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(54) APPARATUS FOR THE PREPARATION OF A GAS MIXTURE CONTAINING HYDROGEN AND CARBON MONOXIDE

(54)

(72)	(Country):	**LEONARD W. TER HAAR** (Not Available)
(73)	(Country):	**SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ, N.V.**
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The invention relates to an apparatus for the preparation of a gas mixture comprising hydrogen and carbon monoxide, including a reaction chamber for the partial combustion of hydrocarbons with oxygen or with oxygen-enriched air, with the optional supply of steam, at superatmospheric pressure, and a waste-heat boiler connected to the gas discharge of the reaction chamber, in which the waste-heat boiler is provided with two or more helical tubes through which are passed the gases to be cooled.

In the reaction chamber of the apparatus a gas mixture is obtained by partial combustion of the hydrocarbons, which gas mixture contains hydrogen and carbon monoxide and in addition soot. The amount of soot in the gas mixture may be up to 5% by weight. The gas mixture, which has a high temperature of, for example, 1300°C - 1400°C upon leaving the reaction chamber, and is at a pressure of from 5 - 150 atmospheres, is cooled in the waste-heat boiler. Thus, the gas mixture flows through the helical tubes around which a coolant flows. The waste-heat boiler is usually designed as a vertical cylindrical vessel with an inner tube, and is provided with a bottom plate to which are connected one or more helical tubes for the hot gases to be cooled, accommodated in the annular space formed by the outer wall and the inner tube, the lower end of the tube(s) to being in communication with a connecting piece which is connected to the gas outlet of the reaction chamber. The coolant inlet is linked to the said inner tube, the lower end of which is provided with a spray nozzle, in such a way that the coolant supplied through this tube can be sprayed against the hot bottom plate before it is passed upwards in the said annular space.

In an embodiment of the waste-heat boiler in which two or more helical tubes are connected to the bottom plate, cooling of the bottom plate and of the helical tubes is not always equally satisfactory. Moreover, cooling even fails if the pressure of the coolant being passed through the said inner tube disappears as a result of an operational breakdown. The invention now provides means by which the above drawbacks are overcome.

The invention relates therefore to an apparatus for the preparation of a gas mixture comprising hydrogen and carbon monoxide, including a reaction chamber for the partial combustion of hydrocarbons with oxygen or with oxygen-enriched air, with the optional supply of steam, at superatmospheric pressure, and a waste-heat boiler connected to the gas discharge of the reaction chamber, in which the waste-heat boiler is provided with two or more helical tubes, each connected to a straight tube, through which the gases to be cooled are passed around which helical tubes a coolant may flow, and in which the waste heat boiler is provided with a line for a coolant said line comprising two concentric tubes issuing into a spray nozzle which nozzle comprises a central ejector and at least one ancillary ejector arranged at the side of the central ejector and is positioned in such a way that the coolant reaches the gas inlet end of the straight tubes, the said nozzle being constructed such that coolant from the inner tube of the said concentric tubes serves as feed for the ejectors, whereas coolant is sucked out from the outer tube by the said ejectors.

The straight tube to which the helical tubes are connected may have the length required to form the connection between the first coil of the helical tubes and the bottom plate, in which case they serve as connecting piece. However, the tube lengths may also be selected longer, for example, if this is desirable for constructional reasons in view of the space available at the gas inlet side of the waste-heat boiler, or if it is desired to reduce the temperature of the gases before they enter the first coil of the helical tubes.

The use of two concentric tubes which issue into a spray nozzle, the coolant, which is preferably passed into the inner tube under pressure, feeding the ejectors and the ejectors also sucking water out from the outer tube which is, for example, linked to a vessel containing coolant and arranged above the waste-heat boiler, ensures that nevertheless some cooling is obtained by means of the coolant present in the outer tube if the supply of coolant to the inner tube is interruped, thereby giving a brief

period of grace for taking the measures required to eliminate the defect. The use of a spray nozzle comprising a central ejector and at least one ancillary ejector ensures a satisfactory cooling of both the bottom plate and of the straight tubes at their gas inlet ends. This is particularly the case if the number of ancillary ejectors is equal to the number of straight tubes and these ejectors co-operate with spray nozzle arms arranged symmetrically and issuing between the straight tubes. These arms are preferably curved in such a way that the outflowing coolant acquires a direction of movement with a horizontal velocity component.

