March 5, 1946. H. A. ATWATER 2,396,146

FLAME CONTACT UNIT FOR BURNER CONTROL SYSTEMS

Filed June 3, 1942 2 Sheets-Sheet 1

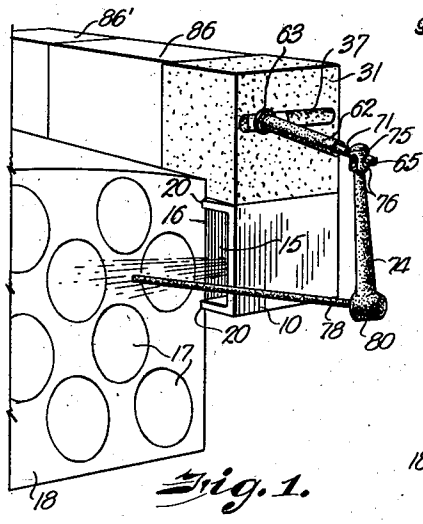


Fig. 1.

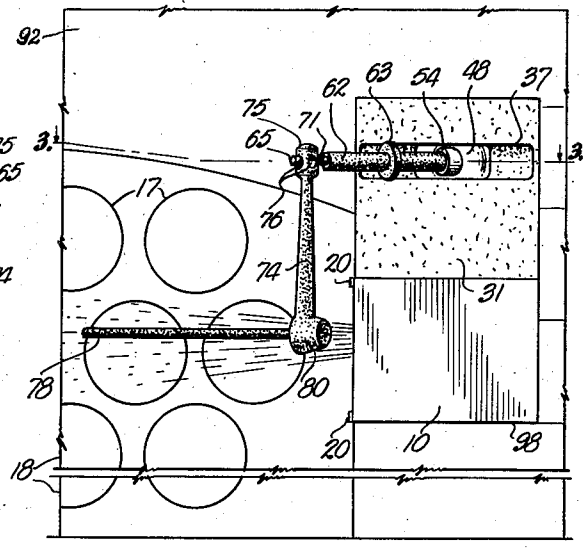


Fig. 2.

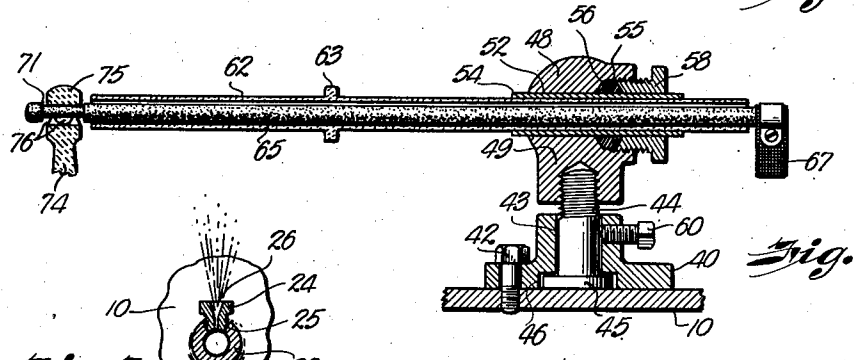


Fig. 5.

Fig. 7.

Fig. 8.

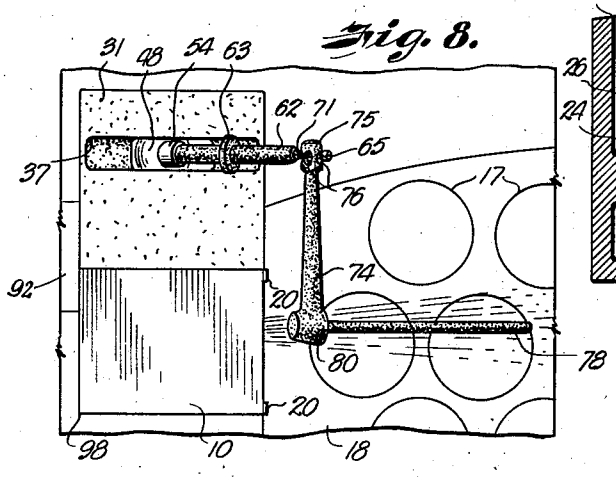
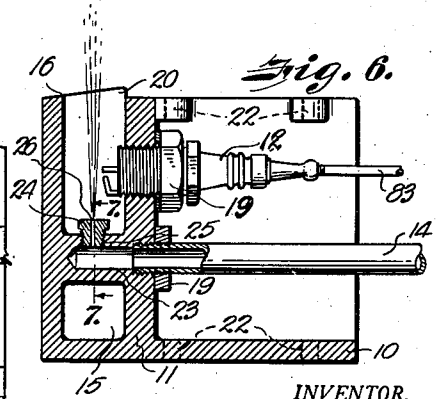


