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R. E. SCHRETER ET AL
SPARK MONITOR FOR FUEL BURNER

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FIG. 1

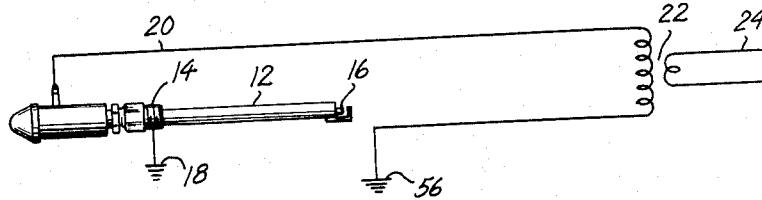


FIG. 2

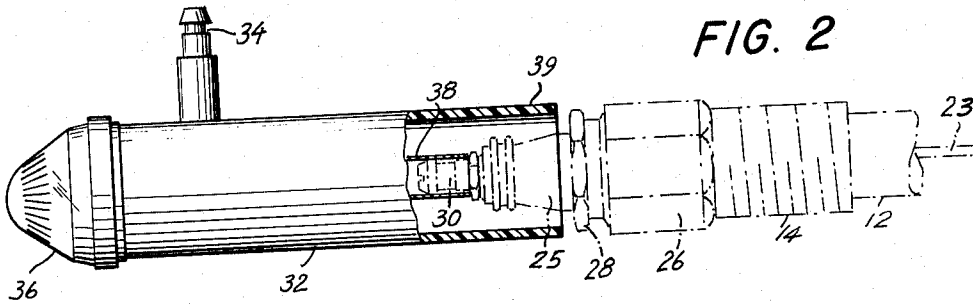


FIG. 3

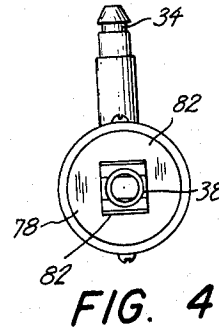
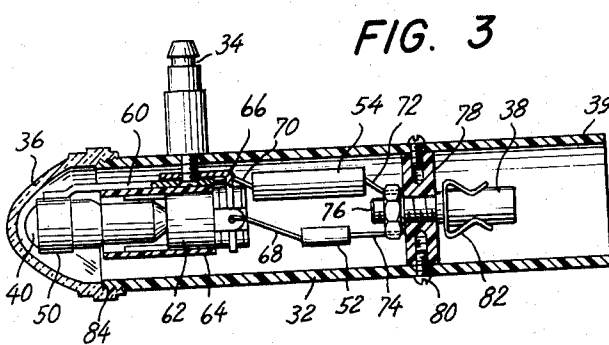
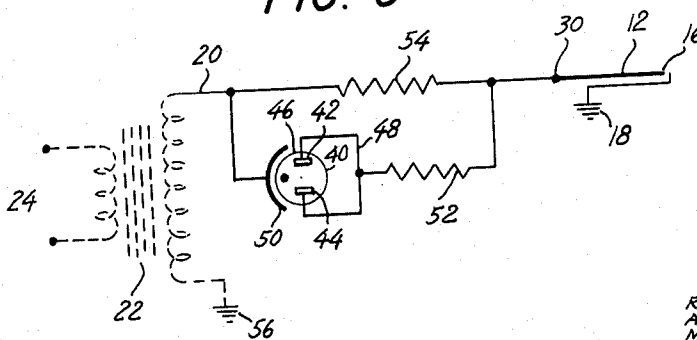


FIG. 4

FIG. 5



INVENTORS
ROBERT E. SCHRETER
ALEXANDER J. TURPIN
MELVIN J. PARKER
BY *James and Franklin*
ATTORNEY

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SPARK MONITOR FOR FUEL BURNER

Robert E. Schreter, Malverne, Alexander J. Turpin, Stewart Manor, and Melvin J. Parker, Garden City, N.Y., assignors to Hauck Manufacturing Company, Brooklyn, N.Y., a corporation of New York
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This invention relates to fuel burners having continuous spark gap ignition, and more particularly to a spark monitor therefor.

