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PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Process and Apparatus for Preparing Gas Mixtures Containing Hydrogen and Carbon Monoxide

We, SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ N.V. a company organised under the laws of The Netherlands, of 30 Carel van Bylandtlaan, The Hague, The Netherlands, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a process and apparatus for preparing gas mixtures containing hydrogen and carbon monoxide by partial combustion of hydrocarbon material with an oxygen-containing gas.

Processes of the above general type are known, e.g. from British Patent Specification 780,120. According to that specification, hydrocarbon material is introduced under pressure into a combustion chamber of special shape together with an oxygen-containing gas, special means being provided for ensuring intimate mixing of the basic materials. Similar processes also require specific arrangements for ensuring a satisfactory conversion of the hydrocarbon, for preventing the formation of unallowable amounts of soot, and also for avoiding harmful effects on the process apparatus, for instance corrosion, erosion or melting of the refractory (e.g. as a result of unequal heat distribution with the occurrence of hot spots or of a maldistribution of the reaction media).

The present invention provides a process and apparatus which has a particular advantage over known processes, namely that gas mixtures can be prepared in relatively small amounts in apparatus of reduced size compared with known installations. The invention can be advantageously applied in cases where the produced gases are directly to be consumed in installations such as gas fuelled furnaces (e.g. blast furnaces), in which case apparatus according to the invention can be located quite close to the gas consuming installation. In principle, the invention is also suitable for the production of a combustible gas for other purposes.

In the process according to the present invention, a hydrocarbon material is injected into a stream of hot combustion gases immediately before introducing that stream as a jet of high velocity via an inlet into a reaction space, oxygen-containing gas being supplied to the jet of hot gases containing the hydrocarbon material (preferably tangentially around the jet), the resultant gas mixture being drawn off from the reaction space through at least one gas outlet, and the outlet being so positioned in relation to the inlet as to ensure the required residence time in the reaction space.

The reaction space may be designed, if so desired, to receive two or more streams of hot combustion gases, each supplied with oxygen-containing gas as described above, and said streams are then introduced in the form of jet to the reaction space.

The process is preferably carried out at superatmospheric pressure.

In the present invention, the stream or streams of hot gases may be introduced into the reaction space at sonic velocity so as to prevent pressure differences occurring in the reaction space influencing the stability in the combustion chamber communicating with the reaction space, in which chamber the hot gases are produced.

The hydrocarbon material preferably consists of a liquid hydrocarbon at a storage temperature of about 20° C. and at atmospheric pressure. The oxygen-containing gas may be air or air enriched with oxygen or

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even pure oxygen. The hot combustion gases may be obtained by burning a hydrocarbon, either gaseous or liquid, with air, preferably in stoichiometric proportions, in a high intensity combustion.

The oxygen-containing gas may be preheated so as to increase the thermal efficiency of the process. In some cases, particularly when the produced gases need not be consumed directly, the produced gases may be employed as the heating medium by which the dual effect is obtained that the gases are cooled and at the same time the air or the like is preheated.

Apparatus suitable for carrying out the above process according to the present invention comprises a reaction vessel and means for producing hot combustion gases for introducing into the reaction chamber at high velocity, said reaction vessel comprising (i) at least one inlet having a central opening for introducing a stream of hot combustion gases containing hydrocarbon, and at least one opening for introducing oxygen-containing gas into said stream (said opening being in a plane at right angles to said stream and tangential to the circumference of the inlet), and (ii) at least one outlet for the resultant gas mixture.

The means for producing the stream or streams of hot combustion gases preferably comprise a mainly cylindrical combustion chamber, axial to each central inlet opening, with a converging gas outlet port terminating in a narrowed outlet opening, and a burner nozzle at the opposite end of the chamber for supplying a mixture of hydrocarbon fuel and air, the narrowed outlet opening having an annular recess via which hydrocarbon is introduced into the gas stream. A second annular recess may be provided in the narrowed outlet opening, for the optional introduction of water or steam into the gas stream.

The combustion chamber may have a water-cooling mantle or channel in the wall thereof, and the cylindrical part thereof may have a heat resisting refractory lining. The burner nozzle part may consist of a non-ferrous material, especially in cases where oxygen or enriched air is used in the combustion chamber instead of air so as to decrease the amount of inert nitrogen in the hot gas stream.

