

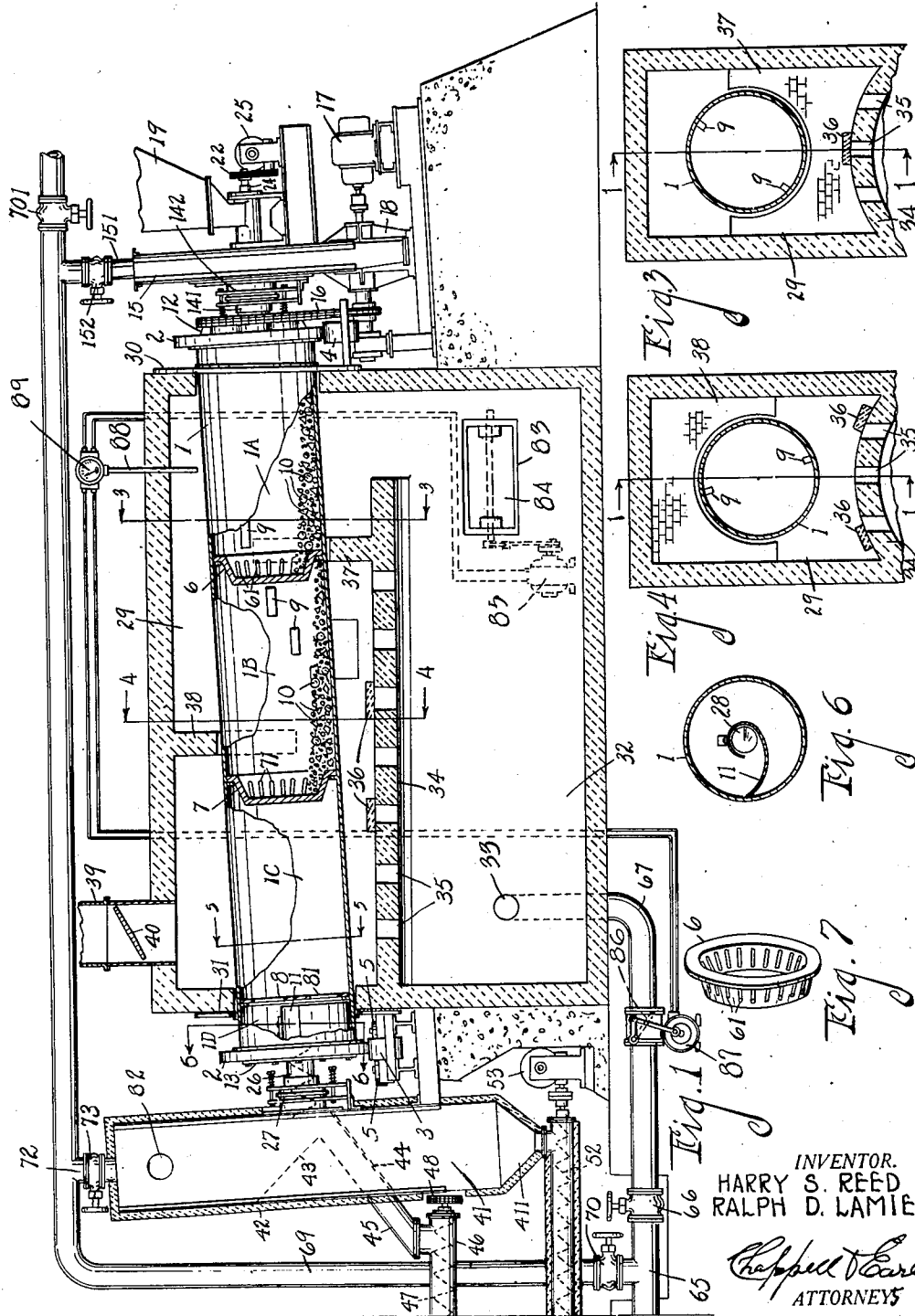
Nov. 13, 1934.

