Sept. 14, 1954

E. H. RECORDS

APPARATUS FOR TREATING AND CALCINING CARBONACEOUS MATERIALS

2,689,213

Filed Aug. 24, 1950

4 Sheets-Sheet 1

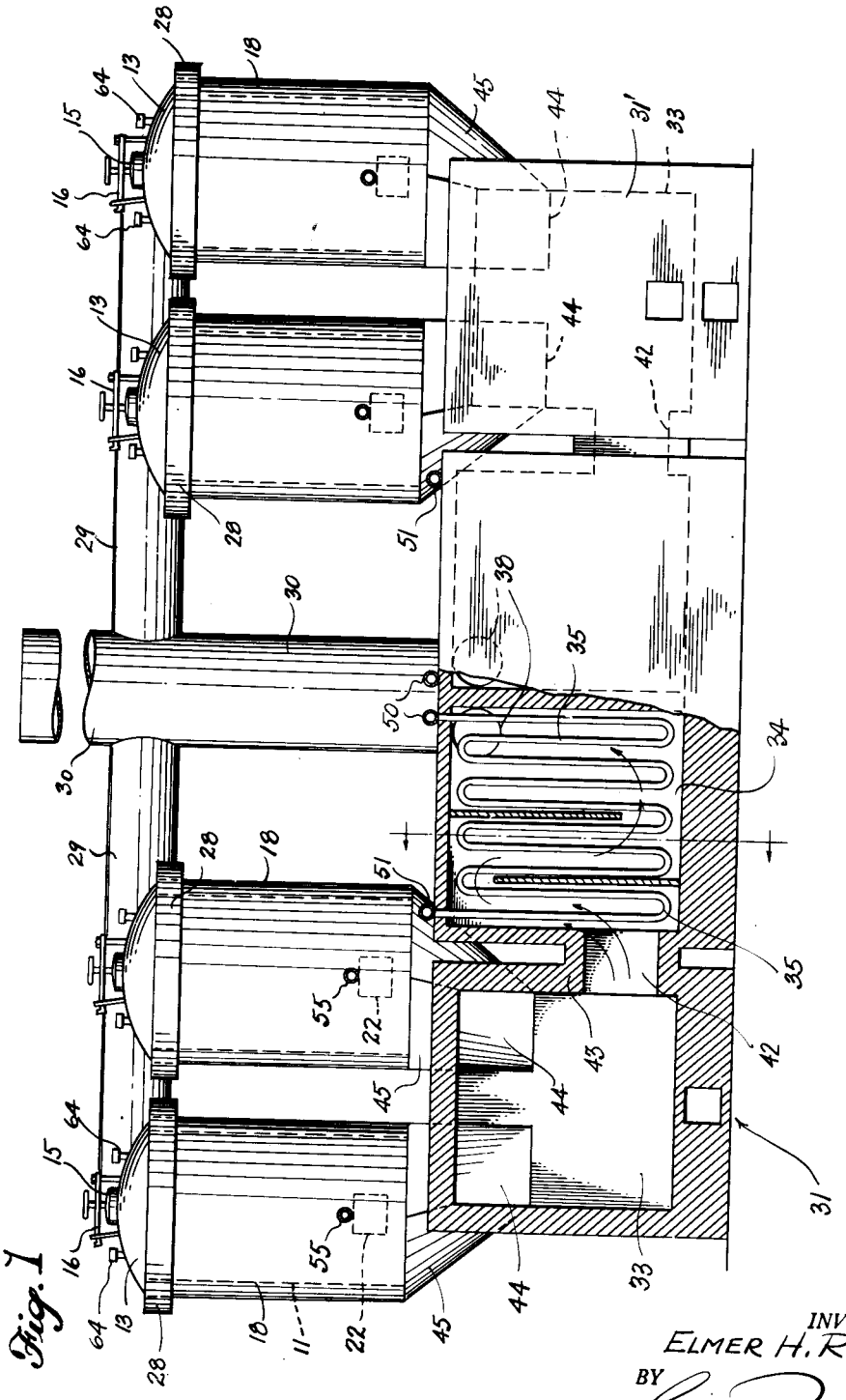


Fig. 1

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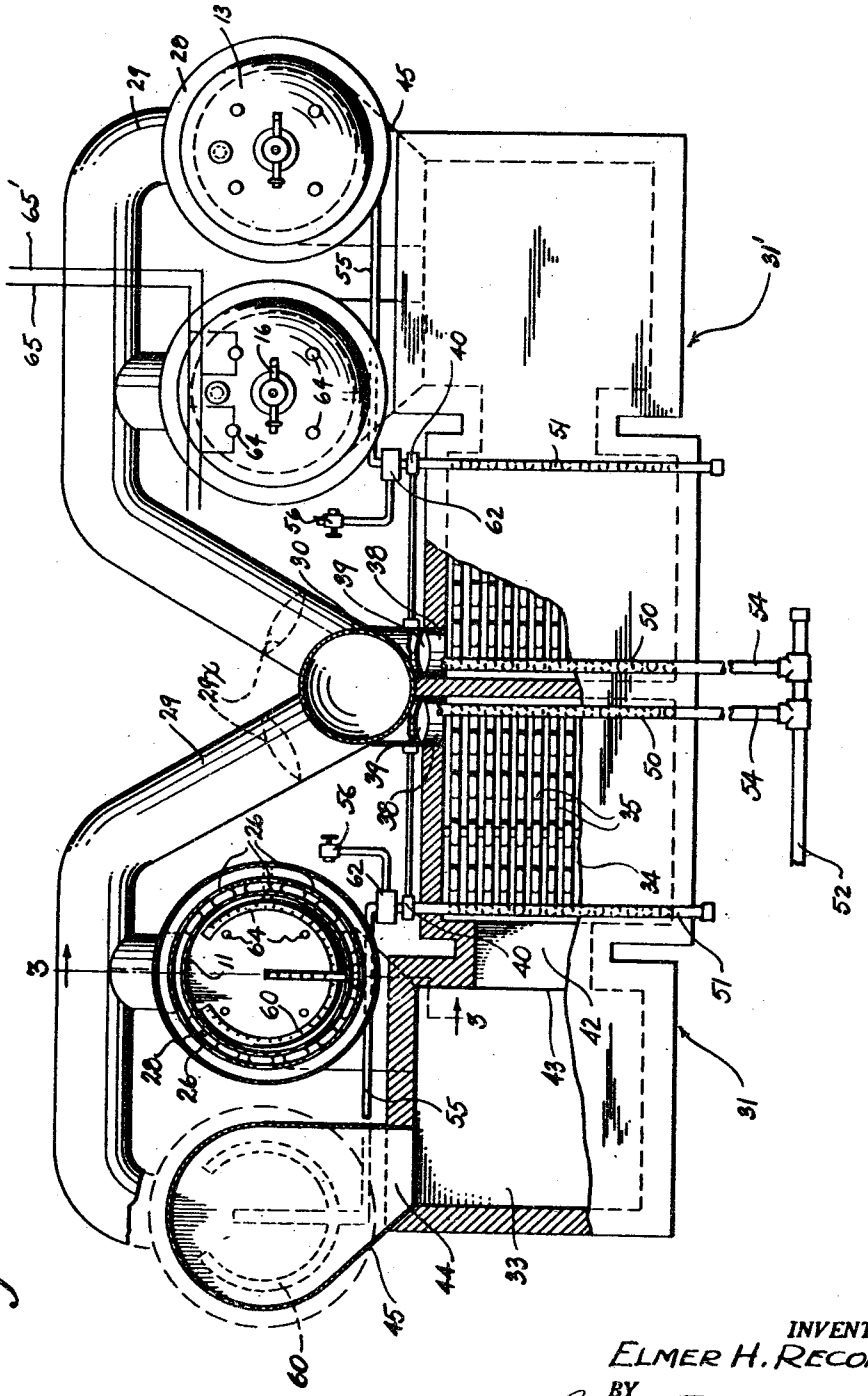


