

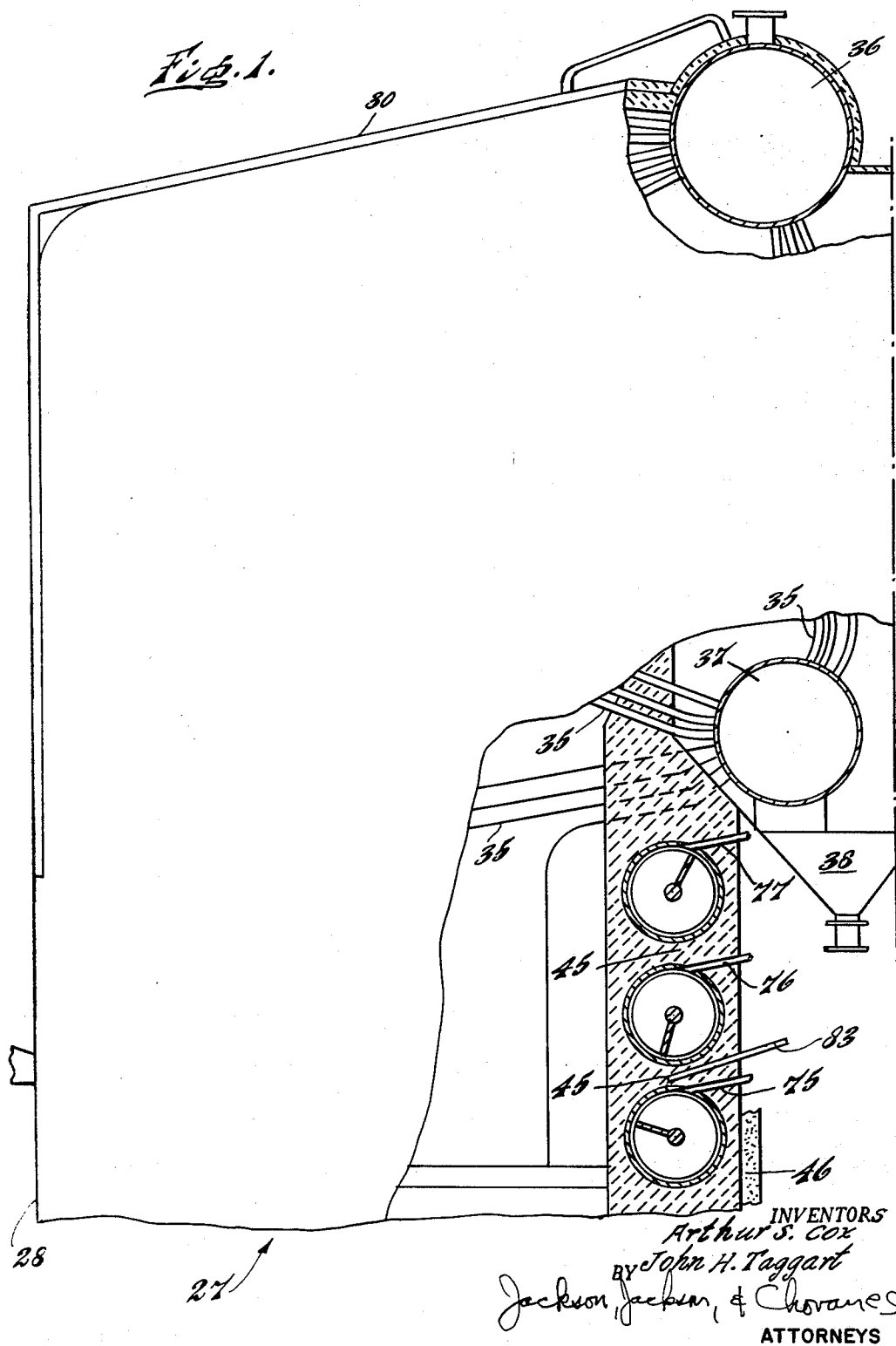
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A. S. COX ET AL
PRODUCTION OF CHAR

