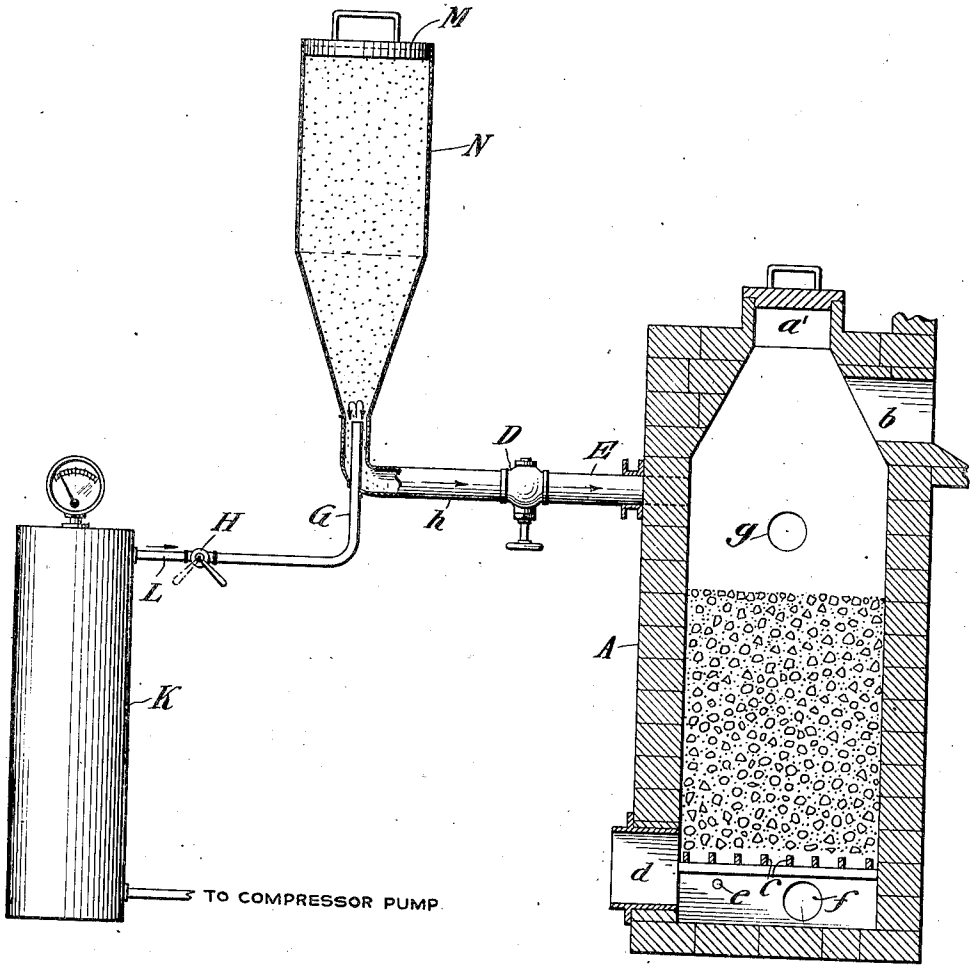
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MANUFACTURE OF GAS

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MANUFACTURE OF GAS.

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The present invention relates to the manufacture of gas, and more particularly to the manufacture of what is generally known as carburetted water gas, that is to say, water gas obtained by the passage of steam through incandescent fuel and enriched by fixation of volatile hydrocarbons introduced into the generator above the level of the body of incandescent fuel therein.

In the present practice of processes for the manufacture of carburetted water gas of this general character, it is customary to employ as the carburetting agent a liquid hydrocarbon injected, by spraying under pressure, into the upper part of the gas generator or into the lower part of the usual fixing-chamber, well known to the art, containing a filling of refractory bricks, preliminarily heated to a high temperature by the combustion therein of the fuel gas produced in the generator during the so-called air blast or blowing up period of the fuel therein. The fuel used in the generator is usually coke or anthracite coal, and the progressively falling level of the fuel bed is restored to normal from time to time, after the removal of ash, by the addition of further quantities of coke or anthracite coal through the charging bell or the like at the upper part of the generator chamber. The increased cost of liquid hydrocarbons and of coke or anthracite coal at the present time makes it particularly desirable and advantageous to supply, if possible, in this manufacture, an efficient and economical substitute for both.

In accordance with the present invention, this purpose is effected by the use of powdered bituminous coal, that is to say, coal rich in hydrocarbons, made use of, as will hereinafter more fully appear, in a way not only to serve as a complete substitute for the liquid hydrocarbons generally in use, but also serving to supply to the generator the necessary amount of coke to maintain the fuel bed at the normal level during the entire operation of the generator—in most cases, without the addition of any other supplemental fuel.

