PATENT SPECIFICATION

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(Under Section 91, subsections (2) and (4) (a) of the Patents and Designs Acts, 1907 to 1932, a single Complete Specification was originally left in respect of this Application and of Applications Nos. 16051 to 16054/36 and was laid open to inspection on Dec. 8, 1936).

COMPLETE SPECIFICATION

Upright, continuously Operating Chamber Ovens and Process for the Production of various Gas Mixtures, e.g. Town Gas or Synthesis Gas, and Coke from solid Bituminous Fuels

I, WILLIAM WARREN TRIGGS, a member of the firm Marks & Clerk, of 57 & 58, Lincoln's Inn Fields, London, W.C.2, a British subject, do hereby declare the nature of this invention (a communication to me from abroad by Braunkohlen-und Brikett - Industrie Aktiengesellschaft Bubiag, of Potsdamerstrasse 14, Berlin, W.9, Germany, a German company), and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

Continuously operating vertical chambers in which gases containing hydrogen, carbon monoxide and hydrocarbons can be produced from solid bituminous fuels are already known. The gases and vapours containing tar forming in the upper part of the chamber by degassing of the fuels pass with the incandescent coke from the top in a downward direction ("unidirectional flow" method) and are thereby subjected to a cracking. The coke which is produced forms water gas with the steam introduced into the bottom part of the chamber, which water gas enters wholly or partly into reaction with the gases originating from the upper part of the chamber.

It is also possible to prepare coke in the same chambers as well as to draw off water gas or the desired end gas together or separately and to carry out the coke gasification only so far that the coke forming still contains so much carbon that further use of the coke is possible. As is known, these ovens operating in accordance with the unidirectional flow method are provided with an exterior heating which is regulable at various heights. Also the promotion or assistance of the degassing in certain cases by interior heating has already been proposed, such as the withdrawal of a branch gas stream which is to lead away the ballast substances, e.g. carbonic acid and steam.

In these unidirectional flow ovens known up to now, it was also possible to vary the composition of the gas obtained within wide limits by temperature regulation, differing velocities of travel on the part of the fuel and by regulable steam introduction in the lower part of the chamber so that in one and the same oven both a town gas as well as a water gas could be obtained. The requirements imposed on water gas for synthesis purposes in recent times, however, required the gas obtained to have in addition to a definite proportion of hydrogen to carbon-monoxide the smallest possible amount of inert gas, such as carbonic acid (10% to 12%) and nitrogen (1% to 2%) and as little methane as possible (below 1%). This is not to be attained forthwith by means of the ovens known up to now, since the ratio of the heating surface of the upper part of the chamber (the degassing zone) to that of the lower part of the chamber (the gasification zone) must differ in both cases, that is to say in the case of town gas production or in the case of synthesis gas production. Furthermore a very extensive cracking of the hydrocarbons, particularly of the methane, is in certain circumstances to be carried out with the aid of superheated steam.

The present invention describes the construction of a unidirectional flow chamber in which products like town gas, water gas or synthesis gas can always be produced with certainty from fuels of various origins, and the constructional directions and mode of procedure described below put anyone skilled in the gas art in the position of being able to attain the desired effect.

As means for attaining the gas of the desired composition, it has been found that for given oven temperature and given

[*Price* 1/-]

chamber cross-section, the chamber heating surface must be varied so that, on the basis of the degree of decomposition desired in the upper part of the chamber for the products released in gas or vapour form from the bituminous constituents of the coal, in the production of synthesis gas the lower part of the chamber must be constructed larger than the upper part on account of the requisite larger portion of gasification gas, whilst in the case of town gas the reverse holds. According to the invention the ratio of the heating surfaces of the chamber is determined by the necessary degassing portion or gasification portion, but nevertheless in the case of town gas production it is to be borne in mind that in the upper part of the chamber a cracking of the tar constituents amounting to 50% to 80% is necessary, whilst in the case of the production of synthesis gas the cracking must be carried out up to 100%.

As regards the desired gas compositions, it is in addition possible according to the invention, bearing in mind the varying tar contents of the individual fuels, to regulate the chamber heating surfaces of the upper and/or of the lower part of the chamber within wide limits.

In the lower part in any case the chamber heating surface must be so dimensioned that the water gas production is controlled in such a way that the quantity of water gas produced from the coke formed and the nature of quality of this gas always yields a desired intended composition of the end gas in reaction or mixture with the gas originating from the upper part.

The invention therefore provides an upright continuously operating chamber oven exteriorly heated to high temperatures for the production of different kinds of gas mixtures with simultaneous obtention of coke from solid bituminous fuels, of the kind in which the gases and vapours forming in the upper part of the chamber flow downwardly in unidirectional flow with the incandescent coke, and water gas is produced in the lower part of the chamber by introduction of steam, which water gas may enter into reaction with the gases from the upper chamber and be led away jointly or may be led away separately, and is characterised by the feature that the composition of the gas is controlled by regulating the ratio of the heating surface of the upper part of the chamber (degassing zone) to the heating surface of the lower part of the chamber (gasification zone) by withdrawal of gas at different levels throughout the charge in combination with the regulable heating of the preliminary low temperature distillation zone, degassing zone and gasification zone and steam introduction at various levels of the chamber.