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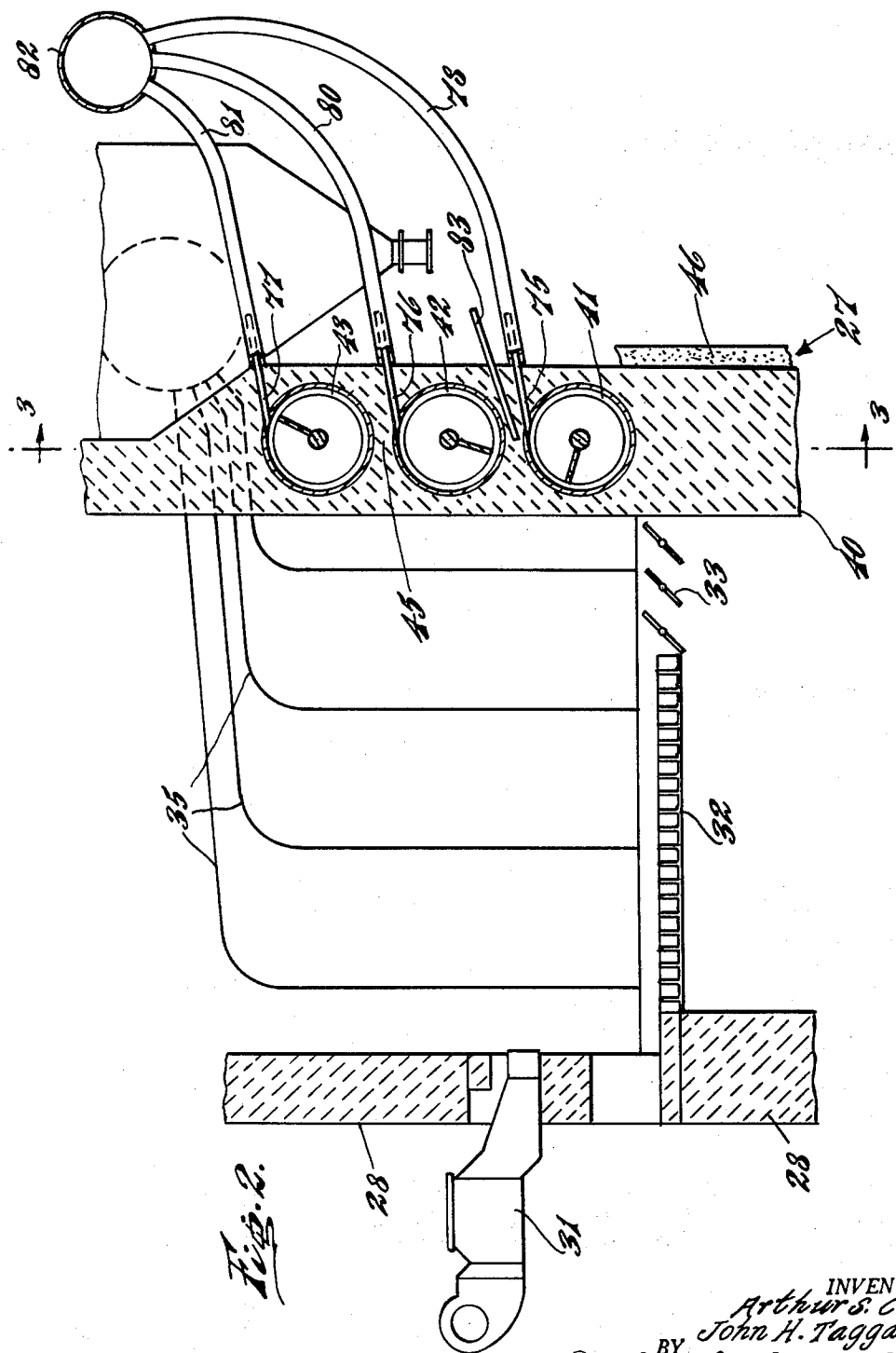


Fig. 2.