H. S. REED ET AL
APPARATUS AND PROCESS FOR DISTILLING AND TREATING
COAL AND OTHER CARBONACEOUS MATERIALS

1,980,828

Filed Jan. 15, 1932

2 Sheets-Sheet 1



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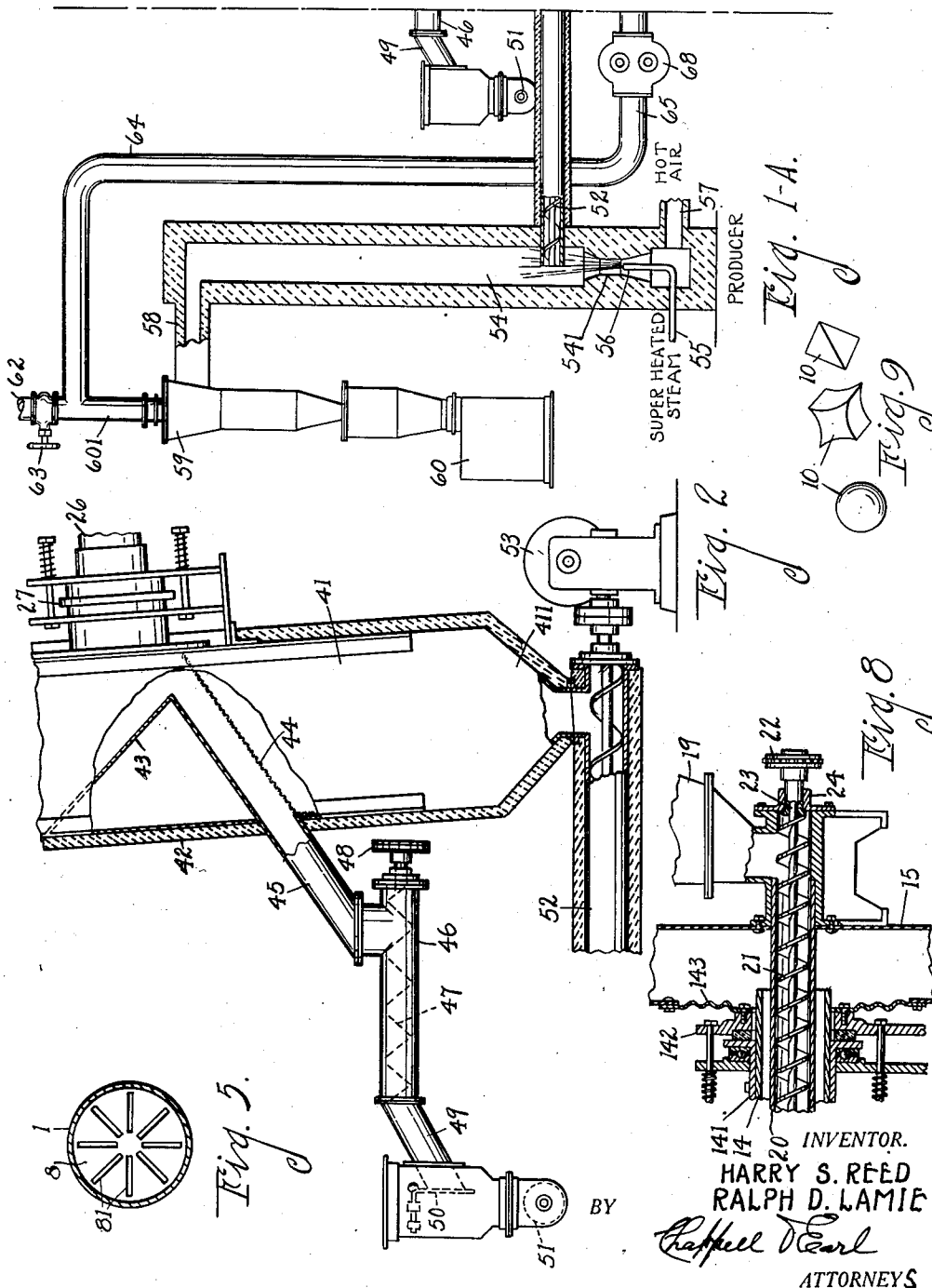
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UNITED STATES PATENT OFFICE

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APPARATUS AND PROCESS FOR DISTILLING
AND TREATING COAL AND OTHER CAR-
BONACEOUS MATERIALSHarry S. Reed and Ralph D. Lamie, East Lansing,
Mich.

