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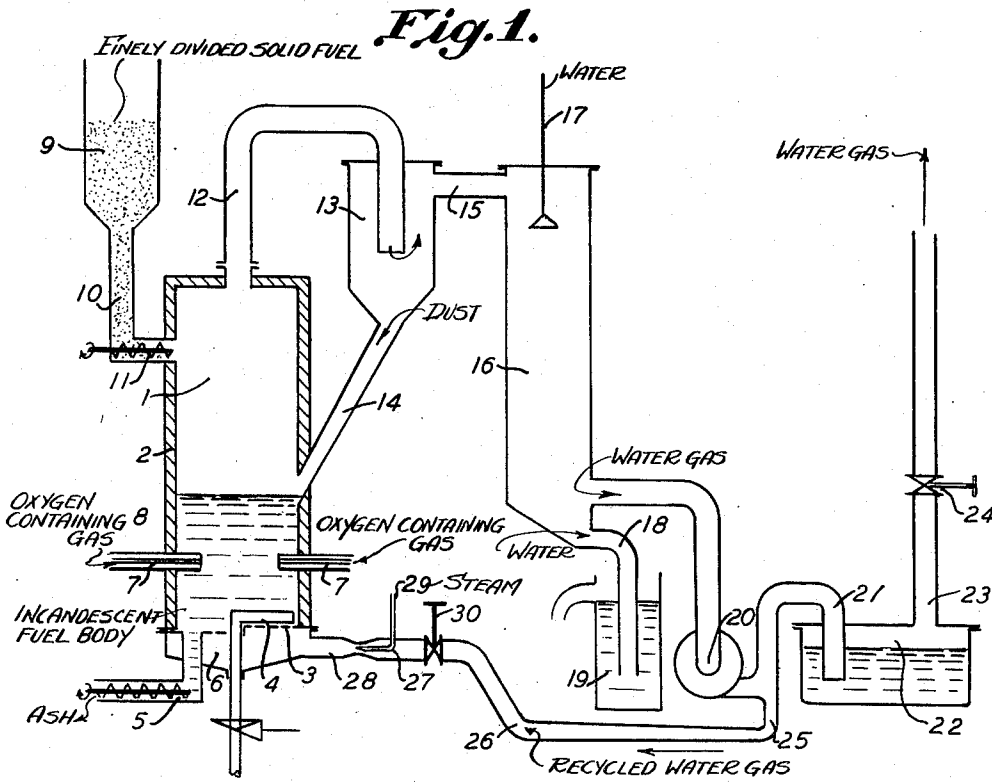
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2,111,579