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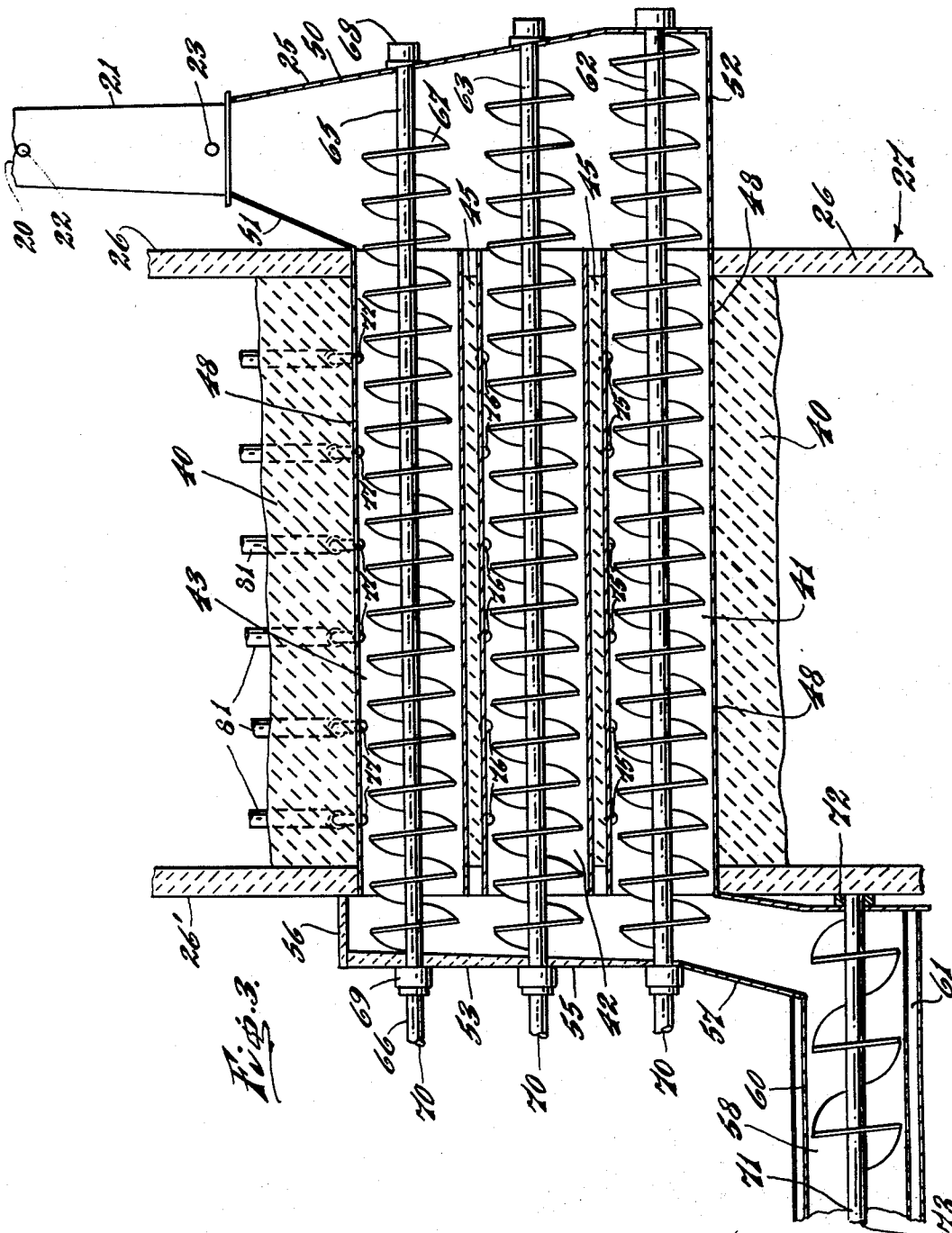
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PRODUCTION OF CHAR

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4 Claims

ABSTRACT OF THE DISCLOSURE

This is a system for producing char from organic materials including waste materials such as trash, wherein the material is comminuted into particles and then passed through a passage in the bridge wall of a boiler by conveyor means, whereby volatile gases are driven from the material. The volatile gases are optionally fed to the boiler firing pit, or to a separate burner for combustion.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention has as its primary purpose the production of char, or charcoal. Char has been known and produced for many years and is essentially a porous solid product containing from 85 to 98% carbon. It is produced by heating carbonaceous materials such as cellulose, wood, peat and coal of bituminous or lower rank at a temperature of about 1000° F. to 1200° F. in the absence of air.

DESCRIPTION OF THE PRIOR ART

Production of char in the prior art has been conventionally in closed batch-type ovens.