Heretofore for sucking off the finished gas either withdrawal ducts led through the heating zone on the wide side of the chamber, or short aprons have been used at the narrow side of the chamber, extending from the top to about the middle of the chamber, and forming gas collecting spaces, and provided with slots at the lower end if desired, whereby the gas was led upwardly to the horizontal pipes situated above the head of the chamber. These arrangements enable the gas to be sucked off only in a comparatively narrow range of the chamber height. Consequently they do not enable the size of the individual chamber zones to be materially varied, which is important for the use of the retort as desired for the production of town gas and synthesis gas, the tar content of different fuels being taken into account. Furthermore they do not enable the various different kinds of gas to be sucked out of one and the same oven at the same time, for example when it is desired to obtain distillation gas as well as the synthesis gas, or separately to lead away the ballast substances, like steam and carbonic acid, which occur in the upper part of the chamber. These drawbacks are overcome by the oven provided by this invention.

Below two modes of regulable gas withdrawal are described with reference to the accompanying drawings which represent particularly simple constructional solutions of the said problems and which permit of every possible variation.

In the accompanying drawings Figures 1*a*—1*c* show by way of example one general mode of gas withdrawal, in which the gas is drawn off through openings at the sides of the oven, whilst Figures 2*a*—2*c* and 3*a*—3*i* show a second general mode of gas withdrawal, in which the gas is drawn off through openings in ducts arranged in the charge.

Referring first of all to Figures 1*a*—1*c* of the drawings, Figure 1*a* shows a longitudinal section of the chamber, and Figure 1*b* a cross section with two adjacent chambers, while Figure 1*c* shows the lateral chamber openings on an enlarged scale.

The unidirectional flow oven shown in Figures 1*a* and 1*b* with the charging hopper 27, and the chamber space proper 28, and which is subdivided into the drying zone, low temperature distillation zone, degassing zone, cracking zone, and water gas zone, is closed off at the bottom by the coke cooling zone 29 and the coke exit sluices 30. In the middle of the chamber there is, for the introduction of steam, the separating pillar 31, for example, with the steam inlet openings 31*a* at various levels. The exterior heating takes place between the two chambers shown in Fig. 1*b*.

Within the masonry on the narrow sides of the chamber there are gas collecting shafts 32 running through from the top to the bottom, which shafts are provided at the head of the chamber and also at the foot thereof with closure members 33 so that they can be cleaned and tightly sealed. The chamber wall 34 closing off the narrow sides of the chamber is perforated by numerous slot-like openings 35 distributed over the height of the chamber these openings 35 enable gas to be withdrawn at any desired level. In order to avoid stoppages the slots are constructed in the known manner so that they ascend in a direction away from the interior of the chamber and on the shaft side possess a horizontal end portion (Figure 1*c*) which serves as a rest for the stopping stone 36 with which the openings can be closed.

In order to be able to close as desired every gas withdrawal slot 35 between the chamber interior 28 and the gas collecting shaft 32 an equal number of openings 37 is arranged at corresponding levels on the outer side of the chamber in the masonry enclosing the gas collecting shaft on the exterior. Stopping stones may be inserted through these openings 37 which can be slipped along by means of guiding rods 39, through the gas collecting shaft 32 into the horizontal end part of the slots 35. In order to seal off the gas collecting shaft from the exterior the openings 37 are either built up with brickwork or provided with sealing means 40 through which the guiding rods are led by way of stuffing boxes.

The outer masonry 38 is also perforated by openings which contain the gas withdrawal pipes 41 (figure 1*a*). Outside the chamber the gas withdrawal pipes, which may be provided with valves 42, such as slide plate valves open into the receivers 43, from which latter the gas is withdrawn.

Since it is frequently desirable to withdraw different gases simultaneously from the oven, it is necessary to subdivide the gas collecting shafts into two or several separate superposed gas collecting spaces by means of horizontally inserted slide plates 44 (Figures 1*a* and 1*c*); a gas withdrawal pipe 41 then leads from each of said spaces. In order to introduce the slide plates the outer masonry 38 of the chamber must be provided with slots 45 (Fig. 1*c*). The openings 37 for the introduction of the stopping stones 36 may be used at the same time for introducing the slide plates. This is attained by the stopping stone 36 and the slide plate 44 forming a common stopper 46 (Fig. 1*c*).

When it is desired to obtain the products of low temperature distillation separately, then either the upper part 27 (supply hopper) is provided with a regulable flue gas heating and with separate gas outlets for the drawing off of the low temperature distillation products, or else it is necessary to draw off the gases out of the highly heated head of the chamber from the inner colder part of the coal in order to avoid subsequent decomposition of the low temperature distillation products at the outer walls of the chamber. For this purpose perforated gas-withdrawal pipes 47 (Figs. 1*a* and 1*b*) are suspended from the head of the chamber in the midst of the chamber filling. According to Figure 1*b* the withdrawal is provided for by sucking-off devices 48 in the upper part of the chamber, which consist of pocket-like boxes or bell-like boxes extending over the whole width. These sucking-off devices are open at the bottom, and possess slots or holes on the side walls and at the top are sloped off in a roof-like manner and are made narrow in order to facilitate the passage of the fuel on both sides.

The gases and vapours which form in the upper part of the chamber pass through the lower opening or lateral slots into the sucking-off devices and are led off through the gas withdrawal pipes 47, which if necessary are provided at the top part of 27. By this means the advantage is attained that the gases and vapours forming in the middle of the chamber can be sucked off in their original composition as compared with that of the products usually more highly decomposed at the walls of the chamber, and without drawing off the latter products with them.

