

April 15, 1947.

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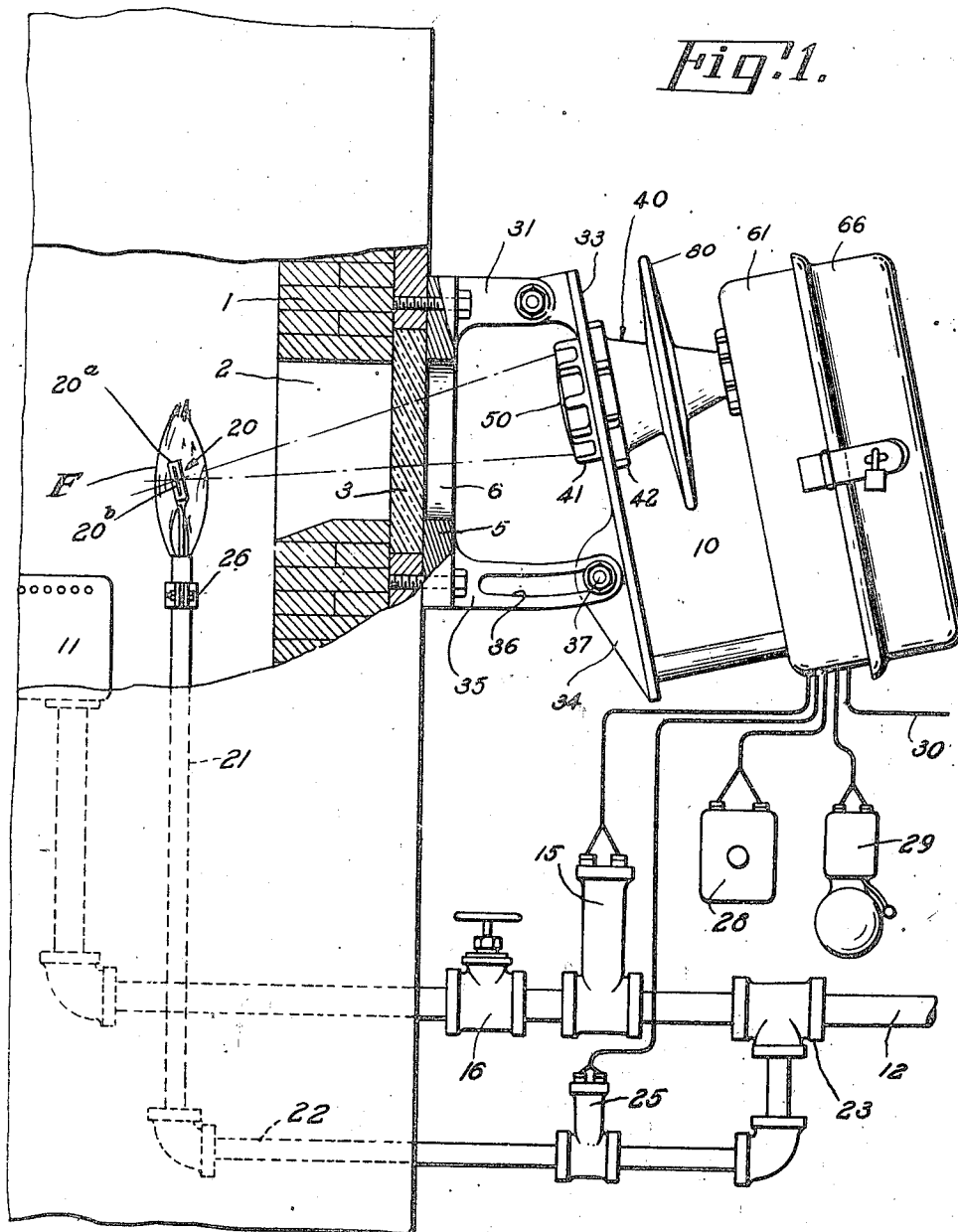
2,418,845

OPTICAL SAFETY DEVICE

Filed March 15, 1944

3 Sheets-Sheet 1.

Fig. 1.



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Filed March 15, 1944

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Fig. 2.

