[Second Edition.]

PATENT SPECIFICATION

364,407

Convention Date (Germany): March 10, 1930.

Application Date (in United Kingdom): Feb. 23, 1931. No 5692 / 31.

Complete Specification Accepted: Jan. 7, 1932.

2283

COMPLETE SPECIFICATION.

Process of and Apparatus for the Production of Gas of High Calorific Power, and By-products, by Gasification with Oxygen under Elevated Pressure.

We, METALLGESELLSCHAFT AKTIENGESELLSCHAFT, of 45, Bockenheimer Anlage, Frankfurt-on-the-Main, Germany, a Corporation organised under the Laws of Germany, 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 a process for the production of gas of high calorific power by gasification with oxygen under elevated pressures exceeding 3 atmospheres and preferably about 10 to 30 atmospheres.

For the production of a high-power gas—that is to say, a gas of higher calorific power than ordinary producer gas—it has recently been proposed to effect the gasification by means of oxygen, and to improve the crude gas by catalytic hydrocarbon reactions and washing out the inert carbon dioxide. For remote supply, this gas must be compressed to the requisite pressure after purification to remove sulphuretted hydrogen and the like, unless such compression has been effected prior to the improving treatment. The production of high-power gas in this manner, however, is intended with technical and economic difficulties which are mainly attributable to the existing inadequate output capacity of the proposed apparatus and processes, the cost of the necessary oxygen, the expense of compressing large volumes of gas and the difficulty of controlling the temperature conditions in the bed of fuel, so that, up to the present, nothing is known with regard to the carrying out of these proposals on a technical scale.

In order to obviate these difficulties, the process of the present invention gasifies the fuel by introducing oxygen or air enriched with oxygen continuously into the fuel bed under a pressure of several atmospheres together with such quantity of steam that the gas produced contains a maximum proportion of hydrogen and methane. The working pressure depends on the quality of the gas which is desired and it is possible to produce a gas containing 25% of methane and more by increasing the pressure to about 40 atmospheres.

Types of gas producers, designated high-pressure producers, are known, but, unlike the invention, these do not work under such conditions as to produce substantial amounts of methane. On the contrary, they serve for the gasification of small coal with blast pressures up to about 700 mm. water-gauge. The positive pressure is mainly applied for the purpose of penetrating through the column of coal in the producer, and the resulting gas is of the ordinary pressure. Although recent proposals refer to the pressure gasification of semi-coke with steam, this process is attended with difficulties which cannot be overcome by the means at present available in the art, since it is essential, for the continuous performance of the endothermic water-gas reaction, to supply heat, the provision of which, by superheating the high-pressure steam to temperatures exceeding 600° C. is technically impracticable.

It has also been proposed to perform the gasification process, at the highest practicable temperatures, with dry air, or air with the smallest possible addition of steam, as gasifying agent, and under such increased pressure that the influence of pressure and high temperature produces extensive cracking of the tar contained in the fuel, and converts it into gaseous hydrocarbons. By this means, the calorific power of the gas is slightly increased and the formation of condensable constituents, such as tar, oil, and the like, prevented.

For remote- or urban gas supply, however, this process cannot be considered, since neither the calorific power nor the composition of the gas, nor, in particular, its specific gravity, or content of hydrogen and carbon monoxide, are sufficient for these purposes.

Furthermore it has been proposed to gasify carbon free from volatile impuri-

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ties with oxygen and steam under elevated pressure and such conditions as to produce a pure mixture of hydrogen and carbon monoxide for the synthesis of organic compounds, such mixture however containing no methane.

On the other hand, a gas of very high-grade quality and rich in hydrogen and methane is obtained by gasification, under elevated pressure, with oxygen, or air enriched with oxygen, and a copious addition of steam, (for instance in the proportion of 5 to 10 volumes of steam per volume of oxygen) in accordance with the present invention.

Thus, it has been possible when working under a pressure of 25 atmospheres, to produce a gas, which, after elimination of carbon dioxide, contains about 20% of methane and having a calorific value of more than 4500 calories per cubic metre, by complete gasification of anthracite and bituminous coals.