Fig. 2

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4 Sheets-Sheet 3

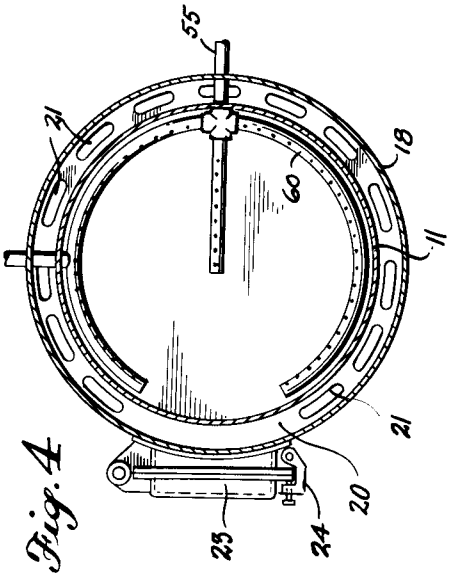


Fig. 4

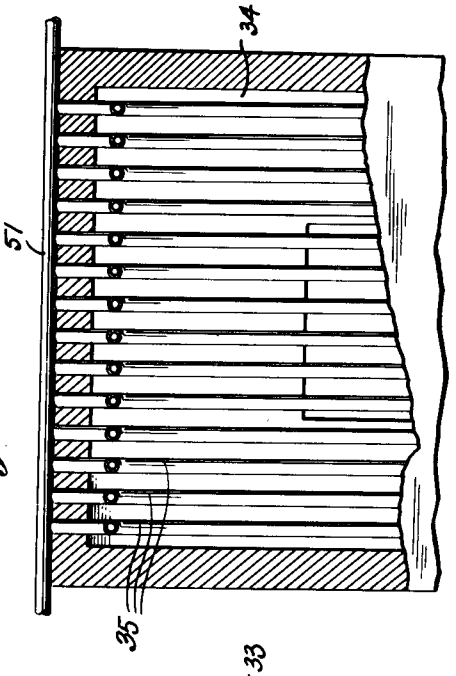


Fig. 5