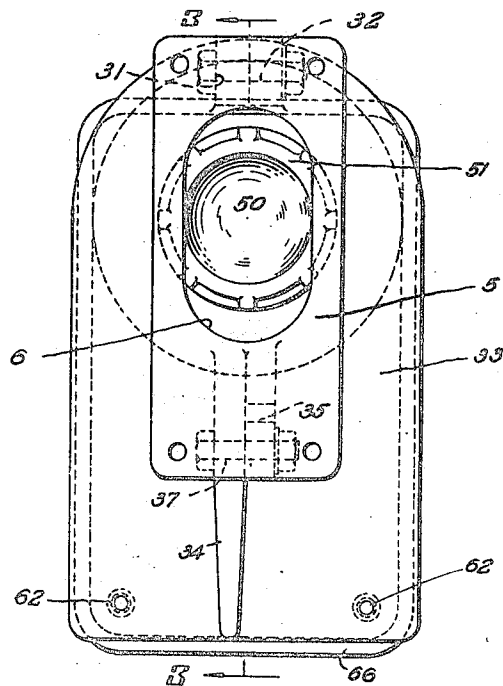
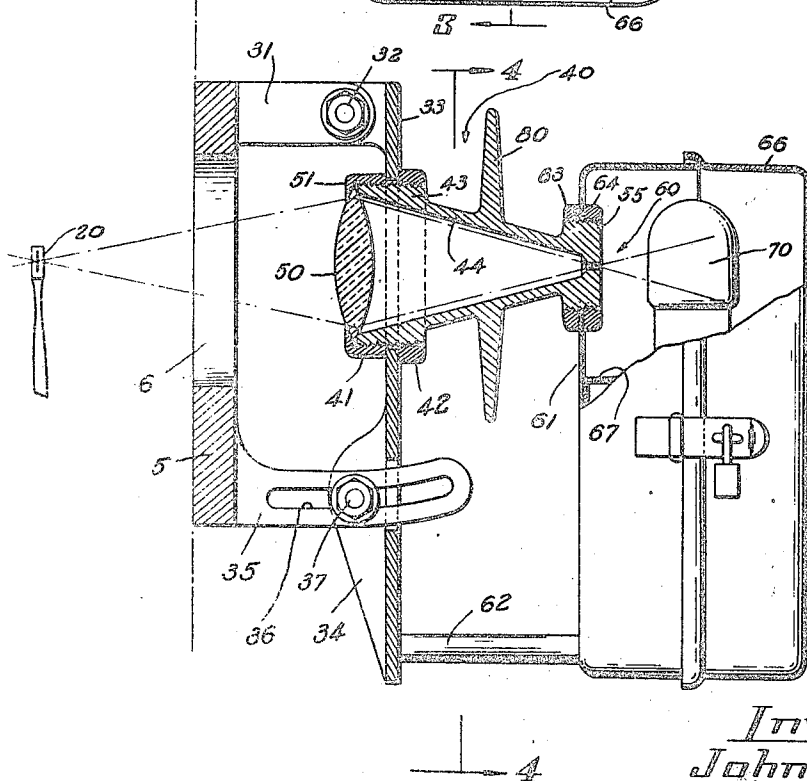


Fig. 3.



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Fig. 4.

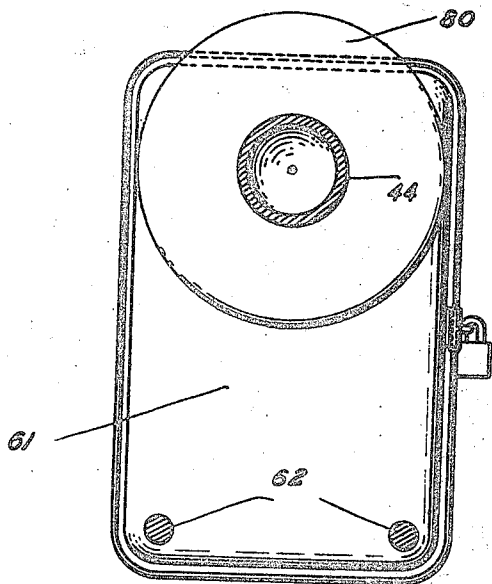


Fig. 5.

