May 9, 1933. C. R. FABEN 1,907,767

APPARATUS FOR DISTILLATION OF CARBONACEOUS LIQUIDS

Filed Feb. 3, 1930

Fig. 1

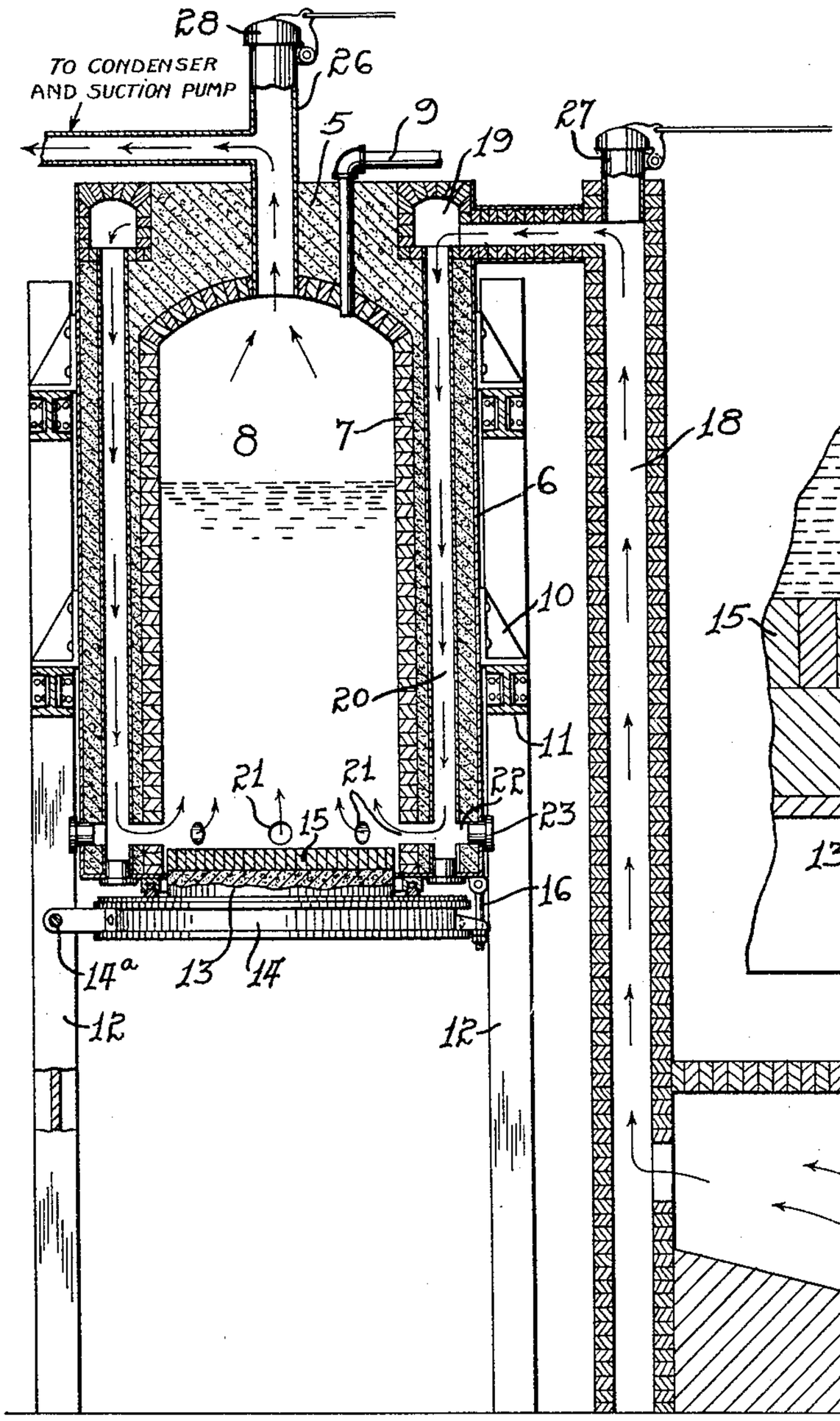
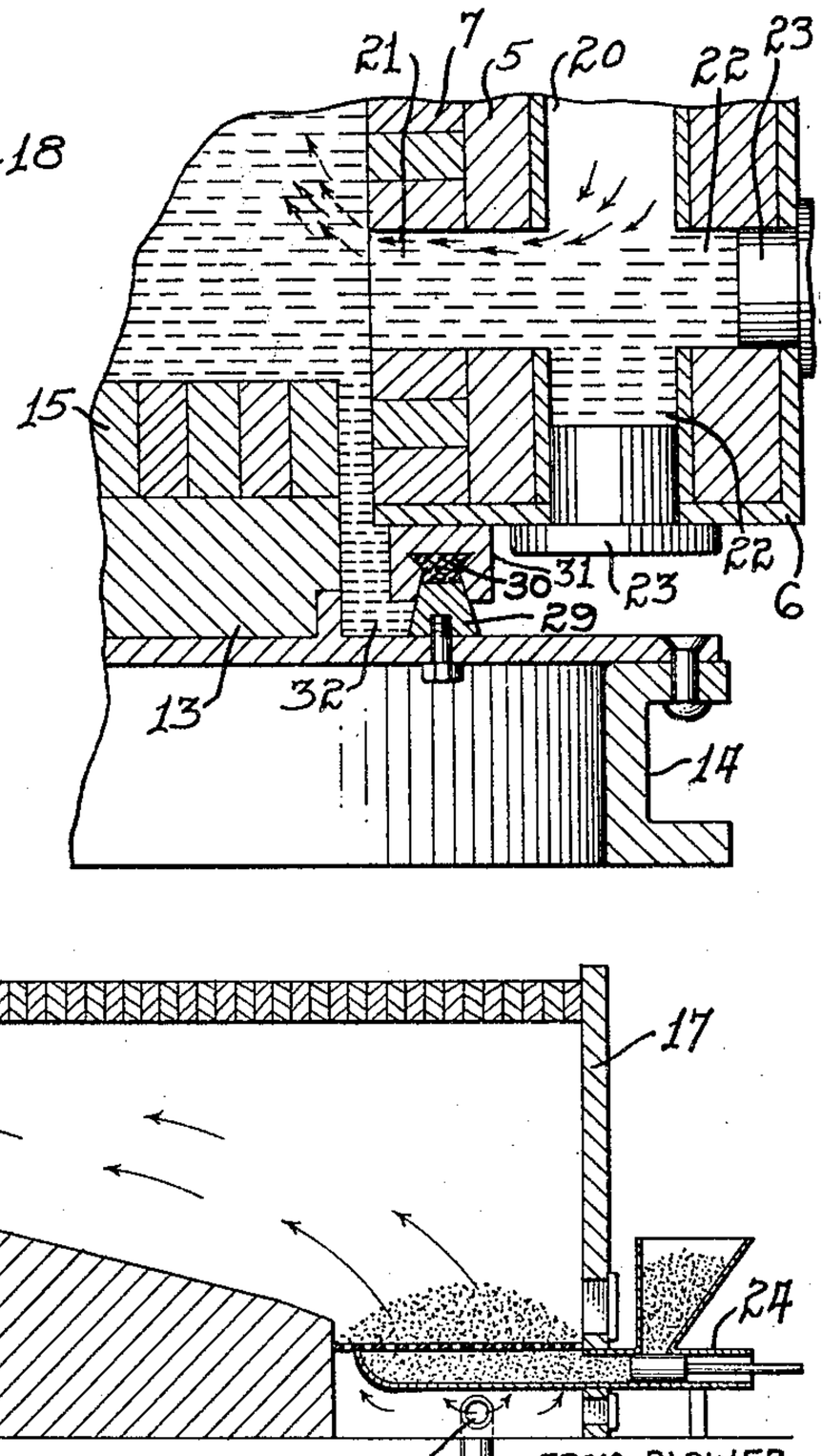