It has been recognized in the prior art that the three primary concerns in the production of char are time, turbulence, and temperature. Time is necessary to expose the raw product to an elevated heat and drive off the volatile gases. An elevated temperature is necessary, since the gases will not be driven off otherwise. Turbulence of the raw material is desirable to expose all of the material uniformly to the heat, to obtain equal and complete treatment of the entire mass of raw material.

Generally speaking, the prior art has neglected turbulence and concentrated on time and temperature, wherein the raw material was exposed in great mass, and on a batch basis, for a long period of time to obtain a final product, such as in the well known coke oven for producing coke from coal. In such coking ovens, it takes for instance, from 12 to 18 hours to produce a batch of coke in an oven.

Efforts have been made to introduce turbulence into the char producing process to reduce the time necessary for producing the char, and to reduce the size of the installation necessary for producing a given quantity of char. One such arrangement is shown in Lantz United States Patent 3,020,212, wherein screw conveyors are used to convey and agitate the material. The elevated temperature in such installations is attained by providing a special combustion chamber wherein gas is supplied from an outside source for burning. Installations of this type greatly reduce the time involved in producing the char.

DESCRIPTION OF THE PRESENT INVENTION

The present invention represents an improvement over the prior art set forth above, and consists essentially of providing a passage through a bridge wall of a boiler

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wherein comminuted or attritioned material of a carbonaceous nature can be conveyed and agitated through the passage.

This system is designed to produce char from trash, debris, garbage and other refuse which is collected in, for instance, municipal trash collecting systems, or industrial wastes. However, the system itself can also be used to produce char from a more refined or useful raw product such as Minnesota peat, Dakota lignite, and all ranks of bituminous coals. Also, the system could be adapted to utilize seaweed and kelp. More broadly, the system can utilize virtually any organic material having a high proportion of hydrocarbons which when baked or heated in the absence of air, releases the volatile gases and leaves a remainder of fixed carbon.

The raw material being fed through the bridge wall must be in a relatively finely comminuted or attritioned state. The material is generally attritioned mechanically to such a relatively fine state to permit rapid processing. However, should the raw material occur in an attritioned state as a by-product from some operation, no attritioning would be necessary, as for instance with saw dust or wood chips.

In the present system, conventional prior art boilers are used, and a passage, for instance, a tubular tunnel-type opening, is created longitudinally through the bridge wall of the boiler. A typical thickness of a prior art bridge wall is about 18". The bridge wall is generally of a refractory material of a somewhat insulating character to retard heat flow through the bridge wall. In the present invention, it is desirable to allow a heat flow into the raw material traveling through the passages, so that preferably a refractory of a heat transmitting type in the bridge wall is used. This could be of a type, for instance, used in checker bricks in many industrial operations wherein the brick selectively absorbs and stores heat and then releases it. However, to prevent the complete passage of heat through the wall, the back or cold face of the bridge wall is desirably lined with insulating material of, for instance, 4½" thickness, to keep the heat toward the boiler and direct it toward the raw material being processed. This allows the material as it is traveling to continually absorb heat, but it does not allow heat to escape out the back of the boiler.

The system of the invention yields optimum time, turbulence, and temperature results. Considering temperature, a well operated boiler has no less than 1700° F. temperature on the hot face of the bridge wall. This heat is available for use in the invention. The operating temperature of the boiler itself, to achieve this bridge wall temperature would be about 2000° to 2500° F. and above. The temperature in a typical bridge wall will drop from 1700° F. on the hot face to a temperature of approximately 1200° F. on the cold face. The insulating layer adjacent to the bridge wall cold face will prevent escape of heat to the exterior of the furnace. The average temperature under these conditions at the center line of the conveyor moving the raw material through the passage would be about 1400° F. Where the operating temperature of the boiler is above or below the operating temperature set forth above, there will be a corresponding increase or decrease in the temperature at the center line of the conveyor, and the proper charring can be obtained by a corresponding increase or decrease in the speed of the conveyor whereby the material is subjected to the heat for a greater or lesser amount of time.

Considering the turbulence to which the material is subjected, the conveyor, which desirably is in the form of a helical screw, in forcing the material longitudinally through the passages or conduits in the bridge wall, will mix or agitate the comminuted or attritioned material.

