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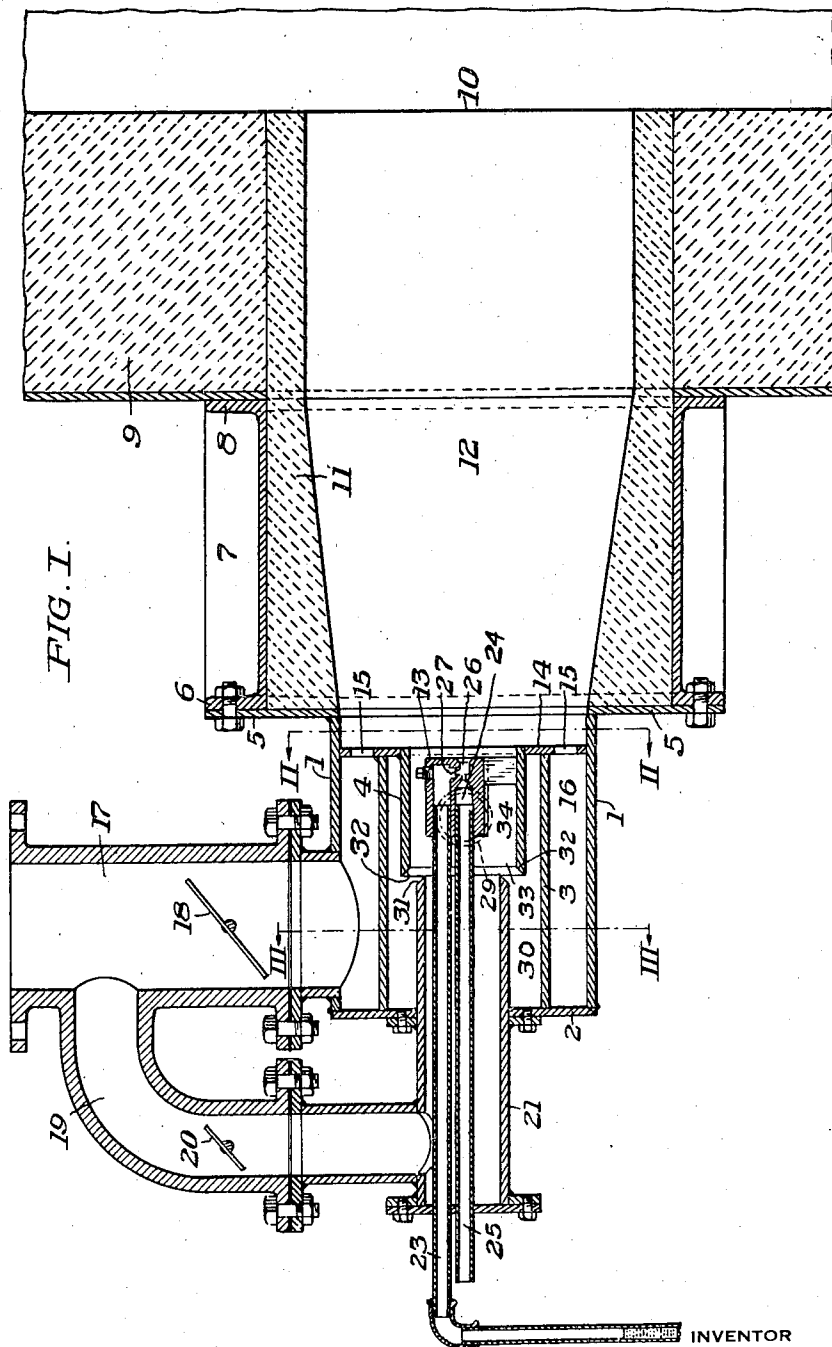
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LOW VELOCITY OIL AND GAS BURNER

