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PROVISIONAL SPECIFICATION.

Improvements in and relating to the Manufacture of Gas from Coal and like Carbonaceous Material.

We, Bamag Limited, a British Company, of Universal House, 60, Buckingham Palace Road, London, S.W.1, and Konstanty Laidler, of Polish Nationality, and Julian Wisniewski, of Polish Nationality, both of 147, Castlenau, Barnes, London, S.W.13, do hereby declare the nature of this invention to be as follows:—

This invention relates to the manufacture of gas from solid carbonaceous materials, such as lignites, brown coals, bituminous coals, or low-temperature or other reactive cokes, by means of air, or steam and air, or steam and air enriched with oxygen, or steam and oxygen, to yield gases containing hydrogen and oxides of carbon, with or without nitrogen and/or methane.

More particularly, the invention relates to the gasification of disintegrated carbonaceous material, or fuel fines, which are "fluidised" by the gasification media so that they behave in the gas producer like liquids. It has long been recognized that if a combustion-supporting or promoting gaseous medium be made to flow upwardly through a bed of solid fuel fines, the bed may be brought to a state resembling the liquid state in that the particles flow within the bed in convection streams (which promotes uniformity of temperature throughout the bed) and pass off with the gaseous medium by an action akin to diffusion. These conditions are favourable for the achievement of a very high rate of gasification, especially with highly reactive fuels, and no clinker troubles are encountered even with fuels having a high ash content provided that the gasification temperature is below the fusion temperature of the ash.

As hitherto practised, the gasification of fuel fines by this method of "fluidisation" is carried out under a pressure only slightly above that of the atmosphere. This, however, is disadvantageous in that to afford the time required for the gasification reactions between the solid particles and the rapidly flowing gaseous medium, a long gas path has to be provided within the producer. Thus, notwithstanding that the rate of gasification relative to the cross-sectional area of the producer is high, in relation to the volume of the gasification zone within the producer this rate is not higher than is obtainable with the standard intermittent gas producer. Even the shortest gasification path hitherto attained, with gas velocities just sufficient to cause the fuel bed to "boil", is very long, and if higher velocities are employed either a plurality of producer units in series is provided in order to afford the required length of gasification path, or alternatively ungasified fuel particles are separated from the product gases and recycled into the reaction zone.

[*Price* 2/-]

It has been proposed to employ in intermittent gas producers operating with a solid bed of carbonaceous material pressures up to about thirty atmospheres for the oxygen gasification of carbonaceous materials.

However, it has not been hitherto proposed to operate producers for the gasification of disintegrated carbonaceous materials by the "fluidising" method at any pressure higher than slightly above atmospheric.

We have investigated the application of high pressure conditions to the latter method of gasification, and have found that this method may be operated without disadvantage and with substantial advantages under pressures of from about two atmospheres to fifty atmospheres, and preferably under a pressure of the order of ten to twenty atmospheres.

Some of the advantages which derive from operation under high pressure are the following:—

(1) Due to the higher density of the gasifying media under higher pressure, the linear velocities of the media required to cause "fluidisation" of the fuel bed and flotation of the solid particles are lower,

and the necessary reaction time for complete gasification may accordingly be attained with a shorter path, that is, with a producer of considerably reduced height.

(2) Again, due to the higher density of the gasifying media under the higher pressure, for a given capacity the diameter is considerably reduced, simplifying the requirements of refractory and insulating brickwork.

(3) The higher gas density extends the carrying capacity of the gas so that less finely disintegrated carbonaceous material may be treated, including materials containing elements having linear dimensions up to the order of ½″.

(4) Since the higher pressure influences the composition of the product gas, principally by increasing the carbon dioxide content, and further since subsequent processes of conversion of residual carbon monoxide to carbon dioxide, and removal of carbon dioxide by scrubbing with water, are required or desirably to be carried out under elevated pressures, the production of the raw gas under pressure is advantageous in many chemical processes where a gas free from oxides of carbon is required.

(5) The oxygen consumption is reduced.

The present invention thus consists in the method of continuous manufacture from disintegrated carbonaceous material of gas containing mainly hydrogen and oxides of carbon which is characterised by the bringing of the material into intimate contact with gases containing oxygen and steam in a reaction zone wherein the gases, while under a pressure of from five to fifty atmospheres move upwards with a velocity such that the elements of the material are caused to float in the gases.

The method as aforesaid may be practised for the manufacture of a gas containing hydrogen, nitrogen and oxides of carbon, with a low content of methane, as a starting material for ammonia synthesis by bringing the carbonaceous material into intimate contact with steam and air enriched with oxygen, or for the manufacture of a gas containing hydrogen and oxides of carbon, for example, for hydrocarbon or alcohol synthesis, or for the eventual production of pure hydrogen, by bringing the carbonaceous material into intimate contact with the steam and oxygen, under an elevated pressure as stated.

