

April 16, 1946.

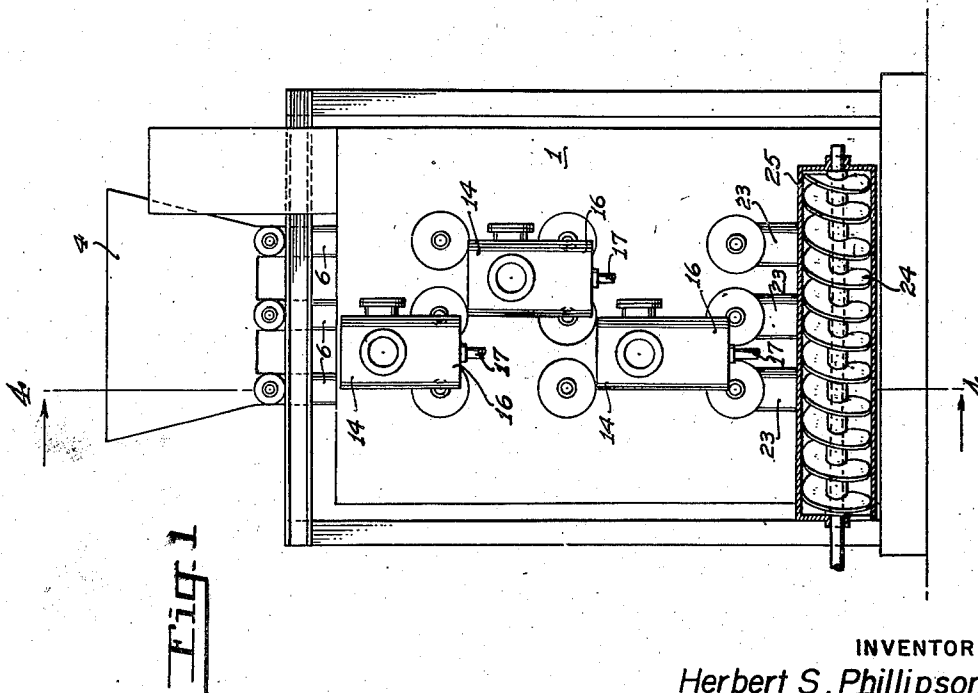
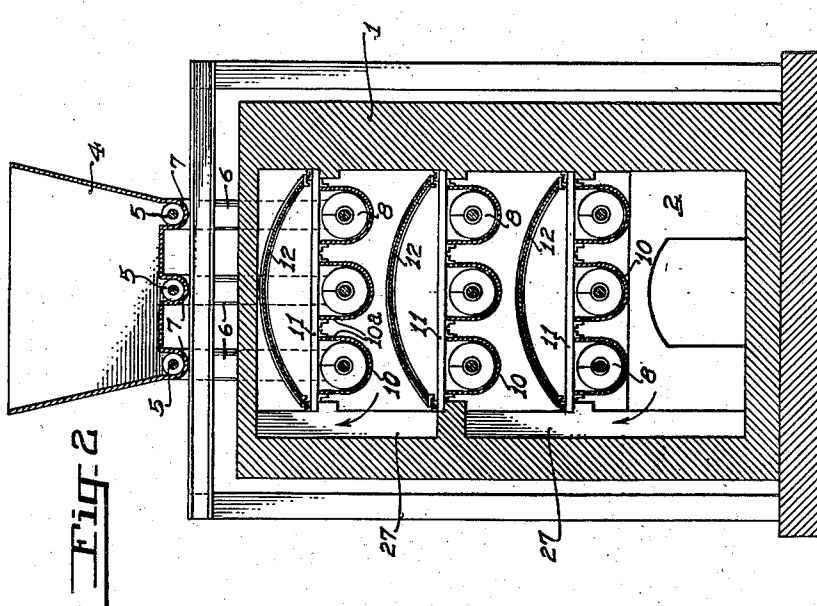
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2,398,446

