Dec. 24, 1968 L. S. SPIELMAN ETAL 3,418,060

NOZZLE MIXING GAS BURNER

Filed May 25, 1967

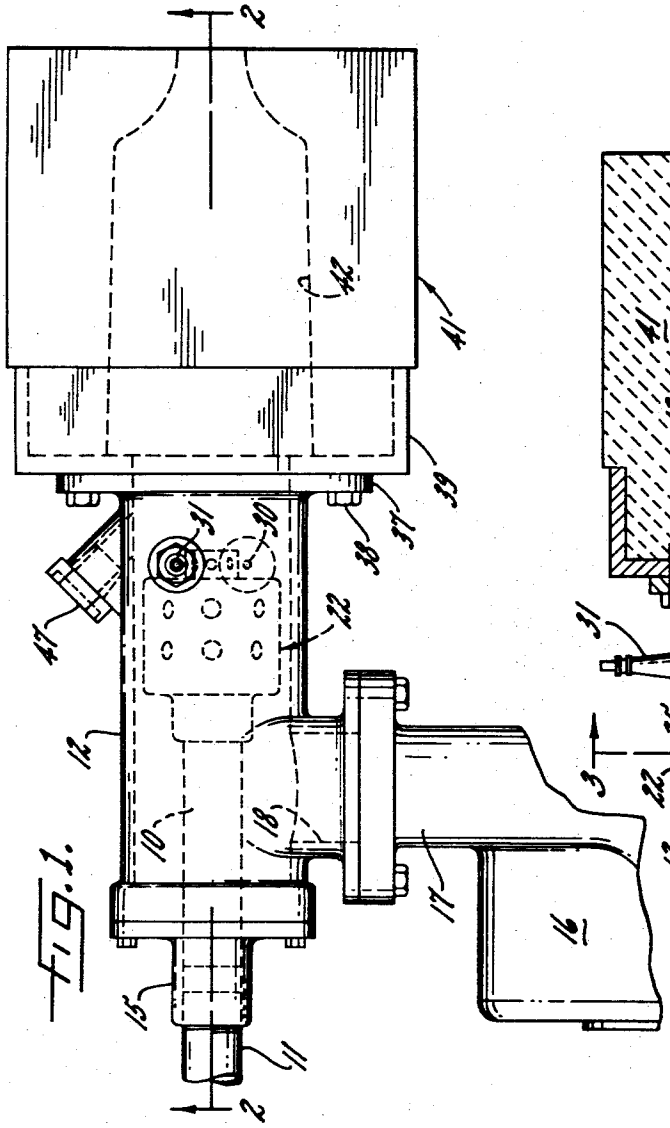


FIG. 1.

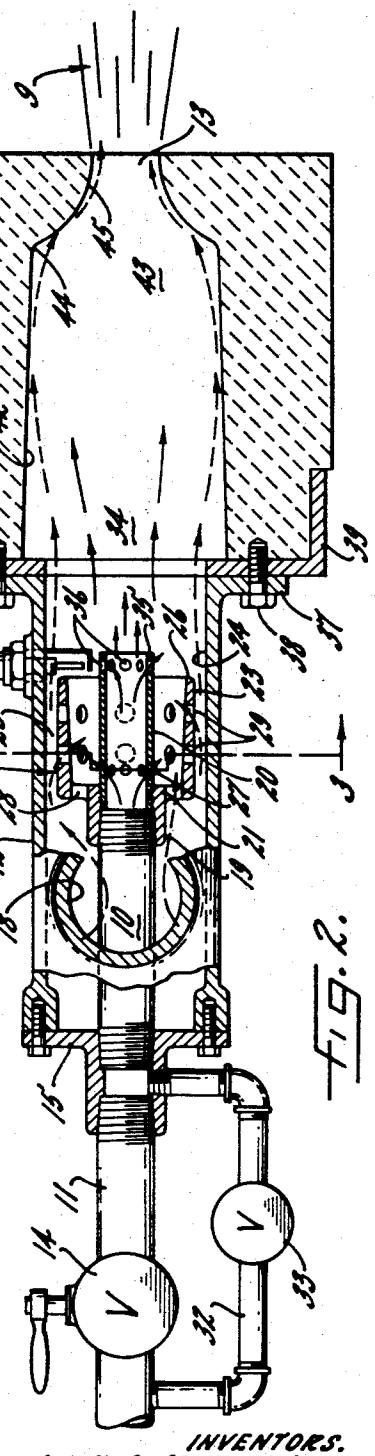


FIG. 2.

