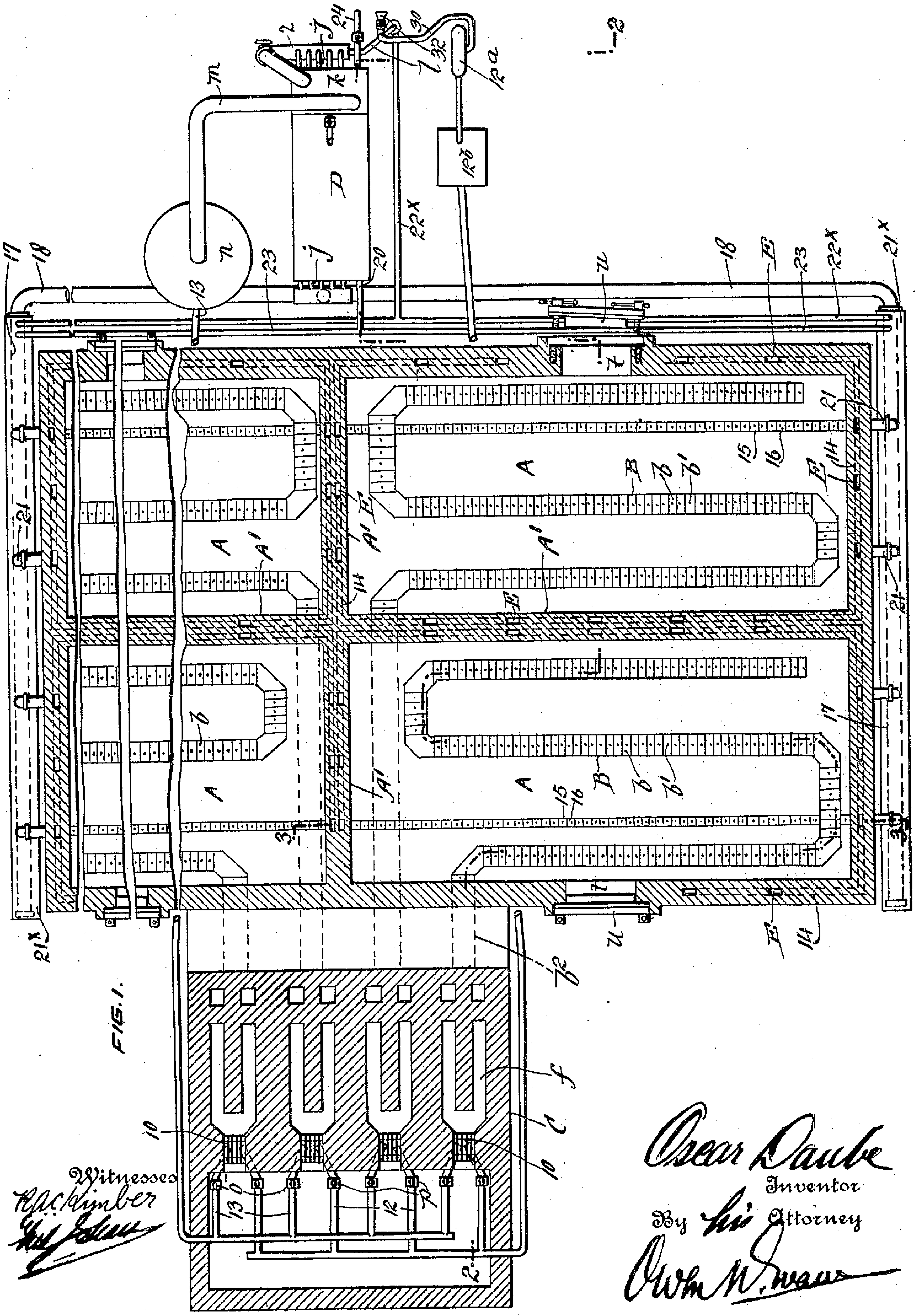
No. 705,213. Patented July 22, 1902.