Large burners using gas are ignited by an igniter producing an electrical spark. Sometimes a large gas or oil burner has a gas pilot light, and the pilot light is ignited by a spark. In many industries the spark is run continuously, so that if the gas pressure fails or fluctuates, there will nevertheless be dependable combustion, and no opportunity for collection of a large amount of unburned fuel with danger of possible explosion. However, there is no way to be sure that the hidden spark gap is actually sparking.

The spark may fail if the electrodes are short circuited, or if carbon builds up and fills the gap. The metal at the gap usually is a nickel alloy, and when there is sulphur in the gas being burned, nickel sulphide forms which expands or foams to large dimension, and may short circuit the gap. The electrodes may be carelessly handled during a servicing operation and may be bent in such fashion as to close the gap. The electrodes may burn away or be so bent that the gap becomes excessively large, with resulting failure of the spark.

The primary object of the present invention is to provide a monitor which indicates outside the furnace whether the spark is functioning at the spark gap. A more specific object is to provide a monitor which includes a lamp which lights when the spark is operating, and which is extinguished when the spark fails, whether the failure is caused by short circuiting or open circuiting or severance or disconnection of either the high voltage lead or the ground lead to the igniter. A further object is to provide such a monitor in which the lamp lights only dimly when the spark is weak, and flickers if the spark flickers. Still another object is to provide such a device which may be applied readily to the exposed outer end of the igniter, and which then receives the high voltage lead which usually is connected to the igniter, so that the monitor is easily added without any change in the existing installation.

To accomplish the foregoing general objects, and such other more specific objects as may hereinafter appear, our invention resides in the spark monitor elements and their relation one to another as are hereinafter more particularly described in the following specification. The specification is accompanied by a drawing in which:

FIG. 1 is a schematic view drawn to small scale and showing an igniter with a spark monitor applied thereto;

FIG. 2 is a partially sectioned view showing how the monitor is applied to the outer end of the igniter;

FIG. 3 is a longitudinal section through a preferred form of monitor;

FIG. 4 is an end view thereof; and

FIG. 5 is a schematic wiring diagram explanatory of the invention.

Referring to the drawing, and more particularly to FIG. 1, the igniter comprises a long slender tube 12 made of metal, usually steel. Its outer end may be fitted with a threaded bushing 14 and then is adapted to be screwed in position somewhat like an engine spark plug, except that the igniter 12 is very much longer. We also use a slip fit bushing instead of a thread. Its spark gap is indicated at 16, one side being grounded at 18, and the

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other being connected to a high voltage lead 20. The high voltage supply is usually obtained from a step-up transformer 22, the primary of which usually is energized from an ordinary 110 volt A.C. line 24, but any other conveniently available primary voltage may be used. The output voltage of the transformer may be in the range of 5,000 to 10,000 volts in a typical installation.

Referring now to FIG. 2, the center rod 23 of the igniter is insulatedly carried by an insulation bushing 25 secured in an outer metal nut 26 by means of a threaded metal bushing 28. The nut 26 has an internal thread to receive bushing 28, and has an external thread at 14. The center rod 23 terminates in a metal stud or terminal 30 which is so shaped and dimensioned as to receive a spring snap solderless terminal, which terminal is at the free end of the high voltage lead 20 shown in FIG. 1. In the specific form of monitor here shown the monitor has a cylindrical case 32 and is applied over the terminal 30. The case 32 is preferably made of insulation, and itself carries a high voltage terminal 34 which replaces the terminal 30, so that the high voltage lead 20 may be snapped on the upper end of terminal 34 instead of on the terminal 30. Thus the monitor is readily applied to the igniter of an existing fuel burner.

The lamp is visible through a protective transparent cover or lens 36, which may be made of glass, or of a transparent plastic material. The monitor has a metal part 38 which acts as a snap connector or cap which is received on the terminal 30 of the igniter. The casing 32 may be extended toward the right to provide a protective skirt 39 which helps improve the mounting of the monitor on the igniter.

