(No Model.) 3 Sheets—Sheet 1.

S. M. LILLIE.

APPARATUS FOR DRYING BONE BLACK IN SUGAR REFINERIES.

No. 343,666. Patented June 15, 1886.

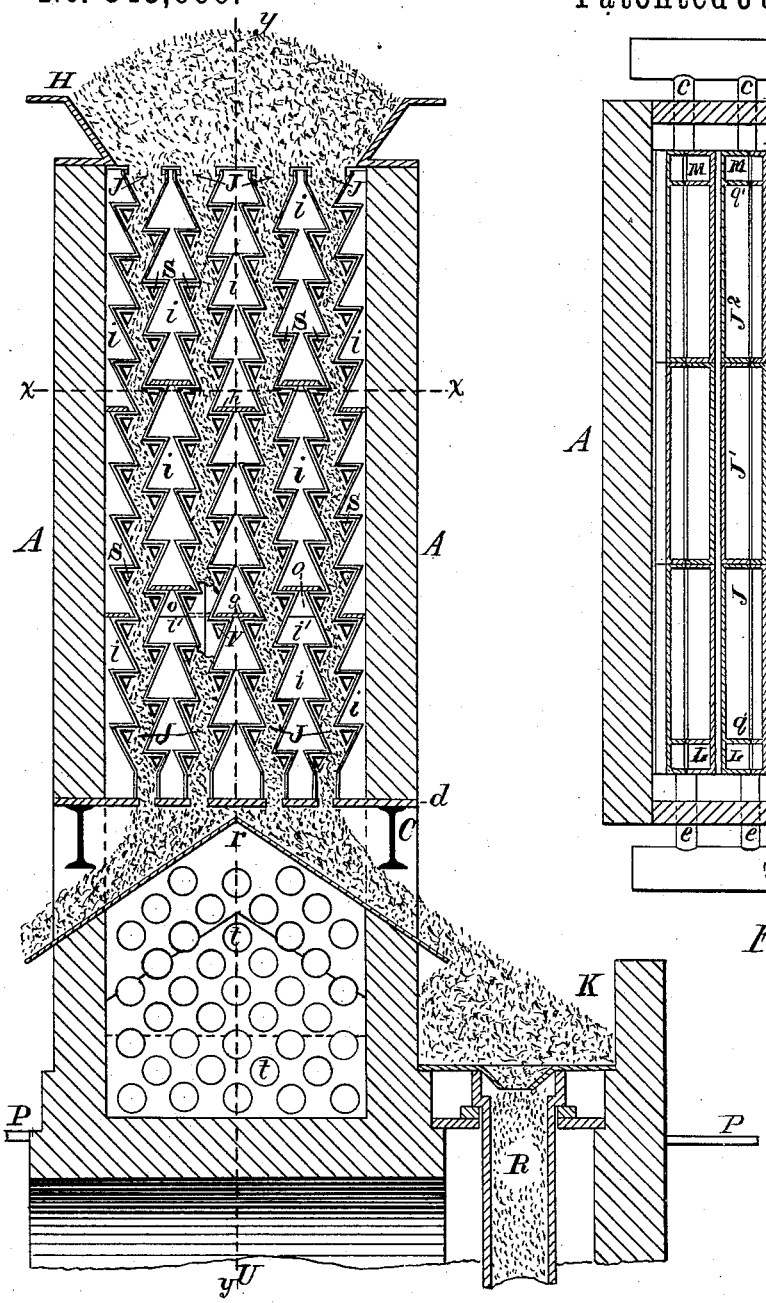

Fig. 1

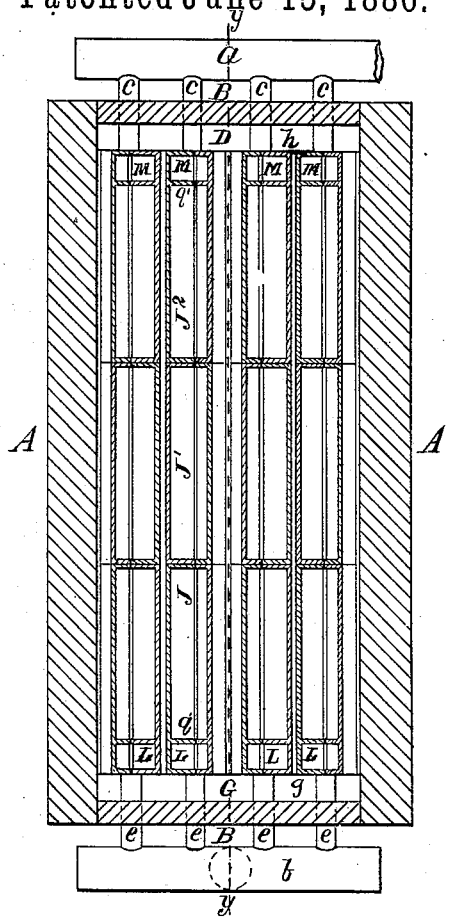

