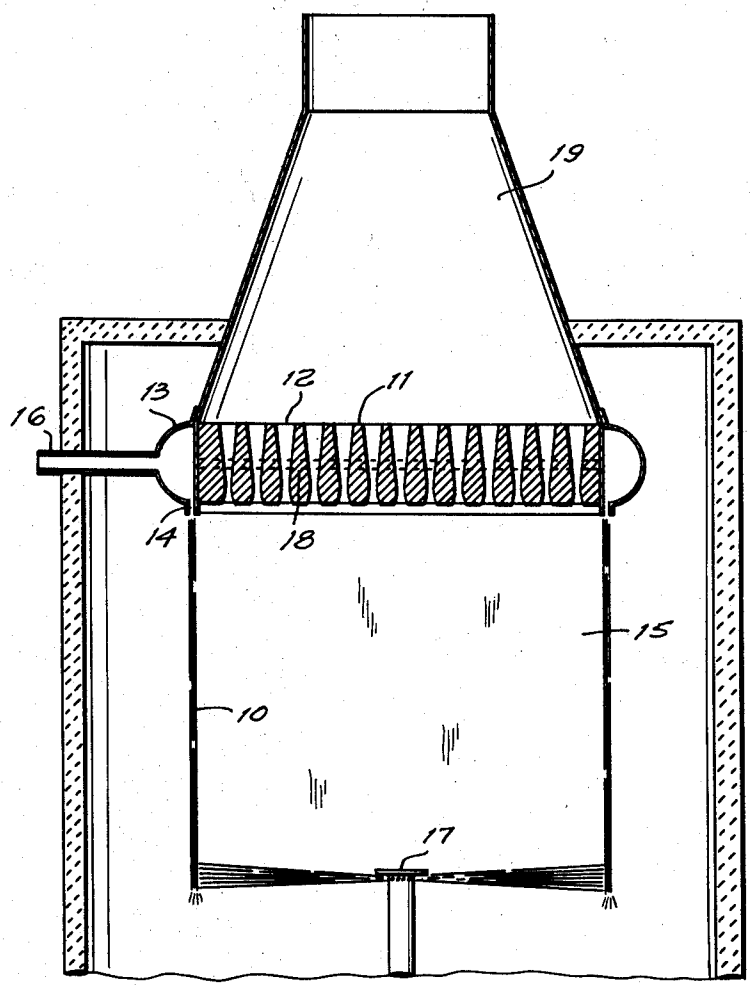
Dec. 18, 1962 F. F. A. BRACONIER ETAL 3,069,248

BURNER FOR HYDROCARBONS

Original Filed May 25, 1954 6 Sheets-Sheet 1

FIG. 1.

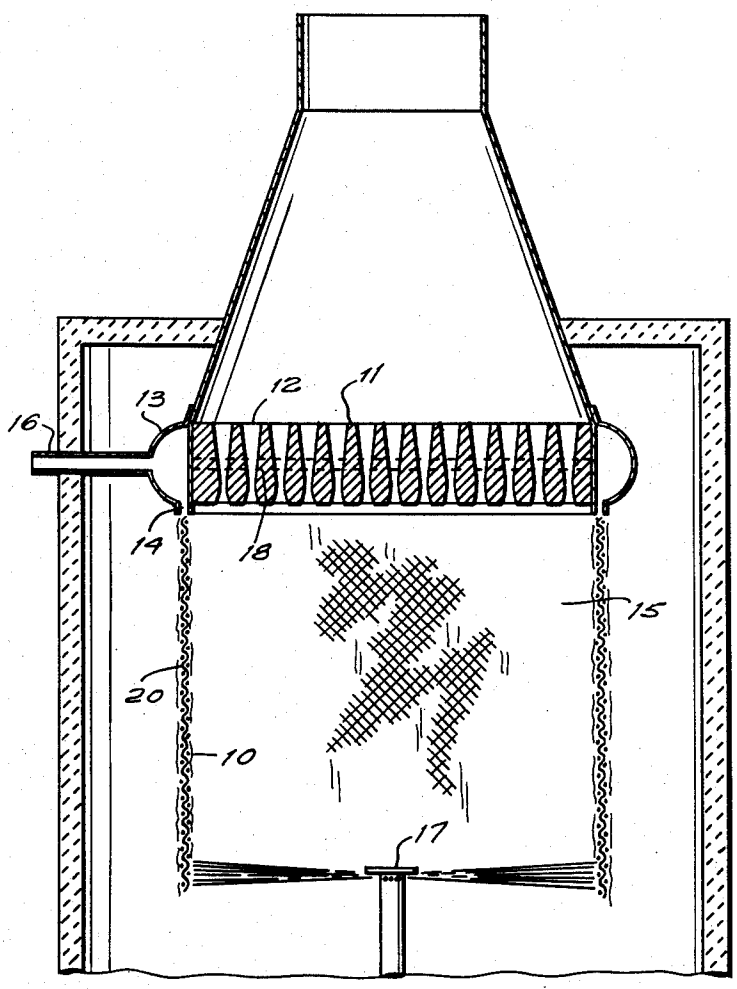


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BURNER FOR HYDROCARBONS

Original Filed May 25, 1954 6 Sheets-Sheet 2

FIG. 2.

