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GAS BURNER SYSTEM

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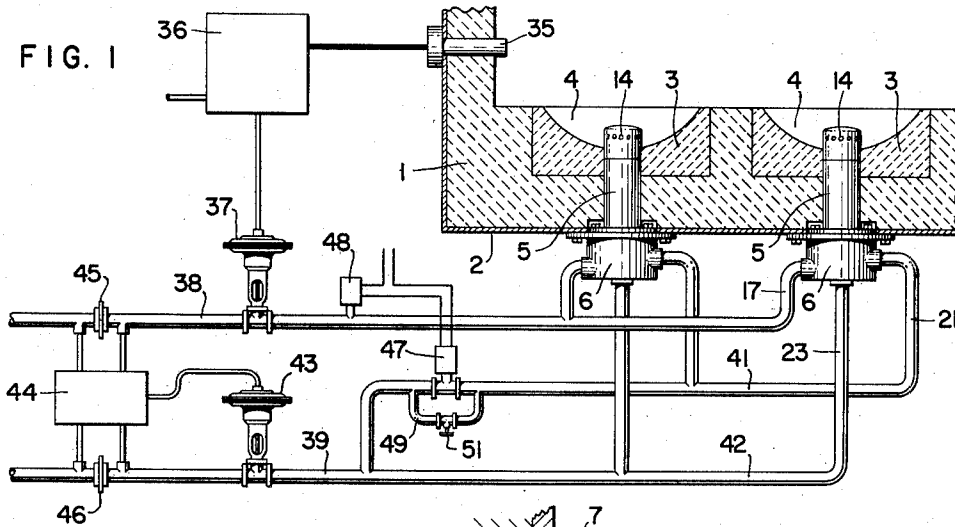


FIG. 2

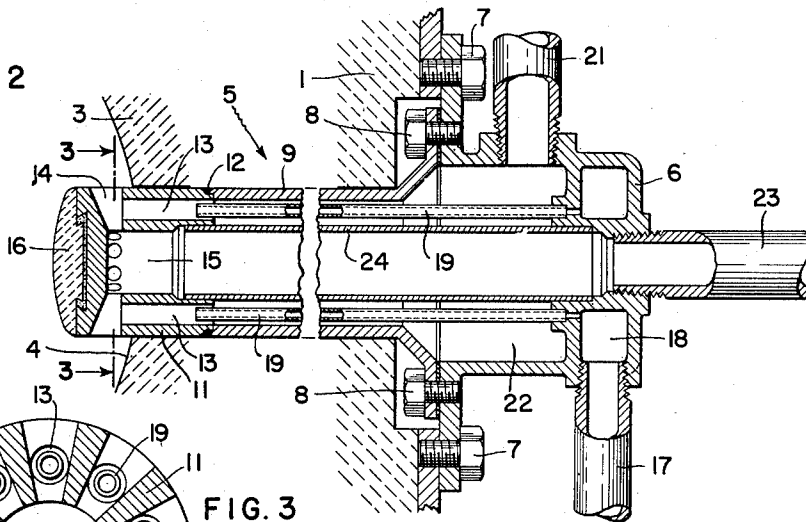


FIG. 3

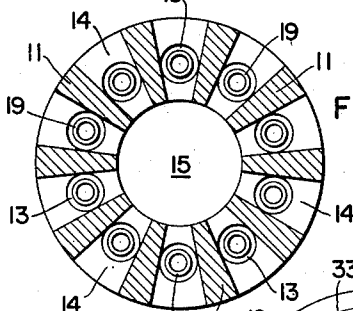


FIG. 5

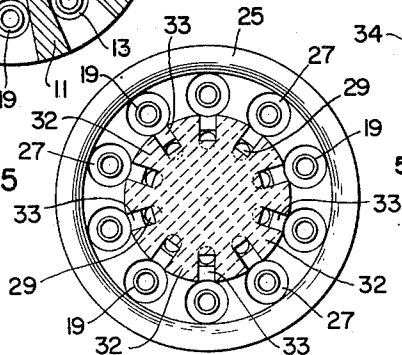
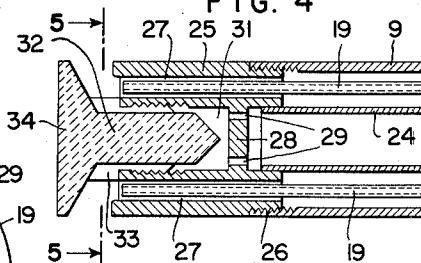


FIG. 4



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2,823,740

GAS BURNER SYSTEM

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4 Claims. (Cl. 158—119)

The present invention relates to gas burners and more particularly to a nozzle mix gas burner that has an unusually high turn-down ratio and a system whereby the burner may be controlled.

