July 3, 1962 G. F. REDWAY 3,042,907

SMOKE DETECTOR

Filed Nov. 15, 1957

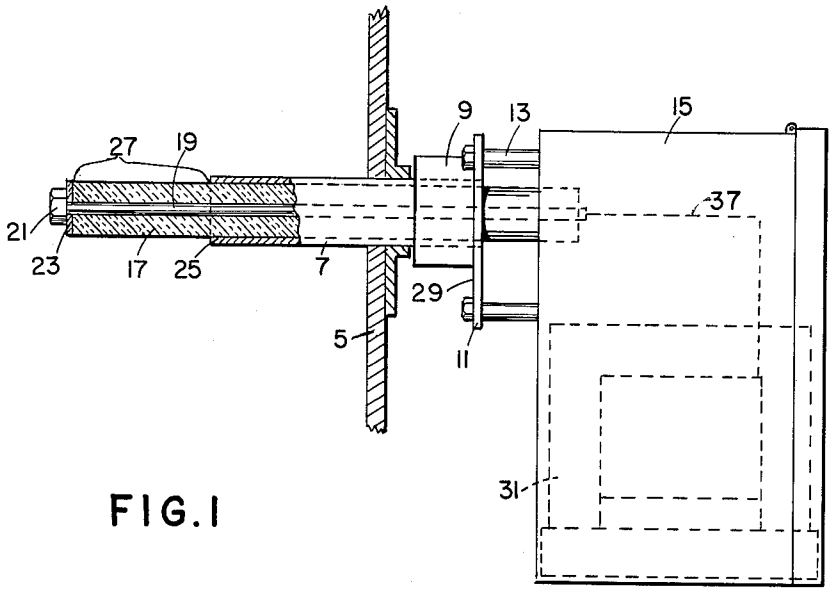


FIG. 1

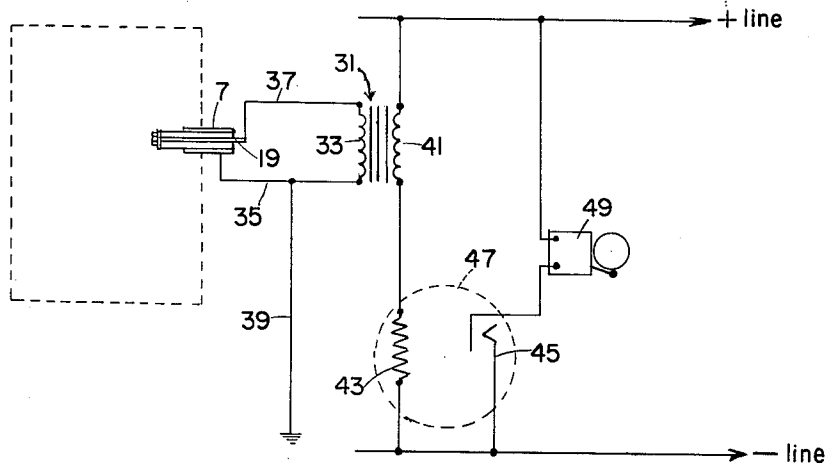


FIG. 2

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SMOKE DETECTOR

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This invention relates to instruments for detection of excessive smoke forming conditions in furnaces or combustion apparatus. It is well adapted to use with furnaces for boilers or heating apparatus but may be used wherever it is desirable to show or produce a response to excessive smoking or soot forming conditions.

The device preferably includes means for giving a warning signal advising the operator of the furnace that smoking or soot forming conditions exist which should be corrected, or it may be applied to control apparatus by which such conditions may be automatically corrected.

The invention comprises basically the provision of a pair of high voltage terminals or electrodes separated by a non-conducting space or area, the resistance of which will be reduced upon the deposit of soot or carbon between the terminals. When the resistance has been sufficiently decreased, transmission of current between the terminals will sound an alarm or cause other indication of or response to the soot condition. Any source of current providing sufficient voltage to cause increased current flow upon deposit of soot or carbon may be utilized.

