PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Method and Apparatus for Gasifying Fine Coal or Dust Coal with Circulating Gas chiefly for the Production of Water Gas or Gas for the Synthesis of Benzine

We, WINTERSHALL ARTIENGESELLSCHAFT, of 139, Hohenzollernstrasse, Kassel, Germany, a German Company, and HANS SCHMALFELDT of 15, Bergstrasse, Kassel, Germany, a German Citizen, 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:—

The gasification of fine coal or coal dust is mostly carried out so that the coal bed either remains continually in movement when it is a question of fine coal, or in that the coal particles are maintained chiefly in suspension when the coal to be treated consists of coal dust.

The gasification with a circulating gas current is chiefly preferable when it is a question of producing high-grade gases, that is above all water gas. As it is necessary to employ high temperatures (700°—1600° C.), the circulating gas is usually re-heated according to the regenerative principle. The fundamental mode of operation is shown by Figure I.

a is a reaction chamber or dust gasifier, *b* are nozzles for the introduction of the material thereinto, d_1 and d_2 are regenerators, c_1 and c_2 are inlets to the circulating gas current, *e* is an outlet for the gas formed, f_1 and f_2 are furnaces and g_1 l_1 and g_2 l_2 are gas and air supply conduits for the furnaces; m_1, m_2, p_1 p_2 and r_1 r_2 are slide valves.

The operation takes place in the known manner as follows:

When the regenerator d_1 is the heated regenerator (i.e. the regenerator being heated) the valves in the supply conduits g_1 l_1 and the slide valve m_1 are open while the slide valves p_1 and r_1 are closed. At the same time gas is passing through the working regenerator d_2 the valves in the supply conduits g_2 l_2 and the slide valve m_2 being kept closed while the slide valve p_2 and r_2 are open. After a certain time the functions of the two regenerators are reversed d_2 being heated while gas passes through d_1, all the slide valves occupying the opposite position.

When working in the manner described great difficulties are experienced with the heating gas slide valves r_1 and r_2 which are subjected to temperatures up to 1200°—1400° C. The slide valves therefore no longer close sufficiently tightly after some time, even with water cooling, they wear easily, bind and, in the case of water cooling, give off much heat which is lost for the gasifying process.

For this reason constructions have already been proposed, in which the slide valves are omitted and in which the heating gas current, the flue gas current and also the circulating gas current are controlled by corresponding differences in pressure between the individual chambers. However, in practice it is not possible by this adjustment of the pressures even approximately to shunt off the regenerator to be heated because the pressures can never be so accurately adjusted.

The difficulties are similar, although not quite as great, when the heating gas passages from the regenerators are united in front of the entry into the gasifier and a common heating gas passage leads into the gasifier.

For gas producers it has already been proposed to provide in the pipe leading the gas containing steam to the reaction chamber a convoluted nozzle for the purpose of ensuring a thorough mixing of the admitted pulverized fuel and gas current. The narrowing of this nozzle is far from ensuring a sealing between the heating and the reaction zone under certain conditions. This is also evidenced by the fact that this former proposal provides a valve between the steam injector on the one side and the reaction chamber and a heat accumulator on the other side. Furthermore, according to this former process a continuous flow of water gas must be provided, water gas passing during the heating stage from the reaction chamber into the heat accumulator,

[*Price* 1/-]

thus preventing the passage of fire gases into the reaction chamber.

For gasifying coal in the form of powder it has been furthermore proposed to provide a nozzle shaped constricted passage between the firing chamber and the reaction chamber in order to increase the velocity of the stream. But this stream consists of a mixture of the fuel and a heating gas. This process does not mention at all how a sealing is obtained and does not work by means of circulating gas.

Finally it has also been proposed to provide heating and gasifying chambers adjacent to each other, dust and steam being blown into the gasifying chamber and discharging the resulting gases through a central passage. A special proposal in this connection is the maintainance of the same pressure in the reaction and heating chambers.

As shown above, some of these former processes do not work by means of circulating gases at all and none of them shows a method of preventing back flow from the reaction chamber to the heating zone and vice versa only by means of a sufficient superpressure in the path between the two zones and without valves in this path.

