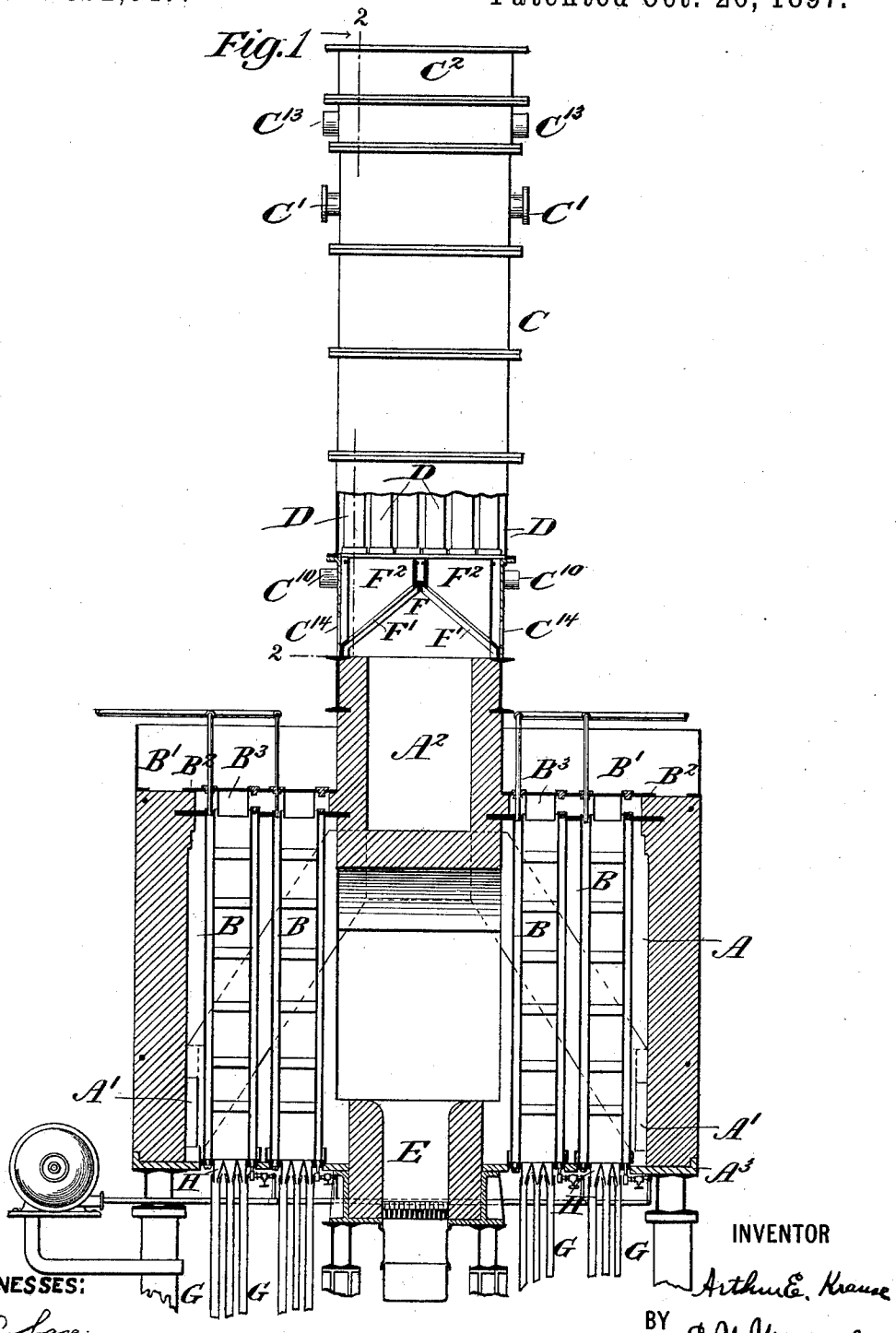
(No Model.) 5 Sheets—Sheet 1.

A. E. KRAUSE.

APPARATUS FOR REVIVIFYING BONE BLACK.

No. 592,547. Patented Oct. 26, 1897.

Fig. 1



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APPARATUS FOR REVIVIFYING BONE BLACK.

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Fig. 2.