Fig. 2

WITNESSES:
Samuel C. Hooker.
Jacob C. Muench.

INVENTOR
S. Morris Lillie

(No Model.) 3 Sheets—Sheet 2.

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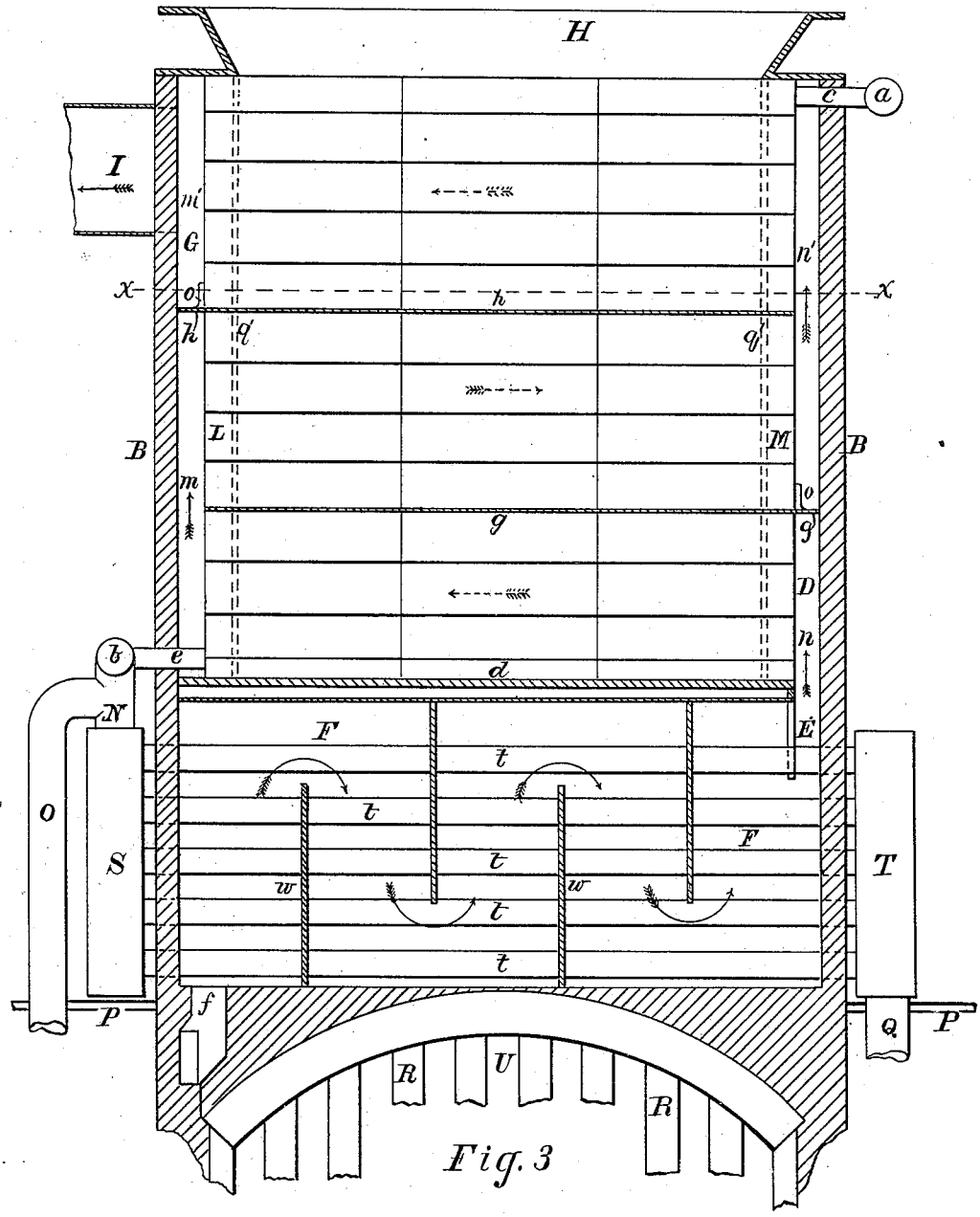