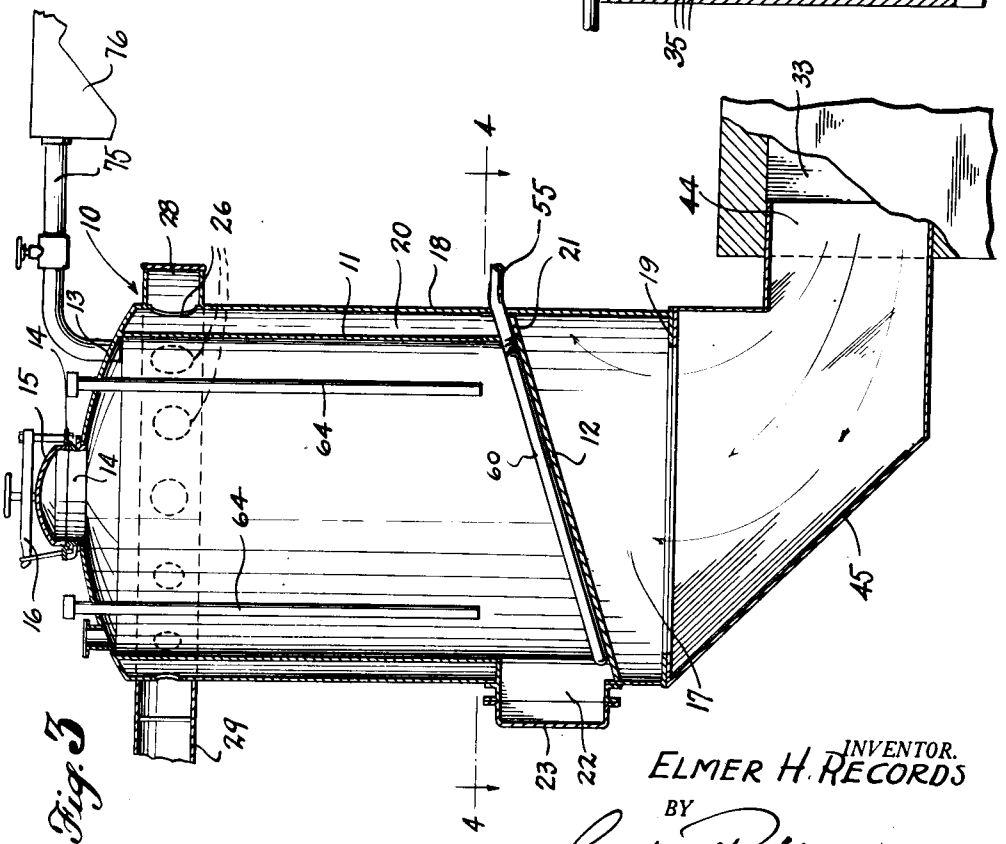


Fig. 3

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Fig. 7

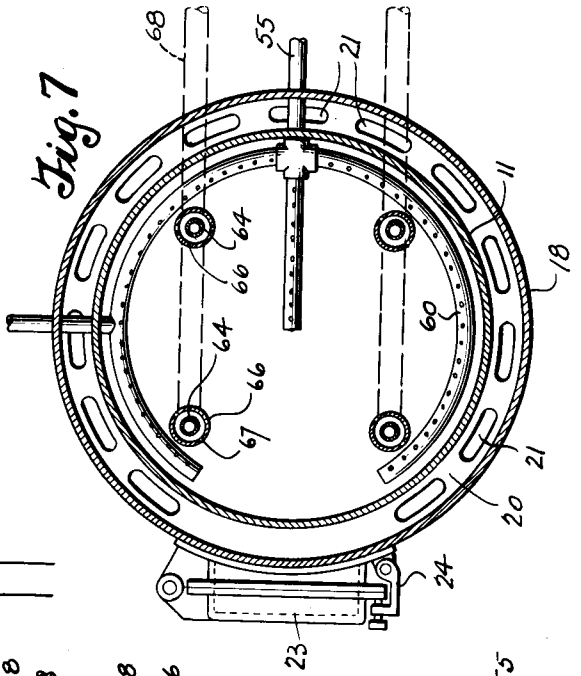
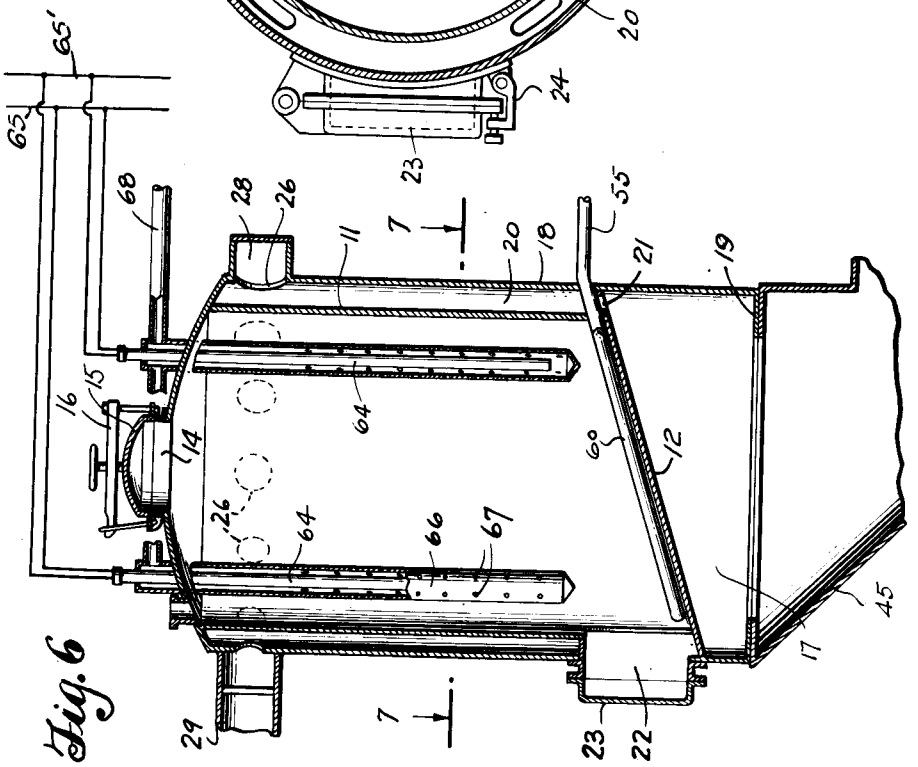