Fig. 2



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Patented May 9, 1933 1,907,767

UNITED STATES PATENT OFFICE

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APPARATUS FOR DISTILLATION OF CARBONACEOUS LIQUIDS

Application filed February 3, 1930. Serial No. 425,413.

This invention relates to the distillation of carbonaceous liquids, more particularly where the batch is heated by introducing the hot flue gases from the furnace directly into the bottom of the still. In the usual operation of a furnace, a considerable amount of uncombined oxygen passes into the flue. Also, if the flue gases are discharged into the bottom of the liquid in the still, the height of the liquid exerts a hydrostatic pressure which must be overcome. Heretofore in overcoming such pressure, either by forcing the air through the furnace by pressure alone or by drawing it through the still by suction alone, particularly when the quantity taken is great enough to effect distillation, uncombined oxygen has invariably been introduced into the still in such quantities that it has limited the application of this principle of distillation to materials which will absorb oxygen at high temperatures without burning or exploding.

I have found, however, that such an operation can be materially improved by using a forced draft such as is employed with an underfeed stoker, to provide air for combustion, and a vacuum pump connected with the outlet end of the still and capable of handling the volume required to draw the products of combustion through the liquid charge. Since these two agencies are distinct and capable of independent manipulation, it is possible and practicable to control the stack gas analysis and deliver the hot flue gas at atmospheric pressure or at any desirable pressure at the inlet of the still, whence the vacuum pump will draw it through the liquid. In practice, the best results appear to be obtained by maintaining atmospheric pressure above the fire in the furnace. This can be closely approximated by noting the draft or pressure at the draft holes in the fire door of the furnace. If air is fed to the furnace faster than the pump is taking the hot gas away, some of the gas will be discharged through the openings in the furnace door. If the pump is taking the gas faster than the air is being forced through the fire, outside air will be sucked in through the draft holes over the fire. By adjusting the air damper, a condition can be maintained between these two so that there will be no noticeable draft through the fire door opening.

By thus controlling the pressure in the stack, maintaining a minimum amount of oxygen and a maximum amount of carbon dioxide therein, it is possible to keep the oxygen component of the flue gas so small that combustion or explosion within the still is impossible. It is to be noted that this can only be accomplished by a combination of pressure and suction. The necessary and sufficient conditions are that the furnace should have a tight ash pit capable of receiving and distributing air under pressure great enough to pass through the fire bed in the quantity desired; also that a vacuum pump be available with capacity great enough to handle the hot gas produced and to draw the same through the liquid charge in the still.

A further object of my invention is to arrange the flues in such a manner with relation to the still that they may be easily cleaned out, and so that the distillation may be carried on continuously to its ultimate stage, leaving as a residue a mass of coke of homogeneous texture which may be removed from the still in a single block.

The invention also includes the provision of a door in the bottom of the still, with a liquid seal which is beyond the direct influence of the heat within the still so that its liquid does not become solidified during the final stage of the distillation.

The invention will be more specifically explained in connection with the accompanying drawing, in which

Figure 1 is a central vertical section through the main part of the apparatus used.

Figure 2 is an enlarged sectional view showing the liquid seal and adjacent portions of the apparatus.

As illustrated in the drawing, the still 5 is formed largely of concrete which is encased with steel 6 and lined with suitable fire brick 7, providing a chamber 8 to receive a batch of liquid which may be introduced through an inlet pipe 9. The still is supported some distance above the ground by means of shoul-

dered brackets 10 which are secured to the steel casing 6 and rest upon girders 11 constituting part of a steel framework 12.

The bottom of the still is in the form of a door 13, also preferably composed largely of concrete secured in a steel frame 14 which is hinged, as at 14*a*, to the steel framework 12 and is provided with a lining of firebrick 15. During the operation of the still the door 13 is held in closed position by suitable fastening means 16.

The heat for effecting the distillation is supplied by a furnace 17 from which the products of combustion pass through a stack 18 and into an annular manifold 19 at the upper end of the still. A number of pipes 20, embedded in the concrete 5, lead downwardly from the manifold 19 into inlets 21 arranged radially at the bottom of the still. In alinement with each inlet 21 is a cleanout opening 22 which is normally closed by a plug 23. Similar cleanout openings are provided in alinement with the passageways 20. Fuel is fed to the furnace 17 by means of an automatic underfeed stoker 24, with which is associated a blower having an inlet 25 into the base of the furnace.

After the flue gases are discharged into the still through the openings 21, they bubble up through the liquid therein and are discharged through a stack 26 which is connected with a condenser and a suction pump of sufficient capacity to take care of a volume of gas large enough to maintain the requisite temperature in the still. The stacks 18 and 26 are provided with dampers 27 and 28 respectively, which may be opened when desired.

For the purpose of securing a tight closure for the door 13, the latter has an annular rim 29 secured thereto which seats against a gasket 30 of asbestos, or similar fire resistant material, which is packed in an annular seat 31 secured to the lower end of the still wall. The meeting faces of the annular members 29 and 31 are removed some distance from the inner surface of the still, beyond the direct influence of the heat therein. The space 32 between the main part of the door 13 and the side wall of the still is, of course, filled with liquid at the beginning of the distilling process. As the contents of the still are raised to a high temperature, convection will cause some interchange of material between the space 32 and the main part of the batch. As the distillation approaches its ultimate stage leaving a solid residue of coke in the still, the material in the space 32 still remains liquid and maintains the seal as well as providing sufficient heat insulation to prevent warping of the metal parts of the door and adjacent portion of the still.

