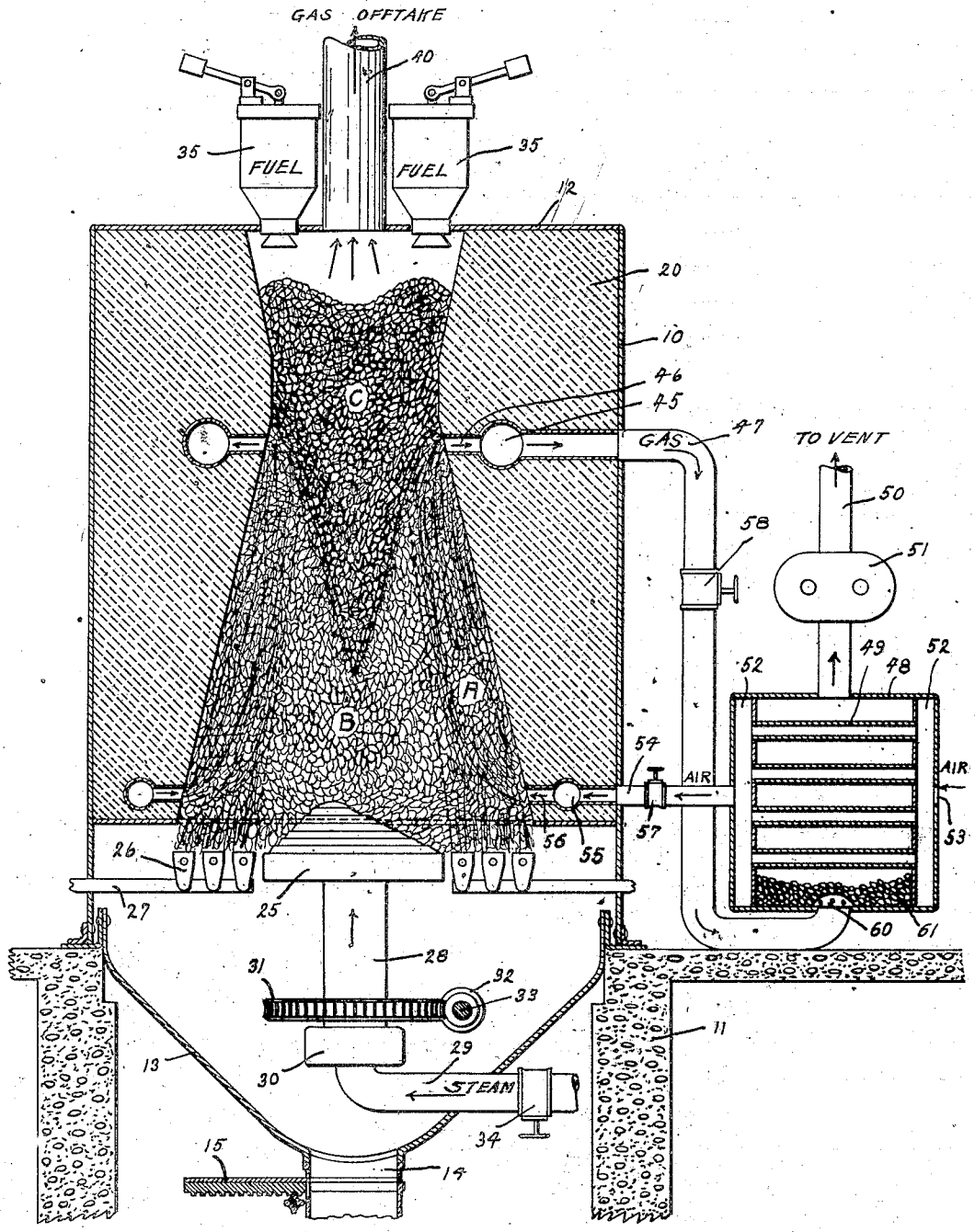
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METHOD OF AND APPARATUS FOR GENERATING COMBUSTIBLE GAS AND COKE

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METHOD OF AND APPARATUS FOR GENERATING COMBUSTIBLE GAS AND COKE

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This invention relates to the production of a combustible gas and of coke or charcoal from carbonaceous fuel such as coal, wood, peat and the like.