The interior sucking off of gas, which according to Figure 2*a* may also proceed in the whole middle of the chamber, has the advantage that the gases may be sucked off without sub-atmospheric pressure, in the case of leakages in the gas collecting duct no flue gases and outer air but only gases from the individual zones are sucked off. The utilisation of the temperature of the gases coming off for subjecting the coal to preheating, predistilling, and so forth, is very advantageous. Heretofore however it was possible with one oven and the gas collecting shaft present in the interior to withdraw only either water gas or only synthesis gas or only town gas, since the length of the gas collecting shaft, with its bottom withdrawal of gas, was of decisive importance.

The present invention removes this disadvantage in a very simple manner in that the walls of the gas collecting shafts are provided with closable openings in the individual zones of water gas formation, town gas formation, and so forth, so that either town gas, or synthesis gas or the like can be led off as required with one and the same gas collecting shaft without structural alteration.

In Figures 3*a* to 3*i* of the accompanying drawings is schematically shown the arrangement of variously constructed interior gas collecting shafts with different closing devices. The retort shown in Figures 3*a*, 3*b*, 3*c* in cross section and in Figure 3*d* in longitudinal section, is a similar flow or unidirectional flow oven. Reference 49 represents the gas collecting shaft in the interior of the chamber, which in Figure 3*a* is opened somewhat above the water gas zone and in Figure 3*b* is closed at that place. In Figure 3*c* the gas collecting shaft extends about just as far as in Figures 3*a* and 3*b* is closed below and is extended in a narrower form up to above the cooling zone. Figure 3*e* shows the gas collecting shaft of Figure 3*c* on an enlarged scale.

In figures 3*a*—3*e* the gas withdrawal takes place at 50, where openings are provided at different levels of the gas collecting shaft, which openings may be opened and closed according to the desired composition of the gas. For this purpose ducts are let into the wall of the shaft in which imperforate or perforated stoppers are displaceably arranged. In Figure 3*f* is shown in cross section an enlarged reproduction of a gas collecting shaft wall 51 in which are situated apertures 52 (corresponding to apertures 50 of Figs. 3*a*—3*e*) for the passage of the gas and displaceable perforated stoppers 53*a* and imperforate stoppers 53*b*. Figure 3*g* shows a horizontal section through the wall 51 at the level of the gas outlet openings. If the gas is to flow into the gas collecting space without any hindrance then the imperforate and perforated stoppers are so far displaced in their longitudinal direction that the perforated stoppers 53*a* are situated between each pair of opposite wall apertures 52. Conversely, according to Figure 3*h* the imperforate stoppers 53*b* are placed opposite the wall apertures 52 with the result that then the passage of gas from the chamber is prevented. In order to avoid loss of gas the length of the imperforate stoppers is provided greater than that of the openings 52.

In order to avoid the collection of dust and small coal within the ducts for the perforated and imperforate stoppers, which might cause the stoppers to jam, the gas passages 52 are constructed at the lower sides 54 in a roof-like manner so that dust and so forth cannot settle thereon but slides in a downward direction. This however requires a good guide for the perforated and imperforate stoppers so that they do not fall out of the ducts. For this purpose guides, for example nose members 56, are provided in the horizontal middle piece 55 of the gas passage 52 which engage in corresponding recesses, e.g. grooves 57, in the perforated and imperforate stoppers and thereby ensure a satisfactory guidance during the displacement of the said stoppers. The stoppers are likewise guided at 58 at their upper parts.

The displacement of the stoppers in their longitudinal direction is effected from the narrow sides of the chamber, in that, as shown in Figure 3*d*, the stoppers are only pushed, which has the consequence that the individual imperforate and perforated stoppers can be arranged behind one another without any joining together whatever. The individual series of stoppers I, II, III, IV, (Figure 3*d*) distributed over the height of the gas collecting shaft in the zones coming into question are each arranged so as to be displaceable in itself, so that a regulable sucking-off of the gases is obtained which is necessary for the prevailing need.

Another method of effecting closable gas withdrawal is shown in Figure 3*i*, being indicated at I, II and III. Here instead of the imperforate and perforated stoppers a highly refractory tube, or several concentrically arranged tubes 59, 60, with passages 61 are provided so as to be rotatable in round ducts. The double tube guide, as for example in the case of Figure 3*i* (III), has for its object better rotation and sealing off of the inner tube.

The dust falling in the lower part of the gas collecting shaft is removed by means of a device according to Figure 3*i* (IV). It consists of a simple or double closure tube 63. In the case of a simple closed gas collecting shaft corresponding to Figure 3*b* the dust on actuation of the emptying device falls directly down into the oven, or in the case of the arrangement of the gas collecting shafts corresponding to Figures 3*a* and 3*c* through channels 64 (as in Fig. 3*i*) into the oven.

If, besides for sucking off the gases just mentioned, the requirement also arises of leading away themselves the low temperature distillation gases, carbonic acid, and other gases formed or liberated in the upper part of the chamber, then the known external gas collecting shafts 65 (Figure 3*d*) are retained at the top part of the chamber which lead away the gases of the upper zones through known gas withdrawal means.

In Figures 3*e*, 3*f* and 3*h* is shown the position of the steam delivery pipes 65 within the walls of the gas collecting shaft, the outlet openings being indicated by 65*a*.

