

(No Model.)

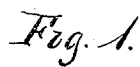
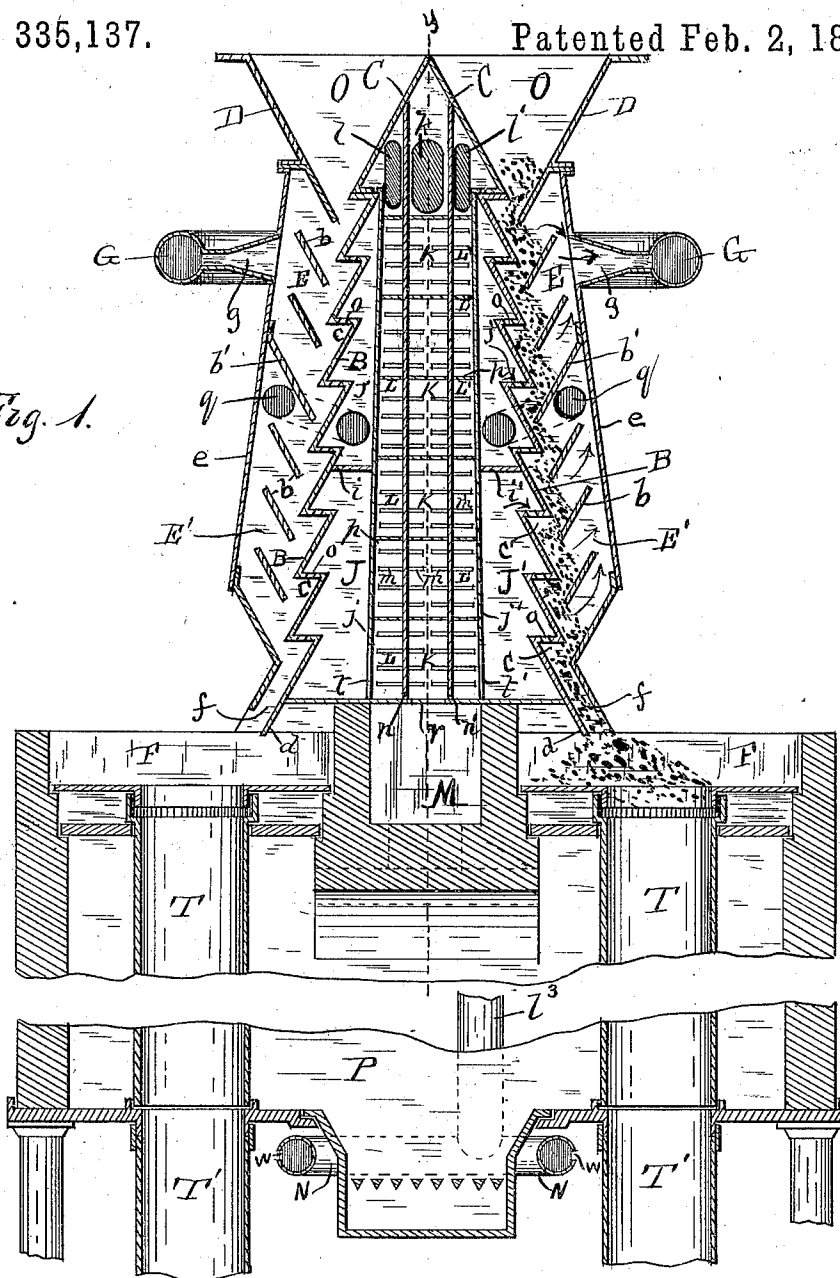
3 Sheets—Sheet 1.

S. M. LILLIE.

PROCESS OF AND APPARATUS FOR DRYING BONE BLACK.

No. 335,137.

Patented Feb. 2, 1886.



WITNESSES:

J. P. LIESE

Jacob C. Muench.

INVENTOR

INVENTOR
S. Morris Lillie

(No Model.)

