

UNITED STATES PATENT OFFICE

2,302,156

PROCESS AND APPARATUS FOR THE PRODUCTION OF USEFUL FUEL GAS

Friedrich Totzek, Essen, Germany, assignor, by mesne assignments, to Koppers Company, Pittsburgh, Pa., a corporation of Delaware

Application May 20, 1940, Serial No. 336,124
In Germany May 27, 1939

9 Claims. (Cl. 48—74)

This invention relates to the production of fuel gas of high heating power out of dusty or finely granular fuels, such as black or brown coal, or coke or semi-coke made therefrom, the fuel being converted at a high temperature with air (oxygen), steam and carbon dioxide, whereby a gas is produced which is rich in hydrogen and carbon monoxide.

It is possible to produce a fuel gas of high calorific value in such a manner that part of the finely reduced fuel is burnt in a coal dust firing chamber and the hot gases produced are brought into contact with the other part of the reduced fuel, the mixture then being passed continuously, preferably in circular current, through a cylindrical reaction chamber, steam being added to the mixture of fuel dust and hot combustion gases leaving the coal dust firing chamber.

The present invention has for its principal object to produce a high grade fuel gas out of dusty or finely granular fuels in such a manner that part of the produced fuel gas, preferably after a suitable preheating, is burnt with oxygen (air) and the combustion gases of high temperature thus produced are mixed with the fuel dust, whereupon the mixture is treated with steam.

Contrary to a former method, this invention enables a considerable simplification of the gas production in that a special coal dust burner together with the requisite comparatively complicated auxiliary contrivances are dispensed with and replaced by a gas-air burner which is a simple means from a constructional and operating point of view.

Another advantage of the present invention is that the production of hot combustion gases of a certain uniform high temperature may be carried out in a considerably simpler way by the combustion of fuel gas than is the case with the combustion of fuel dust. Thus the temperature of the hot gases mixed with the fuel dust may be raised approximately up to that point which is limited by the durability of the building material necessary for the construction of the reaction chamber.

A further characteristic feature of my invention is that the hot mixture of gas and fuel dust is brought into contact with a highly heated mixture consisting of steam and combustion gases which is obtained by the combustion of fuel gas, preferably by burning part of the fuel gas produced and by mixing the hot combustion gases with steam, if possible with superheated steam. The combustion gases contained in the steam-gas mixture preferably serve as a heat car-

rier and assist the conversion of steam with carbon in such a manner that a fuel gas similar to water gas with a high calorific value is obtained.

In order that my invention may be clearly set forth and understood, I now describe with reference to the accompanying drawing a preferred manner in which it may be carried out and practiced. In the drawing,

Fig. 1 is a vertical section through an apparatus built according to this invention for carrying out the process.

Fig. 2 is a horizontal section on line II—II of Fig. 1.

Referring to the drawing, a gas producer is illustrated which has a gas reaction chamber 1 having substantially the shape of a horizontal cylinder formed by refractory brickwork 2 placed in a metal jacket 3. At one axial end of the gas reaction chamber 1 there is arranged a multiple flamed gas-air burner 4 which terminates substantially tangentially into the gas producer chamber 1, as may be seen from Fig. 1. In front of the burner 4, in the wall 2 of the gas reaction chamber 1 there is provided a recess 5 serving as a mixing box, into which terminates the slot-like fuel dust supply 6. The fuel dust to be gasified is filled into the delivery slot 6 in a well distributed manner and meets the hot combustion gases within the mixing box 5, said combustion gases escaping from the burner 4 at high velocity. The fuel dust is finely distributed by the hot combustion gases and in this form it is delivered tangentially into the gas producer chamber 1. The mixture of fuel dust and gas moves through the gas reaction chamber 1 in a spiral-like current. The effective or useful gas produced is withdrawn axially from the gasifying chamber 1 through the opening 7 at the axial end of the producer opposite the end at which the burner 4 is arranged.

A series of ring-like distributing channels 8 is provided in the bricklining 2 of the gas producer chamber 1. These channels are connected in pairs or in groups with the main-distributing ducts 9, 10 as may be seen from Figure 2. Furthermore the ring-like distributing channels 8 are coupled with the gas producer chamber 1 by means of nozzle-like apertures 11.

