May 12, 1931. P. J. J. ANDRIEUX 1,805,066

GAS BURNER OR NOZZLE

Filed April 23, 1929 2 Sheets-Sheet 1

Fig. 1

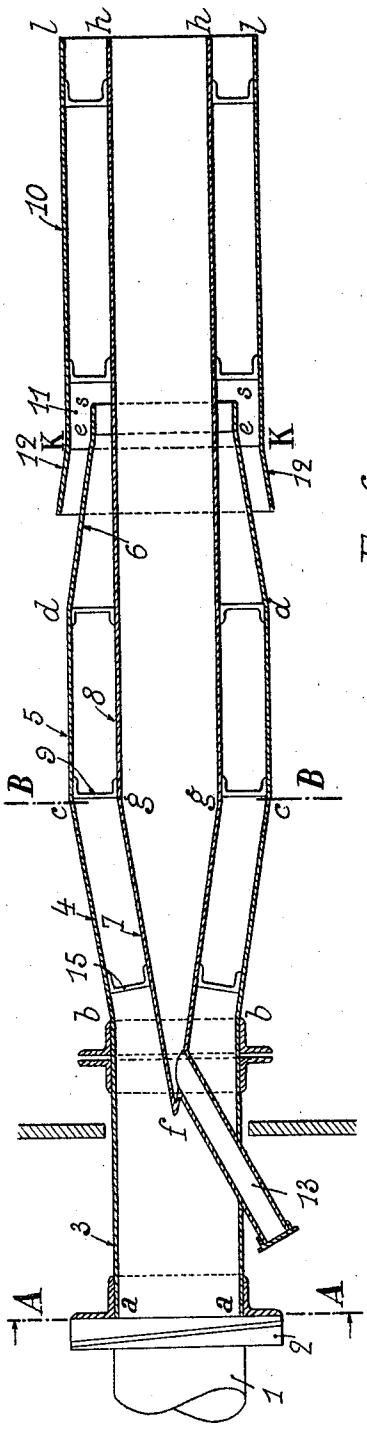


Fig. 6

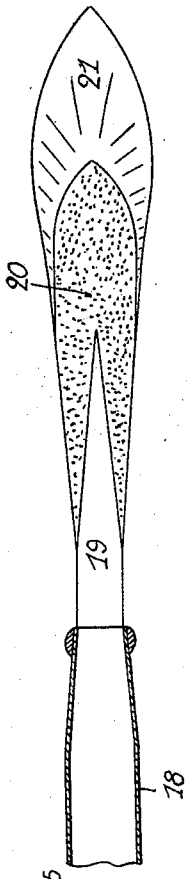


Fig. 3

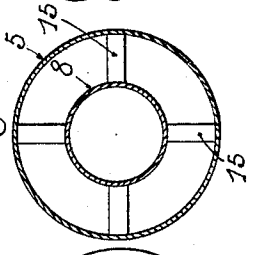
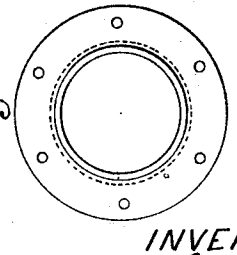