One of the principal objects of the invention is to provide a method for continuously producing a combustible gas, and at the same time producing coke or charcoal.

Another object of the invention is to provide a method of producing a combustible gas which is in the nature of a continuous water gas-coal gas-producer gas method.

Another object of the invention is to provide a method of making a combustible gas from carbonaceous material in which the character of the gas generated may be controlled to give a gas of desired composition and heating value.

Still another object of the invention is to provide an improved form of apparatus for carrying this method into effect.

Other objects and advantages of the invention will be apparent from the description set out below when taken in connection with the accompanying drawing; in which is illustrated in section, and somewhat diagrammatically, a form of apparatus for carrying out a method of gas and coke making according to this invention.

This apparatus consists essentially of a metallic shell 10, supported upon suitable foundations 11, its upper end being closed by means of a top 12 and its lower end by means of a closure member 13 which is preferably pocket or trough shaped and which serves to receive the ashes and coke generated during the gas making operations. This member 13 which may be of any desired construction, is, preferably, as shown, a pocket or trough shaped metallic pan supported from the foundations 11 and having an opening 14, controlled by a suitable form of gate 15, in the bottom thereof, through which material within this ash pit may be withdrawn. This discharging mechanism, as shown is connected to the lowest part of the member 13 and ash and coke therefore readily slide out of the discharge opening when the gate is opened. The arrangement is such that removal of the ash or coke in the pit 13 may be readily accomplished without interrupting the continuous carrying on of the gas and coke making reactions. But if desired another type of discharge may be used—any of the well known types of fuel feeders which are capable of passing coal or the like therethrough without permitting substantial leakage of air or gas through the feeder, being suitable.

The shell 10 is provided, throughout part of its height, with a lining 20, which may be of any suitable character, and is therefore shown diagrammatically. This lining is preferably of firebrick, or other similar refractory material, and has a centrally arranged passage or chamber therein which is constructed to receive a fuel bed of carbonaceous material. As shown this chamber has its least diameter intermediate its upper and lower ends, the walls defining the chamber being flared outwardly toward the bottom and the top thereof, as shown in the drawing. The lower end of this chamber is closed by means of a revolving grate designated generally by the numeral 25, which is of less diameter than the lower open end of this chamber, this revolving grate 25 being surrounded by sections of grate designated generally by the numeral 26, which sections of grate may be of any suitable and conventional character. As shown the sections of grate 26 consist of pivoted grate bars which are provided with means, shown generally at 27, so constructed that they may be actuated from outside the shell 10 to shake down the ashes or fuel bed resting upon them. The central grate 25 is preferably of the stepped form shown, the angle of inclination of one side of the grate being greater than the angle of inclination of the other side so that the various steps forming the grate are positioned eccentric to the axis of rotation of the grate as a whole. By means of this construction of eccentric grate, rotation of the grate will cause a compacting of the fuel bed resting upon it and also suitable agitation or breaking up of the coked mass of that fuel bed to permit of such compacting as will maintain the bed of material substantially continuous throughout. The grate is prefer-

ably mounted upon a hollow standard 28, which is connected to a steam supply pipe 29, by means of a swivel coupling, designated generally by the numeral 30, which may be of any suitable type. The hollow standard 28 carries a gear wheel 31, with which meshes a worm pinion 32, mounted upon a shaft 33 driven from any suitable source of power, this construction being such that the grate 25 may be continuously rotated during operation of the device.

Fuel is introduced into the chamber by means of fuel feeding mechanism 35, which is conventional in character and therefore not shown in detail. Any other suitable type of fuel feeding mechanism may be used. Two fuel feeders are shown; but of course any other number necessary for feeding the fuel at the desired rate and to spread it with reasonable uniformity throughout the chamber may be used if circumstances demand.