Fig. 6.



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FLAME CONTACT UNIT FOR BURNER CONTROL SYSTEMS

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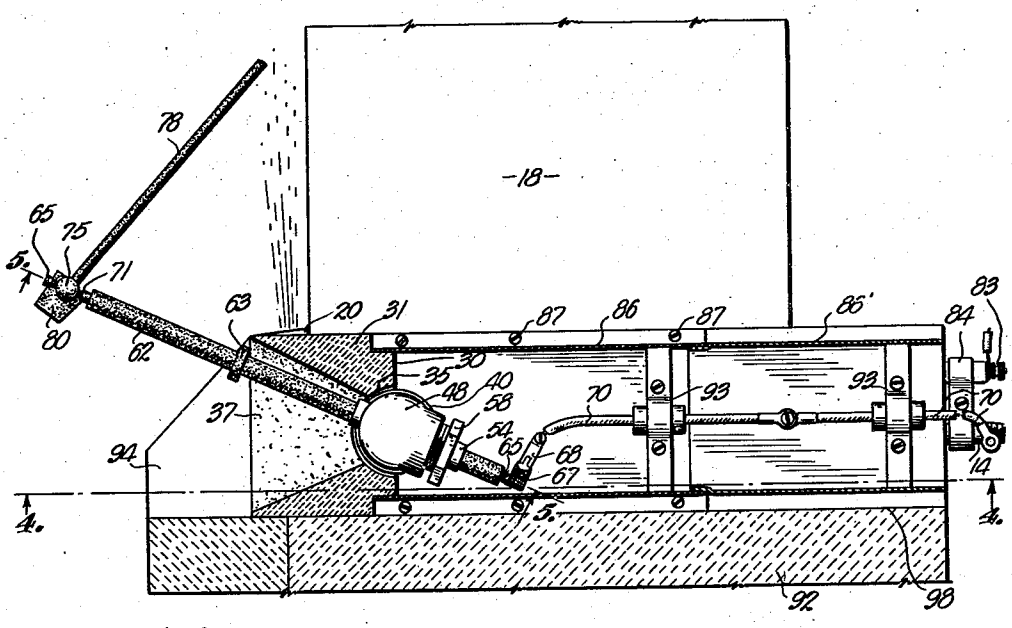


Fig. 3.