The process of the invention operates, for example, in the following manner:

The gasifying medium admitted into the producer consists of oxygen under pressure, to which, according to the invention and contrary to the usual practice, steam is added in such quantities that the fixed carbon of the fuel is converted to a considerable extent into carbon dioxide and hydrocarbons and that the reaction temperature is lowered in such a manner that the difficulties with regard to the structural material of the gasification shaft and the clinkering of the gasification residue are entirely obviated. Moreover, the said steam can be supplied at a superheat of about 450° C., which is easily attained in practice. Since the admission pressure of the gasifying medium is very high, preferably 10 to 80 atmospheres, the necessity for compressing the resulting gas any further for the purpose of remote supply and purification (such as washing out the carbon dioxide) is obviated. No compression is needed, both the steam and oxygen required for the gasification being obtainable, without any considerably increased expense, under the pressure at which they are employed according to the invention. On the other hand, in all the existing processes furnishing gas for remote supply, the resulting gas—the volume of which is 5—6 times that of the oxygen employed as gasifying agent—must be compressed—before or after purification—to the requisite degree. Economical gasification with oxygen has, for the first time, been rendered possible by the economy which the new process effects by dispensing with any further compression and by the economy in oxygen due to the exothermic nature of the methane-formation reaction.

The reaction under high pressure has a further advantageous effect in that it is attended with a substantial increase in the throughput. For a given grain-size of fuel, the production of dust and the risk of local eruptions of gas in the producer is known to be proportional to the square of the velocity, and directly proportional to the specific gravity of the gasifying agent, and therefore with increasing gasification pressure, (in contrast to the usual gasification under approximately atmospheric pressure), the cross-sectional load can also be increased in proportion with the square root of said pressure, so that—quite irrespective of the increased output already rendered possible through gasification with oxygen—the throughput of fuel can also be increased, for example by about 3.8-fold in the case of gasification under a pressure of 15 atmospheres.

Moreover, the methane-formation reaction may be substantially accelerated by adding catalytically active substances such as metals or metal oxides to the fuel. A particularly advantageous feature, however, is that the formation of carbon monoxide is lessened, by the low gasification temperature and the effect of the high pressure, in favour of the formation of carbon dioxide and methane, so that the final gas contains the desired low proportion of carbon monoxide, whilst the inert carbon dioxide can be easily removed by the aid of known methods. This is the more feasible inasmuch as the gas blown in accordance with the present invention is produced with the pressure needed for this process of eliminating carbon dioxide, and the compression otherwise required is therefore superfluous. At the same time, the amount of oxygen needed per cubic metre of gas produced, decreases as the pressure increases.

The gas furnished by the process of the present invention can be subjected direct to any convenient processes for purification and improvement, the performance of which processes is substantially facilitated and accelerated by the pressure already existing. This applies for example, for the abovementioned washing out of carbon dioxide, moreover for the employment of the Sabatier methane formation reaction the purification from sulphur and the condensation of the benzene hydrocarbons. By gasification under elevated pressure, the present process enables even inferior fuels—poor in gas—such as brown-coal—to be converted into a high-power gas corresponding to coal gas in point of density, calorific power and low content of carbon monoxide, for example 18% CO.

When operating in accordance with the present invention, it is necessary, in order to avoid any loss of gas, for the fuel to be gasified to be introduced into the gasifying chamber with the aid of special devices. To this end, a lock chamber is provided, into which the fuel is introduced, the chamber being then closed and the internal pressure raised to that of the gasification chamber by means of the surplus carbon dioxide from the process itself, or/and by steam, or similar means. The fuel is then transferred from the lock to the gasifier, and communication between the lock and gasifier is again interrupted, for the purpose of introducing a fresh charge. For very moist fuels, the charging lock can also be designed in such a manner that the fuel can be dried therein, in known manner, by the direct introduction of high-pressure steam. Similarly, the discharge of the gasification residue can be effected with the aid of a lock, or by flushing. The gas producer itself is designed, in the usual manner, as a lined cylindrical shaft, with or without mechanical ash-handling appliances, and, notwithstanding the high pressure, is of relatively large cross section, since, owing to the lower gasification temperatures employed, the stresses to which the shell of the producer is exposed, can be kept within technically controllable limits.

