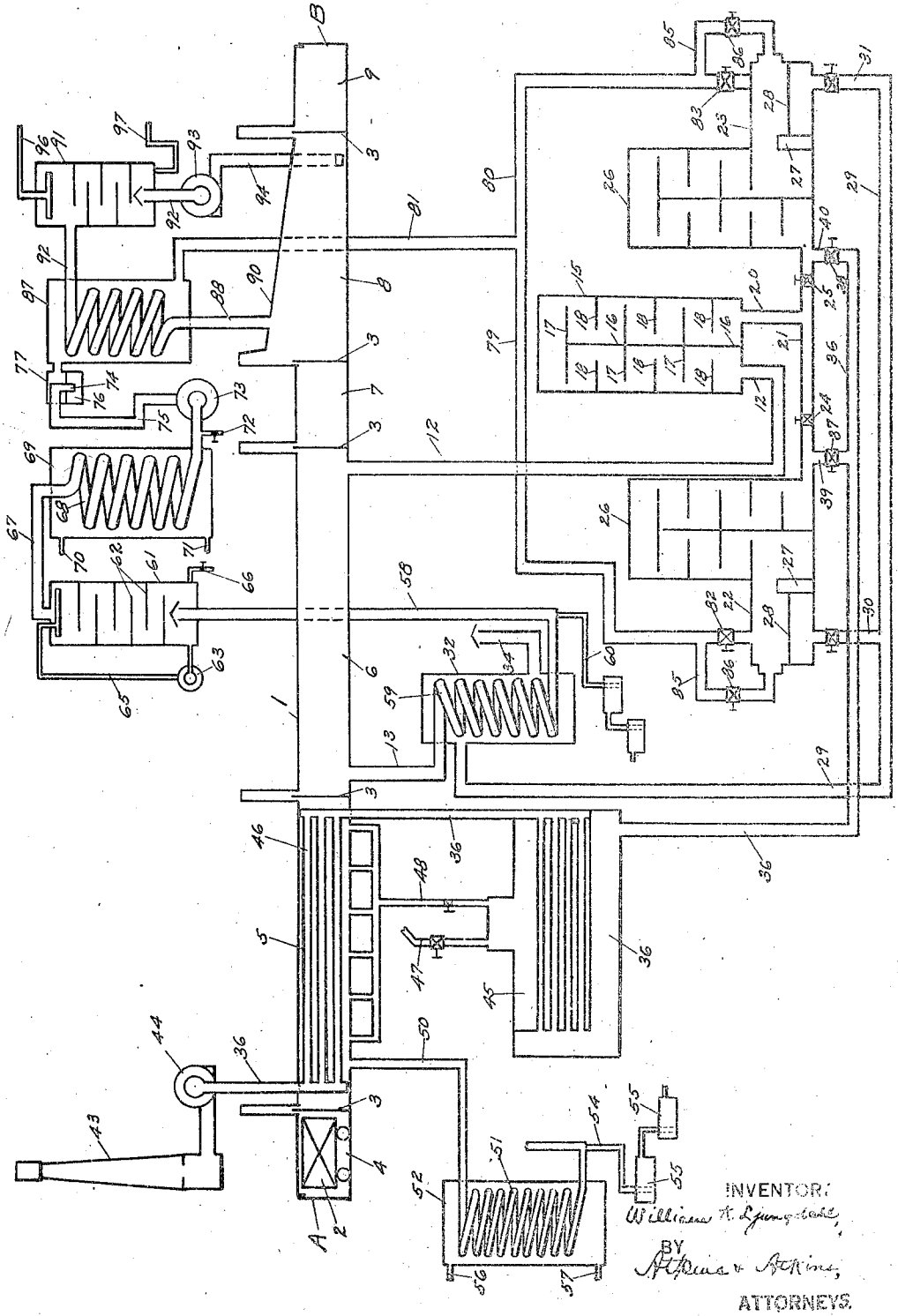
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ART AND APPARATUS FOR ULTIMATE DESTRUCTIVE DISTILLATION OF ORGANIC MATTER

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## ART AND APPARATUS FOR ULTIMATE DESTRUCTIVE DISTILLATION OF ORGANIC MATTER.

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My invention relates ultimately to the destructive distillation of organic substances, of which, for example only, wood is referred to for convenience throughout this specification; but it has for its object, in general terms, the promotion of economy and efficiency in thhe manufacture of products recoverable by distillation, whereof destructive distillation constitutes a final step.

In respect to the said item of economy, my invention is chiefly concerned in the manner of utilization of the heat employed in the process of distillation, whereby at the same time that its waste is minimized, the heat is distributed and applied at different temperatures so as to save substantially all the fluid constituents (liquid and gaseous) as well as the solid residual product or charcoal of the substance treated.

Again, in respect to the item of efficiency aforementioned, provision is, by my invention, made for uniformity and economy of manufacture of charcoal of the highest grade and such as will satisfy the requirements of the most exacting demands.

In view particularly of the foregoing general statement, what constitutes my present invention will be hereinafter specified in detail and succinctly set forth in the appended claims.

Inasmuch as the various mechanical instrumentalities which enter into the embodiment of my present invention, as it is herein described, may be of a kind well known in the art, it is deemed equally conducive, not only to simplicity and clearness, but also to ample fullness of description to strip the illustration of my invention of all details that are non-essential.