Fig. 3

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(No Model.) 3 Sheets—Sheet 3.

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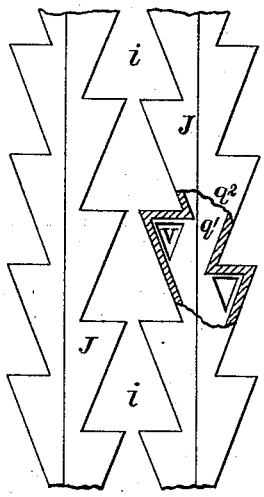

Fig. 4

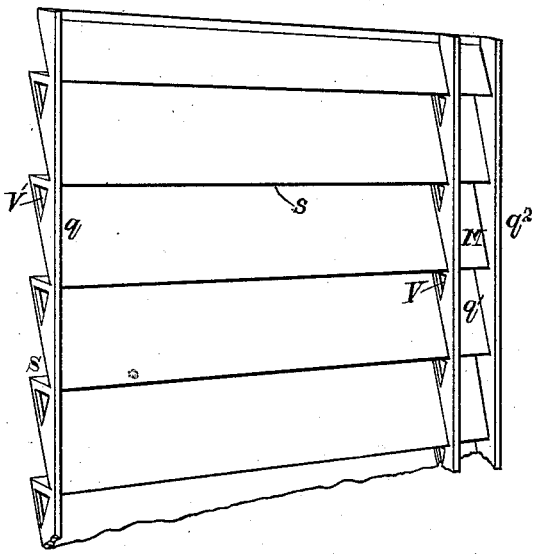

Fig. 5

WITNESSES:
Samuel C. Hookes.
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INVENTOR
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UNITED STATES PATENT OFFICE.

S. MORRIS LILLIE, OF PHILADELPHIA, PENNSYLVANIA.

APPARATUS FOR DRYING BONE-BLACK IN SUGAR-REFINERIES.

SPECIFICATION forming part of Letters Patent No. 343,666, dated June 15, 1886.

Application filed February 17, 1886. Serial No. 192,319. (No model.)

To all whom it may concern:

Be it known that I, S. MORRIS LILLIE, of Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented new and useful Apparatus for Drying Bone-Black in Sugar-Refineries, of which the following is a specification, reference being had to the accompanying drawings.

My improvements relate to char-driers, which work on the principle of those patented to me by United States Patents No. 329,324, of October 27, 1885, and No. 335,137, of February 2, 1886—namely, that of drawing air heated by the radiation from the parts of the kiln and heated in a surface-heater by the products of combustion from the kiln through or over wet bone-black contained in suitable receptacles.