In a preferred embodiment, the reaction chamber is elongate, has a rectangular cross-section, is closed at one end, has at the opposite end one or more inlets, and has outlets arranged in the side walls near each corner at the inlet end of the reactor. More specifically, the reactor may have a square cross-section and an inlet centrally arranged at one end.

The present invention will now be further described with reference to the drawings accompanying the provisional specification, in which: Figure 1 is a diagrammatic longitudinal section of apparatus for carrying out the process according to the invention; and Figure 2 is a detail on an enlarged scale of a preferred embodiment of the combustion chamber for creating the hot gas stream.

In Figure 1, the apparatus comprises a reaction chamber of elongated shape and square cross-section. The walls thereof may consist of refractory material surrounded by a steel mantle. At the bottom, the chamber 1 has a central opening 2. A stream of hot combustion gases 3 containing hydrocarbon is introduced via the opening 2 into the space 4 from a central inlet 5 communicating with a combustion chamber 6. Around said stream, an oxygen-containing gas (e.g. air) is introduced via a tangential inlet 7. The apparatus also has gas outlets 8 arranged in the bottom corners.

As indicated by the arrows, the gas stream rises during operation to the top of the reactor, after which the gases turn outwardly to the wall part and then return downwardly to the gas outlets 8. During the downward movement, intimate mingling between ascending and descending gases takes place, which promotes an equal heat distribution and vigorous mixing of the reaction media. A special advantage of the square cross-section of the chamber 1 is that in the four corners a relatively undisturbed stream of gaseous reaction products is allowed to descend towards the gas outlets 8 arranged in the corners.

In Figure 2, the combustion chamber (item 6 in Figure 1) is shown on an enlarged scale. The chamber is cylindrical and is partly double-walled so as to create a water-cooling mantle 10 in the wall part 9. The mantle 10 has an inlet 11 and an outlet 12 at the opposite side thereof. The cylindrical part of the combustion chamber has a refractory lining 13. Radiant heat reflected from the lining 13 during operation will contribute to equalise the heat distribution over the length of the chamber. The chamber is provided at one end with a burner, comprising a supply tube 14 for fuel premixed with air (e.g. propane and air) and a burner nozzle 15 suitable for introducing a concial jet of fuel and air into the chamber. At the opposite end, the combustion chamber has a converging outlet port 16 terminating in a narrowed outlet opening 17. The opening 17 has a first recess 18 connected to a supply line 19 for introducing a hydrocarbon into the gas stream, and a second recess 20 connected to a supply line 21 for introducing water into said stream.

The burner nozzle 15 is connected with a central barrel 22 having a fuel supply channel 23 and containing at the end a non-return spring loaded ball valve 24. A fuel distributing chamber 25 communicates via ports 26 with a laterally arranged fuel supply slit

27 issuing into a conical supply channel 28 for the air (or oxygen) near the outlet end thereof.

An apparatus as described above has been built on pilot plant scale, and tests carried out with this apparatus gave satisfactory results.

It is possible to construct apparatus according to the present invention in quite different ways. For instance, a cylindrical reactor having inlets situated at right angles and tangentially to the side wall of said reactors can be used, each inlet comprising an axial combustion chamber of the type described with reference to Figure 2. Also, more elongated shapes of the reactor can be used (enabling provisions of gas outlets at the top) if suitable intermixing and sufficient residence time of the reaction media can be ensured.

WHAT WE CLAIM IS:—

1. A process for preparing gas mixtures containing hydrogen and carbon monoxide by partial combustion of hydrocarbon material with an oxygen-containing gas, comprising injecting the hydrocarbon material into a stream of hot combustion gases immediately before introducing that stream as a jet of high velocity via an inlet into a reaction space, oxygen-containing gas being supplied to the jet of hot gases containing the hydrocarbon material, the resultant gas mixture being drawn off from the reaction space through at least one gas outlet, and the outlet being so positioned in relation to the inlet as to ensure the required residence time in the reaction space.

2. A process according to claim 1, in which the oxygen-containing gas is supplied tangentially around the jet of hot gases containing the hydrocarbon material.

3. A process according to claim 1 or 2, in which streams of hot combustion gases containing hydrocarbon material are introduced in the form of a jet to a common reaction space, each of the streams being supplied with oxygen-containing gas.

4. A process according to any one of claims 1 to 3, in which the process is carried out at superatmospheric pressure.

5. A process according to any one of the claims 1 to 4, in which the stream or streams of hot gases are introduced into the reaction space at sonic velocity.