For instance, with a regular helicoid flight conveyor screw, the material travels slowly through a helical path as it progresses through the conduit. To obtain additional turbulence, the basic helicoid flight conveyor screw can be modified into any number of conventional or unconventional forms. These could include a cut flight conveyor screw which merely has portions cut out of the flight of the screw to allow some material to pass through the flights, thus increasing turbulence. There are any number of other modifications such as a cut and folded flight conveyor screw or a screw with paddles, or a ribbon flight conveyor screw or a paddle conveyor screw. The turbulence imparted to the raw material produces a more uniform grade of char because (1) it exposes the material more uniformly to the heat; (2) it presents more surface of the material to the heat; (3) it prevents the creation of cold pockets within the material; (4) it creates a more uniform char since it equalizes the various original differences in chemical composition; and (5) it promotes release of the gas because it stirs the char and allows the gas to escape from the pockets wherein it was created. By attritioning or comminuting the material in a raw state, a foundation for the subsequent high turbulence is provided, since it promotes ready movement of one particle with respect to another particle which is the essence of turbulence. Furthermore, by attritioning, individual small particles are created which are in effect treated individually in the process, and hence the gas can more rapidly be driven off from the small particle.

Considering the time necessary for the process, the time will be variable and will depend to a large extent on the type of the composition of the raw material being fed. Where a material having a percentage of volatile gases which are quickly driven off is being processed, the time will, of course, be less. For instance, trash and garbage are generally high gas producers because they have above 80% volatiles. These will go through faster than, for instance, a peat or lignite or bituminous coal which have a lower content of volatiles and more solid, thus requiring more time for processing. Many plastics are virtually all gas and hence would require much shorter time for processing.

A further factor in the time for processing the raw material into char depends on the temperature of the bridge wall of the boiler. In one embodiment of the present invention, wherein the boiler was an Erie City 4YC boiler of 50,000 pounds steam per hour capacity, production of char (on a continuous basis) took 13 minutes at an average temperature within the passage of 1400° M. It should be understood of course that the entire operation works on a continuous basis and the conveyor is constantly passing raw material through the passage of the bridge wall. The time, as referred to above, is that which it takes for a given particle of the raw material to pass completely through the passage and be converted from a raw state into a completed portion of char.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiment of our invention is illustrated in the drawings, of which:

FIGURE 1 is a diagrammatic fragmentary elevational view of a boiler, partly broken away to show the bridge wall in vertical section.

FIGURE 2 is a fragmentary vertical section, likewise through the bridge wall, of the same boiler.

FIGURE 3 is a fragmentary vertical section along the line 3—3 in FIGURE 2.

Comminuted or attritioned raw material is fed into a receiving hopper at 20. This raw material has been attritioned or comminuted to a relatively fine particle size by any suitable attritioning means such as a hogger of a type using a punch and die action, wherein teeth mounted on a shaft rotate through slots in the anvils

which are mounted horizontally adjacent to the rotating teeth. The majority of material discharging from an attrition mill of this type would be of a diameter of one-half inch or less and of a thickness of $\frac{1}{1000}$ inch or less. A small percentage of the discharge runs approximately one inch in diameter and of a thickness of, for instance, $\frac{3}{1000}$ inch. A small percentage of the discharge of the attrition mill will be in the form of a fine powder.

An accumulator bin 21 is of rectangular or other suitable cross section and receives the raw material 20. An upper limit switch 22 controls the flow of raw material to the bin 21 and shuts off flow of material into the bin when the upper level is reached. A similar lower limit switch 23 is positioned at the lower end of the bin 21 and opens the control gate allowing raw material to be deposited into the bin 21 when a lower limit is reached.

The bin rests atop an inlet manifold structure 25 which extends adjacent to and is supported from the side wall 26 of boiler 27. Boiler 27 has a conventional front wall 28, a top structure 30, a firing burner 31, and grate structure 32 including adjustable grates 33. Water tubes 35 extend along the side walls of the boiler and connect upper steam drum 36 and lower drum 37. A fly ash hopper 38 extends downwardly and collects fly ash in the conventional manner.