Surrounding the chamber, adjacent its zone of minimum diameter, is a manifold 45, having a plurality of pipes or passages 46 which connect that manifold to the interior of the chamber, at a point adjacent the zone of minimum diameter. As shown these pipes or passages 46 open into the chamber just below the zone of minimum diameter. Also connected to the manifold 45 is a pipe 47, the other end of which opens into the bottom of a heat interchanger, or recuperator 48, which is provided with a plurality of pipes 49, over which the gases passing through the pipe 47 into the heat interchanger flow, passing out through the pipe 50 which has positioned therein a blower or pump 51, of any suitable construction. The heat interchanger 48 is provided at each end with a chamber 52, into each of which each of the pipes 49 opens, one of these chambers 52 being connected to the atmosphere through the opening 53, the other having a pipe 54 connected thereto, which pipe opens into the manifold 55, this manifold in turn being positioned adjacent the lower end of the chamber, and having a plurality of pipes or passages 56 which open into the lower end of that chamber. During operation of the device the pump 51 will create a suction drawing the air through the opening 53, pipes 49, pipe 54, manifold 55 and passages 56 into the fuel bed within the chamber whence it will pass upwardly along the wall or surface of the lining 20, and through any space which exists during operation between the outer zone of the fuel bed and the lining, the resulting gases passing out through the passages 46 into the manifold 45 and thence through the pipe 47 and heat interchanger 48 and then out through the pipe 50 which connects to vent or stack. Valves 57 and 58 are positioned in the pipes 54 and 47 respectively to control flow through those pipes.

In the carrying on of this method a fuel bed of carbonaceous material, such as coal, wood, or the like, is built up within the chamber, this fuel bed resting partly upon the rotatable grate 25 and partly upon the adjacent sections of grate 26. That portion of the fuel bed resting upon the grates 26 is then ignited, the blower 51 is started and a blast of air, or air and moisture, is forced into this portion of the fuel bed and upwardly therethrough, along the surface of the lining 20 the products resulting from such blasting passing outwardly through the pipe 47, and heat interchanger 48 to the stack, or upwardly through the remainder of the fuel and thence outwardly through the offtake pipe 40. Obviously the relative proportion of these products which pass off through the pipes 40 and 47 may be readily controlled by manipulating the valve 58, within the offtake 47, to thus cause all or any desired proportion to pass upwardly and out through the pipe 40.

This outer zone is designated, somewhat diagrammatically by the letter A, this zone constituting in effect a cylinder or layer of highly heated incandescent fuel, which surrounds the central portion or zone of the fuel bed, which is designated generally by the letter B. Because of the high temperature which is maintained within this zone A heat is transmitted therefrom, by radiation and conduction, into the central portion B of the fuel bed. Fresh green fuel is introduced into the chamber through the fuel feeders 35, this portion of fuel being designated generally by the numeral C. As the blasting of the zone A continues, with consequent development of considerable quantities of heat, the fuel within the zone B is heated and the volatile matter therein driven out to form incandescent coke, this coke, during rotation of the grate 25 being gradually fed over the edges of that grate and into the ash pit 13 whence it is removed, as desired, through the opening 14.

This is a particularly desirable method of making coke. It has been the general practice heretofore in the manufacture of coke to utilize retorts, constructed of some refractory material, which are so constructed that the fuel to be coked is fed into the interior of the retort, the outside of the retort being subjected to intense heat. Obviously this method is inefficient since an excessive amount of heat must be used in order to raise the temperature of the coal within the retorts sufficiently high to secure the desired coking action. This is true not only because of the resistance of the material of the retort itself to the conduction of heat therethrough, but is probably even more due to the fact that as the coal is heated it tends to shrink away from the walls of the retort to greatly increase the resistance to heat transfer into this coal. A second objection to the conventional type of coke oven retort is that considerable temperature shocks tend to break

it down. In other words the refractory material of which the retorts are composed are not adapted to stand wide temperature fluctuations and after they are once brought up to temperature it is quite dangerous to cool them down again, such procedure resulting very frequently in cracked or broken retorts.