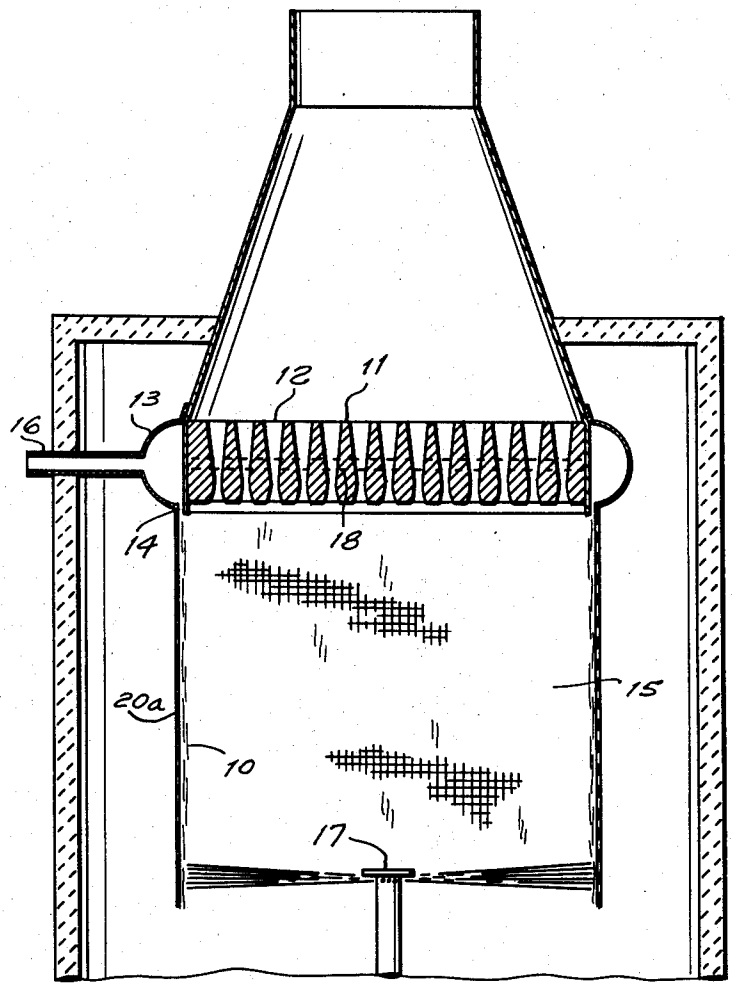


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BURNER FOR HYDROCARBONS

Original Filed May 25, 1954 6 Sheets-Sheet 3

FIG. 3.