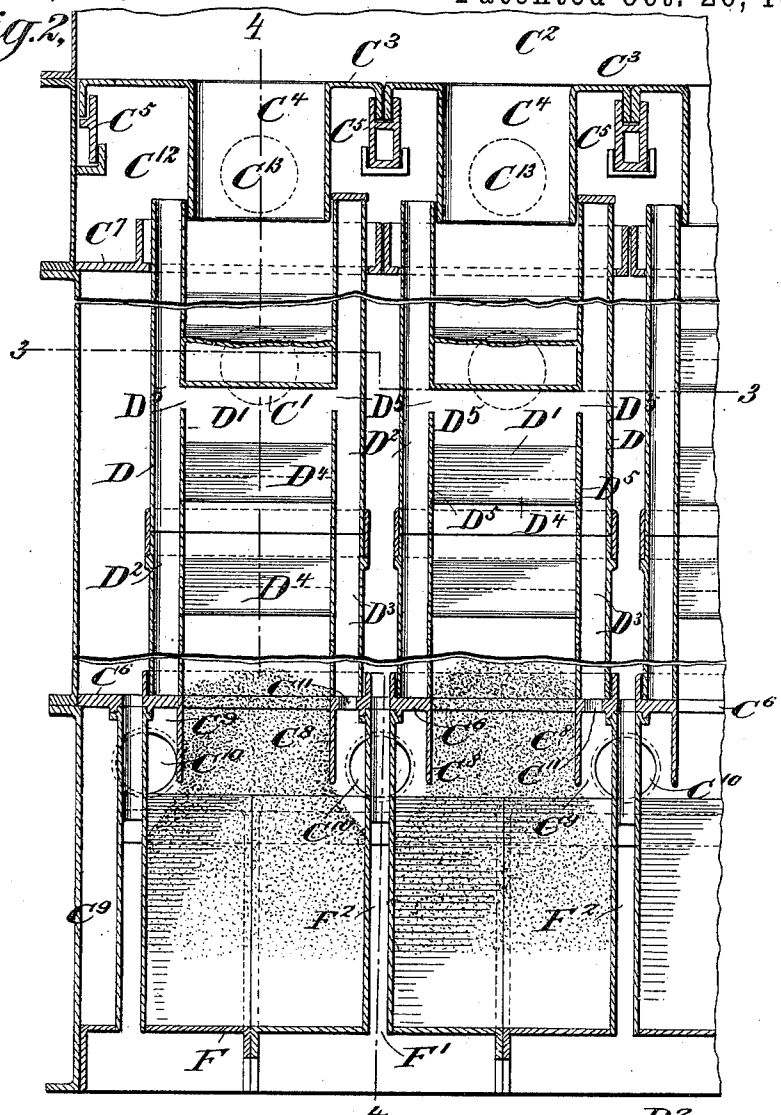

Fig. 3.

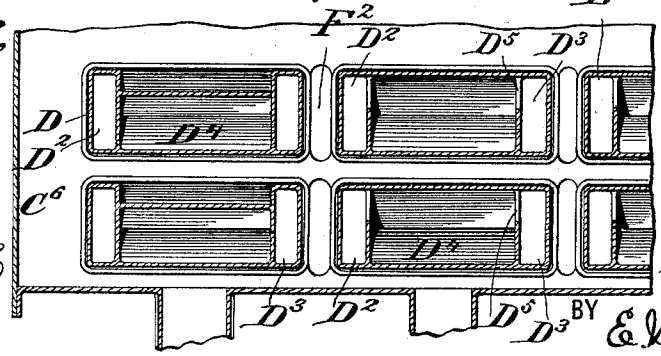

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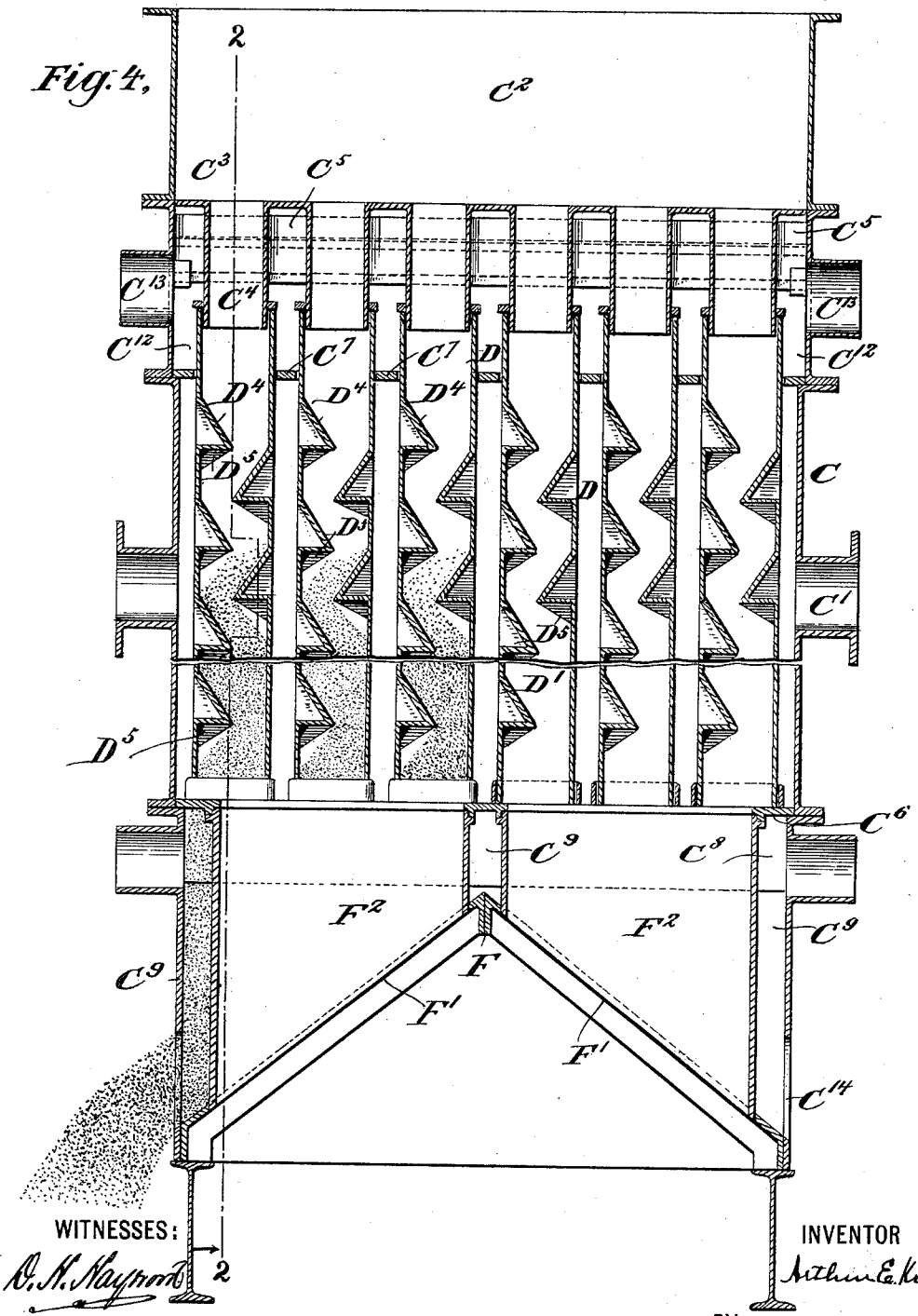
Fig. 4.