The form of apparatus described above, and illustrated in the drawing, is substantially free from both of these big objections. The retort, which houses the carbonizing chamber, in lined with ordinary fire brick, or other similar refractory material, being quite similar in construction to the ordinary gas producer, and, therefore the danger attendant upon shutting down the apparatus is entirely obviated, and it may be shut down and started up again at will. Furthermore because of the fact that the fuel bed is continuous throughout without any retort walls separating the burning fuel from the fuel being carbonized the efficiency of the device is considerably increased, the quantity of coal consumed in the zone A per ton of coke produced being less than would be the case with the conventional retort apparatus. The retort illustrated is cylindrical in form, but of course this general shape is not essential. But since the heat is transmitted into the central zone B principally by conduction and radiation from the fuel within zone A, the thickness of the layer of material in the zone B is quite limited. Of course, where the gases generated within the zone A pass upwardly along the lining 20 and out through the pipe 40 they tend to highly heat that lining and as a result the fuel in the zone C will be heated by radiation from this heated lining. If it is desired to increase the capacity of a retort, therefore, it would in practice be accomplished by making the chamber within the retort rectangular, instead of cylindrical, and making corresponding changes in the grate, blasting mechanism, discharge mechanism, etc., all of which changes are obvious ones.

But this form of apparatus not only lends itself to the carrying out of a very efficient and satisfactory method of producing coke, it also permits of at the same time producing a very useful and satisfactory type of combustible gas. With the ordinary coke oven retort a combustible gas is of course produced, this gas consisting of the volatile material which is driven off during the distillation of the coal to form the coke. This gas is of a very high heat value, and while it is of course a very good gaseous fuel, nevertheless it is of unnecessarily high heat value and should ordinarily be diluted with some other gas of lower heat value before it is used. The form of apparatus described above lends itself particularly to the production of a combustible gas which is of very desirable character. The zone B being incandescent is in such condition that if steam is passed in contact therewith this steam will be broken down and hydrogen and carbon monoxide will be produced, in other words so called "water-gas" will be generated. As described above the pipe 29, which is connected to the hollow standard 28 by means of the swivel joint 30 is also connected to a suitable source of supply of steam which may be introduced, under pressure, into the fuel within the zone B, through suitable openings within the grate 25. These openings are not specifically shown, but the grate 25 is of conventional design, serving both as a grate to support the fuel bed, and also as a blast tuyère through which steam under pressure is introduced into the fuel resting upon it. As this steam is introduced into the fuel within the zone B, and comes in contact with that incandescent fuel it is decomposed and forms a gas consisting essentially of hydrogen and carbon-monoxide. Of course the temperature of this gas is quite high and as it passes upwardly through the fresh or green fuel in the zone C it heats that fuel and causes an initial distillation of the volatile hydrocarbon therein to form so called coal gas, which mixes with the water gas and carburates it, or increases its heat value. The resulting mixed gas passes off through the offtake pipe 40 to any desired place of use or storage. By properly controlling the quantity of steam with which the incandescent coke in the lower portion of the zone B is blasted, through manipulation of the valve 34, or in any other way, the relative proportions of water gas and coal gas may be controlled to give a gas of desired heat value.

By properly manipulating the valve 57 the blasting of the outer zone A may be controlled to effect complete combustion of the fuel within that zone, or to generate producer gas. And, as stated above, by properly manipulating the valve 58 all, or any desired fraction, of this gas may be caused to pass off through the pipe 47, or all, or any fraction, of it may be admixed with the water gas and coal gas evolved within the zones B and C, to dilute those admixed gases, the resulting diluted gas passing off through the pipe 40. Thus a gas of any desired heat value over a wide range may be secured—this gas, as desired, consisting of coal gas, coal gas-water gas, coal gas-producer gas, coal gas-water gas-producer gas, or, where coke, or the like is used as fuel instead of a material having volatile hydrocarbons therein, then water gas alone, or a mixed water gas and producer gas may be obtained. Consequently in the operation of this apparatus, not only is coke produced but also a combustible gas which may be of almost any desired composition to give, within a considerable range, any desired heat value; and the generation of the coke and of the gas may be continuously effected.