Referring now to FIG. 5, the lamp 40 is a glow discharge lamp having one or more internal electrodes 42, 44. The glass envelope 46 contains an ionizable inert gas indicated by the dot. In the simplest and preferred arrangement the lamp 40 is an ordinary commercially available neon glow lamp having two spaced electrodes 42 and 44, but in the present circuit these are connected together externally as indicated at 48. The lamp also may be used with only one electrode connected in circuit, and the other electrode free. The reason for this is that the true opposed electrode is a conductive shield or external electrode 50 disposed around the lamp. There is a resistor 52 which may be called a "lamp resistor," connected in series with the internal electrodes 42, 44. There is another resistor 54 which may be termed a "main resistor," which is in shunt with the series circuit comprising the shield 50, the lamp 40 and the lamp resistor 52.

The high voltage supply is the transformer 22, the primary of which is energized from a suitable A.C. source. In this case terminals 24 represent an ordinary 110 volt A.C. outlet. One side of the high voltage secondary is grounded, as shown at 56, and the other side is connected to the high voltage lead 20, which ordinarily would be applied directly to the terminal 30 of the igniter 12. The other side of spark gap 16 is grounded as indicated at 18. It will be evident from inspection of FIG. 5 that the monitor is connected electrically in series with the high voltage supply to the igniter.

In a typical and preferred case the lamp 40 is a type NE51H neon lamp; the lamp resistor 52 is a 1/2 watt resistor having a value of 2500 ohms; and the main resistor 54 is a two watt resistor having a value of 3900 ohms. The transformer output voltage is 6000 volts. The spark gap was 0.046 inch in length, this being a standard gap already in use. However, all these values are subject to very wide variation, as is discussed later in greater detail.

The structural arrangement of one form of monitor is illustrated in FIGS. 3 and 4 of the drawing. The casing 32 is cylindrical and made of an insulating material. One end of the lamp is shown at 40, the lamp being surrounded

by a cylindrical metal shield 50. The latter is carried by one end of an arm 60, the other end of which is secured to the inner end of the high voltage terminal 34.

The lamp is received in a socket 62 carried in an insulation tube 64, and the parts 62, 64 are carried by a bracket 66. The lamp has two electrodes and two leads, both of which are preferably connected to the lamp resistor 52, one connection being shown at 68. The main resistor 54 has one lead 70 connected to the high voltage terminal 34, or more specifically to the bracket 66. The other lead 72 of resistor 54, and the other lead 74 of resistor 52, are connected in common to the stud 76 of a spring cap 38. This is carried by an insulation disc or plug 78 which is secured in cylinder 32 by means of a plurality of screws 80. For a reason previously explained, the cap 38 is preferably located deeply within the housing 32.

The spring cap may assume a number of known forms. In the present case it comprises a fixed hollow cylinder 38 around which there is applied a spring clip 82 having parts received through slots in the cylinder wall, and adapted to engage an undercut in the terminal 30 (FIG. 2) of the igniter with a snap fit. The lens 36 may be threaded and screwed on to a mating thread formed at the end of casing 32, as shown at 84.

As previously mentioned, the device is operable despite wide variation in the component values employed. The usual two-electrode neon lamp will function with only one electrode connected, but it is found that if the two electrodes are joined, a glow appears around each electrode, thus increasing the light produced, and we therefore prefer to employ both electrodes. A special lamp could be constructed with a single electrode, or with three or more electrodes, and all should prove operable.

As examples of the invention which we have made, we have used a type NE48 lamp with a lamp resistor of 3900 ohms. The main resistor varied from 2400 ohms, with good light intensity, up to a value of ten million ohms, at which time the light intensity was reduced to only a fair to poor value.

We have used an NE48 neon lamp with a lamp resistor of 900 ohms, and with a main resistor varying from 100,000 ohms up to ten million ohms. In that case the light intensity was still good at ten million ohms. It was also good at 100,000 ohms, but becoming poorer at any lower value.