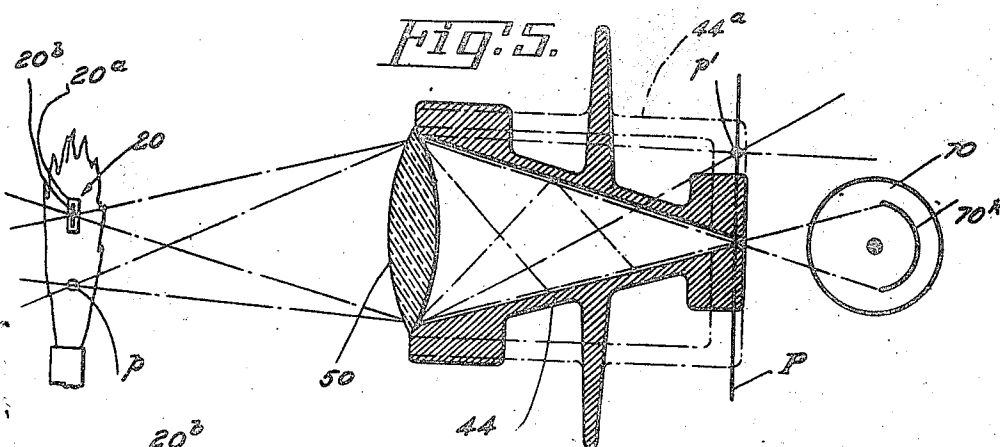
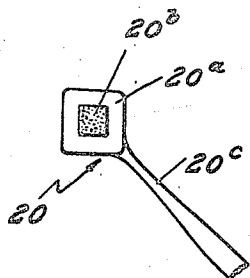


Fig. 6.



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UNITED STATES PATENT OFFICE

2,418,845

OPTICAL SAFETY DEVICE

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Application March 15, 1944, Serial No. 526,639

4 Claims. (Cl. 250—41.5)

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This invention relates to optical apparatus for observing heat sources, and more particularly to safety arrangements for photoelectrically supervising the operation of heating plants with respect to proper flame condition.

It is well known that explosions are an ever-present hazard in the operation of heating plants such as boilers, heaters, furnaces, heat-treatment ovens, kilns and similar, especially pressure fed, equipment. Such explosions are mainly due to failure promptly to detect loss of flame. As soon as the flame dies, fumes and gases accumulate and combine with air to form a highly explosive mixture in the combustion chamber. If only a few seconds elapse before the fuel is cut off, a stray spark, the hot refractory lining, or another flame may set off the flash.

It is one of the main purposes of the present invention to provide a reliable safeguard against such dangerous conditions, by directly supervising a selected flame which may be a main flame, a pilot flame, or a combination of both, or other radiating body while, if desired, excluding interference with this function by other radiators which need or should not be included in the supervisory function; to provide equipment of this type which is suitable for a large variety of fuels such as oil, gas, pulverized coal; and generally to provide a device of this type which is able to operate at relatively high ambient temperatures and can be conveniently combined with heating equipment of various types.

These and other objects and aspects will be more fully apparent from the following description of a practical embodiment illustrating the genus of the invention. The description refers to a drawing in which

Fig. 1 is a schematic representation of a heating installation incorporating the optical observation unit according to the invention;

Fig. 2 a front elevation of the optical unit according to the invention;

Fig. 3 a section on line 3—3 of Fig. 2;

Fig. 4 a section on line 4—4 of Fig. 3;

Fig. 5 a diagrammatical illustration of the function of apparatus according to the invention, including a side elevation of the auxiliary radiator; and

Fig. 6 a front elevation of the auxiliary radiator.

The general arrangement and the environment of a practical embodiment of the invention will first be described with reference to Fig. 1 in which 1 represents a wall of a furnace which has a window 2 covered by a transparent plate 3 of

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suitable material for example heat-resisting glass. Suitably fastened to the wall is a mounting bracket 5 which has an opening 6 approximately aligned with the furnace window 2 and to which is suitably fastened, in a manner to be described in detail herebelow, the supervisory unit proper indicated at 10. Within the furnace is suitably mounted a main burner 11 which is supplied from a fuel line 12, the fuel supply being controlled by a main solenoid valve 15 and a manual valve 16. Combustion is initiated by means of a pilot burner 21 supplied by a pilot fuel line 22 which branches from the main fuel line at 23 and may be controlled by an electrically operated pilot solenoid valve 25. The cycle of operation may be initiated by a thermostat, pressurestat, or manually by means of a push button, which devices are indicated at 28. An abnormal condition, as extinction of the pilot flame, may be indicated by a signaling device such as an alarm bell 29. The entire installation is supplied with electrical current from a supply network 30.

For the purposes of the present invention the flame to be supervised, in the present instance the pilot flame F, is preferably provided with an auxiliary radiating body 20 which will be described more in detail hereinbelow and which may be fastened to the pilot burner by means of a clamp 26.

