operated device such as the signal lamp 17.

Another photoelectric element 31, which may be of the same general type as the element 21, is mounted by bolts 32 on a U-shaped bracket 33, one arm of which is secured by bolts 34 to the flange 4 of the frame 3. The light-sensitive surface of said cell 31 faces upwardly toward and in diagonal relation to an opening 35 in the partition 4a so as to be subject to light rays passing from the light source 10 through said opening 35. Preferably a transparent or translucent plate 36 is disposed across the opening 35 to diffuse the light rays.

To vary the extent of exposure of the photoelectric element 31 to the light rays, a shutter or baffle 37 overlies the light-sensitive surface of the cell and has connected thereto, preferably cast integrally therewith, a nut 38 through which is threaded a screw 39, one end of which is journaled in one arm 40 of the bracket 33, while its other end portion is rotatably mounted in a bearing 41 on the other arm of the bracket. The screw is held against longitudinal movement by means of stop collars 42 fastened on the screw at opposite sides of the bearing 41, and for holding the screw in adjusted position, a compression spring is interposed between one of said collars 42 and a head 44 on the screw which is exposed through an opening 45 in the cover 2 and has suitable means such as a kerf 46 to facilitate rotation of the screw.

With this construction, it will be observed that by rotating the screw 39, the shutter 37 will be moved in such a way as to expose more or less of the light-sensitive surface of the cell 31, as best shown in Figures 5 and 6.

The photoelectric element 31 is connected in circuit with the photoelectric element 21 and the "Sensitrol" 12 in what is known as an "opposed parallel" arrangement, or so that the photoelectric effects of said elements are caused to operate in compensating differential or exposed relation; in other words, the electrodes of the element 31 are connected respectively to the opposite electrodes of the element 21 as shown in the wiring diagrams of Figures 7 and 8.

With this construction, initially, the photoelec-

5

tric cell circuit is so adjusted that the relay or other device 12 will assume a normal condition; for example, to open the signal circuit when no smoke is present in the duct 26, and when smoke or other fluid containing suspended matter is caused to flow through the duct into the beam of light, some of the light rays will be reflected from the solid particles in the stream upon the photoelectric cell 21, whereupon the relay or other device 12 will be actuated by the current in the photoelectric cell circuit.

In the specific relay 12 illustrated in the drawings, there is a pointer or swingable arm 47 which is responsive through the electromagnetic coil 64 to current in the photoelectric cell circuit and normally spaced from a fixed contact 48, but is actuated into engagement with said contact when the photoelectric cell circuit is energized, as shown in Figure 2.

When the "Sensitrol" is energized by electricity generated by the photoelectric cell 21, its contact arm 47 engages the contact 48 and tends to remain in such contact because of magnetic attraction of the latter for the pointer as is well known in the art. It is customary to provide means for resetting this contact arm either directly or indirectly from a remote point. As shown in Figure 2, the resetting mechanism includes two arms 49 which are pivoted to move toward each other upon manual pressure exerted on a push rod 50, said arms 49 being disposed at opposite sides of the pointer, and when moved together actuating the pointer to its neutral position away from the contact 48. The arms 49 are actuated into normal inoperative position by springs 51. All of this structure is old and well known and no claim thereto is made in this application.

In one form of remotely controlled resetting mechanism which is schematically illustrated in Figure 8, a push rod 52 is actuated by an electromagnetic coil 53 controlled by a manually operated electric switch so as to push the pointer 54 of the "Sensitrol" away from its cooperating fixed contact 55.

The photoelectric cells, light source, "Sensitrol" and signals may be connected in circuit in different ways, and one possible circuit arrangement is shown in Figure 7. A suitable source of current is provided, for example a transformer 56 for stepping down house current to say 22½ volts, for operating the signal such as the lamp 17 or a gong 57. One terminal of the source is connected to one terminal of the coil 58 of a relay which includes a switch 59 that controls the circuit through a trouble lamp 18 and buzzer 61, the other terminal of said coil 58 being connected through the exciter lamp 10 to the other terminal of the circuit.

One terminal of the coil 62 of a power relay is connected to one terminal of the source and has its other terminal connected through the "Sensitrol" switch 47—48 to the other terminal of the source. The coil 62 controls a relay switch 63 which is connected in circuit with the smoke-indicating lamp 17.

With this construction, it will be understood that normally the "Sensitrol" switch 47—48 will be open, but when smoke enters the duct 26, the photoelectric cell circuit will be operated so as to energize the actuating coil 64 of the "Sensitrol" and thereby close the switch 47—48. This in turn will cause energization of the power relay coil 62 which will close the switch 63 and energize the smoke-indicating lamp 17. Should any

6

trouble arise in the circuit, for example should the exciter lamp 10 burn out, the series relay switch 59 will be opened so as to cause operation of the trouble lamp 18 and buzzer 61.

In Figure 8, the circuit is similar, but the signal lamp 17, the trouble lamp 18 and the gong 57 may be mounted at a remote point from the detector unit, for example on an instrument board in the office of a factory. Also, on such an instrument board may be mounted a manually operated switch 60 for controlling the circuit through the coil 53 of the "Sensitrol" resetting mechanism. The circuit includes the series relay switch 58—59 and the power relay switch 62—63 which perform the same functions as they do in the circuit shown in Figure 7. A toggle switch 65 is also mounted on the instrument board and connected in circuit for throwing the circuit into "on" and "off" positions.

