June 26, 1934. L. L. CUNNINGHAM 1,963,957

COMPENSATED PILOT DEVICE

Filed July 25, 1928 2 Sheets-Sheet 1

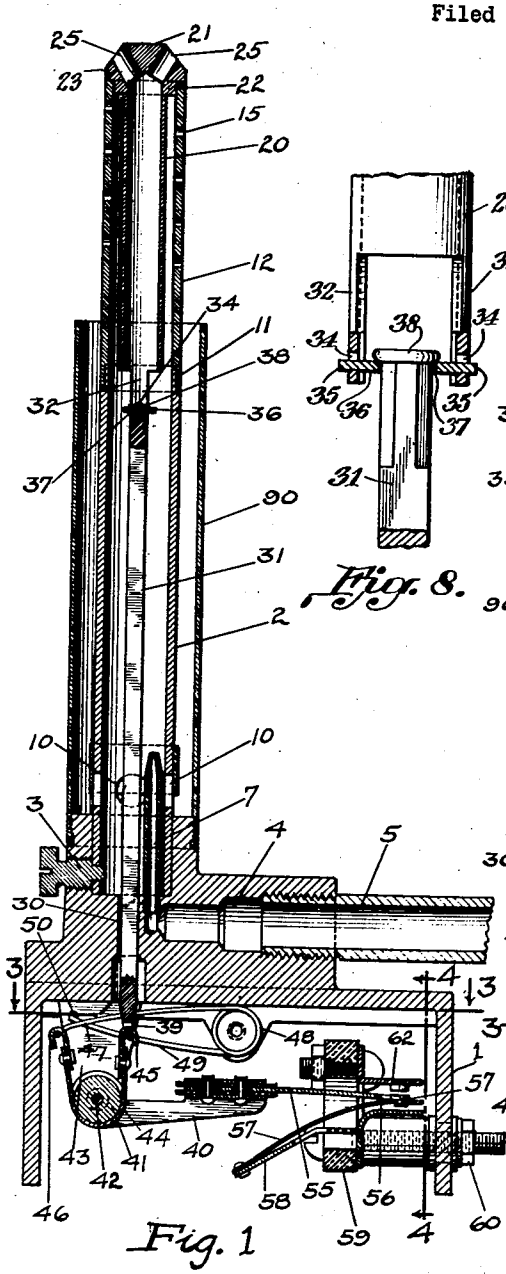


Fig. 1

Fig. 8.