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APPARATUS FOR REVIVIFYING BONE BLACK.

No. 592,547. Patented Oct. 26, 1897.

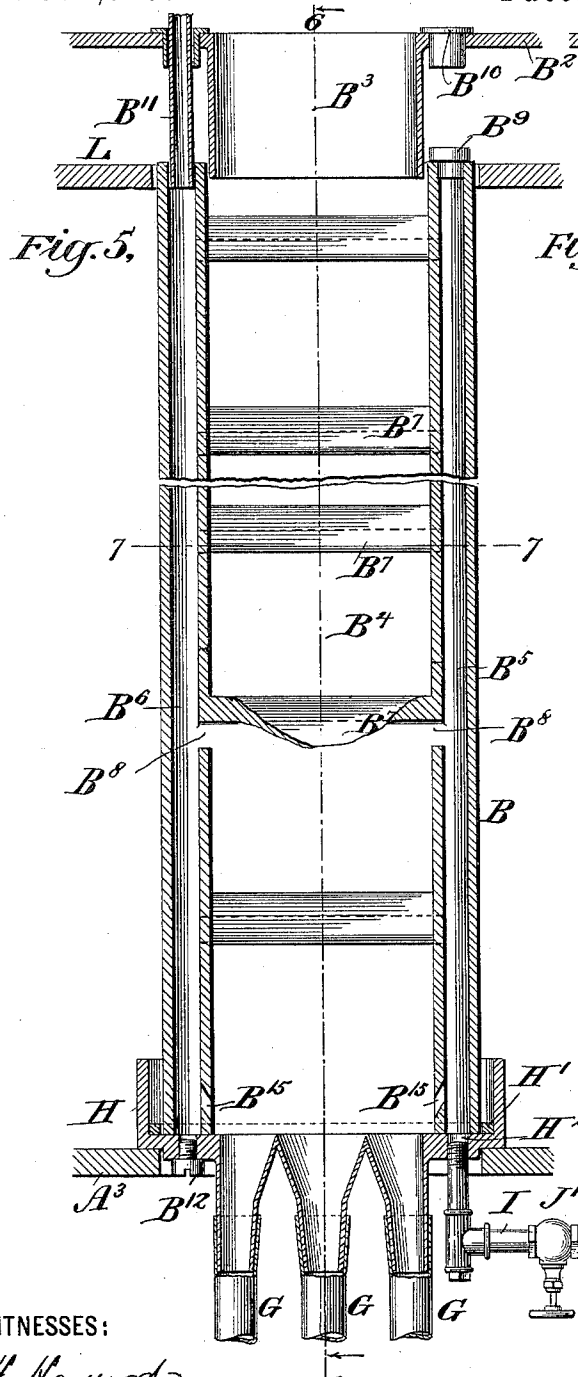

Fig. 5,

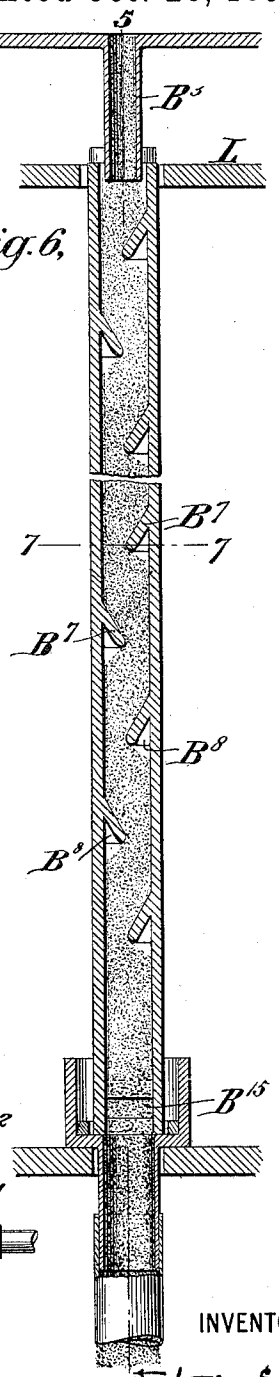

Fig. 6,

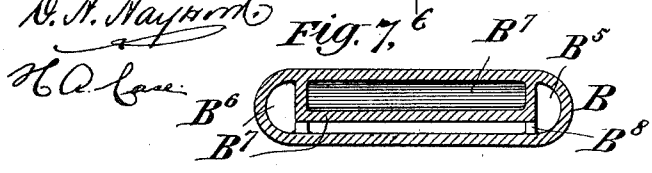

Fig. 7,

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A. E. KRAUSE.