Filed Nov. 16, 1944

2 Sheets-Sheet 1



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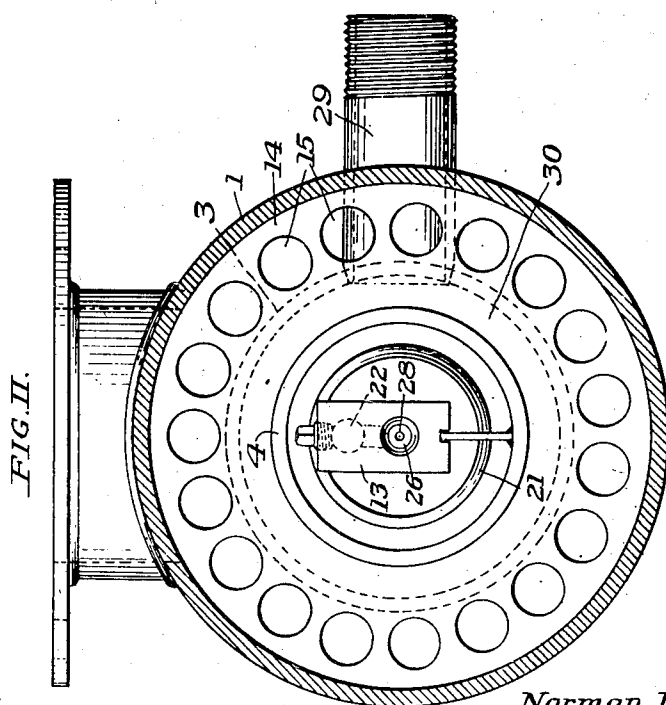
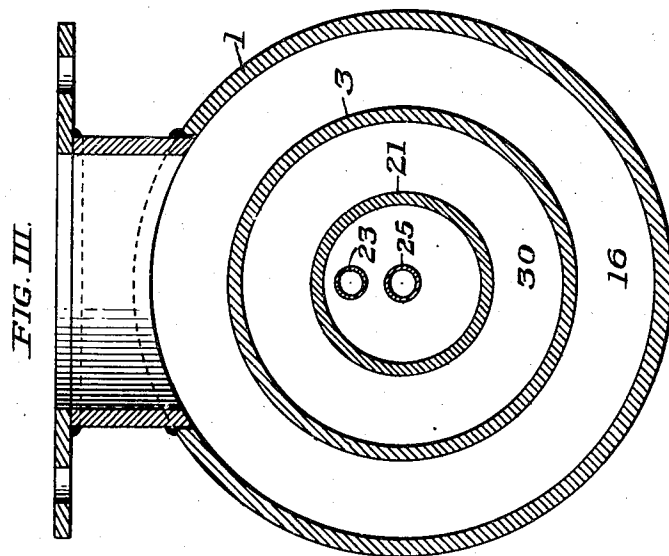
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UNITED STATES PATENT OFFICE

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LOW VELOCITY OIL AND GAS BURNER

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Application November 16, 1944, Serial No. 563,685

3 Claims. (Cl. 153—11)

1

This invention relates to a combination oil and gas burner and particularly to a combination oil and gas burner having advantageous features when used in conjunction with furnaces of various sorts.

It is a primary object of my invention to combine an oil and gas burner which, when used either with oil as a fuel, gas as a fuel, or using gas and oil simultaneously, is capable of furnishing a low velocity luminous flame composed of an unstratified blend of gases; in which the type of flame and the atmosphere created by the burner in the enclosed space of a furnace is under control; and in which the combined fuel and air volume delivered to the burner may be varied within wide limits and the type of flame and atmosphere created by the burner combustion may be varied without departing from the low velocity of the combustion flame and without loss of its high luminosity.

In attaining these objects I depart from the usual principles of burner construction by an arrangement which avoids rapid flame movement and which does not utilize the principles of pre-mixing the combustion air and fuel or of multi-stage combustion. On the contrary my burner is so arranged that whether oil, gas, or both of those fuels be used, mixing takes place within the combustion areas of the burner and is begun in the rearward portion thereof under the heating effect of an initial supporting flame of substantial heating value. Also, the oil or gas providing the fluid fuel consumed in the burner is so introduced with relation to the supporting flame and additional air is so supplied with respect to both that mixing in the combustion areas of the burner is effected at an early stage under the influence of cracking conditions and conditions which produce a high rate of molecular movement of the several gases with complete and uniform mixing thereof. Thus as used with either oil, gas, or both of them as its fuel, the burner creates and supplies throughout a wide operating range an unstratified blend of reacted and unreacted gases, with such early cracking and rapid and complete commingling that as delivered to the furnace it gives therein a highly luminous condition and an atmosphere which is proof against oxygen slippage, and which therefore does not bring substantial quantities of free reactive oxygen into contact with the furnace charge. Considering a prime utility of the burner, this effect is of great value in metallurgical furnaces in which the effect of the furnace atmosphere in producing oxidation of the fur-

2

nace charge is a matter of primary importance.