GASIFICATION OF FINE-GRAINED SOLID FUELS

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2 Sheets-Sheet 1



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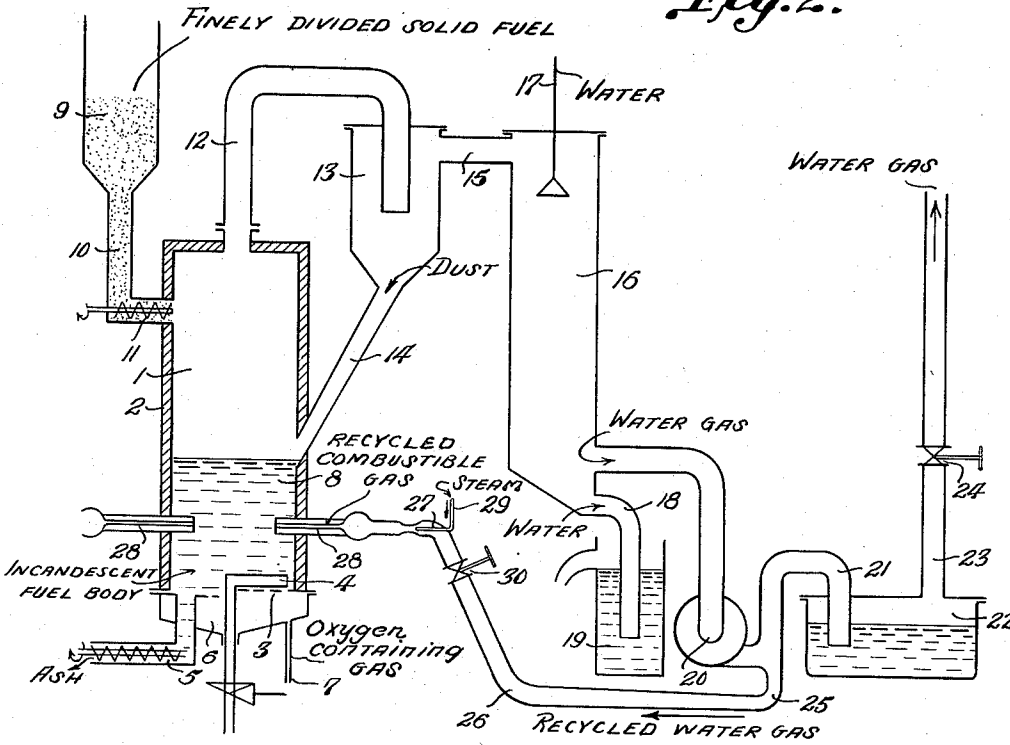
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Fig. 2.



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# UNITED STATES PATENT OFFICE

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## GASIFICATION OF FINE-GRAINED SOLID FUELS

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5 Claims. (Cl. 48—203)

The present invention relates to improvements in and apparatus for the gasification of fine-grained solid fuels.

In the gasification of fine-grained solid fuels according to the U. S. Patents Nos. 1,687,118 and 1,776,876, in which fine-grained fuels are kept in movement similar to a boiling liquid on a support and throughout the whole thickness of the layer with the aid of the gasifying agent, difficulty is sometimes encountered when the fine-grained fuel is especially heavy, as for example when it consists of coal poor in bitumen or foundry coke; in such cases the amount of gasifying agent necessary for the desired gasification is not always sufficient to satisfactorily mix the fuel and to bring it into movement. Even when gasifying light fuels, as for example brown coal or lignite coke, with pure oxygen or gases having a high content of oxygen, the amount of gasifying agent is frequently insufficient to effect a thorough mixing and movement of the fuel. If, in the latter case, another gasifying agent, such as steam or carbon dioxide, be added, a satisfactory movement of the layer of fuel can be obtained with certainty but there is then the drawback that the steam or the carbon dioxide reduces the temperature of the fuel too greatly so that a gas of inferior quality is obtained. The unsatisfactory movement of the layer of fuel also causes the temperature of the layer of fuel, which otherwise according to the process of the said specification is very uniform, to become very irregular and consequently marked slagging takes place.

We have now found that the said drawbacks can be avoided and that in all cases of gasifying fine-grained solid fuels in the manner described in the said patents a sufficient movement of the fine-grained glowing layer of fuel may be produced throughout its entire thickness by leading, in addition to the proper gasifying agent, (such as gases comprising oxygen in which the oxygen is capable of reacting with carbon with the formation of carbon monoxide, as for example oxygen, gases rich in oxygen, air, carbon dioxide, steam and mixtures of these gases), one or more combustible gases, such as water-gas, producer gas or mixed gases, preferably a part of the final gases leaving the top of the gas producer, into the layer of fuel, preferably laterally or from below, and preferably at a place separate from that of the introduction of the gasifying agent. The size of the grains of the solid fuels preferably ranges between that of dust particles and 10 millimeters. The amount of the said combustible gases is selected depending on the par-

ticular fuel to be gasified and on the nature of the gasifying agent. With gasifying agents having a high concentration of oxygen and with heavy fuels larger amounts of the said combustible gases are used than with gasifying agents having a lower concentration of oxygen and with comparatively less heavy fuels. When employing oxygen as the gasifying agent, the said manner of working may be effected for example with the aid of nozzles which are arranged above and in close proximity to the grate and through which the gasifying agent is blown into the layer of fuel, while the additional combustible gases are blown from below through the grate into the fine-grained fuel.

