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ANNULUS TYPE BURNER FOR THE PRODUCTION OF SYNTHESIS GAS

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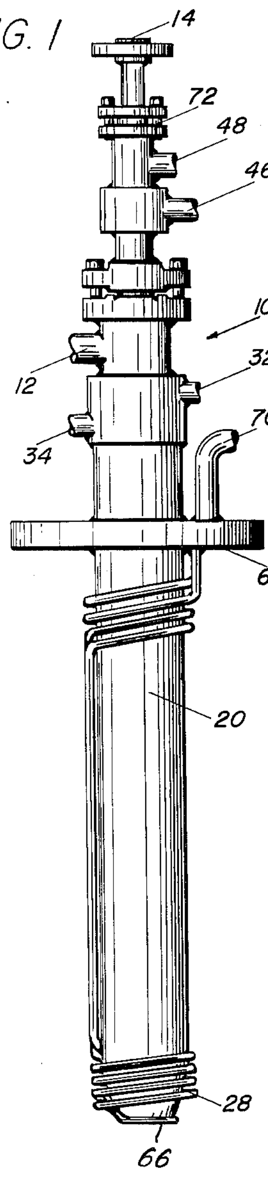
FIG. 1



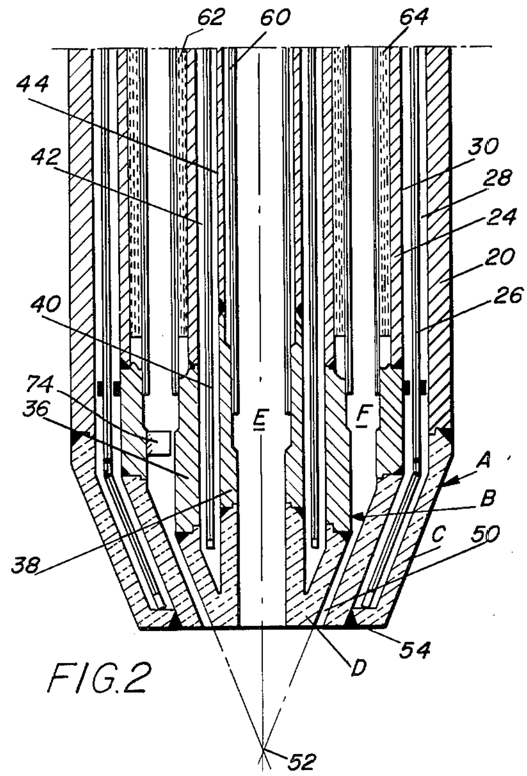
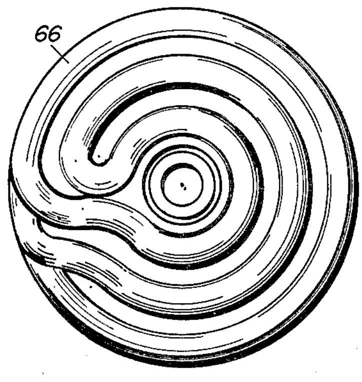


FIG. 2

FIG. 3



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ANNULUS TYPE BURNER FOR THE PRODUCTION OF SYNTHESIS GAS

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This application is a continuation-in-part of our copending application, Serial No. 161,697, filed December 22, 1961, now abandoned.

This invention relates generally to an apparatus for partial oxidation, synthesis gas generation and is particularly applicable to the generation of carbon monoxide and hydrogen by the partial combustion of a gaseous hydrocarbon with oxygen-enriched air or substantially pure oxygen.

Synthesis gas mixtures consisting essentially of carbon monoxide and hydrogen are important commercially as a source of hydrogen for hydrogenation reactions and as a source of feed gas for the synthesis of hydrocarbons, oxygen-containing organic compounds or ammonia.

The partial combustion of a hydrocarbon fuel with oxygen-enriched air or with relatively pure oxygen to produce carbon monoxide and hydrogen presents unique problems not encountered normally in the burner art. It is necessary, for example, to effect very rapid and complete mixing of the reactants, as well as to take special precautions to protect the burner or mixer from overheating.

Because of the reactivity of oxygen with the metal from which a suitable burner may be fabricated, it is extremely important to prevent the burner elements from reaching those temperatures at which their rapid oxidation takes place. In this connection, it is essential that the reaction between the hydrocarbon and oxygen take place entirely outside the burner proper and that localized concentration of combustible mixtures at or near the surfaces of the burner elements is prevented. Even though the reaction takes place beyond the point of discharge from the burner, the burner elements are subjected to heating by radiation from it.

