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COMBUSTION DEVICE FOR HYDROCARBON FUEL

Filed Feb. 7, 1963

2 Sheets-Sheet 1

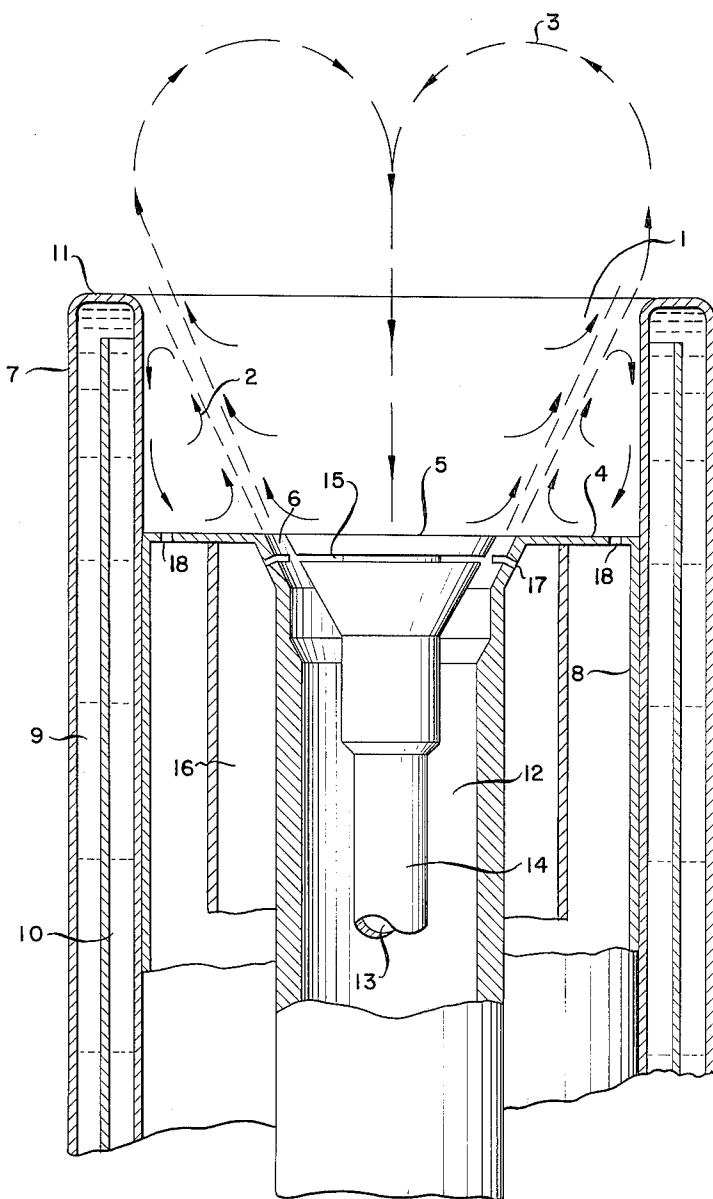


FIG. 1

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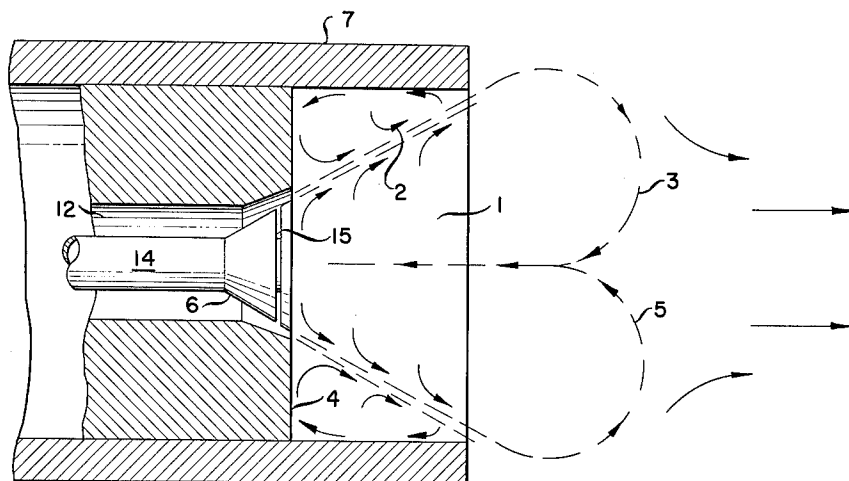


