(No Model.) 2 Sheets—Sheet 1.

S. M. LILLIE.

BONE BLACK DRIER.

No. 351,929. Patented Nov. 2, 1886.

Fig. 1.

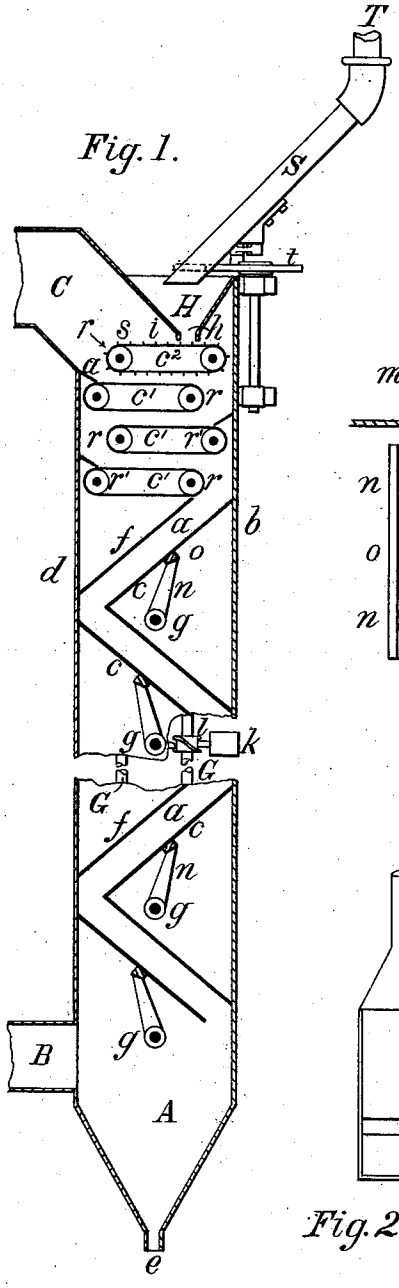


Fig. 4.

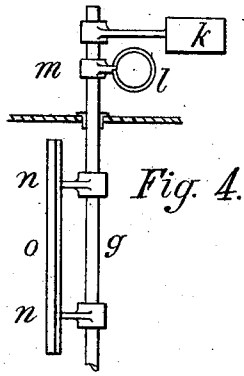


Fig. 2.

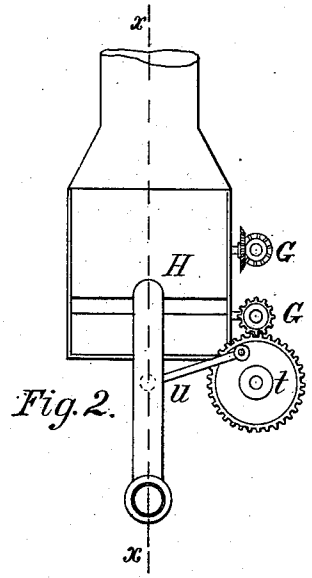
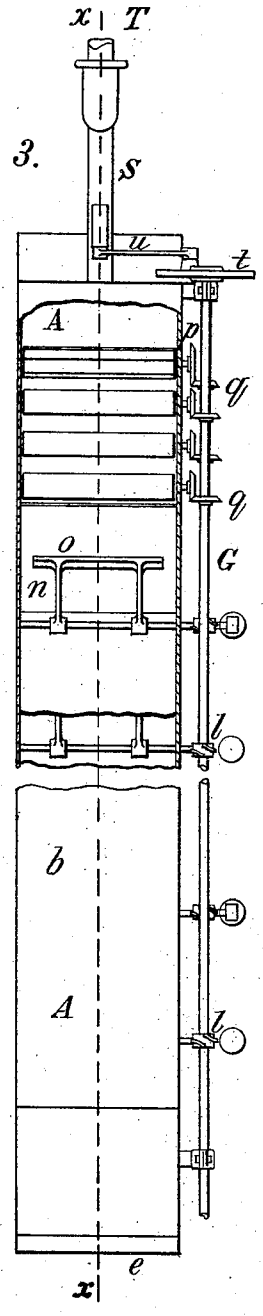


Fig. 3.



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(No Model.) 2 Sheets—Sheet 2.