Referring to Figs. 2, 3, and 4, the construction of the optical unit according to the invention will now be described in detail. The above-mentioned mounting plate 5, with window 6, carries on its upper part a bracket 31 to which is hinged at 32 a support plate 33 which is provided with a flange 34 corresponding to an arm 35 extending from the lower portion of mounting plate 5 and having a slot 36 which permits adjustment of the inclination of plate 33 relatively to mounting plate 5 and flame F by means of a screw bolt 37 inserted through a hole of flange 34 and through slot 36.

The lens plate 33 has a circular opening fitted with an optical mount 40 fastened to the plate with two rings 41 and 42 which have inside threads engaging the threaded boss 43 of aperture cone 44. A lens 50 is confined between the wider end of cone 44 and flange 51 of ring 41.

The apex end of the cone 44 has an aperture boss 55 pierced with a small aperture 60 and threaded on the outside.

An apparatus box 61 is fastened to the optical mount 40 and to the lens plate 33 by means of two rings 63, 64 screwed to boss 55 confining therebetween the wall of box 61 which has at that point a circular window dimensioned to receive

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the boss; a stud 62 distances the lower portions of plate 33 and housing 61.

Box 61 has a cover 66 and carries a chassis 67 upon which is mounted a radiation responsive device such as phototube 70. The box 61 may also contain, mounted on chassis 67, suitable apparatus for amplifying the phototube output current, and relay apparatus whose construction depends upon the particular installation. Since the control circuit proper does not constitute part of the present invention, only the phototube is shown.

The aperture cone 44 is preferably so constructed that its inner surface fairly closely envelops the light beam which lens 50 projects towards aperture 60 in the manner to be described below. The cone is preferably provided with one or more cooling flanges indicated at 80.

The above-described arrangement operates as follows.

The auxiliary radiator 20 remains incandescent so long as the flame with which it is associated burns and will emit intense radiation predominantly of a wave length higher than that of the usual heating flame and well within the range to which conventional phototubes are predominantly sensitive. On the other hand, due to its very small mass, the body 20 will cease to radiate practically immediately upon extinction of the flame. These radiators may comprise, as shown in Figs. 5 and 6, a protective envelope 20a for example of quartz, a radiating element 20b, for example a small platinum sheet or body of oxidized tungsten, sealed in the quartz envelope, and a supporting rod 20c.

Lens 50 is so placed relatively to radiator 20 that it images the latter at aperture 60; the photocell 70 is arranged behind aperture 60 so that the effect upon cathode 70k, of the light flux coming from aperture 60, is an optimum under the prevailing conditions including the nature and shape of the cathode and the nature of the radiation in question.

Radiation coming from any region in front of lens 50, other than that in the present embodiment occupied by radiator 20, will be refracted by the lens to form beams which do not converge at aperture 60 and which do not conform to the shape of aperture cone 44 and are therefore intercepted and absorbed by the inner cone surface which is preferably rough and blackened. For example, a point *p* below radiator 20 would be imaged at *p'* in image plane P and the respective beam intercepted as indicated. Similarly, a point between radiator and lens would be imaged beyond aperture 60, and a point in front of the radiator would be imaged between lens and aperture; in either case only a small portion of the respective stray radiation will reach aperture 60; by adjusting, with conventional means, the sensitivity of the circuit including the photocell 70 to a minimum value above that of this stray radiation it is easily possible to render effective only the image of fully emitting radiator 20 at aperture 60.

In this manner, any effect upon the phototube of radiation from furnace walls or from other more or less voluminous structural elements which might continue to radiate during a considerable time after extinction of the flame to be supervised, is effectively excluded. It will be understood that, if such structures as furnace walls or main burners were directly observed by the supervising photocell, the appreciable time required for cooling would allow accumulation of

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explosive mixtures before the control arrangement responded.

Referring now also to Fig. 1, the operation of an installation of this type may include the following steps. With the pilot flame burning and auxiliary radiator 20 emitting, actuation of the controlling thermostat or of a manually operated switch will open the main solenoid valve 15 and the main flame will ignite. Upon actuation of the controlling element in the reverse sense, the main valve closes whereas the pilot flame continues to burn. If the pilot flame should fail at any time, regardless whether the main flame is on or off, the phototube 70 responds to the instantaneous cooling of auxiliary radiator 20 and the relay circuit closes the automatic pilot valve if the main flame is off, or both valves if the latter is on during extinction of the pilot flame.

It will be evident that the mass of radiator 20 can be kept very small since the efficiency of its effect upon the phototube is very high; this small size permits full utilization of the above described selective effect of the aperture 60.