APPARATUS FOR REVIVIFYING BONE BLACK.

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Fig. 8.

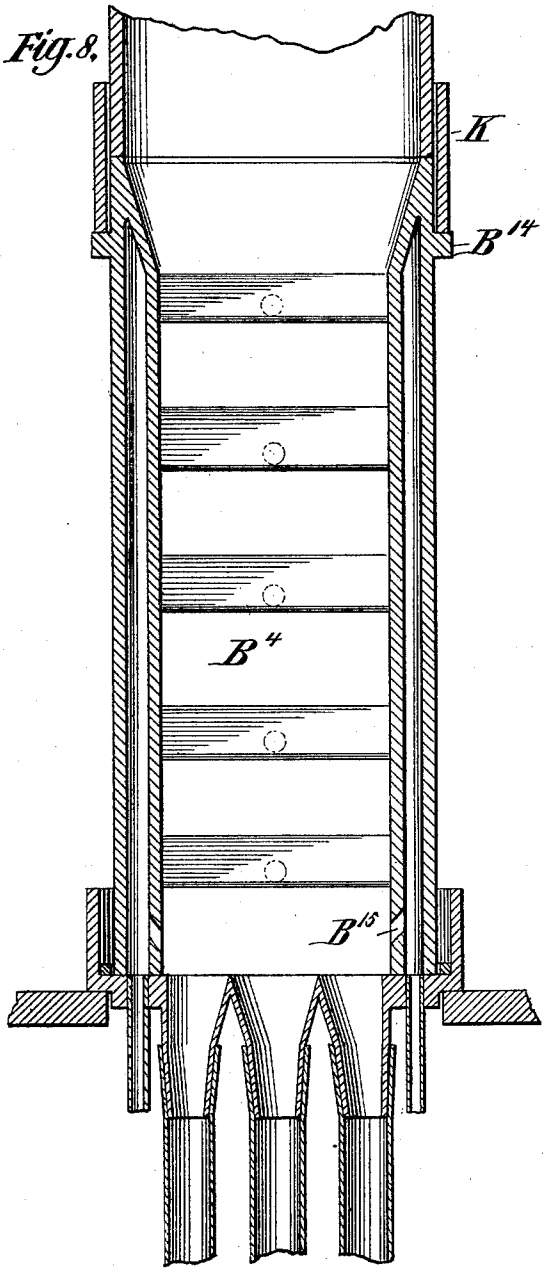
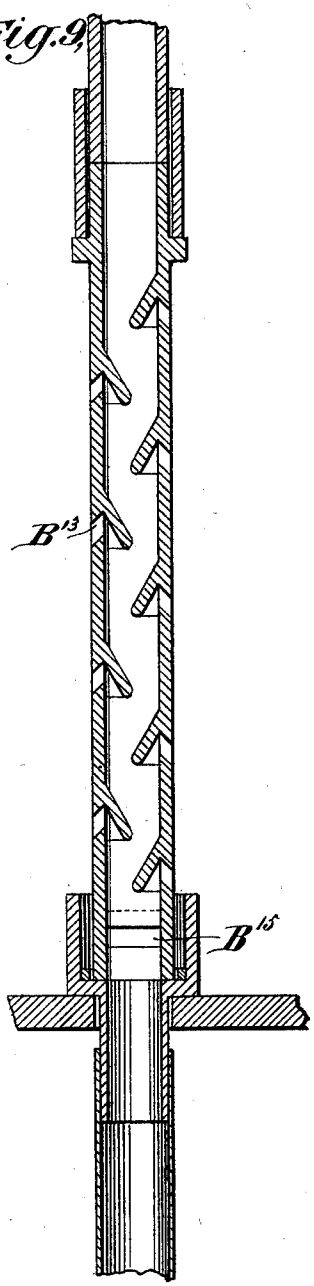


Fig. 9.



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UNITED STATES PATENT OFFICE.

ARTHUR E. KRAUSE, OF JERSEY CITY, NEW JERSEY.

APPARATUS FOR REVIVIFYING BONE-BLACK.

SPECIFICATION forming part of Letters Patent No. 592,547, dated October 26, 1897.

Application filed April 13, 1896. Renewed July 10, 1897. Serial No. 644,131. (No model.)

To all whom it may concern:

Be it known that I, ARTHUR E. KRAUSE, a citizen of the United States, residing at Jersey City, in the county of Hudson and State of New Jersey, have invented certain new and useful Improvements in Apparatus for Drying, Revivifying, and Decarbonizing Bone-Black; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to apparatus for drying, revivifying, and decarbonizing bone-black, such as is used in the processes of purifying sugar, and for the treatment of other substances of a similar nature which require drying or heating within retorts; and my invention consists in the novel means provided for securing circulation of air through the revivifying-retorts and for regulating the circulation of air, in the novel means provided for decarbonizing bone-black, in the novel means provided for carrying away moisture, vapors, and gases, in the novel means provided for preventing overheating of the bone-black at the edges of the retorts, in the novel means provided for preventing warping of the retorts, in the novel construction of the drier and the drying-tubes thereof, and in the novel details of construction, combination, and arrangement of the parts of the apparatus hereinafter specified.

