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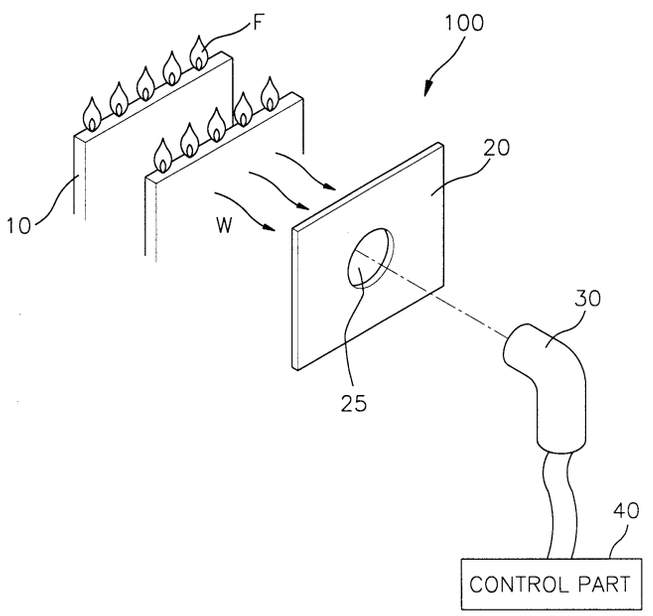
## (54) Boiler with combustion control apparatus

(57) A boiler (100) with combustion control apparatus having a phototransistor (30) for precisely detecting a combustion status of the boiler is disclosed. The boiler (100) with the combustion control has a burner for generating a flame by means of a mixing fuel containing combustion gas and air, and the phototransistor (30) for detecting a light wavelength of the flame. A combustion chamber cover (20) is installed between the burner and the phototransistor (30). A heat-resistant window (25) is installed on the combustion chamber cover (20) in a straight line with the flame (F) and the phototransistor (30) so that the heat-resistant window (25) can prevent heat of the flame from transmitting into the phototransistor (30) while normally sensing the light of the flame (F). A control part is installed in the combustion control apparatus of the boiler in order to control the amount of air flowing into the burner according to output signal of the phototransistor (30).

FIG.1

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## Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

**[0001]** This invention relates to a boiler with a combustion control apparatus, and more particularly to a boiler with a combustion control apparatus which has a phototransistor detecting a wavelength of a frame when burning.

2. Prior Art

**[0002]** Generally, various methods of detecting a flame are known to control burning by a water heater or boiler.

**[0003]** U.S. Pat. No. 3,727,073 to Cade discloses a flame sensor control circuit. The preferred embodiment of this invention features a control apparatus for a burner. Cade utilizes a flame rod detector that provides a signal to an electronic amplifier, which in turn operates multiple relays responsive to the flame rod detector signal. However, when the flame is generated, electric current intensity flowing on the flame rod is very small (approximately 300 μA). Accordingly, when being used for a long time, a detecting capacity of the flame rod declines by corrosion and/or humidity and thus the flame rod may malfunction. Also, if the temperature of the flame is high, the flame rod is weak during heating and may crack.

**[0004]** Further, a cadmium sulfide (CdS) detection type is mainly used in an oil boiler. The CdS detection cell controls burning by the boiler by detecting an illumination of a flame and providing a resistance value proportional to the illumination. That is, if the illumination is large the resistance value is small, but if the illumination is small the resistance value is large. However, there is a drawback because the CdS detection cell is sensitive to visible rays, so the detection cell malfunctions by detecting together not only the flame generated from a burner but also any general light source(sunlight, light by electric bulb, etc.). Also, dirty substances produced during combustion of oil pollute the CdS cell, thereby reducing the detecting capacity.

**[0005]** U.S. Pat. No. 2,911,540 to Powers discloses a flame detection system incorporating a photoconductive cell such as cadmium sulfide cell which is electrically sensitive to flame.