Also, as indicated above, the combustion rate and heat output of the burner may be varied within wide limits without causing stratification, without producing high velocity of flame movement and without loss of luminosity. Thus it is possible to control combustion by regulating the volume of the fuel and total air supply to the burner to vary the heat output of the burner and the atmosphere created in the furnace, while retaining throughout different orders of combustion the desirable burner and furnace conditions which have been noted above.

In the accompanying drawings illustrative of my invention:

Fig. I is a longitudinal sectional view through a combination oil and gas burner organization embodying the principles of my invention;

Fig. II is a cross-sectional view through the burner taken in the plane of the section line II—II of Fig. I;

Fig. III is a cross-sectional view through the burner taken in the plane of the section line III—III of Fig. I;

Considering both that portion of the structural organization of the burner as shown in the accompanying drawings which applies both to its use as an oil burner and as a gas burner, the burner comprises an outer shell having a peripheral wall 1 and a rear closure wall 2, an inner shell having a peripheral wall 3 and a gas ignition tube 4. At its forward end the wall 1 of the outer shell is flanged and has connected to its flange 5 the flange 6 of an adapter shell 7. This adapter shell 7 has a forwardly presented flange 8 which is welded or otherwise suitably secured to the wall 9 of a furnace to surround a port 10 of the furnace wall. Within shell 7 and port 10 there is a refractory lining 11 which abuts rearwardly against flange 5 of the burner shell proper and extends forwardly into the port 10 of the furnace wall, to bound a combustion tunnel 12.

In the inner shell of the burner and within gas ignition tube 4 there is a nozzle 13 from which oil is projected with compressed air or steam of moderately high pressure. Surrounding nozzle 13 and inner shell there is a flange 14 extended between wall 3 of the inner shell and wall 1 of the outer shell. This flange 14 is provided with a series of ports 15 arranged to deliver air from chamber 16 lying between walls 1 and 3 of the outer and inner shells. These ports 15 desirably are, as shown, extended through the complete annular extent of flange 14 and are equidistantly spaced therein.

3

Air is supplied through an air inlet duct 17, having therein a butterfly valve 18 which opens directly into secondary air chamber 16, which may be considered an extension of the duct 17. A branch air duct 19 provided with butterfly valve 20 opens into a primary air supply tube 21 arranged concentrically within the inner shell of the burner. The chamber 2 which may be considered an extension of the primary air duct 19, and the air introduced by branch inlet duct 19 to the interior of air supply tube 21 may be considered primary air, inasmuch as it supports combustion in a film of oil or envelope of gas to provide primary combustion in the form of an inner supporting and heating flame. The peripheral wall 1 and the rear wall 2 define a casing.

It will be convenient now to consider the burner as operating solely with oil as a fuel and then to note the likeness and differences in burner operation if the fuel be gas or if both oil and gas be used. It will thus initially be taken that the primary air surrounds a film of oil delivered by nozzle 13 to provide the primary supporting and heating flame. The total combustion air is supplied at relatively low pressure, such as a pressure of from about .5 pound per square inch to 1.5 pounds per square inch in a suitable manner as by the action of a low pressure fan. It is to be noted that this air supply, introduced under relatively low pressure to provide low velocity burner operation, constitutes in practical effect the entire air supply depended on for combustion, no additional air being drawn or forced into the burner to support the burner flame at different stages in progressive combustion of the fuel.

Secondary air issues into tunnel 12 through ports 15 around the inner flame comprising primary air and a film of oil from the nozzle. In the primary flame the oil is carried by and surrounds the jet of compressed air or steam, and the compressed air or steam expanding as it issues from nozzle 13 carries the oil in a conical oil film, which mixes with the surrounding primary air to produce the initial supporting flame. In proper operation of the burner, primary air must be insufficient to approximate complete combustion of the fuel, but must be sufficient to produce with the fuel a primary flame of substantial heating value. It may be explained that with the oil broken up in the nozzle and carried as a film on the expanding cone of compressed air or steam there is an interior flame in which combustion is substantially complete and which is surrounded by the secondary air and by excess fuel. The primary flame is a clear, smokeless and relatively non-luminous flame; and its central portion in which combustion is substantially complete insures against its extinguishment under the exigencies attendant upon practical use of the burner.