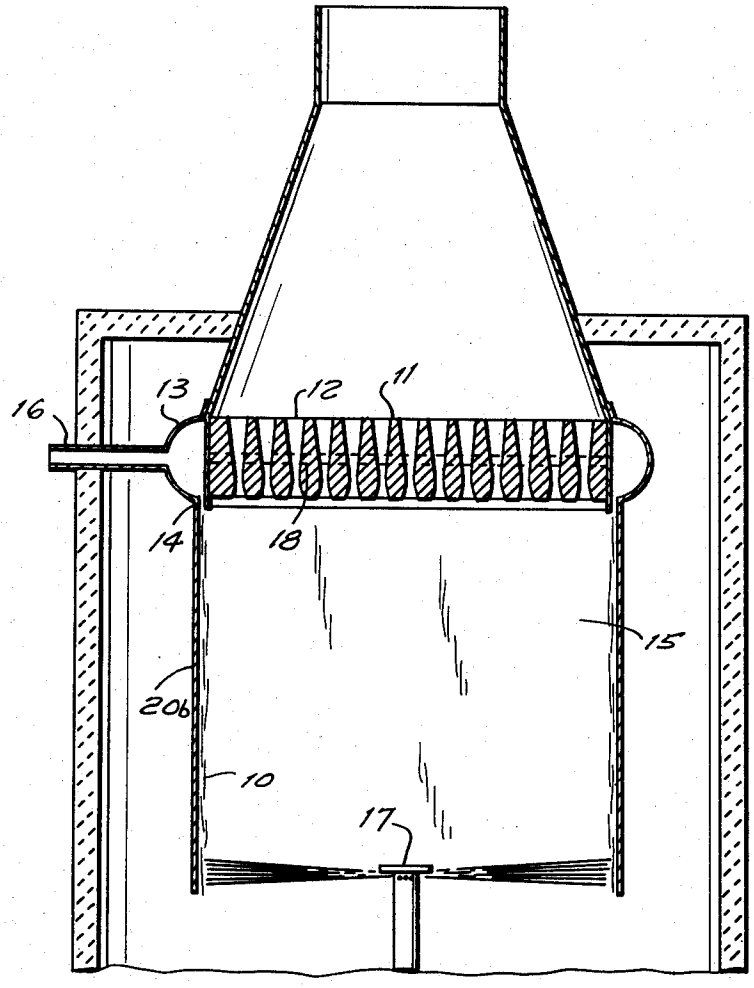


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BURNER FOR HYDROCARBONS

Original Filed May 25, 1954 6 Sheets-Sheet 4

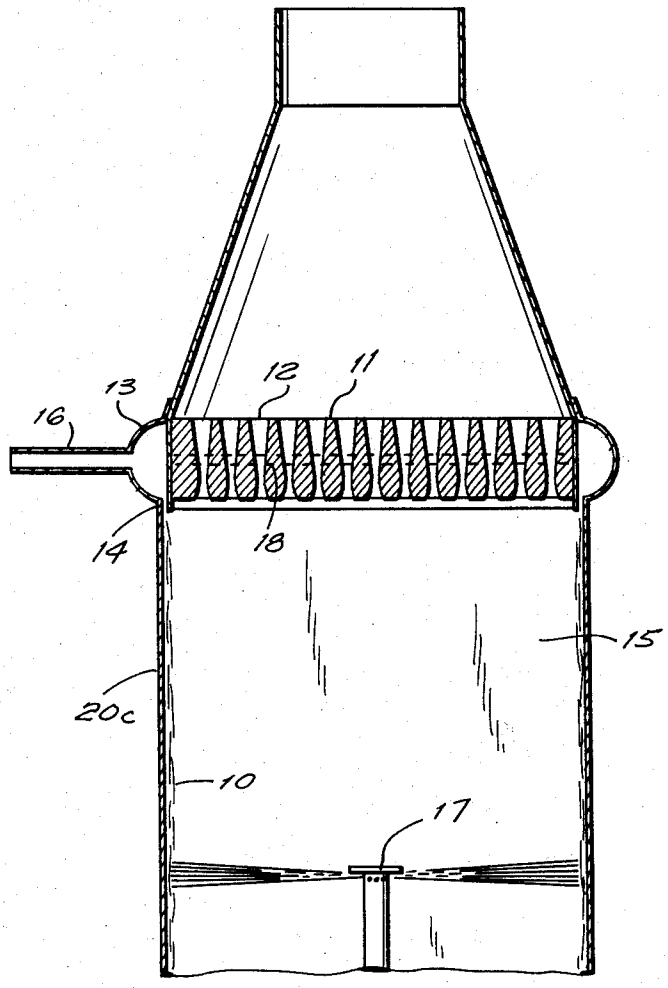
FIG. 4.



BURNER FOR HYDROCARBONS

Original Filed May 25, 1954 6 Sheets-Sheet 5

FIG. 5.



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BURNER FOR HYDROCARBONS

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FIG. 6.