In a preferred application of the invention, the terminals are mounted upon an insulating body such as a tube of porcelain, an area of the porcelain separating the terminals. On the occurrence of excessive smoking or soot conditions, the carbon or soot will build up a deposit upon the exposed porcelain and eventually will provide a conducting path from one terminal to the other. Various methods of utilizing the current transmitted may be employed. In a preferred form of the invention a high voltage transformer is used, the secondary circuit of which includes the two spaced terminals. Included in the primary side of the transformer is a resistance heating element associated with a heat responsive device such as a thermostatic switch. As long as there is little or no current flowing through the secondary circuit of the transformer, insufficient current will flow through the resistance heater to actuate the thermostatic switch. However, as the smoke deposit or soot builds up on the insulator separating the terminals of the secondary circuit. The current flow in the secondary circuit will increase which will result in a corresponding increase in the current flow through the primary coil of the transformer and the resistance heater. At a proper point the thermostatic switch will close, thereby giving the desired signal that an objectionable smoking or sooting condition exists.

In the accompanying drawings:

FIG. 1 is a side elevation of an instrument embodying the present invention applied to the breech or stack wall of a furnace, part of the porcelain insulator element and terminals or electrodes being shown in longitudinal section;

FIG. 2 is a wiring diagram of the apparatus.

Referring to the drawings in detail, the breech or stack wall is shown at **5**. Mounted in a hole in this wall is a metal tube **7** which constitutes one of the terminals or electrodes and on which is mounted a bracket sleeve **9** to which is affixed a metal plate **11**. Secured to the plate **11** by spacing bolts **13** is a box **15**. Mounted in the tube **7** is an insulating tube **17** preferably of porcelain or the like. The rear end of this tube extends into the box **15**. Extending through the bore of the tube **17** is a metal rod **19** carrying at its outer end a head **21** and plate **23** which constitute the outer terminal or electrode which is spaced from the outer end **25** of the tube **7** by an exposed area **27** of the insulating sleeve. The outer surface **29** of the plate **11** constitutes a reflecting surface acting to prevent direct heat from the breech from adversely affecting the temperature conditions within the box **15**.

Mounted in the box **15** is a transformer **31** having a secondary or high voltage coil **33** which is connected by lead **35** with the terminal or electrode tube **7** and by lead **37** with the inner end of the rod **19**. The circuit may be grounded by ground wire **39** if found desirable. The primary or low voltage coil **41** of the transformer is connected with the power line usually of 115 or 220 volts. Connected in series with the primary coil **41** is the resistance heater coil **43** and mounted in a position to be influenced by this resistance heater is a heat responsive device such as a thermostatic switch **45**. The construction shown is what is known as a delay relay which includes the resistance heater and a thermostatic switch enclosed in an evacuated glass tube indicated by dotted lines at **47**. A delay relay which has been found satisfactory for the purpose is an "Amperite" delay relay having a rating of 10 seconds to close at 6 volts. This is used with a 115 volt line voltage of 60 cycles A.C. Mounted in circuit with the thermostatic switch is a suitable indicating alarm or control element such as the bell **49**.

It will be understood that any suitable devices responsive to changes in the current flow in the primary coil **41** that gives an alarm or other indication or control action may be utilized. A suitable voltage for the secondary of the transformer is 3500 volts. This is cited as an example and not as a limitation. The resistance of the heater and its circuit is such that under "no smoke" conditions the voltage through the heater will not exceed approximately 4 volts which is insufficient to close the thermostatic switch.

Upon occurrence of excessive smoking conditions in the furnace or stack, carbon particles or soot will gather on the exposed portion **27** of the ceramic insulator, thereby providing a conducting path between the electrodes **23** and **25**. Eventually the current flow across this path will be sufficient to increase the current flow through the transformer coils and when the current flowing through the resistance heater element reaches a voltage of approximately 5.5 volts, the switch **45** will close and the bell **49** or other responsive device will be activated.

Upon the smoking condition being corrected by the firemen, or automatically, the deposit of carbon particles or soot on the exposed portion of the insulator will cease. The high voltage current across the insulator, however, will continue which will produce a burning off or disintegration of the carbon deposit thereon, whereupon the current flow will decrease, the resistance heater will cool and the thermostatic switch will open. The device is now in condition to respond if smoke forming conditions again obtain. The device is thus self-cleaning and self-restoring to sensitive condition so that it does not have to be cleaned or reset by the operator. This presents a very decided advantage over indicators which have to be taken apart or cleaned or otherwise serviced each time a smoke forming condition occurs.

While one preferred embodiment of the invention has been illustrated and described in detail, it is to be understood that changes may be made therein and the invention embodied in other structures. It is not, therefore, the intention to limit the patent to specific construction illustrated but to cover the invention broadly in whatever form its principles may be utilized.