RETORT

Filed Aug. 5, 1943

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

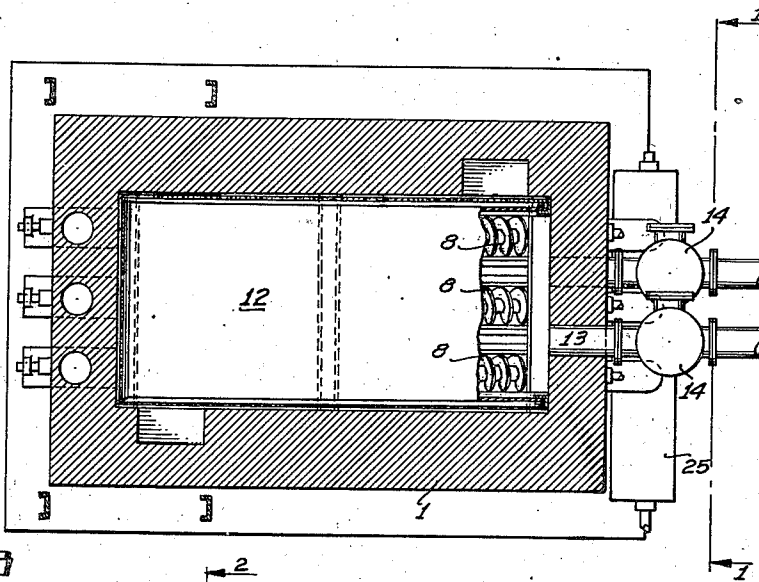


Fig. 3

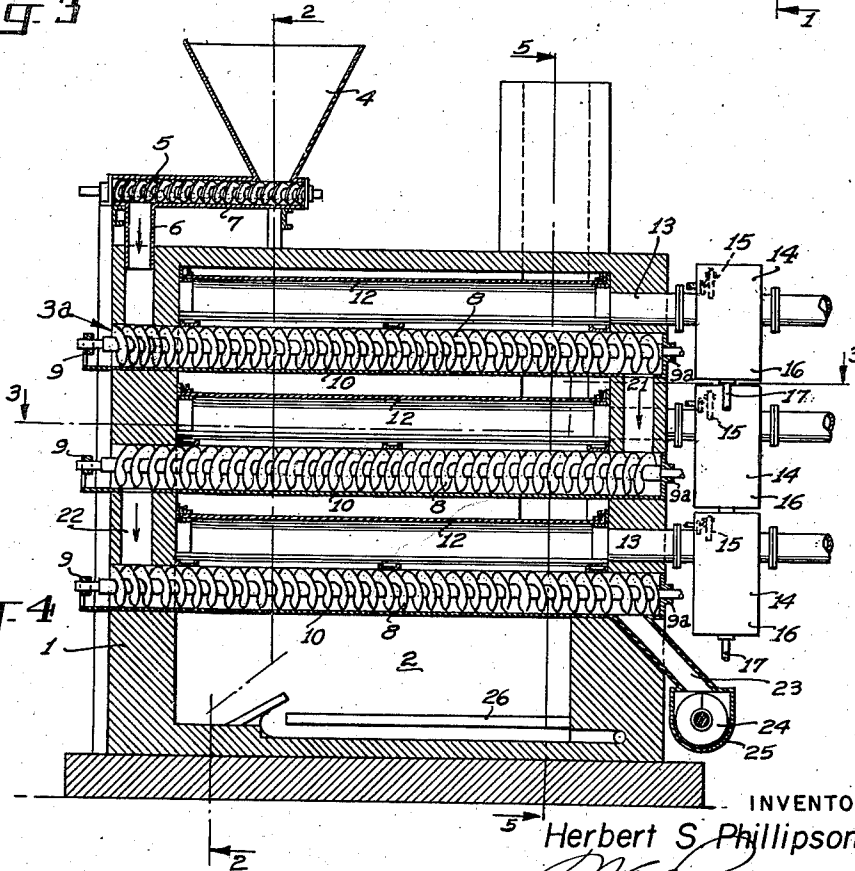


Fig. 4

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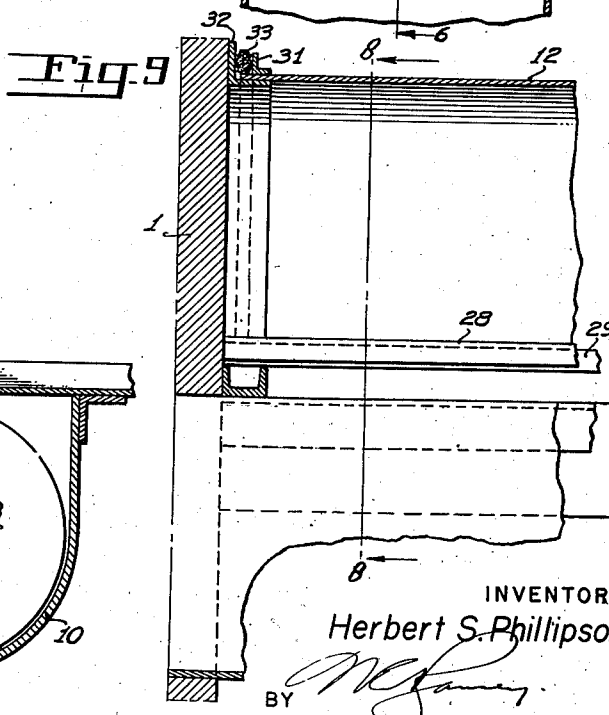