The objects of my invention are, first, to provide an apparatus of the class described which may be capable of drying, revivifying or calcining, and decarbonizing bone-black or substances of a similar nature more thoroughly, efficiently, and economically than the apparatus heretofore used; second, to provide improved means for carrying off the gases and moisture; third, to provide improved means for decarbonizing bone-black within the revivifying-retorts themselves; fourth, to provide retorts so constructed as to avoid the possibility of overheating the bone-black near the edges of the retorts; fifth, to provide an improved drier for drying the bone-black before it passes into the revivifying-retorts, and, sixth, to make the whole apparatus simple, compact, economical in operation, easy of maintenance and repair, and as inexpensive as possible. These objects are attained in the apparatus for drying, revivifying or calcining, and decarbonizing bone-black and other similar substances herein described, and illustrated in the drawings which accompany and form a part of this application, in which the same reference-letters indicate the same or corresponding parts, and in which—

Figure 1 is a general elevation of the apparatus, the revivifying kiln and retorts and a portion of the drier being shown in section. Fig. 2 is a vertical section of a portion of the drier and the drying-tubes on the section-line 2 2 of Figs. 1 and 4. Fig. 3 is a horizontal transverse section of a portion of the drier on the irregular section-line 3 3 of Fig. 2. Fig. 4 is a vertical section of the drier on the irregular section-line 4 4 of Fig. 2, and at right angles to the section of Fig. 2, the section-line passing through the center of a drying-tube and through the center of one of the flues F^2. Fig. 5 is a central transverse vertical section of a revivifying-retort, taken through the center of the retort. Fig. 6 is a transverse vertical section of the retort, taken on a plane at right angles to the plane of section of Fig. 5, the section of Fig. 5 being taken on the line 5 5 of Fig. 6 and the section of Fig. 6 taken on the line 6 6 of Fig. 5. Fig. 7 is a transverse horizontal section of the revivifying-retort on the line 7 7 of Figs. 5 and 6. Figs. 8 and 9 show a modified form of retort particularly adapted for use where existing retorts of the ordinary type are to be altered so as to decarbonize the bone-black by the method hereinafter described, Fig. 8 being a sectional view similar to Fig. 5 and Fig. 9 being a sectional view similar to Fig. 6.

In the drawings, A is the revivifying-kiln. B B are revivifying-retorts within said kiln. C is a drier through which the bone-black passes before it enters the retorts B, so that as much moisture as possible may be driven off before it enters the retorts. The drier is provided with a series of drying-tubes D. E is the furnace of the kiln A. The products of combustion rising from this furnace fill the kiln A and pass out through flues A′ A′ at the sides and near the bottom of the kiln into a collecting-chamber A^2 at the top of the kiln, from whence they pass out through openings F′ in a bridge F at the bottom of the drier C

and through flues F^2 F^2 into the main body of the drier and around the drying-tubes D thereof, and thence out through pipes C′ C′ into a chimney.

At the top of the drier C is a hopper C^2, into which the bone-black is delivered. The bottom of the hopper C^2 is formed by a series of sleeve-plates C^3, having downwardly-projecting sleeves C^4, fitting into the tops of the drying-tubes D. The sleeve-plates are supported by transverse beams C^5, themselves supported by brackets secured to the casing of the drier C. The drying-tubes D are supported at the bottom by bottom plates C^6 and are steadied at the top by top plates C^7, through openings in which they pass. The bottoms of the drying-tubes D rest within sockets formed on the bottom plate C^6, and these sockets may be luted with clay or other similar fireproof material, if desired, to make the joints air-tight. The bottom plates are also provided with aprons C^8. The purpose of these aprons will be hereinafter apparent.

The drying-tubes consist of tubes of substantially rectangular form having three passages—viz., the main or central passage D′, through which the bone-black passes, and side air-flues D^2 and D^3. The air-flues D^3 are closed at the top, but are open at the bottom, opening into the chamber C^9 below the bottom plate C^6 of the drier. The bottom of the chamber C^9 is formed by the bridge F, formed of inclined plates which meet at an apex in the center of the drier and having in them openings F′ for the passage of the furnace-gases, the flues F^2 connecting the openings F′ with corresponding openings in the bottom plate C^6 of the drier, so as to conduct the furnace-gases into the main portion of the drier and to permit them to circulate around the drying-tubes and heat the same. Pipes C^{10} conduct air into the body of the chamber C^9, and this air passes into the flues D^3 through openings C^{11} in the bottom plate C^6, opposite the lower ends of the flues D^3. The flues D^2 are closed at the bottom, but are open at the top. The flues D^3 are closed at the top.