The drier forming the subject-matter of this invention consists of a rectangular case erected above the kiln, and having at each end a vertical chamber with horizontal flues of triangular cross-sections extending between the chambers, one of which chambers connects with the fire-chamber of the kiln by suitable flues and receives the hot products of combustion from it, and the other of which connects with the chimney or with exhausting apparatus by which the draft for the kiln-fire is produced. The horizontal flues between the chambers form in this rectangular case inclosing the drier vertical zigzag channels, which are filled by the black to be dried, and down through which the black slowly moves, being fed into a hopper above and drawn from the passages below into the retorts of the kiln. The black in the passages forms with the under surfaces of the triangular flues triangular spaces or passages, which extend from end to end of the drier; and the apparatus consists, further, in conduits connected with one end of each of these triangular passages and arranged for collecting the heated air from round the cooler-tubes, &c., of the kiln and from the surface-heater of the kiln, and also in conduits connected with the other ends of the triangular passages and with suitable exhausting apparatus, by which the heated air is drawn through the triangular passages, and so over the surface of the wet black.

In the drawings, Figure 1 is a vertical cross-section of the drier and of a portion of the kiln below it. Fig. 2 is a horizontal section along the broken line *x*, Figs. 1 and 3. Fig. 3 is a vertical longitudinal section along the broken line *y*, Figs. 1 and 2; and the remaining two figures are views of detached parts, as hereinafter described.

Referring to the drawings, A A are the vertical side walls of the rectangular box or case of the drier, and B B are the end walls of the same, all of which walls may be constructed of fire-brick or of other heat non-conducting material; or they may be formed of iron plates. The drier is supported upon the bed-plate *d* and beams C, and is surmounted by a hopper, H, into which the wet black is dumped, and from which the black flows into the zigzag vertical channels in the drier, presently to be described.

D is a vertical chamber at one end of the drier, which is connected by the flue E with the horizontal chamber F, located above the kiln and below the drier, into which the products of combustion from the fire-chamber of the kiln below flow through the connecting-flue *f*. At the opposite end of the drier is a vertical chamber, G, which connects with the chimney or other draft-producing apparatus through the flue I. The two vertical chambers D G are connected by the horizontal triangular flues *i*, and they, together with the vertical chambers D G, form the conduits for the hot products of combustion from the kiln-flue F to the chimney or exhausting-flue I.

The chamber D is divided into two compartments, *n n'*, by the horizontal partition *g*, located above the bottom of the chamber by about one-third of the height of the same, and the chamber G is similarly divided into two compartments, *m m'*, by a horizontal partition, *h*, located in the same about one-third of its height below the top of it. These plates each bear at the edge toward the flues the vertical triangular projections *o*, which close the portions of flues *i* which project above the level of the partition—as, for example, the upper portions of the flues *i' i'*. These partitions compel the gases to take a circuitous course through the flues of the drier, as indicated by the arrows, Fig. 3—namely, from the compartment *n* of the chamber D (which receives

the products of combustion from the kiln) through the lower tier of the flues *i* into the lower compartment, *m*, of the opposite chamber G, thence back through the middle tier of flues into the upper compartment, *n'*, of the chamber D, and thence through the upper tier of flues to the upper compartment, *m'*, of the chamber G, and thence to the exhaust. The flues *i* are arranged flue above flue in five vertical rows, forming between the rows the four vertical zigzag char-channels J, which open above into the hopper H, and below through the bed-plate *d* of the drier. Through these passages the char to be dried slowly moves, entering them from the hopper H above, and leaving them from below in proportion as the char which lies in the boxes K and on the roof *r* of the chamber F settles into the retorts R. The black in the zigzag channels forms with the walls of the flues *i* the triangular horizontal passages *s*, which open at opposite ends into the vertical passages L M. The ends of the zigzag channels are closed by vertical plates *q'*, which prevent the black falling into the vertical passages L M, but which have openings *v* through them between the passages and the vertical passages L M, as shown in Fig. 4, which is an elevation showing the end of a portion of one of the vertical rows of the flues *i* and the closed ends of the two adjacent zigzag channels J, of one of which latter the outer walls, *q²*, of the vertical passage L is broken away so as to show the inner plate, *q'*, with the openings *v* through it into the passages *s*. The vertical passages L connect at their lower extremities through the pipes *c* with the manifold *b*, which has the branching mains N O, the former of which connects with the surface-heater in the horizontal flue F, while the latter, O, passes through the floor P, and is arranged so as to collect the hot air from around the kiln and the cooler-tubes which are fitted to the lower extremities of the retorts R.