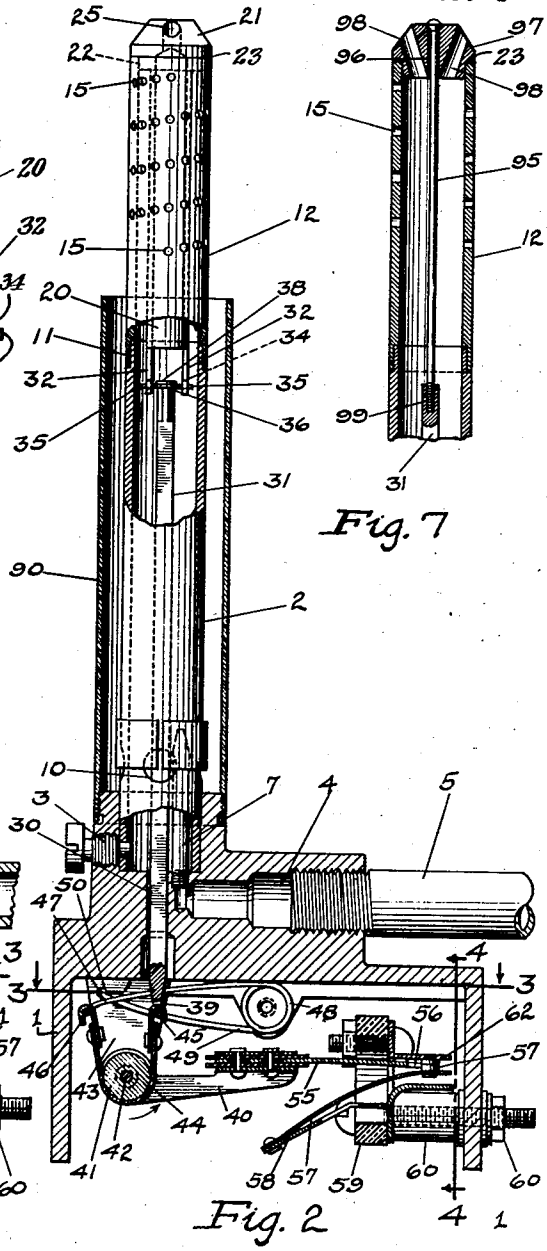


Fig. 2

Fig. 7

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Fig. 5

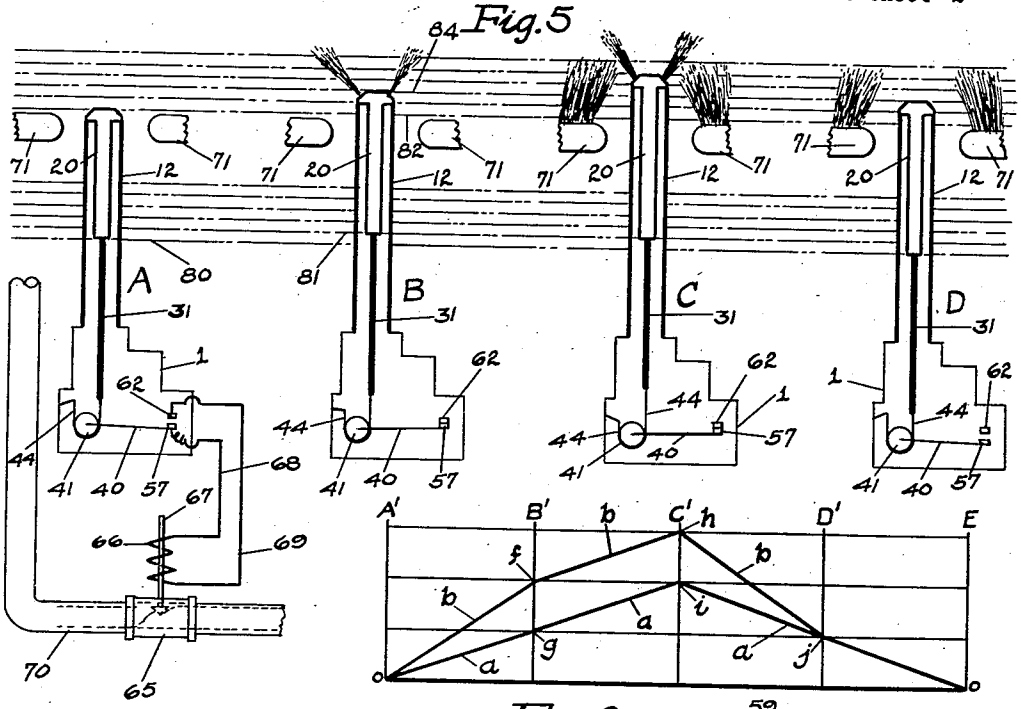


Fig. 6

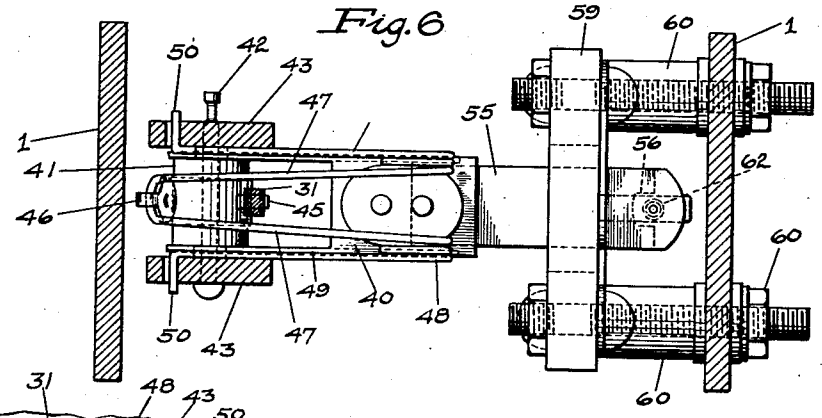


Fig. 3

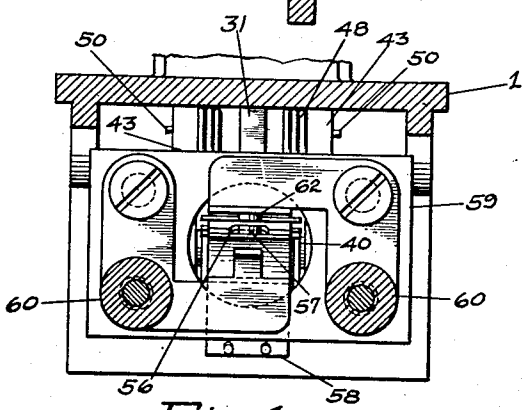


Fig. 4

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UNITED STATES PATENT OFFICE

1,963,957

COMPENSATED PILOT DEVICE

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Application July 25, 1928, Serial No. 295,221

1 Claim. (Cl. 158—117.1)

This invention relates generally to improvements in devices for supplying pilot flames, and ordinarily known as pilot lights.

The essential object of the invention is to provide a pilot device which will, for example, control a switch in a manner to unfailingly and speedily bring the switch to one control position, and afterwards maintain the switch in this control position as long as the pilot is lighted, and which will unfailingly and as speedily bring the switch to another control position when the pilot flame is extinguished, and maintain the switch in this second position regardless of changes in temperature in the furnace or other heating apparatus with which the device is used.

The proper operation of the device is therefore based on the provision of compensating means whereby temperatures other than that provided by the pilot flame itself, are not effective to interfere with the proper operation of the device to control another device such as a switch in a predetermined manner.

Another object of the invention is to provide a device in which compensation is made for "growth" in the thermostatic elements. By the term "growth" is meant the permanent enlargement or increase in length occurring in metallic parts which are heated to a high temperature for a considerable period of time. It will be understood that a pilot light is submitted to high temperatures over long periods, and that under these conditions the thermal elements may "grow" to such an extent that the accuracy, and sometimes the proper operation of the