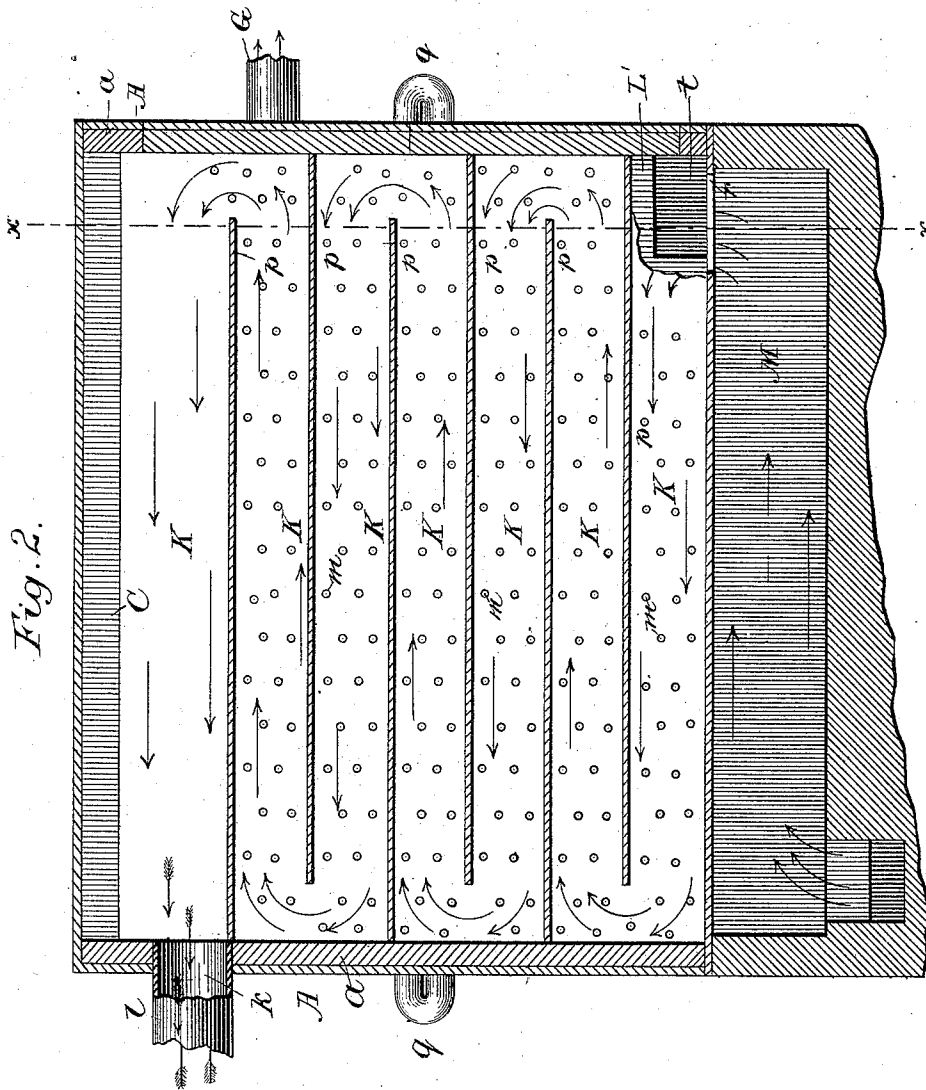
3 Sheets—Sheet 2.

S. M. LILLIE.

PROCESS OF AND APPARATUS FOR DRYING BONE BLACK.

No. 335,137.

Patented Feb. 2, 1886.



Witnesses:

Paul E. Seiber.

Jacob b. Muench.

Inventor.

S. Morris Lillie

(No Model.)

3 Sheets—Sheet 3.

S. M. LILLIE.

PROCESS OF AND APPARATUS FOR DRYING BONE BLACK.

No. 335,137.

Patented Feb. 2, 1886.