A further means of securing with certainty the desired composition of the end gas is the withdrawal of branch streams of gas from the chamber, for which purpose the device just described is very suited. It will be advisable to lead away those gases and vapours which unfavourably influence the conversion processes in the chamber. Thus, for example, a tar-rich coal brings about a reduction in throughput owing to the fact that in a given chamber only a definite quantity of tar can be cracked. By the withdrawal of tar-containing branch streams of gas, which are led away from the upper part of the chamber or from a preliminary drier or predistilling apparatus disposed in direct combination with the chamber, the chamber can be substantially relieved, the gas composition favoured in the direction of synthesis gas production, and the throughput raised, since practically the tar-rich coal is converted to a coal which is poor in tar. Furthermore, such branch streams of gas will be led away as are undesirable in the end product, for example, the carbonic acid gas of the first degassing stage in the case of town gas production, and above all methane-containing gases and vapours in the case of synthesis gas production, and the sulphur compounds in both cases. The heating relief afforded the chamber by the upper gas withdrawal enables the chamber heating surface to be chosen correspondingly smaller in the upper part.

Two general modes of gas withdrawal have been described above, viz. that in which the gas is drawn off through openings at the sides of the oven (cf. Figures 1*a*, 1*b* and 1*c*) and that in which the gas is drawn off through openings in ducts arranged in the charge (cf. Figures 3*a*—*h*). The invention is to be understood as including, besides ovens which utilise only one of these two general modes of withdrawal, also ovens which utilise both modes of withdrawal in one and the same oven.

In order for reasons of economy not to have to make the structural height of the chamber excessively great, it is advisable to introduce the heat into the fuel by means of circulating gas in addition. For this purpose, with employment of the slide plate 44 (Figure 1*c*) and of the stopper 36, branch streams of the gas jointly sucked off can be introduced into the gas collecting shafts again, after heating up in the chamber, at the places where increased heat supply is necessary. In this manner, with simultaneous exterior heating, on the one hand the cracking of the hydrocarbons liberated in the upper part of the chamber can be better carried out, and on the other hand the water gas yield can be raised in the lower part of the chamber by means of introduced hot circulating gas and steam. The chamber construction therefore enables the branch gas streams withdrawn from the chamber to be introduced into the chamber again as reaction gas, admixing gas or heat carrier after previous treatment, for example detarring, removal or diminution of carbon dioxide and sulphur, converting of carbon dioxide, tar and gas cracking, heating up and so forth. By means of this process, the composition of the final gas can be influenced in that these gases which contain a large proportion of the available hydrogen of the coal in gas form raise the hydrogen content in the end gas in the production of synthesis gas. In the case of the production of town gas operations will be limited to the removal of the carbonic acid and the sulphur compounds in order not to lower the hydrocarbon content of the end gas with respect to the necessary heating value.

The branch streams of gas drawn off, which in consequence of their composition are not adapted for return into the chamber or into the end gas, are rejected after recovery of their heat content and separation of hydrocarbons, or, in so far as they are still sufficiently possessed of heating power, are used in boiler furnaces. If for example a water gas is desired as end product which is to have a very high carbon monoxide content but little hydrogen, then it is necessary separately to lead away the gases of the first degassing fraction, which contain a high proportion of available hydrogen.

For the adjustment of the oven to gases of definite composition a further consideration is very important. It has been stated above that in the production of synthesis gas the cracking of the hydrocarbons must be carried out further in the upper part of the chamber than in the lower part thereof, whilst in the case of town gas the reverse is the case. However, for the dimensioning of the chamber heating surface the quantity of the gas varieties, namely, degassing gas and water gas, obtainable in the upper part of the chamber and in the lower part of the chamber is of great importance. Whereas in the case of town gas the quantity of degassing gas with high heating value must be greater from the upper part of the chamber, in the case of synthesis gas production the portion of water gas to be admixed taken from the water gas zone that is to say from the lower part of the chamber, is to be substantially higher. From this will be apparent, in addition to the considerations for the cracking operations explained above, the possibility of using the various levels of gas withdrawal for the purpose of adjusting the chamber heating surface ratio between the upper part of the chamber and the lower part of the chamber. According to the invention the heating surfaces are to be so chosen that, in the production of town gas, for given chamber cross-section and given fuel throughput, the ratio between the upper part of the chamber and the lower part of the chamber is approximately 1.7:1, whilst in the case of the production of synthesis gas this ratio is approximately 1:1. It is extremely important that this heating surface ratio must be adjusted in order to obtain the desired gases.

The following compositions may be given as examples for a town gas and a synthesis gas obtained by this manner of working:

Town Gas		Synthesis Gas	
CO_2	6.0%	$CO+H_2$	85 —87%
CnHm	1.9%	CO_2	10 —12%
O_2	0.5%	N_2+CH_4	2.5—3%
CO	19.8%	$CO:H_2$	1 : 2
H_2	54.5%		
CH_4	14.4%		
N_2	3.4%		
H_o	4100 kcal/m³		

In addition to the manner of heating, the withdrawal of the gases and the dimensioning of the heating surfaces the regulable introduction of steam at various levels of the chamber is necessary, on the one hand in order to produce the necessary water gas fraction in both modes of procedure as well as for the purpose of the bringing about efficient cracking of the hydrocarbons, more particularly in the case of synthesis gas production, and in this respect it is particularly to be emphasized that town gas is also obtained by dry operation without supply of additional steam to the chamber. In the case of synthesis gas production on the other hand the production of the desired gas composition requires a supply of steam of higher temperature which is introduced both from below into the water gas zone as well as from above into the unidirectional flow zone. At the top the supply of steam takes place at a point in the chamber where the degassing is already far advanced and the steam serves preeminently to split up the methane which resists the cracking and is difficult to decompose. In the case of synthesis gas production quantities of steam must be introduced into the chamber which lie between 0.4 and 1.4 kilogram per kilogram of coal, whilst in the case of town gas production the quantity of steam varies between 0.2 and 0.9 kilogram of steam per kilogram of coal.