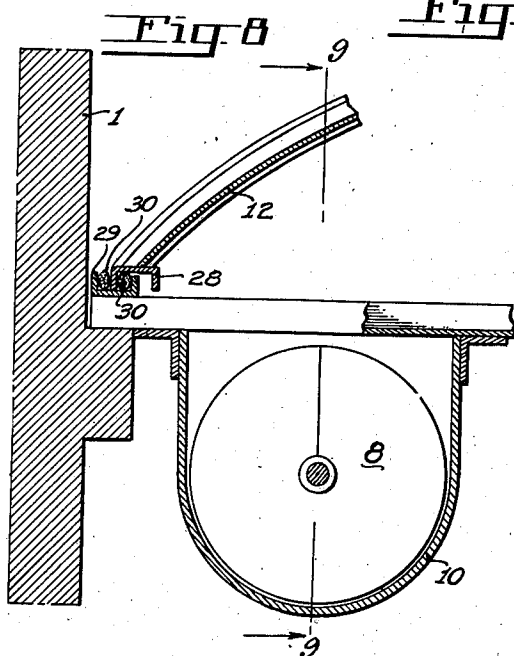
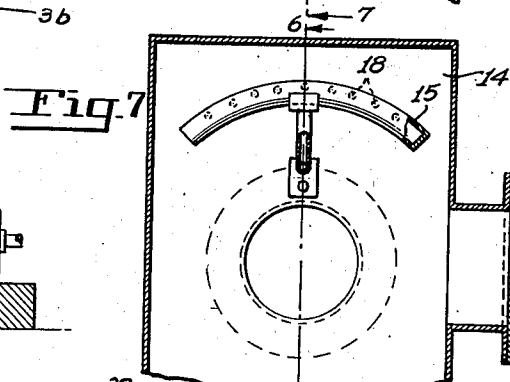
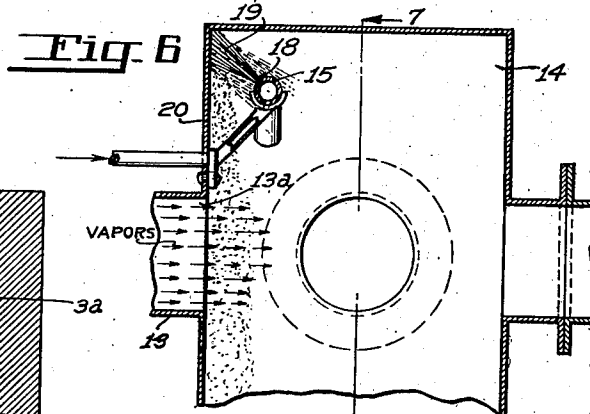
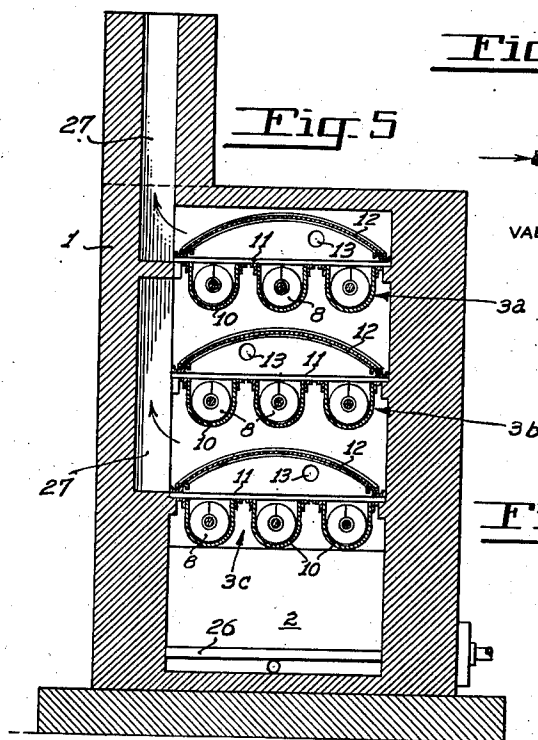
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,398,446