In carrying the invention into effect, the generator, as in usual water gas practice is filled to the predetermined level with a bed of coke or anthracite coal, adapted to be brought to a condition of high incandescence by the admission of an air blast below the grate. At the beginning of the air blasting period, the products of combustion are permitted to escape through an open flue leading from the top of the generator into the outer air. After the fuel bed has attained a sufficient temperature, a blast of secondary air is preferably admitted immediately above the upper surface of the fuel bed, thereby completing the combustion of the fuel gases, as fully as possible, and storing the heat incident to such combustion, in the refractory brick walls of the upper part of the generator, which are thus brought to a temperature appropriate to the subsequent distillation and fixing of the hydrocarbons contained in the powdered bituminous coal subsequently employed in the process. An appropriate temperature for this purpose is in the neighborhood of 2000° Fahrenheit, and the air blasting is so regulated both below and above the fuel bed, that the fuel will be brought to the proper temperature of production of water gas on the passage of steam therethrough, while, at the same time the upper part of the generator is being brought up to the suitable predetermined distilling and fixing temperature.

In the succeeding steam blasting period of water gas production, finely pulverized fuel is brought into suspension, in any suitable fluid-carrying medium, in the upper part of the generator above the level of the fuel bed. The fuel-carrying medium employed for introducing and bringing into suspension the powdered bituminous coal is preferably a gas (as, for instance, water gas) and the bituminous coal employed is ground to a fine powder, preferably to such a degree of comminution that 85% thereof will pass through a 200 mesh screen, so that when borne into the generator by the gas current it will be suspended in the generator substantially in the form of a cloud of finely divided particles which meet the uprising water gas resulting from the passage of the steam through the incandescent fuel. The suspended particles of bituminous coal are immediately distilled, releasing their content of volatile hydrocarbons under the influence of the heat of the uprising water gas and the heat radiated from the highly incandescent brick work of the upper part of the generator.

The distillation of the particles of bituminous coal likewise results in the formation of particles of coke, which apparently agglomerate into larger aggregates than the individual coal particles, and which settle down progressively through the uprising water gas and onto the upper surface of the fuel bed. The normal level of the fuel bed, more or less lowered during the preceding air blast period, is thus progressively renewed by the falling coke particles, and, in general, the amount of coke thus supplied is fully equal to all of the demands of the next succeeding air blast period.

It has been found desirable to maintain a relatively low steam admission during the time in which the powdered bituminous coal is being admitted into the generator, in order that the uprising water gas shall have the minimum tendency to carry off the particles of suspended coal, or their more or less coked residue, into the exit flues of the generator and in order that the particles of coke formed from the bituminous coal may sink or drop down with sufficient promptness and in substantially equal distribution upon the top of the fuel bed. As soon as the temperature of the upper part of the generator falls below the temperature appropriate to the proper distillation and fixing of the hydrocarbons liberated from the distilled bituminous coal, the supply of the bituminous coal is interrupted, and thereafter, if the temperature of the fuel bed is still sufficient for the economical production of water gas (which will usually be the case) the steam blasting period is continued and preferably at a more rapid rate, the uncarburetted water gas thus produced being either conveyed to the same gas holder, or led off to a separate holder, or otherwise, for use as a fuel gas, and for supplying, under pressure, the relatively small amount of water gas preferred for use in the introduction of the powdered bituminous coal into the generator.

A particularly practical means for introducing the powdered bituminous coal into the generator consists in admitting it in a rapid succession of puffs, by means of the fluid-conveying medium, that is, preferably water gas. To effect this purpose, the water gas is put under pressure of from 10 to 40 pounds to a square inch in a suitable receptacle, provided with a valved exit pipe leading into the receptacle containing the powdered bituminous coal employed. This receptacle is likewise provided with a valved exit pipe leading into the top of the generator, and the entire arrangement is such that by alternately opening and closing the valve leading from the gas pressure receptacle, the powdered coal is injected in a series of puffs, forming satisfactory clouds of powdered coal in the generator and requiring much less gas for injection than if a continuous jet of water gas were employed. The details of this puff injector are hereinafter described more in detail.

It has been found that in the practice of the invention, a carburetted water gas may be produced having a high thermal and illuminating value, and that this value may be controlled within reasonable limits by varying the amount and richness of the pulverized bituminous coal employed, or if special conditions make it desirable, the gas may be further enriched with oil gas. A particularly notable feature in the practice of the invention is the comparatively low production of tar. Apparently the high temperature of the upper part of the generator reaches whatever finely divided particles of tar may be in suspension as a product of distillation of the bituminous coal, and converts such tar products likewise into fixed gases, thereby further enriching the product.