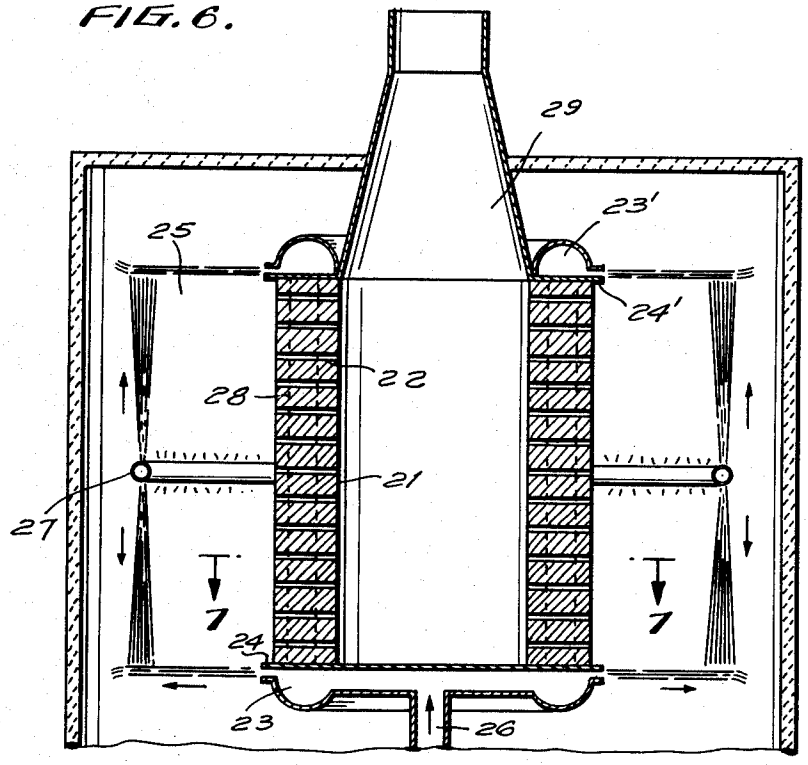
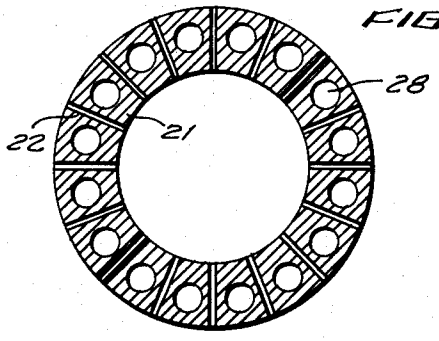


FIG. 7.



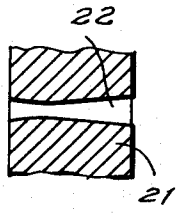


FIG. 8.

United States Patent Office 3,069,248 Patented Dec. 18, 1962

3,069,248

BURNER FOR HYDROCARBONS

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Original application May 25, 1954, Ser. No. 432,216. Divided and this application Dec. 22, 1958, Ser. No. 825,619

Claims priority, application Belgium June 30, 1953

10 Claims. (Cl. 48—196)

This invention relates to a novel method for the combustion of gases and to a novel burner construction suitable for effecting the novel process. More particularly, it relates to a novel process for the partial combustion of hydrocarbons and to a novel furnace wherein said partial combustion is effected.

It is known that one of the products of partial combustion of hydrocarbons in oxygen, particularly of hydrocarbons containing more than one carbon atom, especially unsaturated hydrocarbons, is in the form of amorphous carbon deposited on the walls of the combustion chamber and closely resembling coke. These deposits of amorphous carbon inhibit the formation of the flame, reduce the yield of the apparatus, and go so far as to form obstructions.

Numerous devices have heretofore been suggested for preventing or inhibiting the formation of carbon deposits, or for periodically removing these deposits. Industrial scale use of such devices, which generally comprise complex mechanical arrangements, is attended by certain difficulties which increase the cost of construction and operation of the furnaces and hence of the products resulting from the treatment. In addition, the prior arrangements prevent the continuous operation of the apparatus thereby decreasing the capacity of the equipment.

It is therefore an object of the present invention to provide a novel process whereby the deposit of carbon in the partial combustion of hydrocarbons is avoided.

It is another object of the present invention to provide a process whereby the partial combustion of hydrocarbons may be effected continuously.

Another object of the present invention is to provide a process wherein amorphous carbon is removed as formed during the partial combustion of hydrocarbons so that the treatment may be effected continuously.

It is another object of the invention to provide means permitting the continuous thermal treatment of hydrocarbons.

Still another object of the invention is to provide means ensuring the removal of amorphous carbon as formed during the thermal treatment of hydrocarbons.

Another object is to provide a novel distributor suitable for supplying a gas mixture to a furnace wherein hydrocarbons are pyrolytically decomposed.

Another object is to provide a dynamic arrangement whereby carbon particles are removed as formed in the partial combustion of hydrocarbons.

A further object is to provide a combustion chamber which is unaffected by the deposit of carbon and which therefore is of constant volume.

It has now been found that hydrocarbons may be subjected to a partial combustion continuously while avoiding the deposit on the walls of the furnace of carbon particles formed. To this end, a combustible mixture of a fuel and a substance capable of supporting combustion, e.g., a hydrocarbon and oxygen, is ignited in a furnace wherein the combustible mixture is introduced through a distributor having a plurality of orifices into a combustion chamber. The individual flames originating at the issuance from each orifice of the distributor join

within the combustion chamber to form one compound combustion flame, hereinafter referred to as the flame. This flame is bounded by a continuous sheet of liquid of homogeneous form, supplied from a source disposed about the distributor. Thus the fixed, solid walls of the conventional furnaces, defining the zone of combustion, are replaced by liquid, dynamic walls which carry away the carbon particles thereby defining a combustion zone, the volume of which remains constant.