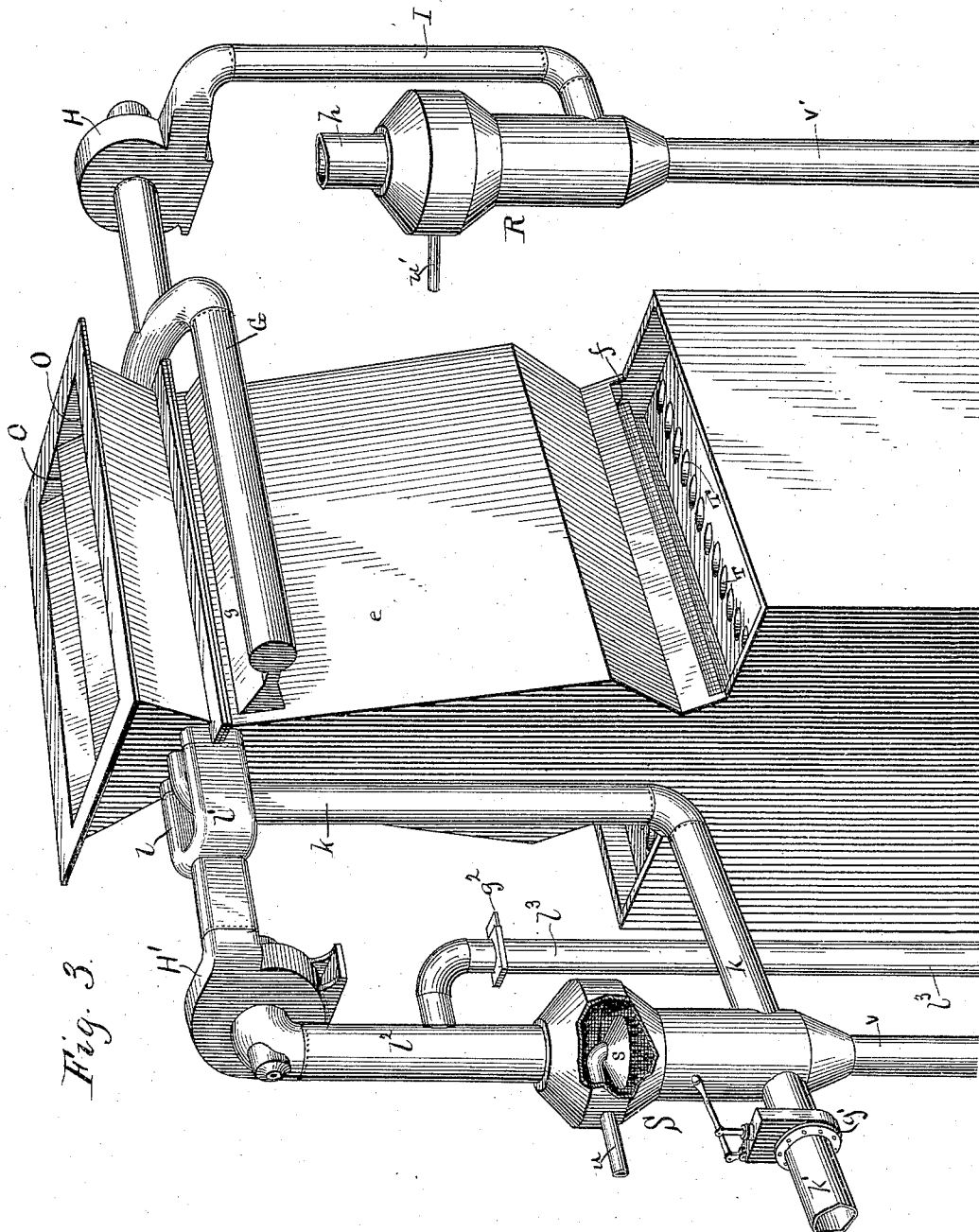


Fig. 3.

WITNESSES:

J. O. Lister.
Jacob G. Muench.

INVENTOR

S. Morris Lillie

UNITED STATES PATENT OFFICE.

S. MORRIS LILLIE, OF PHILADELPHIA, PENNSYLVANIA.

PROCESS OF AND APPARATUS FOR DRYING BONE-BLACK.

SPECIFICATION forming part of Letters Patent No. 335,137, dated February 2, 1886.

Application filed September 23, 1884. Serial No. 143,813. (No model.)

To all whom it may concern:

Be it known that I, S. MORRIS LILLIE, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia, and State of Pennsylvania, have invented a process of and apparatus for drying the bone-black of sugar-refineries preparatory to passing it through the revivifying-kilns, and of utilizing the waste heat from the said revivifying-kilns, of which said process and apparatus the following is a specification.