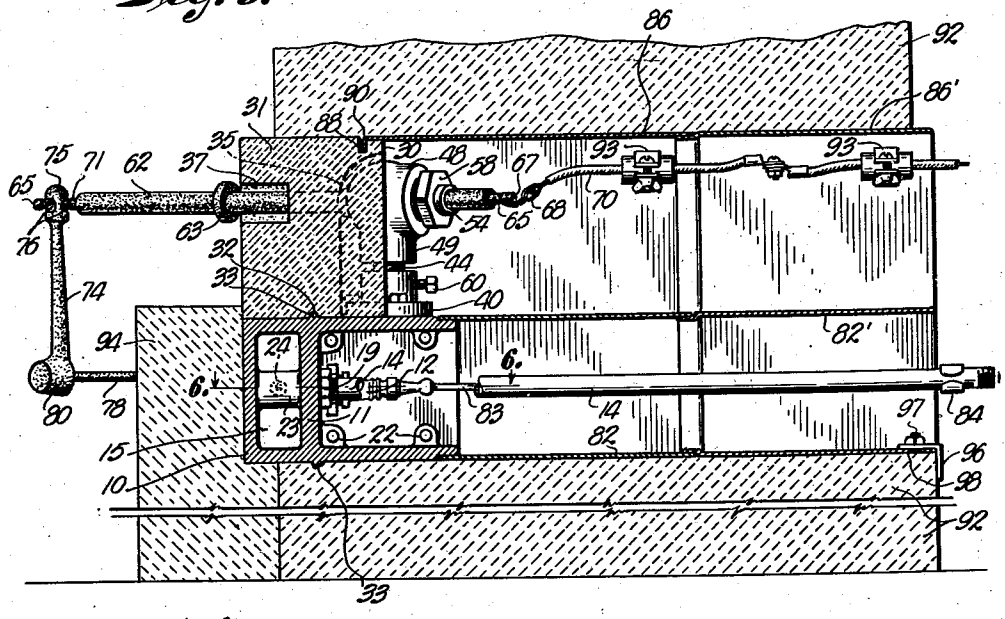


Fig. 4.

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UNITED STATES PATENT OFFICE

2,396,146

FLAME CONTACT UNIT FOR BURNER CONTROL SYSTEMS

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Application June 3, 1942, Serial No. 445,559

11 Claims. (Cl. 158—28)

The present invention relates to apparatus designed to control the supply of fuel to burners of a type producing a flame in the combustion process, and aims to devise a novel and improved control means utilizing such combustion flame as part of an electric control circuit which is operative for automatically shutting off the fuel supply when necessary as a safety feature.

A primary feature of the invention is to provide a highly refractory flame contact structure as part of the control circuit, and adapted to withstand the entire range of temperatures which may be encountered in gas burner operation, and so arranged as to render the circuit definitely responsive to flame conditions within a substantial space or area traversed by the main flow of gas from the burner; and where this space or area is traversed by a pilot lighting flame the arrangement is such that said lighting flame can not reach or contact the flame-contact structure without having first traversed this intervening space or area, the object being to prevent a possible grounding or completion of the control circuit through any flame contacts to which the main gas flow has not also been subjected.

A further object of the invention is to provide a control circuit arrangement of this character in combination with a pilot lighting construction and so arranged as to provide a compact and practically fixed assembly which is not likely to be disturbed or materially disarranged by workmen in making installations embodying the apparatus.

It is further sought to devise such a construction as will provide for all necessary adjustments for properly varying the flame contact structure with relation to the combustion face of the burner, as required for efficient control operation, and also for enabling the flame contact unit to be located in operative position at either side of the burner.

With the foregoing general objects in view, as well as various minor objects which will hereinafter appear, the invention will now be more specifically described by reference to the accompanying drawings illustrating a practical form of apparatus which has been found satisfactory for the embodiment of my proposed improvements, after which those features and combinations deemed to be both novel and patentable will be particularly set forth and claimed.

In the drawings—

Figure 1 is a perspective view showing a flame contact unit embodying the present invention and in operative relation to the combustion face of a gas burner;

Figure 2 is a front elevation of the same on a somewhat larger scale;

Figure 3 is a horizontal longitudinal sectional view, representing a section taken on the line 3—3 of Figure 2;

Figure 4 is a vertical longitudinal sectional view, representing a section taken on the line 4—4 of Figure 3;

Figure 5 is an enlarged sectional detail view, representing a section taken on the line 5—5 of Figure 3;

Figure 6 is a similar sectional detail view, representing a section as indicated by the line 6—6 of Figure 4;

Figure 7 is an enlarged sectional detail view, indicating a section taken on the line 7—7 of Figure 6; and

Figure 8 is a front elevation similar to the view shown in Figure 2 but illustrating the flame contact structure and other parts of the unit assembled in operative position at the opposite side of the burner.