Accordingly, in the accompanying drawing, I show a diagrammatical illustration of apparatus either directly entering into my invention or adapted and employed for carrying it into effect.

Referring to the numerals on the drawing, 1 indicates an elongated composite chamber or tunnel which may be of any suitable and preferred construction, materials, dimensions and extent. It is provided throughout its longitudinal extent with means, such as rails or tracks, not illustrated but whose use for a like purpose is familiar in the art, for the transportation, from end to end of the chamber, of a succession of conveyors, represented, for example and to avoid unnecessary multiplication of detail, by a single car. The cars so indicated at 2 may be of any suitable kind preferred that are built of material adapted to endure, without injury, the high degree of heat to which they are subjected in their passage through the chamber or tunnel 1, which is also built of suitable heat-resisting materials.

The said chamber is provided at its opposite ends with air-tight terminal doors A and B, and at intervals with suitable intermediate transverse partitions, doors, gates or locks 3, such as are of familiar use in the art or which may be any other suitable kind preferred. The doors 3 constitute, in effect and to all practical purposes, considering the effect of the presence of the terminal doors A and B, air or gas tight movable walls, which serve to divide transversely the length of the chamber 1 into a plurality of separate but consecutively communicating compartments.

In practical operation, the cars are advanced one by one through the compartments at intervals, upon which occasions the doors 3 are opened as required for their passage in accordance with methods already well understood in the art.

In the drawing, six of said compartments are, for example only, illustrated, namely, compartments 4, 5, 6, 7, 8 and 9. Of those named, 4 and 9 constitute, respectively, car intake and outlet compartments, and they, including also compartment 7, may be designated sealing compartments, because the function of each is that of a seal to compartments contiguous to them so as to exclude, when their doors are closed, communication between different compartments or with the outside atmosphere as the respective situation of the compartment in question may require.

Besides the sealing compartments just designated, of the three remaining compartments, 5 may be designated a low-temperature distillation compartment, 6 a high-temperature distillation compartment, and 8 a cooling compartment, whereof the several functions are specified in the paragraphs next succeeding.

The compartment 6 is that in which destructive distillation takes place. Conse-

quently it is desirable and to a greater or less degree essential, to exclude therefrom intrusion of oxygen that is an element ever present in the outside air. To that end the presence upon opposite ends of it, of the compartments 4 and 5, and 7, 8, and 9, respectively, effectively contribute, in connection with the terminal doors A and B.

The intake compartment 4 is in effect a mere receiver into which cars 2 loaded with wood or other material with which the process is useful are first introduced one by one in succession. From compartment 4 the cars pass into compartment 5, and from the former to the latter a modicum of air, minimized in volume at the utmost to the interior capacity of the former, may pass.

The comparatively low temperature employed in the compartment 5 being such only as is sufficient to dry the organic contents of the cars without combustion, and to distil therefrom the more volatile constituent elements thereof, it is, nevertheless, sufficient substantially to deoxygenize the air confined within the compartment 5. Wherefore, when the door between compartments 5 and 6 is opened all danger of explosion through combustion of the mixture of air with the gaseous contents of compartment 6 is eliminated.

Compartment 6, being, as has been specified, that in which destructive distillation takes place, is one adapted to operate under high temperature. Provision is made in the manner and for the purpose hereinafter specified, for graduating the distribution of the heat within the compartment 6, whereby the heat within the said compartment is maintained at a desired maximum at the car outlet end thereof and is gradually decreased to about one half at the car intake end of said compartment.

It is practically important to continue exclusion of oxygen (air) from the charcoal product while in an incandescent state, both during its occupancy of and after its withdrawal from compartment 6. To that end the gas-tight compartment 7 is provided to receive the loaded cars 2, one at a time, from compartment 6, and might be used to hold them until sufficiently cool to be exposed to the air. Such provision, although in itself sufficient in one sense, would be attended by a loss of time which would impair, if not practically destroy, the practical economy of the apparatus in use.

For that reason, I prefer to employ a special cooling compartment 8, in which a deoxygenated atmosphere is utilized for gradually lowering the temperature of the charcoal product in the cars or until it may be safely exposed to the outside atmosphere without danger of any combustion taking place in it or of injury otherwise to its quality.

The capacity of the compartment 8 is, for reasons hereinafter again referred to, sufficient to accommodate a plurality of cars at one time.

As a safeguard against intrusion of oxygen into the compartment 8, a final outlet or sealing compartment 9 may be and preferably is provided.

Having now described the preferred form of the composite chamber 1, I next proceed to specify the method and means wherein and whereby it is utilized in respect to its several compartments.

It will have been gathered from the foregoing specification that the compartment 6 is the one in whose functioning the ultimate capacity of the apparatus for distillation is reached. For that reason reference is directed in the first instance to it. It derives heat, preferably, from a circulatory heating system comprising an induction pipe 12 and an eduction pipe 13 which are in operative communication with a suitable source of heat. The pipe 12 makes delivery of a circulatory heating medium at a point slightly removed from but adjacent to the car outlet end of compartment 6 or that end thereof next to compartment 7, and is preferably introduced through or near the floor thereof.