6. A process according to any one of claims 1 to 5, in which the hydrocarbon material is a liquid hydrocarbon at a storage temperature of about 20° C. and at atmospheric pressure.

7. A process according to any one of claims 1 to 6, in which the oxygen-containing gas is air.

8. A process according to claim 7, in which the oxygen-containing gas is air enriched with oxygen.

9. A process according to any one of claims 1 to 6, in which the oxygen-containing gas is pure oxygen.

10. A process according to any one of claims 1 to 9, in which the hot combustion gases are obtained by burning a hydrocarbon with air in a high intensity combustor.

11. A process according to any one of claims 1 to 10, in which the oxygen-containing gas is preheated before being introduced into the gas streams.

12. A process according to claim 11, in which the oxygen-containing gas is preheated by heat exchange with the produced gases.

13. A process for preparing gas mixtures containing hydrogen and carbon monoxide, substantially as described with reference to the accompanying drawings.

14. An apparatus suitable for carrying out a process according to any one of claims 1 to 13, comprising a reaction vessel and means for producing hot combustion gases for introducing into the reaction chamber at high velocity, said reaction vessel comprising (i) an inlet having a central opening for introducing a stream of hot combustion gases containing hydrocarbon and an opening for introducing oxygen-containing gas into said stream and (ii) an outlet for the resultant gas mixture.

15. An apparatus according to claim 14, in which the opening for introducing oxygen-containing gas into the stream of hot combustion gases is in a plane at right angles to the axis of the inlet and tangential to the circumference of said inlet.

16. An apparatus according to claim 14 or 15, in which the means for producing the stream or streams of hot combustion gases comprise a mainly cylindrical combustion chamber, axial to each central inlet opening, with a converging gas outlet port terminating in a narrowed outlet opening, and a burner nozzle at the opposite end of the chamber for supplying a mixture of hydrocarbon fuel and air, the narrowed outlet opening being provided with an annular recess via which the hydrocarbon is introduced into the gas stream.

17. An apparatus according to claim 16, in which a second annular recess is provided in the narrowed outlet opening for the introduction of water or steam into the gas stream.

18. An apparatus according to any one of claims 14 to 17, in which the combustion chamber has a water-cooling channel or mantle in the wall thereof.

19. An apparatus according to any one of claims 14 to 18, in which the cylindrical part of the combustion chamber has a heat-resisting refractory lining.

20. An apparatus according to any one of claims 14 to 19, in which the burner nozzle part consists of a non-ferrous material.

21. An apparatus according to any one of

claims 14 to 20, in which the reaction chamber is elongate, has a rectangular cross-section, is closed at one end, has at the opposite end an inlet, and has outlets arranged in the side walls near each corner at the inlet end of the reactor.

22. An apparatus according to claim 21, in which the reactor has a square cross-section and an inlet centrally arranged at one end.

23. An apparatus for preparing gas mixtures containing hydrogen and carbon monoxide, substantially as described with reference to the drawings accompanying the provisional specification.

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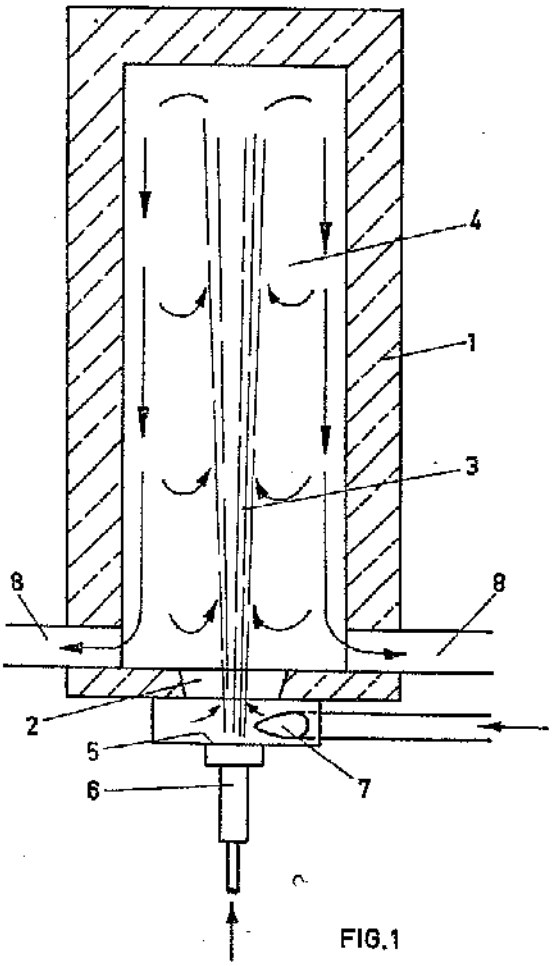