device is entirely destroyed. A feature, therefore, of the invention is compensation for "growth" of its expansible portions in a manner to maintain a delicately sensitive operative condition notwithstanding this "growth" due to continued exposure of one or more thermal elements to burner and furnace temperatures.

Features of the invention include the broad idea of providing a pilot device having thermally operable control elements, operative to perform their functions only as the result of presence or absence of heat furnished by the flame of the pilot device itself; of details of construction of the specific device as illustrated to show one application of the invention, and including means for compensating for "growth"; and for reducing liability of extinguishment of the pilot flame due to pressure changes in the combustion chamber, wherein the pilot device is placed.

Advantages and features of the invention will be set forth in the description of the drawings forming part of this application, and in said drawings:

Figure 1 is a vertical section through a pilot device, constructed according to the principles of this invention and showing the switch in open position;

Figure 2 is a view substantially similar to Figure 1 showing the switch in closed position;

Figure 3 is a plan section on lines 3—3 of Figures 1 and 2;

Figure 4 is a vertical cross-section on lines 4—4 of Figure 1.

Figure 5 is a diagrammatic view illustrating the action of the pilot device under the varying conditions of use;

Figure 6 is a view supplementary to Figure 5;

Figure 7 is a sectional view showing a modification; and

Figure 8 is an enlarged detail view illustrating the swivel connection between the inner tube and the connecting rod.

The device has herein been shown as of the Bunsen burner type but it will be understood that the form of the device can be changed without departing from the spirit of the invention. It will further be understood that although all details of construction are claimed, there is no intention to be limited to such details.

