

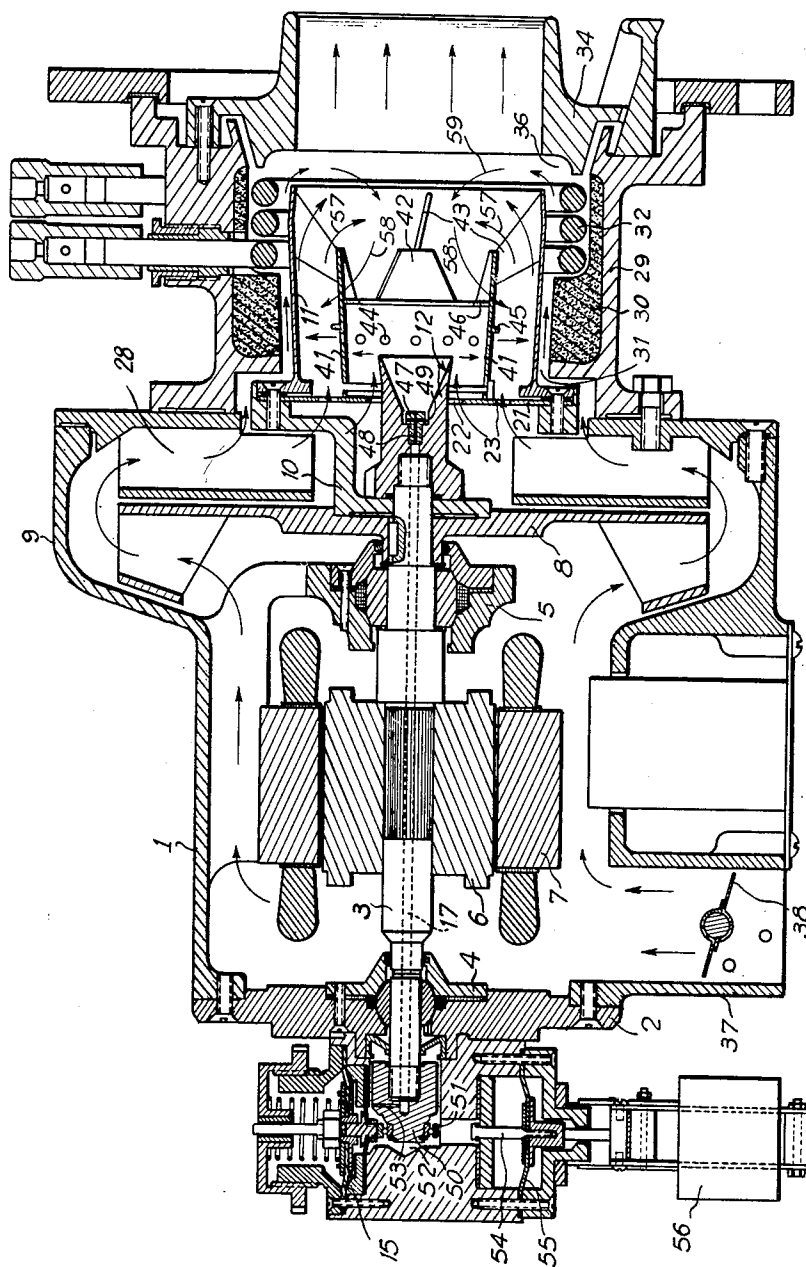
Feb. 20, 1962

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3,021,892

BURNER APPARATUS

Filed Jan. 7, 1959



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3,021,892

BURNER APPARATUS

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Filed Jan. 7, 1959, Ser. No. 785,535

9 Claims. (Cl. 158-77)

This invention relates to an improved burner device capable of being fed with any suitable type of fuel including both liquid and gaseous fuels, and one that will be useful with various types of thermal apparatus where high-temperature combustion gases are to be generated.

More particularly, this invention relates to improvements in burners of the type comprising a combustion chamber mounted for rotation within a burner body, means rotatably driving said chamber and means for directing a combustible mixture against the internal wall surface of the chamber.

With such an arrangement, as the combustion chamber revolves, a film of fuel forms which coats the inner wall surface of the chamber, the depth of such film depending on the rotational velocity of the chamber with respect to the air, assuming a given (more or less smooth or rough) surface condition of the wall. Since the body of air within the chamber tends to revolve with the latter, the relative velocity of the air with respect to the wall is comparatively low and the fuel film therefore has a comparatively large depth or thickness. The combustion occurs within this film and such surface combustion imparts great stability to the "flame front" in the apparatus.