In order more clearly to understand the invention reference is made to the accompanying drawing which illustrates a cross-section of a gas producer which is particularly suitable for carrying out the hereindescribed process.

In said drawing, 1 denotes the wall of substantial thickness, of the gas producer which is lined with refractory material 2, 3 denotes the charging hopper attached to the top of the casing and 4 is a lock for discharging the ashes. The column of fuel in the gas producer is carried by a stationary table 5 on which is eccentrically mounted an agitating or displacing member 6 keyed on a shaft 7 passing up through a stuffing box 8 into the gas producer. The shaft and displacing member 6 can be set into rotation by a worm driven 11 and the eccentric movement of the displacing member 6 thus forces the residues of gasification corresponding to the speed of the shaft continuously over the edge of the table 5. In order to relieve the shaft and stuffing box from lateral stresses, the upper end of the shaft or displacing member 6 is mounted in a ball race 9 bearing against the table whilst the lower end of the shaft is mounted in a thrust-bearing 10. This bearing is so constructed that the weight of the fuel column and the pressure due to the internal pressure in the gasification zone are transmitted axially through the shaft direct on to the bearing. Discharging plates 12 are mounted on the shaft in the gasification chamber and are, on rotation of the shaft, adapted to convey the ash residues beyond the edge of the table to the outlet device 4. The gasifying medium is supplied through a conduit 13. In order to lead air and steam direct to the inner part of the fuel column, channels 25 are provided in the connection between the shaft and the displacing member 6 through which channels the gasifying medium passes beneath the displacing member and from thence flows into the fuel column. The gas produced is removed from the gas producer by the branch 14.

The connections 15 and 16 serve for introducing steam, water or gas into the charging hopper 3 and the lock chamber 4. The charging hopper 3 is closed externally by a lid 17 and internally by a cone 18. The lower seal 4 is likewise closed externally and internally by the lid 20 and cone 19 respectively. The fuel to be gasified is charged into the hopper 3 with the lid 17 open and the cone 18 closed. After closing the lid 17, the hopper is brought up by means of the conduit 15 using for example steam, to the internal pressure of the gas producer. On opening the cone 18 the fuel falls into the gasifying chamber and after closing the cone 18 the pressure in the hopper chamber is relieved through the branch 15 to atmospheric pressure and after opening the lid 17 the filling process can be renewed. The discharging of the gasification residues through the lock chamber 4 is effected in an analogous manner.

If, where high power gas of a desired composition is to be produced, very high pressures are to be employed, intermittent gasification may be preferred to this continuous operation. For this purpose, the pressure in the gasification chamber is relieved when the reaction has terminated, the residue is evacuated, and the chamber is recharged with fuel. Under these conditions, the provision of double locks may be omitted.

The pressure under which the gasification proceeds need not, of course, correspond to that in the remote-supply mains. Thus, in some cases, it may be preferable to gasify under a higher pressure of 50 atmospheres or more, if this enables a high power gas to be produced which will have the desired composition after the carbon dioxide has been washed out. The surplus pressure energy can then be utilised, to advantage, for driving the

auxiliary machines required for carrying out the process. Conversely—taking the process, as a whole, into consideration—the pressure in the gas producer may be kept somewhat lower than is needed for the further application of the gas, and may be increased, by stages, directly after, or between, the several operations of purification and improvement.

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). A process for the production of gas of high calorific value by gasifying fuels with oxygen and steam at a pressure of several atmospheres, in which the conditions of gasification namely pressure, temperature and quantity of steam are so selected that substantial amounts of methane are formed.

2). Process as set forth in claim 1, in which the gas produced is directly subjected under its own pressure to improving or purifying processes, such as washing out the carbon dioxide and condensable hydrocarbons and catalytic conversion reactions.

3). Process as set forth in claims 1 and 2, in which the expansion of the gas which is produced under pressure prior to or after carrying out the further stages of the treatment is utilised for the generation of power required for the process.

4). Process as set forth in claims 1 to 3, in which additional substances having catalytic action are added to the fuel.