In the sides of each drying-tube are openings or air-holes D^5, connecting the air-flues D^2 and D^3 with the central passage D′. In order to prevent the bone-black from entering these openings and so filling up the flues D^2 and D^3, and also in order to form air-passages across the chamber D′, through which air may pass from flue D^2 to flue D^3, passing over the bone-black and carrying away any moisture, vapors, or gases which may be liberated within the drying-tubes, the chamber D′ is provided with inclined shelves D^4 just above the air-holes D^5, which extend about half-way into the chamber D′, converting it into a zigzag passage, down which the bone-black passes somewhat slowly, being thrown from side to side by the inclined shelves, so that all of the particles of the bone-black are brought into proximity with the heated metal surfaces of the drying-tubes, and are therefore heated equably. The bone-black fills in under the shelves D^4, but in such a manner as to preserve uninterrupted air-passages between the air-holes D^5 for the passage of air across the chamber D′, as shown in Fig. 4.

In order that the drying-tubes may have the maximum of heating-surface, these inclined shelves D^4 are formed by setting inward the sides of the drying-tubes in the manner shown in Figs. 3 and 4.

Air passes out of the tops of the air-flues D^2 into the chamber C^{12} at the top of the drier, and from thence is led off through tubes C^{13}. Exhaust-fans may be connected to the pipes C^{13} or blowers may be connected to the pipes C^{10} to produce a draft through the flues D^3 and D^2 and across the passages D′ of the drying-tubes in case the natural draft is not sufficient.

The aprons C^8 prevent the bone-black which falls from the drying-tubes D from collecting on the roof F to such a height as to close the mouths of the air-pipes C^{10} and the air-openings C^{11}, leading to the air-flues D^3, but the bone-black fills in below the level of the apron, so as to form with the aprons natural air-conduits leading directly from the air-pipes C^{10} to the air-openings C^{11} and preventing the air from escaping through the discharge-openings C^{14} at the bottom of the chamber C^9. This is illustrated in Fig. 2.

The bone-black falling from the drying-tubes D upon the roof F slides down the inclined sides of the roof F and passes out through openings C^{14} in the casing of the drier C into hoppers B′ over the retorts B. The bottoms of the hoppers B′ are formed by sleeve-plates B^2, having downwardly-projecting sleeves B^3, fitting into the tops of the revivifying-retorts B. The revivifying-retorts communicate at the bottom with cooling-pipes G, in which the bone-black from the retorts B is cooled to a temperature at which it can be used. The connection between the retorts B and cooling-pipes G, of which there are a number to each retort, is made by socket or junction pieces H, supported by the bottom plate A^3 of the kiln. These socket-pieces are provided with sockets, into which the ends of the retorts B fit, and with nozzles, to which the cooling-pipes G are connected. To make the retorts air-tight at the bottom, the sockets of the socket-pieces H may be luted with clay or similar fireproof material, and to hold the retorts stationary in the socket-pieces spacing rings or pieces H′ are used. The retorts B are steadied at the top by head-plates L, through openings in which they pass.

The revivifying-retorts have an oval or rectangular section, but are proportionately narrower than are the drying-tubes. Like the drying-tubes they each have three passages—viz., a central chamber B^4 and air-flues B^5 and B^6. They have also transverse inclined shelves B^7, extending about half-way into the retorts and so converting the chambers B^4 into zigzag passage-ways. Beneath the shelves are holes

B^8, connecting the air-flues B^5 and B^6 with the central chambers B^4. An air-pipe I is connected to an opening H^2 in each socket-piece H and communicates with the air-flue B^5. The flue B^5 is closed at the top by the plug B^9, and directly above the plug B^9 is an opening in the socket-plate B^2, closed by a similar plug B^{10}. By removing these plugs access may be gained to the flue B^5 for the purpose of cleaning the same. The flue B^6 is closed at the bottom, but is open at the top, an air-pipe B^{11} being provided to carry away the air. Access to the flue B^6 may be gained from the bottom by removing the plug B^{12}.

When the retorts are heated, there is a natural draft of air through the pipe I and flue B^5, through the openings B^8 and across the chamber B^4 into the flue B^6, and thence out through the pipe B^{11}. The air thus circulating through the chamber B^4 performs two functions. In the upper portion of the retort it carries out the moisture still remaining in the bone-black, which was not entirely removed by the drier, together with the gases which are volatilized. In the apparatus most generally used formerly moisture which may remain in the char after it has passed into the revivifying-retorts is obliged to escape at the tops of the retorts and becomes immediately condensed in the cooler char within the upper portions of the retorts and hopper B′ and causes clogging of the char, and also causes a constant loss of efficiency, due to the constant reëvaporation of the moisture; but in my retort all such moisture, together with the vapors and gases evolved from the char, are carried up through the flue B^6 and the exhaust-pipe B^{11}. In the lower portion of the retort the current of air across the retort accomplishes the decarbonization of the char. The char is calcined in the central portion of the retort and the volatilization of the greater portion of the impurities contained therein is effected. By this calcination there is left in the pores of the char finely-divided carbon, which chokes and fills the pores of the char and impairs its action as a filtering agent. It has been found that char may be decarbonized by bringing the char when sufficiently hot into contact with a limited quantity of air. Care must be used that too much air is not admitted to the char; otherwise too much of the carbon will be burned off and the effectiveness of the char as a filtering agent will be impaired. Hitherto this decarbonization has been effected in separate and special decarbonizing apparatus, since it has been impossible, as retorts have been constructed heretofore, to introduce air into the retorts and bring it into contact with all portions of the char. In my retorts, however, all of the char passing through the retorts is brought into contact with air passing across the retorts beneath the shelves B^7. The admission of air to the retorts may be regulated with great nicety by valves I′ in the pipes J′. I prefer that the air delivered by the pipes I shall be heated, for when a hot blast is supplied both the drying and decarbonizing take place more readily, and for this purpose hot air is drawn off from around the cooling-pipes, thus avoiding the necessity of using a special air-heater and at the same time producing a circulation of air around the cooling-pipes. A pressure-blower may force this air through the pipes I, or an exhaust-fan may be connected to the exhaust-pipes B^{11} in case natural draft is not sufficient.