Fig. 6



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UNITED STATES PATENT OFFICE

2,689,213

APPARATUS FOR TREATING AND CALCINING CARBONACEOUS MATERIALS

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Application August 24, 1950, Serial No. 181,286

3 Claims. (Cl. 202—106)

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This invention relates to retorts and associated apparatus designed for the calcining and heat treating of various carbonaceous materials for the recovery of useful by-products therefrom. More particularly, the invention relates to improvements in apparatus of the general character of that of my prior application that matured into U. S. Patent No. 2,385,731, and the apparatus of my co-pending application, filed on June 26, 1948, under Ser. No. 35,327 and which matured into United States Patent No. 2,586,862, in each of which applications the use of an inclined retort is described and illustrated.

It is the principal object of this invention to provide improvements in apparatus of the above character provided for the heat treating of oil shale, tar sand, coal, wood and similar carbonaceous materials, for the recovery therefrom of oils, vapors, hydro-carbons and other useful by-products. Furthermore, to provide a treating apparatus that is designed to avoid or to overcome those difficulties or disadvantages that occur by reason of the use of inclined or sloping retort chambers, and the heat shrinkage of the charge and the gas channeling thereof that follows the shrinkage.

It is also an object of this invention to provide certain improvements in the use of superheater coils in the retort furnace for the production of superheated steam, and in a means for the automatic control of flow of hot gases about the superheater coils to maintain the temperature of superheated steam at a predetermined degree.

Further objects of the invention reside in the details of construction and combination of parts, and in the mode of operation of the apparatus to insure more uniform and complete carbonization of the treated material to any desired degree of residual volatile matter.

In accomplishing the above mentioned and other objects of the invention, I have provided the improved details of construction, the preferred forms of which are illustrated in the accompanying drawings, wherein—

Fig. 1 is an elevation of apparatus embodied by the present invention; one of the furnaces being shown in vertical section for better understanding of the character and location of the steam superheating coils.

Fig. 2 is a plan view of the same, with parts broken away for better illustration of the retort and furnace.

Fig. 3 is a vertical, cross-sectional view of one of the retorts; this being taken on line 3—3 in Fig. 2.

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Fig. 4 is a horizontal section taken on line 4—4 in Fig. 3.

Fig. 5 is a cross-section of a furnace, showing the superheater coils therein.

Fig. 6 is a vertical section of a retort equipped with superheaters.

Fig. 7 is a cross-section on line 7—7 in Fig. 6.

Present day needs in both the ferrous and non-ferrous industries, for industrial carbon with varying specifications, have stressed the desirability for better facilities not only to meet the present, but also to meet future demands. This invention, therefore, has been developed with the idea of meeting these demands.

In so far as the present method of treating carbonaceous material is concerned, it is substantially in accordance with the method followed in my previously mentioned patent and co-pending application, and will not herein be described in detail. However, the present apparatus embodies certain improvements which have been illustrated and will be fully described.

Referring more in detail to the drawings—

In Figs. 1 and 2, I have illustrated a typical installation of retorts and furnaces for an oil shale treating operation. The apparatus herein shown includes four retorts, arranged in banks of two each; each bank being served by a furnace of Dutch oven type and the two furnaces are connected to a stack common to both of them. It is to be understood, however, that one or more retorts could be used with each furnace and that details of construction might be varied in accordance with requirements for the particular material being treated. The retorts and furnaces here shown are substantially alike in construction and mode of use, and therefor the following description, as applied to one unit, will be understood to apply equally to the others.

As distinguished from the use of an inclined retort, as shown in the apparatus of my above mentioned U. S. patent, the present apparatus employs vertically disposed retorts. This change from inclined to vertical is made in order that the difficulties and disadvantages that have been found to result from the gas channeling of material after heat shrinkage in an inclined retort will be avoided. Each retort is herein designated in its entirety by reference numeral 10, and, as best shown in Fig. 3, comprises an inner, vertically disposed cylindrical vessel 11, in which the charge of carbonaceous material is to be contained for treatment. This vessel is equipped with a flat, inclined bottom 12, which serves as a support for the vessel as presently understood, and with an upwardly crowned upper end wall 13 closing

the upper end of the retort; this latter wall being formed centrally with an opening 14, through which the chamber is charged, and which opening is fitted with a removable closure member 15. The closure member is adapted to be secured in a closed position by any suitable means such as the clamping bar 16.