The fuel may be in gaseous, vaporized or atomized form and the gaseous products of partial combustion, which are still in a substantially reactive condition, are abruptly cooled by the sheet of liquid, preferably water, in order to terminate the reaction at the desired stage of equilibrium.

The sheet of liquid is obtained, for example, by injecting water under pressure through a slot of desired shape positioned at the periphery of the distributor, the slot being specially calibrated and adapted to impart the desired profile to the liquid in the form of a continuous sheet or lamen surrounding the flame and directed parallel thereto.

In order to maintain conditions conducive to maximum efficiency of this operation, and in order to obtain a high yield of the desired products of partial combustion, the output and pressure of the water, and the location and dimensions of the slot, are determined by the following considerations:

(1) The sheet of water should be thin, uninterrupted and homogeneous.

(2) The direction of the flow of the sheet of water should be parallel to the axis of the flame.

(3) The speed at which the water issues from the slot must be sufficient to maintain the sheet of water parallel to the flame and prevent intermingling of the liquid and the flame, such as might occur due to gravity in a horizontal burner.

In order to prevent deflection of the liquid sheet from its desired position and shape, for example in a vertical burner where the flame is directed downwardly, and wherein the surface tension of the liquid would tend to introduce a certain amount of taper toward the bottom end of a cylindrical sheet of water, it may be useful to provide a support for the sheet of water such as by causing it to flow down the walls of the combustion chamber. Alternatively, a separate support of desired shape may be provided. The purpose of such support is to fix the position and shape of the liquid sheet as it flows over and is distributed along the support. The adherence of the liquid sheet to a support of this nature, which is of rigid construction, permits a reduction in the quantity of liquid and/or in the pressure of injection.

The invention, which has been set forth briefly, will now be described in greater detail, reference being had to the accompanying drawings wherein:

FIG. 1 is a diagrammatic view in axial section through a furnace in accordance with a first embodiment of the invention;

FIGS. 2 to 5 are diagrammatic views in axial section through furnaces provided with different supports for the sheet of liquid;

FIG. 6 is a diagrammatic view in axial section of a further embodiment of the invention;

FIG. 7 is a sectional view taken along line 7—7 of FIG. 6; and

FIG. 8 is a sectional view on an enlarged scale of one of the orifices of the distributor of FIG. 6.

Referring now to FIG. 1, there is shown a distributor **11**, comprising a cylindrical metallic disc which is both refractory and resistant to oxidation, provided with parallel orifices or gas distribution channels **12** extending therethrough. The gaseous combustible mixture is supplied

to the furnace through an expansion chamber **19** from which it issues through the orifices **12** to form the flame in the combustion zone **15** at the other side of the distributor **11**. The distributor **11** is provided at its periphery with a hollow metal ring **13** sealed to the upper edge of the distributor **11** but defining with the lower edge thereof a slot **14** shaped to direct a protective liquid sheet **10** in a direction parallel to the axis of the combustion chamber **15**. The protective liquid, for example water, is supplied under pressure through a pipe **16** to the inside of the hollow metallic ring **13**, and it issues from the ring **13** through the slot **14** in the form of a thin, uninterrupted film defining a lateral wall for the combustion zone **15**.

The gaseous products formed by the partial combustion are abruptly cooled by a jet of water issuing from nozzle **17**.

In order to prevent premature ignition of the gaseous reaction mixture by flash-back into the expansion chamber **19**, caused by excessive heating of the distributor **11**, the distributor **11** may be water-cooled by internal passages **18** communicating with the hollow ring **13** and having the same water circulating therethrough under pressure.

When an otherwise conventional gas distributor is equipped, according to the present invention, with means for producing a sheet of water defining the lateral boundary of the combustion zone, there are no carbon deposits on the walls of the combustion chamber. It is therefore possible to increase substantially both the yield of acetylene in the combustion products and the total output of the furnace, since the latter can be used continuously without those interruptions generally necessitated for cleaning and replacement of the walls of the combustion chamber.

An improved distributor according to the present invention is readily manufactured starting from a solid metallic disc which is first drilled and tapped in a direction parallel to the axis in order to provide the distribution channels **12** for the combustible mixture, and then drilled in a direction perpendicular to the axis in order to provide the water cooling channels **18**. The velocity of flow of the gaseous mixture through the distribution channels **12** depends upon the speed of advance of the flame on the combustion chamber side of the distributor. Since the former should be substantially greater than the latter, it is important to reduce as much as possible the loss of head occasioned by the narrow distribution channels and to shape the latter as convergent-divergent tuyeres. Furthermore, in order that the individual flames issuing from each orifice of the distributor may have the maximum possible stability, and in order to prevent carbon deposits on the hot side of the distributor, the edges of the orifices on the combustion chamber side may be rounded off to merge into the front face of the distributor.