Inadequate mixing results in such concentrations of oxygen in localized areas that relatively complete combustion of a portion of the fuel takes place in these areas, releasing large quantities of heat. In addition, regardless of the type of burner construction employed, eddies of the reactants form combustible mixtures near the burner surfaces. Unless these surfaces are maintained at a temperature below the ignition temperature of the mixtures, they act as flame holders, with the ensuing combustion along the surfaces soon causing overheating and failure of the burner.

Another problem peculiar to this reaction is the tendency for free carbon to form either on the burner or within the reaction zone, due primarily to inadequate mixing of the gases, leading to burner failure, since formation of carbon on the surface of the burner interferes with the mixing of the gases and causes localized concentrations of oxygen, with resulting overheating of burner elements following its combustion.

With conventional burners, it has been found necessary to use a quantity of oxygen in excess of the theoretical to prevent carbon formation. This often causes undesirably high reaction temperatures and increases the problem of cooling the burner. The problem is further aggravated by the fact that in the partial combustion of gases, it is desirable to charge the reactant gases to the

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burner in a highly preheated state to reduce the oxygen requirements and give a maximum yield of the desired product gas.

For one or more of the foregoing reasons, the prior art burners are characterized by failure of burner elements, particularly by erosion of metal at the burner tips even where these elements have been water cooled, and where the reactants are premixed and injected from the burner at rates of flow in excess of the rate of flame propagation, the highly reactive oxygen-hydrocarbon mixtures react along a film of gases ever-present along the surface of the conduit or orifice through which they are discharged, soon causing failure of the burner.

It is an object of the invention to provide a novel burner for synthesis gas generation which overcomes the shortcomings of the prior art structures, is simple in construction, and is economical in operation.

It is another object of the invention to provide an improved burner structure which is adaptable for use with various reactants.

Still another object of the invention is to provide an improved type of burner for partial oxidation and synthesis gas generation wherein the parts are less sensitive to change due to heat influence and are cooled more readily.

Another object of the invention is to provide a burner construction which will have a predetermined angle of discharge of gaseous reactants, which angle will not vary during the operation of the burner.

Further objects and advantages of the invention will appear from the following description of a preferred form of embodiment thereof taken in connection with the attached drawing in which:

FIG. 1 is a general illustration of a burner assembly;

FIG. 2 is a cross section of the tip of the burner through the longitudinal axis showing the internal construction; and

FIG. 3 is an end view of the burner assembly showing the cooling coil.

The present invention relates to burners in which the reactants are mixed at the point of discharge from the burner and specifically to burners of the annulus type, wherein streams of reactant gases are introduced through concentric conduits, one stream of the gases being discharged from a central conduit into admixture with another gas stream which is discharged as an envelope from the annular passageway between the central conduit and a surrounding exterior conduit.

The burner assembly, generally indicated at **10** in FIG. 1, is formed conveniently from a series of concentric pipes or tubular members which serve as conduit members in the form of a substantially cylindrical, hollow outer wall member, generally indicated at A, FIG. 2 and a substantially concentric and cylindrical, hollow inner wall member B. The outer wall member A is surmounted by a heat resistant tip assembly C and the inner wall member B has a corresponding coaxial heat resisting tip D. This structure thereby forms an inner cylindrical passage E within the internal wall member B and an annular passage F between the inner wall member B and the outer wall member A.

In practice, the hydrocarbon gas feeds to the passage F between the wall members through the inlet **12** and the oxygen-containing gas is introduced to the passage E through the inlet **14**.

The outer wall member A, as shown in FIG. 2, is formed conveniently from concentric tubular members **20** and **24** joined at their discharge ends by the heat resistant tip C having a central cylindrical discharge port and having an internal concentric web **26** which extends substantially to the discharge end of the tip and serves as a diaphragm to divide the interior of the outer wall member into two coolant paths 28 and 30. The coolant (e.g. water) connections to these paths are shown at 32 and at 34.

In a similar manner, the inner wall member B is comprised of two substantially concentric tubular members 36 and 38 and similarly having an internal concentric diaphragm or web 40 to form two internal coolant paths or courses 42 and 44. The coolant connections for these courses are shown at 46 and at 48.