RETORT

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Application August 5, 1943, Serial No. 497,452

13 Claims. (Cl. 202-118)

My invention relates generally to retorts for carbonizing comminuted carboniferous materials. It has specific application to that type of retort for treating sawdust and other forms of mill waste so as to form charcoal therefrom.

One of the particular objects of my invention is to provide a retort of this character in which the mill waste may be treated in successive stages and the volatile materials may be removed at said stages before "cracking" occurs, which forms a gummy residue. Said gummy residue tends to lodge in the conveyor parts and requires said parts to be cleansed after relatively short runs because it is not discharged with the char and partially from the charred materials as they flow from course to course.

A retort of this character normally comprises a masonry housed combustion chamber with a fire on the grates at the lowermost portion thereof. A series of vertically stacked courses extend across said chamber, and the material being treated enters from the upper portion and flows successively downwardly through said courses. Thus, as the material approaches the fire, it is subjected successively to increasing temperatures. Thus, if the most volatile substances are removed immediately as they pass into a vapor stage, they are not subjected to the increasing temperatures as the carboniferous materials from which they are distilled are subjected to said higher temperatures.

A further and more specific object of my invention is to provide means at the points when said vapors are removed which reduce the temperatures of said vapors substantially, and also tend effectively to prevent the return flow of said vapors into the course of the retort from which they have been removed. To this end I provide a spray which flows transversely of the flow of vapors at the point where they are removed from the retort. Said spray preferably is a water spray which is of substantially lower temperature than the vapors removed. This causes the vapors to be immediately cooled and said screen effectively blocks their return flow.

A further object of my invention is to provide a retort of this character with horizontally disposed courses, including a plurality of screw-type conveyors with a common overlying dome element. To accommodate differential expansion, said courses must be provided with means for preventing the walls of the retort from being subjected to rupturing strains of sufficient amplitude which would permit leakage of vapors at such point. This specific object of my invention is

attained by making said vapor dome independent of the remainder of the walls of said horizontally disposed courses and joining said dome to the remainder of said walls by a yielding, resilient sealing joint. Thus, differential expansion may be accommodated at this point by said yielding, resilient sealing joint to prevent rupturing strains from being set up.

Further and other details of my invention are hereinafter described with reference to the accompanying drawings, in which:

Figure 1 is a vertical elevation of a retort embodying my invention, taken substantially on the line 1-1 in Figure 3;

Figure 2 is a transverse sectional view taken on the line 2-2 in Figure 4, illustrating by arrows the manner in which the heating gases flow upwardly about the successive stacked horizontally disposed courses;

Figure 3 is a longitudinal section through said retort taken substantially on line 3-3 in Figure 4;

Figure 4 is a longitudinal section through said retort taken on the line 4-4 in Figure 1;

Figure 5 is a sectional view taken substantially on the line 5-5 in Figure 4;

Figure 6 is an enlarged sectional detail, partially diagrammatic, taken on the line 6-6 in Figure 7, illustrating the manner in which a water screen is formed about the discharge end of a vapor duct at one end of a horizontally disposed course;

Figure 7 is a view similar to Figure 6, taken on the line 7-7 in said Figure 6;

Figure 8 is an enlarged detail view illustrating the manner in which the parts of a horizontally disposed course are formed to accommodate the differential expansion between the dome and the remainder of said course, said figure being taken on the line 8-8 in Figure 9; and

Figure 9 is a sectional view taken on a similar scale to that to which Figure 8 is taken, said figure being taken on the line 9-9 in Figure 8.