S. M. LILLIE.

BONE BLACK DRIER.

No. 351,929. Patented Nov. 2, 1886.

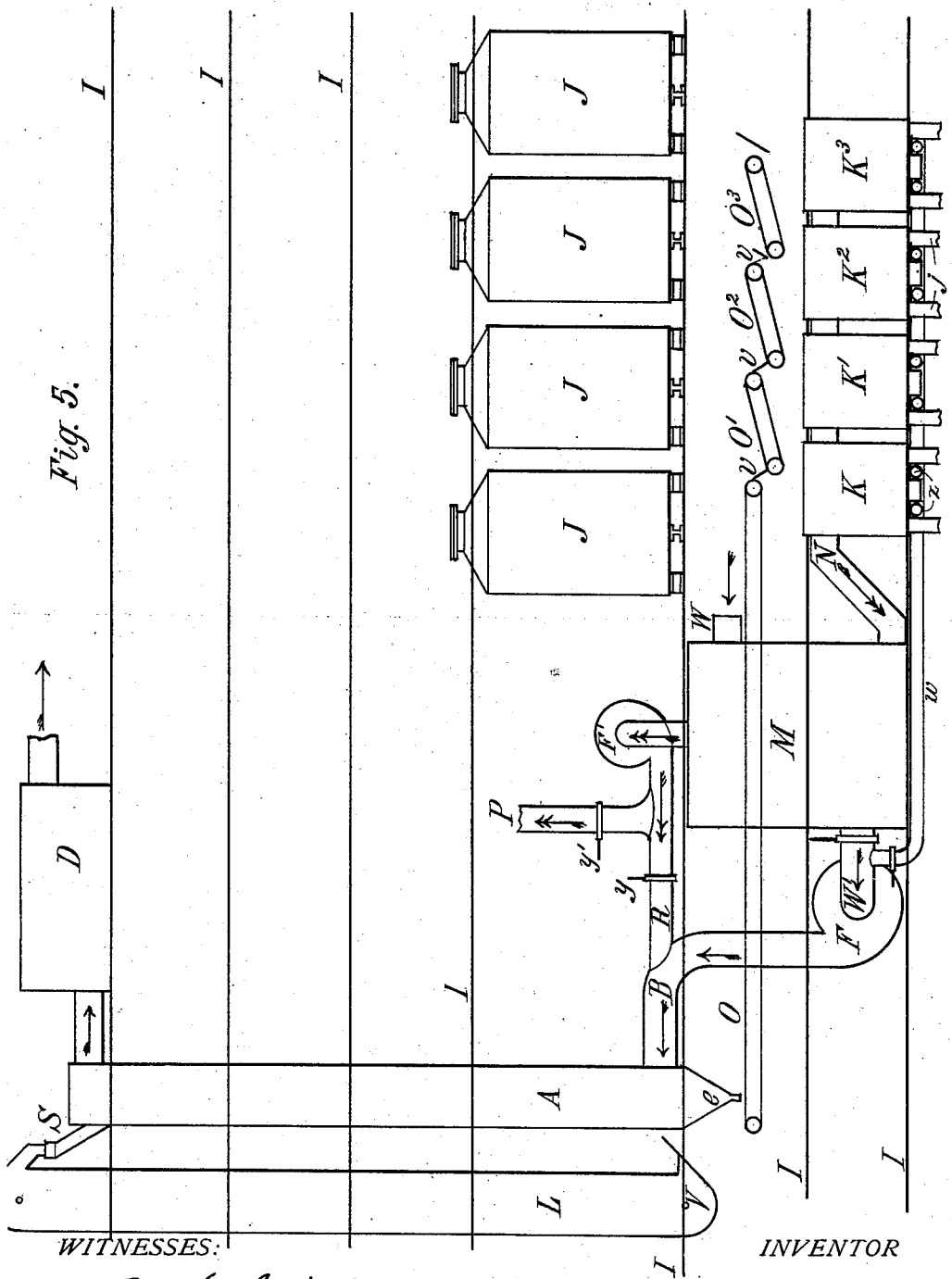


Fig. 5.

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UNITED STATES PATENT OFFICE.

S. MORRIS LILLIE, OF PHILADELPHIA, PENNSYLVANIA.

BONE-BLACK DRIER.

