

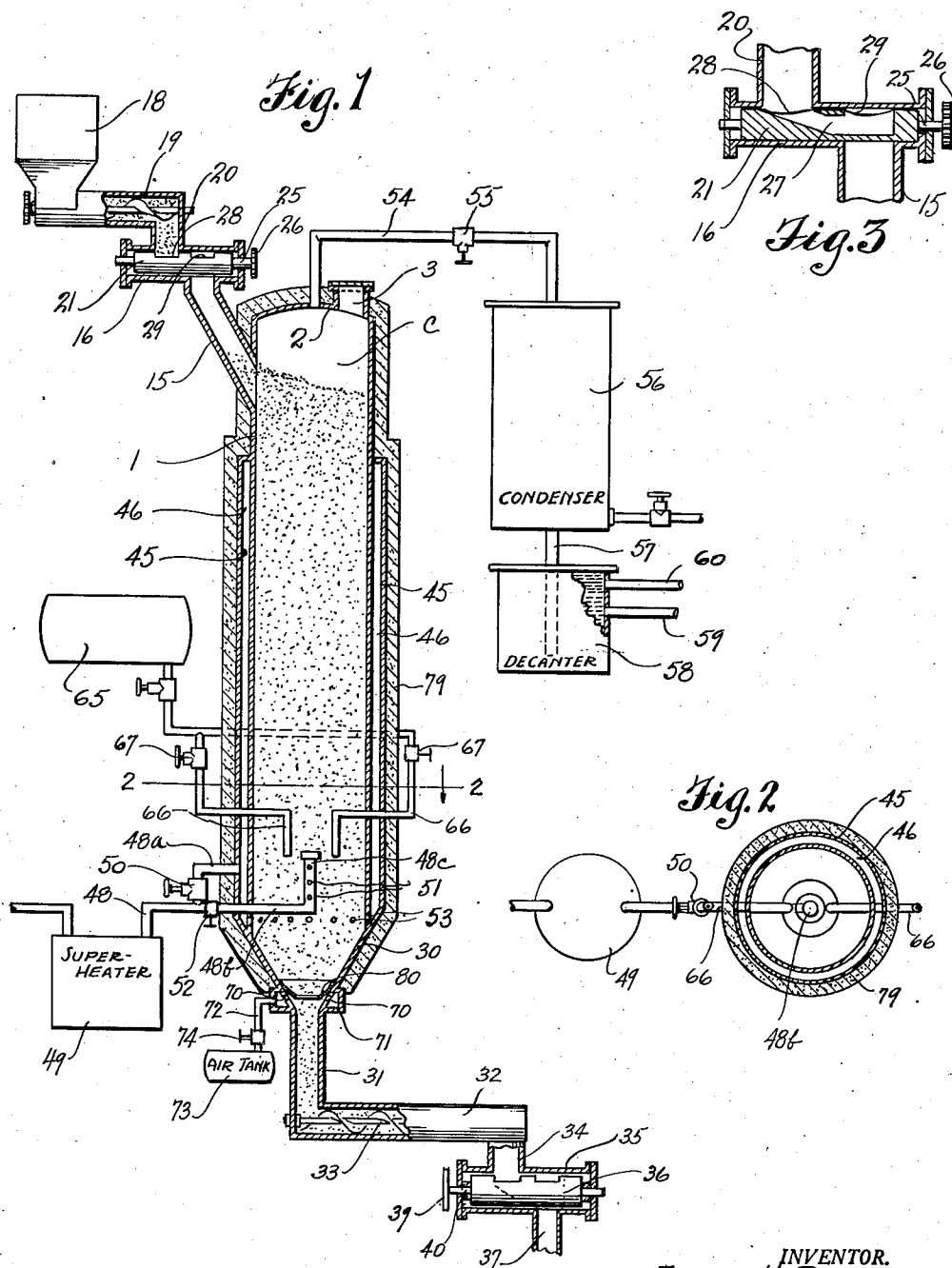
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APPARATUS FOR TREATING CARBONACEOUS MATERIAL

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APPARATUS FOR TREATING CARBONACEOUS MATERIAL

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This invention relates to the treatment of carbonaceous materials for the recovery therefrom of useful by-products, and it has for its principal object to provide an improved method of and novel apparatus for the heat treatment of oil shale, tar sand, coal, wood and other carbonaceous materials, for the recovery therefrom of oils, vapors, hydrocarbons, gases and other useful by-products that may result from said treatment.