O. DAUBE.

METHOD OF CARBONIZING ORGANIC MATERIALS.

(Application filed Oct. 25, 1901.)

(No Model.) 2 Sheets—Sheet 1.



Witnesses
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By his Attorney
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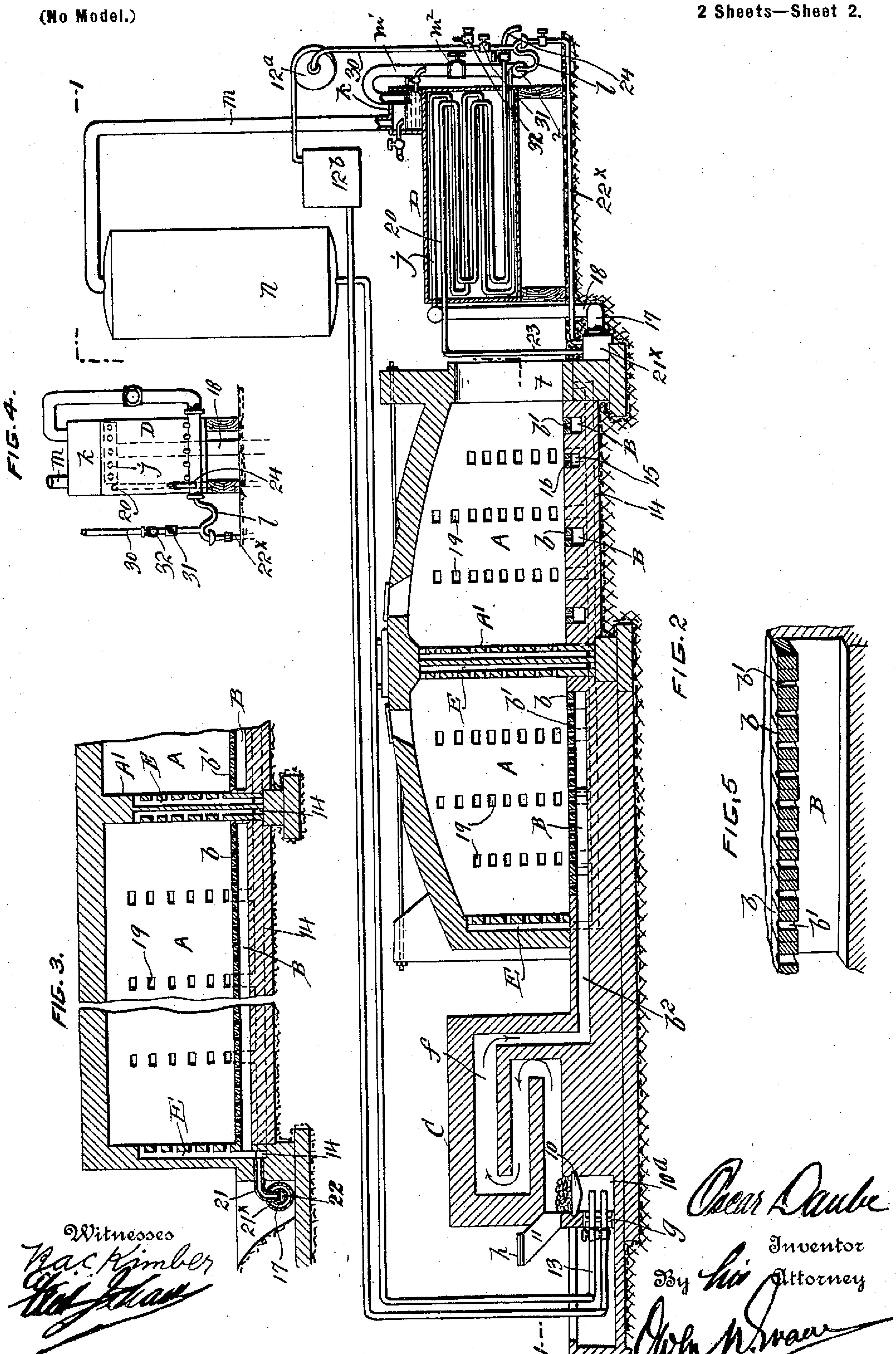

Witnesses

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UNITED STATES PATENT OFFICE.