The air-flues B^5 and B^6 serve a further important function in that they prevent the front edges of the retorts from becoming overheated, which causes unequal heating of the char within the retorts. As is shown in Fig. 1, the retorts are arranged within the kiln A edgewise, so that the furnace-gases passing from the furnace E to the flues A′ strike the edges of the retorts nearest the fire. The front edges of the retorts are therefore heated to a higher degree than the sides and rear edges of the retorts, and in revivifying-kilns heretofore used considerable trouble has been caused by the unequal heating of the retorts, as also of the char therein. This trouble my invention obviates, since the air-flues B^5 and B^6 protect the front edges of the central chambers B^4 from unequal heating and cause the char therein to be heated uniformly. In passing through the flues B^5, also, the air becomes highly heated, and therefore is more efficient for effecting decarbonization of the char and for taking up and carrying off moisture evaporated from the char.

The shelves B^7, besides deflecting the flow of the char through retorts and besides forming the horizontal passages across the retorts, serve as stiffening-ribs to prevent warping or bending of the retorts, as do the partitions separating the flues B^5 and B^6 from the chamber B^4. This is important, because the retorts, heated to a red heat, in time, if not stiffened, tend to warp or change shape considerably, whereby their usefulness is impaired; but the shelves B^7 and the partitions so stiffen the retorts that little or no warping can occur.

The operation of my apparatus is as follows: The kiln A is heated by a fire within the furnace E, the furnace-gases filling the interior of the kiln A and passing out through flues into the collecting-chamber A^2, and thence through the openings F′ in the roof F and the flues F^2 into the drier C and around the retorts D, and thus out through the pipes C′. At the same time bone-black or char deposited within the hopper C^2 flows down into the drying-tubes D and is thrown from side to side by the action of the inclined shelves D^4, thus intermingling the particles of char so that all of the particles are brought into proximity with the heated metal surfaces and are heated uniformly. This intermingling also causes all of the particles of char to be brought into contact with the air-currents passing across the drying-tubes from the air-flues D^3 to the air-flues D^2. From the drying-tubes

D the char falls upon the inclined sides of the roof F and then flows out through the openings C^{14} in the sides of the drier C upon the hopper B′ over the revivifying-retorts. From the hopper B′ the char passes into the revivifying-retorts B, being heated therein as it flows down through the retorts. In the upper portion of the retorts what moisture still remains in the char is driven off, together with all volatile substances, and the gases thus driven off are carried by the currents of air flowing across the retorts from the flues B^5 into the flues B^6 and into the exhaust-pipes B^{11}, and thence are drawn off. As the char descends through the retorts it becomes heated sufficiently, so that the fine particles of carbon left in its pores when the volatile substances are driven off are burned away, leaving the pores of the char clear. The extent of this decarbonization is regulated by regulating the amount of air admitted through the valves J′. From the retorts B the char falls directly into the cooling-pipes G, where it is cooled, as in an ordinary apparatus of this kind.

In Figs. 8 and 9 there is illustrated a method of altering the retorts of existing bone-black-revivifying apparatus, so that the char may be decarbonized within the retorts in the manner above described. Sections may be cut from the lower ends of the existing retorts, and in the place of the sections thus cut off new sections may be provided, each having a central chamber B^4 with air-flues at its sides. These air-flues may be one a supply-flue and the other an exhaust-flue, similar to the retorts shown in Figs. 5 and 6, or both flues may be supply-flues, and the vapors and gases resulting from the decarbonization may be exhausted through passages B^{13} directly into the interior of the furnace. The sections of the retorts are connected by a collar K, supported upon lugs or a flange B^{14}, and this collar K may be luted to prevent the entrance of furnace-gases.

While the drying-tubes D of the drier C may be formed in one piece, as are the retorts B of the kiln A, they may with greater advantage be cast in sections, the sections being joined together by rings or collars, as shown in the drawings.

The revivifying-retorts B have at the bottom openings B^{15}, connecting the flues B^5 and B^6 with the chamber B^4, so that any char which may have gotten into the flues B^5 and B^6 will fall into the chamber B^4 at the bottom of the retort, and so be carried away with the main body of char.

Having thus completely described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In an apparatus for revivifying or calcining bone-black and similar substances, the combination, with a kiln having a retort-chamber and a furnace therefor, of a series of vertical retorts in said chamber having passages through which the bone-black may pass by gravity, having openings communicating with the bone-black passages, through which air may be admitted to and brought into contact with the bone-black, and having also escape-openings through which gases liberated within the retorts may escape, and means for conducting air to said air-openings, whereby the decarbonization of the bone-black is effected, substantially as described.