Moreover, centrally of the chamber a vacuum is created due to the action of centrifugal force and this creates a recycling movement of the gas in the chamber, from the center outward. This recycling action in turn generates vortices which promote stability and uniformity of the flame and facilitate pre-ignition of the fuel mixture when the burner is started up.

The means used for discharging the fuel mixture against the inner wall of the combustion chamber, may desirably comprise a cup-shaped feeder member rotatable with and disposed axially of the chamber and having a fuel inlet conduit connecting with it. An air inlet conduit connects with the combustion chamber outwardly of the feeder cup.

In accordance with an aspect of this invention, the burner includes two combustion chambers coaxially mounted one within the other and bodily rotatable with each other. The two chambers may be interconnected by way of fins or blades extending at a relatively small angle to the burner axis, e.g. 10 to 15°. The inner chamber may be made shorter axially than the outer chamber, and its trailing or outlet edge may be cut out into fingers or castellations each of which is connected by way of a blade with the outer chamber. An auxiliary air inlet duct may be provided connecting with the outer combustion chamber near the outlet of the latter, and a fixed furnace tube may be provided in association with the combustion chamber and as an extension of it.

The combustion chamber may be surrounded with a heating element such as an electric resistance. To start the burner, it then is simply necessary to energize such heating element, start rotation of the combustion chamber and deliver fuel into the chamber. This fuel vaporizes as it contacts the chamber wall and the fuel vapor is ignited at the outlet from the chamber. The resulting flame is drawn into the center of the chamber by the vacuum present thereat and rises up through the chamber thereby heating the combustion chamber wall. The auxiliary heating means may then be deenergized.

In order to ensure reliable ignition without danger of

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misfire, means may be provided for injecting into the combustion chamber an amount of fuel prior to ignition of the burner. A pilot flame can thus be produced which will ensure the ignition of the combustible mixture when the burner is started in operation.

An exemplary embodiment of the burner device according to the invention is described hereinafter for purposes of illustration but not of limitation with reference to the accompanying drawing showing an axial sectional view of the burner device.

Referring to the drawing in detail, it will be seen that an improved burner apparatus embodying the invention comprises a casing 1 sealed at its rear end by an end plate 2 and containing a shaft 3 journaled in bearings 4 and 5. Secured on shaft 3 is the rotor 6 of an electric motor the stator 7 of which is secured in the casing 1 by suitable means. Also secured on the shaft 3 is the turbine rotor 8 of a fan or blower including a spiral casing 9 formed as an extension of the casing 1. Secured on the shaft 3 beyond the turbine 8 are spider arms 10 supporting a combustion chamber 11 presently described, as well as a flared cuplike feeder nozzle 12 which overlies the end of the shaft 3.

Interposed between the spider arms 10 and the combustion chamber 11 is a disc 21 formed with a central opening larger in diameter than the diameter of the feeder cup 12, so that an annular space 22 is defined around the cup through which air from the blower 8, 9 is able to reach the area around the cup. The disc is, furthermore, formed with a circular row of holes 23.

Secured to the spiral casing 9 of the blower is a flow-rectifier member 28 positioned behind the blower rotor or turbine 8, and followed by a casing section 29. A ceramic sleeve 30 is mounted in this casing section between it and the combustion chamber 11, so that an annular space 31 is defined around the chamber 11 through which air from the fan is able to pass. The sleeve 30 encloses an electric resistance 32 coiled around the chamber 11.

The casing section 29 is connected with a stationary furnace tube 34 forming an extension of it. Between this tube and the combustion chamber 11 there is defined an annular opening 36 through which the furnace tube communicates with the space 31.

The casing section 1 ahead of the stator 7 of the electric motor is connected with an air inlet conduit 37 controlled by a flapper valve 38.

In the burner apparatus embodying this invention, the outer combustion chamber 11 further has an inner combustion chamber 41 therein, shorter than the outer chamber 11 and having its discharge end cut into a number of branches or castellations 42 forming a tuliplike pattern. Each of these castellations is connected with the wall of the outer combustion chamber 11 by way of a blade 43 which is inclined with respect to the burner axis at a comparatively small angle of about 12° in the illustrated construction.

The inner combustion chamber 41 is formed in its periphery with a series of holes 44 and is externally formed with an annular projection 45 near the series of holes and spaced beyond them in the direction of flow. An inner annular flange 46 is further formed in the combustion chamber 41 near the roots of the fingers or castellations 42.