It thus is to be understood, and this is an important feature in the operation of my burner, that the primary flame above described not only serves as a pilot and combustion supporting flame, but that it has of itself sufficient heating value to raise the interior of tunnel 12 and its bounding refractory surface to a high temperature. Secondary air, which in the proper operation of my burner is supplied in volume sufficient to take part at least substantially in the combustion, is heated by radiant heat from the surface of combustion tunnel 12 immediately upon its entry into the tunnel, as well as by heat directly received from the primary flame.

4

In operating my burner the supply of primary air, fuel and secondary air are all adjusted to give a primary flame of desired characteristics and such adjustment readily may be made initially by observing the primary flame itself. That is, fuel and primary air supply may be adjusted until a clear flame of substantial size and obviously high heating value has been obtained. Desirably this primary flame is allowed to burn with a relatively small supply of secondary air until the wall of the combustion tunnel has been brought to a relatively high temperature, and at such stage the supply of secondary air is gradually increased until a very bright luminous flame moving forwardly at low velocity is seen to be entering the furnace from the tunnel. At this point it is frequently desirable to make some compensatory relative adjustment between primary air and secondary air to get the exact desired combustion conditions.

The effect of proper burner operation, which is described and specifically illustrated in my companion application Serial No. 563,684, filed November 16, 1944, gives the desired condition referred to above. Let it be assumed that the burner is operating with both butterfly valve 18 in secondary air duct 17 and butterfly valve 20 in primary air duct 19 fully open. This provides a proportioning of primary air and secondary air substantially in accordance with the cross-sectional areas of primary air duct 19 and secondary air duct 17. Desirably, though not necessarily the ratio between the cross-sectional areas of these ducts is such as of itself to approximate optimum proportioning of primary air and secondary air with both butterfly valves fully open.

The rapidly expanding conical film of oil supported by the interior jet of compressed air or steam and reacting with the primary air, gives a primary flame of substantial size. Under its heating effect, and the heating effect of radiation from the tunnel wall there is a rapid expansion of both the primary and secondary air accompanied by vaporization and cracking of the oil and expansion of the gases produced thereby.

The expansion, incident to the heating and cracking, exerts an expanding pressure against the wall of the combustion tunnel which forces the secondary air inwardly as primary air and fuel expand outwardly. The secondary air being introduced under low pressure, the expansion produces transverse mixing rather than accelerated forward motion. This action is the one which primarily gives the advantageous results produced by the burner.

The actual effect produced by heating the gases in this rearward region of the combustion tunnel thus is one of rapid molecular motion by which the gaseous substance of the secondary air moves inwardly and the gaseous substance of the primary flame, including the primary air and the gaseous products of vaporization and cracking of the oil, moves outwardly. In movement forwardly of the tunnel this blending progresses to such extent that the gaseous mixture, comprising both reacted and unreacted gases, is unstratified and is of approximately uniform composition throughout its entire volume. This unstratified blending of the gases persists when the gaseous blend issues into the work chamber of a furnace.

The fundamental action in tunnel 12 is thus the production of a fine and uniform blend of air and cracked oil vapors, in which combustion has in some measure taken place; together with the pro-

5

duction of high luminosity in such gaseous body moving at low velocity through the tunnel. Apparently this fundamental effect obtains without reference to the degree to which combustion takes place in the gaseous blend. I believe that the high luminosity of the flame is due to the uniform distribution of a great number of incandescent carbon particles in the blended gases.

In many prior art burners this effect is obtainable for one combined volume of fuel and air and within a very narrow range of total fuel and air supply. It obtains throughout a very wide range of total air and fuel supply in operating my burner, as above described. That is, the total air and fuel supply may be cut to a very low point without destroying the function of the primary flame in heating the air and fuel in such manner as rapidly to produce an unstratified uniform gaseous blend. There is of course a point at which it is impossible to maintain an adequate heating effect of the primary flame, but such point is low beyond that at which any one reasonably might desire to cut down the heat output of the burner.