During the distillation, if the blower alone is depended upon to force the gases through the openings 21 into the bottom of the still, a pressure considerably above that of the atmosphere must be maintained above the fire and in the stack 18 in order to overcome the hydrostatic pressure of the liquid at the bottom of the still. This would necessitate the forcing of a great deal more air through the furnace than is necessary to support combustion, resulting in too high a percentage of oxygen in the flue gases and also inevitably causing a good deal of gas to escape through the interstices in the upper part of the furnace and the stack. If the suction pump alone is used, the pressure within the stack 18 must be considerably below atmospheric, with the result that an excess of air will be drawn through the fire as well as through the interstices in the upper part of the furnace and stack. By using both a blower and a suction pump, however, the action may be regulated so as to maintain substantially atmospheric pressure above the fire and in the stack 18 at all times, with the result that very little uncombined oxygen is introduced into the still.

The process may be continued with gradually increasing temperature until destructive distillation takes place and indeed until coke is left as a final residue. Toward the end of the process, the action becomes exothermic and finally for a brief period air may be admitted by opening the damper 27 to burn off the small percentage of hydrocarbons remaining. When this step is completed, the door 13 is opened and, as the mass of coke gradually cools, it settles slowly by gravity and drops to the ground.

By using both pressure and suction, properly regulated, it is possible to distill any kind of carbonaceous material which is liquid or liquefiable, by introducing the hot flue gases directly into the batch at or near the bottom thereof, thereby obtaining the maximum efficiency for the amount of fuel used, at the same time permitting the metal jacket of the still to be fully protected from the intense heat by a heat insulating lining. This protection of the steel jacket is one of the chief factors in making it feasible to carry on the process to the coking point.

It is, of course, to be understood that the invention includes all such modifications as may properly fall within the scope of the appended claims.

What I claim is:

1. The combination with a furnace and means for supplying air under pressure thereto, of a still provided with a chamber for receiving a liquid batch and having a heat insulating wall, means for discharging the products of combustion from the furnace directly into the batch chamber in the interior of the still near the bottom thereof, an outlet from the top of the still, and means for producing a partial vacuum in said outlet.

2. In combination, a still provided with a chamber for receiving a liquid batch and having a heat insulating wall, a manifold

formed in the wall of the chamber having passageways leading into the interior of the chamber near the bottom thereof, a furnace having its outlet flue leading into said manifold, means for supplying air under pressure to the furnace, an outlet from the top of the chamber, and means for producing a partial vacuum in said outlet.

3. In combination, a still provided with a chamber for receiving a liquid batch and having a heat insulating wall, a manifold contained in the upper part of said wall and having vertical passageways leading downwardly therefrom, radial inlets from said passageways into the interior of the chamber near the bottom thereof, normally closed cleanout openings in alinement with said passageways and radial inlets respectively, and means for inducing a flow of combustion gases to said manifold and thence through said inlets when the chamber contains a batch of liquid.

4. In combination, a still provided with a batch chamber having a perpendicular side wall and open at the bottom, means for supporting said still in elevated position, a door for closing said bottom, a seal between the outer edge of the door and the side wall, said side wall and door being provided with heat resistant lining forming an annular space between said seal and the distillation chamber proper, said annular space being adapted to retain liquid throughout the distillation while the residue within the distillation chamber proper becomes solid, and means for delivering combustion gases directly into said chamber near the bottom thereof, the interior of said chamber being entirely unobstructed when the door is opened, to permit a solid residue to be dropped therefrom in a single block.

5. In combination, a still provided with a batch chamber having a perpendicular side wall and open at the bottom, a frame-work supporting said still in elevated position, a door hingedly supported on said frame-work for closing said bottom, a seal for said door, said side wall and door being provided with heat resistant lining forming an annular space between said seal and the distillation chamber proper, said annular space being adapted to retain liquid throughout the distillation while the residue within said chamber becomes solid, a furnace, and means for delivering combustion gases from said furnace directly into said chamber near the bottom thereof, the interior of said chamber being entirely unobstructed when the door is opened, to permit a solid residue to be dropped therefrom in a single block.

6. In combination, a still provided with a batch chamber having a heat insulating side wall with a seat at the bottom thereof, means for supporting the still in elevated position, a bottom door having a flange thereon engaging said seat to form a liquid-tight seal, and a heat insulating facing on the interior side of said door and within said flange extending into the bottom portion of said chamber and spaced from the side wall when the door is closed, and means for introducing combustion gases directly into the bottom of said chamber, the space between said facing and the side wall being adapted to retain liquid throughout the distillation while the residue within said chamber becomes solid.

In testimony whereof I have hereunto signed my name to this specification.

CHARLES R. FABEN.