FIG. 2

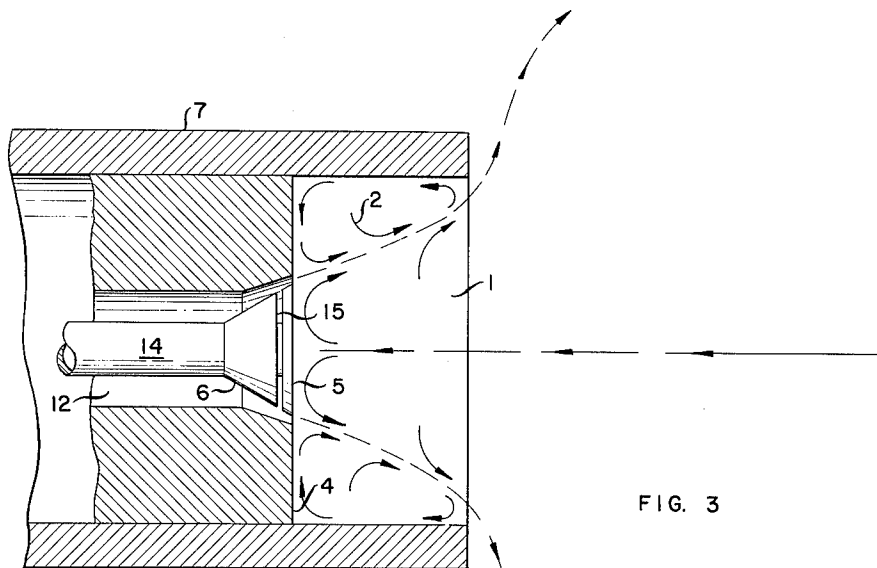


FIG. 3

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COMBUSTION DEVICE FOR HYDROCARBON FUEL

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24,502/62

7 Claims. (Cl. 239—132.3)

The present invention relates to a combustion device for hydrocarbon fuel comprising a cup-shaped flame chamber adapted to be connected to a heating or reaction space or the like, the bottom of the cup-shaped flame chamber having an opening for the supply of fuel and an oxidizing medium, for instance, oxygen or air.

Combustion devices of this type are known and will be referred to as combustion devices of the type specified. The combustion takes place entirely or at least to a large extent inside the flame chamber, and the hot gases find their way into a heating or reaction space to which the device is connected. A very compact combustion or reaction zone is obtained by which a complete combustion of hydrocarbon material can be obtained without excess air and also complete or partial combustion may be possible.

It is an object of the invention to provide a combustion device which is constructed in such a way that a very high intensity reaction zone is formed and wherein the risk of damaging the walls of the flame chamber is minimized, and which is suitable to be applied in a process for producing, by partial combustion of a hydrocarbon with an oxygen-containing gas, a product gas containing hydrogen and carbon monoxide.

The combustion device according to the invention can also be advantageously used in combination with open hearth furnaces for melting steel.

Another object of the invention is to provide a system wherein the flame pattern and gas flow can be changed according to the relative positions of specific constructional elements of the system.

According to the present invention, a combustion system of the type specified is characterized by the combination of a water-cooled metal side wall containing an intermediate circular baffle terminating near the open end of the flame chamber and constituting two concentric annular cooling channels through which the cooling medium is enabled to circulate, of a burner nozzle comprising an annular conical channel for the fuel and oxygen or air, the diameter of the flame chamber being larger than and preferably at least 1.5 times and at most 6 times the diameter of the outlet of the annular conical channel, and of a flat metal bottom of the flame chamber comprising a flat-faced centrally arranged burner nozzle tip.

It has been found that the above-arrangements ensure that the metal parts of the system will be protected against excessive high temperatures occurring within the flame chamber during operation and that simultaneously a stable combustion or conversion zone is obtained as a result of the required relationship between the diameters of the outlet of the annular conical channel and of the flame chamber, respectively. In particular, a specific gas flow pattern is created, with as the main feature an outer toroidal whirl of gases leading back heat to near the place where the reaction media issue from the annular opening, thus ensuring a stable reaction.

The side wall of the flame chamber is preferably adjustable in length between 0.1 and 0.8 of the diameter of the flame chamber.

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By moving the center portion axially with regard to the flame chamber wall the flame shape can be influenced at will from an open toroidal form, corresponding with the above-mentioned shorter length of the chamber wall as a limit for ensuring that the outer whirl will at least be maintained during operation, to a closed, double toroidal form corresponding with the greater length of the flame chamber wall. The open toroidal flame shape is suitable to be used in cases wherein the burner is connected to a heating or reaction chamber in an oblique position, e.g., at 45°, so that then during operation an equal distribution of the hot products from the burner over the chamber is ensured.

The diverging conical fuel supply channel may have a mouth cone angle lying between 30° and 120° as outer allowable limits for ensuring a satisfactory operation of the system.

In the outer and/or inner wall of the conical annular channel one or more supply openings for liquid fuel may be provided so as to introduce fuel into and mix it with the oxygen or air stream; an additional axial channel may also be present in a central barrel of the burner through which, for instance, oxygen alone can be passed to provide oxygen lancing before burner shut down, or steam for the modification of a partial combustion process in which case the channel is preferably in the form of a second inner divergently conical passage.

A combustion device in accordance with the present invention will now be described by way of example with reference to the accompanying drawing, in which FIG. 1 shows a diagrammatic cross-section of the system and in which FIGS. 2 and 3 show, on a reduced scale, diagrammatic views in section of the system in two different positions of the flame chamber wall with the corresponding flame patterns occurring therein during operation.