We have used a type NE51H neon lamp with a lamp resistor of 3900 ohms, and with a main resistor of from 230 to 1000 ohms. The light intensity was very good at 230 ohms, and was less but still good at 1000 ohms. For the present purpose we prefer a good rather than very good light intensity, but only for the reason that the life of the lamp is reduced when operated at very high intensity, and it is preferred to give the equipment long life before requiring lamp replacement. Even then the spark monitor is "fail safe" in that if the lamp fails it will go out, which serves as a warning.

We have used the same lamp type NE51H with a lamp resistor of 10,000 ohms and with a main resistor ranging from 15 ohms upward to 3,000 ohms. In this case the light intensity was very good at the low value, but the higher value would be preferred for long life. At values above 3,000 ohms the light intensity tends to fall off.

We have used the same lamp with a lamp resistor of 5,000 ohms, and with a main resistor ranging from 15 to 1500 ohms. Here again, the light intensity was very good (and therefore excessive, as explained above) at 15 ohms. It was good at 1500 ohms, but fell off at values higher than 1500 ohms.

We have used the same lamp with a lamp resistor of 900 ohms, and with a main resistor varying from 100 to 680 ohms. The light intensity was found to be good throughout that range, but with a tendency to fall off or become poor above 680 ohms.

In all cases in which the lamp was specified to be

NE51H, another similar lamp designated NE51 may be used, but with a slight reduction in light intensity.

In all cases the current carrying capacity of the main resistor 54 is preferably greater than that of the lamp resistor 52. The latter carries only the negligible current needed to operate the glow lamp.

We are not certain of the theory of operation of the spark monitor, and it may be considered to be an empirical discovery. One theory is that when using an internal and an external electrode, a very high firing voltage is required. When the spark gap is short circuited the secondary voltage presumably drops below the firing voltage and the lamp then does not glow. Inasmuch as we are uncertain of the theory of operation, we do not wish the patent to be bound by this suggested theory. It is sufficient to say that in operation the neon lamp glows as long as a spark is present at the spark gap, and that if the spark gap is short circuited the neon lamp is extinguished. An open circuit also extinguishes the lamp.

The NE51H lamp is preferred because it is small and compact and has a high intensity glow. However, we have conducted successful operation with not only that lamp and the NE51 and NE48 previously mentioned, but also the NE16 and the NE30, but then the size of the metal shield or external electrode has to be changed, and also the resistance values.

In general the resistance values are dependent on a number of factors, including the length and diameter of the external electrode. An increase in diameter reduces the intensity of the glow. An increase in length increases the glow up to a point, following which an exaggerated length reduces the glow.

It should be mentioned that the main resistor serves an additional purpose in acting as a suppressor which reduces oscillation in the circuit, and this in turn prolongs the igniter life at the spark gap. For suppression purposes the main resistor is preferably kept between 2,000 and 20,000 ohms.

Decreasing the resistive value of the lamp resistor tends to increase the brightness of the lamp, if other things are held constant.

The lamp connection employed is of course unusual in that the two internal electrodes are tied together, and the glass envelope of the lamp is used as a dielectric between the internal electrodes and the external electrode or shield.

It is believed that the construction, method of use, and operation of our improved spark monitor, as well as the advantages thereof, will be apparent from the foregoing detailed description. It will also be apparent that while we have shown and described the invention in several preferred forms, changes may be made in the structure and in the component values shown, without departing from the scope of the invention as sought to be defined in the following claims.

We claim:

1. A spark monitor for a large fuel burner for use in industrial furnaces or the like, said burner being ignited by a spark gap igniter energized by a high voltage supply, said igniter having a high voltage terminal, said high voltage supply terminating in a spring terminal cap dimensioned to fit on the high voltage terminal of the igniter, said monitor comprising a neon glow lamp having an internal electrode with a lead connected thereto, a conductive shield adjacent the lamp and acting as an external electrode, a lamp resistor in series with said lead of said internal lamp electrode, a main resistor in shunt with a series circuit which series circuit comprises the shield, the lamp, and the lamp resistor, a housing for the aforesaid parts, said housing exposing the lamp at one end, the other end having a spring cap dimensioned to snap on the high voltage terminal of the igniter, the body of said housing having a high voltage terminal shaped like that of the igniter to receive the spring terminal cap of the high voltage supply line, a connection from said terminal to

one end of the shunt circuit, and a connection from said spring cap to the other end of the shunt circuit, whereby high voltage supply to the igniter.

