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APPARATUS FOR DETERMINING THE DENSITY OF SMOKE

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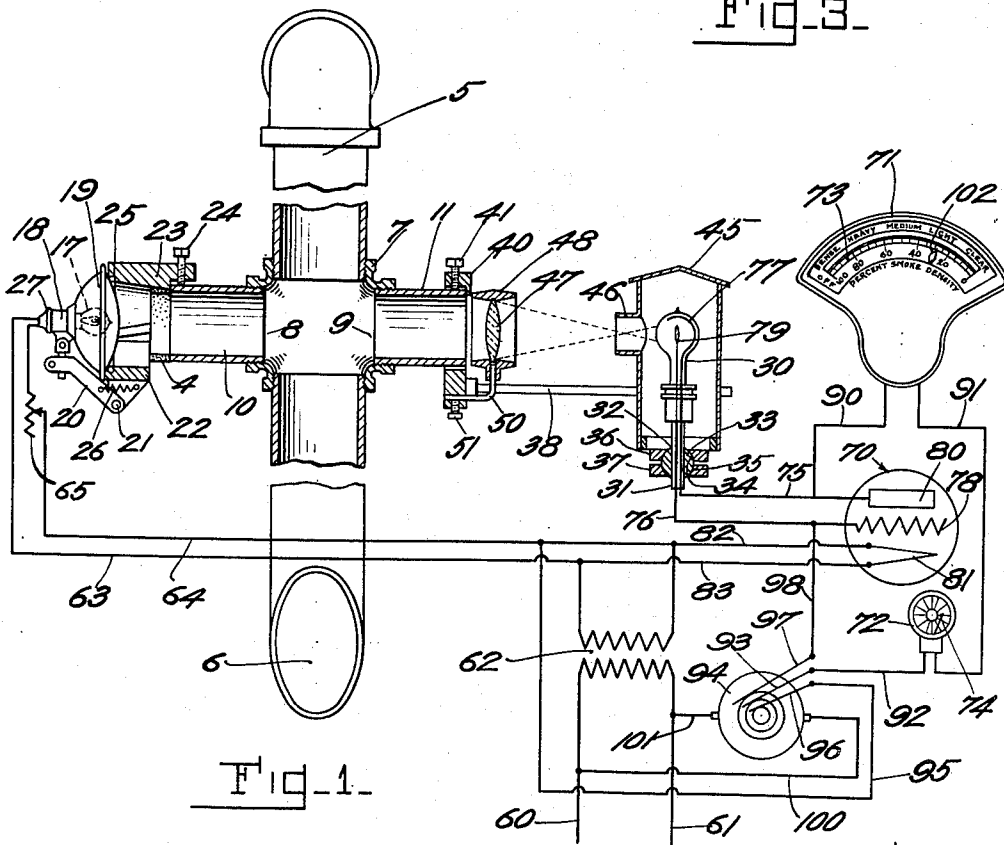
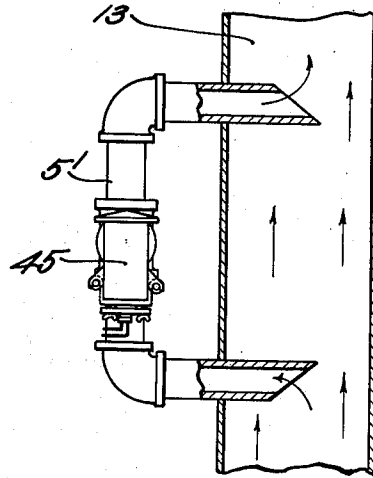
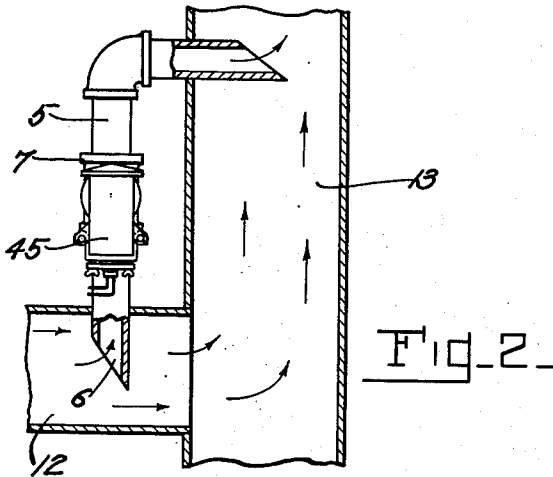


Fig. 1.

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APPARATUS FOR DETERMINING THE DENSITY OF SMOKE

Application filed November 19, 1928. Serial No. 320,387.

This invention relates to an apparatus for indicating the density of smoke in a flue.

In my application filed March 28, 1927, Serial No. 178,963, I have described an apparatus for determining the density of smoke in a flue which included a tube extending across the flue. The tube was provided with openings within the flue so that smoke passing up the flue could cross the tube. A light ray was passed longitudinally through the tube so as to strike the column of smoke passing across the tube. The light not absorbed by the smoke was caused to make an impression upon a light sensitive device and this impression indicated in terms of the density of smoke.