Alternatively, the method may be operated for the manufacture of a gas of higher calorific value to be used as a fuel gas, by introducing the disintegrated carbonaceous material at the upper part of the reaction zone, so that while the finer elements are rapidly gasified the coarser elements of the material fall through the rising gases in said zone undergoing attrition and gasification at their surfaces, and separating the generated gases from ash close to the point of introduction of the material, so that undissociated methane, derived chiefly from said finer elements is discharged with the product gases.

In the method according to the invention, the course of the gasification reactions may be controlled, for example with the object of creating specific zones for particular reactions, by the injection of portions of the gasifying media, of the same or different compositions, as suitably spaced points within the length of the reaction path, this advantageous feature being facilitated as a result of the lower gas velocities employable with high pressure.

The process of gasification may also be controlled, either independently of or in association with selective injection of the gasifying media as aforesaid, by the application through the walls of the producer, within the length of the reaction path, of heating or cooling for the attainment of specific or localised specific reaction temperatures of the reacting gases and materials. This again is facilitated by the reduction of cross-sectional area of the reaction zone resulting from the increased density and by the greater heat conductivity of the gases under higher pressure, which enable the applied heat or cold to be rapidly distributed throughout the entire cross-section of the said zone. Moreover, the ratio of the internal surface area of the walls is increased in relation to the combined volume, making available a proportionately greater area for the heat transfer.

The advantages hereinbefore recited attain their optimum when the method according to the invention is carried out under a pressure of the order of ten to twenty atmospheres, and we therefore prefer to operate with a pressure of this order. At pressures higher or lower than this range, the beneficial results of higher gas density and lower velocity, while substantial, are not so outstandingly remarkable having regard to the provisions required to render suitable for operation under pressure the producer structure and the associated means for introduction of the carbonaceous material and gasifying media and for the removal of the product gases, ash and ungasified particles, if any.

Part of the product gases may be recycled to the producer operating according to the method above described, and may then serve as carrier gases for the introduction of the disintegrated carbonaceous material. This recycling, whether to serve for the introduction of the carbonaceous material or not, may also be advantageous when a producer initially designed for the manufacture of gases of various compositions by the reaction of the carbonaceous material with gaseous media including steam and air, and consequently having a nitrogen content in the product, is operated according to a modification of the method with a gaseous medium consisting of steam and oxygen to produce a nitrogen-free water gas, the recycled portion of the product gases then occupying the volume which would otherwise be occupied by nitrogen and enabling the operation of the producer under the flotation conditions for which it was designed.

The solid material may of course be introduced in any other convenient manner, for example, mechanically, as by means of a conveyor screw.

A producer for carrying out the method according to the invention may comprise a substantially vertical refractory shaft of small diameter in relation to its height, enclosed in a pressure-resisting steel casing, with means for the introduction of the solid carbonaceous material and for the introduction of the solid carbonaceous material and for the introduction of a gaseous medium under high pressure at a selected point or points through the bottom and/or side of the shaft, and means for the extraction from the bottom of the shaft of ash which falls through the rising gases. In operation according to the method of the invention, a proportion of the ash is in the form known as "fly" ash and is either taken out of the producer with the product gases and separated from them in a later stage, or alternatively, is separated from the product gases in an enlarged upper part of the producer where the velocity of the gases is reduced so that the ashes are dropped and may be collected and discharged from a zone at the lower end of the said enlarged part. In the event of the ash collected as last mentioned containing a proportion of ungasified carbonaceous material, as may occur especially when the latter is introduced towards the top of the producer shaft as for the production of gas containing methane, the ash and other material then collected may be returned to the producer.

Further, the gasification temperatures may be so controlled as to increase towards the end of the gasification path, in which case the ash is fused and may be collected in molten form. The molten ash may be broken up and quenched by means of water, with the production of steam for use as part of the gasifying medium.

Dated this 18th day of June, 1946.
W. J. SIMS,
Agent for the Applicants,

COMPLETE SPECIFICATION.

Improvements in and relating to the Manufacture of Gas from Coal and like Carbonaceous Material.

We, Bamag Limited, a British Company, of Universal House, 60, Buckingham Palace Road, London, S.W.1, and Konstanty Laidler, of Polish Nationality, of Gliwice, Poland, and Julian Wisniewski, of Polish Nationality, of 122, Lexham Gardens, London, W.8, (both formerly of 147, Castlenau, Barnes, London, S.W.13), do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to the manufacture of gas from solid carbonaceous materials, such as lignites, brown coals, bituminous coals, or low-temperature or other reactive cokes, by means of air, or steam and air, or steam and air enriched with oxygen, or steam and oxygen, to yield gases containing hydrogen and oxides of carbon, with or without nitrogen and/or methane.