SPECIFICATION forming part of Letters Patent No. 351,929, dated November 2, 1886.

Application filed June 16, 1886. Serial No. 205,305. (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 a new and useful bone-black drier for drying black preparatory to its passing through the revivifying-kilns of sugar-refineries, and a new and useful method of arranging the driers as regards location with respect to the kilns, of which the following is a specification.

The arrangement of kiln and drier heretofore practiced is that of the drier placed immediately over the kiln, with one drier for each kiln, the driers occupying one story, or a vertical space equivalent about to one story, of the refinery. The working of the drier and kiln in combination is as follows: The wet bone-black is fed into a hopper forming the top of the drier, and slowly flows down through variously-arranged passages in the drier to the retorts of the kiln below, while the hot products of combustion from the kiln below flow continuously through the drier with the effect of more or less thoroughly drying the black in the drier.

My improved arrangement consists in locating the drier or driers apart from the kilns with conduits connecting the two for conveying the hot products of combustion, or air heated by the waste heat of the kiln, or both, from the kilns to the drier or driers in which they are used for drying the bone-black, the partially-dried black from the drier or driers being conveyed from the latter to the tops of the kilns by any suitable means. Following this arrangement, I prefer to use one large drier for a number of kilns, the waste heat from all of this number of kilns being conducted to and used in the one large drier, and the black dried by the latter being distributed among the kilns of the system. The advantage of this arrangement of kilns and drier is that one story less is required in a refinery or kiln-house than at present—viz., the story now occupied by the driers—that the exhausting labor in the hot and moist atmosphere of the drier-floor is avoided, and that in various ways economy or ease in working is furthered.

In the drawings I have shown a construction of drier well adapted to the disposition of drier and kilns, above set forth, having a small horizontal extent, but being long vertically, extending upward through several stories of the refinery, occupying, for example, no more space than an elevator-shaft.

The general principle of the operation of this drier in utilizing the waste heat of the kilns in drying bone-black is the passing of air or other gases heated by the waste heat of the kilns over thin or somewhat widely-extended moving surfaces or sheets of black, and also through the wet black as it falls through space. In the apparatus illustrated two methods are employed of presenting such thin moving surfaces of the wet black to the currents of heated air—viz., that of evenly distributing the wet black across the surface of a moving belt, and that of evenly distributing it across the surface of an inclined shelf near its upper limit, down which the black moves by gravity, assisted by vibrations imparted to the inclined shelf by suitable mechanism. Falling black is offered for the currents of heated air to pass through by having a series of these moving belts or inclined shelves placed one above the other, and moving or inclined, as the case may be, alternately in opposite directions, so that the black delivered upon the upper shelf or belt falls in thin sheets from member to member of the series while the heated air passes through the falling black as it passes successively over the thin layers of moving black on the shelves or belts of the system. The direction of the currents of heated air is opposite to that of the moving black, so that as it becomes more and more laden with moisture it will meet with wetter and wetter black.

The construction of the drier is that of a long upright case, of square or oblong cross-section, preferably, upward through which the air or gases heated by the waste heat of the kilns are made to pass, entering the case near the bottom and passing from the same at the top to and through a dust-chamber, in which subsides and collects the black dust, which the current of air carries from the black being dried, which black is fed into the case at the top and flows downward through the same against the ascending current of heated air and gases, and finally issues more or less dried from the bottom of the case through a narrow slot, and falls upon the first of a system of carrier-belts, by which it is delivered to and dis-

tributed among the tops of the kilns of the system. In the example shown the upward flow of the heated air or gases and the downward movement of the black through the case are made to be through a long circuitous channel by means of stationary or moving shelves extending from side to side of the case, and touching alternately the front and back walls of the case. In the drawings are shown a drier of this construction, and also its location in a refinery with respect to the kilns.

Figure 1 is a vertical section of the drier along the broken line *x x*, Fig. 2; Fig. 2, a plan of the same; Fig. 3, an elevation; Fig. 4, a view of a detached part, and Fig. 5 a view of the interior, of a sugar-refinery, showing an arrangement of the drier with respect to the kilns.