FIG.1

1033924 PROVISIONAL SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheets 1 & 2

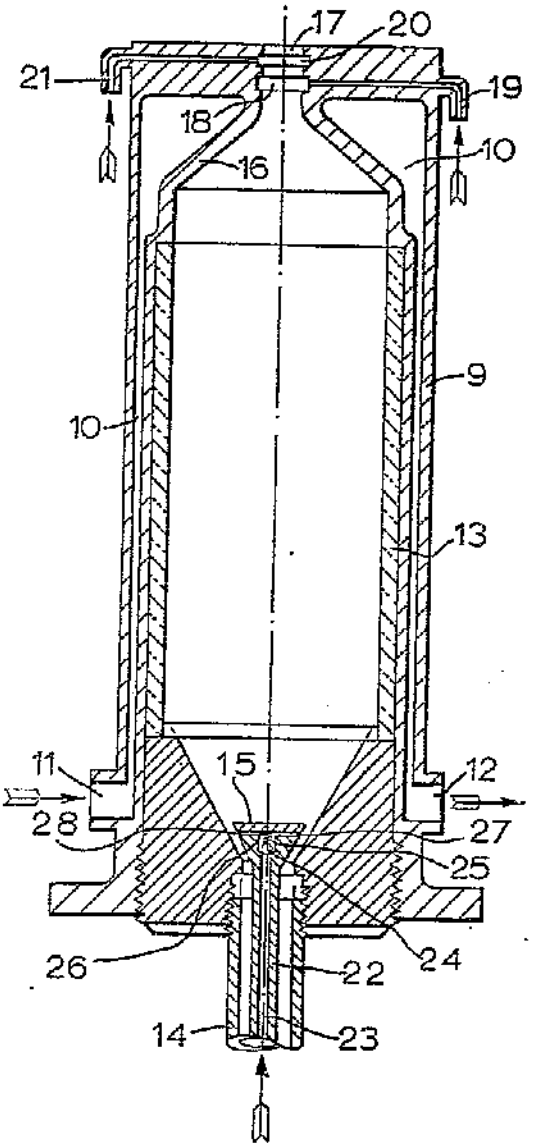

FIG. 2

1063924 PROVISIONAL SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheets 1 & 2

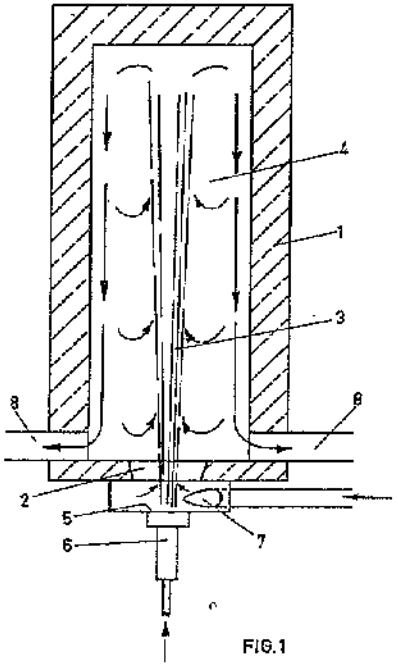

FIG.1

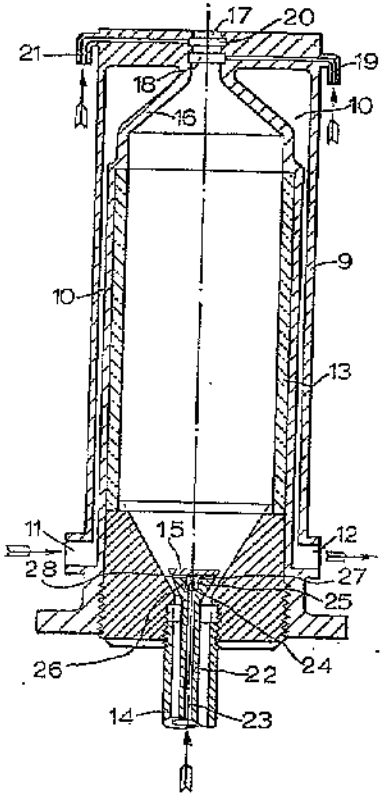

FIG. 2