To simplify the following specification, that part of the present apparatus which receives the charges of carbonaceous material for heat treatment will hereinafter be referred to as the "retort" and the material treated, whether it be oil shale, coal, tar sand, wood or a mixture of such materials, will be referred to as "carbonaceous material," with the understanding that it might be any one or a mixture of the material that might be treated.

More specifically stated, the principal object of the present invention is to provide an economical, expeditious and efficient method of and means for the recovery of valuable by-products, such as oil, vapors and gases, from carbonaceous materials, and which is based upon the controlled application within a retort and to the material under treatment therein, of super-heated steam, or other gases, at temperatures that might range from 700° F. to 1800° F. and at pressures that might range from zero gauge pressure to fifty pounds per square inch.

Still other objects of the invention reside in the details of construction of the various parts of the novel apparatus, in their combination, and in their mode of use, as will hereinafter be described.

In carrying out the objects of this invention, I have provided apparatus, a preferred form of which is illustrated in the accompanying drawing, wherein:

Fig. 1 is a diagrammatic illustration of the treating apparatus, showing the retort, and portions of the retort charging and unloading mechanism, in vertical section.

Fig. 2 is a cross section on line 2—2 in Fig. 1.

Fig. 3 is a sectional detail of the charging valve.

In carrying out the present invention, cognizance has been taken of the way in which super-heated steam, or other hot gases used for the treatment of the carbonaceous material, give up their heat; of the necessity of proper distribution of the steam throughout the entire charge; of the necessity for a reaction space to allow proper comingling of the gases, vapors and oils formed and extracted, and of the necessity of sweeping said

gases, vapors and oils from the retort before thermal cracking, with resultant coke formation, can take place to any appreciable extent.

The present apparatus for the treatment of oil shale, tar sand, coal and other carbonaceous material, makes use of rotating valves, at upper and lower ends of the retort, specially designed and constructed to permit the ingress and egress of such carbonaceous material without the loss of gaseous pressure within the retort. These special valves raise the apparatus above the level of a batch process retort and make possible a continuous through-put of the carbonaceous materials to be treated.

Cognizance has been taken of the chemical and physical instability of the hydrocarbon gases, vapors and oils formed from some types of carbonaceous materials, such as oil shale and tar sand and a partial remedy for this has been provided by the injection into the charge as it progresses, of heavy hydrocarbon oils, such as crude petroleum. The gases and vapors of such heavy hydrocarbon oils are caused to comingling with those of the oil shale and tar sand and will thereby help to stabilize them, and by so doing will increase the yield of gases, vapors and oils from said oil shale and tar sand.

For further stabilization of the gases, vapors and oils evolved and for improving and diversifying the various end products, such chemicals as phosphorous compounds, nitrogen compounds and other chemicals may be added to the retort charge.

Cognizance has also been taken of the fact that all of the carbon and carbon compounds cannot be removed from such materials as oil shale and tar sand by any heat treatment, so at the spent material exit neck at the discharge end or base of the retort, a series of ports has been provided through which a controlled amount of air is admitted to cause said carbon and carbon compounds to burn, thus furnishing further heat while obtaining therefrom other valuable by-products such as carbon monoxide (CO).

Means has been provided in connection with the retort to keep its inner walls, that are in contact with the charge, at a constant temperature throughout the entire distance of contact. By so doing, a more even control of retort temperatures can be maintained, thereby assuring uniformity of chemical and thermal reactions taking place and also assuring a uniformity of end products.

