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[11] **3,594,746**

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[54] FLAME SCANNER FAULT DETECTION SYSTEM

4 Claims, 5 Drawing Figs.

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[50] **Field of Search** ..... 340/214, 228, 228.1, 258 B, 259, 410, 41; 250/83.3 UV; 431/79; 317/130; 328/6; 137/624.14; 350/266; 356/207

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ABSTRACT: A system for detecting a fault in the output signal of a flame scanner circuit, the system comprising ball means, normally gravity biased to a nonblocking position, periodically pneumatically activated to intercept, and block, the scanning view of a glow discharge tube detector used to indicate the presence of a flame. A logic circuit having an AND gate receives independent signals from the pneumatic activating means for the ball means (indicating ball means actuation) and from the flame scanner circuit (indicating positive firing of the glow discharge tube detector). The tube detector, of course, should not be firing, and thus signaling the existence of a flame, when its scanning view is blocked by the ball means. If both of the above-mentioned signals reach the AND gate at the same instant, the gate will operate to pass a signal to a fault indicator which may operate any suitable alarm means to indicate a fault in the glow discharge tube detector.

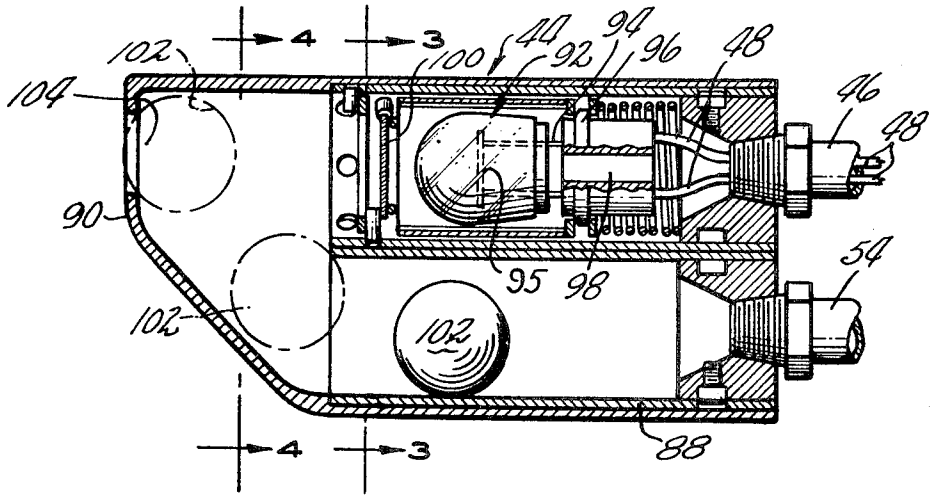


FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIG. 5

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FLAME SCANNER FAULT DETECTION SYSTEM

BACKGROUND AND SUMMARY OF THE INVENTION

This invention relates to flame scanners and more particularly to a means for detecting a fault in the operation thereof.

Flame scanners are used to monitor the presence of a flame in the combustion chamber of a furnace. One common scanner for this purpose uses a glow discharge tube, of the ultraviolet-type for example, mounted in the furnace relative to the burner of the furnace and in such a manner so as to be able to "see" the flame produced by the burner. A flame from the burner will activate the tube in a well-known manner, producing a signal which may be delivered to a flame scanner circuit, such as that by Gilbert in U.S. Pat. No. 3,286,093 assigned to the same assignee as is this invention. Such a positive indication of flame is necessary so that a cessation thereof may be immediately detected. The operator of a furnace must know when a flame ceases to exist in order to prevent an excessive amount of unburned fuel from accumulating in the combustion chamber. There could be disastrous results if such raw fuel were allowed to accumulate; for example, the fuel could easily be explosively ignited by hot refractory or when an attempt is made to reignite it.

