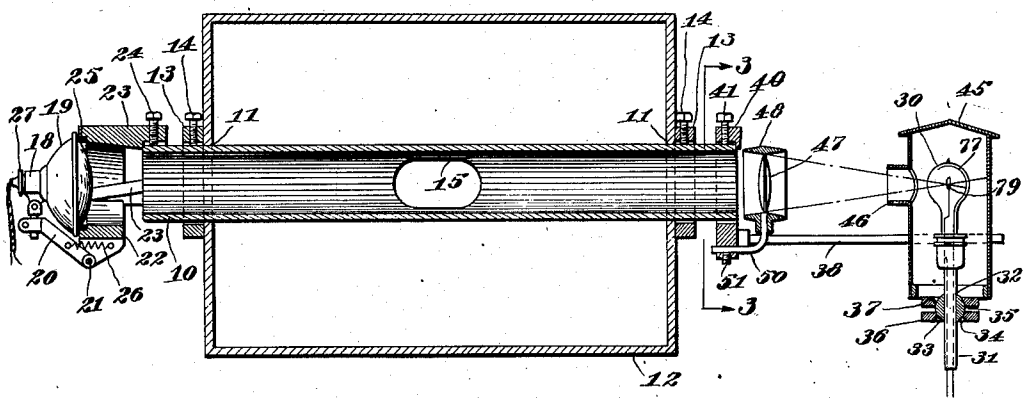
Dec. 16, 1930. F. SAWFORD ET AL 1,785,392

DEVICE FOR INDICATING AND RECORDING THE QUALITY OF SMOKE

Filed March 28, 1927

Fig. 2.