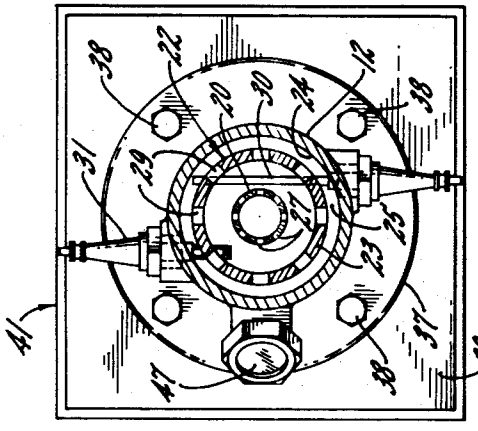


FIG. 3.

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United States Patent Office 3,418,060 Patented Dec. 24, 1968

3,418,060

NOZZLE MIXING GAS BURNER

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Filed May 25, 1967, Ser. No. 641,338
7 Claims. (Cl. 431—158)

ABSTRACT OF THE DISCLOSURE

A gas delivery pipe extends through the closed end and terminates near the open end of a cup which is disposed within and concentric with a tube to which air is delivered so as to be formed into a curtain around the cup and the stream of gas discharged from the end of the pipe. Some of the gas flows out of the pipe through holes and is mixed within the cup with air entering through holes so as to provide a continuing pilot flame. Partial combustion of the remaining gas occurs within the tube beyond the cup and is completed beyond a high velocity nozzle as a result of a necking down of the air tube starting well beyond the cup and leading to a restricted discharge nozzle.

Background of the invention

This invention relates to gas burners in which air and gas are supplied through separate conduits into one end of an elongated tube in which small portions of each are mixed within the inlet end of the tube to form a continuous pilot flame while the remaining air and gas are mixed and ignited within the tube producing an efficiently burning flame discharged from the downstream end of the tube.

Summary of the invention

In the improved burner, air is delivered into one end of an elongated tube and formed into a cylindrical tubular stream by a cup which opens downstream and surrounds a pipe to which gas is delivered into the tubular air stream beyond the cup. Holes around the pipe and cup admit gas from the pipe and air from the stream to form a pilot mixture which burns continuously at different gas flows as adjusted to provide various temperatures of flame discharged from the burner nozzle.

Beyond the cup, the gas delivered from the pipe end picks up air from the surrounding tubular air stream, the mixture continuing to burn along the tube. In approaching the nozzle, the air stream is contracted by converging of the tube wall thus providing an air-gas mixture for most efficient or blue flame burning at the different gas flow rates. The tube wall is shaped to retain the tubular form of the air stream all the way through the nozzle thus preventing objectionable heating or erosion of the tube wall.

Brief description of the drawings

FIGURE 1 is a side view, on a one-third scale, of a gas burner embodying the novel features of the present invention.

FIG. 2 is a fragmentary section taken along the line 2—2 of FIG. 1.

FIG. 3 is a section taken along the broken line 3—3 of FIG. 2.

Description of the preferred embodiment

The invention is shown in the drawings incorporated in a nozzle mixing burner comprising an inner tube **10** into which gas is delivered at one end through a pipe **11** and air is forced through a surrounding outer tube **12** to provide at all rates of gas flow a continuously burning pilot within the inlet end of the tube and an efficiently burning and high velocity blue flame **9** discharged from a nozzle **13** at the downstream end of the tube. A valve **14**, adjustable manually or automatically, is interposed in the gas supply pipe **11** which is threaded into a fitting **15** clamped against the inlet end of the air tube. A power driven blower **16** delivers air to the tube at the desired rate, the air being conducted through a pipe **17** into an opening **18** in the side of the tube adjacent the fitting **15**.

Within the air tube shortly beyond the inlet **18**, the gas tube **10** projects through and is secured in a flange **19** projecting from the bottom **21** of a cup **22** having a cylindrical wall **23** somewhat smaller in diameter than the tube **12** and cooperating with the cylindrical internal wall **24** thereof to form a passage **25** of sufficiently narrow thickness, one-fourth of an inch in the present instance, and of sufficient length to convert the air delivered through the opening **18** into a stream of tubular form, indicated by the dotted arrows in FIG. 2, and direct such stream in such form along and well beyond the open end **26** of the cup and substantially to the nozzle **13**.