The base of the device is generally indicated at 1. Socketed in the base is a burner tube 2 held against withdrawal by a set screw 3. The base is drilled to provide a passage 4 with which a fuel supply pipe 5 is in threaded engagement. The passage 4 communicates with a nipple extension 7 entering the tube 2 to deliver the fuel upwardly therein. The tube 2 has usual air intake openings 10. The tube 2, in this instance, is made in sections, and the upper end is exteriorly counter-turned as at 11. A second tube 12 having a corresponding interiorly counter-turned portion is fitted over the counter-turned terminal of tube 2. The upper tube, in this instance, is made perforate by a series of openings 15 spirally arranged. It has been discovered that it is best to construct the tube 12 from cold rolled steel, and that this metal thus far gives the best result in the present embodiment of the invention. Within the tube 12 is a second tube 20, for example, of cold rolled steel, having a head 21 closing the upper end of the first tube, this second tube 20 being supported by the head and centered by a counter-turned portion 22 of the head. The tubes 12 and 20, constituting thermal-expansion elements of the pilot device, may obviously be made of any metal adapted to withstand the temperatures to which

they are subjected in use provided the lengths and coefficients of expansion of the respective elements are such that they expand or contract substantially equal amounts upon equal temperature changes. The tube 20 has an exterior diameter less than the interior diameter of the tube 12 to permit flow of gas between the tubes. The inner tube 20 is open at the bottom and is unattached so that expansion can take place in a direction opposite that of tube 2, or of sections 2 and 12. The flow of gas takes place between the tubes and through openings 15 and through the inner tube and openings 25 of the head 21. These openings 25 may be considered the main flame orifices arranged in upwardly divergent relation for the purpose of spreading the flame toward the burners 71, see Figure 5.

Although the tube 2 is herein shown as sectional, it is conceivable that a single outer tube may be employed. The tubes 2, 12 and 20 and their relative arrangement may be considered as broadly constituting applicant's invention, regardless of the character of the connection between the inner tube, and an element to be controlled by expansible elements of the device. The tubes 12 and 20, in the specific embodiment illustrated, constitute the expansible elements of the pilot device since the other elements of the device are located considerably below the main burner as shown in Fig. 5 and are shielded to a considerable extent by an outer tube 90. The joints at the lower ends of the tubes 12 and 20 minimize conduction of heat from the thermal-expansion elements to the other parts of the device.

In explanation of the action of the device, it is apparent that the presence of the pilot flame increases the temperature of the outer tube over that of the inner, and that in the presence of a burner flame this differential in temperature is always maintained, notwithstanding the fact that the thermal elements may be additionally elongated. It is also apparent that the flow of gas toward the burning point has some effect in maintaining this temperature differential, by shielding the inner tube 20 and conducting heat therefrom but at present it is impossible to state what the proportional effects are. This question will be discussed below.

The base is formed as at 30 vertically for the passage of a connecting element, in this instance a square metal rod 31. The upper end of this rod has a swivel connection with the lower free end of the tube 20. For this purpose the lower end of the tube is cut to provide depending arms 32 each having an opening 34, the openings being diametrically aligned to receive extensions 35 of the swivel plate 36. This plate has an opening 37 slidably receiving the rod 31. The upper end of the rod is, in this instance, flattened and enlarged to provide a shoulder 38 which prevents downward movement of the rod 31. The rod 31, in this instance, is slidable in the square opening 30 and cannot rotate. However, the swivel connection provides means whereby the tube 20 can be rotated, to properly dispose flame openings 25 relative to the burner or burners. It will be understood that the head 21 is centered by the counter-turned portion 22, which portion has a rotative fit in tube 12, so that tube 20 can be rotatably adjusted. The shoulder 23 formed by this counter-turned portion prevents downward motion of the tube 20.

A feature of the invention includes the switch which is controlled by the thermostatic device, in this instance for the purpose of discontinuing fuel supply to the burner, whenever the pilot light is extinguished and for maintaining the fuel supply when the pilot is lighted.

