

Feb. 13, 1940.

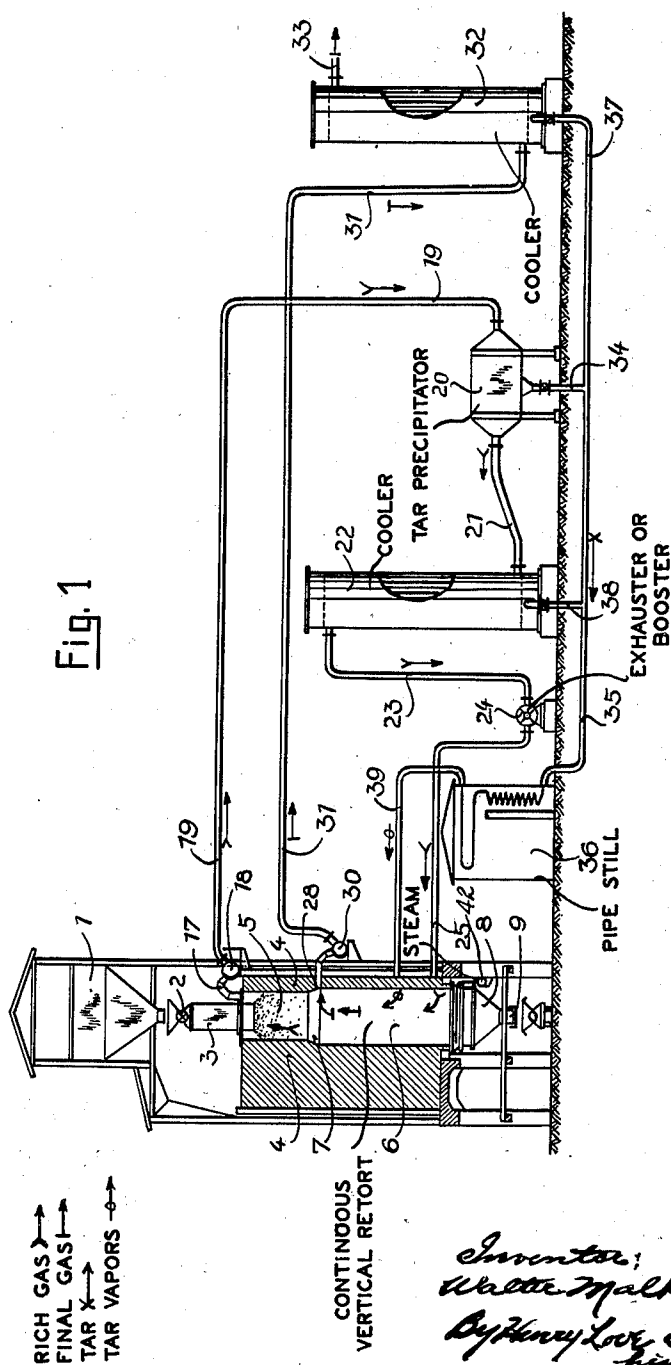
W. MALKOMES

2,190,293

PROCESS FOR THE PRODUCTION OF COMBUSTIBLE GASES FROM BITUMINOUS FUELS

Filed Nov. 11, 1936

2 Sheets-Sheet 1



Feb. 13, 1940.