More particularly, the invention relates to the gasification of disintegrated carbonaceous material, or fuel fines, which are "fluidised" by the gasification media so that they behave in the gas producer like liquids. It has long been recognized that if a combustion-supporting or promoting gaseous medium be made to flow upwardly through a bed of solid fuel fines, the bed may be brought to a state resembling the liquid state in that the particles flow within the bed in convection streams (which promotes uniformity of temperature throughout the bed) and pass off with the gaseous medium by an action akin to diffusion. These conditions are favourable for the achievement of a very high rate of gasification, especially with highly reactive fuels, and no clinker troubles are encountered even with fuels having a high ash content provided that the gasification temperature is below the fusion temperature of the ash.

As hitherto practised, the gasification of fuel fines by this method of "fluidisation" is carried out under a pressure only slightly above that of the atmosphere. This, however, is disadvantageous in that to afford the time required for the gasification reactions between the solid particles and the rapidly flowing gaseous medium, a long gas path has to be provided within the producer. Thus, notwithstanding that the rate of gasification relative to the cross-sectional area of the producer is high, in relation to the volume of the gasification zone within the producer this rate is not higher than is obtainable with the standard intermittent gas producer. Even the shortest gasification path hitherto attained, with gas velocities just sufficient to cause the fuel bed to "boil", is very long, and if higher velocities are employed either a plurality of producer units in series is provided in order to afford the required length of gasification path, or alternatively ungasified fuel particles are separated from the product gases and recycled into the reaction zone.

It has been proposed to employ in intermittent gas producers operating with a solid bed of carbonaceous material pressures up to about thirty atmospheres for the oxygen gasification of carbonaceous materials.

There is disclosed in Specification No. 558,879 and stated therein to be applicable to the low temperature carbonization of coal or the production of water gas from coal, a process for continuously circulating finely divided solids through a treating zone, which comprises maintaining a vertical column of said finely divided solids, maintaining a fluidizing gas in intimate mixture with said solids, throughout the full length of said column, controlling the amount of fluidizing gas in admixture with said solids within said column to maintain said solids in a fluidized condition and thereby generate fluid pressure at the base thereof, discharging finely divided solids from the base of said column into a stream of gas passing to the treating zone, maintaining the finely divided solids in contact with said gas within the treating zone for a predetermined period, separating the finely divided solids from the gas, and subsequently returning the solids so separated to the top of said column for return to said treating zone. It is further stated that the system may be operated under any desired pressure since standpipes are employed to produce enough fluid pressure at the base of the column of fluidized solids to overcome the pressure drop in the system.

However, it has not hitherto been proposed to operate producers for the gasification of a disintegrated carbonaceous material, by a single passage of the material in fluidized condition through a reaction zone, at any specified pressure substantially above atmospheric.

We have investigated the application of high pressure conditions to the latter method of gasification, and have found that this method may be operated without disadvantage and with substantial advantages under pressures of from about five atmospheres to fifty atmospheres, and preferably under a pressure of the order of ten tc twenty atmospheres.

Some of the advantages which derive from operation under high pressure are the following:—

(1) Due to the higher density of the gasifying media under higher pressure, the linear velocities of the media required to cause "fluidization" of the fuel bed and flotation of the solid particles are lower, and the necessary reaction time for complete gasification may accordingly be attained with a shorter path, that is, with a producer of considerably reduced height.

(2) Again, due to the higher density of the gasifying media under the higher pressure, for a given capacity the diameter is considerably reduced, simplifying the requirements of refractory and insulating brickwork.

(3) The higher gas density extends the carrying capacity of the gas so that less finely disintegrated carbonaceous material may be treated, including materials containing elements having linear dimensions up to the order of ½".

(4) The higher pressure influences the composition of the product gas, principally by increasing the carbon dioxide content, and the production of the raw gas under pressure is advantageous in many chemical processes where a gas free from oxides of carbon is required, since subsequent processes of conversion of residual carbon monoxide to carbon dioxide and removal of carbon dioxide by scrubbing with water, are required or desirably to be carried out under elevated pressures.

(5) The oxygen consumption is reduced.

The present invention thus consists in the method of continuous manufacture from disintegrated carbonaceous material of gas containing mainly hydrogen and oxides of carbon which is characterised by the bringing of the material into intimate contact with gases containing oxygen and steam in a reaction zone wherein the gases, while under a pressure of from five to fifty atmospheres, move upwards with a velocity such that the elements of the material are caused to float in the gases.

The method as aforesaid may be practised for the manufacture of a gas containing hydrogen, nitrogen and oxides of carbon, with a low content of methane, as a starting material for ammonia synthesis, by bringing the carbonaceous material into intimate contact with steam and air, or steam and air enriched with oxygen, or for the manufacture of a gas containing hydrogen and oxides of carbon, for example, for hydrocarbon or alcohol synthesis, or for the eventual production of pure hydrogen, by bringing the carbonaceous material into intimate contact with the steam and oxygen, under an elevated pressure as stated, adjacent the lower end of the reaction zone.