The eduction pipe 13 communicates in a corresponding manner with the compartment 6 near the car inlet end thereof which is next to compartment 5.

The disposition and capacities of the pipes 12 and 13, relatively to each other and to the inside capacity of the compartment 6, are such as to effect in operation substantially uniform ratio between the temperature near the outlet end of the said compartment and that adjacent to the inlet end thereof.

The object is to maintain, in conjunction with a graduated intermediate temperature, different but substantially uniform temperatures for the respective opposite ends of the interior of the compartment 6, as further explained in the next paragraph.

The temperature of the circulatory heating medium at the entrance of the induction pipe 12 into compartment 6 should approximate five hundred degrees centigrade (500° C.) below which a variation at that point of not to exceed fifty degrees is permissible. The temperature of said medium at the opposite or car inlet end of the compartment 6, or that end which is adjacent to the mouth of the eduction pipe 13, should approximate two hundred and fifty degrees centigrade (250° C.) which, as will hereinafter appear, is substantially equal to the temperature maintained in compartment 5. Consequently, there is no substantial or material change of temperature in the substance treated produced in passing from compartment 5 into

compartment 6. The uniformity of temperature just mentioned is maintained with advantageous results in respect to the quality of the product obtained, and with distinct gain in the economy of its manufacture.

The circulatory heating system aforementioned as comprising the combination of the pipes 12 and 13 with a suitable source of heat preferably includes an equalizer 15 whose function is to maintain a substantial uniformity in temperature of the gaseous contents of the induction pipe 12, and through which directly, communication with the source of heat is preferably made. The equalizer preferably consists of a closed chamber built of heat resisting and absorbing material, such for example as firebrick, and is provided within its interior with a medial partition wall 16 and with baffle plates 17 and 18 extending, respectively, in opposite directions from the wall 16 and from the opposing inside walls of the chamber 15. The members 16, 17, and 18, are, like the body of the equalizer, made of heat resisting and absorbing material, the wall 16 being shorter than the interior length of the chamber 15 and the plates 17 and 18 being made to overreach one another, whereby a circuitous passage of indefinite extent is provided within the chamber 15 for the flow of the circulatory medium through it.

From the same end of the equalizer 15 with which the pipe 12 communicates, but upon the other side of the wall pipe, a pipe 20 leads to a cross-over pipe 21 which establishes communication between it and a plurality of furnaces, as for example the two indicated by the respective numerals 22 and 23. In the pipe 21, on opposite sides of the pipe 20, respectively, I provide cut-off valves 24 and 25, the number of said valves being equal to the number of the furnaces employed, and their function being severally to make communication between the equalizer 15 and either one of the furnaces which is temporarily operative to supply it with heat. At the same time that one valve is opened to make communication as last stated, the other valve is operated as a cut-off to such furnace or furnaces as may be for the time being out of immediate service.

Each furnace is provided, in effect, with a regenerator chamber 26, whose interior construction corresponds in effect or in all material respects with that of the chamber or equalizer 15 already described. Upon the side of each chamber 26, opposite to that on which the pipe 21 enters it, I provide a fire wall 27 over which the heated products of combustion while maintained in the furnace pass from the furnace of which it forms a part into the circuitous passage with which the regenerator chamber 26 is, as has been specified, provided. A grade 28 is indicated for burning of solid fuel when desired.

With each furnace an air supply pipe 29 is adapted at intervals operatively to communicate, as through a valve-controlled branch pipe 30—31. The pipe 29 derives air preferably through a preheater jacket 32, which communicates with a preferably hooded air intake 34 located in the open outside atmosphere.

A smoke pipe 36, as it may be called for the purpose of distinction, constitutes a common discharge conduit for the products of combustion from each of the furnaces, and is, to that end, provided, for example, with a valve 37 or 38 in the respective branch-pipes 39 and 40, through which the pipe 29 communicates with the cross-over 21.

The branch-pipes 39 and 40 connect, respectively, with the cross-over 21 between its respective valves 24—25 and the respective furnaces, so as to render the latter operatively independent.

The smoke-pipe 36 leads through the compartment 5 to a place of discharge such for example, as a stack 43, whose draft upon said pipe is preferably augmented by a suction fan 44 operatively introduced into it. In operative communication with the pipe 36 which may be suitably amplified for the purpose, I prefer to introduce between the furnaces 22—23 and the compartment 5, a boiler 45 that is preferably of the return tubular type, and within the compartment 5, prefer to amplify the heating surface of the pipe 36 by means of the multiplied form of pipe 46, shown for example, in the drawing.

The reason for the provision of the boiler 45 is, at least, threefold. In the first place, it affords, through employment of a properly predetermined proportion between the capacity of the single pipe 36 and that of the surface of the tubes of the boiler 45, a means of tempering, substantially to a desired maximum say of two hundred and fifty degrees centigrade (250° C.), the heat of the products of combustion from the furnaces before said products reach the interior of the compartment 5. In the second place, the boiler affords economical means for utilizing the heat of said products to generate steam, which may be drawn off for driving the fans of my apparatus or other general uses, as through a valve-controlled steam pipe 47. In the third place, steam supplied from the boiler 45 may be conducted, as, for example, through a valve-controlled and terminally branched pipe 48, into the interior of the compartment 5, for the purpose of humidifying the atmosphere of the same, if means for that purpose be desired.