The feeder cup or nozzle 12 communicates with a central fuel supply conduit 17 extending axially in shaft 3 by way of a nozzle insert 47 formed with a blind axial orifices 48 and radial ports 49 connecting said orifice with the sides of the nozzle.

At the end of casing 1 remote from blower casing 9, there is mounted a supply pump 15 of the diaphragm

type, which is actuated by way of an eccentric member 50 mounted on the end of the shaft 3 and acting by way of a ball bearing 51. The suction and compression chamber 52 of the pump communicates with a fuel supply conduit, not shown, by way of a check-valve, not shown, and communicates with the central shaft bore 17 by way of a radial duct 53.

Slidably mounted within the chamber 52 is a plunger 54 which at the same time serves as a check valve and is secured to the central area of a diaphragm 55 adapted to be displaced up and down through the action of a solenoid 56. The illustrated embodiment of the improved burner apparatus operates as follows:

To start the apparatus and before starting the motor, voltage is applied to the shielded resistance 32 through a suitably controlled electric circuit (not shown). After this resistance has been heated to a suitable temperature it heats the wall of the chamber 11 by radiation, and also heats the wall of inner chamber 41 by heat conduction through the connecting blades 43. Within a few minutes the walls of both chambers are thus brought to a suitable temperature, whereupon voltage is applied to the solenoid 56 and the latter imparts a stroke to the diaphragm 55. This causes discharge of a small amount of fuel through the bore in shaft 3 into the feeder cup 12. The fuel flows down the heated wall of the chamber 41, part of its vaporizes and the remainder flows in liquid form through the holes 44 and reaches the heated wall of the outer chamber 11. This wall is somewhat flared for most of its length, and has a slightly convergent end portion, as shown, so that the fuel flows along the flared portion of the wall of chamber 11 to the part of greatest diameter and is further partially vaporized by contact with the heated chamber wall, while the fuel remaining in the liquid state builds-up at the greatest diameter of the wall of chamber 11 until it overflows the edge of the slightly convergent end portion and drips down on to the resistance 32 and is there ignited, producing a pilot flame. This pilot flame in turn ignites the fuel vapour generated in the chambers 11 and 41.

The electric motor 6, 7 is then started by completion or closing of a suitably controlled electric circuit (not shown), so that the burner is now supplied both with fuel and combustion air and the combustion chambers 11 and 41 are rotated. Owing to centrifugal force, a vacuum is created at the center of the chamber 41 so that the pilot flame is drawn into the chambers 11 and 41 and ignites the combustible mixture delivered by the pump and the fan. The resistance 32 is then deenergized. The flame becomes stabilized inside the chambers and the heated walls of the chambers automatically effect the vaporization of the fuel.

The fuel in its travel towards the feeder cup 12 flows around the excentric 50 and bearing 51 to lubricate these parts and flows through the duct 53. Since this duct is revolving around the axis of the burner, centrifugal force introduces a constant pressure drop or loss of head into the flow of fuel. This constant loss of head facilitates adjustment of the pump delivery rate and makes it possible to render such delivery rate constant regardless of changes of viscosity in the fuel.

Centrifugal force further acts on the fuel in the feeder cup 12 to discharge the fuel in finely divided form against the walls of the inner chamber 41. Contact with the hot walls of this inner chamber vaporizes part of the fuel. The remaining non vaporized fuel flows out through the holes 44 and is discharged against the inner wall surface of the outer chamber 11 there to vaporize. The annular flanges 45 and 46 prevent the fuel from overflowing on to the discharge end of the inner chamber 41.

Combustion air discharged by the turbine of blower 8 is distributed by way of the perforated disc 21 as primary air, secondary air and tertiary air. The primary air enters chamber 41 by way of the annular opening 22 around the feeder cup 12, and mixes with the fuel

vaporized in the chamber 41 so that this fuel burns over the inner wall surface of the chamber. The secondary air is admitted into the outer chamber 11 through the holes 23 and mixes with the vaporized fuel in the outer chamber so that this fuel burns upon the inner wall surface of the chamber 11, i.e. in the annular space between the two chambers 11 and 41.

The bodily rotation of both chambers 11 and 41 creates a film of fuel over the surfaces of the chamber walls, the thickness of such film being a function of the angular velocity of rotation and the flow velocity of the fuel mixture. The combustion occurs at this film or boundary layer and the flame becomes stabilized in this area of surface combustion. To complete the combustion at the outlet from the chambers tertiary air is admitted into the furnace tube 34 by way of the annular space 31 and the opening 36.