I claim:

1. A device responsive to excessive smoke formation comprising a pair of electrodes adapted to be supported in position to be subjected to contact with the smoke, a body of insulating material separating said electrodes upon which carbon particles or soot will be deposited

upon the occurrence of excessive smoke forming conditions, a transformer having a high voltage secondary coil connected in circuit with said electrodes and a low voltage primary coil adapted to be connected in a power circuit, a responsive device including elements in series with said primary coil and responsive to increased current passing therethrough, and means associated with said responsive device for producing a useful effect upon the increase of current flow in said transformer occurring when carbon particles or soot build up a deposit upon said body of insulating material.

2. A construction as claimed in claim 1 in which the responsive means include a resistance heater in series with the primary coil of the transformer and heat responsive means associated with said resistance heater for producing said useful effect.

3. A construction as claimed in claim 1 in which the responsive means comprise a delay relay having a resistance heating element and a thermostatic switch associated therewith.

4. A device responsive to excessive smoke formation comprising a pair of electrodes supported in position to be subjected to contact with the smoke, a body of insulating material separating said electrodes upon which carbon particles or soot will be deposited upon the occurrence of excessive smoke forming conditions, potential supply means connected to said electrodes capable of applying a potential difference to said electrodes insufficient to cause substantial current to flow from one electrode to the other when smoke formation is below a desired minimum but high enough to cause an increased flow of current when a sufficient deposit of soot or carbon is accumulated on the portion of the insulating body separating said electrodes, and means responsive to said increased flow of current between said electrodes for producing a useful effect, said supply means capable of maintaining said increased flow of current for a sufficient time to burn off the conducting soot deposit accumulated on the insulating body when soot depositing conditions have been corrected.

5. A construction as claimed in claim 4 in which the body of insulating material comprises a tube, one of the electrodes being mounted on a conductor passing through said tube and the other of said electrodes comprising a sleeve of a conducting material enclosing and supporting said tube.

6. A construction as claimed in claim 4 in which the body of insulated material is porcelain having a continuous uninterrupted surface extending from one electrode to the other.

7. A device responsive to excessive smoke formation comprising a sleeve of conducting material adapted to be passed through an opening in the wall of a combustion apparatus and to be secured therein projecting partly within a smoke conducting passage of the combustion apparatus and partly outside of said wall, a supporting member mounted on said sleeve and a casing carried by said supporting member, a tube of ceramic insulating material projecting through said sleeve and to a distance beyond the inner end thereof, the other end of said ceramic insulating tube projecting into said casing, a rod

of conducting material extending through the bore of said insulating tube and having a head on the inner end thereof forming an electrode, the inner end of the conducting sleeve forming a cooperative electrode, said inner end of said sleeve being spaced from the head on the rod so as to provide an exposed area of insulating material within the smoke conducting space, the other end of said rod projecting into the casing, a transformer in the casing having a high tension secondary coil connected to said rod and to said sleeve, said transformer having a primary coil adapted to be connected in circuit with a source of alternating current and a responsive device connected in circuit with said primary coil of the transformer for producing a useful effect upon increase of current flow resulting from deposit of carbon particles or soot upon the exposed area of said insulating body within the smoke conducting passages of the combustion apparatus.

8. A device responsive to excessive smoke formation comprising a sleeve of conducting material and means for mounting the same in an opening in the wall of a combustion apparatus, a tube of ceramic insulating material projecting through said sleeve and to a distance beyond the inner end thereof, a rod of conducting material extending through the bore of said insulating tube and having a head on the inner end thereof forming an electrode, the inner end of the conducting sleeve forming a cooperative electrode, said inner end of said sleeve being spaced from the head on the rod so as to provide an exposed uninterrupted area of insulating material within the smoke conducting space capable of supporting a continuous conducting film of soot extending from one electrode to the other, potential supply means connected to said electrodes capable of applying a potential difference to said electrodes insufficient to cause substantial current to flow from one electrode to the other when smoke formation is below a desired minimum but high enough to cause an increased flow of current when a sufficient deposit of soot or carbon is accumulated on the portion of the insulating body separating said electrodes, and means resopnsive to said increased flow of current between said electrodes for producing a useful effect, said supply means capable of maintaining said increased flow of current for a sufficient time to burn off the conducting soot deposit accumulated on the insulating body when soot depositing conditions have been corrected.

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