A retort embodying my invention is adapted to be housed in a masonry form 1, defining a fire box 2 therein. Extending transversely of said fire box is a series of horizontally disposed courses 3, in which comminuted material may be contained and moved successively through said fire box. A hopper 4 arranged at the top of said form is adapted to receive continuously a quantity of material to be carbonized. Preferably, I provide some conveying system (not shown) for keeping said hopper more or less full of material. Said hopper has a feed screw 5 arranged to discharge

the material from said hopper to a vertically disposed conduit 6, leading to the uppermost horizontal course, as is shown most clearly in Figure 4. Said feed screw 5 fits quite tightly within its housing 7, and thus said screw and its housing tend to prevent atmospheric air from being introduced at this point. That is, of course, a certain amount of air is introduced with said comminuted material in the interstices between particles. The amount of air introduced at this point is maintained at a minimum, and said hopper is of substantial depth so that substantial compression of material is maintained adjacent said feed screw to reduce said interstices and voids to a minimum.

I preferably make said retort with a plurality of feed screws and housings, as is shown in Figure 2, and cause them to discharge into a plurality of conduits 6, each leading to a feed screw 8 in the uppermost course 3a in said retort. Said feed screws are journaled in bearings 9-9a at the ends thereof and lie within troughs 10, formed in the floor 11 of the course. Said floors and a dome 12 overlying said feed screws are substantially impermeable except at such points where material is permitted to flow to the course, material permitted to be discharged therefrom, and a conduit 13 opening from the dome and permitting vapors to be discharged therefrom.

Said troughs fit quite tightly about the feed screws except that their marginal walls 10a are straight and lead upwardly to a point substantially above the top of the feed screw, as is shown most clearly in Figure 2. Said troughs are adapted to be filled with material to be acted upon and the feed screws move said material horizontally by their action and virtually churn said material as it passes along said troughs. This is quite important because it causes the material to be heated uniformly and also permits the vapors generated to be released quickly from the material as said vapors form. Said vapors being generated rise above the material in the troughs and are retained within the dome 12. They are permitted to flow outwardly through duct 13, which leads to a condenser or other devices in which they are captured and thereafter treated. Said auxiliary condenser or other treating devices play no part in my invention, and they are thus not illustrated. It is common practice also to provide some fan or other blowing or sucking device for accelerating the flow of vapors from said duct 13, said flow-producing devices being common and unimportant so far as my present invention is concerned, are also not illustrated as they would readily suggest themselves to persons skilled in the art.

Said duct 13 discharges into a heat arresting chamber 14, which I deem to be one of the important parts of my invention. Said chamber has a water spray head 15 arranged therein, which projects a screen of water laterally across the discharge end 13a of duct 13. Thus as the vapors are withdrawn from the dome 12 through the duct 13, they are caused to flow through said water screen, as is illustrated in Figure 6. The water is maintained at relatively low temperatures, such for example as 65° F., and the vapors which come off from the uppermost course 3a, may have a temperature of 250° F. The vapors are immediately chilled as they pass through the water spray head and partially condensed. In said uppermost course also the moisture of the material being treated is vaporized and said water vapor also condenses in said spray, coalesces

therewith and is removed with said spray through a sump 16 at the bottom of the chamber 14. A discharge pipe 17 leading from said sump 16 directs the spray water and condensate away for separation, and waste of the water or other products having no value.

Because of the fact that the temperature of the vapors is suddenly reduced in said heat arresting chamber, said vapors partially or wholly condense and most of said condensates are sticky semi-fluids. They ordinarily tend to collect upon the interior of the walls of said chamber and upon the spray head therein. I have discovered, however, that said condensates do not tend to collect upon a wetted surface. For this reason, it is important, in my belief, to cause said spray to maintain the inner surfaces of said heat arresting chamber wetted to prevent the adhesion of said sticky condensates. To this end, I arrange said spray head as an arcuate member extending above the upper margins of duct 13, as is shown most clearly in Figure 7, and having orifices 18 discharging jets 19 obliquely upwardly. The wall 20 of the heat arresting chamber 14, which lies immediately exteriorly of the discharge end of duct 13, serves as a baffle or deflecting wall against which said jets are projected. As is shown in Figure 6, said jets strike said baffle wall and the roof of the chamber 14, and are deflected back over the spray head and water falls as a finely divided mist or spray across the discharge end 13a of said duct 13. That is, said screen of finely divided water is of substantial depth and extends from the plane of the spray head to the plane of the discharge end 13a of duct 13. Said planes are quite widely separated, a distance of six inches is deemed sufficient in most instances. Thus, said water spray is six inches or more deep, and thus when the vapors pass through said water screen, a substantial time interval elapses for permitting heat exchange, which produces a substantial temperature drop in the vapors as they pass through said water screen. Said water screen also falls with substantial velocity and the path of said falling particles of water is transverse of the path of the vapors. Said screen thus tends to prevent the re-entry of said vapors into the courses of the retort and they are thus effectively removed and blocked out of said retort after they enter the heat arresting chamber.