**[0006]** In addition to the general types as mentioned above, a detection type using an infrared ray sensor is known. However, this type is not prevalent because the infrared ray sensor has a high cost. Also, there is a drawback in that the infrared ray sensor is apt to weaken by heat of the boiler, and thereby the output signal of the sensor is not uniform and life of the sensor is shortened.

**[0007]** Accordingly, a precise detecting apparatus having a low price is required to resolve the above problems.

THE SUMMARY OF THE INVENTION

**[0008]** To resolve the above problems, it is a first object of the present invention to provide a boiler with a combustion control apparatus which optimally burns a combustion gas by precisely detecting a combustion state of a flame.

**[0009]** It is a second object of the present invention to provide a boiler with a combustion control apparatus which includes a phototransistor having low possibility of malfunction of a sensor when being used for a long time and a low price.

**[0010]** To obtain these objects, a boiler with a combustion control apparatus comprises a burner generating a flame during burning; a phototransistor detecting a wavelength from a light of the flame; a combustion chamber cover installed between the burner and the phototransistor; and a heat-resistant window installed on the combustion chamber cover in a straight line with the flame and the phototransistor, the heat-resistant window preventing heat of the flame from transmitting into the phototransistor while penetrating the wavelength of the flame.

**[0011]** The phototransistor further includes a variable resistor for calibrating a reference output value.

BRIEF DESCRIPTION OF THE DRAWINGS

**[0012]** This invention will be better understood and its various objects and advantages will be more fully appreciated from the following description taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a schematic view showing a combustion control apparatus of a boiler according to a preferred embodiment of the present invention,

Fig. 2 is a view for showing a combustion control circuit of the boiler according to the preferred embodiment of the present invention, and

Fig. 3 is a graphical representation of the optimal response curve of a phototransistor according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

**[0013]** Hereinafter, a preferred embodiment according to the present invention will be described in detail with reference to the drawings.

**[0014]** Fig. 1 is a schematic view showing a combustion control apparatus of a boiler according to a preferred embodiment of the present invention, and Fig. 2 is a view for showing a combustion control circuit of the boiler according to the preferred embodiment of the present invention.

**[0015]** As shown in Figs. 1 and 2, the boiler 100 ac-

cording to the present invention has a burner 10 for generating a flame F by means of a mixing fuel containing a combustion gas and air, and a phototransistor 30 for detecting a light wavelength of the flame F. A combustion chamber cover 20 is installed between the burner 10 and the phototransistor 30.

**[0016]** A heat-resistant window 25 is installed on-the combustion chamber cover 20 in a straight line with the flame F and the phototransistor 30 so that the heat-resistant window can prevent heat of the flame from transmitting into the phototransistor while normally sensing the light of the flame F. The heat-resistant window 25 is made from transparent heat-resistant material in order to allow penetration by the wavelength of the flame F and maintain original properties of matter thereof. Preferably, material of the heat-resistant window 25 is a mica plate, but other materials having the heat-resistant property may be used. Furthermore, a control part 40 is installed in the combustion control apparatus of the boiler in order to control the amount of air flowing into the burner according to output signal of the phototransistor 30.

**[0017]** Because special properties of the phototransistors are different respectively, a reduction in the difference of the special properties is required in order to use them in common. Therefore, a variable resistor 35 is integrally installed in the phototransistor 30 in order to vary a resistant value depending on the difference of the special property.

**[0018]** The phototransistor 30 has a collector 36 and an emitter 37. The collector 36 is connected to a voltage Vcc, such as 5 volts, and the emitter 37 is grounded. Also, a resistor R2 and a condenser C1 are mounted around the control part 40 in order to protect the control part 40. That is, the resistor R2 prevents overcurrent from flowing into the control part 40, and the condenser C1 eliminates electric noise of the control part 40.

**[0019]** Hereinafter, an operation of the preferred embodiment according to the present invention will be described.

**[0020]** Fig. 3 is a graphical representation of the optimal response curve of a phototransistor according to the present invention. In Fig. 3 the vertical axis represents sensitivity of the wavelength(nm), and a deviant line area indicates a zone in which an optimal combustion is attained.