W. MALKOMES

2,190,293

PROCESS FOR THE PRODUCTION OF COMBUSTIBLE GASES FROM BITUMINOUS FUELS

Filed Nov. 11, 1936

2 Sheets-Sheet 2

HEATING-GAS FLOW →
RICH GAS →
TAR DISTILLATION VAPOR →

Fig. 2

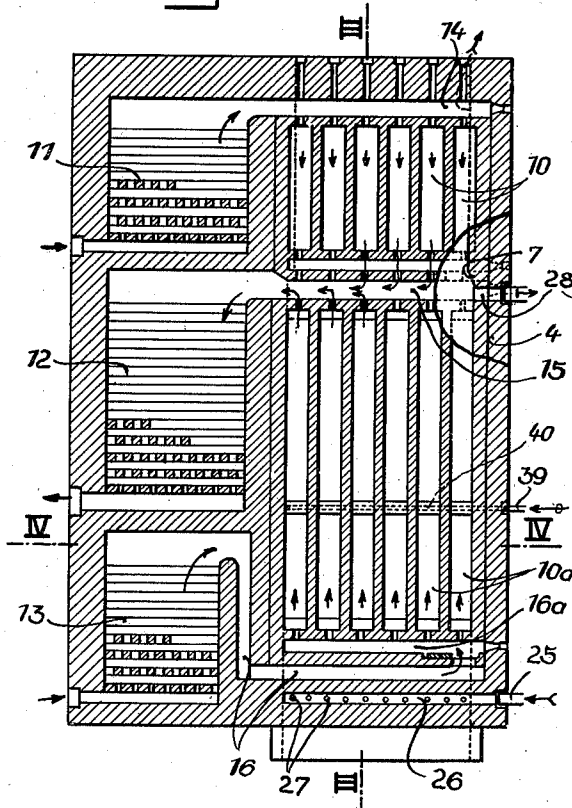


Fig. 3

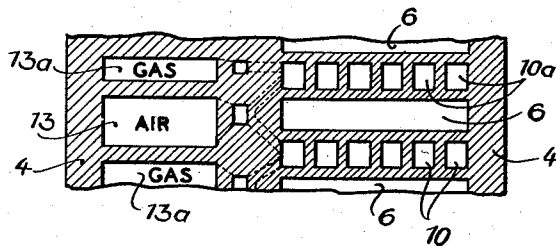
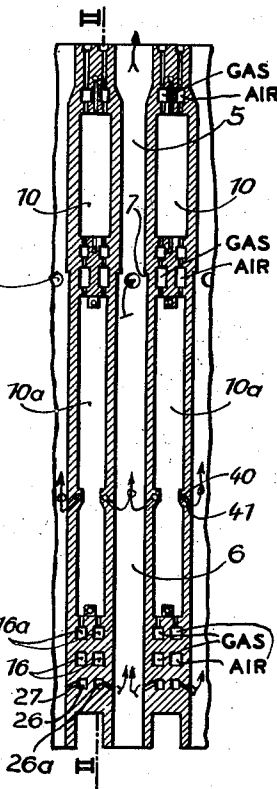


Fig. 4

Inventor:
Walter Malkomes
By Henry Love Clarke
Attorney

UNITED STATES PATENT OFFICE

2,190,293

PROCESS FOR THE PRODUCTION OF COMBUSTIBLE GASES FROM BITUMINOUS FUELS

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

Application November 11, 1936, Serial No. 110,211
In Germany November 12, 1935

4 Claims. (Cl. 202—16)

The invention relates to the production of combustible gases, such as gases from bituminous fuels in continuously operated vertical chambers or retort ovens, containing hydrogen and carbon monoxide with a low content of carbonic acid, or town gas with a high calorific value, so that along with the formation of the gas, coke may be obtained and possibly water-gas formed in the chamber or in the retort. Under the term "bituminous fuels" within the scope of this invention is to be understood the high-volatile pit coal, brown coal and in particular that brown coal, which can be briquetted or dried (for instance in the presence of steam), lignite, oil shale, or the like.

The principal object of my present invention is to provide such improvements in the process of the kind mentioned above so that gases of a given and constant composition can be made with a most favourable utilization of the fuel to be treated.