The gas delivered through the pipe **10** flows through an extension **20** within the cup and part is allowed to escape outwardly through holes **27** in the extension as indicated by the solid arrows in FIG. 2 and to mix within the cup with air forced in through holes **28** angularly spaced around the cup bottom and holes **29** in the side of the cup. The latter holes are arranged in annular series axially spaced apart and disposed beyond the gas holes **27**. The mixture thus formed within the cup may be ignited by sparks formed at the open end of the cup across the electrodes of a spark plug **31**. Initially, gas for the pilot mixture is admitted to the tube **10** through a pipe **32** including a valve **33** and connected at opposite ends to the pipe **11** and in parallel with the main regulating valve **14** which is maintained closed until the pilot mixture has been ignited. The spark plug and the rod **30** of a flame detector project into and are mounted in the outer tube **12** so as to be disposed immediately beyond the open end **26** of the cup.

The gas tube **20** projects as shown a short distance beyond the open end **26** of the cup **22** and is open at this end so that the major part of the gas delivered through the pipe is discharged into a zone **34** of the tube disposed beyond the open end of the cup. Preferably and just short of its end **35**, the gas tube **20** is formed with an annular series of holes **36** which permits some gas to flow outwardly toward the advancing tubular curtain and initiate the formation of a gas-air mixture which is ignited by the pilot flame.

The metal part of the outer tube **12** terminates in an outturned flange **37** axially spaced a short distance beyond the open end of the cup and clamped by screws **38** to a ring **39** telescoped around one end and supporting a relatively thick walled tube **41** composed of refractory material. Herein the internal wall **42** of this tube is somewhat larger in diameter than the tube **12** and extends a substantial distance, about seven inches in the present instance, beyond the end of the metal tube. The refractory tube thus enlarges somewhat and extends the preliminary mixing area to provide for progressive intermixing of the adjacent portions of the advancing tubular air stream and central gas stream over the substantial length of the cylindrical ceramic wall **42**. In the zone **34** and continuing on substantially through the zone **43** defined by the cylindrical refractory wall **42**, the mixture contains an excess of fuel and therefore burns with a yellow flame.

The present invention contemplates the provision of means near the discharge nozzle **13** for increasing at a rapid rate the proportion of air in the air-gas mixture

so as to establish approximately stoichiometric proportions near or beyond the end of the nozzle and therefore optimum combustion efficiency and a blue flame as the products of the combustion are discharged from the nozzle. Such mixing action is achieved by decreasing the diameter of the mixing zone **43** commencing at the end **44** of the cylindrical ceramic wall **42** by a necking down or inwardly tapering of the refractory as indicated at **45** to the discharge nozzle. The diameter of the nozzle is determined by the discharge velocities desired being, in the present instance, about one-third that of the ceramic wall **42**.

The inwardly converging wall **45** not only deflects and contracts the oncoming tubular stream of air inwardly toward the nozzle but also intercepts the straight-forward flowing central air-gas stream and thus induces enough turbulence near the nozzle to cause additional air to be mixed with the available gas so as to provide for optimum efficiency of combustion as evidenced by the blue flame appearing beyond the nozzle opening. This desirable action takes place at all of the varying rates of gas flow resulting from adjustment of the valve **14** to vary the volumetric rate of gas delivery into the supply pipe **10** and thereby vary correspondingly the temperatures of the excess air and products of combustion as discharged from the nozzle.

In accordance with another aspect of the present invention, the converging baffle surface **45** is spaced axially far enough from the open end **26** of the cup **22** to avoid any danger of the resulting turbulence within the ceramic tube from being reflected backwardly and extinguishing or otherwise affecting the continued operation of the pilot flame developed as above described within the cup **22**.

Because of the length and narrow radial width of the passage **25**, the air delivered into the tube **12** is formed into a tubular curtain which advances at high velocity along the tube wall **24** and the refractory extension **42** thereof. Throughout this advance, the tubular form of the air stream is retained thus insulating the walls **24**, **42** from the high temperatures developed within the combustion zones **34**, **43**. The refractory material is thus protected effectually against erosion in spite of the high velocities of flow along the wall.

Such protection of the refractory material is extended over the entire area of the nozzle wall **45** by proper contouring of this wall to maintain the tubular form of the advancing air stream as it is contracted due to the convergence of the nozzle wall. For this purpose, the wall not only tapers inwardly but the slope or angle of convergence of the taper decreases progressively from about 60 degrees near the intersection with the cylindrical wall **42** to zero bear the outer end of the nozzle opening. The resulting contour is similar to part of an air-foil section and thus facilitates air flow in changing the direction to contract the stream while maintaining a layer of air at all times over the entire area of the wall.