**[0021]** In the combustion control apparatus of the boiler according to the present invention, the flame F is generated in the burner 10 of the boiler 100 by injecting the combustion gas mixed with air, and the phototransistor 30 detects the wavelength W of the flame F passed through the heat-resistant window 25 of the combustion chamber cover 20.

**[0022]** The combustion control apparatus is a type of detecting an electric current variation dependant on a wavelength variation. That is, the electric current value of the phototransistor 30 varies depending on the wavelength variation of the yellow flame generated in an adverse wind or the blue flame generated in a normal combustion, and thereby the voltage applied to the resistor R2 varies. Accordingly, if the voltage applied to the control part 40 is $1.3V<V<4.2V$ the status of the combustion is normal, if $V \leq 1.3V$ the status of the combustion is insufficiency for amount of air, and if $V \geq 4.2V$ the status of the combustion indicates an excess amount of air.

**[0023]** As shown in Fig. 3, if the wavelength W of the flame F is not more than about 1,200nm, it represents the status of the blue flame in which the amount of air being supplied is excessive. If the amount of air being supplied is excessive, the flame F is unstable and causes a lifting phenomenon, thereby reducing heat value thereof. Accordingly, the control part 40 controls so that the combustion is attained in the optimal combustion zone by reducing the amount of air supplied in the burner 10.

**[0024]** Further, if the wavelength W of the flame F is nearly 780nm, that represents the status of a yellow flame in which the amount of air is supplied insufficiently. If amount of air is supplied insufficiently, the flame F burns imperfectly and thus exhausts carbon monoxide (CO) gas. Accordingly, the control part 40 controls so that the combustion is attained in the optimal combustion zone by increasing the amount of air supplied in the burner 10.

**[0025]** The phototransistor 30 detects the wavelength emitted from the flame F of the burner 10, a signal dependant on the detected wavelength variation is transmitted into the control part 40, and the control part 40 controls the amount of air in the boiler depending on the transmitted signal. At this time, if a detected wavelength is larger than that of the optimal combustion zone the amount of air is reduced, but if a detected wavelength is smaller than that of the optimal combustion zone the amount of air is increased.

**[0026]** Also, the phototransistor 30 is set to have a uniform reference output value by adjusting the variable resistor Rl. The setting operation is a method for calibrating the reference output value by using the variable resistor in order to receive the precise output value relative to a light. If a light emitting part is installed which is spaced at a predetermined distance from a light receiving part and thereafter a fixed electric current flows in the light emitting part, the light emitted from the light emitting part is the same. At this time, the output values of the light receiving parts, such as phototransistors are different respectively depending on the feature of the phototransistors. Accordingly, the user sets the phototransistor to the reference output value by adjusting the variable resistor, and mounts the adjusted phototransistor in the boiler, so that greater precise control may be attained.

**[0027]** As mentioned above, the combustion control apparatus according to the present invention precisely detects the combustion status of the flame F by using the phototransistor 30. Because the phototransistor 30 has a feature cutoff in a zone of visible rays, the phototransistor 30 detects only the wavelength of the flame

F. Accordingly, a malfunction due to reading other lights is not generated, and the combustion status of the flame is precisely detected. Furthermore, the manufacturing cost of the boiler is greatly reduced because of elimination of dispensable parts and usage of low price parts.

**[0028]** When the phototransistor 30 detects the wavelength W of the flame F, heat of the flame F is transmitted in a circumference simultaneously. However, due to the heat-resistant window 25, only the wavelength of the flame F arrives at the phototransistor 30, and the heat of the flame F is not transmitted in the phototransistor. Therefore, the heat has no effect on the operation of the phototransistor 30.

**[0029]** While this invention has been particularly shown and described with reference to particular embodiments thereof, it will be understood by those skilled in the art that various changes in form and detail may be effected therein without departing from the spirit and scope of the invention as defined by the appended claims.

