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3,061,001

GASEOUS FUEL BURNER

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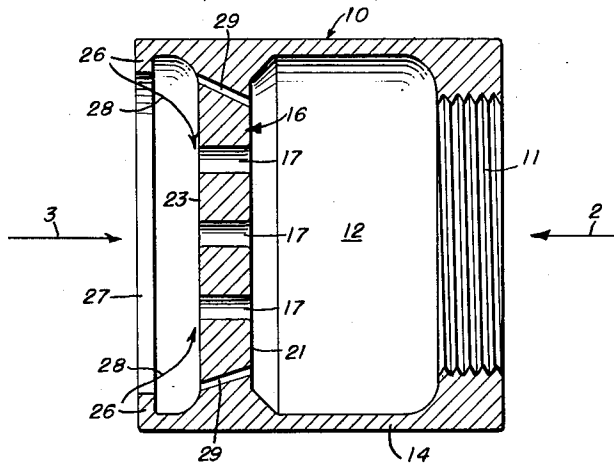


FIG. 1

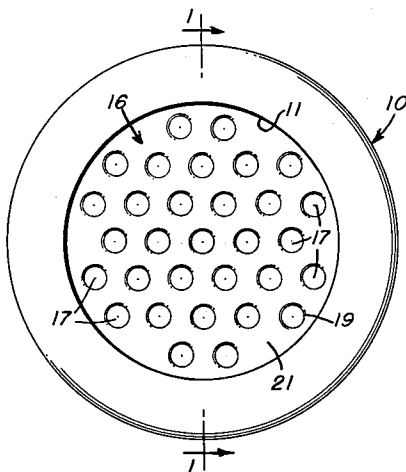


FIG. 2

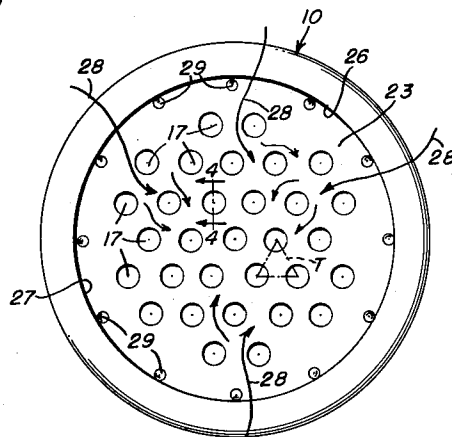


FIG. 3

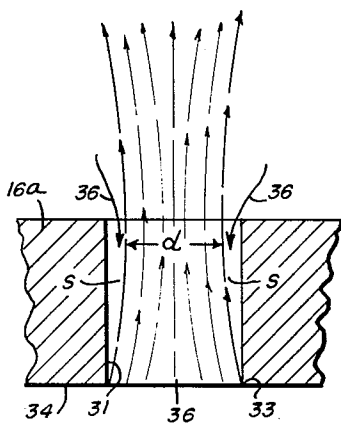


FIG. 5

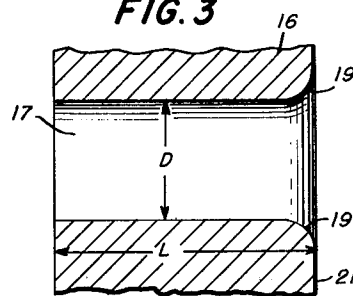


FIG. 4

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1 Claim. (Cl. 158-116)

The present invention relates to a burner for gaseous fuels and more particularly pertains to a burner head or nozzle adapted for promoting combustion of a gas and air mixture and which is so designed as to prevent flashback from the combustion zone into the burner head.

A gaseous fuel formed of a mixture of gas and air which is capable of burning is also explosive and such fuel mixtures have well established rates of flame propagation or well established rates of flame movement through the mass of the gaseous fuel mixture. The rate of flame propagation varies from two to sixteen feet per second according to the nature of the gases which are mixed with air. In theory if the velocity of discharge of a gaseous fuel mixture through an opening exceeds the rate of flame propagation there would be no flashback into the burner head provided that there is a flow coefficient of 1.0 through the discharge opening and when the temperature of the burner structure is maintained below the kindling temperature of the fuel mixture. It is not feasible or possible in manufacturing operations to provide a perfect discharge port or one that provides a flow coefficient of 1.0. It is furthermore not possible to completely avoid an increase in temperature of the burner structure particularly where the discharge ports are provided because of the proximity of such ports to the flame. It is accordingly an object of the invention to provide a burner head with discharge ports each having such a profile at the upstream or entrance end that the flow coefficient of the fuel moving therethrough approaches 1.0 whereby the gaseous fuel mixture substantially fills the entire cross section of each of the discharge ports to thereby avoid space around the jets of gaseous fuel mixture within the ports for entry of the flame from the combustion zone into the upstream portions of the discharge ports thereby avoiding one of the conditions that promotes flashback into the plenum of the burner head.