As will be noted the pipe 47, where it opens into the bottom of the heat interchanger 48, is provided with a burner element 60, which is covered over by refractory material 61. Certain refractory materials, such as fire brick, act as catalysts, and will cause to freely burn a mixture of air and a combustible gas which is so lean that it will not under normal conditions burn at all. During operation of this apparatus even when the zone A is being blasted to complete combustion, the gas resulting from the reactions within that zone will generally be, in fact, a poor producer gas, with an excess of air. Because of the leanness of the mixture this gas would probably not burn under normal conditions, but when it is brought into contact with the refractory material 61, at high temperature, it will burn and generate some additional heat, which will be added to the sensible heat of the gas to increase the preheating effect upon the blast passing through the pipes 49, to thus increase the efficiency of the apparatus.

For purposes of description the invention has been illustrated and described in connection with the carbonizing or distillation of bituminous coal to make coke, but obviously it is just as applicable to other carbonaceous fuels.

While the method herein described, and the form of apparatus for carrying this method into effect, constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to this precise method or this precise form of apparatus, and that changes may be made in either without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. In the distillation of solid carbonaceous material, so as to generate a combustible gas and also produce coke, in which a substantially continuous charge of the material being distilled is maintained within a retort, the method which comprises blasting the outer zone of said charge of ignited material with air to incandescence to generate heat for raising the temperature of the contiguous central zone of said material to cause the driving off of the volatile constituents therefrom; and concomitantly blasting with steam the material within the central zone from which the volatile constituents have been evolved.

2. In the distillation of solid carbonaceous material, so as to generate a combustible gas and produce coke, in which a substantially continuous charge of the material being distilled is maintained within a retort, the method which comprises blasting the outer zone of said charge of ignited material with air to incandescence to generate heat for raising the temperature of the contiguous central zone of said material to cause the driving off of the volatile constituents therefrom; concomitantly blasting the carbonized material within the central zone of the charge of material within said retort with steam, removing at one point gases formed as a result of blasting of said carbonized material with steam and volatile constituents driven off from the fuel within the central zone; and removing at another point products of combustion resulting from the blasting of the outer zone of said charge of material.

3. The method of continuously generating combustible gas including water gas which comprises maintaining a substantially continuous fuel bed of solid carbonaceous material within a generating chamber; blasting one zone of said bed of ignited material with air to incandescence; heating the remaining contiguous portion of said bed of material by conduction and radiation from said incandescent zone to raise the said remaining portion of said fuel bed to incandescence; and continuously blasting the said remaining portion of the fuel bed with steam to effect the generation of water gas.

4. The method of continuously generating combustible gas including water gas which comprises maintaining a substantially continuous fuel bed of solid carbonaceous material within a generating chamber, blasting the outer zone of said bed of ignited material with air to effect combustion thereof to thus generate heat to maintain the contiguous central zone of said bed of material in incandescence; continuously blasting the said central zone with steam to effect the generation of water gas; removing at one point products of the combustion formed in the outer zone of said fuel bed, and removing at another point generated water gas formed in the central zone of the fuel bed.

5. The method of producing combined water gas and coal gas which comprises maintaining a substantially continuous bed of solid carbonaceous material within a retort, blasting the outer zone of said bed of ignited carbonaceous material with air to effect combustion thereof to thus generate heat for distilling the volatile constituents from the material within the contiguous central zone of said bed to carbonize said material and for heating such material to incandescence; blasting the incandescent material within said central zone with steam to effect the generation of water gas, removing the carbonized material from the bottom of said bed and introducing fresh solid carbonaceous material to be carbonized on top of said bed, passing highly heated water gas upwardly through the fresh fuel upon the top of the central zone to assist in distilling the volatile constituents from the fuel within said upper part of the central zone; removing at one point products resulting from the combustion in the outer

zone of said fuel bed, and removing at another point an admixture of water gas and evolved volatile constituents formed in the central zone of the fuel bed.