Fig. 2



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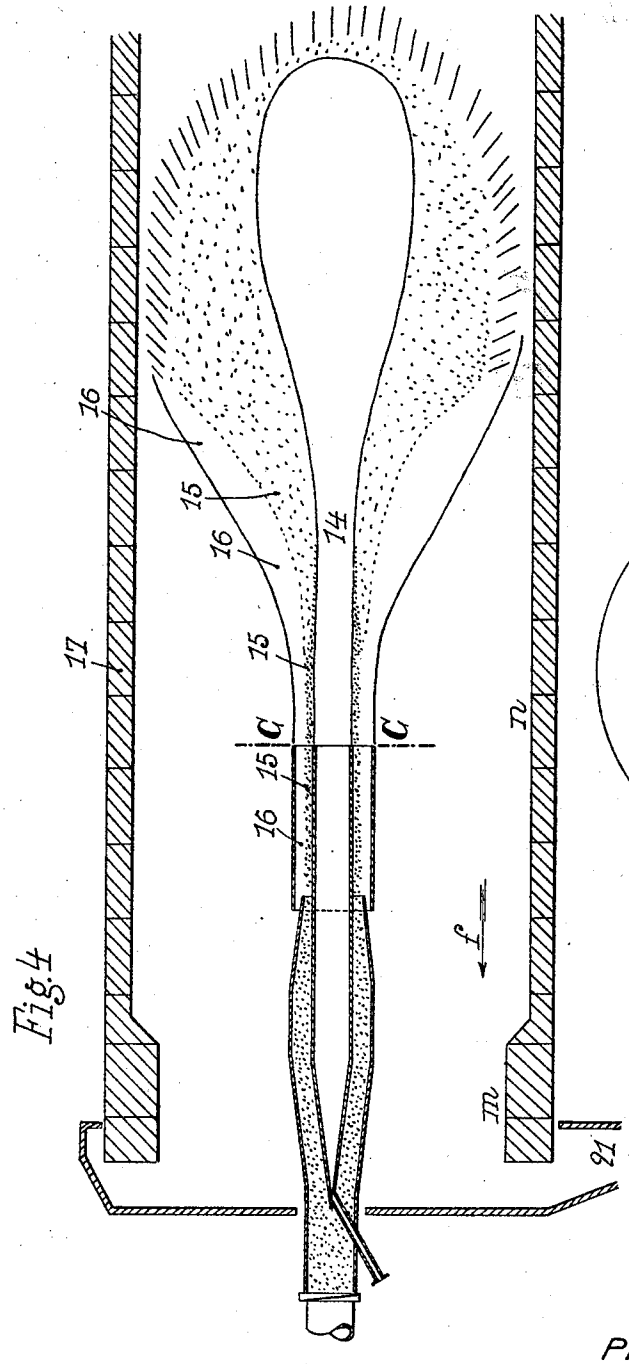


Fig. 4

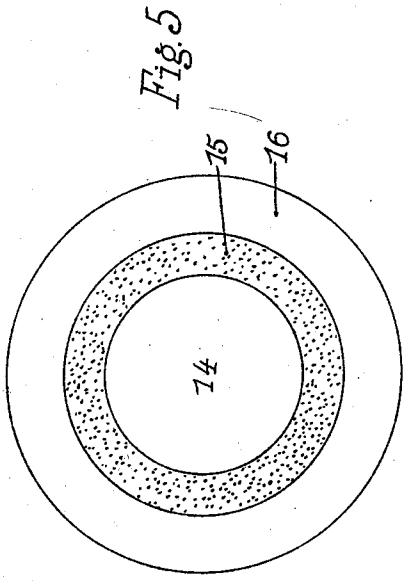


Fig. 5

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UNITED STATES PATENT OFFICE

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GAS BURNER OR NOZZLE

Application filed April 23, 1929, Serial No. 357,534, and in France May 2, 1928.

The present invention relates to gas burners or nozzles adapted for the combustion of a mixture of hot or cold air or oxygen, or like gas, and a combustible consisting of finely powdered solid fuel, or of a liquid or gaseous fuel, and more particularly to burners of the type comprising a central core.

One object of the present invention is to provide a burner of the above mentioned type which will afford a perfect combustion throughout the whole thickness of the flame; another important object is to obtain a flame of ellipsoidal shape without high heated axial point and in which the region of the strongest combustion is at the exterior; a further object resides in the provision of means whereby the diameter and the length of the flame may be easily varied at will.

In the appended drawings, which are given solely by way of example:

Fig. 1 is a diametrical and longitudinal section of a burner according to the invention.

Fig. 2 is an end view of the device shown in Fig. 1 according to the line A—A.

Fig. 3 is a cross section, perpendicular to the longitudinal axis of the burner, on the line B—B of Fig. 1.

Fig. 4 is a sectional view of the end of a furnace, such as a cement furnace, showing the disposition of the burner and the shape of the flame obtained with the burner in conformity to the invention.

Fig. 5 is a cross section on a larger scale on the line C—C of Fig. 4, of the jet or fuel mixture issuing from the burner.