Although glow discharge tube detector devices provide a relatively simple means of detecting the presence of a flame, they have inherent characteristics which give rise to a need for their being constantly monitored in order to detect faults therein. For example, upon overheating of the tube, a signal may be generated similar in nature to the signal produced when a flame is detected. Therefore, there must be some simple and efficient means by which the tube may be tested while in service to indicate that the tube is functioning properly and not merely giving a positive signal due to a malfunction.

Prior art devices have used periodically activated mechanical means to block the monitoring view of the glow discharge tube detector so that the view from the flame to the tube will be periodically cut off, simulating a "flame-out" condition. If the tube still generates a signal indicating the presence of a flame while the mechanical blocking means is in this blocking position, an indication of fault in the tube will be recorded. Rotary operated shutter devices have been utilized in the past. The necessary construction thereof, however, is unsuitable for operation in the extreme conditions, such as high temperatures, under which this device must function.

We have therefore developed an extremely simple means for interrupting either periodically or randomly the view of a glow discharge flame detecting tube so that fault therein may be easily and accurately determined. There is provided a channel intersecting the flame detecting view of the glow discharge tube detector. A pneumatically actuated hollow steel ball rides in this channel. The ball, normally gravity biased to a nonblocking position, is of a sufficient diameter so as to enable it to completely block the flame detecting view of the tube detector upon pneumatic actuation to simulate a "flame-out" condition. A timed solenoid valve is actuated to periodically or randomly admit pressure to this channel to move the ball to interrupt and block the flame detecting view of the tube detector. The solenoid valve will produce a signal indicating actuation thereof. Under normal operating conditions, the flame scanning circuit will produce a signal indicating sensing of flame by the tube detector. Provisions are made to bring these independent signals into a logic circuit containing an AND gate. Thus it can be seen that while the ball is being pneumatically actuated, the flame scanning circuit should produce no signal. If, however, both signals are received by the AND gate simultaneously, there is a fault in the glow discharge tube detector, and the AND gate will allow passage of a signal therethrough, which signal may be used to activate a fault indicator or other suitable alarm means.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view, partly in section and partly schematic, of the flame detecting device and the fault indicating circuitry incorporated in this invention;

FIG. 2 is an enlarged section of the glow discharge tube detector and the pneumatically actuated ball means;

FIG. 3 is a transverse section of the device taken on the line 3–3 of FIG. 2;

FIG. 4 is a transverse section of the device taken on the line 4–4 of FIG. 2; and

FIG. 5 is an end view of a burner nozzle with the flame detecting device installed therein.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings wherein like reference characters are used to designate like elements, the flame scanning device indicated generally at **10** is shown in FIG. 1 mounted in a burner nozzle tip **12**. The device comprises a tubular supporting member indicated generally at **14** having a rigid support member **16** secured in the nozzle tip **12** to one side thereof. Secured to the rigid metal portion **16** by clamps **18** is a flexible metal sleeve **20** which in turn is connected by clamps **22** to a rigid metal pipe **24**. Pipe **24** is secured by any suitable means, such as weld **26**, to the shell **28** of the air duct supplying air to the burner. Secured on the outer end of pipe **24** is a casting **30** having a chamber **32** communicating with the interior of the tubular member **14** and having an air inlet **34** for directing air from a suitable source of supply to the interior of the tubular member **14**.

An aspirator **36** is provided so as to prevent flame or hot gases from feeding back from the furnace through the tubular member **14** under certain conditions. High pressure is supplied to aspirator **36** through inlet **38** from source **60**. Rigid metal pipe **24** has a port **40** located in the side thereof to which high pressure inlet **42** is connected from the same source as that which supplies aspirator **36**. The purpose of inlet **42** and its function will be explained hereinbelow.