Alternatively, the method may be operated for the manufacture of a gas of higher calorific value to be used as a fuel gas, by introducing the disintegrated carbonaceous material at the upper part of the reaction zone, so that while the finer elements are rapidly gasified the coarser elements of the material fall through the rising gases in said zone undergoing attrition and gasification at their surfaces, and separating the generated gases from ash close to the point of introduction of the material, so that carbon monoxide and un-dissociated methane derived chiefly from said finer elements, are discharged with the product gases.

The advantages hereinbefore recited attain their optimum when the method according to the invention is carried out under a pressure of the order of ten to twenty atmospheres, and we therefore prefer to operate with a pressure of this order. At pressures higher or lower than this range, the beneficial results of higher gas density and lower velocity, while substantial, are not so outstandingly remarkable having regard to the provisions required to render suitable for operation under pressure the producer structure and the associated means for introduction of the carbonaceous material and gasifying media and for the removal of the product gases, ash and ungasified particles, if any.

In the method according to the invention, the course of the gasification reactions may be controlled, for example with the object of creating specific zones for particular reactions, by the injection of portions of the gasifying media, of the same or different compositions, at suitably spaced points within the length of the reaction path, this advantageous feature being facilitated as a result of the lower gas velocities employable with high pressure.

The process of gasification may also be controlled, either independently of or in association with selective injection of the gasifying media as aforesaid, by the application through the walls of the producer, within the length of the reaction path, of heating or cooling for the attainment of specific or localised specific reaction temperatures of the reacting gases and materials. This again is facilitated by the reduction of cross-sectional area of the reaction zone resulting from the increased density and by the greater heat conductivity of the gases under high pressure, which enable the applied heat or cold to be rapidly distributed throughout the entire cross-section of the said zone. Moreover, with decrease of diameter, the ratio of the internal surface area of the walls is increased in relation to the contained volume, making available a proportionately greater area for the heat transfer.

Part of the product gases may be recycled to the producer operating according to the method above described, and may then serve as carrier gases for the introduction of the disintegrated carbonaceous material. This recycling, whether to serve for the introduction of the carbonaceous material or not, may also be advantageous when a producer initially designed for the manufacture of gases of various compositions by the reaction of the carbonaceous material with gaseous media including steam and air, and consequently having a nitrogen content in the product, is operated according to a modification of the method with a gaseous medium consisting of steam and oxygen to produce a nitrogen-free water gas, the recycled portion of the product gases then occupying the volume which would otherwise be occupied by nitrogen and enabling the operation of the producer under the flotation conditions for which it was designed.

The solid material may of course be introduced in any other convenient manner, for example, mechanically, as by means of a conveyor screw.

Various schematic modes of construction of gas producers for carrying out the gasification processes according to the invention will be described, by way of example, with reference to the accompanying diagrammatic drawings, wherein

Fig. 1 is an axial section of a producer.

Fig. 2 is a similar section of another embodiment of producer.

Fig. 3 is a transverse section on the line III—III of Fig. 2.

Fig. 4 is an axial section of a variant of the producer shown in Fig. 2, and

Fig. 5 is a transverse section on the line V—V of Fig. 4.

The gas producer constructed to operate under high pressure according to the invention, as shown in Fig. 1., comprises a cylindrical reaction shaft 1, of small diameter in relation to its height, within a refractory and heat-insulating column 2, enclosed in a gas-tight steel casing 3 adapted to resist internal pressure. For the introduction of the solid carbonaceous material in the form of fines, there is provided a substantially gas-tight screw feeder 4, the housing tube 5 of which is secured to the casing 3, and is provided at its upper part with a branch connected to the bottom of a material hopper 6, and supports at its outer end a bearing 7 for the screw feeder shaft 8, rotatable by any suitable driving means (not shown).

The lower end of the refractory column 2 is shown as supported on a centrally apertured transverse plate 9, the bore of the column being enlarged to receive a refractory or heat resisting nozzle block 10 carried by a plate 11 removably screwed to the lower side of the plate 9. The nozzle block 10 comprises a central ash discharge tube 12, of smaller bore than the reaction chamber 1, and disposed below a downwardly tapering portion 13. Four passages 14 extend through the block 10 from the tapering portion 13 to registering holes in the plate 11, to afford communication to the reaction shaft 1 from a chest 15. A gas-tight door 16 removably attached over an opening 17 in the wall of the chest 15 carries a substantially gas-tight ash extractor screw 18, the housing tube 19 of which has, adjacent its inner end an upwardly directed branch 20 fitting over the lower end of the tube 12, and adjacent its outer end a depending discharge branch 21. The shaft 22 of the extractor screw, carried in a bearing 23 mounted at the end of the tube 19, is rotatable by any suitable driving means.

