

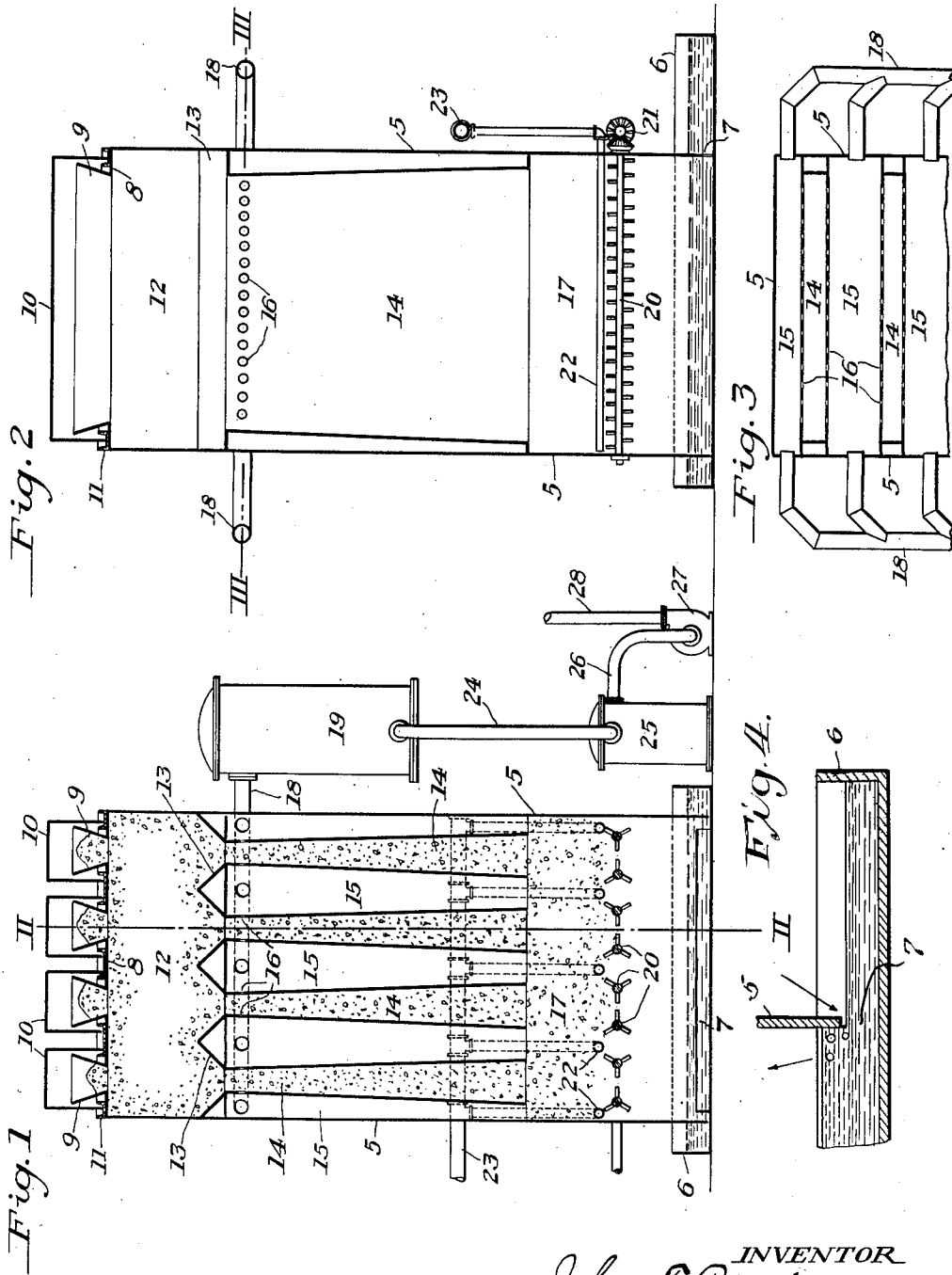
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J. F. RICHARDSON

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DISTILLATION OF SOLID CARBONACEOUS MATERIALS

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INVENTOR
John F. Richardson
by W. G. Doolittle
Attorney.

UNITED STATES PATENT OFFICE.

JOHN F. RICHARDSON, OF PITTSBURGH, PENNSYLVANIA.

DISTILLATION OF SOLID CARBONACEOUS MATERIALS.