From any suitable point, a discharge pipe 50 leads from the bottom of the compartment 5 through the coils 51 of a suitable condenser 52, provided with a tube 54 for transferring to suitable containers 55 the more

volatile constituent distillate elements derived from the first application of a low degree of heat to the substance undergoing treatment during its confinement within the compartment 5. The condenser coils 51 are kept properly supplied from an outside source, not illustrated, with a supply of water or other liquid cooling medium. Pipes 56 and 57 indicate means of incorporation of the coils 51 into a water-cooling system of the kind just indicated.

Having hereinbefore already specified the presence of the eduction pipe 13, and, in general terms, its relationship to the compartment 6 and to the induction pipe 12, I now explain that the pipes 12 and 13 are incorporated into a circulatory heating system for the purpose of effecting a continuous flow of a circulatory medium having a high initial heat (say 500° C.) where it first enters the compartment 6; and next proceed to trace the course in circuit of said circulatory medium, and to describe various functions performed thereby in its course.

Let it be understood that a substantially constant degree of heat at each point in the said circuit should be, in effect, maintained. That is to say, that while there is designed to be a gradual variation of the heat at different points in the circuit, the degree of heat should be, at each point, substantially constant. For example, as has been specified, the heat at the discharge end of the induction pipe 12 should be maintained at say 500° C., a gradual variation of fifty degrees at that point being permissible, because that latitude of gradual variation is, in practice attended by no injurious results, while a greater or a sudden variation might do harm.

Again, the heated circulatory medium in passing through the compartment 6 from the induction pipe 12 to the eduction pipe 13 gives up substantially one half of its heat in doing the work it has to do within the said compartment; but the temperature of say 250° C. so attained by the time the mouth of the eduction pipe 13 is reached, should also be substantially constant.

Furthermore, the heat of the circulatory medium must be, in order to obtain the best results, maintained without any intrusion into it of free oxygen whose effective presence even in small quantity would, to the injury of the product, effect combustion, and which in larger quantity might result in explosion. The necessity of continuously maintaining in the circulatory medium a constant degree of heat for a considerable period, and the necessity of keeping it free of oxygen, dictates the employment of a plurality of independently operative furnaces, because thereby it is made feasible to raise the temperature of the heat storage capacity of one furnace by internal combustion therein at the same time that the storage heat of another furnace cut off from intrusion of oxygen is being drawn upon for keeping heated and in operative motion the circulatory medium. In such case, if two furnaces 22 and 23, for example, are used, one furnace is being, through admission of air thereto through the pipe 29, heated by internal combustion during such period as, by operation of one or the other of the valves 24—25, it is cut off from communication with the circulatory medium, while, at the same time, the other furnace continues without interruption operatively to heat and keep in motion the circulatory medium, after it is temporarily cut off from communication with the air supply pipe 29.

In the operation of shifting into service one freshly heated furnace in place of another whose heat has been reduced by work, considerable and sudden variations of temperature at the discharge end of the induction pipe 12 would be, without provision to the contrary, likely to ensue. Wherefore, I prefer to introduce into the pipe 12 between its discharge end and the furnaces 22—23, which, for example, constitute its primary source of heat supply, the equalizer 15, with the result of effecting through storage by absorption of excess heat from a freshly fired and cut off furnace, instead of leading the heat directly from the latter into the compartment 6.

It is assumed that the reader skilled in the art has now traced the discharge from its source in continuous flow of the heated circulatory medium from the pipe 12 into compartment 6; that he bears in mind that said medium there finds work to do in effecting destructive distillation, say of wood loaded in cars within said compartment; and has noted that in the doing of said work said medium becomes reduced in temperature by about one half and loaded with certain of the fluid constituent elements of the wood that are separated by the heat from their carbon base.

It will be observed that despite the heat lost in the work of distillation, the temperature of the gas in the pipe 13 is still great and amply sufficient to raise the temperature of air admitted through its intake 34.

In order to recover the heavier or tar like products of destructive distillation carried by the heated circulatory medium, I provide a pipe conduit 58 operatively connecting the coils 59 within the jacket 32, provided with their distillate discharge system 60, with the interior of a scrubber case 61. Said scrubber may be of that familiar type which operates by circulation in the first instance of a priming liquid subsequently augmented by accumulation of distillates over baffle plates 62, promoted by the operation of a pump 63 connected to a pipe 65, operatively com-

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municating with the interior of the scrubber case at top and bottom, respectively. A cock 66 is provided for drawing off the accumulation of liquid contents of the scrubber case at will.

For removal of the more volatile products carried in suspension by the hot circulatory medium, additional condensation is required, which may be accomplished by connecting, as by a pipe 67, the scrubber 61 with condenser coils 68 confined within a casing 69, which is put in communication, as by pipes 70 and 71, with a water cooling system. A cock-controlled pipe 72 affords means for drawing off the volatile products condensed within the coils 68.

A suction fan 73 is provided as a means suitable for promoting flow of the gaseous or circulatory medium. Said fan discharges as through the end 74 of a pipe 75 immersed into a volume of liquid 76 confined in a sealing chamber 77. Said sealing chamber performs the function of a regulator, and is adapted to maintain within the entire circuit of the circulatory medium a pressure in excess of outside atmospheric pressure, say an excess of 14 to 16 millimeters, or enough to guard against intrusion of the oxygen of the air at any point by reason of any preponderance of outside over inside pressure.