Application January 15, 1932, Serial No. 586,756

11 Claims. (Cl. 202—28)

The objects of the invention are:

First, to provide an apparatus for low temper-
ature distillation and complete gasification and
utilization of coal or other carbonaceous mate-
rial.

Second, to provide a self-contained complete
distilling and converting apparatus for coal or
similar carbonaceous material.

Third, to provide means in a continuous proc-
ess for distilling coal or carbonaceous material
in a closed retort whereby the volatile portion
is driven off and utilized and the solid portion
delivered hot to a hopper or other apparatus.

Fourth, to provide an improved apparatus and
process especially adapted to distilling and treat-
ing Brazilian coal or other low grade coal.

Objects pertaining to details and economies of
construction will appear from the description to
follow. A preferred form of the apparatus and
means by which we carry out our improved proc-
ess is illustrated in the accompanying drawings,
in which:

Figs. 1, 1A show a general view, largely in ver-
tical longitudinal section, of the distilling appa-
ratus with parts of the casings broken away to
show the interior arrangement of the retort, sec-
tioned on a line corresponding to line 1—1 of
Figs. 3 and 4.

Fig. 2 is an enlarged view of the discharge
chamber coke seal and hot coke feeder delivering
hot coke to the gas producer, being an enlarge-
ment in detail of parts appearing in said Figs.
1 and 1A.

Fig. 3 is a detail sectional view on line 3—3
of Fig. 1 showing the combustion chamber and
the baffle wall.

Fig. 4 is a detail sectional elevation on line
4—4 of Fig. 1, showing the curtain baffle wall and
the fire arch of the combustion chamber.

Fig. 5 is a cross sectional elevation on line
5—5 of Fig. 1 showing the flat discharge screen
with its radial slots.

Fig. 6 is a detail transverse sectional view on
line 6—6 of Fig. 1 through the discharge cham-
ber and discharge scoop.

Fig. 7 is a detail perspective view of one of the
hat-shaped partition screens removed from the
retort.

Fig. 8 is a detail vertical longitudinal section
through the gas-tight joint and feed means, fully
described in our patent application Ser. No.
452,879, filed May 16, 1930.

Fig. 9 is a detail view of the tumbling bodies
or elements for heating, grinding the material,
and clearing the retort walls.

The parts will be identified by their numerals
of reference which are the same in all the views.

1 is a cylindrical tumbling barrel retort. It
has tires 2, 2, one at each end supported upon
rollers 3, 4 whereby the same may be readily ro-
tated. Cushion or thrust rollers 5, 5 (Fig. 1) re-
tain the tire at one end in position permitting the
expansion and contraction of the retort in the
opposite direction. The body of the drum or re-
tort is divided by means of transverse screen par-
titions 6, 7 and 8 into compartments 1A, 1B, 1C
and 1D. Elongated tumbling lugs 9 are disposed
on the inner periphery of the wall of compart-
ments 1A and 1B in stepped relation to each other
as seen particularly in compartment 1B. There
are two sets of these lugs diametrically opposed
so that in the rotation of the drum the contents
is continuously and evenly agitated thereby and
an even application of power secured.

Loose impact tumbling bodies 10, some globular,
some angular, of cast iron or steel or other heat
absorbing and conducting material (detailed in
Fig. 9), are disposed in the compartments 1A
and 1B to tumble with the lumps of coal or car-
bonaceous material to insure movement, to pul-
verize the same, to clean the walls of the retort
and to clean each the other, and to distribute
and transfer heat to the material.

The partitions 6 and 7 are hat-shaped with
continuous rims secured to the inner periphery
of the drum and projecting toward the discharge
end. The side portions of the so-called hat-
shaped part are provided with longitudinal com-
paratively narrow screen slots 61, 71 for the pas-
sage of the pulverized coal or carbonaceous ma-
terial. A flat screen partition 8 (Fig. 5), is be-
tween compartments 1C and 1D and contains
radial screen slots 81 which are spaced from the
periphery of the screen, whereby a light layer of
pulverized material will be retained in the com-
partment 1C. In the compartment 1D and car-
ried by the drum, is a scoop or dipper 11 for ad-
vancing the material into the central spiral con-
veyor hereafter to be described.