Referring more in detail to the drawing:

1 designates a vertically disposed, cylindrical

retort, closed at its upper end by an upwardly crowned end wall 2 in which there is a normally closed inspection passage 3. The selected carbonaceous material to be treated is fed into the retort at the upper end portion thereof, through a downwardly directed tube 15 that extends to the retort from a feed valve housing 16. The tube 15 opens into the retort at a location somewhat below its upper end wall so that the retort will not be completely filled with the carbonaceous material at any time, thus providing an open space as designated at C in Fig. 1, for the mixing of gases and vapors. It is desirable to feed the material that is to be treated by gravity flow from a supply hopper 18 through a screw conveyor 19 that discharges into a pipe 20 connected with the top side of the housing 16 of feed valve. The housing 16 contains a rotary valve 21 whereby measured amounts of material will be periodically fed into the upper end of the tube 15 for gravity flow into the retort chamber. The valve 21 as shown best in Fig. 3, is horizontally disposed and rotatably contained in the housing, and it is adapted to be axially rotated by its shaft 25 through the mediacy of a shaft gear 26. The driving means for this gear is not herein shown, but might be of any suitable character. The valve 21 contains a pocket 27 that has an inlet 28 adapted as the valve rotates, to pass in registration with the discharge end of pipe 20 to receive material from the conveyor. The pocket also has an outlet 29 adapted on each rotation of the valve to be registered with the receiving end of tube 15 for the discharge of the material from the pocket 27 into the tube 15 for delivery into the retort. The openings 28 and 29 open to the same side of the rotary valve, but are offset one from the other in the longitudinal direction of the valve, and thus there is, at no time, any direct outlet for gases under pressure from the retort through the valve housing, as will be understood by inspection of Fig. 3.

At its lower end, the retort has a conically tapered wall 30 leading to the open upper end of a tubular discharge pipe 31 which, at its lower end opens onto a horizontal conveyor tube 32 containing a feed screw 33. At its discharge end, the tube 32 has a downwardly directed pipe connection 34 that opens into the top side of a valve housing 35 containing a rotary valve 36 whereby the material is discharged through an outlet 37 in the lower side of the valve housing. Valve 36 is like that shown in Fig. 3 and like that described in connection with the feed mechanism, and it is driven through a gear 39 fixed on its drive shaft 40. This valve operates to retain gas pressure in the retort chamber while discharging the spent materials.

Enclosing the main body portion of the retort, is a shell 45. This is of greater diameter than the retort and forms a steam chamber 46 thereabout. This chamber extends from the lower end of the retort, upwardly to near the level of the point of entrance of material into the treating chamber.

The retort is supplied with superheated steam through a pipe connection 48 leading from a steam superheater 49. The pipe 48 has one branch 48a leading therefrom and opening into the steam chamber 46 that surrounds the retort near the lower end of the retort, and this pipe is equipped with a control valve 50 affording accurate control of the admittance of steam to the jacket.

Also, leading from the pipe 48, is a branch pipe

48b, and this enters into the lower end portion of the retort chamber, passing to the center line thereof, then is turned upwardly and is closed. This upturned portion 48c of this pipe is formed with a plurality of perforations 51 for the discharge of steam into the charge of material under treatment at this point. A control valve 52 is interposed in the branch pipe 48b and thus, by means of the valves 50 and 52, the amounts and the ratio of amounts of steam applied to the steam jacket 46 and within the retort chamber, through pipe 48b may be accurately determined and controlled.

Beside the superheated steam that enters the chamber through pipe 48b, additional steam is admitted thereto through a circular row of small perforations 53 in the chamber wall opening from the lower end of the steam jacket. These perforations provide for a flow of the steam in the jacket and thus promote a better heating operation.

Gases and vapors are led off from chamber C at the upper end of the retort through a pipe 54 that opens through the end wall 2. This pipe, equipped with a control valve 55, leads to a condenser 56 which in turn discharges through a pipe 57 into a decanter 58. Valve 55 makes possible a control of pressure in the retort chamber. In this decanter, a separation of oil and water is made, and water is drawn therefrom through pipe 59 while oil is drawn off through the pipe 60.

Provision is made for the controlled admittance of hydrocarbon oils into the retort chamber from a storage tank 65, flowing through pipes 66—66 that open into the charge of material at opposite sides of the perforated end portion of the steam pipe 48b. Flow of oil is positive and is controlled by the adjustment of control valves 67—67 that are interposed in the pipe connections 66 and 66.