This effect of the burner in providing a uniform and apparently molecular blending of the gases is of great advantage when the burner is used with metallurgical furnaces. In most such furnace operations, such as those conducted in heating, heat treating, melting and bath furnaces for iron and steel, it usually is desirable to avoid oxidation of the furnace charge. It has been the experience of the art that even though the furnace atmosphere may contain less than a sufficiency of oxygen for complete combustion, there is a tendency for the occurrence of what is known as oxygen slippage. That is, the oxygen of the combustion air tends to separate from the other gases of the furnace atmosphere and to gravitate to the lower regions of the furnace chamber in direct contact with the furnace charge. It is an observed fact that even when sufficient combustion air is provided to complete combustion the blended gases delivered by my burner are substantially proof against such oxygen slippage, so that there may be high heat delivery in the furnace and the furnace charge may be brought to a desired high temperature with minimum scale formation.

It should be emphasized that uniformity in the gaseous blend and an unstratified luminous flame is provided by the burner throughout a wide range in the combined volume of air and fuel and thus throughout wide variation in the rate of combustion. The proportioning of fuel, primary air and secondary air having been established, the volume of fuel and total air then can be adjusted to the desired temperature conditions without in any substantial degree altering the condition of the burner gases and the furnace atmosphere. Thus the furnace temperature may be raised, lowered, or maintained, regardless of heat absorption by the charge, without disturbing the luminosity of the flame and without disturbing the blending which prevents scale formation in the furnace.

In certain furnace operations it is desirable to provide an oxidizing atmosphere in the furnace. One example of such condition exists in soaking pits, in which a close adherent scale on the ingots, or other soaking pit charge, tends toward heat insulation and improvement in the desired effect of the soaking operation. In such case, without increasing the velocity of the flame, and without loss of luminosity therein, I am able to provide in the furnace an oxidizing atmosphere of the sort to form a fine adherent scale on the soaking pit charge. This I do merely by increasing the vol-

6

ume of total air supplied to the burner, without disturbing the ratio between primary air and secondary air, to give a gaseous blend, otherwise identical with that previously described, which contains an excess of oxygen. As so used my burner gives a scale formation of superior sort on the furnace charge, inasmuch as the effect of the oxidizing atmosphere is uniform in its contact with the charge because of the maintenance of a blended atmosphere in the work chamber of the furnace.

It is to be understood, as is specifically illustrated in my above-identified companion application, that my burner not only may be operated to give an effect unobtainable in prior art burners, but if so desired it may be operated to give an effect usual in many prior art burners. If the total air be directed either wholly or excessively into chamber 16 and through ports 15 as secondary air, the effect will not be that above described as attendant upon a proportioning of the primary and secondary air supplies.

Thus if butterfly valve 20 in the primary air duct 19 be completely closed, and butterfly 13 in the secondary air duct 17 be completely open the total air supply is delivered to the burner as secondary air. Under such conditions the primary flame is supported only by such air issuing from ports 15 as mingles with the expanding oil film from nozzle 13, and the major proportion of the air supply of the burner passes forwardly through tunnel 12 to give a stratified as opposed to a blended gaseous mixture therein. Although the primary flame is itself short and of substantially lesser heating value than the flame which is obtained if primary air be supplied, this condition produces a long secondary flame burning within and progressively mixing with an outer envelope of secondary air. The tendency thus is to introduce into the work chamber of a furnace a stratified atmosphere which is not controllable as is the blended atmosphere obtained in the optimum operation of my burner, and is an atmosphere in which oxygen slippage occurs. With combustion of this sort there is only one specific combined volume of fuel and air which produces a luminous flame and in which approximate ultimate blending in the furnace atmosphere is obtainable. With higher and lower total air-fuel volumes to give a greater or lesser heat output, stratification always occurs. An extreme example of this effect is obtained by multi-stage combustion in which secondary air is progressively added along the length of a central flame.