Shutting off the fuel supply as an emergency or safety feature, in connection with boiler operations and the like, is a well-known adjunct characterizing combustion operations, and there are also certain well-known and conventional types of control systems for liquid and gaseous fuel burner installations which utilize suitable relay devices in electric control circuits including the combustion flame as a part of the circuit. The relay in these control circuits is ordinarily provided with a terminal connected with the burner which is grounded, and also a terminal having a conductor adapted to complete the circuit through either the combustion flame of the burner, or its pilot flame, for which purpose said conductor may include what is sometimes called a flame "electrode" designed to be enveloped by the flame and thereby complete the circuit on contact of the flame with the exterior face of the burner.

Obviously a pilot burner and flame are not indispensable to such a control system, since the main gas burner may be lighted either manually or by some suitable automatic means, in which case the control would function simply to cut off the fuel supply in the absence of any flame for completing the control circuit.

Some of the defects characterizing these prior commercial types of installations may be noted as instigating efforts toward the present improvements, viz., the inability of critical parts of the

construction to withstand the higher furnace temperatures which are frequently encountered; the absence of any unitary or composite design of flame contact element and pilot structure with more or less fixed relationships not likely to be disturbed on being actually installed and at the same time providing for an installation in which the pilot flame must actually traverse a material portion of the path of the main burner gas flow before completing the control circuit; and moreover, the lack of sufficient flexibility of design of construction to permit all requisite adjustments required by the demands of any particular burner installation while retaining all the important advantages contemplated by the present improvements. It is quite apparent that apparatus having one or more of these defects will naturally fall short of satisfactory performance; for example, any so-called flame electrodes which will not withstand the required temperatures will either gradually burn away or become pliant and sag down out of operative position, and therefore no longer function. Likewise, where the pilot structure is not incorporated as an integral or component part of the flame-contact controlling unit but is simply a pilot structure roughly adapted to the rest of the construction, such adaptation is of course left to the installing workmen, who can not be expected to understand or to make provision for all the requirements of a proper pilot installation of this type; and this is particularly true as regards lack of any provision for one of the most vital features characterizing the present invention, i. e., the elimination of any chance of the pilot flame's completing the control circuit or rendering it operative without having first traversed a sufficient extent of the main gas flow from the burner to insure ignition thereof prior to such completion of the control circuit.

Referring now to the drawings in detail, the improved construction comprises a pilot casting **10** formed with an interior partition **11** which provides support for a conventional sparkplug device **12** and a pilot gas supply pipe **14**, while at one side of said partition is formed a pilot chamber **15** having a lateral pilot flame opening **16** for discharge of the pilot flame transversely across the adjacent burner orifices **17** in the front or combustion face of the gas burner block **18**— as illustrated in Figure 2. For this purpose the unit is so mounted as to locate said pilot flame opening **16** slightly forward of the burner orifices **17**; and the mounting of the unit in this position is facilitated by providing the shoulders **20** on said casting **10** for engagement with the front face of the burner; and provision is also made for bolting the casting **10** against the side of the burner, through the medium of bolt openings as indicated at **22** (see Figure 4).

One end of the gas supply pipe **14** is connected with the partition **11** and clamped by means of a nut **19** in communication with a discharge chamber **23** formed in said casting **10** and fitted with an orifice element **24**, the shank of which is screw threaded (as indicated at **25**) for removable connection with said chamber **23**. These orifice elements are thus interchangeable and are provided with any desired shape or size of orifices **26** for producing the required form of pilot flame, to be projected laterally through the opening **16**; this flame should preferably be of wide and fan-shaped extent projected in a vertical plane across and in front of the adjacent burner orifices **17**.

Upon the top of the pilot casting **10** is mounted a block **31** of suitable refractory material, in such relation that the outer or front faces of the block and casting register or lie flush with each other; and to facilitate the proper assembly of the parts in this relation the block **31** is formed with a groove **32** for engagement with a rib **33** on the exterior of the casting **10**. Moreover, since this casting may be reversed for the purpose of directing the pilot flame in either of two opposite directions (as may be required for mounting the unit on either side of the burner), the positioning rib **33** may accordingly be formed on both the upper and the lower face of said casting, for engagement with the groove **32** in either of the operative positions of the pilot unit.