It will be understood that the device is now used in conjunction with heating apparatus, in which it is desirable to interrupt supply of fuel in case of failure of the pilot light, so that fuel may not be delivered unless conditions are such that it can be lighted. Therefore, in this instance if the pilot light (the only means herein for lighting the fuel) fails the fuel supply is discontinued. For this purpose a switch is used which controls an electric circuit to a magnetically operable valve in a gas line which supplies the burners, see Figure 5 for a diagrammatical showing of the valve and supply pipe and electrical connections. The switch now to be described is substantially disclosed in a copending application to Lewis L. Cunningham, Serial Number 228,355, for Circuit controlling devices filed October 26, 1927, Patent No. 1,763,094. Nevertheless this type of switch in combination with the present invention for its purposes is considered novel, particularly for the fact that this type of switch controlling device is compensated for "growth" in its expansible elements, due to continued exposure to furnace and/or burner temperatures. A switch operating arm is indicated at 40 and has a cylindrical drum portion 41. The drum 41 is pivoted by any suitable means 42, between spaced lugs 43 of the base 1, the pivot 42 being in this case horizontally arranged. The lower end of the element 31 is perforated as at 39, and a band 44 is detachably connected at one end by a hook 45 passing through the opening 39. The band passes around and flatly engages the drum 41 and is connected at its opposite end by a hook 46 with the arm 47 of a spring having a coil 48 and having an opposite arm 49 terminally connected as at 50, see Figures 1 and 3, with the lugs 43. It will be understood that the spring is under tension to maintain the band 44 in yieldable frictional engagement with the drum. This tensioned arrangement exerts a pulling action to secure the inner tube against outward travel.

Upon the arm 40 is mounted an extension 55 insulated from the arm 40, and connected thereto in any suitable manner as by rivets. The outer end of this arm is forked as at 56, and this forked terminal engages the outer free end of a spring contact 57 suitably secured at one end to a bracket 58 in turn secured to a block of insulating material 59 mounted upon the base 1 and supported, and secured by elements generally designated 60. The spring arm 57, as a current carrying element, cooperates with another current carrying element designated 62, and the element 57 when released, automatically makes contact with this element 62. In Figure 5, these contacts have been respectively designated 57—62, although in this diagram the contact 57 is shown as directly secured to the arm 40. Referring to Figure 5, a magnetic valve is generally designated at 65 and includes the coil 66 and the valve operating plunger 67. One side of this coil is connected by conductor 68 with contact 57 and the other side of the coil is connected by conductor 69 with the contact 62. The fuel supply pipe 70 supposedly delivers to the burner or burners 71 diagrammatically represented in this figure. The connections have only been shown on diagram A of this figure. When the arm 40 moves upwardly the spring arm 57 will be released to make contact. This closed or contact condition is shown in Fig-

ure 2 while the open condition is shown in Figure 1.

Inasmuch as the present invention is believed to be of pioneer nature to the extent that a pilot device is provided controlling a switch or equivalent device in some predetermined manner regardless of the degree of the temperature surrounding it, and speedily responsive to always perform one intended function when the device is lighted, and to speedily and unfailingly perform its other intended function when the pilot flame is extinguished, the diagrams of Figures 5 and 6 have been provided in an attempt to explain the action of the devices. This explanation is partly theoretical and it will be understood there is no intention to be limited by it.