The door 16 also carries a pipe 24 serving for the admission under pressure of gaseous reagents to the chest 15. Supported in the casing 3 are tubes 25 and 26 adapted for the introduction of further gaseous reagents as desired, these tubes extending through the refractory column 2 to the reaction shaft 1. The cover portion 27 of the casing 3 comprises an outlet branch 28.

A producer constructed in principle as described above may be employed for the production of a gas containing hydrogen, nitrogen and oxides of carbon, with a low content of methane, as a starting material for ammonia synthesis. To this end, a gaseous reagent consisting of a mixture of steam and air enriched with oxygen in suitable proportions is introduced under a pressure preferably of 10 to 20 atmospheres by way of the pipe 24 into the chest 15, whence it flows through the passages 14 into the lower part of the reaction shaft 1 and upwards through the length of the latter. By means of the screw feeder 4, fines of solid carbonaceous material, for example lignite, brown coal, bituminous coal or low temperature coke, are continuously fed from the hopper 6 into the reaction shaft 1 adjacent the lower end of the latter, and in the hot rising steam of air and steam are partly burnt to carbon dioxide and partly gasified to carbon monoxide and hydrogen. The product gases, together with the nitrogen of the air, are discharged from the upper end of the reaction chamber 1 by way of the branch 28, which connects with means (not forming part of this invention) for cleaning the gas, for conversion with steam of carbon monoxide to hydrogen and carbon dioxide and for removal of the latter, these treatments preferably being carried out under a pressure corresponding to that of the gasification process, and said means comprising suitable devices for maintaining elevated pressure at least in the producer. Fine ash, particularly that resulting from gasification of the finer elements of the feed material, is carried off through the discharge branch 28 with the bases and removed therefrom externally of the producer in the gas cleaning stage. Heavier ash which the rising stream of gases in the reaction shaft cannot support falls to the bottom of the chamber and passes through the discharge tube 12 for removal by the ash extractor screw 18. It will be understood that within the tapering portion 13 of the nozzle block 10 the gaseous reagents entering by way of the passages 14 have locally a high velocity which serves to keep up within the lower part of the reaction shaft, larger ungasified elements of the carbonaceous material, so that eventually only ash succeeds in passing downwards to the extractor screw 18.

By means of the pipes 25 and 26, under the selective control of externally located valve means, secondary air or more preferably oxygen may be introduced under pressure to serve for completion of the gasification of particles of material rising in the main gas stream in the reaction shaft, these particles including not only those originally of small size, but others formed by partial gasification and attrition of larger particles in the lower part of the reaction shaft. By means of oxygen-supported reactions in the upper part of the shaft, the temperature may there be maintained at about 11000/1200° C. in order to minimise the methane content of the produced gas.

The producer as described with reference to Fig. 1 may also be used for the production under a pressure preferably of about 10 to 20 atm. of a gas containing hydrogen and oxides of carbon to be used for example in hydrocarbon or alcohol synthesis, or for the eventual production of pure hydrogen, by introducing at the bottom of the reaction shaft through the chest 15 a mixture of steam and oxygen (instead of the mixture of steam and air previously referred to).

In the modified producer as shown in Figs. 2 and 3 (wherein parts equivalent to those already described with reference to Fig. 1 are marked with the same reference numerals), the reaction tube 1 of small diameter opens at its upper end into an enlarged upper chamber 29 by means of a frusto-conical portion 30 from one side of which there extends downwardly within the refractory column 2 a fly ash collection duct 31, the lower end of which connects with a substantially gas-tight fly ash extractor screw 32 constructed and housed similarly to the ash extractor screw 18.

The producer as shown in Figs. 2 and 3 operates primarily in the manner described with reference to Fig. 1, but the feeder screw 4 is located adjacent the upper end of the reaction shaft 1 in order to render the producer more suitable for the production of a gas of high calorific value for use as a fuel gas. The quantities of steam-air mixture introduced to the bottom of the reaction shaft by way of the chest 15 and and of secondary air or oxygen introduced through the pipe 25 are so controlled in relation to the quantity of carbonaceous material introduced by the feeder screw 4 that, as a result of the reactions occurring within the shaft 1 the gas velocity at the level of the feeder screw is slightly above the floating velocity of the smaller particles of feed material which are thus immediately carried into the enlarged chamber 29. In the latter, by virtue of the substantial decrease of upward gas velocity, solid particles are dropped, and the product gases substantially free from solids which are discharged, serving to maintain elevated pressure in the producer, by way of the branch 28, contain a high proportion of methane and carbon monoxide developed from said finer particles and discharged rapidly so as to minimise dissociation of the methane and conversion of the carbon monoxide to dioxide. The larger particles of carbonaceous material introduced by the screw 4 cannot be supported by the rising gases and fall downwards in the reaction shaft 1 in counter-current to the rising stream of steam/air mixture during which they are subjected to attrition and gasified, the ash deriving from these larger particles passing out through the bottom discharge tube 12 for removal by the ash extractor screw 18.