For structural reasons, the type of distributor described in connection with FIG. 1 is particularly suitable for medium capacity furnaces used in the production of pyrolysis gas. Where it is desired either to have a large capacity or to have a small ratio of size to output, the distributor may be designed to have a minimum surface in relation to the total volume of the combustion chamber. This is well known in the art, but the protective liquid sheet surrounding the flame according to the present invention is also applicable to this known type of furnace.

The furnace shown in FIG. 2 is generally similar to that described in reference to FIG. 1. It differs from the former in the inclusion of a wire screen **20** which serves as a support and guide for the sheet of liquid discharged through slot **14**. To that end the screen **20** is connected with ring **13** at that side of the slot **14** which is remote from the distributor **11** so that liquid will flow along the combustion zone side of the screen **20** to carry away any amorphous carbon formed. The sheet of liquid therefore conforms in position and contour with the wire screen and does not deviate therefrom due to surface tension, as might be occasioned in a horizontal furnace. The sheet of liquid adheres to the rigid support and permits the requisite protecting film to be formed and maintained with a lesser quantity of liquid ejected at a lower pressure.

FIG. 3 shows the use of a perforated cylinder **20***a* as a support for the sheet of liquid, and connected to ring **13** in the same manner described with reference to FIG. 2. The perforated cylinder may comprise a cylinder of sheet metal provided with a plurality of openings.

In FIG. 4 the support **20***b* takes the form of an imperforate cylinder again preferably comprising a metal sheet. Alternatively, the cylinder may be composed of other materials which are heat resistant. Such other materials, though heat resistant, need not be refractory since they are protected and cooled by the film of liquid.

In FIG. 5 the support **20***c* forms the outer wall of the furnace or combustion chamber as well as of the combustion zone **15**. To this end the support **20***c* is imperforate and extends below nozzle **17**. The furnace walls themselves may form the support and may be composed of metal or of other suitable material. Alternatively, a layer of suitable material may be superimposed upon the walls of the furnace to form the support. This modification is obviously cheaper and easier to construct and, moreover, occupies less space for a combustion zone of a given size.

FIGS. 6 to 8 illustrate a particularly interesting embodiment of the invention wherein the distributor **21** is of hollow cylindrical or annular form having an open top connected to the expansion chamber **29** and a closed bottom end. The distributor is positioned vertically inside a combustion zone **25**, and the combustible mixture is supplied thereto through the expansion chamber **29** to the interior of the distributor from which it issues through orifices **22** toward the outside in a radial lateral direction. The upper and lower edges of the distributor are both provided with hollow rings **23'** and **23** to which water, or other suitable liquid, is supplied under pressure through a pipe **26**. As shown in FIG. 7, the distributor is provided with longitudinal channels **28** establishing communication between the hollow rings **23** and **23'**. Each of the rings **23** and **23'** is provided with a peripheral slot **24** and **24'**, respectively, through which a flat, disc-shaped sheet of water issues in a radial direction substantially parallel to that of the gases issuing through the orifices **22**. The circular flame issuing from the orifices **22** of the distributor **21** in a radial direction is bounded at its top and bottom edges by the thin, flat, disc-shaped sheets of water issuing from the slots **24'** and **24**. The flame is abruptly cooled by a jet of water issuing vertically upwardly and downwardly from an annular nozzle **27** arranged all around the distributor **21** at an appropriate distance therefrom, and provided with suitable discharge outlets.

As seen in FIG. 8, similarly to what has been stated with respect to the channels **12** of distributor **11**, the channels **22** of distributor **21** may be in the form of convergent-divergent tuyeres having rounded edges on the hot side of the distributor. Thus, the velocity of flow of the gaseous mixture inside of the channels **22** is substantially greater than the speed of advance of the flame as it progresses away from the burner.

The longitudinal channels **28** and the slots **24** and **24'** are so dimensioned that the loss of head of the water as it passes vertically through the distributor **21** is of little importance and, in any event, less than the loss of head occasioned by the passage of the water through the slots **24** and **24'**. Likewise, on its way from the pipe **26** to the hollow ring **23'**, the water should not be heated by more than about 5° C. so that the dynamic and thermal conditions of the water, in both rings **23** and **23'** and in both horizontal, disc-shaped sheets is substantially identical.

Where the jets issuing from the nozzle **27** meet the disc-shaped sheets issuing from the slots **24** and **24'**, any turbulence occasioned by the mutually perpendicular direc-

tions of flow is outside of the zone of combustion and has no effect upon the reaction or the acetylene yield.