OSCAR DAUBE, OF NEW YORK, N. Y.

METHOD OF CARBONIZING ORGANIC MATERIALS.

SPECIFICATION forming part of Letters Patent No. 705,213, dated July 22, 1902.

Application filed October 25, 1901. Serial No. 79,997. (No specimens.)

To all whom it may concern:

Be it known that I, OSCAR DAUBE, of the city of New York, borough of Manhattan, in the State of New York, have invented certain new and useful Improvements in Methods of Carbonizing Organic Material and Material of Organic Origin; and I do hereby declare that the following is a full, clear, and exact description of the same.

My invention has for its object to carbonize organic material—such as wood, bones, peat, brown or lignite coal, &c.—and enable charcoal and by-products—such as wood, alcohol, tar, acetic acid, and combustible gases—to be produced in greater relative proportion and in much less time than has been possible heretofore.

My improved method as applied to the carbonization of wood consists of the following: The wood is placed in a chamber having exhaust-ports open to the atmosphere and flues leading to a condenser, the latter being under the control of suitable water seals. While in this receptacle the wood is treated in the following manner: The resultant gas of the carbonization of wood consists of CO, seventeen per cent.; CO_2, fourteen per cent.; CH_4, nine per cent.; H, eleven per cent.; N, forty-five per cent.; C_2H_4, four per cent., free nitrogen being, as is evident, predominant. Air under compression of from five to eight pounds and the permanent gases just mentioned as resulting from the carbonization are first mixed in the proportion of sixty-six and two-thirds per cent. air and thirty-three and one-third per cent. gases. The resultant gas is then rendered non-combustible and brought to a temperature of from 400° to 600° Fahrenheit, preferably in the manner hereinafter specifically set forth, the non-combustible gas thus produced consisting of N, sixty-three per cent.; CO_2, twenty-four per cent., and this non-combustible gas is supplied to the carbonizing-chamber under the said pressure of from five to eight pounds, which will cause the moisture to be driven of from the wood and escape to the open air in the form of steam through the before-mentioned exhaust-ports. Obviously a percentage of heat is lost through the openings through which the steam passes, thus causing the temperature in the chamber to fall to about 300° Fahrenheit, which, while serving the purpose of completely freeing the wood of moisture, will be insufficient to cause carbonization. When the moisture has been completely driven off from the wood, steam will no longer be seen to issue from the exhaust-ports. These ports should then be closed, whereupon the temperature of the chamber will rise to that of the inflowing blast—viz., from 400° to 600° Fahrenheit—and in about thirty-six hours distillation will be completed. Meanwhile after the closing of the said exhaust-ports the volatile matter will be driven, under the said pressure of from about five to eight pounds, through the before-mentioned suitable seals to the condenser, from which the permanent gases are drawn and fed to the mixing-chamber to be mixed with the compressed air, as first mentioned. The raw liquor of the by-products is distilled by subjecting it to the heat of the gas emanating from the carbonizing process, while the material after having been carbonized is cooled by being subjected to the cooled gases flowing from the condenser.

In the accompanying drawings like symbols indicate the same parts.

Figure 1 is a horizontal section of the apparatus adapted for carrying out my improved method, the section being taken on line 1 1, Fig. 2. Fig. 2 is a vertical sectional view taken on lines 2 2 of Fig. 1 and illustrating one complete carbonizing-chamber, a mixing-chamber, a heat-generator, and a condenser of my apparatus. Fig. 3 is a transverse vertical sectional view taken on line 3 3, Fig. 1, looking to the left and illustrating particularly the exhaust connection from the carbonizing-receptacle to the main conduits. Fig. 4 is a detail rear elevation of the condenser; and Fig. 5 is a detail sectional perspective view of a portion of one of the floor-flues, illustrating particularly the perforated tiles thereon.