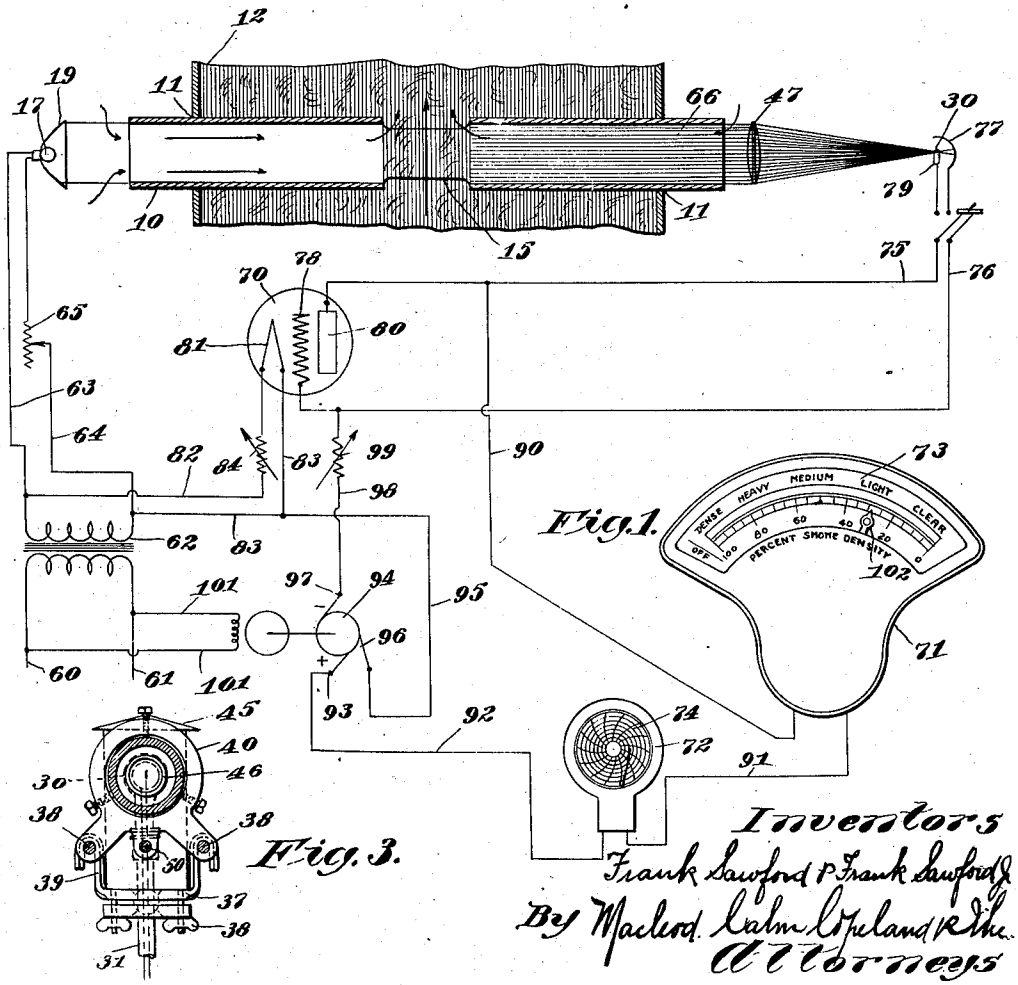


Fig. 1.

Fig. 3.

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DEVICE FOR INDICATING AND RECORDING THE QUALITY OF SMOKE

Application filed March 28, 1927. Serial No. 178,963.

This invention relates to devices for indicating the density of smoke emitted from a furnace flue or the like and particularly to instrumentalities assuring reliable and accurate indications over a long period of time.

It is an object of the present invention to provide an apparatus for indicating the density of smoke which will give an absolute measurement of the smoke density and provide a permanent record of its quality over a period of time, and which will eliminate the guesswork of the human element and be independent of weather conditions.

In accordance with the present invention a source of light is arranged to throw a ray substantially perpendicular to the path of a stream of smoke of substantially constant cross sectional area, and a light sensitive device is arranged so as to receive the ray transmitted through the stream of smoke so as to make an impression thereon which is suitably amplified or magnified for indicating upon a recorder or indicator.

The invention will be more clearly understood from the following description taken in conjunction with the accompanying drawings: in which,

Fig. 1 is a diagrammatic view of an apparatus embodying the invention;

Fig. 2 is a sectional elevational view of a flue in which is arranged a source of light and a light sensitive instrument for receiving a ray transmitted through smoke in the flue; and

Fig. 3 is a sectional view taken upon the line 3—3 of Fig. 2.

One embodiment of the invention is illustrated in the drawings and comprises a tube 10 which is mounted in suitable openings 11 upon opposite sides of a flue 12 so as to extend a short distance from either side thereof. The tube 10 is suitably held in position relative to the flue 12 by rings 13 secured upon the tube adjacent opposite sides of the flue by set screws 14. A suitably calibrated transverse opening 15 is provided in a portion of the tube within the flue so as to provide a path of uniform cross-sectional area for the passage of a stream of smoke which will be representative of the quality of the smoke passing through the flue at all times. A suitable source of light, such as an electric lamp 17, connected with a source of electrical supply is positioned in a mounting 18 carrying reflector 19 so as to throw a ray of light substantially perpendicular to the stream of smoke passing through the opening 15 in the tube 10. Preferably, the mounting 18 for the lamp 17 is held in spaced relation from one end of the tube. For this purpose the mounting 18 is secured upon a link 20 which is pivotally mounted upon a pin 21 on a ring 22 which is held in spaced relation with the end of the tube 10 by integral lugs 23 which are fastened near the end of the tube 10 in any appropriate manner, as by set screws 24. Preferably, the ring 22 is provided with a suitable bearing 25 of rubber, felt or the like for the rim of the reflector 19 which is held thereagainst by a spring 26 extending between the link 20 and the ring 22. The lamp 17 may be adjusted relative to the reflector 19 so as to throw parallel rays into the tube 10 by a suitable adjuster, such as a screw 27.