2. A spark monitor as defined in claim 1 in which the lamp is a type NE48, and in which the lamp resistor has a value of from 900 to 3900 ohms, and in which the main resistor has a value of from 2400 to 10 million ohms.

3. A spark monitor as defined in claim 1 in which the lamp is a type NE48, and in which the lamp resistor has the monitor is connected electrically in series with the a value of 3900 ohms, and in which the main resistor has a value of from 2400 to 10 million ohms.

4. A spark monitor as defined in claim 1 in which the lamp is a type NE48, and in which the lamp resistor has a value of 3900 ohms, and in which the main resistor has a value of from 100,00 to 1 million ohms.

5. A spark monitor as defined in claim 1 in which the lamp is a type NE51H, and in which the lamp resistor has a value of 3900 ohms, and in which the main resistor has a value of from 330 to 1000 ohms.

6. A spark monitor as defined in claim 1 in which the lamp is a type NE51H, and in which the lamp resistor has a value of 10,000 ohms, and in which the main resistor has a value of from 15 to 3000 ohms.

7. A spark monitor as defined in claim 1 in which the lamp is a type NE51H, and in which the lamp resistor has a value of 5000 ohms, and in which the main resistor has a value of from 15 to 1500 ohms.

8. A spark monitor as defined in claim 1 in which the lamp is a type NE51H, and in which the lamp resistor has a value of 900 ohms, and in which the main resistor has a value of from 100 to 680 ohms.

9. A spark monitor as defined in claim 1 in which the lamp is a type NE51H, and in which the lamp resistor has a value of from 900 ohms to 10,000 ohms, and in which the main resistor has a value of from 15 to 3000 ohms.

10. A spark monitor for a large fuel burner for use in industrial furnaces or the like, said burner being ignited by a spark gap igniter energized by a high voltage supply, said igniter having a high voltage terminal, said high voltage supply terminating in a spring terminal cap dimensioned to fit on the high voltage terminal of the igniter, said monitor comprising a neon glow lamp having two internal electrodes with leads connected thereto, means joining the leads of said electrodes outside the lamp, a conductive cylindrical shield fitting closely around

the lamp and acting as an external electrode, a lamp resistor in series with the joined leads of both internal lamp electrodes, a main resistor in shunt with a series circuit which series circuit comprises the shield, the lamp, and the lamp resistor, a cylindrical insulation housing for the aforesaid parts, said housing exposing the lamp at one end, the other end having a deeply recessed spring cap dimensioned to snap on the high voltage terminal of the igniter, the body of said housing having a high voltage terminal shaped like that of the igniter to receive the spring terminal cap of the high voltage supply line, a connection from said terminal to one end of the shunt circuit, and a connection from said spring cap to the other end of the shunt circuit, whereby the monitor is connected electrically in series with the high voltage supply to the igniter.

11. A spark monitor for a large fuel burner for use in industrial furnaces or the like, said burner being ignited by a spark gap igniter energized by a high voltage supply, said monitor comprising a neon glow lamp having the usual two internal electrodes with leads connected thereto, means joining the lead of said electrodes outside the lamp, a conductive cylindrical shield fitting closely around the lamp and acting as an external electrode, a lamp resistor in series with the joined leads of both internal lamp electrodes, and a main resistor in shunt with a series circuit which series circuit comprises the shield, the lamp, and the lamp resistor, said monitor being connected electrically in series with the high voltage supply to the igniter.

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NEIL C. READ, *Primary Examiner.*

45 D. K. MYER, *Assistant Examiner.*