PATENT SPECIFICATION

Convention Date (Germany): Nov. 26, 1934.

453,547

Application Date (In United Kingdom): Nov. 2, 1935. No. 30861/35.

Complete Specification Accepted: Sept. 14, 1936.

3280

COMPLETE SPECIFICATION

Process and Apparatus for the Gasification of Dust or Fine-Grained Fuels with Circulating Gas chiefly for the Production of Water Gas and Gas for the Synthesis of Benzine

We, WINTERSHALL AKTIENGESELLSCHAFT, 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:—

When it is a question of gasifying fuels for the purpose of producing a gas free from nitrogen or poor in nitrogen, for example water gas, large coke is chiefly employed. It has however been found that in the case of dust coal a very rapid gasification can be obtained with simultaneous treatment of a large quantity of coal dust.

The quantity of heat required for the gasification may be introduced, if the inefficient and expensive external heating is avoided, either by internal heating with a gas containing a high percentage of oxygen or with heated circulating gas. As the first method possesses the disadvantage of the high expense of oxygen and the large content of carbon monoxide and carbon dioxide in the gas produced, the production of the reaction heat by means of highly heated circulating gas, consisting of water vapour or of a mixture containing water vapour, is the only convenient method that can be employed when the gas produced is to have the smallest possible percentage of carbon dioxide and carbon monoxide. In the case of these requirements for the gas composition the problem has therefore to be solved to gasify fine-grained and preferably pulverulent fuels by means of circulating gas.

A water gas producer has been previously proposed in which circulatory gas is employed in the reaction chamber in combination with a distilling or a drying apparatus or a combined distilling and drying apparatus, the gas leaving the generator being used for drying and disintegrating the raw fuel to be used in the process and enabling fuels which are moist and contain tar to be employed. Hot water gas passing out of the generator, after the solid particles have been removed therefrom, is charged with the raw fuel and passed through the said apparatus. A portion of the hot water gas is used as the circulatory gas. Additional disintegrating apparatus for the starting fuel was also included in this prior proposal.

The process for the gasification by means of heated circulating gas of fine grain or pulverulent fuels which have been obtained from relatively easily disintegrated raw fuel, such as raw brown coal and the like, according to the present invention, consists in using the gas leaving the gasifier whilst still charged with completely or partially gasified dust to dry and disintegrate the incoming fuel which may be further disintegrated mechanically if necessary, the gas being then separated from the solid matter, part of which passes into the gasifier, the remainder being removed continuously from the circulation to prevent undue accumulation of ash.

Thus according to the present invention all the heat in the gases coming from the reaction chamber is utilised so that the drying of the fuel is more complete and more rapid. Moreover since the dust is retained in the gas until it has been used in the drying process the apparatus is correspondingly simplified.

In one way of carrying out the present invention the finely divided carbonaceous fuel (mineral coal, charcoal, lignite, peat or the like) is gasified in a gasifying zone by means of circulating gas of about 700°—1600° C. The circulating gas always contains steam, together with e.g. water gas of different composition or hydrogen and carbonic acid or producer gas. The gases escaping from this zone and charged with the more or less gasified dust are used to dry the necessary amount of fuel, e.g. by means of drying apparatus. The raw fuel is introduced into

[Price 1/-]

the flowing gas stream; by the quick drying obtained thereby, the fuel is simultaneously disintegrated. The fuel may be further disintegrated mechanically if necessary. Thereupon the mixture of gas and fuel is separated by suitable means and at this point a part of the produced dust (about 10—50% of the total amount produced by drying and disintegrating) is removed from the circulation. The rest of the dust is led back to the gasifying zone. The gas is led—if necessary after washing to free it from the last dust particles—to the gasifying zone. At this stage a part of the produced gas is removed as final product; the amount of this final product naturally corresponds to the amount of gas produced during the circulation. Before the part of the gas which has not been removed from circulation discharges into the gasifying zone, it is reheated. The fuel removed from the circulation may be used for this purpose. It may also be used to heat an air-heater which preheats the combustion air for the regenerators.