In my drawings, I have shown three vertically stacked courses 3a, 3b, and 3c. Inasmuch as the courses are substantially identical to the uppermost course 3a, which has previously been described, I will give similar reference characters to the parts of the middle and lowermost courses.

It is to be noted in Figure 4 that a conduit 21 leads from course 3a to course 3b but at the opposite end thereof. A conduit 22 leads from the left hand end of the middle course 3b to the corresponding end of the lowermost course 3c. A discharge conduit 23 leads from the right hand end of course 3c to a discharge screw conveyor 24. It is to be understood that the conduits 21, 22 and 23 correspond in number to the conveyors in the separate courses, and thus, as is shown in Figures 1 and 2, there are three such conduits and three such conveyors in each case. There is but a single discharge screw conveyor, however, into which all of the conduits 23 discharge. Said conduits 23 are substantially smaller in cross sectional area than that of the housing 25 of the discharge screw conveyor 24. Said conduits 23 also descend obliquely into the housing 25. My purpose in arranging said conduits 23 in this

manner and proportioning them as aforesaid is that the charcoal discharged from the lowermost conduit thus is massed to prevent seepage of air into said conduits or into said housing 25. Air introduced at this point where the charcoal is hot would tend to support combustion of the latter, and also might infiltrate upwardly so as to be withdrawn with the vapors from the dome of the lowermost course 3c.

It is to be understood that a fire is built upon grates 26 and thus the flame is in close proximity with the under portions of the lowermost course 3c. The products of combustion are permitted to move upwardly through flues 27 formed in the masonry walls and about the successive horizontally disposed vertically stacked courses. Said heated products of combustion are directed by said flues 27 to move upwardly about and lengthwise of the courses. That is, said gases strike the undersurface of each of the courses and move about one end and over the top of the dome of the underlying course. Thus, the gases entrapped within said latter dome are maintained heated substantially at the same temperature as are the comminuted particles arranged in the conveyor, from which particles said vapors have been driven. Thus, the dome is heated to a corresponding but slightly lower temperature to that at which the comminuted materials are being subjected, and said dome thus does not provide a cold spot for collecting and condensing said vapors. As is thus apparent, said materials flow downwardly through the successive courses, descending from course to course, and the products of combustion flow upwardly through the fire box sweeping along the upper and lower surfaces of the courses but in the opposite direction.

There is necessarily some difference in temperature because a portion of the heat is subtracted by the comminuted material, and thus the dome on each course is heated to a lesser degree than the bottom portions thereof. If this difference in temperature were substantial, rupturing strains might be set up due to differential expansion which would tend to produce fissures or cracks in a course and permit the vapors to escape and intermix with the products of combustion. To prevent said rupturing strains from being induced, I form the dome as a separate piece from the remainder of the course. Said dome ends in a U-shaped footing 28, which nests within a correspondingly shaped but opposed U-shaped member 29. Lying between the opposed outstanding legs of said members 28 and 29 respectively is asbestos packing 30. Said packing is yielding and resilient so as to accommodate any movement of the dome with respect to the remainder of the course. Although I prefer to use asbestos packing, I do not wish to limit myself thereto, because any type of yielding, resilient heat-resisting sealing material is satisfactory. As is shown in Figure 8, there are two ropes of packing, one lying at each side of the outermost depending flange of the U-shaped footing 28, said ropes lying immediately inside of the two upstanding legs of the U-shaped member 29. Thus, when the dome tends to expand, it tends to move toward the left, as viewed in Figure 8, to compress the left hand packing member and to permit the right hand packing member to expand. When the dome tends to contract relatively, an opposite situation occurs. In either event, the resiliency of said packing tends to maintain an air tight joint at this point. At the ends of said dome, I arrange an angle member 31 and a face

plate 32. Thus, when the dome tends to elongate longitudinally, it is permitted to do so because it will be noted that there is a slight space at the end of said dome. A rope of resilient yielding heat-resisting packing 33, preferably asbestos, is arranged to maintain a heat seal at this point but to accommodate said relative movement.