The process according to this invention has the great advantage that strongly heat-consuming gasifying agents, such as carbon dioxide and steam, need no longer be mixed with the oxygen, or only so much thereof need be so mixed as is necessary for the production of the desired quality of gas. A further advantage is the formation of a fine-grained, porous ash which may be very readily removed from the gas producer.

Examples of solid fuels which may be satisfactorily gasified by the process hereinbefore described are any varieties of coals, such as mineral coal or brown coal, or anthracite, coke or peat. But the invention is not restricted to these particular instances of solid fuels, but quite generally applicable to all kinds of solid fuels.

The following examples, given with reference to Fig. 1 of the accompanying drawings which illustrate two relatively similar arrangements of apparatus suitable for carrying out the process according to this invention, will further illustrate the nature of the said invention, but the invention is not restricted to these examples or to the particular arrangements shown, of which

Fig. 1 illustrates one arrangement of apparatus for carrying out the process and in which the added (recycled) combustible gas is introduced below the grate carrying the incandescent body of fuel, and

Fig. 2 illustrates a slightly modified arrangement from that of Fig. 1. The recycled combustible gas is introduced laterally into the incandescent body of fuel.

### Example 1

Referring to the drawings, 1 is a gas producer operated in the manner described in the said U. S. Patent No. 1,687,118 having an internal diameter of 1.1 meters and provided with brickwork 2, a

grate 3, an ash stirrer 4, an ash outlet 5 and a grate chamber 6.

258 cubic meters of 95 per cent oxygen are blown in per hour through three double-walled water-cooled nozzles 7 while at the same time 935 kilograms of fine-grained brown coal small coke containing 11.2 per cent of water and 22.2 per cent of ash are forced from a bunker 9 through a tube 10 into the gas producer by means of a worm conveyor 11. The layer of fuel is set in whirling motion up and down and has a thickness of about 1 meter. 258 cubic meters of water-gas and 40 kilograms of steam per hour are blown in below the grate 3 whereby the uniform, up and down boiling motion of the fuel is maintained. A temperature of from about 950° to 970° C. is maintained in the bed of fuel by the gasification process. The watergas produced together with the circulating watergas (989 cubic meters per hour in all) leaves the gas producer through a pipe 12. Any dust carried along is partially separated in a dust separator 13, and slides back into the bed of fuel through a tube 14. The gas passes through a tube 15 into a washer 16 in which it is purified and cooled by means of water sprayed in at 17 and withdrawn at 18 through a receiver 19; it then passes to a blower 20 provided with water injection and from thence through a dip tube 21 into a receiver 22. 731 cubic meters of watergas per hour are withdrawn through a pipe 23 provided with a throttle slide 24 and used for any desired purpose. Before reaching the dip-tube 21, 258 cubic meters per hour of watergas are branched off at 25 by the steam injection blower 27 and forced through a pipe 28 into the grate chamber 6 below the grate 3. The steam injection blower 27 requires 40 kilograms per hour of steam heated to 400° C. which is supplied at 29 under a pressure of 3.5 atmospheres. 30 is a regulating valve.

The coke in the gas producer is maintained in vigorous movement by the watergas (258 cubic meters per hour) continuously returned in circulation. The fine ashes containing only small amounts of fine grains of slag and the sand and siliceous matter contained in the initial coke, are continually withdrawn in an amount of 90 kilograms per hour through the ash outlet 5.

The gas produced has the following composition:

13.7 per cent of CO<sub>2</sub>  
50.6 per cent of CO  
29.5 per cent of H<sub>2</sub>  
1.4 per cent of CH<sub>4</sub>  
3.9 per cent of N<sub>2</sub> and  
2.2 grams per cubic meter of H<sub>2</sub>S

1 cubic meter of the gas has a calorific value of 2418 kilogram calories.