A suitable light sensitive instrument, such as a photo-electric cell 30, is positioned in an adjustable mounting in alinement with the lamp 17 and the stream of smoke passing through the opening 15 in the tube 10. For this purpose the cell 30 is held in a tube 31 slidably mounted in a hole 32 in a ball 33 having a radial slot (not shown) cut from one side of the peripheral surface to the hole 32. The ball 33 engages suitable bearing surfaces 34 and 35 upon rings 36 and 37 respectively which are held in position against the ball 33 by clamps 38. The ring 37 is suspended from a pair of rods 38 by means of arms 39 adjustably mounted thereon. The rods 38 are held by a ring 40 mounted upon the end of the tube 10 by set screws 41. A housing 45 is supported upon the ring 37 and surrounds the cell 30 so as to shut off all light except that passing through a window 46 disposed at an appropriate point therein to permit the passage of a ray transmitted from the lamp 17 through the stream of smoke. In order that the ray transmitted through the stream of smoke may be properly concentrated upon the cell 30, a lens 47

is suitably mounted in a shroud 48 which protects the lens from dirt and dust and is adjustably mounted upon an arm 50 extending from the ring 40 and held therein by a set screw 51.

The lamp 17 may be supplied with electrical energy from any suitable source of electrical supply, such as the alternating current supply lines 60 and 61. As shown in Fig. 1 of the drawings the high potential in the lines 60 and 61 is stepped down by a transformer 62 to supply a current of relatively low potential in the lines 63 and 64 leading to the lamp 17. An adjustable resistance 65 is provided in the line 64 so as to vary the intensity of the light rays emitted from the lamp 17. These rays are thrown through the tube 10 so as to strike the stream of smoke passing through the opening 15 substantially perpendicular, and the rays which are not absorbed by the stream of smoke continue through the tube 10 as shown by the lines 66 and are concentrated by the lens 47 upon the photo-electric cell 30. The energy thus generated in the cell 30 is amplified by a vacuum tube 70 and transmitted to an indicator 71 or recorder 72 or both which are milliamperemeters of any well known type embodying a calibrated smoke density scale as will be described hereinafter. As illustrated in Fig. 2 of the drawings the cell 30 is connected to the vacuum tube 70 by conductors 75 and 76, the cathode 77 of the cell 30 being connected to the grid 78 of the vacuum tube by the connector 76, while the anode 79 of the cell 30 is connected to the anode or plate 80 of the vacuum tube by the conductor 75. A current of suitable voltage is supplied for heating the filament 81 of the vacuum tube, in order that it emit a stream of conducting electrons, by conductors 82 and 83 leading from the transformer 62. The conductor 82 may be provided with a variable resistance 84. An indicating or recording instrument may be used separately or in conjunction and are connected in series with the plate circuit. As illustrated, both the indicator 71 and the recorder 72 are connected in series in the plate circuit by conductors 90, 91 and conductor 92 leading from the recorder to the positive terminal or brush 93 of a rotary convertor 94. The negative potential of this circuit is connected to the filament 81 by a conductor 95 leading from a third brush 96 of the rotary convertor. The negative terminal or brush 97 of the rotary convertor is connected to the grid by a conductor 98 having a suitable adjustable high resistance 99 therein. The rotary convertor 94 is supplied with energy from the lines 60 and 61 by conductors 100 and 101.

The indicator 71 is provided with a pointer 102 movable over a calibrated smoke density scale 73. It will be noted that the scale 73 is provided with calibrations from clear to dense or from 0 to 100 per cent showing the quality of the smoke which passes through the opening 15 in the tube 10. A marking "Off" is also provided on the scale 73. If the current supply is interrupted the pointer will move to the "off" portion, but if the indication shows 100 per cent smoke density the apparatus is still working but the light is cut off from the light sensitive cell. The scale 74 may be graduated similarly if desired and is operated by a suitable clock mechanism as will be understood by those skilled in the art.