In Patents Nos. 329,324 and 335,137, issued to me October 27, 1885, and February 2, 1886, respectively, are shown methods which may be employed for collecting the heated air for the main O. The vertical passages M, at the other ends of the zigzag channels J, connect at their upper extremities through the pipes *c* with a manifold, *a*, which leads to an exhausting apparatus—such, for example, as a chimney, used for the kiln or for other furnaces or an exhausting-fan.

The surface-heater in the horizontal chamber F consists of a battery of tubes, *t*, which extend through the chamber longitudinally and protrude through the end walls of the same. The protruding ends of the tubes at opposite ends of the chamber open into the air-tight boxes S and T respectively, the walls of the tubes making air-tight joints with the sides of the boxes through which they open into the interior. The box S is connected by the main N, which is the eduction-main of the surface-heater, with the manifold *b*, while the box T has a main, Q, leading from it to any locality from which it may be wished to draw the air or gases which are to be heated in the surface-heater. The main Q may, for example, lead to the cooler-tubes and deliver heated air from around the same to the surface-heater. The chamber F contains a number of vertical partial partitions, *w*, extending alternately from the floor nearly to the roof of the chamber, and from the roof nearly to the floor of the chamber, through which partitions the tubes *t* pass, and which cause the products of combustion to flow up and down among the staggered rows of tubes while passing through the chamber F, as hereinafter described.

The workings of this drier are as follows: When in operation, the zigzag channels J in the drier are full of black, and black lies upon the roof of the chamber F and in the boxes K, from which the retorts R are fed, and there is a slow constant or intermittent downward motion of the black in the drier, caused by the settling of the black from the boxes K into the retorts R as the revivified black is drawn from the lower extremities of the latter. The hot gaseous products of combustion pass from the fire-chamber U of the kiln through the flue *f*, a part of which only appears in the drawings, into the chamber F, near one end, thence up and down among the staggered rows of tubes *t*, around the partial partitions W, and out of the chamber at the other end, through the flue E into the lower part of the vertical end chamber, D, of the drier, thence, through the lower tier of triangular flues *i*, into the lower compartment of the opposite end chamber, G, then back through the middle tier of flues *i* into the upper compartment of the vertical chamber D, and, finally, through the upper tier of flues into the upper portion of the chamber G and away to the exhaust through the flues I. The hot products of combustion, during their flow through the chamber F, heat air being drawn through the tubes *t* of the surface-heater, and in their passage back and forth through the flues *i* heat the black in the zigzag channels of the drier, which is in contact with the walls of the flues. The exhaust from manifold *a*, effected by an exhausting-fan, chimney, or other means, causes a flow of air heated by contact with and radiation from the cooler-tubes and the other parts of the kiln through the main O to the manifold *b*, and air or gases heated in the tubes *t* of the surface-heater through the main N to the manifold. Thence the heated air flows through the branches *c* into the vertical air-passages L, then along the horizontal passages *s*, over the black in the zigzag channels J, into the vertical air-passages M, and finally through the pipes *c* to the exhausting-main *a*. The hot air in passing through the horizontal passages *s* assists in drying the black exposed to it in the channels J, and carries off the vapors formed by the evaporation of the water in the bone-black, caused by the heated walls of the flues *i* and by the hot air itself.