As shown in the drawing, the system includes a cup-shaped flame chamber 1 in which combustion takes place, toroidal gas eddies being formed in operation in the manner indicated diagrammatically by the arrows 2 and 3. The cup-shaped flame chamber 1 is provided with a flat bottom 4, in which a burner with a flat nozzle 5 is centrally arranged. Between the nozzle 5 and the bottom part 4 a conical annular channel 6 is present for leading the fuel-oxidant mixture into the cup-shaped flame chamber 1 between the toroidal gas streams 2 and 3. The side wall 7 of the flame chamber 1 is hollow and is provided with a circular baffle 8 constituting two concentric annular water cooling channels 9 and 10, these channels being in communication at the most forward end 11 of the side wall. Suitable inlet and outlets for water circulation are provided (not shown in the drawing), connected to the inner and outer cooling channels 9, 10, respectively.

In preferred operation, air or oxygen is supplied through a tube 12 debouching into the annular conical channel 6. A supply for liquid fuel comprises a channel 13 within a central barrel 14, which channel 13 is connected to a slit-shaped opening 15 near the outlet of the channel 6. However, it is also possible to arrange the fuel supply in the outer wall of the channel 6 as, for example, by means of a supply channel 16 and openings 17 in the outer wall of the channel 6. In this case the barrel 14 is available for providing a supply channel for other purposes, as, for instance, for the supply of oxygen alone, to be supplied after a shut down of the apparatus. It is, of course, also possible to use a gaseous hydrocarbon fuel in which case the fuel may be premixed with the air which is to be used for its combustion. Instead of the slit-shaped opening 15 a series of equally distributed separate openings can be used.

In FIGS. 2 and 3, showing the particular flame patterns which occur at different positions of the flame chamber

wall, the wall as well as the bottom part of this chamber are not indicated as hollow members, for the sake of simplicity, but it should be noted that the detailed particulars of this embodiment are similar to those described with reference to FIG. 1.

The present combustion device may also be provided with water supply means for the injection of water into the gas stream when it is intended to produce hydrogen and carbon monoxide containing gas mixtures by partial combustion of hydrocarbons with oxygen or air. Such means may consist of a number of small supply openings 18 arranged in a circle in the bottom 4 of the cup-shaped flame chamber 1 around the channel 6. Alternatively, an annular slit in the inner or outer wall of the channel 6 may be provided for the above purpose. Such a slit can be suitably arranged opposite the fuel supply opening. The water can be supplied through a hollow space surrounding the tube 12, if desired. In the latter case the water passing through said space, can additionally be used as cooling water.

Tests have been carried out with a system according to the invention, wherein it has been operated for preparing gas mixtures containing hydrogen and carbon monoxide by the partial combustion of hydrocarbons with oxygen (air, and air enriched with oxygen may also be employed), which tests gave quite satisfactory results. Also as a high intensity combustor, i.e. for complete combustion, the system has been proved to work satisfactorily.

The test apparatus concerned had the following main dimensions:

	I	II
Inner diameter of the flame chamber (D ₁), inches.....	4	5
Diameter of the annual fuel supply (D ₂), inches.....	1½	2½
Length of flame chamber wall (L).....	(¹)	(¹)
Cone of fuel spray, degrees.....	50	50

¹ From ¼ inch to 2 inches in both cases.

We claim as our invention:

1. A combustion device for hydrocarbon fuel comprising:

a cup-shaped flame chamber adapted to be connected to a heating or reaction chamber, said flame chamber having a greater diameter than depth and a substantially flat bottom wall;

said flame chamber having a hollow liquid cooled side-wall including an intermediate circular baffle terminating near the open end of the flame chamber to

form two concentric annular cooling channels through which a cooling medium may circulate;

a burner nozzle disposed in the center of the bottom wall of the flame chamber for supplying fuel and an oxidizing medium to the flame chamber, said burner nozzle comprising an annular diverging conical channel having a cone angle between 30° and 120°, said conical channel in addition having an outlet opening in the bottom wall of said flame chamber, said burner nozzle in addition having a flat-faced tip;

the diameter of the flame chamber being larger than the diameter of the outlet of said burner nozzle.

2. The combustion device according to claim 1, characterized in that the diameter of the flame chamber is at least 1.5 times and at most 6 times the diameter of the outlet of the annular conical channel.

3. The combustion device according to claim 1, characterized in that the length of the cup-shaped flame chamber is adjustable.

4. The combustion device according to claim 3, characterized in that the length of the flame-chamber is adjustable between 0.1 and 0.8 of the diameter of the flame chamber.

5. The combustion device according to claim 1, characterized in that at least one of the outer and inner walls of the conical annular channel is provided with one or more fuel supply openings.

6. The combustion device according to claim 1, characterized in that the bottom wall of the cup-shaped flame is provided with water supply openings.

7. The combustion device according to claim 1, characterized in that at least one of the inner and outer walls of the annular conical channel is provided with water supply openings.

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