The inner or rear side of the block **31** is formed with a cove or recess **35** terminating short of the top of the block (see Figure 4); and the top portion of this recess **35** communicates with a horizontal and flaring or fan-shaped passage **37** opening upon the front face of said block (see Figures 1, 4 and 8).

This recess **35** provides a sheltering cove or housing for a supporting structure for the parts of the flame-contact unit, all of which will now be described. This supporting structure comprises a flanged base member **40** which is anchored by screws **42** to the top of the pilot casting **10**, and is also formed with a smooth central opening **43** for accommodating a vertical screw **44** having a head portion **45** which is housed within an opening or recess in the lower face of the base member **40**, as illustrated in Figure 5. Carried by the upper end of the screw **44** is a substantially spherical element **48** formed with a shank portion **49** tapped for engagement with the upper end of the screw, and also formed with a horizontal bore for accommodating a mica rod-protecting sleeve **54**. One end of the bore **52** is reamed out, as indicated at **55**, for asbestos fiber packing material **56** which is retained by means of a packing gland nut **58** fitted over one end of said sleeve **54**. The sleeve **54** is thus mounted for pivotal movement horizontally about the axis of the screw **44**, but may be secured in any set position by means of a suitable clamping screw **60**.

Removably mounted in the sleeve **54** is a refractory quartz tube **62** having one of its ends projecting out through the opening or passage **37**, while the intermediate portion of the tube is provided with a knob formation **63** serving as a stop element in connection with the insertion of the tube into the sleeve **54** and adapted, in the pivotal movement of said tube, to engage the sides of the passage **37** for limiting such pivotal movement and thereby prevent any of the parts at its inner end from making any contacts which might result in grounding of the electric circuit.

This tube **62** serves as a support for a rod **65** of highly refractory silicon carbide material, known commercially as Carborundum and of special dense form; this rod protrudes from the opposite ends of the tube **62** and at one end carries a copper wire gauze strip **67** for detachable connection with a clasp element **68** which is attached to a conductor **70** leading to the relay control unit (not shown) of the system. The other end of the rod **65** has a reduced neck portion (as indicated at **71**) designed for the support of the flame contact element in suspended position in front of the burner openings **17**, as illustrated in Figures 1, 2 and 8.

This flame contact element is of substantially

right-angular shape, constructed of the same highly refractory material as the rod 65 and comprising an upright comparatively heavier bar 74, the head portion 75 of which is provided with two sets of rod-receiving openings 76 to permit mounting of the contact member in either of two different positions at right angles to each other, upon the end of the rod element 65 (compare Figures 1 and 8). The lower end of the bar 74 carries a slender horizontally projecting rod 78 (constituting the flame contacting portion) and also a knob or enlargement 80 as a means for counterbalancing said rod 78 and maintaining the latter in approximately horizontal position.

A casing or housing 82 is attached to the rear end of the pilot casting 10 for enclosing the pilot gas supply pipe 14 and also the lead or conductor 83 to the spark plug element 12, said pipe 14 and lead 83 being held in spaced relation by suitable clamping means 84 (see Figure 3).

A top cover casing 86 is mounted upon and attached by screws 87 to said casing 82 and also fits over the reduced portion 30 on the rear face of the refractory block 31, which is also formed with a channel or groove 88 for receiving a lip or flange 90 at the corresponding end of said casing 86 as illustrated in Figure 4, thereby cooperating with the groove 32 and rib 33 to maintain said block 31 in its proper position. At the same time the clearances provided are ample for all necessary expansion and contraction of the construction resulting from the operation of the burner.

If necessary, extra housing extensions 82' as well as cover extensions 86' may be added to correspond with the thickness of the setting wall 92 in which the burner is being installed; and said casing and housing parts will of course be equipped with whatever interior clamp devices 93 may be needed for the proper support of the lead or conductor 70 (see Figures 3 and 4).

Also in the usual installation the pilot box or casting 10 will be suitably protected from direct furnace temperatures by providing additional fire brick protection as indicated at 94, at the front of said casing, as illustrated in Figures 3 and 4.