Another object of the invention is to provide a burner head with means for deflecting air over that portion of the burner head in which the discharge ports are formed so as to reduce the temperature of the burner structure in the vicinity of the discharge ports to thereby avoid another condition which promotes flashback from the combustion zone into the burner head and to provide means in association with the means for cooling of the burner head providing for the maintenance of kindling of the fuel mixture after it has emerged from the discharge ports.

Other objects and features of the invention will be appreciated and become apparent to those skilled in the art to which the invention pertains as the present disclosure proceeds and upon consideration of the accompanying drawing and the following detailed description wherein an exemplary embodiment of the invention is disclosed.

In the drawing:

FIG. 1 is an axial sectional view of a burner head exhibiting invention and taken on the line 1-1 of FIG. 2.

FIG. 2 is an end view of the nozzle taken in the direction of the arrow 2 of FIG. 1.

FIG. 3 is an end elevation of the forward end of the burner head taken in the direction of the arrow 3 of FIG. 1.

FIG. 4 is an enlarged fragmentary sectional view taken on the line 4-4 of FIG. 3 showing the profile of one of the discharge ports.

FIG. 5 is a similar view diagrammatically illustrating a discharge port having a sharp entrance edge.

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The invention is directed to a burner head for gaseous fuel mixtures of the type wherein gas is mixed with the air prior to the arrival of the mixture in the burner head. A feature of the invention pertains to the discharge ports which have a profile at the entrance thereof which during operation avoids constriction of the jets of the fuel mixture escaping therethrough. The escaping fuel mixture substantially fills each port to avoid space within the port into which flame from the combustion zone may creep to thereby prevent flashback. The burner head includes means for deflecting air over the wall in which the discharge ports are formed to maintain the temperature of the wall in which the discharge ports are formed below the kindling temperature of the fuel mixture.

Referring to the drawing there is shown at 10 a burner head or nozzle having a relatively large opening 11 at the downstream end thereof for connection to a fuel supply conduit or the like. A chamber or plenum 12 is formed in the burner head 10 by an annular wall 14 and a dish-shaped wall 16. The gaseous fuel is supplied into the chamber 12 under substantial pressure in excess of five inches of water. The wall 16 has a thickness greater than needed for the pressures involved and in one embodiment has a thickness of three-fourths of an inch.

A plurality of discharge ports 17 are provided which extend through the wall 16. Each port 17 has a length as indicated at L in FIG. 4. The discharge ports 17 are desirably arranged in a pattern with their centers defining equi-lateral triangles one of which is indicated at T in FIG. 3. The diameter D of the ports 17 may vary and in one embodiment the diameter of each port amounts to seven-sixteenths of an inch. The spacing of the discharge ports 17 as shown in FIGS. 2 and 3 is of a substantially constant repeat pattern and they are so arranged that there is a space of not less than 0.8 diameter between the periphery of any one port and the peripheries of adjacent ports.

A feature of the burner head pertains to the shape of the upstream end or entrance of each discharge port 17. Each port is cylindrical shaped throughout a major portion of its length L as shown in FIG. 4. The upstream end of each port 17 has an arcuate profile 19 so that the entrance of each port flares outwardly. The annular arcuate surface 19 in one embodiment is on a one-eighth inch radius when the diameter D is seven-sixteenths of an inch and the total length L of the port is three-fourths of an inch. The annular convex surface 19 merges with the cylindrical portion of the port 17 and the flat upstream face 21 of the wall 16. The cylindrical portion of the port 17 has a smooth finish. Each port 17 has a length diameter ratio of about 1.25.

There is a cooling of the wall 16 in the vicinity of the periphery of each port 17 as a result of the flow of the gaseous fuel mixture from the chamber 12 through the discharge ports. The burner head is provided with means for cooling the wall 16 and maintaining it at a temperature below the kindling temperature of the fuel mixture. The burner head includes means for deflecting air over the downstream face 23 of the wall 16. The forward or downstream end of the burner head 10 carries an annular turned lip 26 having a relatively large central opening or flame port 27 therein. The escape of the gaseous fuel mixture through the ports 17 develops a low pressure condition downstream of the face 23 on the wall 16. Air is thus induced to flow generally radially inwardly in the directions of the arrows 28 (FIGS. 1 and 3). This air flow is between the flame and the face 23 of the wall 16 to cool the wall in which the ports 17 are formed to limit an increase in the temperature of the wall during operation of the burner.