6. The method of producing a combined coal gas, water gas, and producer gas which comprises maintaining a substantially continuous fuel bed of solid carbonaceous material within a retort, blasting the outer zone of said ignited fuel bed with air to generate producer gas and to, at the same time, raise the temperature of said outer zone to heat the material within the contiguous central zone of said fuel bed to effect distillation of that portion of the fuel which is in the central zone to drive off the volatile constituents therefrom to carbonize said fuel and to raise the resulting carbonized fuel within the lower portion of said central zone to incandescence; concomitantly blasting the carbonized fuel within the said lower portion of the central zone of the fuel bed with steam to effect the generation of water gas, and passing the water gas and the producer gas generated in the said outer zone upwardly through the fuel within the upper portion of the fuel bed to effect driving off of the volatile constituents from that fuel.

7. The method of continuously producing a combined coal gas, water gas, and producer gas which comprises maintaining a substantially continuous fuel bed of solid carbonaceous material within a retort, blasting the outer zone of said ignited fuel bed with air to generate producer gas and to, at the same time, raise the temperature of said outer zone to heat the material within the contiguous central zone of said fuel bed to effect distillation of that portion of the fuel which is in the central zone to drive off the volatile constituents therefrom to carbonize said fuel and to raise the resulting carbonized fuel within the said central zone to incandescence; concomitantly blasting the carbonized fuel within the said central portion of the fuel bed with steam to effect the generation of water gas, passing the water gas and the producer gas generated in the said outer zone upwardly through the fuel within the upper portion of the fuel bed to effect further driving off of the volatile constituents from that fuel; removing the ash resulting from the blasting of the outer zone to generate producer gas, and the coke resulting from the carbonizing action within the central zone, from the lower portion of said fuel bed and adding fresh fuel to the upper portion of said fuel bed to take the place of the material removed from the lower portion of said bed.

8. The method of continuously generating a combustible gas comprising water gas and producer gas which comprises maintaining a substantially continuous bed of solid carbonaceous material within a generating chamber, blasting one ignited zone of said bed of material with air to generate producer gas and to raise the temperature of said one zone to incandescence; heating the remaining contiguous portion of said bed to incandescence, by conduction and radiation from said incandescent zone; concomitantly blasting the incandescent material within the said remaining portion of the fuel bed with steam to effect the generation of water gas, and withdrawing generated producer gas and water gas together.

9. The method of generating a gas of controlled heat value from carbonaceous material, which comprises maintaining a substantially continuous fuel bed of solid carbonaceous material within a retort, blasting one ignited zone of said bed with air to incandescence; heating the remaining contiguous zone of said fuel bed by conduction and radiation to distill off volatile constituents from the material within said remaining zone, to produce coke and to raise the temperature of said coke to incandescence; concomitantly blasting the incandescent coke with steam to generate water gas; admixing generated water gas and distilled volatile constituents, withdrawing at one point products of the combustion formed in the one zone of the bed of material, withdrawing at another point admixed water gas and distillation products formed in the remaining contiguous zone of the fuel bed; and controlling the steam blast to vary the generation of water gas to thus give a combustible gas of controlled heat value.

10. The method of making gas of controlled heat value from solid carbonaceous material, which comprises maintaining a substantially continuous fuel bed of carbonaceous material within a retort, blasting the outer ignited zone of said fuel bed with air to generate producer gas, and to raise the temperature of said outer zone of the fuel bed to incandescence; heating the contiguous central portion of the fuel bed by conduction and radiation from the said outer zone, to distill off the volatile constituents from the fuel within the said central portion of the fuel bed, to generate coke and to raise the temperature of said generated coke to incandescence; concomitantly blasting said incandescent coke with steam to effect the generation of water gas; admixing the generated producer gas, water gas, and volatile distillation products; and controlling the steam blasting of the coke within the central portion of the fuel bed, and the air blasting within the outer zone of the fuel bed, to give a resulting admixed gas of predetermined heat value.