Another operation of the burner simulating that of prior art burners, and which condition is illustrated in my above-identified companion application, takes place if the total air supply to the burner be directed wholly or excessively as primary air. In such case butterfly valve 18 in secondary air inlet 17 may be assumed to be wholly closed and butterfly valve 20 in primary air inlet duct 19 may be assumed to be fully open. With this apportionment of the air supply the primary flame is the only flame produced in the burner. That flame begins at a point substantially forward of the jet nozzle. It is a roaring flame in which the air and the atomized oil are in stratified condition, there being no effective initial cracking of the oil or blending in the composition. With a flame of this sort it is impossible to obtain complete combustion without subjecting a furnace charge to the effect of uncontrolled free oxygen. It is therefore a fact that in burners capable of operating only in this man-

ner it is impossible to obtain a high heating effect while avoiding oxidation of a metallurgical charge, or to control oxidation in such manner as to effect it in desired sort and order.

Specific exemplary means for introducing oil in finely atomized condition and in such manner as to form an expanding conical film of oil, comprise the nozzle 13, which has therein an oil chamber 22 communicating with oil inlet duct 23, and jet chamber 24 communicating with a duct 25 leading to a source of compressed air or steam. A relatively small vacuum chamber 26 is in communication with oil chamber 22 by way of port 27 and with chamber 24 for air or steam by way of port 28. Desirably, as shown, both port 27 and port 28 are of relatively small caliber; the port 28 for compressed air or steam being of lesser caliber than port 27, and port 27 being arranged to discharge downwardly into chamber 26 at right angles to the direction in which the jet of compressed air or steam is directed.

In this nozzle, air or steam entering chamber 26 by way of constricted port 28 expands and in expanding creates at the rear of the chamber a vacuum which draws in oil through port 27. This oil is broken up and carried along by the jet of compressed air or steam. As the air or steam jet continues to expand upon issuing from the nozzle, a thin film of the oil projected with it is carried radially outward by the expanding air or steam. This film is in good condition for cracking under the heat of its own combustion and the radiant heat from the wall of combustion tunnel 12. It thus contributes to the desired effect of rapid molecular motion and blending with the primary combustion air and the secondary air, to give the cracked and blended gaseous mixture which is desired.

It is to be understood that the nozzle shown and described is exemplary of nozzles of different specific structure capable of delivering oil in a thin film carried by an expanding stream of air or steam, suitable to form the unstratified blend incident to the proper operation of my burner. It is important that the nozzle of the burner be so arranged with respect to the flow of primary air that the oil being expanded outwardly in the tunnel of the burner is surrounded by the primary air so that there is combustion substantially back to the burner nozzle itself; to give in this region a flame of substantial heating value which, by its direct heat and by radiant heat from the wall of the tunnel, is capable of creating and maintaining in that region a temperature sufficiently high to produce cracking and rapid molecular motion.

It will be observed in Fig. 1 of the drawings that the primary air stream which is supplied through primary air tube 21 and which passes through gas ignition tube 4, surrounds nozzle 13, exerting a cooling effect on the nozzle and itself taking up heat as it enters the burner tunnel around the jet from the nozzle. The arrangement also is such that the primary air which supports combustion in the primary flame rapidly comes in contact with and blends with the film of oil from nozzle 13. It is desirable to avoid carbon formation against the wall 3 of the inner shell by bringing nozzle 13 out approximately to the line of flange 14 in which secondary air ports 15 are placed.

In order to equip the burner to use combustible gas instead of oil as its fuel, there is a gas inlet duct 29 in communication with gas chamber 30 lying between the walls of gas ignition tube 4 and air inlet tube 21 and the wall 3 of the

inner shell. This gas inlet duct 29 is to be connected to a source of suitable combustion gas under moderate pressure such as a pressure of from .5 pound to 1.5 pounds per square inch. When the burner is operated with gas, the gas entering chamber 30 receives heat from the wall of gas ignition tube 4 and enters the interior of that tube at the rear thereof. The forward edge 31 of primary air supply tube 21 and the rearward edge 32 of gas ignition tube 4 are oppositely chamfered to provide an annular gas inlet passage 33 directed obliquely inwardly and forwardly of the chamber 34 in the ignition tube.

In chamber 34 of gas ignition tube 4 the gas mixes sufficiently with primary air entering the chamber from air supply tube 21 to give combustion within the chamber. The major proportion of the gas however, moves forwardly along the interior surface of tube 4 issuing as a relatively thin compact envelope, or film, surrounding the inner flame. In this operation the primary air and the combustible gases are expanded by the heat of the combustion sufficiently to impart to the primary flame and the combustible gas a definite forward propulsion.