Advantageously the dust to be removed from the circulation is taken from the dust separator which shows the highest content of ash.

From the above it is clear that according to the invention it is possible to combine the gasifying known per se with a particular method of drying by introducing the raw fuel into the gas stream charged with gasified dust escaping from the gasifying zone, whereby also disintegration of the lumps of raw fuel takes place. Subsequently the dust thus produced is separated from the gas and part thereof is removed, the rest being introduced into the gasifying zone. Instead of the first described method of simultaneously drying and disintegrating the gases escaping from the gasifying zone may be employed to dry the raw fuel which is disintegrated mechanically.

One form of the present invention will now be described with reference to the accompanying drawings.

According to the method shown in Fig. 1, the dust to be gasified is introduced into the gasifier *a*) at *b*). Instead of one gasifier also several gasifiers may be used, connected in series. The dust to be gasified is in suspension in the gasifier. The amount of the fuel in the gasifier is such that it may be kept in suspension and that the correct temperature for the process may be maintained. The hot circulating gas enters at *c*), and the more or less gasified dust is discharged at *d*), together with the circulating gas which has by this time cooled appreciably. This gas charged with the more or less gasified dust particles is then used for drying and disintegrating the fresh coal. For this purpose the coal, which may have been previously disintegrated, is supplied from the bunker *e*) through a device (in the Figure a worm) *f*) into the current of the hot circulating gas and disintegrated to the necessary fineness in the manner known and partly described. This method of drying works in the following manner: The heated gas stream at a temperature of 500°—900° C. is led through a pipe in which the raw fuel, such as lumps of lignite, is discharged. By the sudden heating of the raw lignite in the quickly moving gas stream the exterior layer of the fuel is dried and bursts into small fragments. The dried fuel thereby is obtained relatively fine. The temperature in the pipe is reduced quickly. At the end of the pipe the fine, dry particles are separated by means known per se, and the larger, not yet perfectly dry ones are led back into the pipe, thereby coming again into the gas stream. This disintegrating (taking place simultaneously with the drying) may be supplemented by mechanical means, e.g. a beater-drum, which disintegrates the particles which are too large by means of short, strong blows. The dry and preferably dust fine coal is now separated by several dust removing devices connected in series, namely in the figure first by a cyclone *g*) and then by an electric dust separation *k*). The gases discharged from *k*) then enter a washer *l*) in order to be simultaneously cooled and freed from the last traces of dust; the working liquids used in the washer may be e.g. water or a suspension of coal dust in water. The circulating gases are drawn out of *l*) and compressed by a fan or a blower *m*). They are then again forced into the device *n*) where the re-heating of the circulating gas takes place. The highly heated circulating gases flow from *n*) into the gasifier. The gas is drawn off from the circulation at *p*).

The dust produced passes through the conduits q_1) and q_2) out of the dust separators into a dust silo with overflow *o*). Most of the dust is now drawn off by a dust pump *r*), and forced through the dust conduit *s*) into the gasifier at *b*). A certain portion of the whole of the dust produced is, however, drawn off at *t*) through a separate conduit and is used for some other purpose.

A great advantage of the present invention lies in the fact that the gasifying apparatus can be kept considerably smaller as complete gasification of the coal dust obtainable is not essential. If, for example, the degree of gasification of

the coal during a single pass is less, the quantity of dust again supplied to the gasifier increases automatically, so that, therefore, the circulation of a somewhat greater quantity of dust takes the place of a more intensive gasification. In order, however, to prevent the ash content from becoming too great in the circulation, a certain portion of the dust coal is always drawn off and thus removed from the circulation together with the ash. This portion of the dust coal is used for some other purpose. The quantities of dust removed from the circulation, however, need not be particularly great in order to keep the average ash content low, as the following example shows:—