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This invention relates to a method and apparatus for the distillation of solid carbonaceous materials and particularly to the treatment of solid carbonaceous materials for the recovery of the volatile hydrocarbon constituents thereof; it will be especially described in connection with a method for extracting tar from bituminous substances, such as oil-shale, coal mine refuse, soft coal, etc.

In the manufacture of coal tar from bituminous minerals by destructive distillation, as now generally practiced, there is a considerable loss of heat, due to the way in which the furnaces are constructed and operated, and there is more or less loss of condensate due to cracking of the vapors to form permanent gases, because of the difficulty in effecting the temperature control and supply of steam.

As now generally practiced, the bituminous minerals are subjected to distillation in a closed retort, around the outside of which are circulated burning gases or intensely heated gases of combustion. A brick or refractory wall accordingly surrounds the retort to prevent the metal of the retort from burning. Frequently, the retort is composed of refractory earth which may break and cause the loss of large quantities of gas and vapors. The refractory walls of the retort absorb and retain large quantities of heat.

According to the present invention, the combustion chamber and the retorts communicate and the gases of combustion mingle with the gases of distillation, the invention including the method of so controlling the introduction of air in such manner as to furnish sufficient oxygen to support combustion to the extent necessary for proper distillation, without normally consuming the vapors which are distilled off, the coke resulting from distillation providing the fuel.

The present invention further aims to automatically supply water vapor to the apparatus in quantities sufficient to increase the efficiency of the process, and prevent, to some extent, cracking of the vapors which might otherwise result.

Still further objects of the invention are to control, to a certain extent, automatically the air supplied to the apparatus and to provide an apparatus whose operation is continuous.

The apparatus is simple in construction and efficient in operation, so that tar can be

obtained at a relatively low cost, and with a minimum requirement for manual labor.

My invention may be readily understood by referring to the accompanying drawing, in which:

Fig. 1 illustrates a longitudinal vertical section through one form of apparatus for carrying out my invention;

Fig. 2 is a transverse vertical section on line II—II of Fig. 1; and

Fig. 3 is a horizontal section in the plane of line III—III of Fig. 2;

Fig. 4 is an enlarged sectional detail view of a portion of Fig. 2, showing the variation in the water level upon increase of vacuum with resulting air supply.

In the drawings, 5 represents the vertical walls of a housing which is supported in a shallow tank 6. Along the bottom of the housing is an opening 7. The housing is closed by a top 8 in which are one or more hoppers 9. Each hopper is normally closed by a bell or hood 10 which rest in troughs 11 to provide a water seal against the entrance of air. The housing is preferably made of metal.

Below the top 8 is a storage space 12. Inclined bottom plates 13 for this storage space direct material into the vertical retorts 14. These retorts, which I prefer to make of metal, are preferably rectangular in cross section and wider at the bottom than at the top. They may be several feet long, but their width must be limited, in order to secure a relatively uniform distribution of heat through the material therein. As the material will begin to heat at the top of the retorts, as hereinafter described, they may increase in width toward the bottom, as the heated material will spread out and the heat in the center of the mass will be practically the same as at the outside. The shape of the retorts facilitates the gravitation of the material therethrough.

Each retort is separated from the adjacent ones by a vertical chamber 15. Ports 16 in the upper parts of the retorts communicate with these chambers. The chambers and the retorts open into a fire box or combustion chamber 17 at their lower ends. Manifolds 18 serve to convey gases from the chambers 15 to a condenser 19. The bottom of the combustion chamber is closed by a plurality of mechanically driven grate bars 20 arranged in pairs, and driven in a suitable way,

as by gearing 21. At the bottom of the combustion chamber, which has an appreciable depth, there may be provided transversely disposed perforated air inlet pipes 22, one pipe being disposed directly below each chamber 15. Air under pressure may be supplied from a manifold 23.

Leading from the condenser 19, is a pipe 24 going to tank 25, where condensates are collected. Pipe 26 leads from tank 25 to suction pump 27, and leading from the pump is a pipe 28, which may go to a gas washer or other suitable gas treating means, not shown.

In operation, the tank 6 is filled with water to a point just above the top of opening 7, to form a seal. The oil shale, mine refuse, or other material being treated is emptied into storage space 12, after which the hoppers 9 are closed. Air is introduced through pipes 22 to support a fire, which has been previously started in the bottom of the combustion chambers.