On issuing from gas ignition tube 4 into combustion tunnel 12 expansion of the gases continues. There is thus produced an expanding cone of burning primary air and gas which carries the unburned gas outwardly in substantially the same manner which has been described with respect to a film of oil from nozzle 13. Thus, in the same manner as when the burner utilizes oil as its fuel, there is substantially complete combustion in the inner or primary flame and the fuel is carried radially outward in the same manner for commingling with the secondary air. Thus the conditions established in the combustion tunnel 12 are substantially identical with those described above when the burner is utilizing oil as its fluid fuel.

It should be noted that gas ignition tube 4 is relatively short, so that there is no smothering effect therein because of the insufficiency of the primary air. The burner may be used with gas with its various elements in the position shown in Fig. 1 of the drawings, and in such condition it is found that the presence of nozzle 13 does not interfere with the action in chamber 34 to produce the primary flame. The combustion in chamber 34 does however, ultimately destroy the nozzle, and it is therefore desirable to remove the nozzle and its connections when it is proposed to operate the burner solely with gas as the fuel.

It is, however, possible to operate my combustion burner simultaneously with both oil and combustible gas. In such case all the primary air is delivered into the chamber 34 of ignition tube 4 by primary air tube 21. Additionally to primary air there is used also a jet of compressed air or steam for projecting and filming the oil.

Under these circumstances the primary combustion comprises the oil film which is projected from nozzle 13 as an expanding cone. Combustion of the gas being effected in chamber 34 of the ignition tube, the flame thus produced surrounds the oil film and the supply of primary air desirably is made sufficient to burn at least some oil of that film. An envelope of preponderantly unconsumed combustible gas also is present in an expanding condition around the central flame.

I have observed that the primary flame produced by this conjoint combustion appears iden-

tical with the primary flames produced when either oil or gas alone is used as the fluid fuel. There is apparently, however, some intensified heat output of the primary flame as compared with the primary flame produced solely by oil or gas and some acceleration in the blending of the gases from the primary combustion with the secondary air of the burner. An advantage in primary combustion conditions is obtained by the heating effect of the nozzle which itself becomes highly heated and radiates heat to the primary air and gas within ignition tube 4. A disadvantage of such conjoint operation is, however, the above noted destructive effect of high temperature on the burner nozzle.

It is to be understood that if gas, or both gas and oil, are used as the combustible fluid of the burner, the same general regulation and apportionment which has been described above with respect to the sole use of oil should still be followed in order to obtain the advantageous combustion conditions possible in operation of my burner.

I have found it impossible to give critical relative dimensions for most of my burner elements because such proportional relations vary with different sizes of burner. It can, however, be said that combustion tunnel 12 should be of such bore diameter that the inner surface of its wall closely surrounds ports 15 which deliver the secondary air. This is in order that such wall may be highly heated by combustion in the tunnel and so that secondary air is prevented from expanding outwardly and flowing along the tunnel wall to give a stratified tunnel atmosphere. In other words, the bore diameter of the tunnel should not be so great as to defeat the desired blending action which has been described above. The length of the tunnel should be adequate to provide complete blending of the gases therein before delivery of those slowly moving gases to the work chamber of a furnace.

I have found no fixed critical relation between the diameter and length of the combustion tunnel and the ratio between the diameter and length of the tunnel will vary with burners of different size and low velocity capacity. A simple consideration of the requisites will give an appropriate length of the tunnel for any size burner, it being understood that at least the rearward portion of the tunnel wall should closely surround the secondary air ports.

Certain desirable characteristics of my oil burner may be further explained. It will have been noted that in practical entirety combustion air is introduced in the low velocity air stream which is divided into the primary and secondary air. If compressed air rather than steam be used to provide a jet for carrying the film of oil, such compressed air which is of negligible volume takes no substantial part in the combustion. The low velocity of the gases permits combustion of the sort which has been above described and avoids stratification in a furnace with which the burner is associated as well as in the burner itself.

It is to be noted that the burner does not use the impingement principle to obtain cracking and blending. That is, the burner does not direct a rapidly moving gaseous body against a refractory surface, such as the wall of a furnace, so to utilize the heat thereof as to crack the fuel. It thus avoids the uncertainties of operation, erosive effect and other undesirable effects of impingement burners. As is seen in the drawings, the arrangement of secondary air ports, gas ignition

tube and jet nozzle is coaxial. This avoids the possibility of angularly directing the flame, to cause bodily impingement against the wall of the combustion tunnel.