The apparatus in which I prefer to carry out my improved process consists of a group of receptacles A, of which I show four, separated from one another by division-walls A′, while the heat for each receptacle is generated in a separate furnace C of a battery of furnaces, each having a fire-grate 10 and ash-pit

10ᵃ, the latter constituting a combustion-chamber. As all four receptacles, together with their intake and exhaust flues, are the same, I will describe only one of them, with the connections between it and its furnace. A zigzag flue *f* in the furnace leads from the spaces above the fire-grate 10 to and communicates with a horizontal flue b^2, leading to said receptacles A and being connected therein to a horizontal serpentine flue B, located with its top on a level with the bottom of the floor of said receptacle. The inner end of this serpentine flue is closed, and its top is preferably formed by a series of tiles *b*, perforated, as at *b'*, these perforations increasing in transverse area from the outer to the inner end of the flue. The combustion-chamber 10ᵃ, which, as before mentioned, is constituted by the ash-pit, is closed by a door *g*, adapted to be hermetically sealed, and the fuel is fed to the fire-grate 10 through a chute 11, provided with a door or cover *h*, also adapted to be hermetically sealed while my process is being carried out. The walls of the receptacle are constructed with a series of vertical flues E, communicating at a number of points in their length with the interior of the said receptacle by means of flue-ducts 19, while their lower ends communicate with a horizontal flue 14, extending longitudinally through the lower portions of the walls and almost completely around the receptacle and connected to the ends of a flue 15, extending longitudinally of the receptacle and the top of which, like the top of the serpentine flue, is formed by perforated tiles 16, the perforations whereof, however, are preferably of uniform transverse area. The walls of the receptacle are formed with openings *t*, which constitute main exhaust-ports to allow the escape of the vaporized moisture or steam during the first step of the process, and doors *u* are provided to close these openings during the carbonization process proper. A pair of conduits 17 extend along the outside of the end walls of the group of receptacles and have their ends adjacent to the battery of furnaces closed, while their other ends are connected to a branch pipe 18, to which are also connected a series of coils *j* of a condenser, (indicated at D.) These conduits communicate with the receptacles by curved branches 21, leading to the flue 14, and the ends thereof which communicate with the conduits 17 are extended thereinto below the level of a water seal 22, Fig. 3, in the said conduit. The opposite ends of the coils *j* are connected to a header or separating-drum 2, from which the raw liquor is drawn off at 1, and the permanent gases rise through a pipe *m'*, controlled by a valve m^2 and the upper end whereof is bent over and dips into the water in a seal-box *k*, and from which the gases are conducted to a storage-tank or gas-holder, (indicated at *n*,) to which one end of each of a series of pipes 13 is connected, the other ends whereof lead to the mixing-chambers 10ᵃ, these pipes 13 being provided with taps *o*. A pipe with a series of branch pipes 12, provided with taps *p*, lead from an air-compression tank 12ᵇ, to be hereinafter described, to said mixing-chambers, the doors of which are adapted to be hermetically sealed.

In addition to the bank of coils *j* I provide a single coil 20, also within the condenser-casing, and inclose the pipe 17 in a larger pipe 21ˣ, constituting a vaporizer, to which I conduct the raw liquor by means of a pipe 22ˣ, while a pipe 23 leads from the top side of this vaporizer-pipe to one end of the said coil 20, the other end whereof is extended outside of the end wall of the condenser and provided with a drip-cock 24. The function of this arrangement is to utilize the radiant heat of the pipe 17 (for conducting the oven-gases to the condenser) to vaporize the raw liquor, and thereby free the wood-alcohol therefrom, the wood-alcohol then rising into the said coil 20, wherein it is condensed and runs therefrom in a liquefied state. The air-compressor (indicated at 12ᵃ) and its compression-tank 12ᵇ are also in communication with the raw-liquor vent 1 by means of a branch pipe 30, controlled at one end by a valve 31 and having a valve-controlled air-intake 32, in order to allow oven-gases to be drawn from the oven through the condenser, thereby being cooled and then compressed and finally forced under the required pressure to the combustion-chambers of the furnaces, thereby reducing the temperature in the receptacles A.