In a particular embodiment of the apparatus the space of the waste-heat boiler in which the spray nozzle is accommodated, has, at the point where the nozzle is connected to the concentric tubes, a free cross-sectional area which does not exceed 30% of the space accommodating the helical coils. This results in an improved flow of the coolant through the waste-heat boiler.

The above free cross-sectional area may be given the desired value by arranging baffle plates, which, for example, with a waste-heat boiler having four straight tubes, may have the shape of a curved shield and be disposed symmetrically along the wall of the space, the concave side facing the wall.

If desired, the temperature of the gases to be cooled may be lowered by injecting a coolant, for example, water, into the gases after they have left the reaction chamber. This precooling of the gases may be carried out continuously or temporarily, for example, if difficulties are encountered in the supply of coolant to the waste-heat boiler.

The invention will now be further explained with reference to the diagrammatic drawing, in which different embodiments of the apparatus according to the invention are shown by way of example.

Figure 1 is a diagrammatic representation of an apparatus for the partial combustion of hydrocarbons and the cooling thereof.

Figure 2 is a side view of an embodiment of the waste-heat boiler.

Figure 3 shows a cross-section of an embodiment of the waste-heat boiler through the space accommodating the straight tubes, i.e., immediately above the outflow point of the arms with which the ancillary ejectors co-operate, and in which the waste-heat boiler is provided with four helical tubes each linked to a straight tube.

Figure 4 shows a cross-section of an embodiment of the waste-heat boiler through the space accommodating the straight tubes, i.e. at some distance above the level at which the spray nozzle is connected, and in which the waste-heat boiler is provided with four helical tubes each linked to a straight tube and with four baffle plates which are arranged in the space accommodating the straight tubes and which extend to near the bottom plate.

Referring to Figure 1, part A represents the actual reactor, which is provided with a fuel supply line a leading to a burner part A' of the reactor, and an oxygen supply line b, while steam, if used, may be supplied through both a and b. Part B is a connection between the reactor and a connecting piece C. The hot gases are passed through the connection B and the connecting piece C to a waste-heat boiler D which is provided with two straight tubes and two helical tubes, and further with discharges c and d for the cooled gases, and inlets e and f for the coolant, for example, water, and an outlet k for the coolant. The straight tubes are designated by g and h and the helical tubes by i and j.

Figure 2 is a side view of a part of the embodiment of the waste-heat boiler. The waste-heat boiler comprises a cylindrical vessel 1 having a bottom plate 2, placed on a connecting piece 3 which is provided with a gas supply line 4. The waste-heat boiler further comprises the concentric tubes 5 and 6 through which the coolant is supplied

(the coolant is under pressure in tube 6), the bottom ends of which are linked to a spray nozzle comprising a central ejector 11 which co-operates with a central arm 12 and two ancillary ejectors 7 and 8 which co-operate with the arms 9 and 10, respectively. The coolant, in general water, which is supplied through the tubes 5 and 6 is sprayed against the bottom plate by the arms 9, 10 and 12 and subsequently flows upwards, thereby cooling the straight tubes 13 and 14.

Figure 3 is a cross-section through the space accommodating the straight tubes, taken immediately above the outflow point of the arms with which the ancillary ejectors co-operate, of an embodiment of the waste-heat boiler having the configuration shown in Figure 2, but which has four helical tubes each connected to a straight tube. The cross-section shows the four straight tubes, the central arm of the spray nozzle and the four arms with which the ancillary ejectors co-operate. In the drawing the reference numerals 21,22,23 and 24 designate the straight tubes, 25 is the central arm of the spray nozzle and 26, 27, 28 and 29 designate the arms with which the ancillary ejectors co-operate. The outflowing coolant acquires a horizontal component of movement as a result of the lateral curvature of the arms 26, 27, 28 and 29.

Figure 4 is a cross-section through the space accommodating the straight tubes of an embodiment of the waste-heat boiler having the configuration shown in Figure 3, but in which the cross-section is taken at some distance above the point at which the spray nozzle is connected. The cross-section shows the four straight tubes, the concentric tubes through which the coolant flows and the baffle plates for the coolant. In the drawing the reference numerals 31, 32, 33 and 34 designate the straight tubes, 35 is the inner tube through which the coolant flows under pressure, 36 is the outer tube through which the coolant is sucked along by the ejectors, and 37, 38, 39 and 40 designate the baffle plates for the coolant.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. An apparatus for the preparation of a gas mixture comprising hydrogen and carbon monoxide, including a reaction chamber for the partial combustion of hydrocarbons with oxygen or with oxygen-enriched air, with the optional supply of steam, at superatmospheric pressure, and a waste heat boiler connected to the gas discharge of the reaction chamber, in which the waste-heat boiler is provided with two or more helical tubes, each connected to a straight tube, through which the gases to be cooled are passed, around which helical tubes a coolant may flow, and in which the waste-heat boiler is provided with a line for a coolant, said line comprising two concentric tubes issuing into a spray nozzle which nozzle comprises a central ejector and at least one ancillary ejector arranged at the side of the central ejector, and is positioned in such a way that the coolant reaches the gas inlet end of the straight tubes, the said nozzle being constructed such that coolant from the inner tube of the said concentric tubes serves as feed for the ejectors, whereas coolant is sucked out from the outer tube by the said ejectors.