Formerly it has been tried to operate these retorts so as to extract the gases of the first distillation period, often called the low-temperature gases, in the upper part of the chamber of the continuous coking retort oven, for the purpose of removing the valuable combustible gases from raw brown coal and similar fuels in vertical chamber oven and then to introduce the gases into the highly heated coke at the lower end of the continuous coking retort oven chamber. In this way, it is possible on the one hand to convert the steam formed from the H_2O content of the initially introduced fuel into water-gas and on the other hand, to decompose (crack) the hydrocarbons of the low-temperature gas; but the quality and analysis of the gas which is finally withdrawn varies considerably and it is even impossible to produce the first kind of the above mentioned gases of a given composition according to the formula in which for instance, the ratio of hydrogen to carbon monoxide is 2:1 and from which valuable hydrocarbons (motor fuel) are later obtained by a catalytic reaction.

The process according to the present invention consists essentially in extracting from the gases of the first distillation period the fuel in the upper part of the chamber, by heating said upper part separately at comparatively low temperatures and withdrawing the gases in an adjustable and exactly regulatable quantity at the roof of the chamber. Thereupon, after a partial or complete detarring, the steam content of these gases is exactly adjusted by suitable cooling or other means, and the gases are introduced into the

highly heated coke at the lower end of the chamber, whereas the gases formed during the second period of distillation in the high-temperature zone at the lower part of the chamber which lower part is likewise heated separately from the upper part, are discharged together with the gases produced by the conversion or cracking of the low-temperature gases and vapours through a gas outlet, arranged between the high-temperature and low-temperature zone of the chamber. These gases leaving said outlet are the final product, useful for the purposes intended, for instance, as illuminating gas.

Furthermore, the invention consists in eliminating the tarry constituents from the gas of the first distillation period and from the gas of the second distillation period and subjecting the tar obtained either separately or conjointly to fractional distillation, whereupon the gases and vapours thereby formed are introduced wholly or partly into the lower part of the coking chamber, preferably above the underneath inlet to the lower part of the retort for reintroducing the low-temperature gases of the first distillation period.

Another important feature of the present invention is the further provision for so adjusting the contrivances for extracting the gases from the first distillation period that a portion of the gas from the lower high-temperature zone can flow into and along with the gases from the upper low-temperature zone, so that a part of the high-temperature gases may pass in cycle through the coking chamber.

Finally, the invention comprehends a new and useful design of apparatus serving to carry out this process, according to my invention.

The process according to this invention is an advantage in that by an exact regulation and adjustment of the quantity of gases or vapours extracted from the differently heated upper distillation zones and introduced again into the other higher temperature zone, as well as by an exact control of the temperatures in the various zones of the coking chamber, the composition of the final outlet-gas can be maintained exactly as required in any individual case, especially with regard to the proportion of carbonic acid and hydrocarbons contained in the outlet-gas. In this way it is possible, according to the present invention, to recover a gas having a high calorific value and a low carbonic-acid content from brown coal, or to obtain a gas of a low carbonic acid content, which essentially only consists of hydro-

gen and carbon monoxide, that is a gas, suitable for the synthesis of hydrocarbons.

Another advantage of the present invention is that the conditions of the distillation process can be exactly adapted to the properties of the fuel to be treated so that, for instance in one and the same oven a pit coal or, alternatively, brown coal may be used in the process.

Still further objects of my present invention will be apparent from the following description of a preferred embodiment of my invention when read in connection with the accompanying drawings, in which

Figure 1 is a side view, partly a vertical section, of plant for carrying out the process according to my invention,

Figure 2 is a vertical section through the chamber oven of the plant of Figure 1 on an enlarged scale, and

Figure 3 is a section through a part of the oven on lines III—III of Figure 2, and

Figure 4 is a horizontal section through a part of the oven on line IV—IV of Figure 2.

The raw coal to be treated is continuously supplied from the bunker 1, through a distributing device 2 to a charging box 3, the lower end of which projects into the top of the coking chamber, consisting of refractory brickwork 4. The coking chamber is provided with an upper zone 5, and with a lower zone 6 of larger cross-section, so that a step 7 is formed in the wall of the lower zone between the two zones 5 and 6. The lower part of the coking chamber is closed by a continuous extractor 8, from which the coke can be discharged at 9.