In carrying out my improved process in connection with the treatment of wood I will describe the action in one compartment only and its furnace. A fire is caused to burn on the fire-grate, and the gases collected from previous treatments and stored in the gas-holder *n* are by opening of a tap *o* allowed to flow into the combustion-chamber, and simultaneously air under a pressure of from five to eight pounds is by the opening of the tap *p* also allowed to flow into the combustion-chamber in a sufficient quantity (controlled by said tap *p*) to cause the fire to burn, say, two hundred cubic feet per minute of a compressed air to one hundred cubic feet per minute of the gases above mentioned. The burning, as is well known, consumes a large percentage of the oxygen contained in the gases and air, the heated gas emitted from the fire being largely nitrogen and carbonic-acid gas, and consequently non-combustible, and the quantity of this non-combustible gas is increased by the supply of air, owing to the heated nitrogen liberated therefrom during combustion. It is consequently obvious that as these gases supplied to the carbonizing-chamber constitute the carbonizing-blast said blast is a non-supporter of combustion. The heated non-combustible gases emanating from the fire are forced by the pressure before mentioned through the zigzag flue *f*, horizontal flue b^2, serpentine flue B, and perforations *b'* into the receptacle containing the wood to be carbonized, where it will arrive at a temperature of from about 400° to 600° Fahrenheit.

It may be pointed out here that the temperature of the gases as they leave the fire is about 1,500° Fahrenheit, which is too intense a heat for the purpose, hence the zigzag and horizontal flues, which allow said intense heat to dissipate itself to a certain extent by radiation and absorption by the material in the ovens, and thereby become reduced to from about 400° to 600° Fahrenheit, above mentioned. These non-combustible heated dry gases flowing under pressure into the receptacle at the temperature of from 400° to 600° Fahrenheit act upon the wood therein vaporizing its moisture and driving it off therefrom and out through the openings *t*, in the form of steam, thereby maintaining a temperature within the receptacle of about 300° Fahrenheit while the doors are displaced. As soon as steam is no longer visible issuing from the openings *t*, and consequently no more moisture is being driven off from the wood, the doors should be set in place and sealed, when the temperature in the receptacle will rise to that of the blast—viz., from 400° to 600° Fahrenheit—and carbonization will commence and being continued for about thirty-six hours will be completed. Meanwhile after the closing of the doors the by-products will have passed from the receptacle through exhaust-flue ducts 19 and E and 15 to the conduits 17, and thence to the condenser, and finally in the form of permanent gases to the gas-holder or raw liquor into any suitable reservoir.

The water seals in the conduits prevent backflow from the condenser to the receptacle.

If desired, the material in the two front ovens can be carbonized, and the indirect heat generated from said carbonization will serve to dry out the damp wood in the two rear ovens or the reverse.

The advantages attendant upon this method are that owing to the preliminary drying of the material carbonization will take place in much less time than has been possible heretofore and the raw liquor will be of greater commercial value, for the reason that (owing to the elimination of the moisture from the wood) the distillate will come from the condenser in a reduced quantity, proportionately speaking, but at a very much increased Baumé strength, causing a great saving in the fractional distillation of the raw liquor into wood-alcohol and acetic acid. Furthermore, owing to the pressure of from five to eight pounds the drying-draft is altogether outward while the doors *u* are displaced, and when they are set in place and sealed the gases emanating from the material being carbonized are driven through the exhaust-ports immediately they free themselves, consequently insuring the constant subjection of the material to a fresh carbonizing-blast with its full efficiency.