The tumbling barrel 1 is provided with a head
12 at its intake end and a head 13 at the dis-
charge end secured gas-tight by suitable means
to the said drum or retort. The head 12 is pro-
vided with an axially extending hollow tubular
hub or sleeve 14 which carries a flange collar 141
which is embraced by a gas-tight rotary bearing
142 carried by the flexible diaphragm 143 (Fig.
8). The diaphragm is carried by the wall of
mixing and discharge chamber 15.

A sprocket drive connection 16 is secured to

the head 12. It is driven by the motor 17 having a variable and changeable speed gear connection 18, whereby the drum or retort is rotated and driven at any speed desired or required. The details of the change speed are immaterial and are not shown. 19 is the feed hopper provided with a tubular feed spout 20, extending axially into retort 1 (see Fig. 8). A feed screw 21 is in the feed tube and is driven by sprocket 22 on the shaft 23 extending through stuffing box 24 at the end of the feed tube. This sprocket is driven by a variable speed motor 25 (see Fig. 1).

It will be seen that when coal or carbonaceous material is introduced into hopper 19 it will be advanced into the retort by the screw conveyor 21 (see Fig. 8). The speed of this conveyor is controlled so that there will be a mass of coal and material substantially plugging the tube 20 so that little or no gas will escape at that point. Gas can pass to expansion chamber 15 through the annular space between sleeve 14 and tube 20 from the retort. This chamber 15 is provided with gas inlet pipe 151 controlled by valve 152.

The head 13 at the opposite discharge end of the retort is provided with an extending tubular hub or sleeve 26 extending through a gas-tight joint 27 and discharges the volatiles from the retort. It is provided with a spiral conveyor 28 inside (see Fig. 6) to deliver the coke and solid matter from the retort by the combined action of the scoop or dipper 11 and the conveyor already referred to.

29 is the furnace within which is disposed the revolving retort 1 sealed by suitable flange plates 30, 31 at each end. 32 is the fire chamber supplied with gas burner means at 33. Over this chamber there is an arch 34 of brick work containing openings 35 for the passage of the flame and heated products of combustion. These openings are controlled by placing bricks or slabs 36 of fire clay over the openings to control the same. 37 (see Figs. 1 and 3) is a baffle wall carried by the said arch 34 and partially surrounding the retort. 38 is a baffle wall curtain or partition extending downwardly from the top of the furnace (see Fig. 4). 39 is a stack controlled by a butterfly damper 40 by which, it will be noted, the heated products of combustion pass upwardly at the right hand end of the furnace, as illustrated in Fig. 1, heating the chamber 1A with a very strong heat, thence curving over the top and downwardly, thence passing toward the left and downwardly, heating chamber 1B, thence under the curtain 38 and up and out at the stack 39, heating chamber 1C (the chamber 1D being heated indirectly), which shows the manner in which the revolving retort is heated.

41 is a separating chamber provided with a vapor outlet 82. The solid material from the retort 1 is discharged into chamber 41 as before indicated. This chamber 41 is covered with insulation 42. It is provided with a baffle 43 inside which causes coke and solid material to be delivered downwardly against the screen 44 (see Fig. 2).

The coke and coarse material is passed out at discharge spout 45 above the screen to a pipe conveyor 46 with a conveyor screw 47 therein, indicated by dotted lines in Fig. 2, driven from sprocket wheel 48. Pipe 46 delivers into the downwardly inclined pipe 49 which is closed by a weighted flap lid 50 indicated by dotted lines in Fig. 2. This delivers into a screw conveyor 51 to discharge the contents into a bin or to a fire box or into a conveyor to be returned to the

hopper 19 to be mixed with the fresh supply of material being distilled, as desired.

The bottom of the chamber 41 terminates in a hopper 411 delivering into screw conveyor 52 operated by the variable speed motor 53 (see Fig. 2) delivering into a combustion and gas converting chamber 54 (see Fig. 1A), the conveyor 52 and the chamber 41 being constructed of heat insulating material such as fire brick or fire clay or material of similar character. This is in effect a vertical flue for the passage of the materials for the manufacture of gas. Producer gas is here produced.