The position of the steam inlet places in the chamber is of great importance in order on the one hand to enable the steam to be efficiently distributed in the fuel, and on the other hand to introduce the steam where the desired reaction with the steam is to proceed. Preferably introduction through a separating pillar or an interior gas collecting shaft is to be chosen for this purpose. It is important that the openings situated at each particular level are according to the invention connected to a common supply lead, regulable in itself or that each lead or each group of leads, separately on its own, must be regulable.

These modes of steam introduction are represented in Figures 2a—2c of the accompanying drawings.

Figure 2a shows the section of a unidirectional flow chamber, in which 16 is the coal inlet, and 17, 18 and 19 represent the degassing, cracking and gasifying zones. The finished gas is withdrawn at selected levels through an interior gas withdrawal lead 20, which is prolonged into the lower part of the chamber and here has steam outlet openings at various levels for supplying steam into the chamber. At the same time provision is made at 22 in the outer wall of the chamber for the admission of steam at various levels. Figure 2b shows the same chamber in longitudinal section with a separating pillar 23 illustrated, which in this case is prolonged up to the head of the chamber and has steam outlet openings 24 situated at various levels. Reference may here particularly be made to the steam openings 24a and 24b which debouch in the upper part of the chamber and at the head of the chamber. In additional or exclusive introduction at these places is employed in order to decompose the liberated hydrocarbons or to produce water gas at the hotter marginal parts (in the production of synthesis gas). By means of these expedients the production of water gas in the lower part of the chamber is either reduced or, particularly in the case of the production of hard lump coke, even avoided. The openings 25a, 25b, 25c of the steam supplies situated in each individual level of the chamber may, according to the constructional example shown in Figure 2c, be connected to a common supply lead 26a, 26b, 26c, which is regulable in itself. Consequently it is forthwith possible to allow the steam to issue in regulable amounts as required at the various levels.

For the economical operation of a chamber for producing gas it is very essential to be able to use the by-products which form. By means of the expedients described, on the one hand the degassing in the upper part of the chamber, and on the other hand the gasification in the lower part of the chamber may be controlled within the widest of limits. In order now, as the most important by-product, to obtain a saleable coke which is as hard as possible, it is necessary that the gasification in the lower part of the chamber, more particularly by the steam regulation which has just been described, is driven only so far that a sufficient quantity of water gas is obtained which is necessary for the composition of the end gas but varies only within such limits that the fuel in the lower part of the chamber is not too far gasified. In this way it is possible, with the maintenance of a sufficiently high throughput performance, to obtain a coke which conforms to the imposed requirements.

In order to obtain maximum yield of gas, coke and any by-products, it is necessary so to conduct the degassing process that neither gas losses through the walls of the retort occur nor are foreign gases sucked up out of the firing streams or flues, which may lead to impairing of the gas or to partial combustion of the coke. In contradistinction to operation with mineral coal, the chambers consisting of refractory material do not seal themselves off with the same reliability when working up younger fuels owing to the deposition of carbon or graphite. It is necessary therefore to ensure the production of a desired end gas by regulation of the chamber pressure, and in fact in such a manner that the sucking-off of the gases formed from the chamber is so regulated that the gas pressure in the interior of the chamber about corresponds to the pressure or the suction in the firing streams or flues. The regulation of the gas pressure at the withdrawal places of the individual branch gas streams is accordingly particularly important. For this purpose gas pressure regulators are installed at appropriate places. Thus, for example, in sucking off low temperature distillation gas from a preliminary drier pre-inserted with respect to the unidirectional flow chamber, the pressure is to be regulated such that at the top part of the preliminary drier such a superatmospheric pressure prevails that the steam developed has time to penetrate the coal, and to heat it at the same time, in order to avoid a premature disintegration. Small excess pressures of 10—100 mm. of water are already sufficient for this purpose. These pressures are also maintained when a low temperature distillation of the coal is to be effected in the preliminary drier at the same time.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. An upright continuously operating chamber oven exteriorly heated to high temperature for the production of different kinds of gas mixtures, for example town gas or synthesis gas, with simultaneous obtention of coke from solid bituminous fuels, of the kind in which the gases and vapours forming in the upper part of the chamber flow downwardly in unidirectional flow with the incandescent coke, and water gas is produced in the lower part of the chamber by introduction of steam, which water gas may enter into reaction with the gases from the upper chamber and be led away jointly or may be led away separately, characterised by the feat re that the composition of the gas is controlled by regulating the ratio of the heating surface of the upper part of the chamber (degassing zone) to the heating surface of the lower part of the chamber (gasification zone) by withdrawal of gas at different levels throughout the charge in combination with the regulable heating of the preliminary low temperature distillation zone, degassing zone and gasification zone and steam introduction at various levels of the chamber.