In the drawings, A is a vertical chamber, which has a rectangular oblong horizontal cross-section, as shown in Fig. 2.

a is a circuitous passage extending from top to bottom of the chamber A, being formed in the same by shelves *c* and *c'*, and c^2, which extend from side to side of the chamber and part way between the front and back walls of the same, alternately touching the front wall, *b*, and the back wall, *d*, of the chamber. The chamber A connects at the bottom below the lowest shelf, *c*, through a main, B, with the bone-black kilns and with a surface-heater connected with the kilns, from which kilns and surface-heater it receives the products of combustion, or air or gases heated by the waste heat of the kilns that are used in drying the bone-black, as hereinafter described.

Below the lower shelf, *c*, the front and back walls, *b* and *d*, of the chamber A are inclined toward each other to form the narrow slot *e'*. Above the upper shelf, c^2, an air-conduit, C, leads from the chamber A to a dust-chamber, D, (shown in Fig. 5,) and the chamber is closed at the top by the hopper H, which extends from side to side of the chamber and downward nearly to the shelf, or, as hereinafter pointed out, belt c^2, upon which it discharges through an opening, *h*, which opening also extends from side to side of the chamber, and has its front edge, *i*, parallel to and a short distance above the surface of the belt c^2.

I have shown in the drawings two descriptions of shelves or septa by which the circuitous channel *a* is formed in the chamber A—viz., fixed inclined shelves *c* and moving shelves or belts *c'* and c^2, which may be inclined or may be horizontal, as shown. The construction shown is as follows: The shelves *c* consist of plates fixed alternately to the front and back walls, *b* and *d*, and extending with a downward inclination nearly to the opposite wall, a proper width of passage being left between the lower edge of the shelf and the opposing wall, the inclination of the shelf being about that at which bone-black will slide down if left to itself. A short distance above each shelf *c* is fixed the approximately-parallel plate *f*, which extends from side to side of the chamber A, and part way between the front and back walls, *b d*, touching the wall that the corresponding inclined shelf *c* does not touch, and reaching nearly to the opposite walls. The plates *f*, in combination with the shelves *c*, form the zigzag inclined channel *a*, leading back and forth from front to back of the chamber A.

In combination with the fixed shelves *c* is a mechanism for constantly tapping the under side of each shelf while the apparatus is at work, which mechanism consists of a shaft, *g*, underneath each shelf, which shaft extends horizontally through the chamber A and projects through and has bearings in the side walls of the chamber, as shown in the detached view, Fig. 4. Inside the chamber the shaft *g* bears the radiating arms *n*, which support a bar, *o*, parallel to the shelf, while outside of the chamber the shaft carries an arm and counterpoise, *k*, whose weight tends to revolve the shaft, so as to keep the bar *o* in contact with the under side of its shelf *c*, and also a hub with finger *m*, which works with two spiral projections or cams, *l*, on a vertical revolving shaft, G, which cams, as the shaft G revolves, in turn press down the finger *m* and revolve the shaft *g*, so as to lower the tapping-bar *o* and raise the counterpoise *k*, and then release the same, allowing the counterpoise to fall, and, through the shaft *g*, causes the bar *o* to give the under side of its shelf *c* a sharp tap about evenly distributed across the middle of the shelf. The effect of the vibrations of the shelf thus produced by the tapping mechanism is to agitate the black which during the operation of the apparatus lies upon or is moving down the shelves, which agitation tends to distribute it over the surface of the shelf. If not so distributed, it causes the grains of black to present new surfaces continually to the heated air or gases which pass up through the channel *a* and urges the black down the shelf and tends to prevent its lodging in masses on the same.

There are various ways in which the vibration of the shelves *c* may be produced, and I do not limit myself to the particular means for doing it shown. The shelves *c'* and c^2 each consists of or is a belt having a width equal to that of the chamber A and running on rollers *r r'*, of which the roller *r* is a driving-roller whose arbor extends through the side wall of the chamber, bearing at its extremity a gear-wheel, *p*, which engages and is driven by the gear-wheel *q* on the revolving vertical shaft G. As in the case of the fixed shelves *c*, the belts *c' c²* touch or approximately touch alternately the front and back walls, *b* and *d*, of the chamber A and extend nearly across the chamber, and are properly spaced apart from each other vertically to form the circuitous channel *a*, along which the heated gases may flow. The upper belt, c^2—*i. e.*, the one that is designed to receive wet black from the hopper H, as hereinafter set forth—bears upon its upper surface the thin ribs *s*, which extend horizontally the full width of the belt and upward nearly to a

level with the front edge, *i*, of the bottom of the hopper H, which edge, as hereinbefore stated, is but a little above the surface of the belt c^2.