In many furnace applications, it is not only desirable but is necessary to be able to vary the heat input to the furnace through a wide range. This is frequently difficult to do without turning off some of the burners and thus upsetting the heat pattern of the furnace. The basic difficulty is due to the fact that burners designed for a large capacity do not operate successfully at low rates. The turn-down ratio of most burners is very limited.

It is an object of the present invention to provide a large capacity gas burner that has an exceptionally high turn-down ratio. It is a further object of the invention to provide a burner that will perform as well when operating at minimum fuel rates as it will at maximum fuel rates.

It is a further object of the invention to provide a control system for a burner in which the manner of supplying air to the burner is varied in accordance with the supply of fuel. This system permits the combustion process to be carried out efficiently at any point within the range of operation of the burner.

These objects are accomplished by making a burner in which the fuel and air are mixed just prior to the time they are introduced into the combustion space of the burner. The arrangement is such that the air is supplied to the burner in a plurality of streams on high fuel flow and predominantly in a single stream on low fuel flow. A control system is provided to supply at all times the proper amount of air for the fuel being burned, and to control the number of streams in which the air is supplied.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages and specific objects attained with its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described a preferred embodiment of the invention.

In the drawings:

Figure 1 is a view partly in section showing a burner mounted in the furnace and the control system therefor;

Figure 2 is a sectional view of the burner;

Figure 3 is a section taken on line 3—3 of Figure 2;

Figure 4 is a section of another form the discharge end of the burner may take; and

Figure 5 is a section taken on line 5—5 of Figure 4.

Figure 1 shows a pair of the burners mounted in the wall 1 in a furnace that they are intended to heat. The furnace wall 1 can be made of refractory material in accordance with ordinary furnace practice and is backed up by sheet metal 2. The burners each include a block 3 of refractory material forming part of the furnace wall and which is provided with a cup-shaped depression 4 on the side facing the interior of the furnace. This block

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is provided with an opening at the base of the cup, which opening is continued through the wall of the furnace. The burners also include a distributor member 5 which extends through the openings into the base of the cup of the burner block, which member is suitable attached to a back or body casting 6. Ordinarily, the body casting is fastened to the furnace to hold that portion of the burner in position by bolts 7 extending through a flange on the casting into the metal backing 2.

One form of the burner is shown in detail in Figures 2 and 3. It will be seen that the distributor member 5 is bolted to the back casting 6 by means of bolts 8 with a suitable gasket between the two. The distributor can be made in one piece, but for ease of manufacture and as shown herein, the distributor consists of a tube 9 and a tip member 11 which is fastened thereto such as by welding 12. The interior of tube 9 is preferably unobstructed, but the tip 11 is provided with a plurality of axial passages 13 which terminate in radial passages 14 that extend from the center of the tip to the surface thereof. The tip member is also provided with an axial chamber 15 that communicates with the inner end of each of the radial passages 14. As shown herein, there are ten axial passages and ten radial passages. The tip 11 and the tube 9 are each made of some metal that is capable of resisting the temperature to which it is subjected. If desired, however, the end of the tip facing the furnace chamber may be protected by a ceramic cap 16, as is shown herein.

Gas is supplied to the burner through a pipe 17 which leads to an annular chamber 18 in the casting 6. Gas is discharged from this chamber through tubes 19 into passages 13 and 14. One end of each of the tubes 19 is in communication with chamber 18, while the other end, as shown, extends into an axial passage 13. One of the supplies of air for the burner comes through a pipe 21 into a chamber 22 formed in the body casting 6. This chamber is in open communication with the interior of tube 9 and the axial passages 13, so that air flowing through this chamber will pass around the tubes 19 and into passages 13 along with the gas from tubes 19. Another supply of air for the burner is provided by a pipe 23 which connects with a central chamber formed by a tube 24 extending between the back casting and the space 15 of the tip 11. Air flowing through this tube 24 is discharged through the radial passages 14 to meet and to mix with the air and gas from passages 13.

Another form which the discharge end of the distributor can take is shown in Figures 4 and 5 of the drawing. In this form, a tip holder 25 is attached to the tube 9 by means of threads 26 instead of being welded thereto, although welding can be used if desired. This tip holder is provided with axially extending passages 27 into which the gas tubes 19 extend as they did in the previously described embodiment. As shown herein, however, the tubes 19 extend considerably further toward the outer end of the axial passages than did the tubes in Figure 2 of the drawing for a purpose which will be described. The tip holder is also provided with a partition 28 that has a plurality of passages 29 formed therein. This partition forms with a tip, to be described, a chamber 31 on the outer end of the tip holder.