The apertures 11 are carried out in such a manner that they terminate nearly tangentially into the gas reaction chamber 1. The media introduced through the apertures 11 into the gas producer chamber 1 therefore assist the circular movement of the fuel dust through the gas reaction chamber 1 and prevent the dust from be-

ing deposited in large layers upon the bottom of the gas reaction chamber 1. Moreover, the apertures are inclined in the direction of the longitudinal axis of the gas reaction chamber 1. The spiral-like movement of the fuel dust as mentioned above, is due to this construction. The fuel dust therefore moves from the mixing box 5 arranged at the one end of the gas producer chamber gradually in a spiral-like current to the gas exit 7 situated at the opposite front side of the gas reaction chamber 1.

Beside the gas producer 1 there are arranged two steam superheaters 12, 13 which are connected by means of the channels 14, 15 with the main distributing ducts 9 and 10 respectively. Each steam superheater 12, 13 is equipped with a gas-air burner 16 which serves for the production of hot combustion gases of high temperature. Steam is introduced from above through the opening 17 (see Fig. 1) into the superheaters 12, 13 where the steam is intimately mixed with the hot waste gases of the gas-air burner 16. The highly-heated mixture of gas and steam then flows through the channels 14, 15, the main distributing ducts 9, 10 and the ring-like distributing channels 8 to the apertures 11 through which it passes tangentially into the gas producer chamber 1 at high velocity.

The fuel dust residue depositing on the bottom of the gas reaction chamber 1 gradually reaches the ash-outlet 18 lying at the useful-gas exit end of the chamber 1, due to the spiral-like motion of the gasifying media. The ring-like channels 8 are likewise equipped with special ash-outlets 19 through which the residue may be discharged which latter has passed through the aperture 11 and accumulated in the channels 8.

The fuel gas supplied to the burner 4 and to the burner 16 is taken from the useful-gas stream preferably after the useful-gas has been dedusted. Part of the useful-gas produced is in continuous circulation through the gas producer. The calorific value of the gas is advantageously improved if the conversion of the fuel dust with fuel gas and steam takes place at a low velocity only.

As may be seen from Fig. 1, steam is introduced into the gas reaction chamber 1 even at that part of the reaction chamber wall lying directly opposite the burner 4. This part of the chamber wall is exposed to very high temperatures due to the combustion of gas and air within the burner 4. On account of the fact that steam is introduced from this part of the wall into the gas reaction chamber, a very rapid reaction is caused there with the fuel dust whereby the temperature is reduced to such an extent that the refractory building material may not be superheated at this point, as endothermic conversions are carried into effect. The separation of the ring-like channel series 8 into two groups to be operated independently from each other, as illustrated on the drawing, or into several groups offers the advantage that it is possible to run the various zones of the gas producer 1 with hot gas-steam mixtures of different composition. Thereby it is possible to maintain the most favourable efficiency in any zone of the gas producer 1 without having to fear that dangerous superheatings occur at any point.

The nozzle-like openings in the wall of the gas producer through which steam and hot combustion gases may be introduced are suitably placed at such a distance from one another and

constructed in such a way that no dead spaces are formed between the nozzles in which fuel dust or ash may precipitate. The stream of gasifying media passing along the wall therefore prevents the ash from depositing and sticking onto the walls. Furthermore it is of advantage to arrange the nozzle-like openings along the wall of the gas producer chamber in a tessellated way e. g. like checker-work apertures, thus counteracting the formation of undesired dead spaces to a greater extent.

I have now above described my present invention on the lines of a preferred embodiment thereof but my invention is not limited in all its aspects to the mode of carrying it out as described and shown, since the invention may be variously embodied within the scope of the following claims.

I claim:

1. Apparatus for producing fuel gas of high calorific value from dusty or granular solid carbonaceous fuel, comprising: a gas reaction chamber having an elongated horizontal cylindrical wall; a fuel gas and air burner at one axial end of the cylindrical wall communicating substantially tangentially with the reaction chamber; a mixing chamber in front of the burner directly connecting the same with the reaction chamber; axial gas-outlet means at the end of the cylinder opposite the end thereof at which the burner is arranged; a series of annular channels around the reaction chamber coaxial with its horizontal cylindrical wall; a main distributing duct provided with means for supplying steam thereto, said annular channels being group connected with the distributing duct, and an annular series of nozzles connecting each annular channel with the reaction chamber.