Fig. 6 is a diagrammatic view showing the flame obtained with the known burners having a simple jet.

In the construction shown in Figs. 1, 2 and 3, the whole amount of the fuel is supplied to the cylindrical conduit connecting the burner to a blower (not shown) which delivers a high pressure blast. A joint with inclined surfaces 2 serves to adjust the direction of the nozzle.

The said blower delivers to the conduit only a part of the air necessary for the combustion, which will be designated as primary air, this air being also adapted to produce an energetic stirring and mixing of the fuel and to provide for a high speed when issuing from the burner or nozzle.

The said burner comprises a cylindrical part 3 in the region $a\ b$ extending from the said conduit supplied by the blower. At the end of said cylindrical part 3 is a tapered sheet metal chamber which has a funnel shape at the part $b\ c$ and is cylindrical at the part $c\ d$, then having an inverted funnel shape at 6 at the part $c\ e$, this being followed by a cylindrical part $e\ s$ of a few centimeters length. In the combined device 3, 4, 5, 6, is disposed a solid or hollow internal core which is tapered at 7 at the part $f\ g$, and is cylindrical at 8 outwardly of g, as far as the outlet h of the burner or nozzle. The said core is secured in position by the cross members 9.

The said device is completed by a cylinder 10 concentric with the cylinder 8 of the central core. Into the said cylinder 10, which extends as far as l or to the outlet of the burner, is inserted the tapered part 6, allowing between the latter and the base k of the cylinder 10 a space 11 for the admission of an additional supply of air (secondary air). The cylinder 10 is preferably terminated by a tapered part 12 whose function will be further specified.

The operation of the said blast nozzle is as follows:

The mixture of fuel and primary air is supplied to the cylinder 3, and at f the mass of gas forms a hollow cylinder whose wall is thick at the part $b\ c\ d$ and becomes thinner at the part $d\ e$ corresponding to the converging part 6 of the nozzle. During its flow in $b\ c\ d\ e$ the gas undergoes from b to c a change of direction, speed and form, thus producing a whirling motion by which the mixture of fuel and primary air is well stirred.

The progressive reduction of the flow section in the part $d\ e$ results in a continuous increase of the speed of said mixture, and this attains its maximum at e at the outlet of the tapered part b, thus forming a hollow cylinder, and due to its great speed, this will preserve its shape for a relatively long distance after issuing from the nozzle.

After the point s, the mixture of fuel and primary air moves along the cylindrical wall

8 at a reduced thickness and without being separated from the said wall 8, due to the action of the flow of fluids upon walls.

The secondary air required for the combustion of the said mixture of fuel and primary air is admitted at 11. The high speed of flow of the gas issuing from *s* will cause the suction of the secondary air, this being furthered by the tapered end 12 of the cylinder 10. This air may be either hot or cold, and in particular it may be heated by contact with hot material which is being cooled in a cold part of the furnace, or in a separate cooler employed with the furnace.

The cylindrical chamber 8 ending in the tapered part 7 (should a hollow core be used) can be supplied with hot or cold air through the pipe 13 by means of a blower or the like.

Due to the aforesaid construction, the cylinder of gas discharged from the end of the burner will not be homogeneous, but is in fact heterogeneous and comprises three distinct regions, surrounding the longitudinal axis of the nozzle (Figs. 3 and 5).

A.—The central region has the form of a cylinder of air 14 if air is injected into 17, or otherwise a vacuum will be formed.

B.—At the periphery of the said cylinder of air 14 is situated a thin cylindrical layer 15 consisting of fuel and cold primary air.

C.—A cylinder of secondary air is formed at 16, this being hot or cold; it is in line with the nozzle and forms the outer region of the gas stream discharged by the nozzle.

With the said nozzle, which enters for a relatively long distance into the furnace 17, due to its great length, the combustion takes place as follows: The cylinder of air 16 becomes heated by radiation from the walls of the furnace, and it expands when it enters the heated furnace chamber, the expansion being greater as the jet proceeds farther from the nozzle, and this constitutes around the cylinder 16 which is formed of a mixture of fuel and cold primary air an envelope of a very hot oxidizing gas which greatly furthers the combustion of the mixture of fuel and primary air as well as the outward spreading of the flame perpendicularly to the axis of the burner.