After the scrubbed gas leaves the chamber 77 there remains for it only to find return in circuit to a heated furnace in order to become thereby reheated for repetition of its travel in circuit above described. Such return it may find through either of the branches 79 or 80, into which a return pipe 81 is divided, and which are provided, respectively, with hand-controlled valves 82 and 83. Around each of said valves a by-pass 85, controllable as by a cock 86, affords at will a passage way for fuel gas to one of the furnaces. It will be understood that the by-pass serves as a means for eliminating from the circulatory system, at will, combustible gas. This is desirable for the reason that the circulatory gas will gradually increase in volume, due to the addition of distilled gas from the wood. The by-pass permits removal of excess and combustible gas from the system. The removal may be effected by means of valve 86 which may be a two-way valve permitting the gas to be directed into the furnace to be burned or to be discharged to another place of utilization.

Owing to the functionating of the condenser aforesaid within the casing 69, the circulatory medium will have become cool by the time it enters the pipe 81, and in that regard my invention affords an important economic advantage, in providing means for reheating the said medium after it is cooled in the condenser casing and before its return to a regenerator 26.

The reheating operation last mentioned may be effected, to peculiar economical advantage, by utilizing for the purpose the otherwise waste heat which is obtainable, paradoxical though it may seem, by the method employed for operating the cooling compartment 8. To describe that method, so far as appears to be necessary for the purposes of the present specification in view of its reservation as subject matter for a separate application, it is deemed to be in order to specify that the heat of the loaded cars 2, upon their first admission, one by one, into the compartment 8, is intense, it being substantially equal to the maximum degree of heat developed within the compartment 6. Consequently, by providing in operative communication with the pipe 81 a heating jacket 87 communicating with the interior of the compartment 8 as by a pipe 88, coiled, for example, within the jacket 87, provision is made of a considerable economy for utilizing the heat of the compartment 8 which were otherwise lost, for heating the circulatory medium, and heating it, before its return to a regenerator 26, to a degree approximating the maximum degree ultimately required of it.

The above mentioned result is attained by locating the pipe 88 at the car-intake or hot end of the compartment 8, above which, as by an inclined or raised roof, a hood 90 is provided for directing the heat discharge to the pipe 88. Within the compartment 8 at the end opposite its car-intake end aforesaid, provision is made for a gradual cooling effect, whereby, at substantially regular intervals, the reduction of the temperature of a car load will be accomplished adequate to admit of its safe withdrawal as a finished product from the apparatus.

The interval between such withdrawals last mentioned measures the effective productive capacity of my apparatus. In that connection it may be specified, without restriction to exact dimensions, that while the car capacity of the respective compartments 5 and 8 is equal, that of the compartment 6 is twice that of either 5 or 8. The proportion just specified fixes also a proportional time limit of treatment for each car load in travelling, at a regular rate of advancement, from one end to the other of the chamber 1. Say, for example, the period of treatment required within the compartment 6 be twelve hours, then, under the proportions specified, the same rate of advancement of the succession of cars will allow six hours' treatment to each car in the compartment 5, and six hours' treatment in the compartment 8. Consequently, the compartments 4 and 9 being, like compartment 7, merely sealing compartments and without other function than that of excluding admission of the oxygen of the air into the interior of the chamber 1 at either end, the

time of travel of a car from end to end of the chamber 1 will be twenty-four hours. That is to say, each car requires twenty-four hours in passing through the entire chamber 1. From experience of actual practice, that time is sufficient for the conversion of a load of wet wood, taken in at the intake end of the chamber 1, into high grade charcoal at the outlet end thereof. If the wood at the intake end of the chamber 1 be not wet, the time of its conversion to charcoal may be curtailed somewhat, in proportion to the degree of dryness at which it enters said chamber.

The productive capacity of the apparatus is equal to twice the car capacity of compartment 6. Wherefore, if the car capacity thereof equals twelve, the productive capacity of the apparatus will be twenty-four car loads for every twenty-four hours, or one car load per hour while the apparatus is in full operation.

The means which I prefer to employ for operatively effecting the cooling of the interior of the compartment 8 is that shown in the drawing, and which may, for the purposes of this specification, be described briefly as follows.

Compartment 8 derives heat from the succession of cars loaded with incandescent material supplied to it, but after they are separated from the compartment 6. Consequently the circulatory medium within the compartment 8 is substantially a form of the same medium as that which circulates through compartment 6, although it is separated therefrom and no longer a part or portion of it. One important fact to observe is that the circulatory medium within the compartment 8 is substantially deoxygenized entirely or to such extent as not to cause deterioration of the charcoal while it is undergoing the cooling process in said compartment.

That circulatory system which is in operative communication with the compartment 8, preferably comprises, in addition to the pipe 88 already specified, a scrubber 91. Those members are brought into operative combination, as by aid of suitable pipe connections 92, with each other and with a fan 93, which is adapted to draw off the hot circulatory medium from the hood 90 through the scrubber 91, and to discharge it, as by a pipe 94, into the lower part of that end of the compartment 8 which is substantially opposite, both longitudinally and vertically, in respect to said compartment from that point at which the pipe 88 enters the compartment. A water supply pipe 96 and a waste pipe 97 are in usual operative communication with the scrubber 91.