Ignition of the gaseous fuel mixture after escaping

from the ports 17 is maintained by fuel discharged through a plurality of ignition ports 29. These ignition ports 29 are circumferentially spaced about the burner head and are arranged outwardly of the pattern of the discharge ports 17. The axis of each ignition port 29 is inclined radially outwardly in proceeding downstream of the burner head at approximately twenty degrees with respect to the axis of the burner head or with regard to the axis of a discharge port 17. The streams of gaseous fuel escaping through the ignition ports 29 strike the inner edge of the lip 26. The velocity of the streams of the gaseous fuel mixture is thus destroyed and the fuel escaping through the ignition ports burns stably to maintain ignition of the streams of the gaseous fuel mixture flowing from the discharge ports 17. The air flowing in the direction of the arrows 28 inverts into the combustion zone and passes between the flame and the face 23 of the wall 16 to cool this portion of the burner head.

The annular arcuate convex shape as shown at 19 and forming the profile of the upstream end of each port 17 provides for the filling of each port 17 virtually throughout the length L thereof to avoid space at the periphery of each jet within the ports 17 into which flame from the combustion zone may creep and thus avoiding a tendency of the flame to propagate to the fuel mixture within the chamber 12. The advantage of the arcuate profile 19 at the entrance of each discharge port 17 will be further appreciated upon consideration of FIG. 5 wherein a cylindrical shaped discharge port 31 is provided in a wall 16a having a thickness like that of the wall 16. The entrance end of the port 31 provides a sharp annular corner 33 at the upstream face 34 of the wall 16a in which the discharge ports are formed. The gaseous fuel mixture stored in the chamber at the upstream face 34 of the wall 16a and the molecules thereof do not all approach the entrance of the port 31 in the same direction. Some of the molecules of the gaseous fuel move at right angles to the axis of the port 31 and some of the molecules move in directions axially of the port 31. The energy balance between the molecules of the fuel mixture approaching the entrance of the port 31 in radial directions with the molecules approaching the entrance to the port 31 in axial directions causes a contraction of the gaseous fuel stream moving through the port 31 and in a manner as depicted by the phantom lines and arrows in FIG. 5. Thus the sharp annular edge 33 of the entrance end of the port 31 forms a vena-contracta of the fuel stream which has a diameter approximating that indicated at *d* in FIG. 5 which also represents the point of maximum acceleration of the fuel mixture flowing through the port 31. The jet of the fuel mixture having a diameter less than the diameter of the port 31 provides an annular space S between the periphery of the stream of fuel mixture and the internal diameter of the port 31. A discharge port such as shown at 31 having a sharp annular corner at 33 thus provides an annular space S into which the flame from the combustion zone may creep in the direction of the arrows 36 to promote flashback to the fuel mixture stored upstream of the wall 16a.

As distinguished therefrom the annular arcuate profile as shown at 19 in FIG. 4 permits the gaseous fuel mixture to accelerate over this convex edge and through a diameter greater than the diameter D of the main portion of the port 17. The maximum acceleration of the gaseous fuel mixture is attained as the diameter D of the port 17 is reached. Thus there is no vena-contracta and the gaseous fuel mixture virtually fills the area of the port so that no space is provided into which the flame from the combustion zone may creep.

While the invention has been described with reference to specific structural details it will be appreciated that changes may be made in the structure of the burner head and in other arrangements of the discharge ports. Such modifications and others may be made without departing from the spirit and scope of the invention as set forth in the appended claim.

What I claim and desire to secure by Letters Patent is:

A nozzle for the combustion of a gaseous fuel mixture comprising, a hollow burner head and a wall therein providing a chamber into which a gaseous fuel mixture is supplied under pressure, said wall having a plurality of discharge ports therethrough, said wall having a thickness greater than the diameter of each discharge port, each discharge port having a cylindrical shaped surface throughout a major portion of the length thereof, an annular surface defining the portal portion of each discharge port having an arcuate convex shaped viewed in longitudinal section of the associated port with the downstream end portion of said arcuate convex surface merging smoothly with the upstream end portion of said cylindrical surface and with the upstream end portion of said arcuate convex surface emerging smoothly with an upstream face of said wall, an inturned lip carried by said burner head spaced downstream from the downstream face of said wall over which air is guided for movement over the downstream face of said wall, said wall having ignition ports therethrough circumferentially spaced from each other and arranged outside the pattern of said discharge ports, and said ignition ports directing the gaseous fuel mixture escaping therethrough against the upstream face of said inturned lip.

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