30 tons of dry coal dust transpersed with 8% ash are to be passed hourly through the dust gasifier. However, sufficient coal is to be dried to produce hourly about 10 extra tons of coal dust of normal composition, (that is with 8% ash), which corresponds to about 9.2 tons of ash-free dust coal. Consequently 40 tons of coal dust with 8% must be introduced into the gas stream per hour. The total amount of ash therefore amounts to 3.2 tons per hour. These 3.2 tons of ash must be removed with 9.2 tons of ash-free coal dust to be used for other purposes. Therefore, it is necessary to remove 12.4 tons of coal dust with an average ash content of 26%. With this ash content it is possible to directly employ the coal dust which is drawn out of the circulation, for burning purposes. On the other hand the average ash content in the coal arriving at the gasification is just as high. The gasification can however be still satisfactorily carried out with this ash content in the coal. It is therefore evident that by the manner of operation indicated, that is by the continual returning of the dust coming from the gasification, combined with a simultaneous withdrawal of part of the dust, it is possible to maintain at a satisfactory percentage the ash content of the dust entering the gasifier. This results in a considerable increase in the efficiency of the dust gasifier, as it is no longer dependent upon a high degree of gasification.

The invention may advantageously be employed, using an apparatus wherein the heating of the circulating gas is effected by means of regenerators (Figure 2). In this instance *a*) represents the dust gasifier (or gasifiers connected in series), and the dust to be gasified enters at *b*) and the highly heated circulating gas at *c*). Gasified dust and somewhat cooled circulating gas flows out at *d*), the coal to be dried being introduced from the silo *e*) through the device *f*) into the circulating gas stream. The dust separators *g*) and *k*) again effect the purification of the circulating gases. In the washer *l*) the gas is finally cooled and again washed, before passing into the blower or the fan *m*). The gas produced is withdrawn at *p*). The cold circulating gas enters the two regenerators z_1) and z_2) at x_1) and x_2). Instead of two regenerators several regenerators may be used. The highly heated gases flow out of the regenerators alternatively at y_1) and y_2) and again enter the gasifier at *c*). For the re-heating of the regenerators highly heated air is introduced at u_1) and u_2) and hot gas at w_1) and w_2), the flue gases escaping at v_1) and v_2) during the heating period. The heating of the combustion air to a high temperature is effected in an air heater *n*). A fan *i*) sucks in the air and forces it through the air heater into the regenerator which is to be heated. The air heater *n*) is heated with a coal dust flame. The coal dust necessary for this heating is taken from the collecting silo. The coal dust passes from the dust separator through the conduits q_1) and q_2) into a dust bunker *o*). The greater portion of the dust is pumped, by a dust pump *t*) through a conduit *s*) into the dust gasifier at *b*). The dust pump *t* draws a certain portion of the dust out of the circulation and supplies it to the furnace for heating the air heater.

If it is found that the ash content of the dust from the several dust separators is different, the quantity of dust, which is removed from the circulation is preferably drawn from that dust separator the dust of which has the highest ash content. In this manner the ash content in the dust in circulation and in the dust introduced to the gasifier is further reduced.

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 by means of heated circulating gas of fine grain or pulverulent fuels which have been obtained from relatively easily disintegrated raw fuel, such as raw brown coal and the like consisting in using the gas leaving the gasifier whilst still charged with completely or partially gasified dust to dry and disintegrate the incoming fuel which may be further disintegrated mechanically if necessary, the gas being then separated from the solid matter, part of which passes into the gasifier, the remainder being removed continuously from the circulation to prevent undue accumulation of ash.

2. Process according to Claim 1, char-

acterised further by the feature that that portion of the dust which is removed from the circulation is utilized for heating an air heater, which preheats the combustion air for the regenerators for highly heating the circulating gas.

3. Process according to one of the preceding Claims, characterised further in that the dust to be removed from the circulation is taken from that dust separator which possesses the highest ash content.

4. Process according to one of the preceding Claims, further characterised by the feature that the part of dust remaining after the partial removal is led back to the gasifying zone and the separated gas led also back to the gasifying zone after withdrawal of a part of it, preferably washing the gas before said withdrawal and re-heating the gas before reintroduction into the gasifying zone.