2. A chamber oven as claimed in claim 1, characterised by the feature that at the narrow sides of the chamber gas collecting shafts are provided passing through from the top to the bottom, which shafts are connected with the chamber interior by means of numerous ascending slots which, however, run horizontally towards the shaft side and which are distributed over the whole height, said slots being closable as desired by means of stoppers or plates introduced from the exterior in a gas-tight manner which sub-

divide the gas collecting shafts.

3. A chamber oven as claimed in claim 1 or 2, characterised by the feature that the gas collecting shafts are sub-divided into two or several spaces by means of slide plates, from each of which spaces a horizontal gas outlet proceeds.

4. A chamber oven as claimed in any one of the preceding claims, characterised by the feature that the stoppers are at the same time constructed as slide plates for the gas collecting shafts so that the subdivision of the gas collecting shafts does not involve special introduction openings for separate slide plates, but can be effected as desired at the level of each slot.

5. A chamber oven as claimed in any one of the preceding claims, characterised by the feature that in the upper part of the chamber are arranged in the longitudinal axis thereof, and extending over its length, narrow pockets, bells, suck-off pipes or the like which are perforated or provided with slots.

6. A chamber oven as claimed in any one of the preceding claims, characterised by the feature that gas collecting shafts are provided within the chamber extending over its whole length which possess a plurality of closable openings distributed over a part of the height and over the whole length.

7. A chamber oven as claimed in claim 6, characterised by the feature that the interior gas collecting shafts terminate shortly above the water gas zone.

8. A chamber oven as claimed in claim 6 or 7, characterised by the feature that for the purpose of regulably closing and opening the gas collecting shafts, imperforate and perforated stoppers lying behind one another and displaceable in their longitudinal axes are arranged in horizontally disposed ducts of the collecting shafts within the walls crossing the series of gas outlet openings.

9. A chamber oven as claimed in any one of the preceding claims, characterised by the feature that at various levels of the chamber or of a pre-drier or a preliminary low temperature distilling apparatus gas withdrawal means are provided through which branch streams of gas are withdrawn which are not desired in the end product or unfavourably influence conversion processes, so that the chamber or the heat supply is relieved.

10. A method of operating the chamber oven claimed in any one of the preceding claims, characterised by the feature that the carbonic acid, sulphur compounds, steam, and if necessary also a part of the low temperature distillation gas and of the tar vapours, forming in the upper part of the chamber or in the preliminary low temperature distillation apparatus are separately withdrawn and after recovery of their heat content (e.g. for predrying the fuel or in waste heat boilers) and any liquid hydrocarbons are blown off or used separately.

11. A method as claimed in claim 10, characterised by the feature that at the existing gas withdrawal places branch streams of the gas sucked off in common are led back after being heated up into the upper chamber, or into the lower chamber, or into both.

12. A method as claimed in claim 10 or 11, characterised by the feature that in the case of simultaneous exterior heating for the purpose of producing gases which are poor in hydrocarbon, e.g. synthesis gas, for the purpose of covering the raised heat requirement requisite for cracking the hydrocarbons, zones, either separated from one another or grouped together above one another, are heated, by means of circulating gas originating from the zones themselves, the heated-up gas being introduced through the gas withdrawal places present in the upper part and middle part of the retort.

13. A method of operating a chamber retort as claimed in any one of claims 1 to 9, characterised by the feature that for given retort temperature, given chamber cross-section and fuel throughput, the gas withdrawal places are so chosen that the ratio of the heating surfaces of the upper part of the chamber with respect to the lower part of the chamber is constant corresponding to the requisite mixture of degassing gas and gasification gas, being about 1.7:1 in the case of the production of town gas, and about 1:1 in the case of the production of synthesis gas, irrespective of the tar content of the fuel.

14. A chamber oven as claimed in any one of claims 1 to 9, characterised by the feature that in the walls of the gas collecting shafts, pipes or ducts are provided for the introduction of steam which permit the steam to enter the interior of the chamber at regulable levels and to be distributed over the whole length of the chamber, the steam supplies issuing at the various levels being each connected to a regulable supply lead.

15. A method as claimed in any one of claim 10, 11, 12 or 13 characterised by the feature that in the case of the production of synthesis gas, superheated steam is blown into the chamber through the steam outlets provided in the lower degassing zone, so that the hydrocarbons released are decomposed, and furthermore water gas forms at the hotter places near the edge, and the water gas production in the lower part of the chamber (the water gas

zone) is diminished, or is altogether avoided, more particularly in the case of the production of hard lumpy coke.

16. A method as claimed in any one of claims 10, 11, 12, 13 or 15, characterised by the feature that the coke in the lower part of the chamber is incompletely gasified, so that a final coke is obtained which satisfies the fuel requirement for heating the retort and can be gasified in generators.

17. A method as claimed in claim 10, 11, 12, 13, 14, 15 or 16, characterised by the feature that the gas pressures are so regulated in the gas withdrawal ducts in the various zones by means of gas pressure regulators, in combination with the control of the operations by heating, rate of travel, sucking off, steam and gas introduction, that a mixing of the gas streams and sucking in of flue gases or air is avoided.

18. The improved upright exteriorly heated chamber oven substantially as hereinbefore described with reference to the accompanying drawings.