The pertinent structure of the boiler 27 with which the present invention is concerned is the bridge wall 40. As is well known, the bridge wall of a conventional boiler of the type shown functions as a heat barrier, as well as a structural component of the furnace. Passages 41, 42 and 43 extend horizontally and longitudinally through the bridge wall 40 and are of a diameter of about $\frac{1}{2}$ to $\frac{1}{3}$ of the bridge wall thickness. The passages are spaced vertically to permit a solid area as at 45 to extend between the passages. The bridge wall has at its back wall a layer of insulation 46 which serves to bar the passage of heat from the bridge wall 40 to the exterior environment surrounding the boiler. Passages 41, 42 and 43, are preferably circular in cross section, and are lined with an inner sleeve 48 of a heat transferring material such as metal which possesses relatively good wear characteristics as well as low friction. The liners 48 extend from side wall 26 on one side of the boiler to side wall 26' on the opposite side of the boiler. The inlet manifold 25 extends over all the passages as best seen in FIGURE 3 and has an outer wall 50 and an inner wall 51 and side walls as well as a bottom 52. The passages 41, 42 and 43 have at their outlet end at side wall 26' an outlet manifold 53 which extends over the discharge end of the passages. Outlet manifold 53 has an outside wall 55 and a top portion 56. An enclosed chute 57 extends from the bottom of the outlet manifold 53 to a water or air cooled, and jacketed, discharge passage 58. The inner wall of the passage 58 is preferably circular in cross section and has surrounding it a jacket 61 through which a water or air cooling medium is circulated.

Helical screw conveyors 62, 63 and 65 extend respectively through passages 41, 42 and 43 and comprise a center shaft 66 with a helically formed flight 67 formed thereon. The shaft 66 is rotatably journaled at 68 and 69 respectively in the inlet manifold 25 and the outlet manifold 53. Suitable rotational drive means are connected respectively to the shafts 66 at 70. A similar conveyor 71 is journaled in the discharge passage 60 at 72 and is driven at 73 by a suitable drive.

The entire structure including the inlet and outlet manifolds 25 and 53 and passages 41, 42 and 43, as well as the discharge passage 58 are sealed against passage of air into the interior of the structures.

As best seen in FIGURES 1 and 2, gas escape passages 75, 76 and 77 extend from passages 41, 42 and 43 respectively. Passages 75, 76 and 77, are lined respectively with sleeves formed of high temperature resistant metal. Passages 75, 76 and 77 connected to pipes 78, 80 and 81 which convey the gas to manifold 82. Pipes 78, 80 and

81 are insulated with high temperature resisting insulation. A thermocouple 83 extend through the bridge wall 40 to approximately the center thereof to determine the temperature.

In operation, raw material of the nature referred to above is trucked or otherwise brought to the site of the installation. The material is dumped in the "as is" state into a receiving hopper. The receiving hopper is connected to an intake of a hog or attrition mill and spills the raw material into the mill. The attrition mill shreds the material into confetti size. There is no need for separating or removing any products from the raw material prior to attritioning since metal objects such as car radiators, hub caps, tin cans, outboard motors and the like are all attritioned. This discharge of the attrition mill is directed into a conventional prior art cyclone system with a bottom gravity trap, when necessary, to remove heavier materials, or non-combustibles such as metal, which drop to the bottom of the trap. These elements are not shown since they are conventional. The combustible material is accumulated in a surge bin from where it is chuted into the bin 21 under the limit control switches 22 and 23 which selectively open and close to pass attritioned material 20 into the bin 21.

It should be understood that the above preparation of the attritioned material forms no part of the invention and can be altered to provide a suitable arrangement for various materials. In some instances, as with saw dust, no attritioning is necessary and the supply of material may be fed directly to bin 21.

The attritioned material 20 piles up in the inlet manifold 25.

The material is then passed from inlet manifold 25 by means of conveyors 62, 63, and 65 through passages 41, 42 and 43 respectively. The rate of rotation of the screws is controlled by suitable variable drive means so that the movement of the attritioned raw material through the passages 41, 42 and 43 can be governed as to speed. The material 20 is agitated by the screws. The material as it passes through the bridge wall 40 is being heated and the volatiles are driven off. The volatile gases pass through passages 75, 76 and 77 respectively and through tubes 78, 80 and 81, into gas manifold 82 where it is suitably disposed of. The gas may be brought back into the firing pit of the boiler and burned along with the primary fuel, such as oil, gas, pulverized coal, or initially attritioned material itself. In the alternative, the gas accumulated in manifold 82 can be piped elsewhere and used or burned or flared.

Boiler 27 is operated in the conventional manner to generate steam in tubes 35 and drums 36 and 37 and the production of char within the bridge wall does not alter the conventional function.