The retort vessel 11 is enclosed within and is coaxially of a cylindrical shell 18. This shell extends somewhat below the bottom forming plate 12 of the vessel 11 and rests at its lower end on a flat, annular plate 19. The inside diameter of the plate 19 is substantially equal to the full diameter of the vessel 11. At its upper end, the shell 18 is closed by the peripheral portion of the top wall 13 that closes the upper end of the vessel 11. The shell 18 is so disposed about the vessel 11 as to define an annular passage 20 between them. At its lower end, this annular passage communicates with the open lower end of the shell through a succession of openings 21 formed in the peripheral portion of the plate 12; it being shown in Figs. 3 and 4 that the plate 12, which supports and also serves as a bottom for vessel 11, continues to the walls of shell 18 and is welded thereto. Thus plate 12 sets off a compartment 17 in the lower end portion of the shell. The vessel 11 is equipped at its lower end with a lateral discharge opening 22 located adjacent the lower edge of the bottom wall 12, as shown in Fig. 3, and this opening has a hinged door 23 fitted thereto equipped with locking means 24.

Hot gases, that are supplied as presently described, to the annular space 20 between the shell 18 and vessel 11 through the lower open end of the retort and chamber 17 are discharged from the upper end of the shell through openings 26 therein, into a manifold 28 that surrounds the upper end portion of the retort. A duct 29 leads from the manifold to a stack 30 which is shown in Fig. 2 to be so located as to accommodate the four retorts and two furnaces that are associated with the retorts. Normally open dampers 29x are located in ducts 29 near the stack.

The two furnaces which supply heat for the present two banks of retorts, are in Figs. 1 and 2, designated, respectively, by reference numerals 31 and 31'. Each is of Dutch oven type, being divided to provide a fire box 33 and a combustion chamber 34 at one side of the firebox; the said chamber serving as a superheater chamber in which multiple pipe coils 35 are contained for the superheating therein of steam used in the treating of the carbonaceous material in retort vessels 11.

Leading through the back wall of chamber 34 into the stack 30, as shown in Fig. 2, is a passage 38, fitted with a thermostatically controlled damper 39. The thermostat for control of this damper, as presently explained is located at the discharge end of the superheated steam delivery pipe and in Fig. 2 is designated at 40. When the damper 39 is open, some gases of combustion will flow from the fire box 33 through an opening 42 in the oven bridge wall 43 into the chamber 34, to heat the superheater coils, as presently explained. Most of the hot gases of combustion flow directly from the fire box 33 through openings 44 in its back wall, into ducts 45—45 that lead, respectively, to the open lower ends of the two retort shells associated with the furnace.

The superheater coils contained in the combustion chamber 34 and designated at 35, are connected at their ends to horizontal headers 50 and 51 that extend transversely of the chamber 34 and immediately thereabove, as noted in Fig. 2. The coils 35 are disposed in closely arranged vertical banks. Saturated steam is supplied from any suitable source of supply, here indicated as pipe 52, through a pipe 54 to the header 50 and the superheated steam is delivered from the header 51 through connecting pipe 55 to a diffusion pipe or header 60 located in the base of the chamber 11, closely overlying the bottom plate 12 as understood by reference to Figs. 2, 3 and 4. The diffusion pipe is formed with a multiplicity of small discharge ports from which the superheated steam is delivered upwardly into the charge of material. As noted in Fig. 4, the diffusion pipe does not interfere with outflow of material from the chamber 11 to the discharge opening by reason of terminating short of the opposite sides of the opening.

The pipe 55 through which superheated steam is conveyed from the header 51 to the diffusion pipe 60 leads through an electrically heated superheated steam booster, here designated at 62, that may be used as and when needed for high temperature steam production for calcining operations. This electric device may be of any suitable kind suitable for increasing the temperature of the superheated steam to a degree substantially above that possible to attain by the gases of combustion in chamber 34. The use of this booster will later be explained.

Located in the retort chamber as shown in Fig. 3, are four vertically directed, electrically heated bayonets 64. These extend through and down from the top wall of the retort into the charge of material contained therein. Electric current for heating the bayonets may be supplied thereto from any suitable source of supply, designated in Fig. 2 by the wires 65—65'.