Due to the shape and positioning of the combustion chambers 11 and 41 and their relative motion with respect to the gas flow a recycling of the combustion gases occurs within the chambers. The blades 43 due to their rotation and to the incidence angle presented by them to the gas flow, impart an axial displacement to the gases at the outlet from the outer chamber 11 as indicated by the arrows 57. At the same time such displacement creates a suction which draws out the burning gases from the center of the inner chamber 41 through the spaces between the castellations 42. The flame in chamber 41 is discharged through these spaces outwards and is drawn in through the spaces between the blades 43 as indicated by the arrows 58. The suction thus created in the center of chamber 41 draws in the flames discharged between the blades and simultaneously draws in the tertiary air. This creates a recycling flow of the gases between the two chambers. The recycling in turn generates an annular vortex 59 outside the chambers which stabilizes the flame front at the outlet of the chambers. Consequently combustion occurs upon the wall surfaces of the chambers in the film or boundary layers. Surface combustion and flame stability are thus ensured by the provision of the annular vortex 59.

The improved burner device described is self-regulating in character. That is, if for example the rate of fuel supply to the burner is increased, the amount of heat developed increases; hence the wall of chamber 11 and that of chamber 41 become heated to a higher temperature and a greater quantity of fuel can be vaporized.

It will be understood that various modifications may be made in the embodiment illustrated and described.

What I claim is:

1. In a burner apparatus, the combination of an outer generally cylindrical wall defining a first combustion chamber which is open at one end, means mounting said first combustion chamber for rotation about its axis, a feeder cup mounted within said first combustion chamber coaxially with the latter adjacent the other end of said first combustion chamber and rotatable therewith, means for supplying liquid fuel to the interior of said feeder cup, an inner generally cylindrical wall disposed coaxially with, and radially between said cup and said outer wall and joined to the latter, said inner wall extending from said other end, and terminating before said one end of the outer wall and defining a second combustion chamber which opens at the end thereof closest to said one open end of the first combustion chamber, said inner wall having apertures therein adjacent the edge of said feeder cup so that liquid fuel discharged from said cup and centrifugally projected onto said inner wall will pass through said apertures and engage said outer wall or will be vaporized on the inner wall, means for admitting air into the other end of said second combustion chamber between said inner wall and feeder cup to support the combustion of fuel vaporized in said second combustion chamber with the burning gases of such combustion being subjected to centrifugal force to produce a relatively low

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pressure at the center of said second combustion chamber, and means for admitting air into said other end of the first combustion chamber between said outer and inner walls to support the combustion of the fuel engaging said outer wall, whereby the burning gases of the combustion in said first chamber have a tendency to be recirculated into said open end of the second combustion chamber by said relatively low pressure at the center of the latter and thus provide a stabilized flame front.

2. In a burner apparatus, the combination as in claim 1; wherein said inner and outer walls are joined to each other by blades which extend outwardly from said inner wall to said outer wall adjacent said one ends of the walls and which are inclined with respect to the axis of the walls by an acute angle.

3. In a burner apparatus, the combination as in claim 2; wherein said acute angle is in the range from 10 to 15 degrees.

4. In a burner apparatus, the combination as in claim 2; wherein said one end of the inner wall has notches therein to define fingers between said notches.

5. In a burner apparatus, the combination as in claim 4; wherein each of said fingers has at least one of said blades extending therefrom to said outer wall.

6. In a burner apparatus, the combination as in claim 1; wherein said inner wall has a radially inward directed annular rim extending from its inner surface between said apertures and said one end of the second combustion chamber to arrest the flow of liquid fuel along said inner surface toward said one open end.

7. In a burner apparatus, the combination as in claim

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6; wherein said inner wall further has a radially outward directed annular rim extending from its outer surface between said apertures and said one end of the second combustion chamber to arrest the flow of liquid fuel along said outer surface.

8. In a burner apparatus, the combination as in claim 1; wherein said inner wall has a radially outward directed annular rim extending from its outer surface at a location between said apertures and said one end of the second combustion chamber to arrest the flow of liquid fuel along said outer surface.

9. In a burner apparatus, the combination as in claim 1; wherein said means for admitting air includes a distributor disk extending across said other ends of said inner and outer walls and having openings communicating with said first and second combustion chambers; and further comprising means for supplying air around the outside of said outer cylindrical wall.

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