The heat resistant tips C and D are preferably truncated hollow cones terminating in a common plane to present a minimum exposed surface to the reaction in the gas generator and to provide a constant angle of discharge of the hydrocarbon gas through the annular discharge port 50. As shown in the drawing, this angle is such that the flow axis of the gas from conduit E will intersect the flow axis of the gas discharging from the annular port 50 at a point adjacent 52, which is not less than 1½ inches from face 54 of the heat resistant tip nor at a distance greater than 3 inches from this face. It is found with such construction that the maximum yields of synthesis gas are obtained accompanied by minimum carbon formation.

As a part of a commercial installation, it is found desirable to line the inner surface of the innermost tubular member 38 with an insulating liner, generally indicated at 60, and to utilize a thin wall for the major length of this tubular member 38.

In a similar manner, the outer surface of the tubular member 36 of the inner wall member B is also of reduced section and is provided with suitable insulation and liner, generally indicated at 62.

The inner tubular member 24 of the outer wall member A is also provided with insulation and internal liner 64 to insure a uniform annular passage F for the hydrocarbon gas.

The outer heat resistant tip C forming the exposed face of the burner may be externally as well as internally water cooled if desired. This can be accomplished by the provision of a water coil 66 which is suitably wrapped around the exterior of the burner assembly and interconnected through the burner supporting flange 68 with water connections, of which one is indicated at 70.

Adjustment of the tips C and D may be accomplished in any desired manner, as by the adjustable flange 72, it being noted that spacers 74 are used to hold the two wall members in concentric relationship. These spacers 74, of which there may be three or more, are carried by the inner tubular member 24 of the outer wall member A. They are relatively narrow to minimize obstruction to gas flow, and may be streamlined to minimize turbulence.

As is generally practiced, partial oxidation requires a preheating of the gaseous reactants in the order of 400°–600° F. or higher, and the normal combustion temperature often exceeds 2500° F. While it has been suggested that the inner conduit member be locked in position with respect to the outer conduit member, this tends to set up objectionable stresses in the burner assembly and requires expansion devices which are complicated and readily serve as a source of leaks. In our preferred construction, the inner and outer conduit members are free to move with respect to each other, being guided by the spacers 74. However, to avoid any change of the angle of impingement of the flow axes, which is preferably at least 30° and usually does not exceed 60°, the discharge end surfaces on the outside of the inner conduit member and the inside of the outer conduit member are parallel right circular conic surfaces and the only variation which is possible in the gas flow is the volume which can pass through the passage 50. This can be controlled by the flange and bolt construction shown at 72 in FIG. 1.

It will be understood that the angle of impingement of the flow axes will vary with the cross sectional size of the burner, with the controlling limits of the intersection of the flow axes being 1½ to 3 inches beyond the face of the burner. Within these limits, there may be some further variation based on the type of fuel used.

The construction herein shown has been found to be unusually successful in commercial use and is particularly characterized in being easy to make, readily replaceable, simply cooled, and having long effective commercial life.

Obviously, other modifications and variations of the invention as hereinbefore set forth may be made without departing from the spirit and scope thereof and, therefore, only such limitations should be imposed as are indicated in the appended claims.

We claim:

1. A burner structure comprising an outer conduit and an inner conduit ending adjacent each other and spaced concentrically in adjustable relationship to define an annulus type burner tip, said outer conduit and said inner conduit each having a hollow wall construction throughout the entire length thereof and each having a diaphragm positioned therewithin to define a continuous passage within each conduit, and means to provide coolant to and withdraw coolant from each passage, the diaphragm within said outer conduit ending substantially at the discharge end thereof, and the diaphragm within said inner conduit ending adjacent the discharge end thereof.

2. An annulus type burner for synthesis gas generation by the partial oxidation of a gaseous hydrocarbon comprising a pair of concentrically spaced conduits for carrying reactants, the inner conduit of said pair of conduits ending in a substantially cylindrical discharge port, the outer conduit of said pair of conduits terminating adjacent said cylindrical discharge port thereby defining an annular discharge port, said pair of conduits having opposing parallel surfaces at their discharge ends directed toward the longitudinal axis of said burner thereby establishing an inward direction for said annular discharge port, said inner conduit being adjustable with respect to said outer conduit, each conduit having a hollow wall structure throughout the entire length thereof with a concentrically positioned web therein to form a continuous passage therewithin, the diaphragm within the hollow wall structure of said outer conduit ending in contact with the discharge end thereof, and the diaphragm within the hollow wall structure of said inner conduit ending adjacent the discharge end thereof, and means to provide coolant to and withdraw coolant from each passage.