This drier may be constructed in a variety of ways. For example, the triangular flues *i* may be triangular tubes of cast-iron, supported at their ends one above the other in vertical rows, the flues in each row having positions relative to the flues in the adjoining rows, so as to form the vertical zigzag channels J for the black; or the flues *i* and zigzag vertical channels J may be formed, as in the drawings, of vertical cast-iron plates, one of which is shown in perspective in Fig. 5, having a zigzag cross-section, or, in other words, cast with deep horizontal re-entrant angles *s*, and having at each edge a vertical flange, *q*, of proper width, with openings *v'* through it, opposite or in line with the re-entrant angles. A pair of these plates placed face to face and bolted together form an inclosed zigzag vertical passage J, closed at the ends by the vertical flanges of the plates, the edges of which flanges meet when the plates are bolted together and keep the said plates the proper distance apart. A pair of these plates put together thus may be termed a "section." A pair of these sections placed back to back, so that the edges of the horizontal angles meet, form between them horizontal triangular passages *i*. There are four of these inclosed vertical zigzag passages in the drier thus arranged back to back, as shown in Fig. 1 of the drawings. Again, by placing two or more of these sections edge to edge, so that the re-entrant angles of the sections are in line, in which case the re-entrant angles communicate with each other through the passages *v'* in the flanges *q*, the system may be extended indefinitely in a horizontal direction. In the drawings three of these sections, J J' J^2, are placed end to end. (See Fig. 2.) The vertical air-passages L and M are formed by having the plates forming the two end sections each bear at one edge two flanges, $q' q^2$, q^2 at the extreme edge and q' a short distance from the edge, the latter having openings *v* through it on a line with the re-entrant angles *s* and the other not so perforated. Plates thus formed when put together form a vertical passage, L or M, between the flanges, which passage connects with all of the re-entrant angles *s*, through the perforations or openings *v* through the inner flange, q'.

There are a variety of constructions which may be used for connecting the passages *s* at one end with supply-mains for bringing hot air to them, and at the other end with an exhaust-main, and I do not confine the scope of my invention to the particular method shown, nor do I confine myself to any one manner of causing the hot air to flow along the horizontal passages *s* over the black. Thus an exhausting-fan may be applied to the eduction-manifold *a*, as previously mentioned herein, and the air be drawn through the passages, or an exhausting-fan may be placed at the other end of the drier and draw the heated air from round the kiln and cooler-tubes through a main, such as O, and from the surface-heater in chamber F through a main such, as N, and deliver it into the manifold *b*, in which case the air will be forced along the passages *s* into and through the eduction-manifold *a*; or, again, the eduction end of the passages *s* may open into the vertical chamber D, and the manifold *a*, branches *c*, and vertical air-passages M be dispensed with, and the exhaust formed by the draft of the kiln be relied upon to draw the hot air through the passages *s*. I prefer, however, when a natural or chimney draft is used for the kilns, not to rely upon this draft for drawing the air or gases through the passages *s*, for the reason that if it is thus relied upon the air flowing from the passages *s* into the draft-flues will more or less impair the draft of the kilns, and I therefore prefer to exhaust the air through the passages *s* independently of it—as, for example, in the construction shown in the drawings, by means of an exhausting-fan attached to or connected with the eduction-manifold *a*.

The gist of the construction is the connection of the induction ends of the passages *s* with conduits for bringing air or gases heated by the waste heat of the kiln to the passages, in combination with means for forcing or drawing the said heated air or gases through the passages; and the gist of the process consists in the passing of air or gases heated by the waste heat of the kiln over the surface of wet bone-black to dry the same preparatory to passing it through the retorts of the kiln.