5). The process for the production of gas of high calorific power, substantially as described.

6). Apparatus for carrying out the process set forth in claims 1 to 5, comprising a vertical gasification shaft with a doubly sealed lock chamber for the introduction of the fuel and a similar chamber for the discharge of the ash, and pipes for introducing steam, water or gas into the said lock chambers.

7). Apparatus for carrying out the process set forth in claims 1 to 6 comprising a table supporting the column of fuel in the lower part of the gas producer, a rotating shaft to which said table or members adapted to remove the ash above said table are secured and arms adapted to discharge the ash to a lock chamber, said arms being also secured to said shaft and located below said table.

8. The apparatus for the production of gas of high calorific power, constructed, arranged and operating substantially as described with reference to the accompanying drawings.

Dated this 23rd day of February, 1931.

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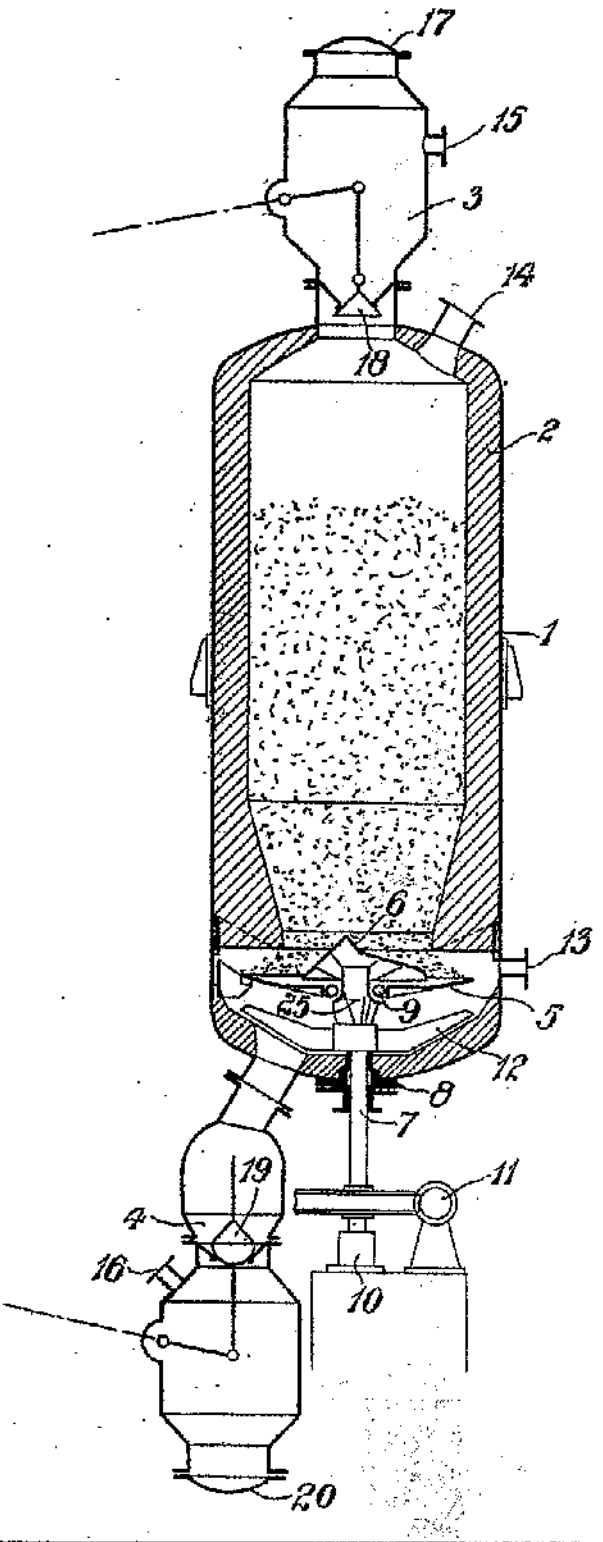
Abingdon: Printed for His Majesty's Stationery Office, by Burgess & Son.
[Wt. 8030.—50/1/1939.]

2nd Edition



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