As an aid to facilitate installing the unit in its proper operative position, an extension lug or bracket 96 is suitably fastened, as by means of a bolt 97, to the rear end of the casing structure 86 or 86', as a stop for engagement with the margin of the wall opening 98 provided in the furnace wall for accommodating the unit;—or for engagement with any suitable liner (not shown) which may be provided for housing the unit within said wall opening. It may be further explained that as a matter of practice, provision is usually made in the way of either a side window or opening adjacent the front face of the burner or a passage alongside the wall opening 98 (to be filled with loose brick) for obtaining access to the front end of the unit as required for removing the flame contact element 74 in the making of any repairs or adjustments which may necessitate withdrawing the unit from the wall; in this operation, after the removal of said contact element 74, the screw 60 is loosened and the supporting structure (including the tube 62) swung round to central position to allow the unit to be withdrawn.

By means of such a construction and arrangement of pilot unit and flame contact element it will be very apparent that the aforesaid objects of the invention are completely and satisfactorily attained. For the position of the flame contact rod 78 is maintained in such relation to the burner orifices that said rod does not project into the path of the pilot flame except at some distance from the pilot chamber 15, so that the pilot lighting flame must first traverse a material expanse of the main gas flow from the orifices 17 before contacting the end of the rod 78 which is in proximity to the burner face, through which the control circuit is to be closed or grounded—see Figure 3. Therefore, in the operation of the burner it is clear that such arrangement precludes any possibility of the pilot lighting flame itself, alone, operating to close the circuit (that is, without also igniting the main gas flow), inasmuch as said pilot flame must always travel across a substantial volume of the main burner gas flow and thereby unfailingly ignite any such main flow of gas from the burner. Hence one of the chief causes of the disastrous explosions often resulting from delayed ignition, or from total failure of ignition, and the consequent accumulation of gas, is effectively eliminated.

Moreover, this same certainty of the desired operation is assured for each installation, regardless of whether the same degree or skill is employed on each job, because of the same uniform design or set relationship of the pilot and flame contacting parts being embodied in each and every unit for producing the same operative relationship of those parts, with relation to the face of the burner. Consequently the critical relationship necessary for the purposes of my invention can not be so varied or changed as to affect or interfere with the proper operation of the control circuit by careless or indifferent workmen, for it is of course obvious that once the flame contact parts are set, with the support therefor moved into either of the supporting positions shown in Figures 1 and 8, the flame contact element 78 can not be reached by the pilot flame except by the passage of said flame across some material portion of the main gas flow.

Proper and continuously satisfactory operation is further assured by the character of materials used for the flame contact elements for withstanding temperatures which are much higher than those designed to be endured by the conventional metallic types of electrodes employing various alloys not adapted to withstand furnace temperatures much in excess at 2100° to 2200°. The supporting rod 65 and flame contact structure 74—78 being of silicon carbide material which has a melting point upwards of 2700° F., and said rod being mounted in the quartz tube 62, this provides not only insulation but also very effective resistance to all such temperatures as are developed in any of the well-known commercial processes. The mica tube 54 provides an additional insulating element between said parts and the supporting structure 48—49, which is in turn shielded by being housed within the cove 35 of the refractory block 31. Such a construction protects these elements of the control circuit from the disintegrating effects of the intense furnace heat, and furthermore, the Carborundum material comprising the rod 62 and the flame contact structure being, as indicated, of special dense form, said elements are adapted to withstand such softening action as would cause them to droop and sag out of proper operative position.

Another function served by the quartz tube 62 is as a reinforcement for the special refractory rod 65, to help carry the load supported by its outer end. The reduced neck portion 71 on said outer end of the rod 65, insertable into either of the two sets of openings 76 of the flame con-

tact shape 74, affords means for quick and easy shifting of the latter into either of the two alternative positions illustrated in Figures 1 and 8, and without any danger of displacement from such operative positions. In this connection it may be explained that the simple gravity contact between these elements is entirely sufficient for the proper functioning of the circuit, which is designed to operate normally with a relatively high resistance factor.