The belt c^2 may be considered, in connection with the hopper H, as the feeder and measurer of the wet black to the apparatus. The lip or edge *i* of the hopper fixes or limits the thickness of the layer of black which the belt shall bear away on its surface, and the ribs *s* on the belt scrape, as it were, the black from the hopper constantly and uniformly and prevent any portion of the belt slipping by or under the back without receiving and bearing away its quota, which might very readily be the case were the surface of the belt perfectly smooth. The driving-roller *r* of this belt c^2 is geared with the driving-shaft G, so as to move more slowly than the belts below it, the result being that the black lies upon these more rapidly-moving belts in thinner layers than upon the upper belt, and this arrangement permits the feeding and measuring belt receiving the wet black in a thicker layer than it is desirable to have on the drying-belts c'. This difference in the rate of motion between the feeding belt c^2 and the belts c', I consider the better arrangement, for with a slow motion and deeper layer of black the belt c^2 is like to receive the black more evenly distributed over its surface and to deliver it more evenly distributed upon the surface of the belt below; but this difference in motion is not essential to the working of the apparatus, and so I do not limit myself to it.

The belts c' and c^2 may be constructed of various materials, and in different ways, as of rubber or of metal. Of the latter, belts formed of articulated transverse metal strips, or of wire-cloth of a mesh so fine that the grains of black cannot pass through, may be instanced, and consequently I do not confine myself to any particular character of belting; and, again, with respect to the feeding-belt c^2, I wish to say that, while I have specified the thin transverse ribs *s* on the surface of the belt as the means to insure a more even robbing of the hopper H of the wet black, other forms of projections or roughness on the surface of the belt will answer the same purpose to a greater or less degree, and that I do not restrict myself to the form shown.

The operation of this apparatus in drying black is as follows: The hot air or gases from the kilns is led into the chamber A, at the bottom, through the main B, and is made to pass up along the zigzag channel *a* and back and forth over the shelves *c* and c', and out of the chamber at the top through the main C, into or through an arrangement for catching the black and dust which may be carried from the chamber A by the current of air. The black to be dried is delivered into the hopper H through the spout S, which, moving on the bone-black supply-tube T as a pivot, has an oscillating motion imparted to it by the revolving disk *t* and connecting-rod *u* in such fashion that the black is more or less uniformly distributed across the hopper H, and when the hopper chances to be empty of black also across the feeding-belt c^2. The wet black is taken from the hopper H by the feeding-belt c^2, and is delivered by it upon the first-belt, c', evenly distributed across its surface, and is delivered as a thin falling sheet of black, through which the ascending current of heated air or gases pass, from belt to belt, and is borne on the surface of each along the passage *a* in a direction contrary to that of the heated gases. From the lower belt, c', the black passes to the inclining shelves *c*, successively down which it slowly moves, urged and agitated by the vibrations of the shelves, produced by the tapping mechanism hereinbefore described, or by other means, and falls from each to the next shelf below as a thin sheet of black, through which the heated gases flow, until it falls finally into the lower portion of the chamber A, more or less dried by its exposure to the heated air or gases passing up through the chamber. The dried black escapes from the chamber through the slot *e*, and is delivered by any suitable means to and is distributed among the kilns whose waste heat has been used in the chamber A for drying the black. The drying of the black is effected by the hot gases, partly while passing through the black as it falls from shelf to shelf, and partly in passing over the surface of the black as it rests upon the surfaces of the inclined shelves and belts in the chamber.

In Fig. 5 I have shown the interior of a black and filter house of a sugar-refinery, and exhibited a bone-black drier of the description above set forth, arranged in connection with the kiln and other apparatus with which it operates. In the figure several stories of the filter-house are shown, the floors of which stories are indicated by the heavy horizontal lines I.

Referring still to Fig. 5, K K′ K^2 K^3 represent four of a series of revivifying-kilns having the usual cooler-tubes, *j*, beneath them.