After the air 16 has been heated, the gas cylinder 15 consisting of the mixture of fuel and primary air is in turn heated at its outer part, and this becomes ignited at a certain distance from the nozzle, the combustion then progressing through the mass, and spreading throughout the entire mass within a short time, the thickness of the layer of gas being small and its surface which receives heat by radiation from the chamber being large.

The gases resulting from the combustion of the primary mixture expand with great force and seek to spread and to complete their combustion. They encounter at the exterior an environment which is well adapted for this purpose, that is, the region of hot air 16.

In the interior, on the contrary, the central cylinder of air 14 remains at a lower temperature until the gaseous mass is in complete combustion; since the temperature of this air is lower, it does not further the spreading of the flame to the interior, and on the other hand the expansion of this air when in contact with the flaming gas will tend to remove the gaseous mass charged with combustible substance, and hence the region of combustion, from the axis of the nozzle.

In practice, the apparatus affords a flame of ellipsoidal form and without a highly heated axial point, in which the region of the strongest combustion is at the exterior, as compared with the nozzle of the current type 18 having a simple jet in which the flame has the form shown in Fig. 6 comprising three regions, firstly a region 19 in the interior which is without brightness and comprises the mixture of fuel and air which does not burn, since the action of the radiation from the exterior fails to heat this mixture sufficiently to allow it to burn; secondly, a region 20 in which the combustion progresses, by successive contact, from the exterior towards the axis of the flame, this being a region of incomplete combustion having reducing properties; thirdly, a region 21 situated at the point of the flame and on the axis, in which the gas attains its complete combustion in a highly heated environment.

It is obvious that in the gas burner, the subject-matter of the invention, the diameter of the flame in a plane perpendicular to the axis can be regulated, since the flame can be shortened while its diameter increases, this effect depending directly upon the mount of secondary air supplied at 11 and upon the temperature of this air.

This adjustment can be made chiefly by the use of the tapered part 12 whose displacement varies the intake section 11, and the flame can thus be regulated to obtain a great thermic efficiency both by radiation upon the material and by direct contact between the flame and the material to be heated.

The invention is obviously applicable to all nozzles or gas burners.

The secondary air may be heated by the use of any desired system for the recovery of hot gas and air, whether directly by the suction of the burner or nozzle, or indirectly.

The said invention is chiefly applicable to the revolving furnaces employed in metallurgy, or in the cement or the chemical industries, or the like. In such cylindrical or cylindro-conical furnaces, the flame from the said burner will proceed along the walls of the furnace and it thus makes contact with the material to be heated and with the walls of the furnace.

In such furnaces, when a region of maxi-

mum temperature is followed by a region in which the material is cooled, such as the region *m n* of Fig. 4, the burner provides for the recovery of a part of the heat withdrawn by this material, by the use of the secondary air which circulates, before it enters the nozzle or burner, around the said material in course of cooling.

The said burner permits, and chiefly in the revolving cement furnaces in which finely powdered coal is burned, eliminating all air in excess of the quantity actually required for the combustion. In such furnaces, which comprise a cooling device (not shown) which is supplied through one or more conduits 21 with the material circulating in the furnace in the direction of the arrow *f*, a considerable amount of air is admitted into the furnace by the said cooling device and the conduit or conduits 21, and this air, after recovering the heat given off by the material while cooling, enters the front part of the furnace in which it becomes gradually heated by its contact with the material proceeding from the heating region towards the said cooling device. This heated air attains the region of the burner, and then reaches the flame. With the known burners, it is observed that the major part of this air passes around the flame between its outer wall and the lining of the furnace, since the flame produced by an ordinary burner has a small diameter and a great length on the axis of the burner and the furnace, and it is thus at some distance from the wall of the furnace.

The burner according to the invention offers the following advantages. On the one hand it distributes by automatic suction in the burner around the mixture of fuel and primary air the major part of the air heated by recovery and facilitates the complete combustion of the elements, and on the other hand it produces a flame of large diameter which occupies nearly the whole of the section of the furnace as far as its wall.