55 is a steam pipe delivering through nozzle 56 for delivering super-heated steam centrally and upwardly through the said gasification chamber or flue 54. 57 is a hot air connection for delivering (by blower or otherwise) a regulated amount of hot air to be entrained by the steam through the contracted passage 541 at the bottom of the chamber 54. 58 is a laterally projecting pipe connection delivering to a dust collector 59 of the usual construction with ash bins 60 below and with a gas delivery pipe 601 out at the top of the said dust collector. The pipe 601 extends upwardly at 62 and is provided with a valve 63 so that it may be used as a purge pipe or purging outlet for the apparatus. Pipe 64 connects by T-connection to pipe 601 and delivers downwardly and then laterally at 65 through valve 66 to pipe 67 which supplies the burner structure 33 within the furnace. A gas pump 68 is in pipe 65. 69 is a riser pipe from pipe 65 and is controlled by valve 70 and extends upwardly and forwardly to the forward part of the apparatus where the discharge of surplus gas is controlled by valve 701. A connection 72 leads to the top of chamber 41 from pipe 69 and is controlled by valve 73. Likewise a connection from pipe 69 to expansion chamber 15 is controlled by valve 152. Valves 73 and 152 provide for the mixing of the producer or water gas supplied by pipe 69 with the gas produced by the primary distillation of the coal or other carbonaceous material in retort 1 as desired.

In the operation of this structure, coal in comparatively small lumps is introduced into the hopper 19 along with "fines" and the hopper is maintained partially filled, at least, to prevent the escape of any material amount of gas. Coal is delivered by the conveyor inwardly and dropped into chamber 1A where it is at once heated by the strong current of hot gases from the combustion chamber. This heat is rapidly and efficiently transferred to the coal as it is being broken up by the heat conducting bodies 10, causing it at once to begin to discharge the volatiles which pass out at the pipe 26 to the chamber 41. Best results are obtained by heating to from 900 to 1250 degrees Fahrenheit.

The contents is agitated by the lugs 9 as the retort revolves and, owing to the incline of the retort, the solid material is advanced to the partition 6 and the fragments, with a part of their volatiles, are discharged past the screen slots to chamber 1B where the fragments are further broken up and reduced to a powder, the action in chamber 1B being a continuation of the action in chamber 1A, except, of course, that the fragments of coal are smaller. The tumbling bodies 10 still further insure the heating and discharge of volatiles as the powder is advanced to the partition 7 past slots 71 and discharged into the chamber 1C.

Here the agitation by the tumbling bodies is

discontinued. There is such agitation as occurs from the revolving of the drum. It is the purpose to minimize the agitation at this point because of the development of an undue amount of dust. All of the volatiles that can be readily eliminated are driven off at this point and the more or less spent powder which still contains a considerable quantity of volatiles and all of the fixed carbon is advanced to the chamber 41. Here the powder passes over screen 44. The coarse coke and material pass through the discharge pipe 45 through pipe conveyor 46 past the sealing discharge valve 50 to the conveyor 51. The fine coke and material are dropped into the bottom of chamber 41 into the hopper 411 formed at the bottom, the heat being retained by the insulation, and the material is then passed through the insulated screw conveyor to the gasification chamber 54. As the hot coked carbonaceous material is discharged into the insulated chamber 54, it is blown upwardly by the jet of superheated steam which entrains a controlled amount of hot air and the whole is converted into producer gas which passes through the delivery pipe 58 to the dust separator 59 where the ash drops down to the bin 60 and the gas is carried forward into pipe 601. The gas thence passes through pipe 64 to the pump 68, and is delivered to the burner in the furnace and also distributed to pipe 69 where it is utilized as before explained.