In the accompanying drawing is illustrated, in vertical section, an appropriate installation for the practice of the invention. A indicates the water gas generator, suitably lined with refractory brick work and provided with a closable top exit opening *a* communicating with the outer air, and a port *b* communicating with any suitable gas holder. The generator is provided with the usual grate *c*, ash cleaning port *d*, steam inlet *e*, air blast inlet *f* below the grate and secondary air blast inlet *g* above the fuel bed. E represents the port for the admission of pulverized bituminous coal.

As hereinbefore indicated, the pulverized bituminous coal is preferably injected in puffs, and this may be conveniently accomplished by the apparatus shown in the drawings, wherein N is the coal chamber, M is the gas-tight cover thereof, *h* is a pipe leading to the straight-way shut-off valve D, and E is the pipe leading into the generator. K is a pressure tank into which gas (preferably water gas) is compressed in any suitable way, not shown. K is connected to the interior of N by the pipe L, shut-off valve H, and pipe G. The direction of flow of the gas and of the mixture of gas and coal is indicated by the arrows.

When the cover M is in place and the valves D and H closed, the chamber N and the connecting pipes form a gas-tight receptacle. To operate, the cover M is removed, the chamber N is filled with pulverized coal and the cover M is replaced. The valve D is then opened to permit communication with the interior of the generator. Water gas having been pumped into the receptacle K (pressures all the way from 10 to 40 pounds gauge pressure having been used successfully), the valve H is opened and then closed almost instantly, the actual duration

of opening being dependent upon the pressure in K. With the opening of the valve H a jet of gas passes through L, H, G, and into chamber N, where it picks up pulverized bituminous coal and discharges it into the generator as a cloud, passing en route through *h*, D, E. The valve H may be operated either by hand or mechanically, as the case may be, and a sufficient number of jets are admitted into the chamber N to clean the chamber of coal. The valves D and H are then closed and the chamber N is refilled with pulverized coal in readiness for the next injection period. It will be noted that this apparatus dispenses with any ordinary kind of mechanical feeder. The intermittent character of the jets insures the complete discharge of the chamber N, inasmuch as the coal is agitated by each puff of gas and is then permitted to settle down before the next puff, whereas, if a constant stream of gas were permitted to pass through the chamber N the tendency would be to create "rat holes" through the coal so that the gas would pass on into the generator without picking up the coal dust.

The method of operation of the invention will be apparent from the foregoing description. By using the coal as powder and introducing it only during the water gas making period, it is almost instantly distilled on entering the generator so that the enrichment of the water gas is under direct control and all of the volatile hydrocarbons used go into the water gas.

The amount of powdered coal introduced should, of course, bear the proper relation to the other items of running of the generator. The gas-making period is characterized by strong absorption of heat; it is a cooling down period. The supply of heat available at the surface of the fuel bed and stored up in the brick lining of the fuel bed will not distill or coke an indefinite amount of powdered coal. No more powdered coal should be introduced, therefore, than can be properly distilled by the available heat during the gas making period. Again, the coke from this distillation is consumed by steam during the subsequent gas-making periods and by air during subsequent blowing-up periods. It is important, therefore, that no more coke be formed than the average amount which is consumed altogether, that is, by steam in one gas making period and then by air in one blowing-up period. It is also important that no less coke be formed. It results, that the amount of powdered coal introduced during one gas-making period should be that needed to form the coke necessary for supplying one cycle of running of the generator; that is, one gas-making period plus one blowing-up period. If more is used, the level of the fuel bed will rise; if less, it will fall. For continuous proper running, with the fuel bed kept at the right level the supply of powdered coal in one gas-making period is determined.

It is possible, however, to use less than this determined amount, if auxiliary amounts of other non-volatile fuel are introduced above the fuel bed. If less than the maximum amount of powdered coal is used, and the level of the fuel bed would consequently tend to fall, other fuel, such as coke or anthracite coal, in lumps or fines, may be introduced either simultaneously with the powdered high-volatile fuel during the gas-making period, or during the blowing-up period, or intermediate of the two. This fixed fuel must be in such amount as will make up the deficit of coke from the high-volatile fuel, necessary to run the generator at the proper depth of fuel bed.

As hereinbefore noted, the powdered bituminous coal enters the generator in the form of a cloud together with the water gas employed in effecting its injection. Particularly satisfactory results are obtained, when operating by the jet or puff method described, when the powdered bituminous coal, of the mesh specified, is puffed into the generator, at the rate of six or more puffs per pound of powdered coal, and at a pressure of water gas approximating 40 pounds to the square inch, under which conditions about one and one half cubic feet of water gas would be required for the injection of one pound of the powdered coal. It will, of course, be understood that this example is but illustrative of practice under the invention, and that it may be varied, within wide limits, without departing from the spirit of the invention itself, as covered by the annexed claims, interpreted by the foregoing specification.