It is an object of the invention to maintain a temperature difference between the outer element 12 or its equivalent, and some form of thermostatic element within the shell equivalent to the element 20, regardless of the temperature level or degree at the outside of the device. Referring to Figure 5 and to the first diagram designated A in this case, there is no pilot flame and, therefore, the elements are cold and the lower end of the element 20 lies, for example, at the level of the line 80. The contacts 62 and 57 are open and the valve 65 is closed. In diagram B the pilot has been lighted, and both elements 12 and 20 have expanded and the contacts 62 and 57 have been closed. In this condition it is assumed that the valve 65 has been opened to permit flow of fuel to the burner or burners 71. It will be understood that under these conditions and referring to Figure 1, gas is flowing to the flame outlets 25—15, and that gas passes between the tubes and through the inner tube. Referring to diagram 6, beginning at line B', which corresponds to B of Figure 5, it will be seen that both elements have expanded, but that the outer element represented by the line *b* has expanded at a greater rate than the inner element represented by line *a*, and that *b* has reached the temperature level *f*, while *a* has only reached the temperature level *g*. A thermal equilibrium has been set up, in which the outer tube has attained some definite temperature above the temperature attained by the inner tube. This relation particularly applies to the upper portion of the device including the tubular section 12 and the tube 20. It is apparent that the outer tube is always more exposed to flame. Referring again to diagram B of Figure 5, it will be seen that while the lower end of the inner tube has risen only from line 80 to line 81, the upper end of the device has moved a greater distance from 82 to 84. Referring to diagram C of Figure 5, it is now assumed that the burner or furnace heat has been added to that of the pilot resulting in an additional elongation of both elements 12 and 20. The theory is that when the furnace heat is added the outer and inner tubes are raised the same number of degrees due to equal distribution of heat to both, all without disturbing the differential of temperatures or the thermal equilibrium existing between the two. This is represented in diagram 6 between lines B'—C' in which it will be noted that the lines *b*—*a* are parallel but that there has been a temperature rise from levels *f*—*g* of line B' to levels *h*—*i* of line C'. This maintenance of a temperature differential between the outer and inner tubes, is believed partly due to conduction of heat from the flame to the outer tube, and partly to the cooling of the inner tube by the passage of unburned gases toward the flame orifices. It will be noted that the lower end of the tube 20 in diagrams B and C of Figure 5 is the same, although both tubes have expanded upwardly as shown at C. It is a fact that after the device reaches the condition shown in B of Figure 5, the lower end of the element 20 remains substantially in the position shown, notwithstanding that the temperature is raised exteriorly of the pilot device as a result of burner heat.

It will therefore be seen that the elements have reached what may be termed a thermal equilibrium, and that in Figure 5c, although the elements have expanded additionally, the same temperature differential has been maintained. It will be understood that although there may be a movement of the lower end of the element 20 it is always in a direction to maintain the switch, in this instance, closed. However, there is no intention to be limited by the statement just made, as to the immobility or substantial immobility of the lower end of the inner element because it is shown by experiment that under these conditions the switch is never opened, either under the condition illustrated at B or under the condition shown at C.

In other words, no matter what temperature changes take place (other than a reduction of temperature due to extinguishment of the pilot flame) the control switch or equivalent element will remain in the desired position, and will only move from that position on extinguishment of pilot flame. This latter condition is shown in diagram D of Figure 5, in which it will be seen that the burner flames are operating while the pilot flame has been extinguished. It will, of course, be understood that shortly after extinguishment of the pilot flame, the burner flames will also be extinguished, in this instance due to the interruption of fuel supply, as is intended by this device. Referring to Figure 6, it will be seen that, due to the extinguishment of the pilot flame the elements *b*—*a* are cooled and reach the temperature level *j*, the outer cooling at a greater rate than the inner. In Figure 6, it has been additionally shown that on extinguishment of burner flame the elements will again reach zero point as shown in line E which corresponds to the condition shown at line A'. It is believed that when the pilot flame is extinguished, there is a reduction of temperature of the outer tube, causing it to contract. If the supply of gas to the pilot has also been cut off, the inner tube expands due partly to conducted heat, and because there are no gases present to cool the inner tube. Thus in either case the thermal equilibrium is destroyed resulting in the opening of the contacts 57—62. The contacts will remain in this position until the pilot flame is again lighted, after which they will again assume the position shown in diagram B.

It will be noted that the thickness of the inner tube is less than that of the outer. By this means, the heat capacity of the tube is reduced and it seems that this smaller heat capacity in conjunction with the cooling effect of the gases gives better results than if the inner tube were the same thickness as the outer. It must also be remembered that both tubes 12 and 20, if of the same length have substantially the same coefficient of expansion, and in any event have substantially the same total expansion for equal increments of temperature. It will again be noted that the discovery that making the tubes 12 and 20 of ordinary cold rolled steel will im-

prove results, under the present use, is also claimed. Therefore the feature of the invention is this discovery of the use of cold rolled steel in this environment.

It will be understood that the upper portion of the device herein is often arranged between two burners, and that it is a feature of the invention to have the inner element 20 rotatable, so that the flame openings 25 can be disposed in proper relation to the burners.