The rich gas produced by the primary distillation in retort 1 passes by means of sleeve 26 through gas seal 27 into chamber 41, thence through vapor outlet 82 to conventional scrubbing, condensing and gas cleaning means, not shown, (incidentally for the recovery of liquid by-products). It may be readily understood that either, or both, chamber 41 and retort 1 may be used as mixing chambers for the lean and rich gases by control of valves 73 and 152. A gas of the desired or required heat value in B. t. u. is thereby delivered through outlet 81 to the conventional condensing, scrubbing and gas cleaning apparatus and thence to a holder.

83 is an air inlet vent passage or opening into the side of the furnace towards its front end, controlled by a hinged damper 84 which is controlled by electric motor 85, conventionally shown. 86 is a butterfly damper valve in gas supply pipe 67 controlled by motor 87, also conventionally shown. 88 is a pyrometer. 89 is a thermostat associated therewith for controlling the said motors 85 and 87. These are shown diagrammatically, as we use such instruments as we can buy.

If, for any reason, the supply of coal to the retort is cut off, the temperature will at once rise to a dangerous point. The pyrometer 88 is connected to thermostatic control 89 to open the vent damper to admit cold air through the opening 83 and to cut down the gas supply by controlling motor 87 that actuates valve 86. This is done automatically and protects the equipment from injury because of overheating. The structures are the usual stock articles and are shown conventionally.

We have shown our improved structure adapted to screen out coarse material and convert the fine material into producer or water gas, returning the coarse material to the feed hopper to be passed through the apparatus again with fresh material. It is not necessary to do this. It is not feasible to reduce to a fine powder coal or carbonaceous material of certain character such as Brazilian coal. We take this step in the way described because of the liability to produce an undue amount

of dust with Brazilian coal and it is best not to grind it too fine. It is also desirable to leave some of the volatiles in the mass. Where this is done, the screen to which we refer is very desirable as it passes the fine material which can be very readily converted into producer or water gas.

Of course, it is not necessary to mix the water gas and the producer gas with the gas of high heat value that is first driven off, but it is entirely feasible to do so. It is best to use the producer or water gas in the furnace as there is an abundance of it.

The apparatus will handle any coal or carbonaceous material of any description.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. In an apparatus for distilling coal and manufacturing the same into gas, the combination of an inclined rotary tumbling barrel retort having screen partitions thereacross dividing the same into compartments; the last screen toward the discharge end having a broad peripheral imperforate band, a furnace with gas burner means surrounding the body of said retort containing an arch and baffle walls disposed to deliver the products of combustion and circulate the same around the said retort, a gas-tight intake delivery tube into the head at the intake end of the said retort, a coal hopper having a pipe conveyor concentric of said tube for advancing the coal into the retort, an expansion chamber having a gas-tight joint at the intake end of the said retort, engaging lugs on the inner periphery of the said retort in the first of the compartments between the said screen partitions, tumbling bodies, spherical and angular, of heat conducting material in the first of said compartments and none in the last compartment, a hollow central trunnion at the coke discharge end of the said retort, including a helical conveyor blade therein, means in the last compartment of said retort to deliver pulverized material to the said conveyor, an insulated vertical separating chamber with a hopper bottom having a valved intake pipe at the top and a separate gas discharge passage at the top, a connection from the retort to receive the heated solids and gas from the said rotary retort, having a baffle and screen for separating the coarse solids from the fine and accumulating the fines in the hopper at the bottom of said chamber, a pipe conveyor for advancing the coarse coked material having a gas-sealed flap valve at the end, an insulated pipe conveyor for the hopper at the bottom of said separating chamber, a vertical insulated gasification chamber for the manufacture of gas connected to receive said fines as they are advanced, a superheated steam jet pipe delivering upwardly in the bottom of the said gasification chamber, a passage for the intake of a controlled amount of hot air to be entrained by said steam jet, a discharge passage at the top of said gasification chamber, a dust collector, a purging outlet, a valved gas delivery pipe from the said dust collector, a gas pump in said delivery pipe, a valved branch connection from the said pipe to the burner means in the said furnace, and branch connections to the top of the separating chamber and to the top of the expansion chamber to control the delivery and the mixing of the said gases.