From the foregoing it will be seen that my invention provides a small and compact smoke-detector and signal unit which can be easily and quickly applied to and removed from a duct, and wherein the photoelectric cell may be properly adjusted to provide the desired sensitivity easily, quickly and before the unit is mounted on the duct. Also, a simple and easily operated means is provided for adjusting at will the balancing photoelectric cell 31.

It will be understood by those skilled in the art that the smoke-detecting unit may be connected to the source of current in any suitable manner, but for convenience I have adopted a plug coupling or connector 66 to which may be connected a socket member on an electric cord or cable that in turn may be connected to the source of electricity, this separable plug connection facilitating the application and removal of the unit to and from the duct.

While I have shown and described the invention as embodied in certain combinations of structural details, it should be understood that many modifications and changes in the construction of the apparatus may be made within the spirit and scope of the invention.

I claim:

1. The combination of a duct having an opening in one wall thereof, and apparatus for detecting suspended matter in fluid flowing through said duct, said apparatus comprising a support secured upon the exterior of said duct wall and closing said opening against entry of light there-through into the duct, said support having an aperture in register with said opening, a light source mounted on one side of said support and arranged to project a beam of light through said aperture and said opening into said duct, and photoelectric mechanism including a photoelectric element mounted on the other side of said support and projecting into said duct through said opening at one side of said light beam so as to receive light rays reflected from suspended matter in said fluid.

2. The combination as defined in claim 1 with the addition of a second photoelectric element mounted on the first mentioned side of said support and subject to light from said source, means connecting said photoelectric elements in an electric circuit so that the photoelectric effects of the second photoelectric element oppose the photoelectric effects of the first-named photoelectric element, and an electrical responsive means connected in said circuit.

3. A smoke detector of the character described comprising a casing having a base plate and a

removable cover connected thereto, a partition in said casing dividing it into two compartments, one of which has an aperture in its outer walls, a light source in the first-mentioned compartment arranged to project a beam of light outwardly through said aperture, a photoelectric element mounted exteriorly on said casing at one side of said aperture and having a light-sensitive surface approximately parallel to said beam, a second photoelectric element mounted in the other of said compartments, said partition having a transparency through which light from said source is projected upon said second photoelectric element, means connecting said photoelectric elements in an electric circuit so that the photoelectric effects of the second photoelectric element oppose the photoelectric effects of the first-named photoelectric element, and an electrical responsive means connected in said circuit.

4. A smoke detector of the character described comprising a casing having a base plate and a removable cover connected thereto, a partition in said casing dividing it into two compartments, one of which has an aperture in its outer walls, a light source in the first-mentioned compartment arranged to project a beam of light outwardly through said aperture, a photoelectric element mounted exteriorly on said casing at one side of said aperture and having a light-sensitive surface approximately parallel to said beam, a second photoelectric element, said partition having a transparency therein, a U-shaped bracket on the base of which said second photoelectric element is mounted, means connecting one arm of said bracket to said base plate in the other compartment so that said second photoelectric element is subject to light rays from said source that pass through said transparency, a shutter overlying said light-sensitive surface of said second photoelectric element, and means mounted in the arms of said bracket for adjusting said shutter to vary the extent of exposure of said light-sensitive surface to said light rays.

5. The smoke detector as defined in claim 4 wherein the last-named means includes a nut fixed on said shutter and a rod rotatably but non-longitudinally movably mounted in said arms of said bracket and having a screw-threaded connection with said nut.

6. Apparatus for detecting suspended matter in fluid flowing through a duct having an opening in one wall thereof comprising a support constructed to be secured upon the exterior of the duct and closing the duct wall opening against the entry of light from around the support, the support having an aperture in register with said opening, a light source mounted on one side of

said support and arranged to project a beam of light through the said aperture and said opening into the duct, and photoelectric mechanism including a photoelectric element mounted on the other side of said support and arranged to extend into the duct through the opening at one side of said light beam so as to receive light rays reflected from suspended matter in said fluid.

7. The combination as defined in claim 6 with the addition of a second photoelectric element mounted on the first mentioned side of said support and subject to light from said source, means connecting said photoelectric elements in an electric circuit so that the photoelectric effects of the second photoelectric element oppose the photoelectric effects of the first-named photoelectric element, and an electrical responsive means connected in said circuit.

8. A smoke detector for detecting suspended matter in fluid flowing through a duct having an opening in one wall thereof comprising a support constructed to be secured upon the exterior of the duct and closing the duct wall opening against the entry of light therethrough into the duct, the support having an aperture therein in alignment with the opening in the duct, a light source carried by the support to project a beam of light outwardly through the aperture, and a photoelectric element mounted on said support and shielded thereby against direct rays of light from the light source, the photoelectric element having a light-sensitive surface extending approximately parallel to the beam of light, a second photoelectric element carried by the support and subject to light from the source transmitted other than through the fluid being tested, means connecting the photoelectric elements in an electric circuit so that the photoelectric effects of the second photoelectric element oppose the photoelectric effects of the first-named photoelectric element, and an electrical responsive means connected in said circuit to indicate the presence of smoke in the fluid being tested.

CLARENCE NOEL CAHUSAC.

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