One function of the scrubber 91 is to reduce gradually the temperature of each successive car load of charcoal to a degree at which it may be removed from the compartment 8 with safety, that is, with perfect immunity from danger of combustion.

Another function of the scrubber 91 is to remove any possible remnant or trace of oil or other substance which might deleteriously affect the quality of the charcoal for some important uses, such, for instance, as use for poultry food.

In view of the foregoing specifications, the following description of the operation and carrying into effect of my invention is deemed to be all sufficient for present purposes.

Let it be assumed that the chamber 1 is at first provided with a supply of loaded cars 2, which in such case will fill only compartment 5, either in single or in plural trains according to the track equipment of said chamber.

Afterwards, the terminal doors A and B and the intermediate doors 3 being properly closed, one or more as desired of the furnaces, for example the two, namely 22—23, are fired by the combustion therein of any convenient form of fuel. Both of the valves 24 and 25 are, in the first instance closed so that all products of combustion find exit through the smoke pipe 36 by the course already specified.

In following said course, the heat of combustion, reduced from that generated in the furnace substantially to 250° C., is admitted to the interior of compartment 5 which is charged, for example, with wood as aforesaid, for distillation in whatever state of dryness the source of supply may render convenient. It may, for example, come from a water basin in which it is floated in customary log cuts.

The initial action of the heat upon the wood within compartment 5 is to dry it, and afterwards to distil therefrom its more volatile constituent elements, which, at the aforesaid temperature developed within compartment 5, are driven off without injury to them or change of their quality or identity. At the end of a period say of six hours, which is the period heretofore specified for treatment within the compartment 5, all of the constituents aforesaid which are more volatile and none other will have been exhausted from the wood, the wood will be properly dried and heated throughout its mass, and also the atmosphere of the compartment 5 will be perfectly deoxygenized.

The said period of treatment having been completed, the door 3 between compartments 5 and 6 is then opened, the terminal car or cars, if there be more than one train of cars, is, by any usual or preferred method, advanced into compartment 6, and the said door 3 is again closed. The operation described in the last sentence is repeated

at regular intervals, with the necessary opening of the terminal door A for admission upon each occasion of a fresh car into compartment 5 to take the place of the car withdrawn therefrom, until the compartment 6 is filled with its full complement of cars. Thereupon, for the first time if desired, although with due care it may be done before the compartment 6 is full of cars, heat, say at a temperature of 500° C., is admitted to the said compartment through the induction pipe 12. Passing thence through the longitudinal extent of compartment 6 it loses part of its heat in doing the work of distillation it performs, until, by the time it reaches the car-inlet end of said compartment where it finds exit by way of the eduction pipe 13, it is reduced to a temperature of 250° C. The direct source of the heat supply aforesaid is the equalizer 15, and the remote source is that one (or battery) of furnaces which is temporarily in operative communication and in circuit with the equalizer, as heretofore specified. While in the operative communication last mentioned, said furnace is cut off from communication with the air supply pipe 29, and the circulatory medium at the initial heat of 500° C., as heretofore specified, becomes charged with such gaseous constituents of the substance undergoing treatment as have hitherto resisted distillation, and is protected from combustion only by exclusion of oxygen therefrom. Wherefore, if it be desired, a portion of said medium may be, in inflammable state, drawn from the main volume of the circulatory medium through a by-pass 85, and, upon supply of air to it from pipe 29, may be used for fuel in order to effect economically the reheating of a furnace at required intervals, as has been already specified.

The method of employment and of the functioning of the circulatory medium in its travel in circuit has been heretofore described in terms which are, in this description of operation, believed to require no enlargement.

What I claim is:

1. Apparatus for the destructive distillation of wood comprising a chamber closed as a whole against intrusion of air and provided with a plurality of successively communicating separable compartments, a circulatory closed heating system of which at least one of said compartments forms a part, said system containing a gaseous heating medium, a furnace heated by internal combustion adapted to heat said medium, means for heating another of the compartments excluded from said circulatory system by the products of combustion from said furnace, said closed system being cut off from the products of combustion, and means for closing said compartments from one another whereby they may be each independently heated without affecting the degree of heat in the other compartment.

2. Apparatus for the destructive distillation of wood comprising a chamber closed as a whole against intrusion of air and provided with a plurality of successively communicating separable compartments, a circulatory closed heating system of which at least one of said compartments forms a part, said system containing a gaseous heating medium, a furnace heated by internal combustion adapted to heat said medium, and means for directing the products of combustion from said furnace to another of the compartments excluded from said circulatory system to impart heat thereto, said last mentioned means preventing direct contact between the products of combustion and the material in said compartment, means for closing said compartments from one another whereby they may be each independently heated without affecting the degree of heat in the other compartment and means excluding the products of combustion from said closed system.