5. Apparatus for carrying out the process according to the preceding Claims, comprising gasifying chambers, a pipe leading from these to means for drying and disintegrating the raw fuel, a supply for raw fuel being connected to said pipe, the latter discharging into an apparatus for separating solid and gas constituents, pipes leading from this apparatus to a vessel with an outlet and a further pipe leading to the gasifying chambers; a pipe connecting the separation apparatus with the gasifying chambers, an escape pipe being connected to this latter pipe and leading finally through re-heaters before discharging into the gasifying chambers; pumps for moving the produced dust.

6. Apparatus according to Claim 5, further comprising a washer interposed in the pipe leading through re-heaters to the gasifying chambers, said washer being placed before the branching of the escape pipe.

7. Process for the gasification of fuel substantially as described.

8. Apparatus for the gasification of dust or fine-grained fuels with circulating gas constructed, arranged and adapted to operate substantially as described with reference to and as illustrated in the drawings.

Dated this 2nd day of November, 1935.

MEWBURN, ELLIS & CO.,
70–72, Chancery Lane, London, W.C.2,
Chartered Patent Agents.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1936.

SHEET 1

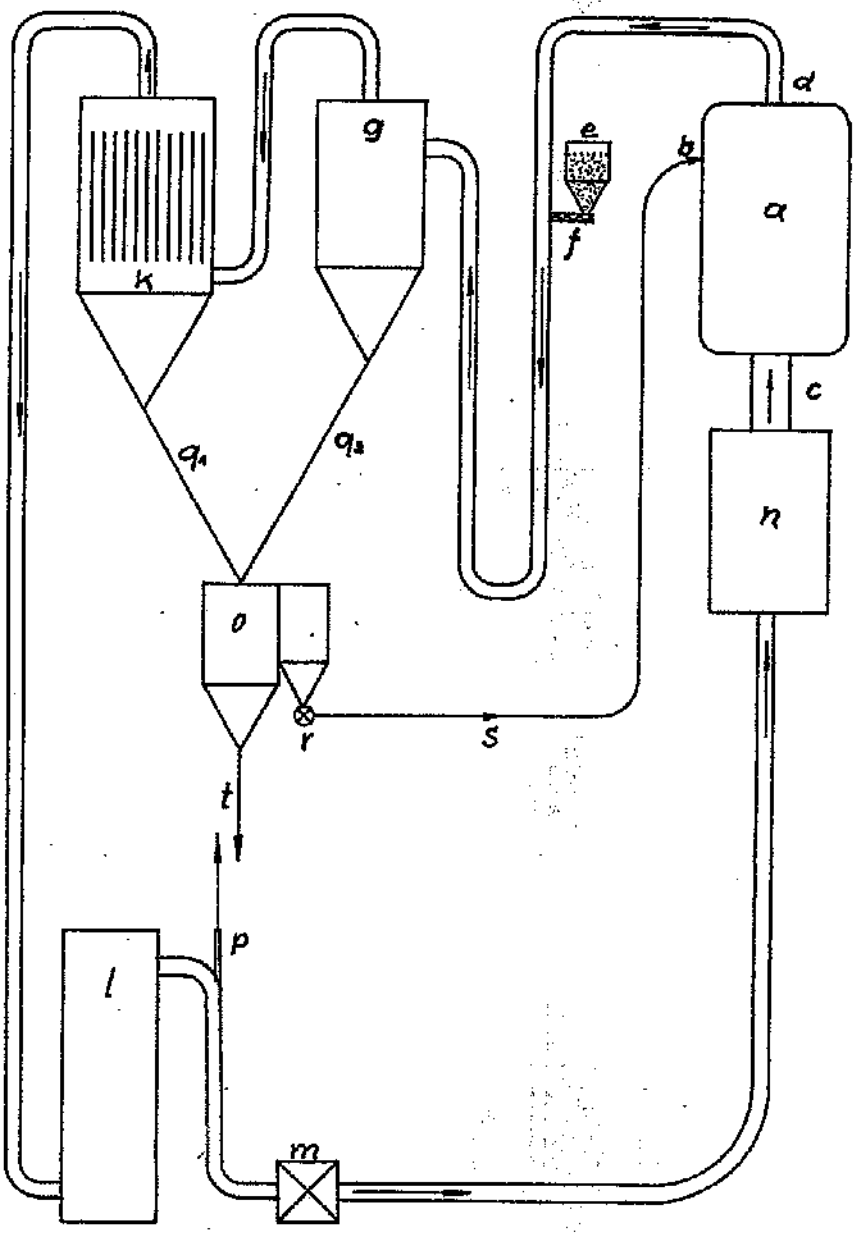

Fig. 1.

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

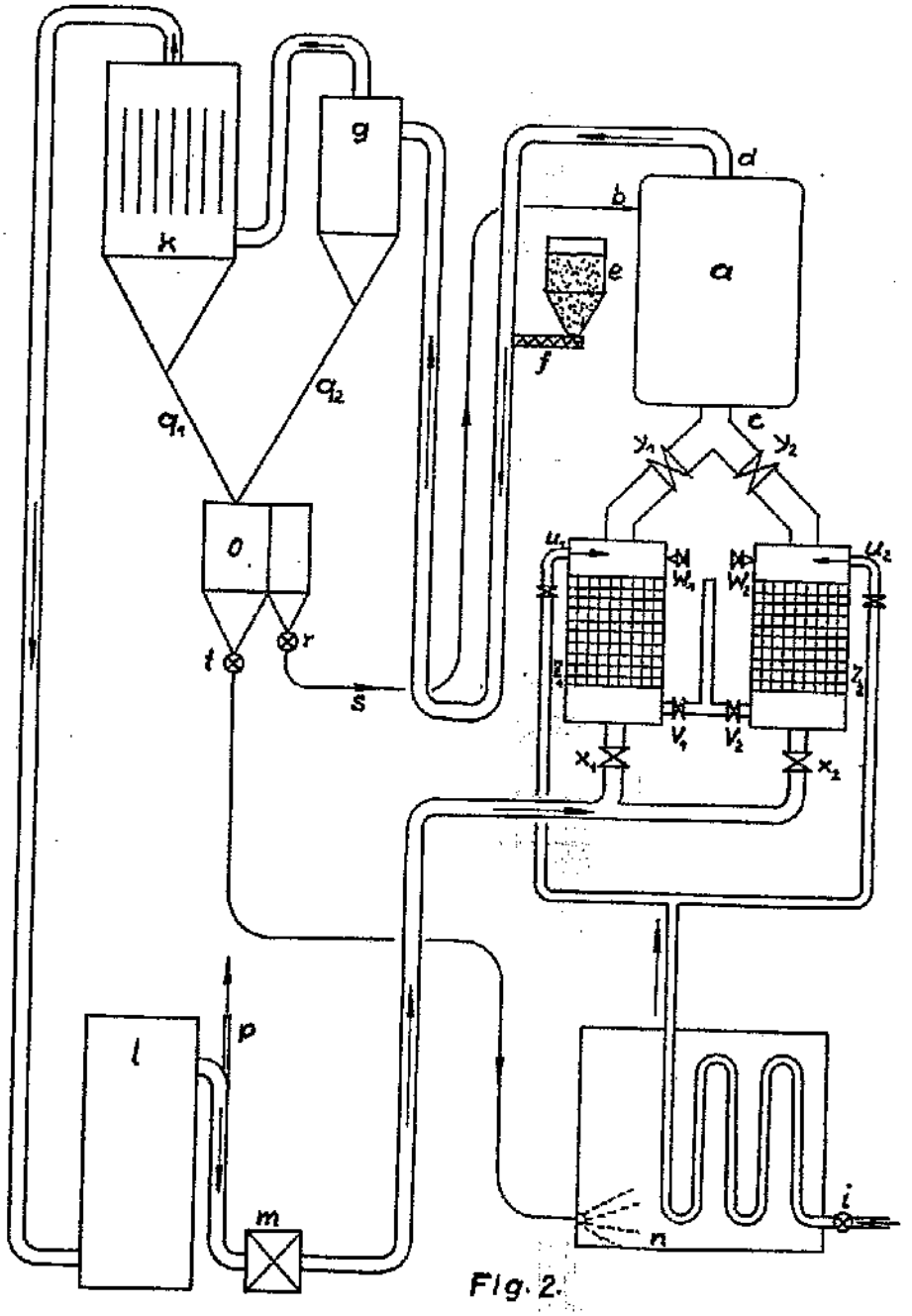

Fig. 2.