The present invention relates to the gasification of pulverulent or fine-grained fuels in a gasifying zone, chiefly for the production of water gas or gas for the synthesis of benzine, by means of gases heated in regenerating zones and circulating from these to the gasifying zone and back to the regenerating zones; consisting in supplying fuel and gas to the reaction chamber through separate inlets and providing a restricted path between the reaction or gasifying chamber and each of the regenerating zones, whereby a super-pressure at this point must be overcome by the flow of gases between the regenerator which is being heated and the reaction chamber, which super-pressure prevents or reduces the flow of gas between the reaction chamber and the heated regenerator to a negligible amount.

The invention will now be described with reference to Fig. 2:—

The inlet-passages for the hot circulating gases (700°—1600° C.) into the gasifier or the connecting pipe conduits between regenerator and gasifier have either at the entrance into the gasifier or at some other suitable point a nozzle or a restriction in the tube which increases the pressure necessary to force a sufficient quantity of the hot circulating gas out of the corresponding regenerator into the gasifier. (The circulating gas always contains steam, e.g. together with water gas of different composition or hydrogen and carbonic acid or producer gas). The cross-section at the point in question is reduced e.g. by 5—80% of the average. The nozzle shaped restriction of the connecting conduits need not be arranged at the entrance into the gasifier, but may be provided at any other point of the connecting conduit. The narrowing of the conduit at the entrance into the gasifier —where it provides an inlet nozzle—presents, however, the advantage that by reason of the high admission speed at which the hot circulating gases flow into the gasifier a good circulation or a continuous interwhirling of the gas takes place in this gasifier and consequently the fine coal particles to be gasified are permanently maintained in suspension so that the gasification is accelerated.

If the nozzle is, for example, so dimensioned that the pressure in front of the nozzle during the passage therethrough of the circulating gas is about 2000 mms. water column and if the pressure difference, as above described, is maintained at 2 mms. water column between the gasifier and the heated regenerator, the value of the missing gas current on the heating side is only

$$\frac{\sqrt{2}}{\sqrt{2000}} = \frac{31}{1000}\text{th}$$

part of the circulating current, i.e. therefore only about a 30th part of the quantity of circulating gas flows either as flue gas into the circulating gas or as circulating gas out of the gasifier into the flue gas of the heated regenerator. The quantity of missing gas has thus been reduced to a relatively small quantity, whereas the quantity of missing gas according to Figure 1 which represents half the quantity of circulating gas, cannot possibly be permitted in practice.

However, even when the pressure difference between gasifier and the heated regenerator is considerably greater, for example when it amounts to 20 mms. water column, the value of the escaping gas current is always only a tenth part of the circulating gas.

The superpressure produced in the connecting path between the regenerating zone and the gasifying zone for sealing may be used advantageously to circulate or to maintain in movement the gas masses in the gasifying zone by means of the speed increase in the flowing gases resulting from said superpressure; in this way the carbonaceous particles are kept in suspension.

It is consequently certain that the restriction in the gas inlet, according to the invention, e.g. the nozzle shaped construction of the circulating gas inlet, results in such a reduction of the quantity of escaping gas, that the heating gas slide valves can be confidently omitted, so that a regulated, economical working is possible. A slight dilution of the circulating gas can be tolerated, as also a slight loss of circulating gas.