The fly ash separated from the gases in the enlarged upper chamber 29 passes into the downwardly extending duct 31 from the bottom of which it is extracted by the fly ash extractor screw 32, and discharged. If this fly ash should be found to contain any substantial proportion of unreacted carbonaceous material, it may be returned to the reaction shaft 1 either by being elevated into the feed hopper 6, or separately introduced, as for example by means of the gas stream entering under pressure through pipe 25 or through another similar pipe specially provided.

The gas producer shown in Figs. 4 and 5 is similar in constructional principle to that described with reference to Figs. 2 and 3, the primary difference being that a duct 33 for the collection of fly ash from the enlarged upper chamber 29 is provided with one or more pipes 34 extending into it through the casing 3 and the refractory column 2 for the introduction under pressure of a gaseous reagent, preferably oxygen, for the purpose of ensuring complete gasification of any unreacted particles of carbonaceous material included in the fly ash. Oxygen reactions occurring in the duct 33 have the result of raising the temperature locally above the fusion point of the ash so that the latter is discharged from the outwardly extended lower end 35 in molten form. This ash may be quenched and broken up, for example by immersion in water, in means under pressure serving for the production of steam to be used as part of the gasifying medium.

The fuel gas produced by the known processes operated at or slightly above atmospheric pressure from typical brown coal fines containing approximately 8% water and 13% ash, is found to have a calorific value of about 100 B.T.U. per cubic foot. When the pressure is increased according to the method of the invention to 10 atmospheres, the calorific value is neardly doubled and may further be increased by the introduction of oxygen as described to yield a gas which in crude form has a calorific value of approximately 300, or after removal of carbon dioxide, 400 B.T.U. per cubic foot. The latter again may be further raised by increasing the operating pressure, being about 420 B.T.U. at 15 atmospheres and about 480 B.T.U. at 20 atmospheres.

Further, when similar brown coal fines are gasified in a continuous run in fluidised form to yield water gas, but under atmospheric pressure, the oxygen requirement is about 0.27 cubic foot of gas produced. By increasing the pressure under which the gasification is carried out to 10 atmospheres, according to the method of the invention, this oxygen consumption is reduced to 0.16 cubic feet.

Evidently the diameter of the reaction shaft will be such as to afford gas velocities capable of supporting fine elements of carbonaceous material of preferred size, in dependence on the rate of production desired, and where the gaseous reagent consists of steam and oxygen the diameter will be less than when such reagent consists of steam and air to allow for the reduced gas volume due to the absence of nitrogen. Alternatively, when a producer designed for use with steam and air is to be used with steam and oxygen for the manufacture of a nitrogen-free product gas, part of such product gas may be re-cycled to occupy that volume in the gas flow which would ordinarily be taken up by nitrogen.

Re-cycled product gas may also be used for the introduction of the feed material by pneumatic transport in place of the feeder screw described with reference to the drawings.

Provision may be made for fluid cooling of elements such as the gas supply tubes 25, 26 and 34, and also if desired for the cooling of the inner ends of feeder screw 4 and ash extractor screws 18 and 32.

Further, means may be provided for the application to any selected portion or portions of the reaction shaft, or any ash discharge duct such as the duct 33 shown in Fig. 4, of heating or cooling for local control of the temperatures of the reacting gases and materials. For example, such portion or portions of the reaction shaft or ash duct may be made of heat resisting steel or equivalent material closely surrounded by coils through which the heating or cooling fluid medium is passed, or closely wound heating or cooling coils may themselves form part or parts of the wall of such shaft or duct.

It is to be understood that the descriptions of the producers with reference to the attached diagrammatic drawings are given solely for the purpose of indicating modes of carrying out the method of the invention, and that the latter is not limited to operation in apparatus of the type so described.

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

1. The method of continuous manufacture from disintegrated carbonaceous material of gas containing hydrogen and oxides of carbon, characterised by the bringing of the material into intimate contact with gases containing oxygen and steam in a reaction zone wherein the gases, while under a pressure of from 5 to 50 atmospheres, move upwards with a velocity such that the elements of the material are caused to float in the gases.

2. The method of continuous manufacture from disintegrated carbonaceous material of gas containing hydrogen, nitrogen and oxides of carbon, with a low content of methane, characterised by the bringing of the material into intimate contact with steam and air, or steam and air enriched with oxygen, adjacent the lower end of a reaction zone wherein the gases, while under a pressure of from 5 to 50 atmospheres, move upwards with a velocity such that the material is caused to float in the gases.

3. The method of continuous manufacture from disintegrated carbonaceous material of gas containing hydrogen and oxides of carbon, characterised by the bringing of the material into intimate contact with steam and oxygen adjacent the lower end of a reaction zone wherein the gases while under a pressure of from five to fifty atmospheres, move upwards with a velocity such that the material is caused to float in the gases.