It has been found in actual practice that this apparatus is not adaptable for use with many installations particularly where both sides of the stack or flue are not readily accessible. The apparatus must be specially designed to suit the requirements of each installation. In installations for large flues difficulties are encountered on account of the distance through which the light ray must be projected.

It is the object of the present invention to overcome these difficulties and provide an apparatus which is extremely flexible and adaptable to any installation regardless of its position or size.

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

Fig. 1 is a view of the unit of the invention, partly in section;

Fig. 2 is a sectional view of a stack having a flue connected thereto and illustrating the application of the unit of the invention; and

Fig. 3 is a sectional view of a stack or flue showing the application of a modified form of the invention.

Before explaining in detail the present invention, it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being prac-

tised or carried out in various ways. Also it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation, and it is not intended to limit the invention beyond the terms of the several claims heretofore appended as considered in view of the prior art and the requirement thereof.

In the practice of the invention a unit is provided including a by-pass pipe through which a representative sample of the smoke in the flue is caused to pass. This unit may comprise a by-pass pipe 5 one or both ends of which project into the main stack or flue leading thereto. The ends of the by-pass pipe and particularly the inlet end is provided with an opening 6 larger than the cross-sectional area of the by-pass pipe. Such an opening can be provided by cutting the pipe along a plane inclined to the axis of the pipe or by slitting the pipe and removing the slit portion. Preferably, the by-pass pipe 5 is composed of two sections connected together by a cross fitting 7 so as to provide oppositely disposed orifices 8 and 9. Tubes 10 and 11 are fitted in the orifices 8 and 9 respectively in alinement so as to extend outwardly from the by-pass pipe. In Fig. 2 of the drawings I have shown the by-pass pipe 5 extending from a flue 12 into the main stack 13 whereas in Fig. 3 I have shown both ends of the by-pass pipe 5 of modified form projecting into the main flue 13 and extending in the direction of the flow of the smoke through the main stack, as shown by the arrow, so as to withdraw or by-pass a representative sample of smoke in the flue or stack.

A suitable source of light such as an electrical lamp 17 connected with a source of electrical supply is positioned in a mounting 18 carrying a reflector 19 so as to throw a ray of light through the alined tubes 10 and 11. Preferably, the mounting is held in spaced relation from one end of the tube 10. 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 space between the end of the tube 10 and the lamp is closed by a ring 4 to such extent that the smoke will flow through the by-pass pipe. 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 tubes 10 and 11 by a suitable adjustor, 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 passage through the tubes 10 and 11. For this purpose 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 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 suitable clamps (not shown). The ring 37 is suspended from a pair of rods 38 by arms (not shown). The rods 38 are held by a ring 40 mounted upon the end of the tube 11 by set screws 41. A housing 45 is supported 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 light ray transmitted through the tubes 10 and 11. In order that the transmitted ray 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 rings 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 projected from the lamp 17. These rays are thrown through the tube 10 so as to cross a stream of smoke passing through the by-pass pipe 5 and the rays which are not absorbed pass through the tube 11 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 described hereinafter. As illustrated in Fig. 1 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 plate 80 of the vacuum tube by the conductor 76, while the anode 79 of the cell 30 is connected to the anode or grid 78 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 may emit a stream of conducting electrons by conductors 82 and 83 leading from the transformer 62. 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 converter 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 converter. The negative terminal or brush 97 of the rotary converter is connected to the grid 78 by a conductor 98. The rotary converter 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 zero to one hundred per cent. showing the density of the smoke which passes through the by-pass pipe. A marking "Off" is also provided on a scale 73. If the current supply is interrupted the pointer will move to the "Off" portion but if the indication shows one hundred 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.

The by-pass pipe is provided with an inlet so constructed and arranged that a representative sample of the smoke passing through the main stack or flue will be withdrawn and passed through the by-pass pipe and returned to the flue or main stack. Suitable energy is supplied to the filament 81 of the tube 70, and the potential of the grid is adjusted so that the pointer 102 is deflected from the "Off" portion to the position marked One hundred 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 Zero smoke density or Clear provided no smoke is passing through the main stack or flue or the by-pass pipe. Should a body of smoke pass through the main stack or flue a portion of this smoke will pass through the by-pass pipe partially or wholly obscuring the light from the photo-electric

cell 30. In such a 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 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.

The invention makes possible the provision of an apparatus which can be constituted and assembled as a unit which is flexible in the sense that it is readily adaptable to any boiler or fuel burning installation regardless of the position or size of the main stack or flue. It may be manufactured and installed as a unit without substantial change, no special design being required for each installation.

What I claim is:

In an apparatus for indicating the density of smoke in a flue, stack, or the like, in combination, a by-pass pipe extending in the direction of flow of smoke in said flue, two oppositely disposed alined orifices in said by-pass pipe, a source of light arranged to throw a ray through said orifices, a light sensitive device for receiving said light ray, said orifices being disposed in a line perpendicular to the path of travel of smoke in said by-pass pipe, and means for indicating the density of the smoke in response to the impression of said light upon said device, said by-pass pipe extending into and being arranged in said flue so as to receive for passage therethrough a representative sample of smoke passing through said flue.

In testimony whereof I affix my signature.

FRANK SAWFORD.

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