In operation, the blower is started to deliver air at the rate required for maximum gas flow and flame temperature, for example 5200 c.f.h. for a burner of the size indicated. With the valve **14** closed, the valve **33** is opened to supply gas for the pilot flame. After ignition as observed through a peep opening **47**, the valve **14** is opened progressively to deliver gas through the pipe **20** at the rate required to produce the desired velocity and temperature of the products of combustion. The latter burns efficiently for all rates of gas flow and appears as a blue flame discharged from the nozzle.

With a burner constructed as above described and of the size indicated, it has been found that with air delivered into the tube **12** at 5200 c.f.h. and gas supplied at the rate of 43 c.f.h., the velocity of the flame discharged from the nozzle **13** will be approximately 10,500 ft./min. By increasing the gas supply to 520 c.f.h. while maintaining the same rate of air flow, the flame velocity is increased to about 27,000 f.p.m. Thus, by adjusting the valve **14** alone, any desired flame velocity and temperature may be obtained.

The burner constructed as above described possesses numerous advantages in addition to those enumerated above. First, a separate pilot is not required since a stable pilot flame is developed and maintained within the cup **22**. Secondly, high discharge velocities are attained without the necessity of setting and maintaining specific air-gas ratios. The burner is relatively insensitive to variations of the air-gas ratio and therefore is not subject to the pulsating normally associated with systems in which the flame is discharged into a tube submerged in water. Spark ignition and flame safety devices may be extended through the metal instead of the refractory parts and disposed in proper positions relative to the pilot flame.

We claim:

1. A nozzle mixing gas burner having, in combination, an elongated outer tube closed at one end and having a generally cylindrical inner wall, means for delivering air into said tube through an inlet at said closed end, a generally cylindrical and shallow cup mounted within said tube and opening downstream with the closed bottom of the cup disposed adjacent and downstream from said inlet, said cup being centered within the tube and somewhat smaller in diameter than said wall so as to cooperate therewith in forming the incoming air into a stream which is of narrow radial thickness and remains in tubular form in flowing along said wall beyond the cup, a gas supply pipe having a flow regulating valve therein and extending into the closed end portion of said tube and axially through said bottom to the open end of the cup, holes angularly spaced around said cup and said pipe within the cup and allowing for the escape of gas from the pipe and the flow of air inwardly to provide within the cup at all rates of gas flow a combustible mixture adapted to burn continuously and form a continuous pilot, said pipe being open at its downstream end so as to deliver the remainder of the gas supply into a preliminary air-gas mixing zone within said tubular air stream, the internal wall of said tube being substantially cylindrical for a substantial distance beyond the open end of said cup, and a wall at the downstream end of said cylindrical wall converging inwardly and progressively to a central discharge nozzle substantially smaller in diameter than said tube wall, said end wall acting to contract said tubular air stream rapidly around the advancing gas stream to effect rapid final mixing of the air and gas into proper proportions to produce efficient combustion in and beyond said nozzle irrespective of the prevailing rate of supply of gas to said pipe.

2. A gas burner as defined in claim **1** in which said converging end wall is spaced downstream from said cup a substantial distance sufficient to prevent turbulence developed in the air-gas mixing adjacent said nozzle from extinguishing the pilot flame within said cup.

3. A gas burner as defined in claim **1** in which the angle of convergence of said converging wall decreases progressively from a maximum adjacent the downstream end of said cylindrical wall.

4. A gas burner as defined in claim **3** in which said decrease in the angle of convergence of said converging wall is such as to maintain a layer of air covering the wall all the way to the discharge opening of said nozzle.

5. A gas burner as defined in claim **1** in which said gas pipe extends beyond the open end of said cup and beyond such end is formed with an annular series of holes that permit some of the gas supply to flow outwardly toward said tubular air stream.

6. A gas burner as defined in claim **1** in which the cross-sectional area of the opening in said nozzle is about one-third that of said tube within said cylindrical wall.

7. A gas burner as defined in claim **1** in which the interior of said tube, said converging wall and said nozzle, starting at a point shortly beyond said cup, are com-

posed of refractory material the surface of which is covered by the air of said stream all the way through said nozzle.

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U.S. Cl. X.R.

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