It is apparent that in so far as the formation of the horizontal passages *s* through the black is concerned it is immaterial whether the inclined ledges—the sides of the flues *i* in the drawings—extending horizontally through the chamber of the drier are the side walls of triangular flues or whether they are simply inclined shelves or ledges supported horizontally on the faces of vertical plates extending from top to bottom and from end to end of the drier-chamber, and I therefore do not limit myself to passages *s* formed between horizontal "flues" and the black. It is also evident that by having the passages *s* on one side of each of the vertical zigzag channels J connect only with the induction vertical channel L and the passages *s* on the other side of the channel J connect only with the eduction-main M the heated air or gases will pass through the black as well as over it—that is, they will flow from the vertical passage L into the passages S on one side of the zigzag channel J, and then pass through the body of the black into the passages *s* on the other side, and thence to the eduction-passages M. I wish also to add that, following the method described and claimed in the other patents of mine before mentioned in this specification, the eduction manifold or conduit *a* may lead to a condenser or to other apparatus in which the moist and more or less heated air or gases from the passages *s* may be used for heating water or for other useful purposes, for which the latent and sensible heats of the gases, or either, may be used. Thus,

Having described my invention, I claim as mine and wish to secure to myself by Letters ters Patent of the United States—

1. The within-described process of utilizing the waste heat of bone-black-revivifying kilns, consisting in passing air or gases heated by the said waste heat of the kilns over the surface of wet bone-black to dry the same preparatory to passing it through the retorts of the kiln, substantially as and for the purpose specified.

2. In the bone-black drier of a revivifying-kiln constructed substantially as described, with horizontal flues for the products of combustion from the kiln to pass through, the combination, with the horizontal passages such as *s* formed between the black and the under surface of the flues, of hot-air conduits connecting with the passages at one end, and means for forcing or drawing hot air from the conduit through the passages over the surface of the black, substantially as specified.

3. The within-described apparatus for utilizing the waste heat from bone-black-revivifying kilns for drying bone-black, consisting of a vertical chamber with openings at top and bottom downward, through which the black to be dried slowly flows, inclined ledges, such as the sides of the flues *i*, extending horizontally through the chamber, and forming, with the black in the chamber, horizontal passages, such as *s*, extending through the chamber, conduits connecting with the said passages at one end of the chamber, and leading to the kiln to collect the air or gases heated by the waste heat of the same, and means for forcing or drawing the hot air or gases from the conduits through the horizontal passages formed with the black by the inclined ledges, substantially as specified.

4. In a bone-black drier constructed substantially as described, the combination, with the horizontal passages formed by the black and the inclined ledges, as specified, of induction-conduits for hot air or gases communicating with the passages at one end of the drier, and eduction-conduits connected with the passages at the other end, and fans or other means for forcing or drawing the hot air or gases from the induction-conduits through the said horizontal passages in the black into and through the eduction-conduits to the desired destination for the warm and moisture-ladened gases, substantially as set forth.

5. In a char-drier operating as substantially described, the combination, in the chamber of the same, of vertical plates formed with deep re-entrant angles, the said plates being placed side to side and forming the horizontal flues *i*, and vertical zigzag channels J, extending through the chamber of the drier, substantially as specified.

6. The combination, in the chamber F, with the horizontal tubes *t* of the surface-heater, of the vertical partial partitions *w*, through which the tubes pass, and which touch alternately the floor and the roof of the chamber, the said partial partitions dividing the chamber into a circuitous channel leading up and down among the tubes for the hot products of combustion to flow through, substantially as specified.

7. In a char-drier of a construction equivalently as specified, the combination, with the horizontal air-passages, such as *s*, in the drier, of an exhausting fan or apparatus independent of or additional to the means for producing the draft of the kiln, connected with the air-passages at one end by suitable conduits (as, for example, by the manifold *a* and branches) and operating to draw air or gases through the said air-passages, substantially as described.

S. MORRIS LILLIE.

Witnesses:
W. BUGBEE SMITH,
ROBT. W. SCOTT.