Finally, it is pointed out that the use of flame contacting elements of extremely high refractory properties is an important feature of improvement in the present invention, for the reason that the electrode devices of prior constructions are not adapted to withstand temperatures as high as those to which the flame contact elements of the applicant's arrangement are subjected. As a matter of fact it is significant that prior control systems have recognized the limitations of their electrode devices by actually so locating them as to avoid subjecting them to the maximum temperatures involved, and it is this very practice which has resulted in those defects in operation hereinbefore pointed out, especially that outstanding defect which is due to failure to locate the electrodes or flame-contacting elements in position to require the pilot lighting flame to traverse a sufficient extent of the main gas flow to insure ignition of that main gas flow as a determining factor in the establishment of the control circuit. From this it is very apparent that the high refractory properties of the applicant's flame contact elements constitute an important and essential characteristic of the present invention.

It will therefore be recognized that I have devised a practical and efficient arrangement and construction of apparatus which is effective for carrying out all the desired objects of my improvements, but that the described construction may nevertheless be modified in various minor respects while still embodying the essential principles of my invention. I therefore desire to be understood as expressly reserving the right to make all such changes or modifications as may fairly be deemed to fall within the spirit or scope of my invention as defined by the following claims.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In a flame responsive circuit for controlling burner operations, the combination with a burner block having a combustion face provided with one or more gas discharge orifices, of means for directing a lighting flame in a path transversely across and in contact with the combustion face of the burner, and a circuit connection provided with a flame contact element also projecting a material distance across the path of the main gas flow in the same general direction as said lighting flame but farther away from the face of the burner for bypassing the initial portion of said flame, said contact element terminating at a point within the path of said lighting flame whereby said circuit is closed through said flame to the burner.

2. In a flame responsive circuit for controlling burner operations, the combination with a burner block having a combustion face provided with one or more gas discharge orifices, of a pilot structure operative to direct a lighting flame in a path across and in contact with the combustion face of the burner, and a circuit connection provided with a flame contact element supported by said pilot structure and projecting across the path of the main gas flow but bypassing the initial portion of the path of said lighting flame and terminating in close proximity to the face of the burner, said contact element having refractory properties effective for withstanding temperatures greatly in excess of 2200° F.

3. In a flame responsive circuit for controlling burner operations, the combination with a burner block having a combustion face provided with one or more gas discharge orifices, of a pilot structure mounted in a fixed relation to the burner and operative to direct a lighting flame in a predetermined path transversely across and in contact with the combustion face of the burner, and a circuit connection provided with a flame contact element and refractory supporting means mounted on said pilot structure and carrying said flame contact element with the latter projecting a material distance across the path of the main gas flow in the same general direction as said lighting flame but farther away from the face of the burner for bypassing the initial portion of said flame, said contact element terminating at a point within the path of said lighting flame whereby said circuit is closed through said flame to the burner.

4. A flame contact unit for burner control circuits comprising, in combination with a burner block having a combustion face provided with one or more gas discharge orifices, a pilot unit for assembly in fixed relation to the burner and operative to direct a lighting flame in a predetermined path across and in contact with the combustion face of the burner, a burner control circuit connection provided with a flame contact element and adjustable supporting means including a base element in fixed relation to said pilot unit, and a refractory supporting member carried by said supporting means and removably connected with said flame contact element for suspending the latter in position projecting a material distance across the path of the main gas flow in the same general direction as said lighting flame but farther away from the face of the burner for bypassing the initial portion of said flame, said contact element terminating at a point within the path of said lighting flame whereby said circuit is closed through said flame to the burner.

5. A composite pilot structure and flame contact unit for burner control circuits comprising a pilot unit for assembly in fixed relation to a burner block having a front combustion face provided with one or more gas discharge orifices and operative to direct a lighting flame in a predetermined path across and in contact with the combustion face of the burner, a burner control circuit connection provided with a flame contact element and adjustable supporting means therefor, a refractory block in fixed relation to the pilot unit and provided with a recess for housing said supporting means, and a refractory connection between said supporting means and flame contact element and arranged to suspend the latter in position projecting a material distance across the path of the main gas flow in the same general direction as said lighting flame but farther away from the face of the burner for bypassing the initial portion of said flame, said contact element terminating at a point within the path of said lighting flame whereby said circuit is closed through said flame to the burner.