3. In an annulus type burner as defined in claim 2, means to maintain the radial spaced relationship of said inner conduit with respect to said outer conduit, said inner conduit being adjustable with respect to said outer conduit, the discharge ends of said conduits each comprising a heat resistant element defining a burner tip, the angle of convergence of said inward direction of said annular discharge port with respect to said longitudinal axis being in the range of 15° to 30°, and means for separately supplying reactants to said pair of conduits.

4. A burner assembly for combustion of gas comprising an inner conduit having a substantially uniform circular cross section first gas path terminating in a cylindrical discharge port, an outer conduit disposed coaxially about said inner conduit in spaced adjustable relationship therewith and terminating adjacent said discharge port to define an annular passage between the conduits for a second gas path, the external terminal portion of the inner conduit and the opposite internal and the external terminal portion of the outer conduit being right circular conic surfaces, the terminal portions of said conduits being formed as coaxially spaced, truncated hollow cones forming a reduced diameter exposed coplanar face, said outer conduit forming with said inner conduit a relatively elongated upstream second gas path of uniform diameter and a downstream section of gradually reduced diameter extending to the discharge end of said inner conduit and terminating in an annular dis-

charge port, means for cooling said terminal portion of each of said conduits including an annular cooling chamber located within each of said conduits adjacent the discharge ports, the inner conduit and the outer conduit each having a hollow wall structure throughout the entire length thereof with a substantially concentric, centrally positioned web therein and in spaced relationship from the interior discharge ends thereof thereby defining a coolant course in each conduit via said annular cooling chamber adjacent each discharge port, the web within said outer conduit ending substantially at the discharge end thereof, and the web within said inner conduit ending adjacent the discharge end thereof.

5. In the burner assembly as defined in claim 4, said terminal portions of said conduits each comprising a heat resistant element, the interior and exterior surfaces of said inner conduit and the interior surface of said outer conduit having an insulating structure ending adjacent said terminal portions, the apex angle of said conic surfaces being in the range such that the flow axis of said second gas path intersects the flow axis of said first gas path not less than 1½ inches and not more than 3 inches beyond said exposed face of said burner assembly, said inner conduit being adjustable with respect to said outer conduit, and means to maintain the radial spacial relationship of said inner conduit with respect to said outer conduit.

6. An apparatus for the production of carbon monoxide and hydrogen from the partial combustion of a gasiform hydrocarbon comprising a burner structure for discharging and mixing separate streams of a gasiform hydrocarbon and an oxygen-containing gas which comprises a substantially cylindrical inner conduit member having an unobstructed central passageway of uniform diameter extending axially thereof and ending in a central discharge orifice for the passage therethrough and discharge therefrom of one of said streams, the outer surface of said inner conduit member at its discharge end having a right circular conic surface directed inwardly toward said discharge orifice, a substantially cylindrical outer conduit member coaxially surrounding said inner conduit member and spaced concentrically therefrom in adjustable relationship to form an annular passageway of uniform width leading to the annular discharge port for the passage therethrough of the other of said streams, the inner and outer surfaces at the discharge end of said outer conduit member being parallel to said right circular conic surface, the discharge ends of the conduit members being formed as coaxial, truncated hollow cones to define an exposed burner face of reduced diameter with respect to said conduit members, said conduit members each having a hollow wall structure and each having a substantially concentric, centrally positioned web therewithin and in spaced relationship from the discharge ends thereof thereby defining a flow passage in each conduit, means for providing coolant to and withdrawing coolant from the flow passages, the apex angle of said right circular conic surface varying from 30° to 60°.

7. A burner structure for synthesis gas generation by the partial oxidation of a gaseous hydrocarbon comprising an outer conduit and an inner conduit substantially concentric with and spaced from said outer conduit, means for separately supplying a gaseous hydrocarbon and an oxygen-containing gas to the conduits of said burner structure, said inner conduit being adjustable with respect to said outer conduit, means to maintain the radial relationship of said inner conduit with respect to said outer conduit, said conduits ending adjacent each other and each having a heat resistant element comprising a burner tip with both burner tips defining a burner face, said inner conduit and said outer conduit having a hollow wall construction and each having a substantially concentric, centrally located web therewithin ending adjacent each tip end to form a continuous water course around the tip end within each of said respective conduits, means to introduce cooling water to the water courses and means to remove water from said water courses, said burner tips having conical surfaces defining an annular discharge port directed inwardly toward the longitudinal axis of said conduits, said inner conduit having a central discharge port, the apex angle of said conical surfaces defining said annular discharge port being in the range of 30° to 60° such that the flow axes of gas streams discharged from the ports intersect not less than 1½ inches and not more than 3 inches from said burner face.

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