The tube 90 is provided to establish atmospheric communication with the mixing openings 10, to prevent extinguishment due to a pressure wave in the furnace, which tends to drive the flame backwardly through the spiral openings. With the guard tube 90 the pressure may be equalized and therefore there is no flame extinguishment.

In reference to the compensation for "growth" it will be understood that the pilot is inserted in a gas furnace, for example, and that the pilot flame may be lighted for weeks. During that time the "growth" of the outer tube, which is the hotter of the two thermal elements, amounts to more than the total activity of the elements. When "growth" takes place the rod 31 is pulled in an outward direction and tends to rotate the arm 40 in the direction of the arrow shown in Figure 2. It will be noted that in this position of the device the contacts 57—62 are engaged. When the rod 31 is pulled outwardly, slippage between the element 44 and the drum 41 takes place and thus the switch elements are not injured. However, it will be seen that notwithstanding this growth and this upward or outward pull of the element 31, in case of extinguishment of the pilot flame, the movement of the element 31 in the opposite direction will nevertheless obtain opening of the contacts 62—57 as herein intended. An important feature of the invention is shown in Figure 7 in which a rod 95 is used in lieu of the tube. This rod has a small heat capacity, and has a low thermal conductivity. At present, the tubular sections 12 and 20 as well as the rod 95 are formed from stainless steel. This use of stainless steel for the thermal-expansion elements is also a feature of the invention. By the term "stainless steel" is meant the class of iron alloys which are highly resistant to corrosion because of a relatively high chromium content. The rod 95 is, in the present instance, about one-tenth of an inch in diameter and is cylindrical. The rod has a low co-efficient of expansion with a small thermal conductivity. The rod passes loosely through an opening 96 of the cap 97, which cap is bored as at 98 to provide flame orifices, leading directly into tube 12. Otherwise the cap 97 is generally formed and mounted in the same manner as the cap 21. The rod 95 is threaded at its lower end and these threads cooperate with threads of a socket 99 of the rod 31. By having the rod 95 pass loosely through the opening 96 it may be turned. This swivel connection is for the same general purpose as that described for the construction wherein the tube is used.

In order that the device herein may respond to the presence or absence of pilot flame, the outer tube should be affected as much as possible by the heat of the pilot flame. To do this, the flame must be spread, and the openings 15 accomplish this result. Thus the whole surface of the tube 12 is substantially in contact with pilot flame. All that is necessary is to furnish that quantity of heat to the tube 12, which will maintain it at sufficiently high temperature. At the same time the pilot flame should be in such a position that it will ignite the main burner.

By application of heat through the openings 15 over a relatively large area of the outer surface of the outer tube 15 (or in any manner to maintain this surface at a temperature greater than any ambient temperature produced by the burner with which the device is used as a pilot) the outer tube is rendered relatively insensitive to ambient or burner temperatures. The tube then acts as a shield so that the operating member 20 is shielded against transfer of heat to it sufficient to expand it to open the valve or other device or to move this device to another control position.

Other influences which are believed to effect a cooling of the rod, tube or inner element are: radiation from that part of the inner element below the pilot flame; radiation from the outer tube; and conduction by the inner element or its extension to the base casting, which casting is a good heat radiating body.

I claim as my invention:

A pilot device of the class described comprising, in combination, a first heat-responsive expansible tubular element arranged vertically and having a fixed support for the lower end thereof, said element being provided with a series of apertures around the circumference thereof below the upper end, a second heat-responsive expansible element comprising a head portion swivelled on the upper end of the first heat responsive element and an elongated depending shank portion inside of said first element, a control device operatively connected to the lower end of the elongated shank portion of said second heat-responsive element, the lengths and coefficients of expansion of said elements being so chosen that under thermal expansion thereof the free end of the shank portion of said second element remains substantially stationary when both of the heat-responsive elements are at the same temperature irrespective of the degree of such temperature, the head portion of said second heat-responsive element being provided with a laterally-directed aperture, the angular position of which is adjusted by turning the head portion with respect to the first tubular element, and means for supplying fuel to the inside of said first tubular element to produce a pilot flame at said series of apertures in contact with the outside of said first element and a laterally-directed flame of adjustable position at the upper end of the pilot device.

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