The coking chambers are arranged in series parallel to each other. The heating walls, equipped with the heating flues 10 and 10a (see Figs. 2-4), are situated between the individual coking chambers. Gas and air are burnt in these flues. The heating flues 10 of the upper chamber section for zone 5 are separated from the heating flues 10a of the lower chamber for zone section 6, so that both chamber sections can be heated separately in an adjustable way.

The regenerators 11, 12 and 13, arranged laterally, adjacent to the coking chambers, serve to preheat the heating media. Each of the top-most regenerators 11 is connected through a horizontal channel 14 with the upper end of the heating flues 10 for the chamber for zone section 5. Each of the middle regenerators 12 is connected to a horizontal channel 15, which is in connection with the upper and lower heating flues 10a, and 10, whereas the lower regenerator 13 is connected through two sets of channels 16, 16a, with the lower end of the heating flues 10a. As usual, separate regenerators are provided for preheating the gas and air. The air regenerators of Fig. 4 are marked with 13, and the gas regenerators with 13a. The air and gas regenerators are connected with the heating flues by separate channels. According to Figure 3, one of the sets of channels 16, 16a serves, for instance, for the introduction of gas and the other of the sets of the channels 16, 16a serves for the introduction of air.

The chamber walls are heated in such a way, that in one regenerative working period the heating flues 10 are supplied from the channels 14 and the heating flues 10a from channels 16, 16a. The flames in the upper flues 10 burn, therefore, downwards and in the lower flues 10a upwards with the waste gas flowing off through channels 15 to regenerators 12, whereas during the other

regenerative operating period the heating media are distributed through the channels 15, so that the lower heating flues 10a are supplied downwards and the upper heating flues 10 are supplied upwards. The waste gases are discharged in the usual manner through the opposite horizontal channels 14 and 16, 16a into the other regenerators 11 and 13, thus heating-up same.

The gases in the upper section, zone 5 of the chamber, flow through the ascension pipe 17 into the gas collecting main 18, which is connected through the pipeline 19 with a tar precipitator 20, preferably an electrostatic de-tarrer. From the tar precipitator 20 the gas flows through the pipeline 21 into a cooler 22, where the gas is cooled down to the temperature corresponding to the desired dew point for the purpose of adjusting the steam content of the gas. The cooler 22 is fitted with cooling elements, which can separately be disconnected, so as to cool the gas to a regulatable temperature and to dry it. The drying of the gas that is performed in the cooler 22 can also be effected in any other suitable way, for instance by treating the gas with water-binding substances.

A pipeline 23 leads from the cooler 22 to a positive exhaustor 24, being so designed, that the gas in an exactly adjustable and regulatable quantity can be delivered quite independent of the counter-pressure. In this way it is possible to remove at any time a certain quantity of gas from the upper chamber section 5.

The exhaustor 24 is connected through the pipeline 25 with the channels 26, 26a, lying in the lower part of the chamber walls (see Figs. 2 and 3). These channels 26 and 26a are connected through the openings 27, with the coking chambers at the lower zones 6. The distillation gas freed from tar and possessing a given or predetermined residual content of the steam from the water constituency of the original coal in zone 5 of the upper section of the retort, is therefore introduced into the glowing coke in the lower part 6 of the chamber. The steam reacts with the carbon of the fuel and is converted under the high temperatures with the formation of water-gas, and the hydrocarbons present in the gas are decomposed or cracked by reason of and in amount corresponding to the temperature existing in the coke.

The gases from the lower chamber zone 6 rise upwards up to a middle gas exit 28, situated at the step 7, provided for between the upper chamber zone 5 and the lower chamber zone 6. Small slopes are formed in the fuel at the step 7, resulting in a free space, by which the drawing-off of the gases through the outlet 28 is facilitated.

The gas outlet 28 is in connection with the gas collecting main 30, which on its part is connected through the pipeline 31 to a cooler 32, from which at 33 the pre-cooled outlet gas can be discharged into the usual gas-treatment or purification plant, or for other purposes.