3. Apparatus for the destructive distillation of wood comprising a chamber closed as a whole against intrusion of air from without and provided with a plurality of communicating separable compartments, a plurality of furnaces adapted to be separately heated by internal combustion therein, means for directing the products of combustion through one of said compartments to impart heat to the material therein, a circulatory heat system of which another of said compartments forms a part, a heating medium in said system, means for passing said medium to either of said furnaces selectively whereby heat may be imparted thereto, and means for cutting off the other of said furnaces from said circulatory system and excluding the products of combustion from said system, the circulatory system imparting a higher degree of heat to its said compartment than the products of combustion impart to the other compartment.

4. Apparatus for the destructive distillation of wood comprising a chamber closed as a whole against intrusion of air from without and provided with a plurality of communicating separable compartments, a plurality of furnaces adapted to be separately heated by internal combustion therein, means for directing the products of combustion through one of said compartments to impart heat to the material therein, a circulatory heat system of which another of said compartments forms a part, a heating medium in said system, means for passing said medium through either of said furnaces selectively whereby heat may be imparted thereto, and means for selectively cutting off the other of said furnaces from

said circulatory system to permit the heating of the same by internal combustion, the circulatory system imparting a higher degree of heat to its said compartment than the products of combustion impart to the other compartment.

5. Apparatus for the destructive distillation of wood comprising a chamber closed as a whole against intrusion of air from without and provided with a plurality of communicating separable compartments, a plurality of furnaces adapted to be separately heated by internal combustion therein, means for directing the products of combustion through one of said compartments to impart heat to the material therein, a circulatory heat system of which another of said compartments forms a part, a heating medium in said system, means for passing said medium through any one of said furnaces selectively whereby heat may be imparted thereto, means for cutting off any one of said furnaces from said circulatory system, the circulatory system imparting a higher degree of heat to its said compartment than the products of combustion impart to the other compartment, and a heat equalizer in said circulatory system through which the said heating medium is passed before it enters said compartment.

6. Apparatus for the destructive distillation of wood comprising a chamber closed as a whole against intrusion of air from without and provided with a plurality of communicating separable compartments, a furnace, means for heating the furnace by internal combustion therein, a closed circulatory heating system of which one of said compartments forms a part, said system having a gas therein, means for passing the gas through said furnace, a second furnace, said furnaces adapted to be selectively cut into and out of said circulatory system, means for excluding air selectively from said furnaces when in communication with said circulatory medium, and means for directing the products of combustion from either furnace not in communication with said system through another of said compartments to impart a lower degree of heat thereto.

7. Apparatus for the destructive distillation of wood comprising a chamber closed as a whole against intrusion of air from without and provided with a plurality of communicating separable compartments, a furnace, means for heating the furnace by internal combustion therein, a closed circulatory heating system of which one of said compartments forms a part, said system having a gas therein, means for passing the gas through said furnace, a second furnace, said furnaces adapted to be selectively cut into and out of said circulatory system, means for excluding air selectively from said furnaces when in communication with said circulatory medium, and means for directing the products of combustion from either furnace not in communication with said system through another of said compartments to impart a lower degree of heat thereto, said last mentioned means serving to prevent direct contact with the products of combustion with the material in said compartment.

8. In apparatus for the destructive distillation of wood, the combination with a chamber closed as a whole against intrusion of air from without and provided within with a plurality of successively communicating separable compartments, and a circulatory system in operative communication with one of said compartments, of a plurality of furnaces each adapted to be heated by internal combustion therein, means for cutting a furnace into or off from communication with the circulatory system at will, said circulatory system being kept operative by the heat of said furnaces but closed against intrusion of air, means for directing the products of combustion from a furnace during the period of heating it by internal combustion into operative contact but without communication with another of said compartments and without communication with said circulatory system, and a boiler in operative communication with the means last named and out of communication with said circulatory system.

9. In apparatus for the destructive distillation of wood, the combination with a chamber closed as a whole against intrusion of air from without, and provided within with a plurality of successively communicating separable compartments, and a circulatory system in operative communication with one of said compartments, of a plurality of furnaces each adapted to be heated by internal combustion therein, and means for cutting a furnace into or off from communication with the circulatory system at will, said circulatory system being kept operative by the heat of said furnaces but closed against intrusion of air, means for directing the products of combustion from a furnace during the period of heating it by internal combustion into operative contact but without communication with another of said compartments and out of communication with said circulatory system, and a boiler in operative communication with the means last named, said boiler being in operative communication for humidifying purposes with the compartment last named and out of communication with said circulatory system.

10. Apparatus for the destructive distillation of wood comprising a chamber closed as a whole against intrusion of air

from without and provided with a plurality of communicating separable compartments, a furnace, means for heating the furnace by internal combustion therein, a closed circulatory heating system of which one of said compartments forms a part, said system having a gas therein, means for passing the gas through said furnace, a second furnace, said furnaces adapted to be selectively cut into and out of said circulatory system, means for excluding air selectively from said furnaces when in communication with said circulatory medium, means for directing the products of combustion from either furnace not in communication with said system through another of said compartments to impart a lower degree of heat thereto, said last mentioned means serving to prevent direct contact with the products of combustion with the material in said compartment, and a heat equalizer in said circulatory system between the furnaces and said compartment forming a part of said system.