6. A composite pilot structure and flame contact unit for burner control circuits comprising a pilot unit for assembly in fixed relation to a burner block having a front combustion face provided with one or more gas discharge orifices and operative to direct a lighting flame in a predetermined

path across and in contact with the combustion face of the burner, a burner control circuit having a flame contact element and pivotal supporting means therefor, a refractory block in fixed relation to the pilot unit and forming a protective housing for said supporting means, and a refractory connection between said supporting means and flame contact element and adjustable to suspend the latter in either of two operative positions at opposite sides of the burner with said element projecting a material distance across the path of the main gas flow in the same general direction as said lighting flame but farther away from the face of the burner for bypassing the initial portion of said flame, said contact element terminating at a point within the path of said lighting flame whereby said relay circuit is closed through said flame to the burner.

7. A composite pilot structure and flame contact unit for burner control circuits comprising a pilot unit adapted for assembly at either side of a burner block having a front combustion face provided with one or more gas discharge orifices for projecting a lighting flame in a path across and in contact with the adjacent portion of the combustion face of the burner, a flame responsive control circuit connection provided with a flame contact element and adjustable supporting means therefor, a refractory block adapted for mounting on said pilot unit in either position of the latter and in fixed relation thereto for housing said supporting means, and a refractory connection between said supporting means and flame contact element and adjustable to suspend the latter at either side of the burner with said element projecting a material distance across the path of the main gas flow in the same general direction as said lighting flame but farther away from the face of the burner for bypassing the initial portion of said flame, said contact element terminating at a point within the path of said lighting flame whereby said relay circuit is closed through said flame to the burner.

8. In a flame responsive circuit for controlling burner operations, the combination with a burner block having a front combustion face provided with one or more gas discharge orifices, of means for projecting a lighting flame in a predetermined path across and in contact with said combustion face, a circuit connection provided with a flame contact element projecting directly through a material portion of the combustion space in front of the burner orifices and terminating in the path of said lighting flame, said contact element being of silicon carbide composition having refractory properties effective for withstanding temperatures greatly in excess of 2200° F.

9. In a flame responsive circuit for controlling burner operations, the combination with a burner block having a front combustion face provided with one or more gas discharge orifices, of means for projecting a lighting flame in a predetermined path across and in contact with said combustion face, a circuit connection including a flame contact element and a pivotal supporting member adapted to suspend said contact element directly in the combustion space in front of said burner orifices, said supporting member having means limiting the pivotal movement thereof for positioning the end of said flame contact element in the path of said lighting flame, said contact element and supporting member being of silicon carbide composition having refractory properties effective for withstanding temperatures greatly exceeding 2200° F.

10. In a flame responsive circuit for controlling burner operations, the combination with a burner block having a front combustion face provided with one or more gas discharge orifices, of means for projecting a lighting flame in a predetermined path across and in contact with said combustion face, a circuit connection including a flame contact element and a refractory supporting arm of conductive material mounted for limited horizontal swinging movement, said contact element including connecting means providing restricted movement on the end of said supporting arm and directly in the path of said lighting flame.

11. In a flame responsive circuit for controlling burner operations, the combination with a burner block having a combustion face provided with one or more gas discharge orifices, of means for directing a lighting flame in a path transversely across and in contact with the combustion face of said burner block, and a circuit connection provided with a flame contact element also projecting a material distance across the path of the main gas flow in the same general direction as said lighting flame but farther away from the face of the burner block for bypassing the initial portion of said flame and terminating at a point within the path of said lighting flame whereby said relay circuit is closed through said flame to the burner, and refractory supporting means adjacent said combustion face and provided with a reversible supporting connection for said flame contact element and adapted to suspend the latter in either of two opposite angular positions for operation at either side of the burner block.

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