2. In an apparatus for revivifying or calcining bone-black and similar substances, the combination, with a kiln having a retort-chamber and a furnace therefor, of a series of retorts in said chamber having passages through which the bone-black may pass, having openings communicating with the bone-black passages through which air may be admitted to and brought into contact with the bone-black, and having also escape-openings through which gases liberated within the retorts may escape, shelves in said bone-black passages above and connecting corresponding air and escape openings and forming transverse air-passages, and means for conducting air to said air-openings, whereby the decarbonization of the bone-black is effected, substantially as described.

3. In an apparatus for revivifying or calcining bone-black and similar substances, the combination, with a kiln having a retort-chamber and a furnace therefor, of a series of retorts in said chamber having passages through which the bone-black may pass, having openings communicating with the bone-black passages, through which air may be admitted to and brought into contact with the bone-black, and having also escape-openings through which gases liberated within the retorts may escape, inclined shelves integral with the retorts in said bone-black passages above and connecting corresponding air and escape openings, which stiffen the retorts and form transverse air-passages, and means for conducting air to said air-openings, whereby the decarbonization of the bone-black is effected, substantially as described.

4. In a revivifying or calcining apparatus, the combination, with a kiln having a retort-chamber and a furnace therefor, of a series of retorts within said chamber having passages for the substances to be calcined, and having air-passages upon the sides against which the furnace-gases impinge, whereby the retorts are protected from overheating on those sides, substantially as described.

5. In an apparatus for revivifying or calcining bone-black and similar substances, the combination, with a kiln having a retort-chamber and a furnace therefor, of a series of vertical retorts within said retort-chamber having passages through which the bone-black may pass by gravity, and arranged to discharge the bone-black into cooling apparatus without the retort-chamber wherein the heat of the bone-black is imparted to the surrounding air, said retorts having also openings through which air may be admitted to

and brought into contact with the bone-black and the decarbonization of the bone-black thereby effected, and air-passages connected with said openings and with the air-spaces of the cooling apparatus, and adapted to supply heated air to the retorts, substantially as described.

6. A calcining-retort consisting of a tube formed of one piece of metal and having formed therein a main passage and flues connected with said main passage by openings, said tube being provided with inclined shelves within and extending part way across said main passage, and connecting corresponding openings of said flues, thus forming transverse air-passages across the main passage of the retort, substantially as described.

7. A calcining-retort consisting of a tube formed of one piece of metal and having formed therein a main passage and flues connected with said main passage by openings, and inclined shelves, integral with the retort, within and extending part way across said main passage, and connecting corresponding openings of said flues, which protect the openings, form transverse air-passages across the retort, and stiffen the retort, substantially as described.

8. In a revivifying or calcining apparatus, the combination, with a calcining-kiln, of a vertical tubular retort within said kiln, a socket in which said retort rests at the bottom, surrounding the lower end of said retort and adapted to receive luting material, and projecting through an opening in the bottom of the kiln, cooling-pipes connected with said socket-piece, and a spacing-piece within the socket and outside of the retort, for holding the retort stationary in the socket, substantially as described.

9. In a revivifying or calcining apparatus, the combination with a calcining-kiln, of a tubular retort within said kiln having a main passage and an air-flue at the side of said main passage open at the bottom of the retort, and a socket in which said retort rests at the bottom, surrounding the lower end of the retort and adapted to receive luting material, said socket projecting through the bottom of the kiln and having an opening registering with the open end of the air-flue, whereby air may be admitted to the air-flue, substantially as described.

10. In an apparatus for drying pulverulent and granular substances, a drying-tube consisting of a tube formed of one piece, and having a main passage and at opposite sides of said main passage air and exhaust flues, separated from the main passage by partitions integral with the tube which have in them at intervals openings connecting the main passage with the air and escape flues, said tube having its sides set in between the air and escape flues so as to form inclined shelves above said openings extending part way into the main passage, substantially as described.

11. In an apparatus for drying pulverulent and granular substances, the combination, with a casing containing a main chamber and upper and lower air-chambers separated from the main chamber by top and bottom plates, of a series of drying-tubes within said main chamber, having main passages communicating at the bottom with the lower air-chamber through openings in the bottom plates, and having air and exhaust flues at the sides of the main passages and communicating therewith at intervals throughout the length of the main passages, the air-flues being closed at the top and being in communication with the lower air-chamber through openings in the bottom plate, and the exhaust-flues being closed at the bottom and in communication at the top with the upper air-chamber, and means for circulating heated gases through the main chamber of the drier, substantially as described.

12. In an apparatus for drying pulverulent and granular substances, the combination, with a casing containing a main chamber and a lower air-chamber separated from the main chamber by a bottom plate, of a series of drying-tubes within said main chamber having main passages communicating at the bottom with the lower air-chamber through openings in the bottom plate, and having air and exhaust flues at the sides of the main passages and communicating therewith at intervals throughout the length of the main passages, the air-flues being closed at the top and being in communication with the lower air-chamber through openings in the bottom plate, downwardly-projecting aprons at the lower ends of the drying-tubes arranged to prevent the filling up of the openings in the bottom plate communicating with the air-flues, and forming with the material flowing from the drying-tubes air-conduits leading to said air-openings in the bottom plate, air-supply pipes arranged to deliver air in the conduits so formed, and means for carrying away the air from the exhaust-flues of the drying-tubes, substantially as described.

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

ARTHUR E. KRAUSE.

Witnesses:
HELEN A. CASE,
HARRY M. MARBLE.