The tar obtained in the tar precipitator 20 is delivered through the pipeline 34 (governed by a shut-off valve) over the pipeline 35 into a pipe still furnace 36, or into another suitable distilling apparatus, in which the tar is subjected to a fractionated distillation. The gas cooler 32 is connected through the pipeline 37 with the pipeline 35 and by means of the pipeline 38 the cooler 22 is connected with the pipeline 35. The tar from the coolers 22 and 32 can therefore be supplied to the pipe still furnace 36, as required.

The gases and vapours generated in the still

furnace 36 flow without any primary condensation through the pipeline 39, into the channels 40 (see Figs. 3 and 2). These channels are arranged in the walls between the coking chambers 5 6, but above the underneath channels 26 and are also in connection with the chamber through openings 41.

The method of operation of the plant, as illustrated on the drawings, is about as follows:

10 It is assumed, that a briquetted brown coal is to be dealt with. The heating of the upper chamber zone 5 must be adjusted by a suitable regulation of the heating gas and air, so that the fuel in the upper part of the chamber is ultimately brought to a temperature of about 350° C. The heating of the lower chamber section 15 6 is adjusted, so that the fuel will be ultimately heated to a temperature of about 950° C., the distance of the channels 26 and 40 from 20 each other along the heating flues 10 must be chosen in such a way, that the fuel at the openings of the channels 26 shows a temperature of about 900 and a temperature of about 700° C. at the openings of the channels 40.

25 The positive exhauster 24 is then controlled so that through the gas outlet 17 at the top of the coking chamber only such a quantity of gas is drawn-off, which corresponds to the quantity of gas developed from the fuel during the heating to about 350° C. This quantity of gas is then introduced into the lower section of the coking chamber after the gas has been freed from tar and suitably cooled down, when the gas-steam mixture will meet with the highly heated coke. The steam with the highly heated coke is reduced to water gas and the carbon dioxide contained in a large quantity in the low-temperature distillation gas is converted to carbon monoxide, whereas the hydrocarbons will be cracked by the highly heated chamber walls and in the glowing coke with the formation of gaseous hydrocarbons at normal temperatures.

40 The suction in the gas collecting main 30, which is arranged at the partition between the low-temperature zone and high-temperature zone 45 6 is then adjusted so that only the gas formed in the chamber 6 is sucked-off.

The tars obtained by the treatment of the high-temperature and low-temperature gases may be subjected together in the distilling apparatus 36, to a fractionated distillation, in which case preferably the hydrocarbons of a lower boiling point, which are used directly as a motor fuel or the like, and also the pitch-like high-boiling substances are separately drawn off. The remaining distillation vapours are then led through the channels 40 and the openings 41 into the coking chambers, and a conversion similar to the hot carburetting takes place in the hot coke.

60 An outlet gas with a calorific value of about 4200 cu. m. is obtained, which has a low content of carbonic acid, thus representing an excellent town gas.

As already mentioned before, the plant process 65 can also be adapted for dealing with other fuels, in which event the heating of the two chamber sections, the gas quantities to be drawn off from the gas and the steam and tar content of the gases must be regulated in a suitable way in conformity with the difference in ingredients. Thus it may be advisable to add some steam to the gases to be led into the lower part of the chamber or to introduce the steam separately through a contrivance 42, into the extractor underneath 70 the chamber.