The annular shape of the distributor as shown in FIGS. 6 and 7 has the advantage of combining a minimum surface with a maximum volume of the combustion zone, which enables the treatment with less heat dissipation of larger quantities of gaseous mixture in a furnace of this design than in other known furnaces.

Due to the fact that the fixed walls of the combustion zone are replaced by liquid sheets and that there is no necessity to provide mechanical means for cleaning the combustion chamber, and to the further fact that the distributor is of annular shape, the production capacity of a burner of given size can be very readily increased without important structural alterations of an existing plant. In order to increase the production capacity, one or more additional distributor elements may be interposed between the first element **21** supported on the ring **23** and the upper ring **23'**. The only dimension to be increased, therefore, is the vertical dimension of the whole furnace, to which the capacity is proportional.

Similarly to distributor **11** of FIG. 1, the annular distributor **21** of FIGS. 6 to 8 is very easily manufactured. A hollow metallic annulus or cylinder of refractory material having high resistance to oxidization is first drilled longitudinally to provide the channels **28** for circulation of cooling water, and then drilled radially to provide the channels **22** in the spaces between the channels **28**. FIG. 8 is an enlarged sectional view of a fragment of the distributor of FIGS. 6 and 7 illustrating the convergent-divergent profile of a gas channel **22**.

In order that the sheets of water issuing from the slots **24** and **24'** may be uninterrupted and homogeneous, without forming secondary lateral sprays or fogs penetrating into the combustion zone, the edges of the slots **24** and **24'** are shaped to avoid sharp ridges, and they are preferably hollowed out and slightly rounded.

In comparison with furnaces having metal walls cooled externally by circulation of water, the furnaces according to the present invention having a dynamic sheet of water bounding the flame have been found to be at least as efficient from the thermal point of view, because the heat exchange between the screen of water and the flame, which occurs by radiation, is practically negligible due to the very short time of contact between the moving surfaces of the film of water and the flame.

In a practical experiment, a gaseous mixture containing 1,800–2,000 cubic meters per hour of a given fraction of coke oven gas having an 85% hydrocarbon content of 1 and 2 carbon atoms, and 950–1,050 cubic meters per hour of oxygen, was reacted in a furnace according to the present invention to produce a pyrolysis gas containing 10% to 11% acetylene by volume.

Although water has been referred to herein principally as the liquid to be used for forming the protective liquid screen, it is possible to use other liquids, such as heavy oils which are not readily inflammable but which are more coherent than water, which are more readily adaptable for effecting a partial purification of the products of partial combustion, or for recovering the heat of combustion, these liquids serving the function of an intermediate exchange vehicle for heat which might otherwise be lost.

As to the water used for the abrupt cooling of the combustion product, the very substantial quantity of heat which it absorbs from these products can be very readily recovered and used, for example, for pre-heating the reaction gases or for other industrial purposes.

Various changes and modifications may be made without departing from the spirit and scope of the present invention and it is intended that such obvious changes and modifications be embraced by the annexed claims.

This application is a division of application Serial No. 432,216, filed May 25, 1954.

What is claimed is:

1. A furnace for the partial combustion of a hydrocarbon gas and comprising a wall defining a combustion chamber, a distributor disposed adjacent one end of said chamber and having a plurality of orifices extending therethrough and into said chamber, means for supplying a mixture of hydrocarbon gas and oxygen to said distributor for passage through said orifices therein into said combustion chamber, first liquid supply means disposed around said distributor and having an outlet surrounding said distributor and into said combustion chamber for supplying into said chamber a continuous axially flowing liquid screen defining around said distributor a combustion zone within said chamber and axially thereof, second liquid supply means adjacent the opposite end of said chamber and spaced axially from said distributor for supplying a substantially continuous transverse sheet of quenching liquid all across said combustion zone, whereby, upon ignition of said gas mixture to form a flame within said combustion zone, carbon formed by said combustion is continuously removed on said axially flowing liquid screen and hot combustion products are quenched by said transverse liquid screen to arrest said combustion and stabilize the products thereof.

2. A furnace according to claim 1, including a support extending about said distributor from the exit of said first liquid supply means and toward said second liquid supply means, whereby the continuous screen is constrained to flow along said support to define a combustion zone of constant volume.

3. A furnace according to claim 1, including a wire screen positioned adjacent the exit of said first liquid supply means, about said distributor and extending toward said second liquid supply means, whereby the continuous liquid screen is guided along said wire screen.

4. A furnace according to claim 1, including a perforated sheet of metal positioned adjacent the exit of said first liquid supply means, about said distributor and extending toward said second liquid supply means, whereby the continuous liquid screen is guided along said sheet.