We claim:

1. A method of manufacturing mixed coal and water gas in a generator having a fuel bed, which comprises subjecting the fuel bed to alternate air and steam blasting, injecting pulverized bituminous coal into the generator above the fuel bed as steam is being forced through the fuel bed from beneath, enriching the water gas arising from the fuel bed and resulting from the passage of the steam therethrough by the distillation of the pulverized fuel maintained in suspension by the upward current of water gas, and continuously maintaining the fuel bed at a substantially constant level by the down-falling carbonized residue of the pulverized coal.

2. A method of manufacturing mixed coal and water gas in a generator having a fuel bed, which comprises subjecting the fuel bed to alternate air and steam blasting, injecting pulverized bituminous coal into the generator during the steam blast period to

mingle with the water gas arising from the fuel bed as a result of the passage of the steam upwardly therethrough, enriching the water gas by the distillation of the pulverized fuel maintained in suspension, drawing off the enriched gas from the generator without further contact with the fuel bed, and continuously maintaining the fuel bed at a substantially constant level by the down-falling carbonized residue of the pulverized coal.

3. A method of manufacturing mixed coal and water gas in a generator having a fuel bed, which comprises subjecting the fuel bed to alternate air and steam blasting, injecting pulverized bituminous coal into the generator during the steam blast period to mingle with the water gas arising from the fuel bed as a result of the passage of the steam upwardly therethrough, enriching the water gas by the distillation of the pulverized coal while in suspension, and coordinating the rate of injection of the pulverized coal and the rate of steam admission so that the pulverized coal is maintained in suspension during its distillation and the carbonized residue falling upon the fuel bed continuously maintains the latter at a substantially constant level.

4. A method of manufacturing mixed coal and water gas in a generator having a fuel bed, which comprises subjecting the fuel bed to alternate air and steam blasting, injecting pulverized bituminous coal and admitting water gas therewith into the generator during the steam blast period, the pulverized coal being suspended in a substantially non-oxidizing atmosphere of water gas above the fuel bed, enriching the water gas admitted with the coal and also the water gas arising from the fuel bed by reason of the passage of the steam upwardly therethrough by the distillation of the suspended pulverized coal, and continuously maintaining the fuel bed at a substantially constant level by the down-falling carbonized residue of the pulverized coal.

5. A method of manufacturing mixed coal and water gas in a generator having a fuel bed, which comprises subjecting the fuel bed to alternate air and steam blasting, injecting pulverized bituminous coal into the generator during the steam blast period, this coal being in suspension in a current of substantially non-oxidizing gas, enriching the water gas arising from the fuel bed by the passage of the steam upwardly therethrough by the distillation of the pulverized coal, and coordinating the rate of injection of the pulverized coal and the rate of admission of steam so that the pulverized coal is maintained in suspension during its distillation and the carbonized residue falling upon the fuel bed maintains the latter continuously at a substantially constant working level.

6. A method of manufacturing mixed coal and water gas in a generator having a fuel bed, which comprises subjecting the fuel bed to alternate air and steam blasting, injecting pulverized bituminous coal into the generator during the steam blast period, this coal being in suspension in a current of substantially non-oxidizing gas, enriching the water gas arising from the fuel bed by the passage of the steam upwardly therethrough by the distillation of the pulverized coal, drawing off the enriched gas from the generator without further contact with the fuel bed, and continuously maintaining the fuel bed at a substantially constant level by the down-falling carbonized residue of the pulverized coal.

7. A method of manufacturing mixed coal and water gas in a generator having a fuel bed, which comprises subjecting the fuel bed to alternate air and steam blasting, injecting pulverized bituminous coal into the generator during the steam blast period, this coal being suspended in a current of substantially non-oxidizing gas, enriching the water gas arising from the fuel bed as a result of the passage of steam therethrough by the distillation of the pulverized coal, drawing off the enriched gas from the generator without further contact with the fuel bed, and coordinating the rate of injection of the pulverized coal and the rate of steam admission to the fuel bed so that the pulverized coal is maintained in suspension during its distillation and the carbonized residue falling upon the fuel bed maintains the latter continuously at a substantially constant working level.

8. A method of manufacturing mixed coal and water gas in a generator having a fuel bed, which comprises subjecting the fuel bed to alternate air and steam blasting, injecting pulverized bituminous coal into the generator during the initial portion only of the steam blast period, this pulverized coal being admitted above the top surface of the fuel bed, distilling gases from the pulverized coal, enriching the water gas arising from the fuel bed by reason of the passage of steam upwardly therethrough by distillation of the pulverized coal, and increasing the rate of steam flow after the introduction of the coal is stopped whereby the coal is maintained in suspension during this distillation and the down-falling carbonized residue of the coal maintains the fuel bed at a substantially constant level.

In testimony whereof we affix our signatures.

GUSTAV HENRY KAEMMERLING.
HENRY WALLACE BENNER.