19. The improved method of operating the chamber oven claimed in claim 18 substantially as hereinbefore described.

20. Gases and/or coke made in the oven and/or by the process herebefore-described and claimed.

Dated this 8th day of June, 1936.

MARKS & CLERK.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1938.

SHEET 1

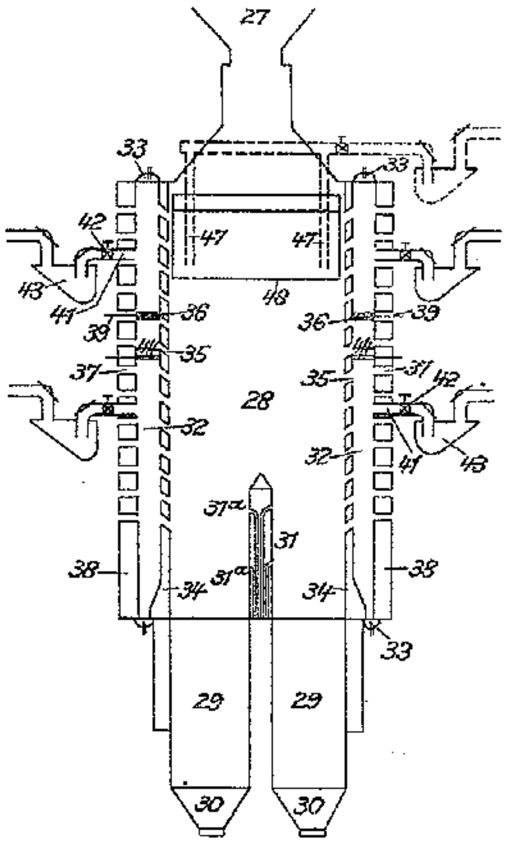


Fig. 1a.

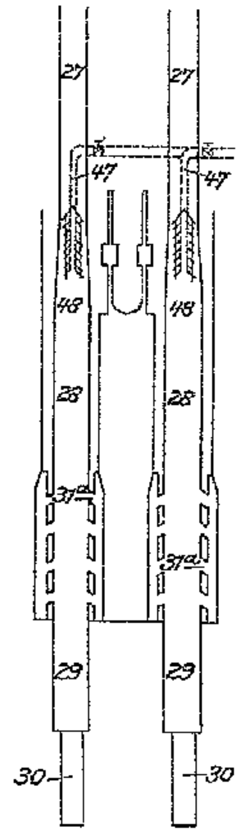


Fig. 1b.

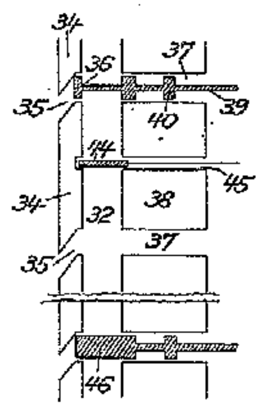
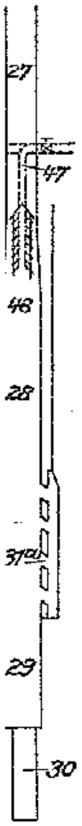


Fig. 1c.

[This Drawing is a reproduction of the Original on a reduced scale.]



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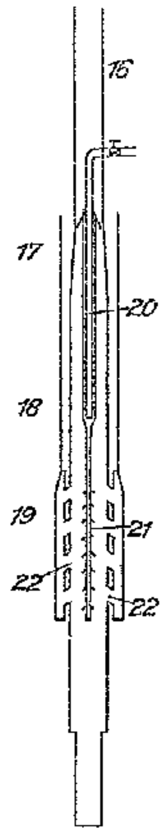

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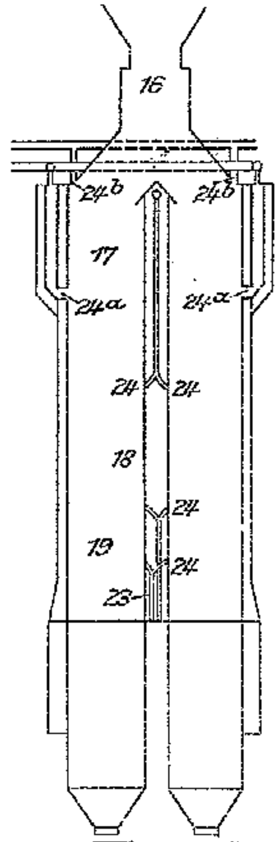

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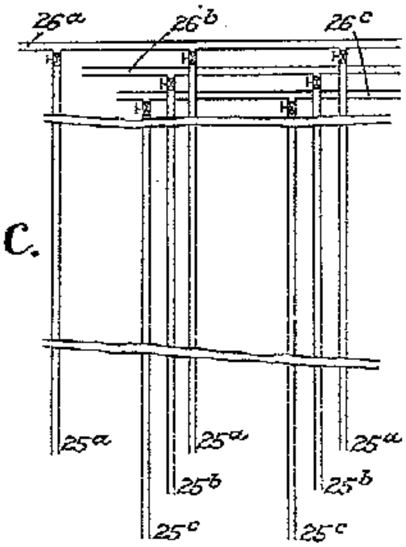