The process consists in drawing or forcing either the hot gaseous products of combustion escaping from the fire-chamber of the kiln, or gases heated by the same, and also in drawing or forcing the heated air from around the cooler-tubes of the kiln through the mass of the black to be dried, by which procedure more or less of the moisture in the said black is evaporated and carried off as vapor by the gases; and the process consists, further, in passing the said moisture-laden gases, after leaving the black, through a suitable condenser, in which the vapors are condensed and the gases cooled by cold fresh water, the heat (latent and sensible) of the vapors and gases being mostly transferred to the water, the latter being more or less heated thereby. This heated water is subsequently used, after additional heating, if necessary, for the purposes of the refinery—*e. g.*, washing bone-black, melting sugars, &c.

In the drawings are illustrated a drier and apparatus for carrying on my process, Figure 1 being a vertical transverse section of the drier and kiln along the broken line *x x*, Fig. 2, which figure is a longitudinal vertical section of the drier along the broken line *y*, Fig. 1, while Fig. 3 is a general view of drier and of the adjuncts necessary for carrying on the process.

In the drawings, P is the fire-chamber of the kiln, containing the retorts T, arranged in two rows—one on each side of the central fire-box—and opening below into the cooler tubes T—one for each retort—and above into the boxes F, above the fire-chamber.

The drier consists of a chamber, constructed as presently to be set forth, supported above the fire-chamber of the kiln, and between, though above, the boxes F, into which the mouths of the retorts open. The end walls, A, of the drier are vertical, and are lined with a non-conducting lining, *a*. The side walls, B,

are formed of cast iron plates, and are slightly inclined to the vertical, each sloping from the top outward toward the bottom. Each is formed with a number of horizontal re-entrant angles, *c*, extending from end to end of the drier. In front of the sloping face of each re-entrant angle is supported a plate, *b*, inclined to the face of the angle, and with its lower edge but a short distance from the same. These plates *b* extend horizontally from end to end of the drier. The top of the chamber is formed by the inclined plates C, which, meeting above the middle, slope to meet the side walls, B. The plates C form with the oppositely-inclined plates D the hoppers O O, which deliver into the channels formed between the side walls, B, of the drier and the inclined plates *b*. Each face of the drier is inclosed in a casing, *e*, air-tight, excepting at the points to be specified, which makes a close joint with the hopper-plate D and with each of the end plates, A. Toward the bottom the plates forming the casing are inclined toward the drier and then parallel with the apron *d*, to form with the latter the narrow passage *f*, through which the black flowing down the face of the drier may flow into the boxes F and retorts T. While the process of drying and burning or calcining the black is in progress this narrow passage *f* is constantly full of black, and serves as a trap to prevent the passage of air into the interior E' of the casing. On each side of the drier a horizontal main, G, communicates with its opposite chamber, E, near the top through a horizontal passage, *g*, which extends the entire length of the drier. This passage is narrow near the main, but widens thence to its juncture with the casing *e*. The mains G curve toward each other around the end of the drier, and join to form a single main, which connects with the exhausting-fan H, from which a main, I, delivers into the condenser R, from which the gases forced through it by the fan, as herein-after described, escape through the port *h* at the top. The interior of the drier is divided into three chambers, J J', and one between the two by the vertical plates *j j'*, extending from front to back of the drier, and from the floor of the same to its roof or dome. Each chamber J is subdivided into two compartments by horizontal plates *i i'*, respectively. The interior of the casing, on each side of the drier, is also subdivided into two compartments, E