As the operation continues, the heat rises up through the coke bed into the chamber 15, heating the retorts 14. A small portion of the heat and products of combustion pass up through the retorts, but, due to the resistance of the material therein, most of the products of combustion pass up through chambers 15. As the retorts heat, the volatile substances in the shale are driven off, the vapors escaping into chambers 15. Care is taken to keep the temperature of the retorts sufficiently low to prevent cracking of the vapors, so that the resulting condensate will contain as much tar as possible and avoid converting the vapors into permanent gases.

As the material at the bottom of the combustion chamber burns, the revolving grate bars empty the ashes and coke which may be removed through opening 7. The material in the retorts thus gravitates continuously toward the grate bars, and the temperature of the material increases as it approaches the zone of combustion.

Those vapors emerging from the retorts through ports 16 serve to dilute the hotter gases of combustion, and thereby automatically control, to some extent, the temperature around the upper part of the retort. The temperature around the top of the retorts is preferably kept at about 400 degrees F., while the temperature at the bottoms of the retorts is preferably kept between a hundred and two hundred degrees higher.

It will thus be seen that the more volatile gases will be driven off in a zone of lower temperatures, while the shale will move into constantly hotter zones to drive off the more resistant hydrocarbons. The temperatures to which the retorts are subjected at any point, however, are sufficiently low as to render unnecessary refractory protecting

walls, or to render the use of refractory materials necessary. This will increase the efficiency of the apparatus by reducing the heat losses due to absorption and decrease the initial cost. It will, furthermore, be more efficient in that a metal wall is not apt to crack or leak as is a refractory wall.

As the hot ashes or coke falls into the water at the bottom of the housing, steam will be generated, which will be sucked up through the firebox into and around the retorts, where it will mix with the gases of distillation to prevent cracking thereof. This steam will also form a fluid medium to assist in carrying off the gases of distillation and overcome to a large extent any tendency of the tars to condense in the manifolds. Some of the steam, coming into contact with hot coke in the combustion chamber, will, furthermore, be decomposed to liberate hydrogen and combine with carbon to form carbon monoxide, and thus increase, to a limited extent, the amount of combustible permanent gases produced.

The suction pump is continuously driven to draw the gases of combustion and the gases of distillation from chambers 15 through the manifolds to the condenser. The condensate collects in the tank 25, while the gases pass out pipe 28, where they may be taken to a suitable treating tower, or other apparatus, not shown, to remove sulphuretted hydrogen, carbon-dioxide, and other undesirable constituents in any well known or preferred way.

The air supply to the fire box is limited and controlled in such a way as to maintain, as nearly as possible, an even temperature in the fire box. All of the air supplied might be admitted through opening 7, or pipes 22 may be provided as an auxiliary supply.

The manner in which combustion is maintained may now be described. Suppose the fire to be burning in the lower part of the fire box. Distillation of materials in the retort will be effected, and the gases of combustion and of distillation will be drawn off by the pump. As the pump, which is designed according to the capacity of the still, is operated, it lowers the pressure in the fire box below atmospheric pressure, whereupon, the water in the tank is sucked up into the lower part of the housing until port or opening 7 is uncovered, as in Fig. 4. As port 7 uncovers, air is admitted to the fire box through it. As the fire continues to burn, and more gases are driven off, the pump is supplied with a greater amount of gases, and the water falls, covering port 7, to cut off the air supply. In this way, the water in the tank is kept continually rising and falling, according to the amount of gases going to the pump, and the air supply is decreased as the volume of gases increases.

Thus, the temperature of the fire may be kept very even, and the temperature of the gases of combustion may be kept at a point below which, when they mingle with the products of the retort, undesired cracking of the hydrocarbons would result.

The pipes 22 may, if desired, be used to furnish a substantially constant supply of air, while port 7 would be opened and closed only to effect the desired control, but these pipes are not necessary to the successful operation of my invention.

The invention is obviously capable of other uses than the reduction of oil bearing shales, being useful for effecting reduction of various substances and carbonaceous materials for different purposes.

It will be apparent that any preferred number of retorts may be included in a single housing, and that while four have been shown, a greater number or a fewer number could be used. Various other changes in the construction of the apparatus may be made within the contemplation of my invention and within the scope of the appended claims. I claim:

1. The method of treating solid carbonaceous materials which consists in passing the materials continuously through a retort and withdrawing the vapors into a space adjacent the retort, passing the residue of the retort continuously into a fire-box with which the retort communicates, supplying air to the bottom of the fire-box in limited amounts varying inversely with the resulting gases to thus effect an even temperature control, passing the products of combustion from the fire-box adjacent and through the retort, and withdrawing the products of combustion and gases of distillation from the space adjacent the retort.