11. Apparatus of the character described comprising a substantially vertical retort, constructed to contain a substantially continuous bed of fuel to be carbonized, a grate closing the lower end of said retort for supporting said fuel bed; an offtake pipe leading off

from the upper end of said retort; a second offtake pipe leading off from about the periphery of the fuel bed within said retort a substantial distance below the said first named offtake pipe; means for operating the said grate to cause removal from the fuel bed within the retort of the carbonized material resting upon that grate, means for introducing fuel into said retort to take the place of the carbonized fuel removed therefrom through the said grate; means for introducing a blast of air into the outer zone of said fuel bed adjacent the wall of the retort to maintain said outer zone in a state of incandescence to heat the contiguous central zone of the fuel bed and drive off the volatile constituents from the fuel within said central zone; and means for concomitantly blasting the resulting carbonized fuel within the central zone of the fuel bed with steam, the positioning of the two said offtake pipes being such that evolved volatile products and products resulting from blasting the carbonized fuel within the central zone of said fuel bed will pass off through the first named offtake pipe and products of combustion resulting from blasting the outer zone of the fuel bed with air will pass off through the second named pipe.

12. A retort of the character described, in which carbonizing of a substantially continuous bed of material is accomplished by blasting the outer zone of said material to generate sufficient heat to carbonize the contiguous central zone of said bed of material, comprising a shell having a carbonizing chamber therein, a refractory lining for said shell, the inner wall of said lining within which the combustion of the outer zone of the bed of material takes place being upwardly tapered; a grate for supporting said bed of material, comprising pivoted grate bars operable from outside the shell and adapted to support the outer zone of the said bed of material, and a rotary eccentric grate having means for cotinuously rotating said grate during operation of said device and positioned for supporting the central zone of the said bed of material.

13. A retort of the character described, in which carbonizing of a substantially continuous bed of material is accomplished by blasting the outer zone of said material to generate sufficient heat to carbonize the contiguous central zone of said bed of material, comprising a shell having a carbonizing chamber therein, a refractory lining for said shell, the inner wall of said lining within which the combustion of the outer zone of the bed of material takes place being upwardly tapered; a grate for supporting the outer zone of the said bed of material, and a grate supporting the central zone of the material, means for separately operating the said two grates; means for blasting the said outer zone of the bed of material with air to effect combustion thereof; and means for concomitantly blasting the carbonized fuel within the central zone of said bed of material with steam to effect the generation of a combustible gas.

14. A retort of the character described, comprising a shell having a carbonizing chamber therein and adapted to contain a substantially continuous bed of solid carbonaceous material to be carbonized, a refractory lining for said shell, means for introducing a blast only into the zone of material adjacent the lining of the said shell to effect combustion of the outer zone of the bed of material, and offtake for the products of combustion formed in said outer zone of the bed of material, the inner wall of said refractory lining within which the combustion of the outer zone of the bed of material takes place being upwardly tapered substantially throughout the extent of said zone, whereby the blast is confined to said outer zone of the material and the contiguous central zone of the material is carbonized by radiation and conduction of heat from said outer zone.

15. A retort of the character described, comprising a shell having a carbonizing chamber therein and adapted to contain a substantially continuous bed of solid carbonaceous material to be carbonized, a refractory lining for said shell, means for introducing a blast only into the zone of material adjacent the lining of the said shell, an offtake for the products of combustion formed in said outer zone of the bed of material, the inner wall of said lining within which the combustion of the outer zone of the bed of material takes place being upwardly tapered substantially throughout the extent of said zone, whereby the blast is confined to the outer zone of the bed of material and the contiguous central zone of the material is carbonized by radiation and conduction of heat therefrom, and a rotary grate for supporting the bed of material within the carbonizing chamber, said grate being adapted to effect compacting of the material within the said tapered portion of the said chamber.

In testimony whereof I hereto affix my signature.

HARRY F. SMITH.