4. The method of continuous manufacture from disintegrated carbonaceous material of gas containing hydrogen, carbon monoxide and methane, characterised by introducing the material into the upper part of a reaction zone wherein gases containing oxygen and steam, while under a pressure of from five to fifty atmospheres, move upwards with a velocity such that the finer elements of the material are caused to float in the gases while coarser elements of the material fall in the reaction zone undergoing attrition and gasification at their surfaces, and separating the generated gases from ash and ungasified material adjacent to the point of introduction of the material, so that carbon monoxide and undissociated methane are discharged with the product gases.

5. The continuous method of gas manufacture according to any of Claims 1 to 4, carried out at a pressure of ten to twenty atmospheres.

6. The method of gas manufacture according to any of the preceding claims, wherein part of the product gas is recycled to the reaction zone.

7. The method of gas manufacture according to any of Claims 1 to 6, wherein the material to be gasified is introduced by pneumatic transport, as by a reagent gas, or by recycled product gas, or part thereof.

8. The method of gas manufacture according to any of Claims 1 to 6, wherein the material to be gasified is introduced mechanically and separately from any reagent gas.

9. The method of gas manufacture according to any of the preceding claims, including extracting ash from the lower end of the reaction zone.

10. The method of gas manufacture according to Claim 9, including reducing the gas velocity at the upper part of the reaction zone to cause deposition of fly ash from the product gases, and extracting of such fly ash from said upper part.

11. The method of gas manufacture according to any of the preceding claims, including returning to the reaction zone ash containing ungasified carbonaceous material.

12. The method of gas manufacture according to any of Claims 1—10, wherein the reaction is carried to a temperature above the ash fusion temperature, and ash extracted in molten form is quenched with water to produce steam for use in the reaction.

13. The method of continuous manufacture under high pressure of gas from disintegrated carbonaceous material, substantially as hereinbefore described.

14. A producer for the continuous manufacture under high pressure of gas from disintegrated carbonaceous material, substantially as hereinbefore described with reference to Fig. 1, or Figs. 2 and 3, or Figs. 4 and 5, of the accompanying drawings.

Dated this 27th day of February, 1948.
W. J. SIMS,
c/o ERIC POTTER & CLARKSON,
4/5, Staple Inn,
London, W.C.1.,
Chartered Patent Agents.

Abingdon : Printed for His Majesty's Stationery Office, by Burgess & Son (Abingdon), Ltd.—1950.
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[This Drawing is a reproduction of the Original on a reduced scale.]

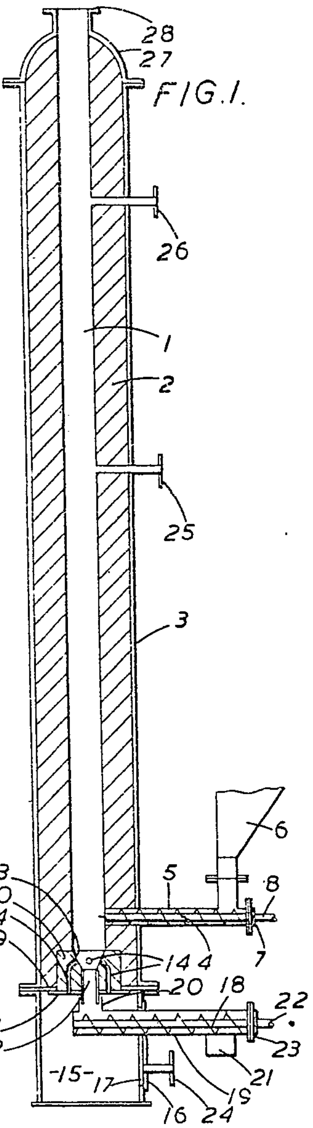

FIG.1.

FIG.2.