As the attritioned material is converted to char and is completely processed thereto, the char accumulates in outlet manifold 53 and then drops into the discharge passage 58. The char at this point is at a temperature of, for instance, 1400° F. and in a red hot state. The char is water or air cooled by means of jacket 61 whereby the coolant is continually circulated in the jacket. Conveyor 71 removes the cooled char to a suitable accumulating area.

It should be understood that the attritioned raw material forms a seal on the inlet side against air, and the processed char forms a seal on the outlet side of the passages through the bridge wall, so that virtually no air or oxygen passes to the raw material in the bridge wall passages and no combustion occurs.

As an alternative, one could use some of the attritioned material 20 in the firing burner 31 from the attrition mill to fire directly into the boiler and to provide the primary source of heat for the boiler. For instance, in the Erie City boiler cited above, approximately 106 tons of attritioned material was used in burner 31 for generating heat and steam during a 24 hour period. During this same

period, a total of 155 tons of attritioned material passed through the passages in the bridge wall to produce char. During the same period, approximately 85 tons of non-combustibles (this constituted a typical trash collection), was separated out after attritioning and before transferring to the surge bin. This accounted for a total trash disposal of 346 tons during a 24 hour period.

There are many uses for the char produced, both activated char and unactivated char, but this invention is not concerned with such use.

It should be noted throughout the description set forth above that the present system involves a continuous process, and hence there is a substantial production over any given period. Although three passages are shown above for illustrative purposes, any desired number of passages may be used to give the required capacity. The system operates in the same manner regardless of whether one or many passages are used. However, one of the limiting factors is that the height of the bridge wall above the grates is limited and this limits the number of passages. The passages likewise may be of any suitable diameter, since the process works equally well on small diameter passages as well as large diameter passages. The variable speeds of the shafts of the conveyors is determined by a variable speed drive, and can be controlled from for instance, a low of ½ revolution per minute to a maximum of 2½ revolutions per minute or higher if necessary. The rotational speed of the conveyor depends on the end results being achieved, and if the char being produced is not fully process, the speed of rotation of the conveyors is reduced. On the other hand, if the char is overbaked, the speed is increased.

In a typical boiler construction, of for instance, 50,000 pounds per hour capacity, and having an inside dimension between side walls of 13' 3", there could be, for instance, a 13 minute travel period, where the raw material would be passing along through the bridge wall at the speed of one foot per minute.

At the end of the discharge from the cooling jacket, the char has to be cooled below the flash point of the carbon, which is about 400° F.

The volatiles driven off from the raw material are of a high combustible content in a typical waste product raw material and may be for instance, in a typical analysis, of a heat content of 250 B.t.u.'s per cubic foot. Approximately 25 cubic feet of gas were emitted for every pound of typical material fed.

In burying the passages within the bridge wall of the boiler, a steady controllable heat is imposed on the raw material rather than a flame heat as would be the case if the tubes were right within the boiler. A flame heat would be a much higher heat as the flame is perhaps 2,000 to 2200° F. and this would result in tube deterioration. Under the present arrangement, there is no deterioration of the liner since the bridge refractory itself is absorbing the deteriorating effect of the flame.

In view of our invention and disclosures, variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain an all or part of the benefits of our invention without copying the structure and method shown, and we, therefore, claim all such insofar as they fall within the reasonable spirit and scope of our claims.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. A system for producing char from organic materials comprising:

- (1) means for comminuting the organic materials into particles,
- (2) means for feeding the comminuted material to the bridge wall of a boiler, said boiler having a fire-box and means for heating water,
- (3) a passage through the bridge wall of the boiler,

- (4) conveyor means within the passage for conveying the comminuted organic material through the passage, and
- (5) vents extending from the passage for venting gases therefrom and an outlet for removing char as product away from the boiler, and
- (6) wherein the means for conveying the material through the wall comprises a helical screw having means associated therewith to reduce the organic materials to char without consuming it.
2. A system of claim 1, in combination with sealing means for sealing the outlet of the passage from the surrounding environment.
3. The system of claim 1, wherein the organic material comprises waste products including garbage.
4. A system of claim 1, in combination with cooling means at the outlet of the passage.

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15 110—10; 122—2; 202—118