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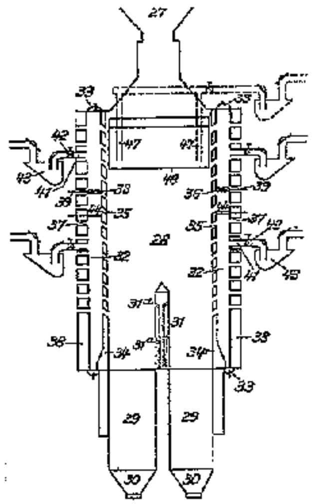

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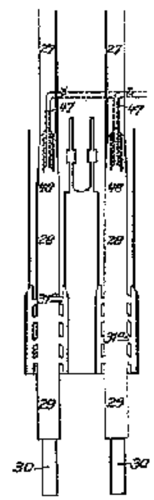

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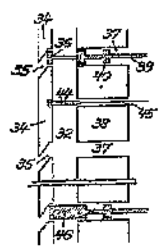

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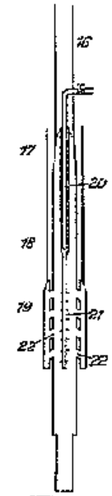

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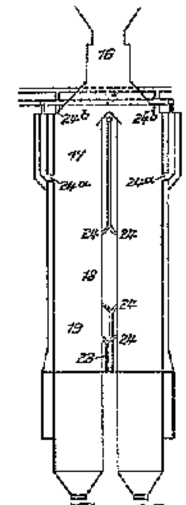

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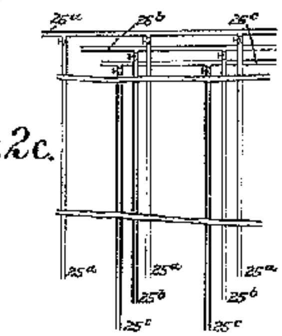

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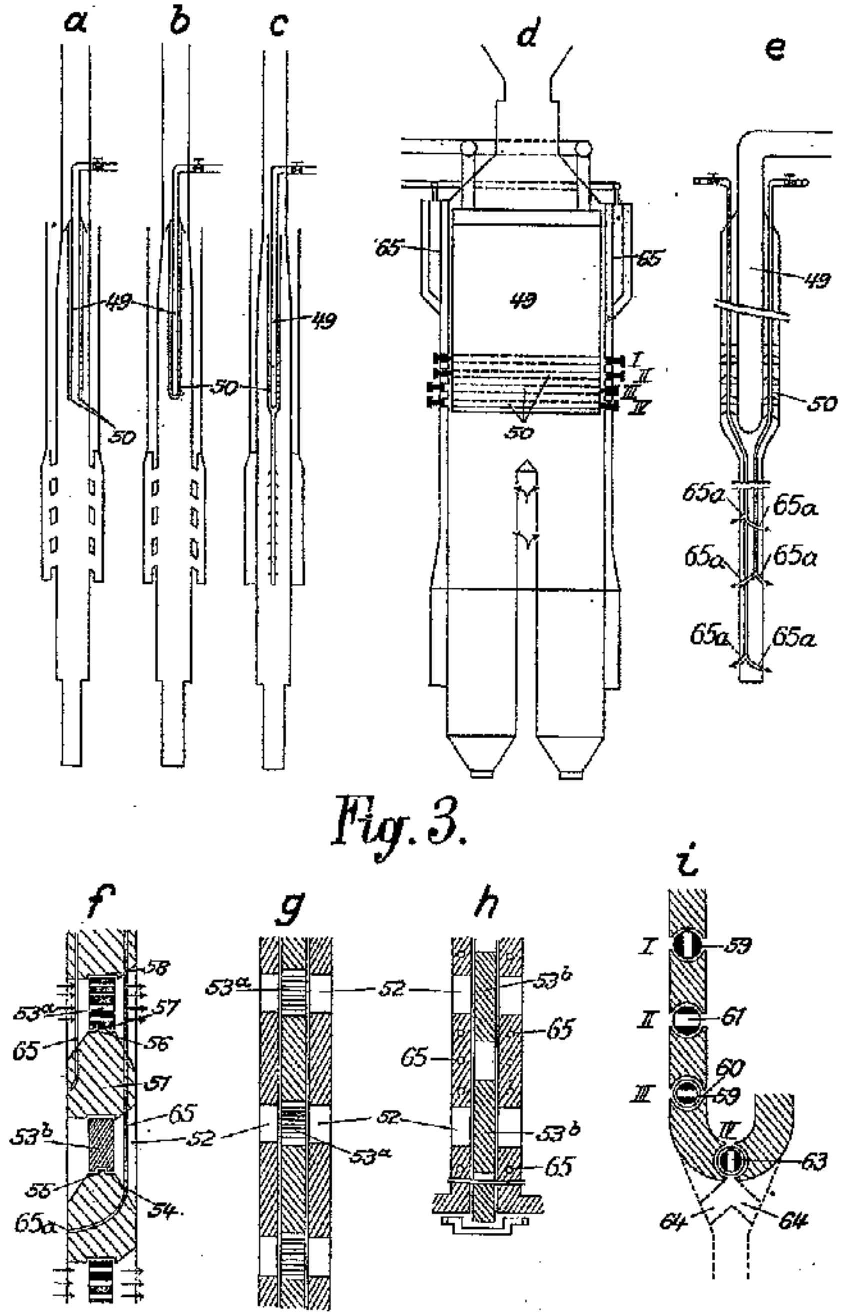

Fig. 3.

[This Drawing is a reproduction of the Original on a reduced scale.]