11. Apparatus for the destructive distillation of wood comprising a chamber closed as a whole against intrusion of air from without and provided with a plurality of communicating separable compartments, a furnace, means for heating the furnace by internal combustion therein, a closed circulatory heating system of which one of said compartments forms a part, said system having a gas therein, means for passing the gas through said furnace, a second furnace, said furnaces adapted to be selectively cut into and out of said circulatory system, means for excluding air selectively from said furnaces when in communication with said circulatory medium, means for directing the products of combustion from either furnace not in communication with said system through another of said compartments to impart a lower degree of heat thereto, said last mentioned means serving to prevent direct contact with the products of combustion with the material in said compartment, a boiler through which the products of combustion pass, means for passing the products of combustion from said furnace through said boiler, and means of communication between said boiler and the compartment to which said products of combustion are directed.

12. In apparatus for the destructive distillation of wood whereby carbonized residue is produced, a chamber closed as a whole against the intrusion of air from without, a circulatory system of which said chamber forms a part, and including a source of heat serving as a regenerator, and a scrubbing and condensing means, said system having therein a circulatory medium, a cooling compartment for cooling the carbonized residue, and means for utilizing the waste heat of the carbonized residue in the cooling compartment for imparting heat to the spent medium of the circulatory system prior to its return to the regenerator of said system.

13. In an apparatus for the destructive distillation of wood whereby carbonized residue is produced, a chamber closed as a whole against the intrusion of air from without, a circulatory system of which said chamber forms a part, and including a source of heat serving as a regenerator, and a scrubbing and condensing means, said system having therein a circulatory medium, a cooling compartment for cooling the carbonized residue, and means for utilizing the waste heat of the carbonized residue in cooling compartment for imparting heat to the spent medium of the circulatory system prior to its return to the regenerator of said system, said source of heat consisting of a furnace adapted to be heated by internal combustion and to be selectively cut into or off from said circulatory system, and a means of air supply for said furnace in operative heating contact with, but not in communication with said circulatory system.

14. The process for effecting destructive distillation of wood which consists in placing the material to be treated in a closed chamber divided into a series of compartments closed from one another, passing a heating medium through a closed circulatory system of which one compartment constitutes a part, heating said medium at required intervals by a furnace, maintaining said furnace cut off from the intrusion of air while employed to heat said medium, intermittently cutting off said furnace from communication with said system and heating the same by internal combustion therewithin and utilizing for the purpose of heating another compartment of said chamber the heated products derived from said furnace while combustion is supported therein.

15. The process for effecting the destructive distillation of wood which consists in placing the material to be treated in a closed chamber divided into a series of compartments closed from one another, passing a heating medium through a closed circulatory system of which one compartment constitutes a part, heating said medium at required intervals by a furnace in communication with said system, maintaining said furnace cut off from the intrusion of air while employed to heat said medium, intermittently cutting off said furnace from communication with said system and heating the same by internal combustion therewithin, utilizing for the purpose of heating another compartment of said chamber the heated products derived from said furnace while combustion is supported

therein and placing the material in a cooling compartment after it has been subjected to said heating medium.

16. The process for effecting the destructive distillation of wood which consists in placing the material to be treated in a closed chamber divided into a series of compartments substantially closed from one another, passing a heating medium through a closed circulatory system of which one compartment constitutes a part, heating said medium at required intervals by a furnace in communication with said system, maintaining said furnace cut off from the intrusion of air while employed to heat said medium, intermittently cutting off said furnace from communication with said system and heating the same by internal combustion therewithin, utilizing for the purpose of heating another compartment of said chamber the heated products derived from said furnace while combustion is supported therein, placing the material in a cooling compartment after it has been subjected to said heating medium, and cooling said compartment by circulating therewithin a gradually cooling portion of said circulatory heating medium separated from the part thereof contained within the circulatory system.

17. The process for effecting the destructive distillation of wood which consists in placing the material to be treated in a closed chamber divided into a series of compartments substantially closed from one another, passing a heating medium through a closed circulatory system of which one compartment constitutes a part, heating said medium at required intervals by a furnace in communication with said system, maintaining said furnace cut off from the intrusion of air while employed to heat said medium, intermittently cutting off said furnace from communication with said system and heating the same by internal combustion therewithin, utilizing for the purpose of heating another compartment of said chamber the heated products derived from said furnace while combustion is supported therein, placing the material in a cooling compartment after it has been subjected to said heating medium, cooling said compartment by circulating therewithin a gradually cooling portion of said circulatory heating medium separated from the part thereof contained within the circulatory system and derived from the material introduced into said cooling compartment, and finally bringing into operative contact but not in communication with the return end of said circulatory system the heated circulatory medium derived from said material, whereby the heat thereof before it is lost in the cooling compartment is utilized to restore to the circulatory medium heat consumed within the circulatory system in its work of distillation.

18. In apparatus for the destructive distillation of wood, in combination, a chamber closed as a whole against intrusion of air from without, a circulatory system having therein a circulatory medium, said chamber forming a part of said circulatory system, a plurality of furnaces each adapted to be heated by internal combustion, means for cutting the furnaces serially into and off from direct communication with the circulatory system at will, said circulatory system being kept operative by the heat of said furnaces, but closed against intrusion of air, and means of air supply for said furnaces in operative heating contact but not in communication with said circulatory system.

In testimony whereof, I have hereunto set my hand.

WILLIAM K. LJUNGDAHL