Cylinder **44**, in which is contained the flame monitoring glow discharge tube detector and the pneumatic interrupting means therefor, has connected thereto a flexible conduit **46** encasing electrical conductors **48** and terminating in a rigid section **50** which is threaded into a casting **52**. Also connected to cylinder **44** is the flexible conduit **54**, which terminates in rigid pipe section **56**, which in turn is connected to high pressure inlet **42** through port **40**. An air inlet connection **58** is provided in the casting **52** leading into the interior of rigid member **50**, flexible member **46** and cylinder **44** to supply a stream of air through the cylinder for cooling purposes.

The high pressure source **60** which is used to supply pressure to aspirator **36** has a connection provided thereto to supply the pneumatic interrupting device through inlet **42**, pipe **56** and flexible connector **54**. A timer **62** of either the periodic or random actuation-type is provided to actuate a solenoid valve **64** in the high pressure line of the pneumatic interrupting device as described hereinbelow. Lead **66** is provided for taking a signal indicating positive actuation of the solenoid valve to terminal **68** of a logic circuit containing an AND gate **70**. Lead **72** is provided from leads **48** to carry a signal indicating flame detection to the flame scanning circuit **74**. Further lead **76** is provided to carry a signal indicating positive flame to AND gate **70** at terminal **78**. A fault indicator **80** is connected to the logic circuit AND gate **70** through lead **82**. Fault indicator **80** may be connected to any appropriate alarm device **84**. Alarm device **84** may be a visual or audible alarm.

The flame monitoring means and pneumatically actuated interrupting means of this invention are best shown in FIG. 2. Within cylinder **44**, are located an upper glow discharge tube detector cylinder **86** and a lower ball carrying cylinder **88**. Extending from ball carrying cylinder **88** is channel means **90**. Channel means **90** is positioned at an angle with respect to the ball carrying cylinder and intersects the axis of the upper tube

detector cylinder **86**. Within the upper cylinder **86** is located a glow discharge tube detector **92**. The tube detector **92** has support pins **94** connected to the tube electrodes **95** at one end and embedded in base **96** at the other end. Base **96** has a central cylindrical bore **98** through which cooling air may be passed for the reasons noted in the above-mentioned Gilbert U.S. Pat. No. 3,241,595. Connected to the tube electrodes **95** through support pins **94** in the base **96** are leads **48** which carry a signal generated by the tube detector **92** in a well-known manner when a flame is detected. A quartz glass window **100**, centered in the tube **86**, serves as a means for protecting tube detector **92** from any foreign particles from the furnace which may enter cylinder **44**.

A ball **102** rides in lower ball cylinder **88**. The ball **102** is shown as a hollow steel sphere, but any other suitable material may be used. The ball **102** is free to move in cylinder **88** and channel **90** against the bias of gravity under influence of the pneumatic pressure. Upon actuation of the solenoid valve **64** by timer **62** as noted above, high pressure from source **60** will be admitted through inlet **42**, pipe **56** and conduit **54** to exert a pneumatic force on ball **102** to move the ball **102** in cylinder **88** and channel **90** to portion **104** thereof. Upon release of pressure, the ball **102** will be returned by gravity to lower ball cylinder **88**.

FIGS. **3** and **4** show sections through cylinder **44** showing the relative positions of upper cylinder **86** and lower cylinder **88** and the interconnecting channel **90**. From these figures it is apparent that actuation of ball **102** by pneumatic pressure will cause the ball to move up into portion **104** of channel **90** to interrupt and block the monitoring view of the glow discharge tube detector **92**.

FIG. **5** shows the location of our detector with relation to a particular burner nozzle tip **12**. Within the nozzle tip **12** is located a burner nozzle **106**. Detector **10** is located as by weld **108** to the nozzle tip **12** in the position shown. When so located, the detector **10** will view the flame area at all times with an unobstructed view. This enables continuous flame monitoring.