E', by the plate *b'*, facing the inclined face of the plate B, next above the partition *i* in the adjoining chamber J. The lower compartment, E', of each casing communicates with the upper compartment of the adjoining chamber J through passages *q* at one or both ends of the drier. The horizontal walls of the re-entrant angles *c* have either numerous perforations or else longitudinal slots *o*, by which the chambers J are put in communication with re-entrant angles *c*. The middle one of the three chambers into which the interior of the drier is divided by the partitions *j j* is itself subdivided into three vertical chambers, L, L', and K, by the cast-iron vertical partitions *nn'*. The plates forming the partitions have projections *m* cast on each face, which project into the chambers L, L', and K, which serve to conduct heat from the gases in K to the gases in L L' when the apparatus is in use, as hereinafter described. Horizontal partial diaphragms *p*, touching alternately the front and back walls, A, of the drier, extend horizontally across the chambers L, L', and K, forming in each a horizontal circuitous channel. Above the upper diaphragm the channel formed in the middle chamber, K, communicates at one end of the drier, through the main *k*, with the bottom of a scrubber, S, presently to be described, and below the lower diaphragm, at the other end of the drier, it communicates through the passage *r* with the flue M, into which the hot products of combustion pass from the fire-chamber of the kiln. The circuitous channels in the chambers L L' communicate through the mains *ll'* with the delivery-nozzle of a fan, H', which exhausts from the top of the scrubber S, while below, at the opposite end of the drier, (which is the end at which the middle chamber, K, communicates with the flue M,) the said channels in L L' communicate with the lower compartments in the chambers J J, through the passages *tt'* in the partitions *j j'*, respectively. The scrubber S consists of a vertical cylinder having an enlargement or bulge near the top. In this bulge is contained a horizontal rose, *s*, directly over the cylindrical portion of the scrubber, which rose is supplied with hot washings from the bone-black through the main *u*, the said washings coming from black in process of purification by washing with hot water after a filtration of liquor through it. The under surface of the rose is perforated, and, when the hot washings from the main *u* are passing through it, delivers a shower which approximately fills the cylindrical portion of the scrubber. The washings escape from the scrubber at the bottom through the main *v*, which delivers into an evaporating apparatus, or into apparatus (not shown) in which the hot washings are utilized for heating fresh water for the purposes of the refinery, in accordance with the process described in the United States Patent No. 263,710, issued to me September 5, 1882. The main *k* connects the flue K of the drier with the bottom of the

scrubber S, with which the flues of the steam-generators, or rather of their furnaces, also communicate through the main *k'*, fitted with the gate *g'*. From the top of the scrubber a main, *l'*, leads to the exhaust-port of the fan H', above mentioned. A main, *l'*, fitted with a gate, *g'*, leads from the main *l'* to the mains N N, which extend horizontally beneath the fire-chamber of the kiln, one on each side of the fire-box. The mains N each have perforations *w* distributed along its entire length, and they and the main *l'* serve to convey the heated air which collects around the tops of the cooling-tubes T to the main *l'*, and thence to the fan H'.

The condenser R, into which the fan H delivers the gases and vapors from the black, as hereinafter to be described, has a construction similar to that of the scrubber S. Its rose is supplied with cold fresh water, and its discharge-pipe *v'* delivers into a suitable tank, (not shown,) from which the more or less warmed water may be drawn for the purposes of the refinery, as hereinafter pointed out.

The operation of the apparatus described above is as follows, supposing it to be in full operation: Cold fresh water is running through the rose in the condenser R, and is falling through the lower cylindrical portion of the latter in a shower, which approximately fills it. Hot char-washings, as they run from the bone-char, are flowing in a similar manner through the scrubber S. The retorts T and cooler-tubes T' are filled with black, and black lies in the trays F, above the retorts, and in the drier on each side in the channels formed between the walls B and the plates *b*, as indicated in the right-hand half of the drier, Fig. 1. As the black is drawn from the bottoms of the cooler-tubes T', the black in the retorts and drier moves downward, and fresh black flows from the hoppers O into the drier, the black in the hoppers being wet, just as it comes from the vats in which it was washed. The fans H H' being in motion, the products of combustion from the fire maintained in the furnace of the kiln are drawn from the fire-chamber, through the circuitous flue K in the drier and through the scrubber S, in which they are washed free of dust, &c., and are delivered, together with hot air drawn from around the cooler-tubes through the main *l'*, as hereinbefore mentioned, through the mains *ll'* into the conduits L L' in the interior of the drier, through which they flow back and forth around the partial partitions *p*, in a direction contrary to the gases in the middle flue, K, until they finally pass from the same through the passages *tt'* into the lower compartments of the chambers J at a temperature approximating that of the products of combustion as they enter the flue K from the fire-chamber, or rather, from the flue M. From the lower compartment of the chamber J the gases pass through the holes in the horizontal walls of the re-entrant angles *c* into the empty spaces left in the same, back of the black, thence through the black into the lower