In the operation of the apparatus suitable energy is supplied to the vacuum tube 70 and the potential of the grid is adjusted so that the pointer 102 is deflected from the "off" position to the position marked 100 per cent smoke density. Energy is then supplied to the lamp 17 so that its rays are transmitted to the sensitive surface 77 of the photo-electric cell 30 whereupon the electron emission will cause the pointer 102 to be deflected to the position marked 0 smoke density or clear, provided that no smoke is passing through the flue 12. Should a body of smoke pass through the flue 12 a portion of this smoke will pass through the opening 15 partially or wholly obscuring the light from the electric cell 30. In such case the electron emission from the cathode or sensitive surface of the cell 30 will diminish proportional to the amount of light which penetrates the smoke passing through the opening 15 and should the light be completely obstructed by dense smoke, the electron emission of the cell 30 will cease. As this electron emission decreases or ceases the current flow through the plate circuit of the vacuum tube will vary proportionally to the density of the light which penetrates the smoke body causing a proportional variation in the reading upon the indicator 71 or the recorder 73. Should the light intensity of the beam from the lamp 17 be such that the pointer 102 does not register 0 smoke density or clear when no smoke is passing through the flue 12 the intensity of the light beam may be adjusted by means of the variable resistance 65 until the pointer registers 0 smoke density or clear when the flue is free from smoke.

The photo-electric cell 30 may be adjusted in a suitable position in alignment with the lamp 17 and stream of smoke to receive the light concentrated from the lens 47 by loosening the clamps 38 so as to permit longitudinal movement of the tube 31 in the ball 33 and universal movement of the ball 33 within its supporting bearings. When the proper adjustment has been obtained the clamps 38 are tightened, thereby clamping the ball rigidly to the tube 31 as well as holding it securely in proper position upon its bearing surfaces 34 and 35 of the rings 36 and 37. By providing the tube 10 extending through the flue 12 the

lamp 17 and the photo-electric cell 30 are maintained in their correct relation with each other regardless of any distortion of the flue caused by expansion or contraction due to temperature changes on which the equipment may be mounted.

The lamp 17 and the lens 47 are spaced from the tube 10 so that a stream of air may flow into the tube 10 by the draft created by the passage of the hot gasses through the flue 12 as shown by the arrows in Fig. 1. This passage of air serves to cool the lamp and lens as well as the interior of the tube 10 and keeps the opening 15 free from accumulation of soot.

In the embodiment of the invention illustrated the necessary electricity is supplied to the plate and grid of the vacuum tube by electro-mechanical means, such as a rotary convertor, and two separate desired potentials may be obtained by adjusting the third brush 96 with relation to the two main brushes 93 and 97.

If desired, the potential delivered from the source of current supply to the vacuum tube may be checked by a voltmeter in the circuits or the indicator may be constructed, as will be understood by those skilled in the art, with a circuit and switch whereby the potentials of these circuits may be read from the indicator.

Throughout the claims appended hereto we have employed the terms "indicator" and "indicating" to include an indicating or recording device or both.

What we claim is:

1. In combination, a flue or smoke passage having two oppositely disposed open orifices to permit the entrance of air into the flue, a source of light outside the flue adjacent one of said orifices, a light-sensitive device outside the flue adjacent the other of said orifices, said light source and light sensitive device being aligned with said orifices and spaced therefrom to provide an annular passage between said orifices and the outside air, an indicator, electric connections between the light-sensitive device and said indicator, and means for enclosing the path of the ray through the flue except for a predetermined distance.

2. The combination with a flue having oppositely disposed orifices, of a light source and a light sensitive device adapted to be aligned with said orifices, an indicator, electrical connections between the light sensitive device and indicator, a tube extending inward from each of said orifices, and means permitting the passage of smoke from said flue across a predetermined portion of the tube.

3. The combination with a flue having oppositely disposed orifices, of a light source and a light sensitive device adapted to be aligned with said orifices, an indicator, electrical connections between the light sensitive device and indicator, a tube extending inwardly and outwardly from each of said orifices, means permitting the passage of smoke from said flue across a predetermined portion of the tube, and means for connecting said light source and said light sensitive device to the opposite outer ends of said tube in spaced relation thereto.

In testimony whereof we affix our signatures.

FRANK SAWFORD.
FRANK SAWFORD, JR.