2. An apparatus as claimed in claim 1, in which the number of ancillary ejectors is equal to the number of straight tubes and the said ejectors co-operate with spray nozzle arms arranged symmetrically and issuing between the straight tubes.

3. An apparatus as claimed in claim 2, in which the arms with which the ancillary ejectors co-operate are curved in such a way that outflowing coolant acquires a direction of movement with a horizontal velocity component.

4. An apparatus as claimed in claim 1, in which the space around the spray nozzle at the point where said nozzle is connected to the concentric tubes has a free cross-sectional area which does not exceed 30% of the space accommodating the helical tubes.

5. An apparatus as claimed in claim 4, in which baffle plates are present in the space accommodating the straight tubes.

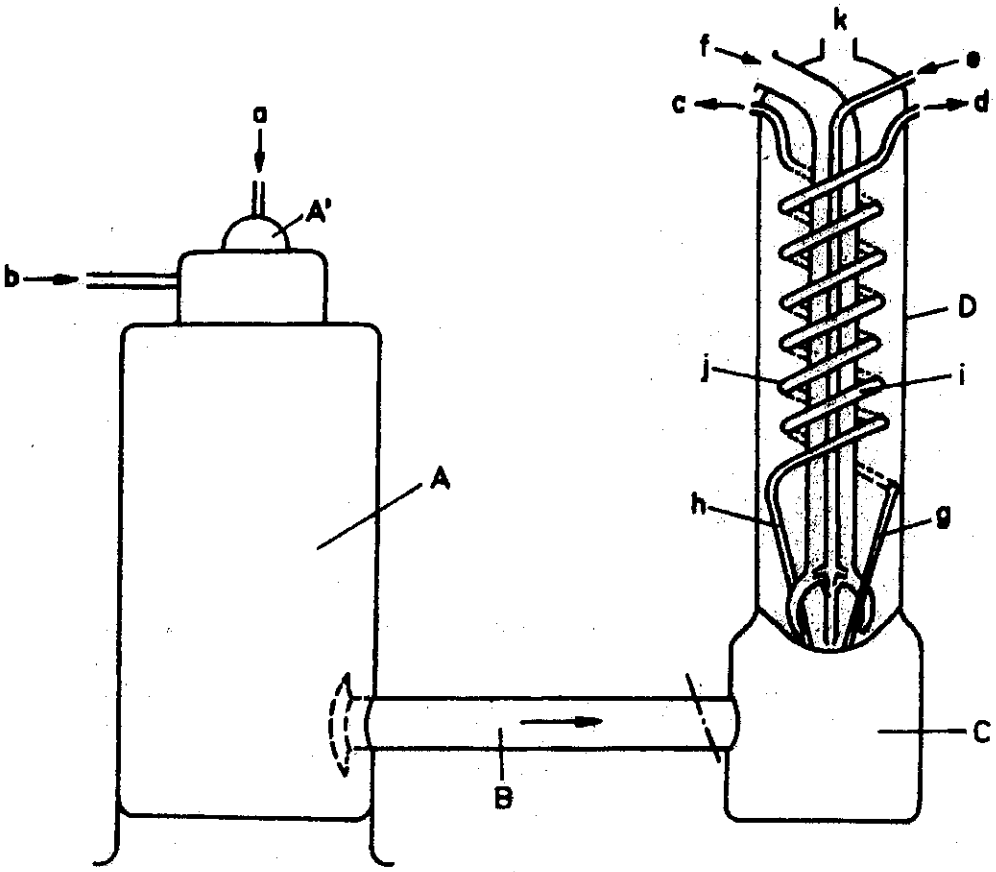

FIG. 1

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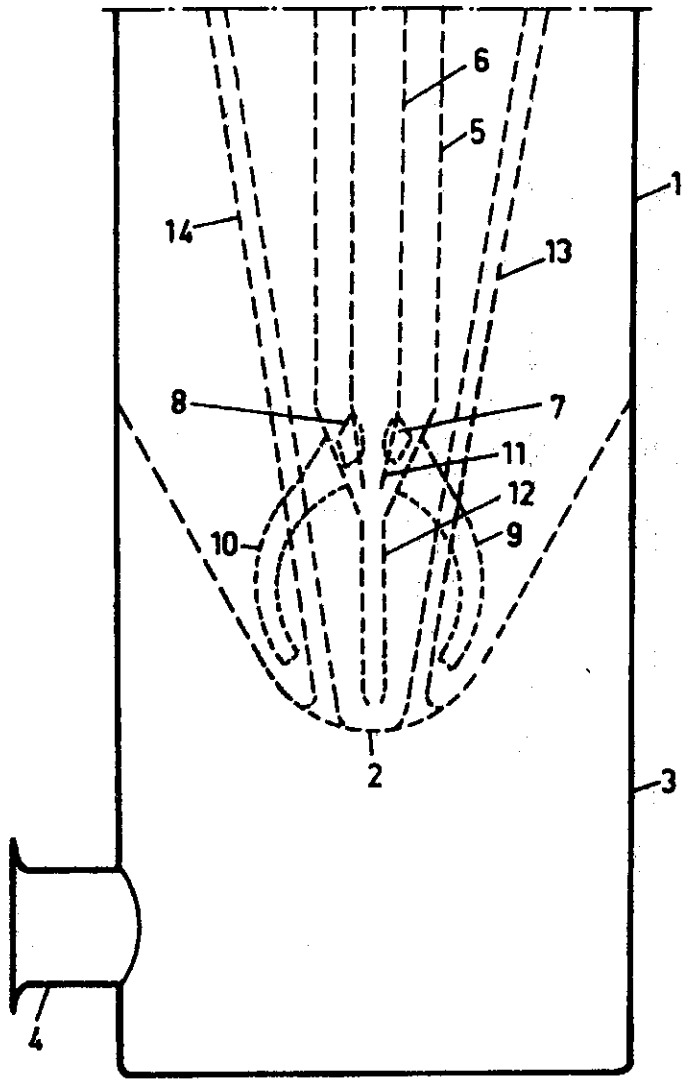

FIG. 2

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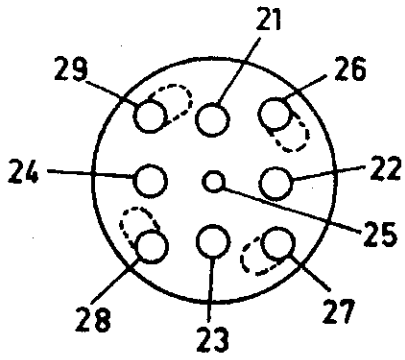

FIG. 3

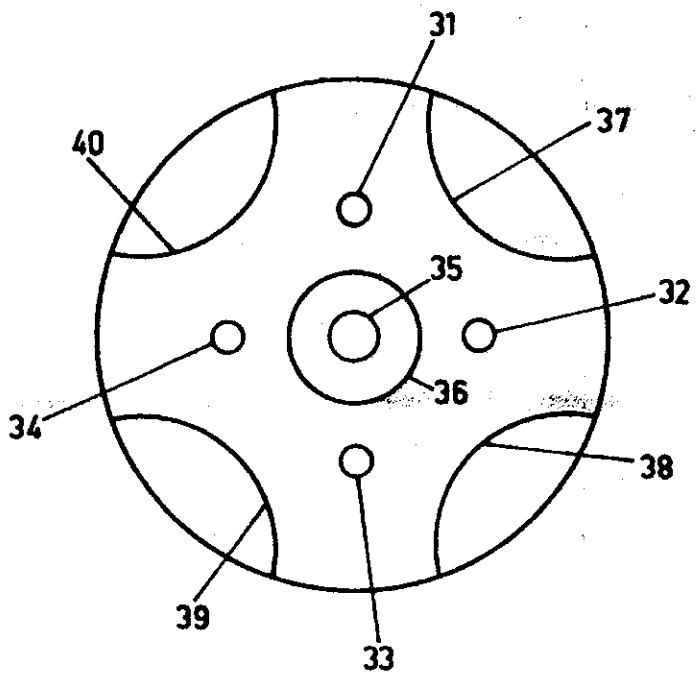

FIG. 4

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