Malby & Sons, Photo-Lith.

453,547 COMPLETE SPECIFICATION

2 SHEETS

SHEET 1

SHEET 2

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

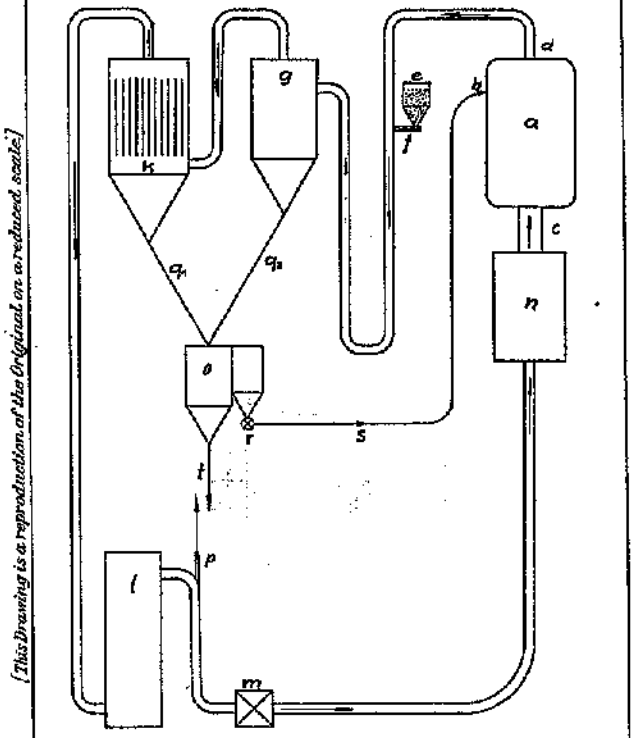

Fig. 1.

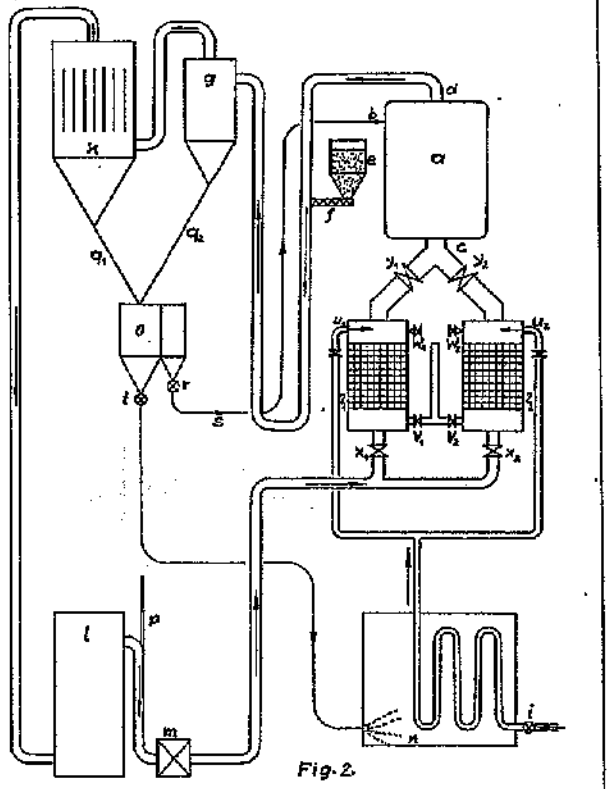

Fig. 2.

Malby & Sons, Photo-Lith