A tip member 32 is threaded into the outer end of the tip holder and forms another wall of the chamber 31. This tip, which may be made of metal or ceramic, is provided around its periphery with a plurality of axially extending slots 33 that are equal in number to the openings 29. These slots form, in effect, a plurality of passages through which the air flow in tube 24 is discharged from the end of the burner. The gas and air discharged through the various passages of the burner are directed in a substantially radial direction by means of a cap 34 that is formed on the end of the tip. In this embodiment

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of the invention, as in the previously described embodiment, there are ten of the axial holes 27, and there are also ten of the slots 33 and passages 29. The slots 33 of tip 32 form, in effect, radial passages.

The control system for controlling the supply of fuel and air to the burners is shown somewhat diagrammatically in Figure 1 of the drawing. It is intended that the gas supply be varied in accordance with the temperature of the furnace, and that the air supply be varied in accordance with the amount of gas that is being used. To this end, the temperature of the furnace is measured by a radiation pyrometer 35, for example, that is connected to a temperature control instrument 36 in a conventional manner. This instrument is used to adjust the opening of a valve 37 in a gas supply manifold 38 to vary the supply of gas in accordance with the temperature of the furnace.

Air is supplied to the burners through a manifold 39 which divides into two branches, 41 to supply the air pipes 21, and 42 to supply the air pipes 23 leading to the burners. The supply of air is adjusted by means of a control valve 43, the opening of which is varied by an ordinary ratio controller 44. These controllers, as is well known in the art, measure the pressure differential across an orifice 45 in the gas line and an orifice 46 in the air line to determine the proper amount of air to be supplied for a given amount of gas. The air valve is, therefore, adjusted in proportion to the adjustment of the gas valve, so that the proper amount of air for combustion of the gas will be delivered to the burners.

It is intended, as will be pointed out more in detail below, that the flow of air through the two branches 41 and 42 be substantially equal when the gas valve is opened beyond the predetermined amount. When, however, the gas valve is closed beyond this amount, the branch 41 is substantially shut off, so that substantially all of the air going through the burners will be supplied through branch 42. To this end, there is provided a solenoid operated valve 47 in the branch 41. This valve is controlled in accordance with the pressure in the gas main by means of a pressure operated switch 48 in the latter main. Even when the valve 48 is closed, however, some predetermined percentage of the air can be passed through branch 41 by means of a by-pass 49 around the valve 47. A valve 51 is used to control the amount of air flowing through the by-pass.

In the ordinary operation of the burners at relatively high capacity, equal volumes of air are supplied through pipes 21 and 23. The air flowing through pipe 21 mixes in passages 13 with gas being discharged from tubes 19. This mixture is too rich to burn and forms what is known as a partial premix. The remainder of the air necessary for combustion is supplied by pipe 23 and flows through tube 24 to passages 14. Final mixing of the gas and air in combustible proportions takes place in the passages 14, so that combustion will take place in a plurality of radially directed flames along the surface of cup or depression 4. The surface of the cup is heated to incandescence to transmit radiant heat to the furnace in addition to the convection heat delivered by the hot products of combustion. Backfiring and preignition will not take place in the burner because of the fact that a complete, combustible mixture of fuel and air does not take place until they reach the passages 14, immediately prior to the time the mixture is discharged into the cup to be burned.

As the fuel requirements of the furnace are reduced, temperature controller 36 acts through valve 37 to reduce the supply of fuel. This reduction is detected by ratio controller 44 which acts through valve 43 to reduce proportionately the supply of air, so that fuel and air in combustible proportions will be supplied at all times to the burner.

When the gas flow is reduced to approximately 10% of its maximum value, pressure switch 48 will close to de-energize solenoid valve 47, thus cutting off flow of air

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through pipe 41 except for the small amount flowing through by-pass 49. Valve 51 is adjusted, so that this is substantially 5% of the total air flowing to the burner at this time. Under these conditions, the preponderant mixing of the air and gas starts in passages 14 where the gas from passages 13 meets the air. The air flowing through passages 13 from pipe 21 is insufficient in quantity to have any noticeable effect on the mixing but does serve the purpose of preventing back flow of gas into the burner body and, therefore, any possibility of an explosive mixture forming in the air line.