Although my burner has been specifically described as used in metallurgical furnaces its utility is not limited to furnaces of that sort. Its various advantageous properties give it definite utility in furnaces of various sorts and for general heating use in which a low velocity flame of high heating value is desirable. In all its variant uses there is great advantage in the fact that the combined volume of fuel and air utilized by the burner, and consequently the combustion rate and heating effect, may be varied within wide limits without changing the flame characteristics or composition.

Having shown and described one physical embodiment of my invention both with respect to the burner and with a respect to method of combustion appropriate to its use, I wish it to be understood that my invention is not limited to the specific physical and operational details given herein, but that the scope of my invention is to be limited only by the statement of the claims appended hereto.

I claim as my invention:

1. The herein described method of producing a low velocity, luminous, unstratified combustion atmosphere comprising the steps of projecting a high velocity expanding gaseous jet within an expansion restraining heat-radiating bounding surface, supplying fuel oil to the outer surface of said expanding gaseous jet, substantially surrounding said expanding mixture of oil and gas with low velocity primary air and substantially surrounding said primary air with low velocity fuel gas, said primary air being sufficient to support combustion of a portion of said fuels, igniting and burning a portion of the said fuels and thereby producing a primary flame of high heating value, thereby highly heating said bounding surface by said primary flame, and surrounding the said primary flame with low velocity secondary air, whereby the heating effect of the primary flame and the heat radiated from said bounding surface produces cracking of the excess of said fuels and restrained expansion of the several gases including the primary air, the secondary air and the cracked fuels.

2. A low velocity oil and gas burner comprising a chambered forwardly opening casing, a secondary air inlet duct including a chamber of said casing and having a forwardly directed opening therefrom, a combustion tunnel comprising a refractory wall surrounding the forward opening of said secondary air inlet duct and extending forwardly of the casing, a gas ignition tube within the said casing and opening in the forward end thereof, a primary air inlet duct to deliver primary air at the rear of said ignition tube, a gas inlet duct and a connection therefrom for introducing fuel gas between said primary air inlet duct and said ignition tube, means for directing said gas in an annular stream around the primary air in the ignition tube to issue into the said combustion tunnel as combustible gas on an expanding core of fire of substantial heating value, and a fluid projector structure in the said ignition tube, said projector structure comprising a duct for high pressure gaseous fluid arranged to discharge a jet of gaseous fluid adjacent the forward opening of the said ignition tube, means for supplying high pressure gaseous fluid to said duct therefor, an

11

oil duct communicating with said duct for high pressure gaseous fluid to supply oil on the stream of gaseous fluid in the duct therefor adjacent the forward end thereof and supply oil to the outer surface of an expanding gaseous jet into the said combustion tunnel to give with the surrounding primary air a primary core of fire blending with the low velocity secondary air, the said refractory wall of the combustion tunnel being in direct heat exchanging relation with air and fuel issuing from said openings.

3. A low velocity oil and gas burner comprising a chambered forwardly opening casing, a secondary air inlet duct including a chamber of said casing and having a forwardly directed opening therefrom, a combustion tunnel comprising a refractory wall surrounding the forward opening of said secondary air inlet duct and extending forwardly of the casing, a gas ignition tube within the said casing and opening in the forward end thereof, a primary air inlet duct arranged to deliver primary air at the rear of said ignition tube, a gas inlet duct and a connection therefrom for introducing fuel gas between said primary air inlet duct and said ignition tube, means for directing said gas in an annular stream around the primary air in the ignition tube to issue into the said combustion tunnel as combustible gas on an expanding core of fire of substantial heating value, and a fluid projector structure in the forward opening of said ignition tube, means for supplying said fluid projector structure with high pressure gaseous fluid, said fluid projector structure including means to supply oil to the outer surface of an expanding gaseous jet into the said combustion

12

tunnel to give with the surrounding primary air a primary core of fire blending with the low velocity secondary air, the said refractory wall of the combustion tunnel being in direct heat exchanging relation with air and fuel issuing from said openings.

NORMAN J. URQUHART.

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