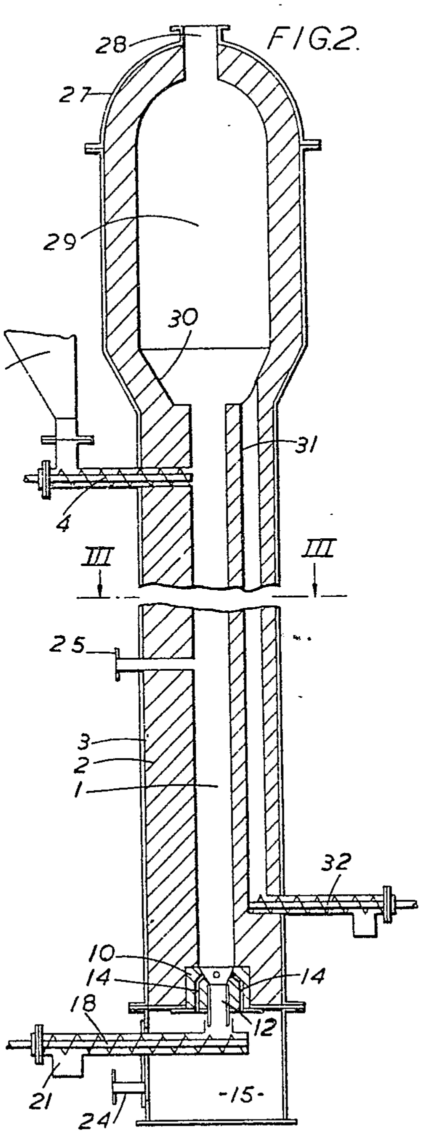

FIG.3

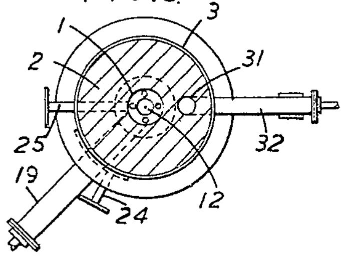

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FIG.4.

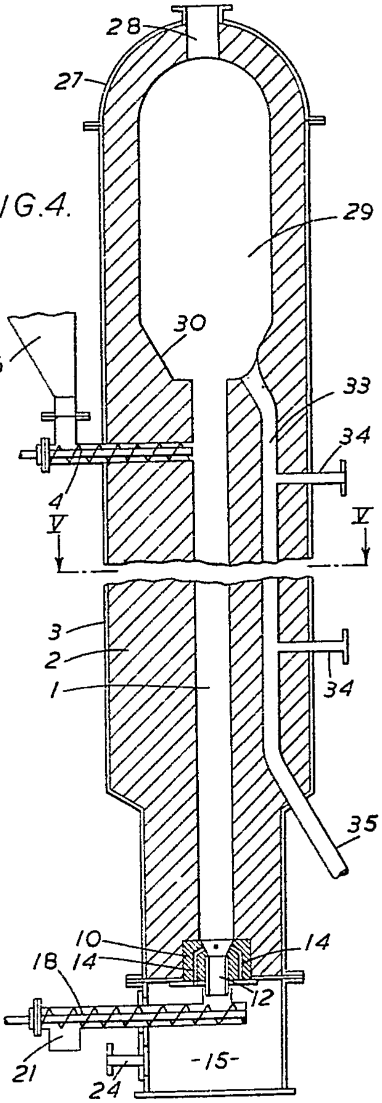
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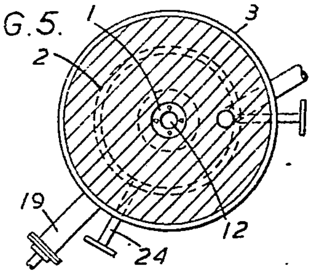
FIG.5.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647,706 COMPLETE SPECIFICATION

2 SHEETS

SHEET 1

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

FIG.1.

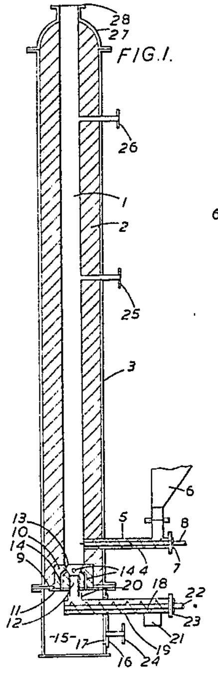


FIG.2.

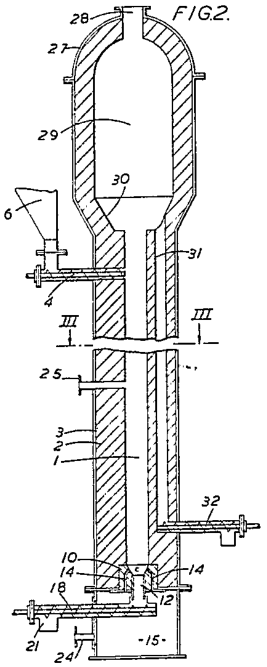
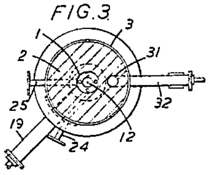


FIG.3.



SHEET 2

FIG.4.

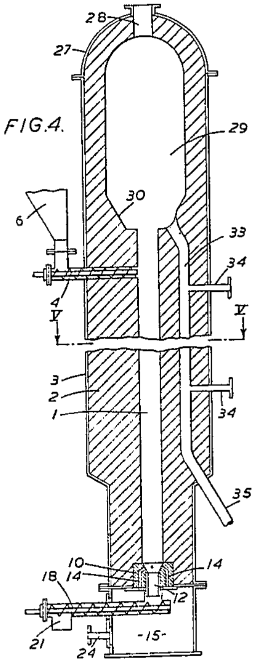
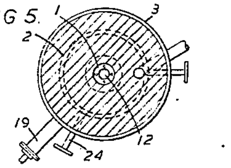


FIG 5.



H.M.S.O. (Ty. P.)