2. In an apparatus for distilling coal and manufacturing the same into gas, the combination of an inclined rotary tumbling barrel retort having screen partitions thereacross dividing the

same into compartments, the last screen toward the discharge end having a broad peripheral imperforate band, a furnace with gas burner means surrounding the body of said retort containing an arch and baffle walls disposed to deliver the products of combustion and circulate the same around the said retort, a gas-tight intake delivery tube into the head at the intake end of the said retort, a coal hopper having a pipe conveyor concentric of said tube for advancing the coal into the retort, an expansion chamber having a gas-tight joint at the intake end of the said retort, engaging lugs on the inner periphery of the said retort in the first of the compartments between the said screen partitions, tumbling bodies, spherical and angular, of heat conducting material in the first of said compartments and none in the last compartment, a hollow central trunnion at the coke discharge end of the said retort, including a helical conveyor blade therein, means in the last compartment of said retort to deliver pulverized material to the said conveyor, an insulated vertical separating chamber with a hopper bottom having a gas discharge passage at the top, a connection from the retort to receive the heated solids and gas from the said rotary retort, sealed conveyor means to deliver the solid material from said separating chamber, and means to deliver a current of gas into said retort to advance the volatiles through said apparatus.

3. In an apparatus for distilling coal and manufacturing the same into gas, the combination of an inclined rotary tumbling barrel retort having screen partitions thereacross dividing the same into compartments, the last screen toward the discharge end having a broad peripheral imperforate band, a furnace with gas burner means surrounding the body of said retort containing an arch and baffle walls disposed to deliver the products of combustion and circulate the same around the said retort, a gas-tight intake delivery tube into the head at the intake end of the said retort, a coal hopper having a pipe conveyor concentric of said tube for advancing the coal into the retort, an expansion chamber having a gas-tight joint at the intake end of the said retort, engaging lugs on the inner periphery of the said retort in the first of the compartments between the said screen partitions, tumbling bodies, spherical and angular, of heat conducting material in the first of said compartments and none in the last compartment, a hollow central trunnion at the coke discharge end of the said retort, including a helical conveyor blade therein, means in the last compartment of said retort to deliver pulverized material to the said conveyor, an insulated vertical separating chamber with a hopper bottom having a gas discharge passage at the top, a connection from the retort to receive the heated solids and gas from the said rotary retort, and sealed conveyor means to deliver the solid material from said separating chamber.

4. In an apparatus for distilling coal and manufacturing the same into gas, the combination of an inclined rotary tumbling barrel retort divided into compartments by screen partitions, the upper end being the feed end, the lower end the discharge, a furnace for externally heating the same, an expansion chamber at the feed end of said retort having a gas-tight joint connection thereto, means of delivering coal into the feed end, engaging lugs in the inner periphery of the feed end compartments of the said retort, heat conducting tumbling bodies within the compart-

ments at the feed end of the said retort, an axial trunnion at the discharge end of said retort containing helical conveyor vanes, means of delivering the solids from said retort to the said conveyor, an insulated separating chamber connected to receive both the solid and volatile materials from the said retort, a gas delivery connection from the top of said retort, an insulated pipe conveyor from the bottom of said separating chamber, a vertical insulated gasification chamber for the manufacture of gas connected to receive the solids from said conveyor as they are advanced, a superheated steam pipe jet delivering upwardly in the bottom of the gasification chamber, a passage for the intake of a controlled amount of hot air to be entrained by the said steam jet, means delivering the gas from the said chamber, and connections for delivering a part of said gas into the said retort to advance the volatiles.

5. In an apparatus for distilling coal and manufacturing the same into gas, the combination of an inclined rotary tumbling barrel retort divided into compartments by screen partitions, the upper end being the feed end, the lower end the discharge, a furnace for externally heating the same, an expansion chamber at the feed end of said retort having a gas-tight joint connection thereto, means of delivering coal into the feed end, engaging lugs in the inner periphery of the feed end compartments of the said retort, heat conducting tumbling bodies within the compartments at the feed end of the said retort, an axial trunnion at the discharge end of said retort containing helical conveyor vanes, means of delivering the solids from said retort to the said conveyor, an insulated separating chamber connected to receive both the solid and volatile materials from the said retort, a gas delivery connection from the top of said retort, an insulated pipe conveyor from the bottom of said separating chamber, a vertical insulated gasification chamber for the manufacture of gas connected to receive the solids from said conveyor as they are advanced, a superheated steam pipe jet delivering upwardly in the bottom of the said gasification chamber, a passage for the intake of a controlled amount of hot air to be entrained by the said steam jet, and means delivering the gas from the said chamber.