It is, however, possible, according to the invention, to obtain an absolutely tight closure or seal if care is taken that the pressure in the heated regenerator is always slightly higher (0.1—100 mms. water column) than the pressure in the gasifier, which can always be attained by corresponding adustment of the waste gas slide valves m). To this end steam is admitted into the connecting conduits between the regenerators and the gasifier in front of the outflow of the circulating gas from the nozzle or in front of the point where the superpressure must be overcome viz. the narrowing. According to Figure 1 o_1) and o_2) with valves s_1) and s_2) serve for this purpose, and are correspondingly controlled and always maintained open on the heating side and closed on the gasifying side. The pressure difference prevailing between the gasifier and the heating regenerator can fluctuate within certain limits. The quantity of sealing steam is so adjusted, that during the greatest possible or permissible pressure difference it is just sufficient to force the whole quantity of sealing steam into the gasifier. In the case of a small pressure difference, only a portion of the sealing steam flows into the gasifier, whereas the remainder passes off into the heated regenerator. The steam, which arrives in the gasifier, obviously does not cause a dilution of the circulating gas, but rather exerts a useful effect, as this steam is utilized to assist the gasification. The quantity of team passing into the heating regenerator likewise does not exert a prejudicial effect as it is relatively small. In any case gas losses and dilution of the generated gas and also after-burning at any point not desired are avoided.

The operation according to the invention is therefore shortly as follows.

Assuming that the regenerating zone d_1 is being heated and the regenerator d_2 is supplying gas to the reaction chamber a, the procedure will be as follows: The valve m_1 is adjusted so that the pressure in the regenerator d_1 is just a little different from the pressure in the reaction chamber a. When this is effected there will be only a slight flow of gas from the regenerator d_1 into the reaction chamber a or vice versa. At the restricted point of c_1 this flow naturally has to overcome a pressure which is due to said restriction and consequently there will be no tendency for the gases in the chamber a to pass into the regenerator d_1 or vice versa and only a very small amount of gases may flow from the regenerator to the reaction chamber or vice versa; this amount is so small that it may be neglected. Even this slight leakage can itself be prevented if desired by opening the valve s_1 which admits relatively high pressure steam into the pipe c_1, thereby forming a complete seal. The pressure in the regenerator d_2, on the other hand, is much greater than that in the reaction chamber a, so that the gases in the regenerator d can pass without obstruction into the reaction chamber a. The restriction in the pipe c_2 will cause the velocity of the gases entering the reaction chamber a through the pipe c_2 to be increased, if this restriction is positioned at the entrance of c_2 into a, with the advantageous results above described. The valve s_2 is kept closed whilst the regenerator d_2 is supplying the reaction chamber a. The various connections are reversed when the regenerator d supplies the reaction chamber a. It will be evident from the foregoing that, irrespective of which regenerator is supplying gas to the reaction chamber a, there will be free communication between the reaction chamber a and the working regenerator only whilst the regenerator is supplying gas to the reaction chamber a and in this case the greater pressure in the regenerator effectively prevents back pressure. On the other hand there can only be a slight leakage in either direction between the reaction chamber a and the regenerating chamber which is being heated, and even this slight leakage can be suppressed if desired by opening the corresponding steam valve s_1 or s_2.

The difference in pressure between the heated regenerator and the gasifier may be of the following range (water column pressure): 0,3—4 mms., but it may be increased up to 80—100 mms. or, if necessary, a little more. The pressure in the gasifier itself may vary between any limits; e.g. it may be regulated to 20—50 mms. water column.

The carbonaceous fuel, finely divided, may be e.g.: mineral coal, charcoal, lignite, peat or the like.

Naturally the pressure in the gasifying regenerator must be higher than in the gasifier.

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. Process for the gasification of pulverulent or fine-grained fuels in a gasifying zone, chiefly for the production of water gas or gas for the synthesis of benzine, by means of gases heated in regenerating zones and circulating from these to the gasifying zone and back to the regenerating zones, consisting in supplying fuel and gas to the reaction chamber through separate inlets and providing a restricted path between the reaction or gasifying chamber and each of the regenerating zones whereby a superpressure at this point must be overcome by the flow of gases between the regenerator which is being heated and the reaction chamber which superpressure prevents or reduces the flow of gas between the reaction chamber and the heated regenerator to a negligible amount.

2. Process according to claim 1, characterised in that the narrowing is placed at the point where the path discharges into the gasifying zone, thus utilizing the superpressure for circulating or maintaining in movement the gas masses in the gasifying zone by the resultant speed increase so that the coal particles are maintained in floating condition.