The intended method of operating the apparatus above described for recovery of certain by-products is as follows:

The discharge door 23 of the retort chamber 11 is closed, and the chamber is then charged through its top opening 14, with the carbonaceous material to be treated. The top opening is then covered by the closure member 15 which is then secured by the clamp bar 16. Usually the retort is charged to about three-fourths the capacity of chamber 11.

The furnace is then fired, causing the combustion gases from the fire box 33 to flow through the outlets 44 and ducts 45 to the retorts, through the chamber 17 and upwardly through the openings 21 in plates 12 into the annular spaces 20 between shells 18 and chambers 11, thus to heat the retort chambers and charges of material therein. From the upper end of each of the annular passages 20, the gases flow through the shell openings 26 to the manifold 28 and thence through the duct 29, past a normally open damper 39x therein, to the stack 30.

It will here be explained that the openings 21 in plate 12 are so graduated in size, from a point nearest the outlet from oven chamber 33, that the distribution of hot gases about the chamber 11 will be equalized. This has been illustrated in Fig. 4. Also, it is to be explained that baffles can be arranged in the shell space 20 about the chamber 11, as may be required to insure an equal distribution of the upflowing hot gases about all sides of the retort prior to their outflow to stack 30.

In the firing of the furnace, a part of the gases

of combustion may flow from chamber 33, through the oven wall opening 42 into chamber 34, and to the stack 30 through the passage 38 under control of the damper 39. The damper 39 is controlled by the thermostat 40 in such way that when the steam as supplied to the retort from the superheated coils reaches a certain predetermined high degree of temperature, the damper will be moved from an open position toward a closed position. This retards the flow of gases through chamber 34 and the heating effect of the coils is thus reduced accordingly. Likewise, when the steam temperature falls below a certain degree, the damper is opened to permit the heating of coils to be increased accordingly. By reason of this automatic control of the damper 39, by thermostat 40, in accordance with the temperature of superheated steam at the point of discharge to the retort, the heating of the coils will be so regulated as to insure a uniform temperature of superheated steam as ordinarily used.

It will here be explained that during the initial or starting up period, before and while the temperature of superheated steam is being brought up to a desired degree, the steam from pipe 55 is discharged to atmosphere through a discharge valve indicated at 56 in Fig. 2, but when the desired degree has been reached, then the valve is closed and the steam caused to be discharged to the distribution header 60. After that, the steam temperature is under automatic control of thermostat 40 and damper 39.

Heat is supplied to the retort directly from the furnace, chamber 33 and as supplied to the charge by the steam injection effect the treatment of material for recovering of useful by-products as has been explained in my prior patent and application. Oven controls are so set as to maintain a working temperature of about 1000° F.

The treating of the charge of carbonaceous material in the chamber 11 under action of heat as supplied by the gases of combustion in the annular space 20, and superheated steam supplied from header 60, is continued until the treatment has been completed.

Upon completion of treatment, the temperature of the superheated steam is decreased to 700° F. by setting the thermostat control down to the point and the superheated steam by-passed to atmosphere. The retort contents is quenched by means of saturated steam. The retort is then unloaded and reloaded with new material and retort closed when superheated steam is again turned in and control of superheated steam set at 1000° F.

It will be understood that by reason of the direct discharge of gases of combustion from the combustion chamber 33 of the oven, the heating of the retort can be maintained regardless of the requirement for steam generation or of variations in steam temperature.

I also have made provision in the present apparatus for calcining material in the retort by use of electrical heating devices located in the retort. In one type of installation, as shown in Fig. 3, the electric bayonets are employed in direct contact with the change of material. In another type of installation, which may be considered the preferred type, as shown in Figs. 6 and 7, the bayonets are used in association with means for effecting the boosting of temperature of superheated steam as supplied from the superheater coils.