When operating at high flows, the air has sufficient pressure to carry the gas into the cup for burning. On low flows, however, this pressure is not available. By supplying substantially all of the air on low flows through a single pipe, enough pressure is available to carry the gas into the cup in a satisfactory manner. The present construction also varies the point at which substantial mixing of the air and gas begins. On high flows, mixing begins at the ends of tubes 19, thereby giving a relatively long time. On low flows, the volumes of air and fuel are so reduced that this time is unnecessary. Furthermore, the delayed mixing insures that even at low flows, burning will not occur within the passages thus causing the burner tip to overheat.

The type of gas being used as fuel will determine the extent that tubes 19 project into passages 13. Some gases, such as natural gas, have a relatively slow ignition rate and require a longer time for mixing with the air. When gases of this type are used as fuel, the tubes 19 terminate adjacent to the inlet end of the air passages such as 13 or 27 as shown in Figure 2. Other gases such as coke oven gas with its high hydrogen content have a very rapid ignition rate. When gases of this type are used as fuel, the tubes 19 terminate adjacent to the outlet end of the air passages 13 or 27 as shown in Figure 4. Mixing of the fuel and air in this case does not begin until immediately prior to the time the fuel is discharged from passages 13, otherwise there would be the danger of combustion taking place in the burner passages. The length of tubes 19 determines the time that will be allotted to the mixing of fuel and air. In any event, this time is shortened automatically for low flows.

The provision in the burner and control system of means for shifting the point in the burner at which mixing of the fuel and air can take place, and the effective increase in the pressure of the air by supplying it from one source only, permits a large turn-down ratio. Previously available burners of the general type of those disclosed herein have a turn-down ratio of approximately eight to one. On burners like those disclosed herein that are designed for a capacity of 500,000 B. t. u., per hour, a turn-down ratio of over twenty to one can be obtained. Performance of this type permits a great flexibility in furnace design.

While in accordance with the provision of the statutes, I have illustrated and described the best form of embodiment of my invention now known to me it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed without departing from the spirit and scope of the invention as set forth in the appended claims, and that in some cases certain features of my invention may be used to advantage without a corresponding use of other features.

What is claimed is:

1. In a burner system, the combination of a burner and means to supply fuel to said burner, means in said burner forming a plurality of burner outlets, means to supply air to said burner in a predetermined proportion to the fuel, means to divide the air supply into a plurality of branches prior to the time it reaches said burner and to deliver the air in said branches to said burner, means in said burner upstream of said outlets to bring all of the fuel and the air supply from one branch together at a predetermined point in their path of travel to a place of combustion downstream of said outlets, means in said burner to bring the

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air supply from the other branch together with the fuel at a point closer to said outlets than said first mentioned point, and means responsive to the flow of fuel to discontinue all but a very minor portion of the flow of air through said one branch while the remainder of its supply of air flows through said other branch upon reduction of said fuel supply to a predetermined value.

2. In combination, a burner having means to receive a first air supply and to discharge said first air supply from said burner into a place where combustion occurs, means to receive a second air supply and to keep said air supply separate from said first air supply and including means to discharge said second air supply into said first air supply at a point adjacent to where said first air supply is discharged from the burner, each of said supplies of air being substantially half the total supply when the fuel supply is above a predetermined value, means to receive a supply of fuel and to discharge said supply of fuel into said second supply of air adjacent to the point where it meets said first supply of air, means to direct the discharge of the first supply of air in a radial direction, means to vary the supply of fuel, means to vary both supplies of air so that the total amount of air supplied will produce a combustible mixture with the fuel, and means responsive to the reduction of the supply of fuel to a predetermined amount to cut off all but a very minor portion of the second supply of air and deliver all but said minor portion of the air necessary for combustion to the first supply.

3. The combination of claim 2 in which there is included means to divide the second supply of air and the

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supply of gas into a plurality of streams prior to the point where they meet the discharge of the first supply of air.

4. In a burner, the combination of means forming a plurality of passages for air including a first passage through which air is discharged to a place of combustion and a second passage which discharges into the first passage at a point adjacent to the place of combustion, means forming a passage for fuel which discharges into said second passage at a point adjacent to the point where the second passage discharges into the first, means to supply fuel in variable amounts to said fuel passage to mix first with the air in said second passage and then with the air in said first passage, means to supply air in equal amounts to said first and second passages in a volume proportional to the volume of fuel, and means to stop the supply of all but a very minor portion of air to said second passage and supply all but said very minor portion of the air to said first passage upon reduction of the supply of fuel to a predetermined amount, whereby at that time the fuel will mix with the air in the first passage.

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