3. Process according to claims 1 or 2, characterised in that the pressure in the heating regenerating zone is always maintained higher than in the gasifying zone by the lowest possible amount and that steam is introduced into the connecting paths between regenerating zones and gasifying zone during the heating so that this steam flows through the nozzles into the gasifying zone during the heating, thus preventing back flow from the heated zone and vice versa.

4. Apparatus for carrying out the process according to the preceding claims, comprising a gasifier, several regenerators, each of these being connected to the gasifier by means of a separate pipe having a restriction or a nozzle.

5. Apparatus according to claim 4, wherein the restriction or nozzle is at the point where the pipe discharges into the gasifier.

6. Process for the gasification of fuels substantially as described.

7. Apparatus for gasifying fine coal or dust coal with circulating gas constructed, arranged and adapted to operate substantially as described with reference to and as illustrated in the drawings herewith.

Dated this 2nd day of November, 1935.

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Fig. 1.

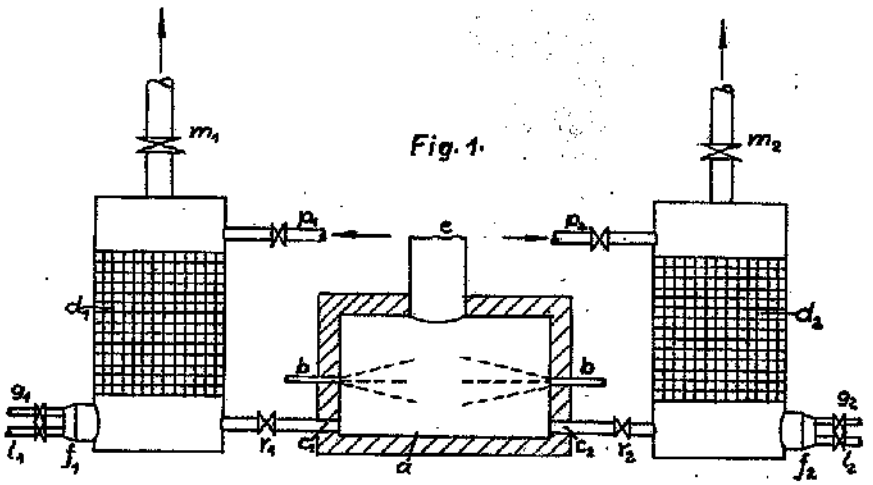
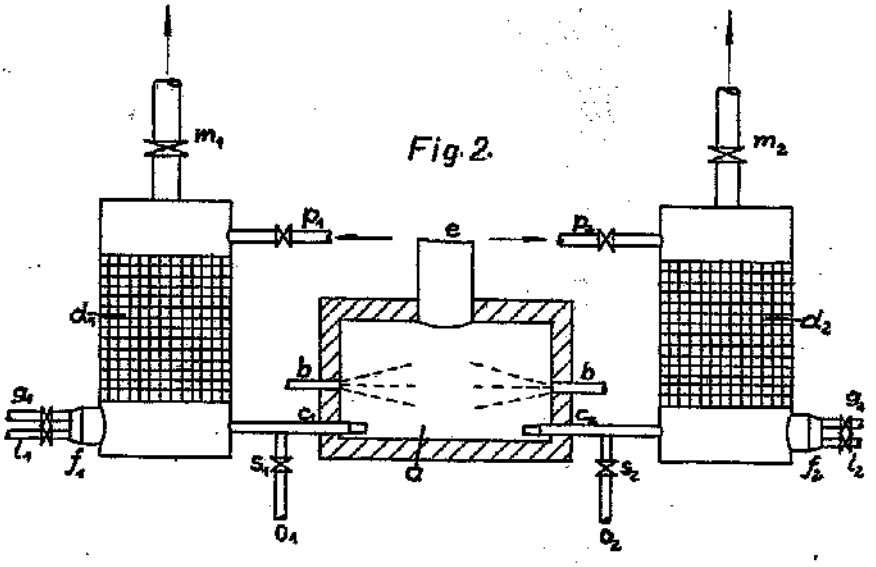


Fig. 2.



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