5. A furnace according to claim 1, including an imperforate sheet of material positioned adjacent the exit of said first liquid supply means, about said distributor and extending toward said second liquid supply means, whereby the continuous liquid screen is guided along said imperforate sheet.

6. A furnace according to claim 1, in which the wall defining the combustion chamber is a metal wall positioned adjacent the exit of said first liquid supply means, about said distributor and extending toward and beyond said second liquid supply means, said combustion zone being defined by that portion of said combustion chamber between the distributor and said second liquid supply means.

7. A furnace for the partial combustion of hydrocarbon gas, comprising a wall defining a combustion chamber, an annular distributor having concentric inner and outer faces and being disposed within said chamber, said distributor being provided with a plurality of orifices extending therethrough from the inner to the outer faces, respectively, and with passageways extending between said opposed ends, means for supplying a mixture of hydrocarbon gas and oxygen to said inner face for passage through said orifices to said outer face, a pair of liquid supply means connected with said distributor at said ends, respectively, each of said pair of liquid supply means being mounted at one end of the distributor, adjacent its outer face and defining a peripheral slot at the edge of the outer face of said distributor, and each peripheral slot being adapted to impart to the liquid the form of a continuous sheet, said pair of liquid supply means communicating through said passageways, whereupon combustion of said hydrocarbon gas forms a flame around said distributor, said flame being confined between continuous sheets of liquid

emerging from said peripheral slots, carbon formed by said partial combustion being continuously carried away by said sheets of liquid.

8. A furnace according to claim 7 having a second liquid supply means comprising an annular nozzle spaced from and disposed about said distributor at a radial distance therefrom, said nozzle being provided with exits for discharging liquid substantially parallel to the axis of said distributor, whereby upon burning of said hydrocarbon gas in the combustion zone around said distributor, said combustion and accompanying thermal reactions are abruptly terminated and the products cooled by liquid emitted from said annular nozzle.

9. A furnace for the partial combustion of hydrocarbon gas, comprising a wall defining a combustion chamber, a distributor having two opposed faces and disposed within said chamber adjacent one end thereof, said distributor being provided with a plurality of orifices extending therethrough for communication between said faces, means extending from without said chamber thereinto and connected with said distributor for supplying hydrocarbon gas to one of said faces for passage through said orifices, liquid supply means connected to said distributor and disposed about said distributor, said liquid supply means being provided with a slot surrounding said distributor adjacent the other of said faces, whereby a continuous axially flowing sheet of liquid defining a combustion zone may be formed adjacent said other face of said distributor, and further liquid supply means within said chamber and spaced axially of said chamber from said distributor and from said one face for providing a transverse sheet of quenching liquid across said chamber, whereby upon actuation of both said liquid supply means and ignition of hydrocarbon gas to form a flame within said combustion zone combustion products of said flame are quenched by said transverse sheet of liquid to terminate combustion of said hydrocarbon gas when only partially completed, carbon formed during said partial combustion being continuously removed by said liquid.

10. In a furnace of the character described for producing a partial combustion pyrolysis reaction of hydrocarbons tending to produce undesired carbonaceous by-products, the combination which comprises an outer wall defining a combustion chamber in said furnace and having a gas inlet for introducing said hydrocarbons to be pyrolyzed and a gas outlet for removing gaseous products of said pyrolysis reaction, a distributor in said combustion chamber adjacent and communicating with said gas inlet thereof for introducing into said chamber said hydrocarbons to be pyrolyzed and a combustion gas for said pyrolysis reaction, said distributor having an outer face exposed to the interior of said chamber, annular jet liquid injection means around said outer face of said distributor for injecting into said chamber liquid forming a continuous liquid screen surrounding said hydrocarbons introduced into said chamber defining within said chamber a reaction zone surrounded by said liquid screen whereby said undesired carbonaceous by-products are removed from said combustion chamber by said flowing liquid screen instead of being deposited on said wall, and liquid quenching means in said chamber and spaced from said distributor along the flow of gases through said reaction zone for forming a sheet of liquid transversely all across said reaction zone for quenching said pyrolysis reaction adjacent said outlet from said chamber.

References Cited in the file of this patent

UNITED STATES PATENTS

2,179,379	Metzger	Nov. 7, 1939
2,630,461	Schasse	Mar. 3, 1953
2,672,488	Jones	Mar. 16, 1954
2,715,648	Schasse	Aug. 16, 1955
2,719,184	Kosbahn	Sept. 27, 1955
2,789,148	Schutte	Apr. 16, 1957

FOREIGN PATENTS

461,497	Great Britain	Feb. 17, 1937