An addition of steam is unnecessary if the fuel has a sufficiently high content of hydrogen or water. In the said manner it is possible to produce a watergas poor in nitrogen, or, if the nitrogen content of the oxygen is appropriately small, a watergas practically free from nitrogen, in a continuous manner, such as is necessary for example in the hydrogenation of coals and tar on a large scale.

If the gas producer be operated without circulating water gas, but only with the supply of steam superheated to 400° C., a very bad decomposition of steam takes place and the gas has a content of from about 25 to 30 per cent of carbon dioxide and thus has a very much lower calorific value. Also slagging takes place in this case.

### Example 2

Fine coke is gasified with oxygen in the apparatus described in Example 1. The coke employed is waste coke from gas works, contains 19 per cent of water and 10 per cent of ash and has grains of from dust particle size to 5 millimeters in diameter.

267 cubic meters of oxygen containing 94.4 per cent of O<sub>2</sub> are introduced per hour through the nozzles 7 and the coke consumption is 677 kilograms per hour. 364 cubic meters of watergas produced in the same apparatus and sucked in at 25 and 40 kilograms of steam are blown in below the grate 3 per hour, the fine coke thereby being maintained in vigorous boiling movement. The thickness of the layer of coke is maintained at about 1.40 meters. 540 cubic meters of watergas per hour are withdrawn from the receiver 22 through the pipe 23.

The watergas produced has the following composition:

14.6 per cent of CO<sub>2</sub>  
58.3 per cent of CO  
23.0 per cent of H<sub>2</sub>  
0.6 per cent of CH<sub>4</sub>  
3.5 per cent of N<sub>2</sub> and  
0.8 gram per cubic meter of H<sub>2</sub>S

1 cubic meter of the gas has a calorific value of 2402 kilogram calories.

The temperature in the bed of coke amounts to from about 1112° to 1088° C., measured by pyrometers. Directly adjacent to the inlet of the nozzles 7, where the oxygen enters the layer of coke which is kept in vigorous motion, the temperature, measured optically, is only from about 50° to 80° C. higher than the average temperature in the layer of coke. This difference can only be maintained so slight by the vigorous movement of the layer of coke by the circulating gases.

No slagging takes place. The major portion of the ash is withdrawn in the form of ashes containing 50 per cent of coke through the worm conveyor 5 (about 94 kilograms per hour). Only quite small pieces of ash of the size of hazel nuts are contained therein.

If a gas is desired having a higher content of carbon monoxide than is specified in Example 1 or 2, the combustible gas is forced by means of a blower into the grate chamber 6. Any addition of steam may then be dispensed with. Of course, it is not necessary to cool the combustible gas introduced into the fuel chamber.

What we claim is:—

1. A process for the gasification of a fine-grained solid fuel which comprises blowing through an incandescent body of this fuel a gasifying agent at one place of introduction and at the same time blowing through said incandescent body of fuel, and from a place of introduction at a distance from the place of introduction of the gasifying agent, a combustible gas having a lower temperature than the said incandescent body, said gasifying agent and combustible gas being introduced with such a speed that a boiling action is established in the incandescent body of fuel.

2. A process for the gasification of a fine-grained solid fuel which comprises introducing into an incandescent body of this fuel a gasifying agent at one place of introduction and at the same time introducing into said incandescent body of fuel, and from a place of introduction at a distance from the place of introduction of the gasifying agent, a combustible gas having a lower

temperature than the said incandescent body, and blowing said gasifying agent and combustible gas through said incandescent body with such a speed that a boiling action is established in the incandescent body of fuel.

3. In the process as claimed in claim 1 using as combustible gas a part of the final gas obtained by the gasification.

4. In the process as claimed in claim 2 introducing the combustible gas laterally into the incandescent body of fuel.

5. In the process as claimed in claim 2 introducing the combustible gas from below into the incandescent body of fuel.

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