The air used in the recovery of heat, when proceeding from the head of the furnace and attaining the region of combustion, encounters the flame which thus constitutes an obstruction, since this flame extends to the wall of the furnace, and hence the whole of the hot air recovered is utilized for the complete combustion. In practice, the supply of primary air is regulated according to needs in order to obtain the complete combustion without excess of air, this regulation depending upon the analyses of the gas issuing from the furnace. The diameter of the cylinder 10 is made such that the optimum quantity of hot air will be supplied to the burner, and this affords a complete combustion with a minimum amount of air, thus reducing the heat losses due to the discharge of the gases of combustion. This reduced amount of air corresponds to a reduced quantity of the powdered material drawn forward by the gases of combustion by reason of the reduced speed of said gases, thus facilitating the utilization of the waste heat in the recovery boilers.

Obviously, the said invention is not limited to the form of construction herein described and represented, which is given solely by way of example. For instance, the jacket for the circulation of the fuel mixture may be replaced by a set of unit nozzles or tubes surrounding a central core of the same length as before and parallel to the longitudinal axis, and each unit tube comprises an ejector for secondary air. The ejector herein represented may be replaced by any other ejector serving the same purpose, without departing from the principle of the invention.

Having now described my invention what I claim as new and desire to secure by Letters Patent is:

1. In a process for burning gaseous, liquid or powdered solid fuel, the steps consisting in blending fuel with a fluid supporting combustion, in forming said mixture into an annular and substantially cylindrical layer having thin walls with respect to its diameter, in imparting to said mixture a high velocity while thoroughly guiding same, in surrounding said layer with an external sheath of fluid supporting combustion formed into a substantially hollow cylinder, the inner diameter of which is substantially equal to the outer diameter of said layer and so guided that it will come tangentially into contact with said layer, and in guiding both said annular layer and sheath in contact with one another, while substantially preventing them from mixing together, whereby they will be able to flow through a surounding heated medium while substantially keeping their cylindrical shape and without burning till the outer sheath will be sufficiently heated by the surounding medium.

2. In a process as claimed in claim 1, regulating at will the quantity of fluid supporting combustion contained in the outer sheath, whereby varying at will the stroke which both the sheath and layer are capable of performing in direct contact with the surrounding heated medium before the combustion takes place.

3. A burner comprising in combination an elongated tubular body connected at one end with means for supplying thereinto a flow of a mixture of fuel and fluid supporting combustion, a core axially disposed within said body and defining therewith an annular space through which the whole amount of said mixture is caused to flow, said core extending into a substantially straight and cylindrical surface projecting greatly ahead of the outlet of said body, the outer diameter of said cylindrical extension being smaller than the inner diameter of the body outlet, a substantially cylindrical tube coaxially disposed

with said core and surounding at a distance the projecting part of said core, the inner diameter of said tube being greater than the inner diameter of the body outlet and means for supplying a fluid supporting combustion into said space between the core and the surrounding tube, so as to form a substantially annular sheath coming tangentially into contact with the annular cylindrical layer of mixture issuing from said tubular body, the end of the straight and annular channel defined by the projecting part of the core and the tube surrounding it forming the outlet of the burner.

4. A burner as claimed in claim 3, comprising means whereby the amount of fluid supporting combustion supplied into said straight and annular channel may be varied at will.

5. A burner as claimed in claim 3, wherein said elongated tubular body comprises first a cylindrical part adapted to be connected at one end with said mixture supplying means and extending at the opposite end into a tapered part of increasing cross-section itself prolonged by a second cylindrical part merging into a second tapered part of decreasing cross-section, the latter ending into a third cylindrical portion of small length, and wherein the core has a tapered closed end in register with said first tapered part of the tubular body, the arrangement being such that the flow section through the annular space in this region will be greater than the flow sections through said supplying means and adjacent the outlet of said tubular body.

In testimony whereof I have signed my name to this specification.

PIERRE JULES JUSTINIEN ANDRIEUX.