It is of the utmost importance to subject the wood or other material to be carbonized to a heat that is capable of absorbing a large amount of moisture naturally contained in wood and in like other material. It is a well-known fact that wood, for instance, has heretofore been stored twelve months previous to proposed carbonization for the purpose of eliminating by evaporation as much moisture as possible. Nevertheless the wood finally reaches the carbonization stage containing from twenty to twenty-eight per cent. of moisture. The dry-air blast which I employ has the tendency to absorb and drive off the larger part of this moisture, which, as before set forth, escapes in the form of steam.

If desired, the gas and air after having been mixed can be raised in temperature in other ways than by passing them through a fire, in which case the proportion of air to the combustible gases will be sufficient to produce combustion—say, for instance, three hundred cubic feet per minute compressed air five to eight pounds pressure to one hundred cubic feet per minute combustible gases—which will be sufficient to give the pressure necessary to cause the desired blast.

The object of passing the above-described mixture of air and gases through the fire is to eliminate any carbon monoxid therein, and thereby produce largely nitrogen and carbonic-acid gas, both of which are known to be non-combustible, as by sequence the carbonizing-blast constituted thereby and flowing to the oven must also be.

The process when used in the treatment of bones, peat, and brown or lignite coal is varied slightly as follows: Bones require a temperature of from 1,500° to 1,800° Fahrenheit, and this is easily obtained by increasing air-blast to twenty pounds and also increasing the supply of gas at the same time. Otherwise the process is just the same as before described. The said process holds good for coal where high temperature is required; but in peat the process is just exactly as described in connection with the carbonization of wood.

What I claim is as follows:

1. The method of carbonizing organic material and material of organic origin which consists in mixing sixty-six and two-thirds per cent. air under a constant pressure of from five to eight pounds and thirty-three and one-third per cent. highly nitrogenous gas; passing the resultant gas through a coal fire; reducing the temperature of the gas issuing from the fire to from 400° to 600° Fahrenheit, subjecting the material to be carbonized to said last-mentioned gas at the said temperature of from 400° to 600° Fahrenheit and under the said pressure still constantly maintained and exhausting the gases emanating from said material during carbonization immediately they free themselves, substantially as set forth.

2. The method of carbonizing organic material and material of organic origin which

consists in mixing sixty-six and two-thirds per cent. air under a constant pressure of from five to eight pounds and thirty-three and one-third per cent. highly nitrogenous gas recovered as by-product from carbonization of organic material, or material of organic origin or gases otherwise generated passing the resultant gas through a coal fire, reducing the temperature of the gas issuing from said fire to from 400° to 600° Fahrenheit, subjecting the material to be carbonized to said last-mentioned gas at the said temperature of from 400° to 600° Fahrenheit and under the said pressure still constantly maintained exhausting the gases emanating from said material during carbonization immediately they free themselves collecting and condensing the gases thus exhausted and collecting the by-products, substantially as set forth.

3. The method of carbonizing organic material and material of organic origin which consists in mixing sixty-six and two-thirds per cent. air and thirty-three and one-third per cent. highly nitrogenous gas recovered as by-products from carbonization of organic material or material of organic origin or like gases otherwise generated; passing the resultant gas through a coal fire, reducing the temperature of the gas issuing from said fire to from 400° to 600° Fahrenheit, preliminarily subjecting the material to be carbonized to said last-mentioned gas at the said temperature of from 400° to 600° Fahrenheit and under the said pressure still constantly maintained and simultaneously allowing the escape to the atmosphere of the vapors emanating from said material during said preliminary step, thus subjecting said material to be carbonized to said last-mentioned gas, cooling the carbonized material by subjecting same to the cooled gases emanating from the carbonizing process after they have been cooled in the condenser.

In testimony whereof I have affixed my signature in presence of two witnesses.

OSCAR DAUBE.

Witnesses:
ALBERT FREDRICK,
EMMA DAUBE.