Under certain conditions the plant as illustrated on the attached drawings also lends itself to increasing the quantity of gas drawn-off through the upper gas collecting main 17 to such an extent, that a larger or a smaller portion of the gases from the lower chamber part 6 can be discharged through the upper zone 5 upwards. In this manner the quantity of the gas circulating into the chamber 6 is increased which may be of advantage, if an outlet gas of a certain carbon monoxide content, especially of a given proportion of carbon monoxide to hydrogen, is to be produced. By increasing the gas flow speed through the coking chamber, the carbonic acid content will be higher, whereas by decreasing the rate of flow the carbon monoxide content will drop. Should it be desirable to save the tar vapours from the distillation contrivance 25 from being too highly decomposed in the lower part of the coking chamber, then the inlet of the tar vapours into the chamber is in such event suitably arranged still higher above the inlet of the low-temperature gas, preferably in a region of the zone 6 of the chamber, in which the coke product has a temperature of about 650-700° C. Moreover, it may also be of advantage to provide the inlets in the chamber for tar vapour at various heights from the lowermost practical region, so that the vapours can be subjected to a different heat treatment, as necessary.

I have now 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 out as described and shown since the invention may be variously embodied within the scope of the following claims.

I claim:

1. In a process for the production of gas of a predetermined ratio of H to CO, and coke in a method comprising, continuously descending coking mass of bituminous fuel in a vertical retort chamber with continuous supply of fuel to be coked at the upper part of the retort mass and with continuous discharge of finished high temperature coke at the bottom of the retort mass; 45 subjecting the fuel in the upper part of the continuously descending mass to externally applied heating laterally inwardly of the mass to initially distill the freshly supplied fuel, and concurrently subjecting the lower portion of the mass to externally applied heating laterally inwardly of the mass to subsequently complete the carbonization of the initially distilled fuel to complete the formation of high temperature coke therefrom: the steps of effecting the external heating of the upper and lower portions by separately controlled heating; controlling the heating of the upper part of the mass so as to expel therefrom only low temperature distillation gas at a temperature of the order of about 350° C., and controlling the heating of the lower part of the mass so as to progressively raise the temperature of the mass in the lower part thereof from about 350° C., at the juncture of the upper part, to about 950° C. at the bottom of the lower part and thereby expel 65 from the fuel in the lower part, gas of high temperature coking up to the order of about 950° C.; drawing off the low temperature gas from the upper part of the mass at the upper part thereof; de-tarring the gas, and adjusting the steam content of the so withdrawn low temperature gas to the amount predetermined as critical to produce the predetermined ratio of H to CO on the final gas from the high temperature zone, and then introducing the de-tarred and steam ad-

- justed low temperature coking gas at the lower part of the descending mass of highly heated coke undergoing completion of high temperature coking for flow of the re-introduced gas upwardly through the more highly heated high temperature coke; and withdrawing the high temperature gas produced from the lower high temperature coking part of the descending mass, together with the gas formed from the de-tarred and steam adjusted low temperature coking gas re-introduced into the descending mass from the initial distillation stage, from the descending mass at a region between the higher temperature carbonization zone in the lower portion and the lower temperature carbonization zone in the upper portion of the descending mass.

2. A method as claimed in claim 1 and in which the tar separated from the gases, withdrawn from the initial lower temperature distillation zone, are fractionated and hydrocarbon vapours thereof are introduced into the lower high temperature coking zone of the descending coking mass for conversion therein during flow therethrough along with the gas re-introduced into the high temperature coking zone from the initial lower temperature distillation zone.

3. A method as claimed in claim 1 and in which

the tar separated from the gases, withdrawn from the initial lower temperature distillation zone, are fractionated and hydrocarbon vapours thereof are introduced into the lower high temperature coking zone of the descending coking mass for conversion therein during flow therethrough along with the gas re-introduced into the high temperature coking zone from the initial lower temperature distillation zone, and in which the hydrocarbon vapours are introduced into the high temperature coking zone, while it is undergoing completion of coking, at a region above the region where the gases from the initial lower temperature distillation are let into the high temperature coking zone.

4. A method as claimed in claim 1 and in which part of the high temperature coking gases, evolved in the higher temperature distillation zone are drawn off from the coking mass through the portion of the coking mass in the upper low temperature distilling mass zone undergoing separate heating for lower temperature initial distillation, and along with the low temperature coking gas evolved by the initial lower temperature distillation under the separately controlled externally applied heating therefor.

WALTER MALKOMES.