half of the chamber E, then through the passages *q* into the upper half of the chambers J, a second time through the black into the upper half of the chamber E, and, finally, through the mains G and pan H to and through the condenser R, escaping from the latter at the top through *h*. The gases by passing through the scrubber are freed of dust, and also more or less perfectly of sulphurous acid generated from the sulphur in the fuel used. The gases would leave the scrubber, as a rule, cooler than they entered it, while the washings would leave it somewhat hotter. This heat transferred to the washings would, however, be partially recovered in the fresh-water heater through which the washings from the scrubber flow. The hot gases in passing through the black evaporate and carry off with them more or less of the moisture contained in it to the condenser R, through which the gases next pass, and in which they are cooled, the water vapors condensed and their latent and sensible heat mostly appropriated by the cool fresh water flowing through the condenser, whereby the said cool water is heated to a degree, and will, in consequence, require less steam from the boilers to raise it to the temperature necessary for use in washing bone-black, melting sugars, &c., than would be the case were it not thus partially heated, as above described.

By means of this process and apparatus the heat contained in the gaseous products of combustion of the kiln, which has heretofore been lost, and a large amount of the heat radiated from the cooler-tubes of the kiln, may be utilized first in drying the wet bone-black in the drier, and then, a second time, in heating fresh water in the condenser R. The fans are intended to be sufficiently powerful to furnish all the draft necessary, thus doing away with the need of a chimney, and, in addition, to draw large quantities of heated air from around the cooler-tubes of the kiln.

This process may be considered also as one for utilizing the heat in the gaseous products of combustion from the furnaces of kilns, boilers, and the like, consisting in first passing the gases through a suitable water-scrubber to free them of objectionable matters, and in then passing them through one or more additional scrubbers, R, in which the heat not absorbed in the first one is given up to the fresh water passing through them, the heat taken up by the washing-water of the first scrubber being recovered by sending the heated water through a surface-heater, in which it is used for heating or evaporating apparatus or evaporating purposes. From the main *K*, hot gases from the boiler furnaces may be drawn after opening the gate *g'*, and be sent through the black, if a greater quantity of these gases is wanted than can be furnished by the kiln itself.

In the above-described apparatus the principal use of the scrubber S is to free the gases of impurities, such as dust and sulphurous acid, which would be injurious to the black.

With a fuel of proper quality—such, for example, as a good anthracite containing little sulphur—the washing and reheating of the gases may be dispensed with, and the same may be drawn directly through the black as they come from the kiln-furnace. In this case the scrubber S and the surface-heater arranged in the interior of the drier would not be needed. The interior of the drier between the walls B would be an empty chamber, into which the gases from the kiln-furnace would flow, and from whence they would be drawn directly through the holes in the re-entrant angles *c* of the plates B, and through the black. The main *l'*, for conveying the heated air from around the cooler-tubes, would open into the interior of the drier.

In my specification I have confined myself in my descriptions to the use of the products of combustion from the kiln-furnace; but my process contemplates not only the use of these gases, but of any gases heated by the products of combustion from the kiln.

Air may be used in the apparatus shown in the drawings by disconnecting the mains *ll'* from the fan H', in which event fresh air would be drawn through the surface-heater, and thence through the black, instead of the products of combustion from the kiln. The use of the products of combustion is advantageous in this respect, that they are composed mostly of gases of little or no oxidizing-power—viz., nitrogen, carbonic-oxide, and carbonic acid—and that consequently there is less danger of destroying the carbon of the black by oxidation than is the case when atmospheric air is used, and I therefore consider the employment of non-oxidizing gases in this process of drying black as a matter of importance.

I wish also to call attention to the fact that the black, while being subjected to the drying effects of the gases drawn through it, is in contact with plates B, heated by the waste heat from the kiln-fire, and is kept more or less heated by the same, the result of which is, that the moisture in the black more readily yields itself up to the gases passing through it than if not thus heated.

In the practicing of my process I do not limit myself to the use of the special apparatus shown, nor to any particular temperature or range of temperature of the air or gases drawn through the black.

I claim as of my invention—

1. The combination, with the bone-black re-vivifying-kilns of sugar-refineries, of surface-heaters in which the gaseous products of combustion from the kilns are used in heating air or other gases, a suitably-arranged drier or receptacles for holding the black to be dried, and means for drawing or forcing the heated gases from the surface-heater over or through the black in the drier, substantially as and for the purpose specified.