Although my invention is illustrated as being adapted for a continuous feed, I wish it to be understood that it is also adapted for a batch feed, although I consider continuous feed to be preferable. I have described my invention in connection with the charring of mill waste. The primary end to be obtained by a retort of this character is to produce charcoal and to collect and utilize the volatile products driven off therefrom. Said charcoal is treated in a retort in which the mill waste is subjected to a temperature of approximately 250° F. in the uppermost course 3a, a temperature of approximately 500° F. in the middle course, and a temperature of approximately 750° F. in the lowermost course. However, if the retort was used for treating shale or other materials, different temperatures would be utilized. In shales, the desired product is the volatile material, and the residue is considered more or less waste material.

With mill waste, I have found it advisable to cause the material to be reduced to a size no greater than one quarter inch in major dimension. That is, if the particles were considered as cubes, they would be reduced to a maximum size of one quarter inch square. The maintaining of predetermined maximum dimensions not only affects the uniformity of the product produced, but also affects the time during which the material may be processed. If, for example, the particles were reduced to a maximum of one-half inch in major dimension, the time for treating such sawdust might be increased more than twice. I deem it desirable in connection with the treatment of mill waste to cause said waste to be continuously agitated by the screw type conveyors, not only to maintain uniformity of heat but also to permit the volatile gases to escape readily into the dome at the temperatures at which they are vaporized and thus they are not subjected to additional heat which would tend to "crack" them. This provides multi-stage selective vaporization without the formation of tarry or sticky residues collecting in the retort.

What I claim is:

1. In a retort for treating comminuted carboniferous materials, comprising a plurality of vertically stacked and horizontally disposed conveyor courses discharging said comminuted carboniferous materials successively downwardly, a vapor dome arranged over each conveyor course, an independent vapor discharge means including an open duct communicating with each course adapted to withdraw the vapors from such course prior to the discharge of said comminuted materials to the succeeding course, means for producing a cooling water screen for lowering the temperature of said vapors and tending to block their return flow, said screen-producing means including a spray head extending about the discharge end of said duct and being spaced substantially from said end, a baffle, said head having spray nozzles formed therein projecting jets upwardly toward said baffle overlying the discharge end of said duct, whereby the jets directed from said nozzles strike said baffle, are deflected back over said spray head to keep it wetted and to form a

mist-like spray intermediate the discharge end of said duct and said spray head.

2. In a retort for treating comminuted carboniferous materials, comprising a plurality of vertically stacked and horizontally disposed conveyor courses discharging said comminuted carboniferous materials successively downwardly, a vapor dome arranged over each conveyor course, an independent vapor discharge means including an open duct communicating with each course adapted to withdraw the vapors from such course prior to the discharge of said comminuted materials to the succeeding course, means for producing a cooling water screen for lowering the temperature of said vapors and tending to block their return flow, said screen-producing means including a spray head extending about the discharge end of said duct and being spaced substantially from said end, a baffle, said head having spray nozzles formed therein projecting jets obliquely upwardly towards said baffle overlying the discharge end of said duct, whereby the jets directed from said nozzles strike said baffle, are deflected back over said spray head to keep it wetted and to form a mist-like spray intermediate the discharge end of said duct and said spray head.

3. In a retort for treating comminuted carboniferous materials, including horizontally disposed conveyor course, comprising an elongated envelope whose floor defines a series of parallel troughs, a corresponding number of feed screw conveyors arranged in said troughs, a vapor dome overlying the entire series of conveyors in a course, said dome and floor portions being joined by a sealing yielding joint for accommodating differential expansion of said parts.

4. In a retort for treating comminuted carboniferous materials, including a horizontally disposed conveyor course, comprising an elongated envelope whose floor defines a series of parallel troughs, a corresponding number of feed screw conveyors arranged in said troughs, a vapor dome overlying the entire series of conveyors in a course, said dome and floor portions being joined by a sealing, yielding joint for accommodating differential expansion of said parts, said joint comprising two elongated U-shaped members with their upstanding leg portions opposed and straddling.