First referring to the disclosures of Figs. 3 and 4; should it be found desirable at the end of the usual treating operation, to calcine the charge, the temperature of steam as brought to a certain degree of superheat in the battery of coils 35, is boosted by additional heating in the electric booster heater 62. This can readily elevate the steam temperature from the usual degree of around 1000° F. to a temperature within a range of from 1400° F. to 1600° F., as may be desired or required for any specific use of the treated material. Also, along with the increase in temperature of superheated steam, the charge is additionally heated by passing current through the electric bayonets 64 until the desired temperature of outgoing gases has been attained.

In lieu of using the bayonets, as shown in Fig. 3, it is preferred for the treating of various materials to utilize the bayonets 64 for a further boosting of temperature of superheated steam, either as supplied from the header 51, or as supplied to the retort after its passage through the booster heater 62. For this latter use, the construction illustrated in Figs. 6 and 7 is employed. In these views it is shown that the bayonets 64 are enclosed within tubular housings 66. These extend the full length of the bayonets and pass through the top wall of the retort and are there supplied at their upper ends with steam from header 51, delivered through pipe 68, either before or after passing through the booster 62. The housings are spaced from the bayonets to provide steam heating space and the steam is discharged from the housings through perforations 67. Steam temperatures may in this way be substantially increased for quick and effective calcining operations.

Vertical retort chambers eliminate gas channeling of charges since there is no horizontal shrinkage that would permit free upflow of gas between charge and retort walls. The apparatus is simple in construction, effective and efficient in its use.

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

1. Apparatus for the treatment of carbonaceous materials comprising in combination, a furnace having a firebox and a combustion chamber, a stack connection adapted to receive hot gases direct from the combustion chamber, a housing forming a closed, vertical retort chamber, gas and vapor off-taking means leading from the upper end of the retort chamber, a steam distributing header located in the lower end of the chamber, steam superheater coils in the combustion chamber of the furnace, means for supplying steam to the coils for superheating and means for delivery of superheated steam therefrom to the said steam distributing header, a shell enclosing the housing which forms the retort chamber and defining a gas chamber thereabout, means for conducting gases of combustion from the furnace firebox into the shell for heating the retort chamber, steam distributing tubes disposed in the upper end portion of the retort chamber, means for supplying steam thereto from the superheater coils, and means for boosting the temperature of superheated steam as delivered thereto; tubular elements extending downwardly into the retort chamber from its upper end to near its lower end, means for supplying steam thereto from the said superheater coils, and electrical heating elements contained in the said tubular elements for boosting the temperature of steam delivered thereinto;

said tubular elements being perforated for the dissipation of the steam of boosted temperature therefrom into the charge contained in the retort.

2. Apparatus for the treating of carbonaceous materials, comprising in combination, a furnace of Dutch oven type having a firebox and a combustion chamber, a stack arranged to receive hot gases, direct from the said combustion chamber, a housing forming a closed, vertical retort chamber, with a charging inlet at its upper end and an unloading outlet at its lower end, valve controlled gas and vapor off-taking means leading from the top end of the retort chamber, a steam distributing means located in the bottom of the chamber, steam superheater coils in the combustion chamber of the furnace, a source of supply of steam connected with said coils to supply steam thereto, means connecting said coils with said steam distributing means in the retort, a shell enclosing the retort with clearance between them defining a gas chamber, means connecting the said chamber at its upper end with the said stack, means for conducting gases of combustion from the furnace firebox into the lower end of the shell for heating the retort chamber, tubular elements extending downwardly into the retort chamber from its upper end to near its lower end, means for supplying steam thereto from the said superheater coils, and electrical heating elements contained in the said tubular elements for boosting the temperature of steam delivered thereinto; said tubular elements being perforated for the dissipation of the steam of boosted temperature therefrom into the charge contained in the retort.

3. In an apparatus for the treating of carbonaceous materials; a closed vertical retort chamber, with charging inlet and unloading outlet, and equipped with gas and vapor off-taking means, a steam dissipating header in the bottom of the chamber, a source of supply of superheated steam, a shell enclosing the retort chamber, means for supplying heated gases into the shell to heat the retort chamber, tubular elements extended downwardly into the retort chamber from its upper end to near its lower end, means for delivering superheated steam from said source of supply to said header and into said tubular elements, and electrical heating means within the said tubular elements for boosting the temperature of steam therein; said tubular elements being perforated for the dissipation of steam of boosted temperature into the charge under treatment.

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