J J J J are four bone black filters supported on the second floor above the kilns. A is the drier, shown extending through some four stories of the filter-house.

L is an elevator for raising the wet black and delivering it through the spout S into the drier.

D is a chamber or apparatus, which may be of various constructions, for collecting the dust and black carried from the drier by the current of the gases passing through the same.

O O′ O^2 O^3 are a system of carrier-belts for delivering the dried black from the drier to the tops of the kilns.

v v v are adjustable aprons, located between the extremities of the carrier-belts for causing the black to pass along from belt to belt, or for diverting onto the top of any one of the kilns K desired. Adjusted as in the figure the black would be delivered onto the top of kiln K^2.

M is a surface-heater in which the hot pro-

ducts of combustion from the kilns are used in heating air to be sent through the drier A. This surface-heater may be constructed after the manner of that shown in United States Patent No. 329,324, October 27, 1885, and in the figure it is supposed to be of the same general construction, although much larger, as it is to utilize the products of combustion from more than one kiln. Of this heater W is the induction-port for the air. W′ is the eduction-conduit for the heated air and leads to the fan F, by which the air is drawn through the heater and is delivered through the main B into the bottom of the drier, as indicated by the single-barbed arrow, which shows the course of the air through the apparatus. A flue, N, receives the hot products of combustion from the series of kilns K, and delivers them to the surface-heater, through which they are drawn by the fan F′, and are delivered by the fan either through the main R to the drier or through the main P into the air, the course of the products of combustion through the apparatus being indicated by the double-barbed arrows. The draft for the kilns is produced by the fan F′. A conduit, *w*, extends from the main W′ underneath the series of kilns K, and has perforated branch mains *z*, which extend under the individual kilns and among the cooler-tubes of the same, and serves to receive and conduct away to the fan F and drier A the hot air which collects around the tubes, the arrangement being substantially that patented to me by Letters Patent No. 335,137, February 2, 1886.

The operation of this combination of apparatus is as follows: The washed wet black removed from the filters J, in which it is supposed to have been washed with water after having served for a filtration of sugar-liquor, is delivered into the well V of the elevator L, by which it is raised and delivered through the spout S into the top of the drier, downward through which it flows against the ascending hot air and gases, as hereinbefore described, and issues from the bottom of the drier through the slot *e*, more or less dried upon the first belt, O, of the system of carrier and distributing belts, which are arranged after a well-known manner, and so do not require and have not received an extended description in this specification, by which the black is delivered upon the top of any one of the kilns K, depending upon the adjustment of the aprons *v*. Air heated by the waste heat of the kiln—viz., by the hot products of combustion in the surface-heater M and by the cooler-tubes *j*—is drawn from the surface-heater and from around the cooler-tubes through the mains W′ and *w*, respectively, by the exhausting-fan F, and is forced along the main B into the bottom of the char-drier A, through which they ascend and act to dry the bone-black, as hereinbefore set forth. The fan F′, which produces the draft for the kilns and draws their hot products of combustion through the surface-heater M, delivers the same, if their purity will warrant it, through the main R into the bottom of the drier A, in which their heat not absorbed by the air in the surface-heater M aids in drying the black, or, if the gases are not pure enough, the fan delivers them through the main P to waste or to other destination. The course which the products of combustion shall take from the fan F′ is governed by the gates *y y′*, located in the mains R and P, respectively. The hot air and gases delivered into the bottom of the drier A pass upward in the same through and over the descending black, as before described, and finally pass from the drier at the top through the main C, to and through a box, D, or apparatus in which subsides or is retained the black dust or grains carried from the drier by the currents of air.

Many forms of apparatus for arresting dust, &c., contained in currents of air are well known in the arts. It is desirable that a dust or black arresting or retaining apparatus be used with a drier of any form in which the black is dried by drawing or forcing heated air over or through the same, for it is likely more or less often to occur that black or dust is carried off by the blast, and I do not limit myself to the use of such a dust-collecting apparatus in combination with bone-black driers of the class above named, nor to the special form herein described. It can be used to advantage with the other driers patented to me and before mentioned in this specification.