2. In apparatus for drying bone-black, the combination of vertical or properly-inclined plates, downward over which the black

to be dried is made to pass, horizontal re-entrant angles or depressions in the said plates, over which the black flows, but does not enter, passages opening into the said re-entrant angles or depressions and connecting with supplies of air or gases to be used in drying the black, and means for forcing or drawing the said air or gases into the re-entrant angles or depressions, and thence through or over the black, substantially as specified.

3. The combination of the perforated mains N, extending underneath the kiln near the upper extremities of the cooler-tubes T, and serving to receive the heated air which collects round the upper ends of the cooler-tubes, a suitably constructed receptacle or drier for holding bone-black to be dried, and exhausting fans or apparatus with connections to the mains N and to the drier, and operating to exhaust the heated air from around the cooler-tubes through the mains N, and to force it or draw it, as the case may be, through or over the mass of the black in the drier to dry the same, substantially as specified.

4. In a surface-heater for heating or cooling gases, projections *m*, extending from the walls separating adjacent flues in the heater into one or both of the said flues, the projections serving to conduct the heat to or from the gases in one flue to the heating or cooling agent, as the case may be, in the adjacent flue, substantially as and for the purpose specified.

5. The combination, with a char-drier in which the char is subjected to currents of heated air or other gases for drying the same, of a condenser connected with the drier by suitable mains and having proper water induction and eduction connections, and of means for causing the vapor-laden gases as they pass from the black to flow from the drier to and through the condenser, the condenser operating to condense the vapors and to transfer their latent and sensible heats to the cold water, or other liquid, for that matter, passing through the condenser, substantially as specified.

6. In a condenser used in connection with a bone-black drier for condensing the water-vapors from the air or other permanent gases passed through the black in the drier for drying the same, the combination of an induction-port for the vapor-laden gases, connected with the drier by suitable mains, an eduction-port for the escape of uncondensed air or gases, induction or eduction ports for condensing water or other liquids, and suitable internal devices for utilizing the liquid for the condensation of the vapors from the gases during their passage through the condenser, substantially as specified.

7. A condenser for condensing water-vapors contained in permanent gases drawn through the black in a bone-black drier, consisting of a vertical chamber having an induction-port for the vapor-laden gases at or near its lower extremity, an eduction-port for the escape of the gases at or near the upper end of the cham-

ber, and a rose or equivalent showering device located in the vertical chamber at or near its upper end, the said showering device having suitable connections with a supply of water or other condensing liquid, and operating, when the condenser is in use, to project a shower of the liquid downward through the vertical chamber against the ascending current of gases, substantially as and for the purpose specified.

8. The combination, with the bone-black drier in which gaseous products of combustion are drawn through or over the black for the drying of the same, of a scrubber—such as S, for example—connected with the drier, through which scrubber the gases pass on their way to the drier, and which operates to purify the gases by removing the dust, sulphurous acid, and the like from them, substantially as specified.

9. The within-described apparatus for utilizing the heat in the gaseous products of combustion from the furnaces of boilers, kilns, &c., in heating water or other liquid, consisting of a water-scrubber, such as S, connected with the said furnaces by suitable conduits, a condenser connected with the scrubber by proper conduits, and means for causing the flow of the gases from the furnaces, first through the scrubber and then through the condenser, the scrubber operating to free the gases of objectionable matters, and the condenser operating to cool and transfer the latent and sensible heats of the vapor-laden gases to the cold water or other liquid passing through the condenser, substantially as and for the purpose specified.

10. The combination, with the scrubber in which the gaseous products of combustion from the furnaces of boilers, kilns, &c., are washed by means of water, of a surface-heater which receives the hot scrubbing-water from the scrubber and utilizes it in heating or evaporating fresh water or other liquid passing through the surface-heater, substantially as specified.

11. The process of utilizing the heat in the gaseous products of combustion from the furnaces of boilers, kilns, &c., consisting in passing the same through a scrubber to free them of mechanical impurities and other objectionable matters, then through a suitable apparatus for heating them, and finally through moist bone-black or other material to be dried, substantially as specified.

12. The within-described process of passing the gaseous products of combustion from the furnaces of boilers, kilns, &c., through a suitable water-scrubber preparatory to their further use, and of using the heated water flowing from the scrubber for heating or evaporating purposes in a suitable surface-heater or evaporator, substantially as specified.

S. MORRIS LILLIE.

Witnesses:

JACOB C. MUENCH,
OSCAR HOUCK.