2. Apparatus for producing fuel gas of high calorific value from dusty or granular solid carbonaceous fuel, comprising: a gas reaction chamber having an elongated horizontal cylindrical wall; a fuel gas and air burner at one axial end of the cylindrical wall communicating substantially tangentially with the reaction chamber; a mixing chamber in front of the burner directly connecting the same with the reaction chamber; axial gas-outlet means at the end of the cylinder opposite the end thereof at which the burner is arranged; a series of annular channels around the reaction chamber; an annular series of nozzles individual to and connecting each annular channel with the reaction chamber; a plurality of main distributing ducts, means for supplying steam thereto; each of the main distributing ducts being individual to and communicating with a group of the channels of the annular series of channels.

3. Apparatus as claimed in claim 2, and in which a separate steam superheater is provided for each of the main distributing ducts, each superheater communicably connecting the means for supplying steam with its respective main distributing duct.

4. Apparatus as claimed in claim 2, and in which a separate steam superheater is provided for each of the main distributing ducts, each superheater communicably connecting the means for supplying steam with its respective main distributing duct, and in which a fuel-gas and air burner is provided for each superheater for admixing hot combustion gas with the steam in the steam superheater.

5. Apparatus as claimed in claim 2, and in which some of the annular channels are disposed

directly opposite the burner for supply of steam from the part of the horizontal cylindrical wall opposite the burner which is exposed to very high temperatures due to the combustion of gas and air within the burner.

6. Apparatus as claimed in claim 1, and in which the openings of the nozzles into the reaction chamber are arranged around the circumference of the reaction chamber like checker-work apertures.

7. In a process for producing fuel gas of high calorific value from dusty or finely granular fuels such as black or brown coal, or coke or semi-coke made therefrom, which process comprises: a primary combustion of part of the fuel gas rich in hydrogen and carbon monoxide produced as an end product of the process, to produce hot combustion gas rich in CO_2 ; initially bringing the dusty or granular fuel in suspension into admixture with the hot combustion gases containing carbon dioxide from the primary combustion stage; converting the initially admixed fuel with the high temperature and CO_2 of the hot combustion gas of the primary combustion stage while flowing together at high velocity to react the solid fuel with the CO_2 to produce conversion gas rich in carbon monoxide, and completing the conversion of the residual fuel of the initially added dusty or granular fuel in the gas while still flowing together by treating the same with steam in the absence of additionally added dusty or granular fuel to produce a gas rich in hydrogen and carbon monoxide.

8. In a process for producing fuel gas of high calorific value from dusty or finely granular fuels such as black or brown coal, or coke or semi-coke made therefrom, which process comprises: a primary combustion of part of the fuel gas rich in hydrogen and carbon monoxide produced as an end product of the process, to produce hot combustion gas rich in CO_2 ; initially

bringing the dusty or granular fuel in suspension into contact with the hot combustion gases containing carbon dioxide from the primary combustion stage; converting the initially admixed fuel with the high temperature and CO_2 of the hot combustion gas of the primary combustion stage while flowing together at high velocity to react the solid fuel with the CO_2 to produce conversion gas rich in carbon monoxide; burning another part of the fuel gas rich in hydrogen and carbon monoxide produced as an end product of the process; mixing steam with the hot combustion gases thereof; and completing the conversion of the residual fuel of the initially added dusty or granular fuel in the gas while still flowing together by treating the same with aforesaid mixture of hot combustion gases and steam, in the absence of additionally added dusty or granular fuel to produce a gas rich in hydrogen and carbon monoxide.

9. Apparatus for producing fuel gas of high calorific value from dusty or granular solid carbonaceous fuel, comprising: a gas reaction chamber having an elongated horizontal cylindrical wall; a fuel gas and air burner at one axial end of the cylindrical wall communicating substantially tangentially with the reaction chamber; means for introducing the solid fuel in front of the burner at said axial end; a mixing chamber interposed between the burner and the means for introducing solid fuel on the one hand, and the conversion chamber on the other hand, and directly connecting tangentially with the reaction chamber for admixing the solid fuel with the hot combustion gases from the burner in advance of their entrance into the reaction chamber, and axial gas-outlet means at the end of the cylinder opposite the end thereof at which the burner is arranged.

FRIEDRICH TOTZEK.