5. In a retort for treating comminuted carboniferous materials, including a horizontally disposed conveyor course, comprising an elongated envelope whose floor defines a series of parallel troughs, a corresponding number of feed screw conveyors arranged in said troughs, a vapor dome overlying the entire series of conveyors in a course, said dome and floor portions being joined by a sealing yielding joint for accommodating differential expansion of said parts, said joint comprising two elongated U-shaped members with their upstanding leg portions opposed and straddling, and resilient packing lying intermediate said straddling leg portions to seal the space between them.

6. In a retort for treating comminuted carboniferous materials, including a horizontally disposed conveyor course, comprising an elongated envelope whose floor defines a series of parallel troughs, a corresponding number of feed screw conveyors arranged in said troughs, a vapor dome overlying the entire series of conveyors in a course, said dome and floor portions being joined by a sealing yielding joint for accommodating differential expansion of said parts, said joint comprising two elongated U-shaped members

with their upstanding leg portions opposed and straddling, resilient asbestos packing lying intermediate said straddling leg portions to seal the space between them.

7. In a retort for treating comminuted carboniferous materials, comprising a plurality of vertically stacked and horizontally disposed conveyor courses discharging said comminuted materials successively downwardly, means for heat treating the materials of the respective courses and thereby developing from the material of each course a vapor rising from the heat treated material, a vapor discharge pipe for delivering the vapor of each course beyond the material of that course, and means at the discharge end of said pipe to direct a liquid spray entirely across the end of the pipe and below such end, the spray being permeable by the vapor and having a temperature materially below that of the vapor, the flow of the spray across the pipe serving to deflect the vapor passing into the spray to substantially prevent the reentry of the vapor into the pipe.

8. In a retort for treating comminuted carboniferous materials comprising a plurality of vertically stacked and horizontally disposed conveyor courses discharging said comminuted materials successively downwardly, means for heat treating the materials while in the courses and permitting the developed vapors to rise freely from the course, a vapor dome arranged above each course to confine said vapor above said course, a vapor pipe receiving the vapor trapped by the dome for remote discharge, and means operating completely across the discharge end of the pipe in the form of a vapor permeable liquid spray delivered below the pipe to deflect the direction of vapor flow after passing into the spray to prevent reentry of the vapor into the discharge pipe.

9. A retort for treating comminuted carboniferous materials comprising a heat generator, a plurality of conveyor courses open to the heat from said generator and receiving and successively discharging said material, means arranged above each course for trapping the vapor rising from the heat treatment of the material in that course, a pipe open to the vapor trapped by each of said means and discharging said vapor remote from the course and a water spray directed entirely across and below the discharge end of the pipe, the velocity of the spray serving to deflect the vapor from its normal path of movement through the pipe.

10. A construction as defined in claim 9 wherein the temperature of the spray is materially below that of the vapor to utilize the spray as the vapor cooling agent.

11. A construction as defined in claim 9 wherein the spray is sufficiently thick longitudinally of the pipe to momentarily trap the vapor passing therethrough and permit the velocity of the spray to carry such vapor beyond its normal path of travel in the pipe.

12. A retort for treating comminuted carboniferous materials comprising a heat generator, a plurality of conveyor courses open to the heat from said generator and receiving and successively discharging said material, means arranged above each course for trapping the vapor rising from the heat treatment of the material in that course, a heat arresting chamber arranged beyond the retort, a pipe open to the trapped vapor above each course and terminating in a discharge opening in one of the walls of the heat arresting chamber and a liquid spray passing over the sur-

face of said wall and over and in contact with the discharge end of the pipe, said spray having a velocity to cause it to travel down the wall below the discharge end of the pipe to substantially deflect the vapor laterally of its path through the discharge end of the pipe. 5

13. A retort for treating comminuted carboniferous materials comprising a heat generator, a plurality of conveyor courses open to the heat from said generator and receiving and successively discharging said material, means arranged above each course for trapping the vapor rising from the heat treatment of the material in that course, a heat arresting chamber arranged beyond 10

the retort, a pipe open to the trapped vapor above each course and terminating in a discharge opening in one of the walls of the heat arresting chamber, and a liquid spray in said heat arresting chamber directed against the wall thereof to which the pipe opens and above the discharge end of the pipe, said spray flowing down said wall completely across and in contact with the discharge end of the pipe and below the pipe, the spray in addition to providing for said flow wetting the surface of the wall and chamber to prevent deposit thereon.

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