At the lower end of the retort, just above the discharge opening, a plurality of air inlet ports 70 open into the chamber through the conical end wall. These lead from a manifold 71 that surrounds the conical end wall and which is connected by a pipe 72 with an air pressure tank 73. A valve 74 in the pipe 72 controls the rate of admission of air and provides for the admittance of the exact amount required to effect the oxidation of that carbon which may be left in the spent material as it arrives at the discharge point, thus to produce carbon monoxide (CO). These perforations are protected against being clogged by material in the retort by an overhanging shield 80 which is affixed to the retort wall, as illustrated in Fig. 1.

To conserve steam in the heating of the retort, it is desirable that the entire retort be encased in a layer of suitable heat insulating material, designated in Figs. 1 and 2 by reference character 79.

Assuming that the parts of the apparatus are so constructed and are assembled as described and illustrated, the method of use of the apparatus is as follows:

First, with the discharge valve closed, the retort is charged with the selected carbonaceous material through the pipe 15 leading from the feed valve mechanism. Then superheated steam or other suitable hot gases are admitted through pipe 48a into the steam jacket 46 to bring the retort up to a desired working temperature, and steam is also admitted through pipe connection 48b into the charge of material.

Incident to this application of heat and steam, reaction takes place in the retort chamber and the gases, vapors and oils that are driven off from the carbonaceous charge rise into the chamber C where they commingle and are then drawn through the pipe 55 into the condenser 56 and ultimately the condensate passes to the decanter 58 for separation.

As carbonaceous material is acted on in the retort, the discharge valve 36 and the feed valve 21 are operated at proper speed to effect a continuous removal of the spent material from the lower end of the retort and a continuous replenishing of the charge to maintain it at the desired level in the retort.

The rate of travel of the material through the retort is predicated on the time necessary to thoroughly and completely treat the charge from the time it enters the retort through pipe 15 until it leaves the discharge end through pipe 31.

Should the gaseous vapors and oils thus evolved be of such nature as to need fortification and stabilization by oily hydrocarbons such as crude petroleum, this may be injected into the retort from the tank 65 through the pipes 66—66 under control of valves 67—67.

Should the charge be of such carbonaceous material that it is desirable to obtain all of the carbon and carbon compounds before ejection from the retort, then a controlled amount of air may be admitted through the ports 70 from the air tank 73 and the carbon thus caused to be burned to carbon monoxide or carbon dioxide whichever is desired.

Operating temperatures in the retort are controlled by the heat of and application of steam to the retort and it varies with the material being treated and results desired. Likewise, pressure in the retort is governed by application of steam discharge of gases and this likewise varies in accordance with requirements and materials un-

der treatment. Steam application is controlled by valves 51 and 52, and pressure in the chamber is regulated by adjustment of valve 55.

Having thus described my invention, what I claim as new therein and desire to secure by Letters Patent is:

1. An apparatus for the treatment of carbonaceous materials comprising a retort having an elongated, closed vertical chamber, and a steam jacket enclosing the chamber; said chamber having an inlet spaced below its upper end and having an outlet at its lower end, valve mechanism for the feeding of material into the chamber through said inlet to maintain a working charge in the chamber to a depth determined by the location of said inlet, a valve mechanism for the removal of material from the lower end of the chamber, to effect a continuous gravity advancement of the charge, valve controlled gas and vapor off-taking connection at the upper end of the chamber; said steam jacket having ports opening therefrom into the lower end of the chamber circumferentially thereof, means for a controlled admittance of superheated steam into the jacket, for flow therefrom into the charge of material through said ports, means for admitting superheated steam into the central portion of the chamber near the lower end, and means for the admittance of air to the chamber in the close vicinity of the outlet, and means for the admittance of oil into the charge near the point of application of superheated steam.

2. Apparatus as recited in claim 1 including also means for a controlled admittance of superheated steam into the body of carbonaceous material in the lower portion of the retort, and means for a controlled admittance of a fortifying oil into the body of material adjacent said superheated steam inlet.

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