With the device thus described, the operation is as follows. Glow discharge tube detector **92** is activated in the well-known manner so as to yield a positive signal through leads **48** upon detection of a flame as seen through quartz window **100**. This signal is transmitted through leads **48** and **72** to flame scanner circuit **74** to monitor the existence of a burner flame. Positive actuation of the tube detector **92** also activates a signal through leads **76** to terminal **78** of the logic circuit AND gate **70**. Periodically or randomly as desired, timer **62** actuates solenoid valve **64** to admit high pressure to the lower ball cylinder **88** to move ball **102** in channel **90** to a position at the end **104** thereof. When the timer **62** actuates the solenoid valve **64**, a signal will be generated which is carried through lead **66** to terminal **68** of the logic circuit AND gate **70**. When at this position, ball **102** will effectively interrupt and block the view of glow discharge tube detector **92**. A correct response by the tube detector **92** will then be to give an indication of a flame failure to the flame scanner circuit **74** (i.e., no positive signal). Positive signals from the tube detector **92** and the pneumatic actuating system are, therefore, incongruous and should not exist at the same instant. When these signals are received simultaneously at the terminals **68** and **78** of the logic circuit AND gate **70**, indicating positive actuation of both the timer **62** and the detecting tube **92**, the AND gate **70** will pass a signal through lead **82** to the fault indicator **80**. Fault indicator **80** will then readout the signal received in any suitable manner, such as by triggering an alarm **84** of either the visual or audible-type as desired. In this manner an immediate indication of fault in the tube detector **92** will be indicated and the furnace operator may act accordingly to prevent damage to the furnace system.

We have found that the flame monitoring device and pneumatically operated fault indicating means associated therewith may be used successfully with a burner of the tilting, tangential type found in large utility boiler furnace systems. The tilting tangential burners have a tilt angle of ±30° from the horizontal. Therefore, in order for ball **102** to properly return to its initial position in lower ball cylinder **88** under the influence of gravity, as explained above, from its interrupting and blocking position at portion **104** of channel **90**, the angle of inclination of channel **90** must be greater than 30°. We have found that an angle of inclination of 45° will yield a properly functioning device.

From the above description it can be seen that we have invented a simple and economically constructed means of determining a fault in a flame monitoring device which utilizes a glow discharge tube detector. The detecting device may be checked periodically or at random as determined by the operator of the furnace, and may activate any visual or audible alarm means as circumstances dictate. The only moving part of the device is a ball, preferably of the hollow stainless steel construction, yielding a device which is simple to manufacture, and not adversely affected by the extreme conditions found in the nozzle tip where the flame scanner must be located. Furthermore, when in its nonoperative condition, the device does not interfere with the normal operation of the tube detector **92** and the cooling means therefor.

While we have illustrated and described a preferred embodiment of our invention, it is to be understood that such is merely illustrative and not restrictive and that variations and modifications may be made therein without departing from the spirit and scope of the invention. We therefore do not wish to be limited to the precise details set forth but desire to avail ourselves of such changes as fall within the purview of our invention.

We claim:

1. In a fault detection apparatus for a flame scanner system being energized by a glow discharge tube detector, the improvement comprising: ball means, ball actuating means, said ball means being located in relationship to said glow discharge tube detector so as to intercept and block the flame detecting view of said tube detector upon periodic positive actuation thereof by said actuating means, a logic circuit having an AND gate therein, said AND gate receiving independent signals from said glow discharge tube detector and said actuating means indicating positive operating conditions thereof, a fault indicating means operatively connected to said logic circuit so as to be activated when said independent signals reach said AND gate simultaneously.

2. Apparatus as claimed in claim **1** wherein said ball actuating means comprises a pneumatic pressure means.

3. Apparatus as claimed in claim **2** wherein said pneumatic pressure means comprises a source of pneumatic pressure, a channel for said ball means, said channel intersecting the path of said flame detecting view of said glow discharge tube detector, a valve means between said pneumatic source and said channel, and a timer means for periodically opening said valve means to allow said pressure to move said ball in said channel to intercept and block said view path of said glow discharge tube detector.

4. Apparatus as claimed in claim **3** wherein said ball means is a hollow stainless steel ball.