6. The process of distilling carbonaceous material, consisting in distilling the same in a tumbling barrel retort divided into successive compartments through which the material is delivered, heating the said material by external heat on the said retort and by heat conducting tumbling bodies within the mass of said coal to pulverize and advance the same, delivering both the pulverized solid material and distilled gas and vapors to a separating chamber where the solid material accumulates by gravity in the bottom and the gas with the volatile by-products is discharged, screening the solid material and delivering the fines by a suitable conveyor to an upright gas-making chamber, delivering a jet of superheated steam with entrained hot air upwardly through the floating particles of solid material to produce gas therefrom, separating the ash and dust from the last aforesaid gas, and delivering and circulating a part of the aforesaid gas through the said retort to advance the said distilled gas and vapors quickly to the separating chamber.

7. The process of distilling carbonaceous material, consisting in distilling the same in a tum-

bling barrel retort divided into successive compartments through which the material is delivered, heating the said material by external heat on the said retort and by heat conducting tumbling bodies within the mass of said coal to pulverize and advance the same, delivering both the pulverized solid material and distilled gas and vapors to a separating chamber where the solid material accumulates by gravity in the bottom and the gas with the volatile by-products is discharged, screening the solid material and delivering the fines by a suitable conveyor to an upright gas-making chamber, delivering a jet of superheated steam with entrained hot air upwardly through the floating particles of solid material to produce gas therefrom, and separating the ash and dust from the last aforesaid gas.

8. The process of distilling carbonaceous material, consisting in distilling the same in a tumbling barrel retort divided into successive compartments through which the material is delivered, heating the said material by external heat on the said retort and by heat conducting tumbling bodies within the mass of said coal to pulverize and advance the same, delivering both the pulverized solid material and distilled gas and vapors to a separating chamber where the solid material accumulates by gravity in the bottom and the gas with the volatile by-products is discharged, delivering the solid material by a suitable conveyor to an upright gas-making chamber, delivering a jet of superheated steam with entrained hot air upwardly through the floating particles of solid material to produce gas therefrom, and separating the ash and dust from the last aforesaid gas.

9. The process of distilling carbonaceous material, consisting in distilling the same in a tumbling barrel retort divided into successive compartments through which the material is delivered, heating the said material by external heat on the said retort and by heat conducting tumbling bodies within the mass of said coal to pulverize the same, heating the same to from 900 to 1250

degrees Fahrenheit, holding the said pulverized material in the last compartment of said retort until the vapors volatile at the temperature employed are expelled, delivering both the pulverized solid material and distilled gas and vapors to a separating chamber where the solid material accumulates by gravity in the bottom and the gas with the volatile by-products is discharged, screening the solid material and delivering the fines by a suitable conveyor to an upright gas-making chamber, delivering a jet or superheated steam upwardly through the floating mass, entraining hot air to make producer gas, separating the dust from the last aforesaid gas, and delivering a part of the aforesaid gas through the said retort to advance the distilled gas and vapors quickly to the separating chamber.

10. In an apparatus for distilling coal or the like, the combination of a rotary tumbling barrel retort, a furnace surrounding the same having passages to deliver heat at the feed end of the said retort and pass the same along the said retort, and having an air intake vent aperture in the side of the said furnace with a damper to control the same, a gas burner means having a gas supply for the said furnace, a throttle valve in the said gas supply pipe, and a pyrometer extending into the said furnace in proximity to the said retort having a thermostat control for cutting off the fuel and opening the vent damper.

11. In an apparatus for distilling coal or the like, the combination of a rotary tumbling barrel retort, a furnace surrounding the same having passages to deliver heat at the feed end of the said retort and pass the same along the said retort, and having an air intake vent aperture in the side of the said furnace with a damper to control the same, and a pyrometer extending into the said furnace in proximity to the said retort having a thermostat control for opening the vent damper.

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