On the other hand, there is sufficient leeway in selecting the mass of the radiator so that rapid fluctuations of the flame such as due to flutter can be rendered harmless by a certain time lag between such flame fluctuations and the corresponding variation in radiation intensity of element 20. It is indeed easily possible to select the mass of the radiator with a view to eliminate the effect of flame fluctuations within a given maximum range, whereas all longer fluctuations will cause cooling of element 20 to such an extent that the phototube circuit will respond.

It will be understood that a cylindrical tube with an aperture baffle, as indicated at 44a of Fig. 5, offers to a certain degree the above-mentioned advantages, and might sometimes be used to advantage; however it will now be obvious that a conical aperture tube is more favorable since it absorbs the undesired radiation as far from the aperture as possible, thus increasing the temperature gradient between heat source and supervisory apparatus. The constricted cross section near the aperture, constituting a bottle neck regarding heat conduction, serves a similar purpose.

It will also be understood that instead of one heat dissipating fin 80, several such elements, or means having analogous effect may be used. Under favorable conditions the aperture tube alone is able to dissipate the heat and the fin can be omitted.

The emission range of a radiator of the type herein referred to compares, as to photoelectric effectivity, very favorably with that of most heater flames which radiate mainly in the photoelectrically rather ineffective blue range although they might appear yellow due to the comparatively high sensitivity of the visual apparatus to that range. Further, the high absolute intensity of the radiation from the auxiliary emitter provides more reliable operation and permits the use of less sensitive and hence cheaper and more rugged photoelectric, amplification and relay equipment. The intensity of the auxiliary radiator is also sufficiently high to penetrate considerable blackening of transparent window closures such as shown at 6 of Fig. 1.

It will be further understood that use of arrangements according to the invention is not restricted to pressure fuel equipment but that it can be advantageously applied to any heating system which presents analogous problems of su-

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pervision and control. Also, the auxiliary radiator 20 may be omitted, in which instance the radiating region, otherwise occupied by this body, will assume the function of the latter if its emission is sufficiently high.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

I claim:

1. In apparatus for photoelectrically supervising a flame within confining walls having an observation window, a mounting plate having an opening adapted to surround said window, a second plate having a lens mounted therein hinged to said mounting plate at a distance therefrom thereby securing free passage of air between said plates, a housing having a phototube mounted therein, and a light confining conduit supportingly connecting and spacing said lens plate and said housing, said hinged connection permitting the uniplanar alignment of said phototube with said flame, and said spacing inhibiting the transmission of heat to said phototube.

2. In apparatus for photoelectrically supervising a flame within confining walls having an observation window, a mounting plate having an opening adapted to surround said window, a second plate having a lens mounted therein hinged to said mounting plate at a distance therefrom thereby securing free passage of air between said plates, a housing having a phototube mounted therein, and a light confining conduit supportingly connecting and spacing said lens plate and said housing, said hinged connection permitting the pivoting of said housing on said mounting plate for the purpose of aligning said lens and said phototube with said flame.

3. In apparatus for photoelectrically supervising a flame within confining walls having an observation window, a mounting plate having an opening adapted to surround said window, a second plate having a lens mounted therein hinged to said mounting plate at a distance therefrom

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which secures free passage of air between said plates, a housing having a phototube mounted therein, and a light confining conduit supportingly connecting and spacing said lens plate and said housing, said hinged connection permitting the pivoting of said housing on said mounting plate for the purpose of aligning said lens and said phototube with said flame, and adjustable locking means connecting said mounting plate with said lens plate for the purpose of maintaining said alignment.

4. In apparatus for photoelectrically supervising a flame within confining walls having an observation window, a mounting plate having an opening adapted to surround said window, a second plate having a lens mounted therein, said second plate hinged to said mounting plate at a distance therefrom which provides free air passage between said plates, a housing having a photoelectric tube mounted therein, a light confining conduit supportingly connecting and spacing said second plate from said housing, a heat radiation fin annularly mounted in said conduit member between said second plate and said housing, locking means connecting the said plates together with the said hinge comprising means for adjusting the vertical angle of the said phototube and lens with the said flame.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,302,554	Kingsbury	Nov. 17, 1942
1,639,534	Ruben	Aug. 16, 1927
1,994,860	Matson	Mar. 19, 1935
2,292,243	Schwartz	Aug. 4, 1942
2,007,714	Gauger	July 9, 1935
2,306,073	Metcalfe	Dec. 22, 1942
2,122,941	Huffer et al.	July 5, 1938
2,360,166	Schumann et al	Oct. 10, 1944