## Claims

**1.** A boiler with a combustion control apparatus comprising:

a burner generating a flame during burning;
a phototransistor detecting a wavelength from a light of the flame;
a combustion chamber cover installed between the burner and the phototransistor; and
a heat-resistant window installed on the combustion chamber cover in a straight line with the flame and the phototransistor, the heat-resistant window preventing heat of the flame from transmitting into the phototransistor while penetrating the wavelength of the flame.

**2.** The boiler with a combustion control apparatus according to claim 1, wherein the phototransistor further comprises a variable resistor for calibrating a reference output value.

**3.** The boiler with a combustion control apparatus according to claim 1, wherein the heat-resistance window includes a mica plate.

FIG. 1

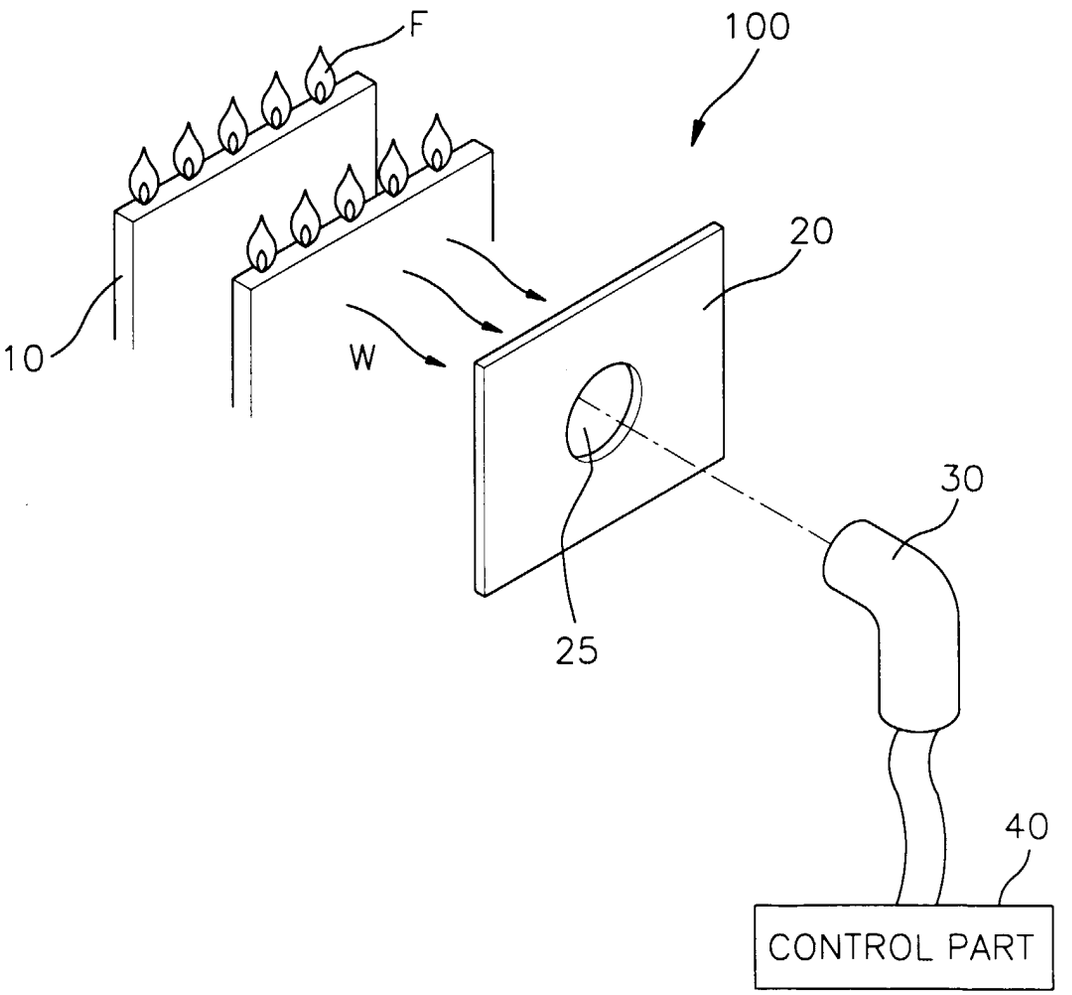


FIG.2

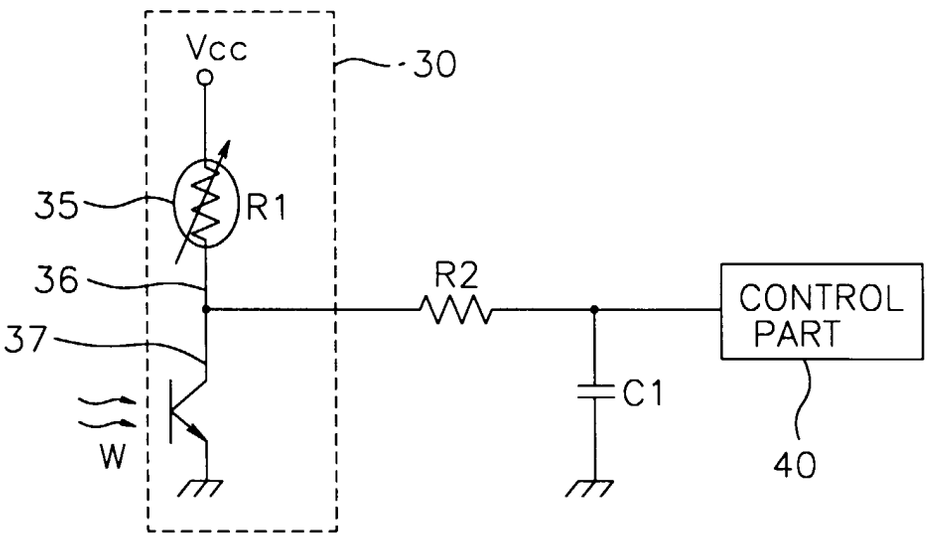
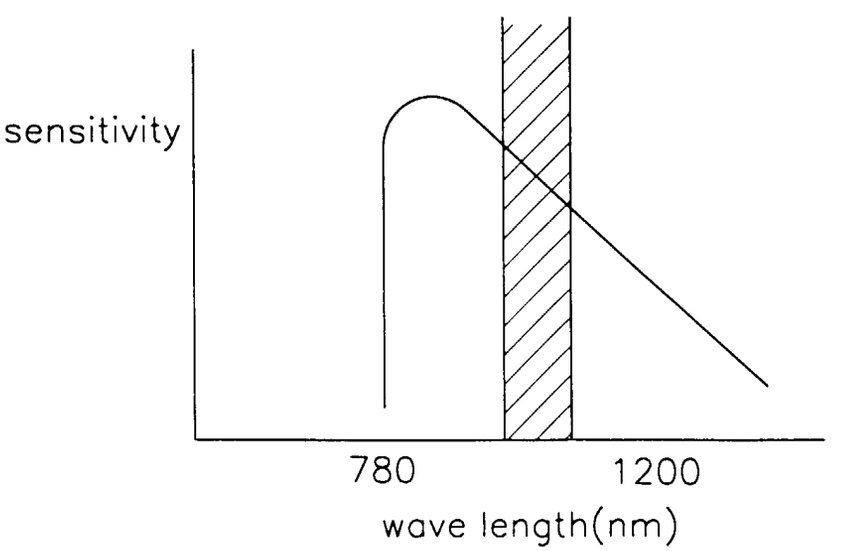

Vcc
30
35
R1
36
R2
CONTROL PART
37
C1
W
40

FIG.3


sensitivity
780
1200
wave length(nm)

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# EUROPEAN SEARCH REPORT

Application Number
EP 99 10 8671

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int.Cl.7) |
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The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
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EPO FORM 1503 03.82 (P04C01)

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# EUROPEAN SEARCH REPORT

Application Number
EP 99 10 8671

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T : theory or principle underlying the invention
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