In the arrangement of drier and kilns before described, and claimed below—viz., that of having the driers separated from the kilns and of having one large drier receive the waste heat from a series of kilns and dry black for the said series—I do not confine myself to the particular form of drier contained in the plant shown and described in this specification as an illustration of this method of arrangement. Any of the forms of drier now used in sugar-refineries could, by being built on a larger scale, be made each to serve several kilns.

Thus having described my invention, I claim as mine and desire to secure to myself by Letters Patent of the United States—

1. The within-described arrangement of bone-black revivifying kiln and drier, consisting of a drier located apart or at a distance from the kiln, conduits connecting the kiln with the drier and serving to lead the hot products of combustion, or hot air heated by the waste heat of the kiln, or both, from the kiln to the drier, and means for causing a flow of the same from the kiln through the conduits to and through the drier, substantially as and for the purpose specified.

2. The combination of a series of bone-black revivifying-kilns, a drier common to the kilns of the series, in which drier the waste heat of the said kilns is used in drying bone-black, mains or flues connecting the kilns with the said common drier and serving to conduct the hot products of combustion or air heated by

the waste heat of the kilns, or both, from the kiln to the drier, and means for causing a flow of the heated air or gases from the kiln to and through the drier, substantially as specified.

3. The combination, with a series of bone-black kilns, of a surface-heater common to the series in which the hot products of combustion from the kilns are used in heating air, a char drier or driers in which the heated air is used in drying bone-black preparatory to its being passed through the kilns, conduits connecting the air-channels of the surface-heater with the driers, flues for the hot products of combustion leading from the kilns to the surface-heater, and means for effecting a flow of the products of combustion from the kilns to and through the surface-heater, and of the air heated by the surface from the latter to and through the drier or driers, substantially as set forth.

4. The within-described process of utilizing the waste heat of bone-black revivifying-kilns in a preliminary drying of the wet black, consisting in passing air or gases heated by the waste heat of the kilns over extended moving surfaces of the black in a direction opposite to that in which the black moves, so that the heated air or gases will meet progressively wetter portions of black as they become more and more laden with moisture, substantially as specified.

5. A char-drier consisting of the long vertical chamber A, containing oppositely-inclined or oppositely-moving shelves or belts *c* *c'*, placed one above the other and arranged as described, means for introducing the wet black upon the upper shelf or belt, a discharge for the black below the lower shelf, an induction-main leading to the revivifying-kilns or surface-heater connected with the kilns and opening into the chamber A below the lower shelf or belt, air-eduction main at the top of the chamber above the upper shelf or belt, and means for causing a flow of heated air or gases from the kilns or surface-heater through the induction-main into and up through the chamber A, around the belts or inclined shelves and out of the eduction-main at the top of the chamber, substantially as specified.

6. In a char-drier constructed and operating substantially as described, the combination, with the inclined shelves *c*, of a tapping or other suitable mechanism for jarring or vibrating the shelves and agitating the black resting upon the same, substantially as specified.

7. In a char-drier constructed and operating substantially as described, the combination of the feeder-belt c^2, and hopper H, above it, the hopper having a long more or less narrow discharge-opening at the bottom extending across the feeder-belt transversely to the direction of its motion, substantially as specified.

8. In a char-drier constructed and operating substantially as described, the ribs *s* on the surface of the feeder-belt working in combination with the lip or edge *i* of the hopper H, substantially as specified.

9. The combination, with the inclined shelves *c* of a char-drier constructed substantially as set forth, of the parallel plates *f*, forming with the shelves the confined zigzag passages, as specified.

10. In a sugar-refinery, a vertical shaft or chamber extending vertically through several stories of the refinery, means for delivering bone-black to be dried into the shaft at the upper end and permitting it to fall through the shaft, a discharge for the dried black at the bottom of the shaft, induction and eduction air-mains at the bottom and top of the shaft, respectively, and devices in the interior of the shaft for breaking the fall of the black and distributing and exposing it to currents of heated air which are made to pass upward through the shaft, substantially as specified.

11. The combination, with a bone-black drier in which the black is dried by currents of air passed over or through the black, of a chamber or apparatus with which the eduction air-mains of the drier connect, and through which the air passes from the drier, and which operates to receive and retain the black dust and grains of black carried from the drier by the currents of air, substantially as specified.

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Witnesses:
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