2. The method of treating solid carbonaceous materials for the recovery of the volatile hydrocarbon constituents thereof, which consists in subjecting the materials to the action of the heat of combustion within an internal combustion chamber, maintaining a liquid seal at the base of the chamber and subjecting the seal to the variations of pressure within the chamber for varying the volume of air supplied to the materials inversely with the gas production.

3. The method of treating solid carbonaceous materials for the recovery of the volatile hydrocarbon constituents thereof, which consists in maintaining the material to be treated in a vertically extending mass within an internal combustion chamber and over a liquid seal, igniting the base portion of the mass of material and maintaining the mass above the ignited portion at a temperature below the cracking temperature of oil, withdrawing the generated gases from the upper end of the mass of material while the liquid seal is subjected to the variations of pressure

in the combustion chamber, and utilizing the liquid seal for varying the volume of air supplied to the mass inversely with the gas production.

4. The method of reducing solid carbonaceous materials by destructive distillation which consists in passing the material through a water sealed retort, maintaining a zone of combustion in the base of the retort only, withdrawing the gases and vapors from the retort, and utilizing the liquid seal by the variations of pressure in the retort as a water valve to control the admission of air to the retort in such manner that a decrease in the products of distillation will give an increased supply of air and an increased quantity of distillation products will reduce the supply of air to thereby effect a temperature control within the retort.

5. The method of subjecting solid carbonaceous materials to destructive distillation which consists in placing the material in a retort, maintaining a zone of combustion in the retort, withdrawing gases and vapors from the retort, and providing a fluid sealed air inlet valve for the retort wherein the fluid is directly responsive to the variations in pressure in the retort to admit air when the pressure is low and exclude it when the pressure is high, and thereby control the rapidity of combustion of said material.

6. The method of subjecting solid carbonaceous material to destructive distillation which consists in passing the material through a retort, maintaining a zone of combustion in the lower part of the retort only, closing the retort against the entrance of air by means of a liquid sealed opening, and subjecting the seal to the differential pressure outside and inside the retort in such manner as to admit air with a decrease in the pressure inside the retort with respect to the pressure outside the retort and shut off the air supply in proportion to the increase in pressure inside the retort.

7. An apparatus for subjecting carbonaceous materials to the action of heat and combustion which consists of a housing having a retort therein, a fire-box into which the retort opens, an air inlet passage to the fire-box, and means including a liquid seal controlling the air inlet for varying the amount of air supplied to the fire-box inversely with the amount of gases produced by the resulting combustion and distillation.

8. An apparatus for effecting destructive distillation of carbonaceous material comprising a retort, a fire-box, means including a pump for withdrawing gases from the retort, a water tank, an air supply port for admitting air to the fire-box disposed in such tank in such manner as to be opened and closed by the falling and rising movement of water in the tank, said pump communicating with the air port and effecting the fall-

ing and rising movement of the water according to the volume of gas production.

9. An apparatus for subjecting carbonaceous materials to the action of heat and combustion which consists of a housing having a retort therein, a fire-box into which the retort opens, an air inlet passage to the fire-box, a confined body of sealing liquid normally above the air inlet passage, and suction mechanism for exhausting fluid products from the housing adapted to effect variations in the level of the sealing liquid to admit air to the fire-box inversely with the rate of production of said products.

10. Apparatus for effecting destructive distillation of carbonaceous materials comprising a casing forming a retort, a hollow shell in the retort and spaced away from some of the walls thereof, said shell being perforated and being open at its bottom, grates in the retort spaced below the end of the shell, a seal at the base of the retort, filling closures at the top of the retort opening into the space above and around the shell, and gas and vapor conduits connected with the interior of the shell.

11. Apparatus for effecting destructive distillation of carbonaceous materials comprising a vertical retort, a hollow shell within the retort spaced from some of the walls thereof, said shell being perforated and being open at its lower end, an outlet conduit connected with the interior of the shell, filling closures at the top of the retort opening into the space above and around the shell, a grate in the retort spaced below the end of the shell, a water seal at the base of the retort, an air inlet port normally below the liquid level of the seal and opened and closed by the water, and a suction pump to which the outlet conduit connects.

12. An apparatus for subjecting carbonaceous materials to the action of heat and combustion which comprises a retort, an air inlet passage in communication with the retort, and means including a body of fluid for controlling the air inlet passage for varying the amount of air supplied to the retort inversely with the gas production of the retort.

In testimony whereof I affix my signature.

JOHN F. RICHARDSON.