(No Model.) 4 Sheets—Sheet 1.

H. FRASCH.

FURNACE FOR ROASTING, CALCINING, AND OXIDIZING METALS AND THEIR COMPOUNDS.

No. 492,551. Patented Feb. 28, 1893.

Fig. 2.

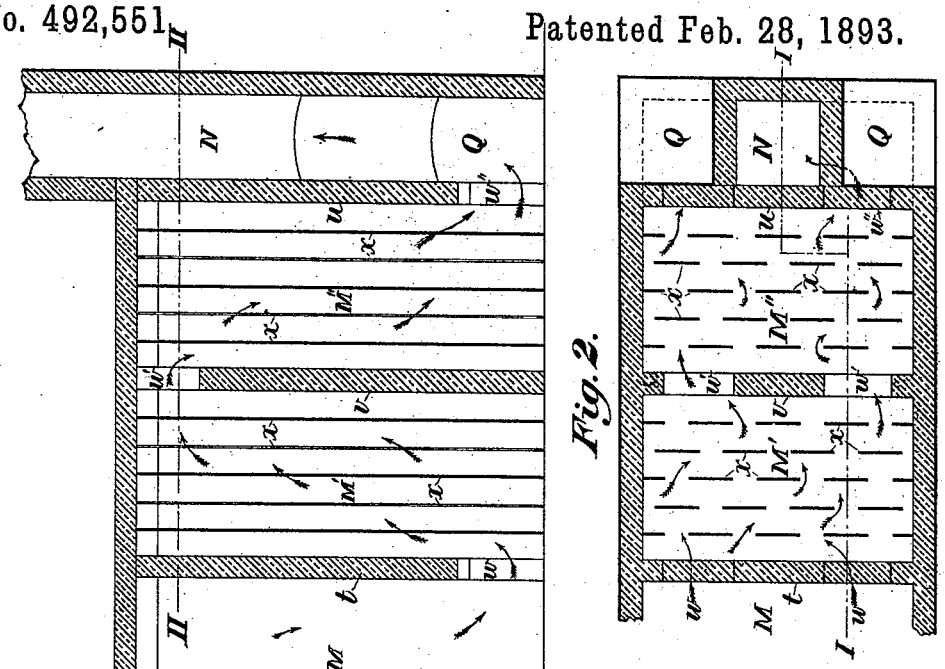
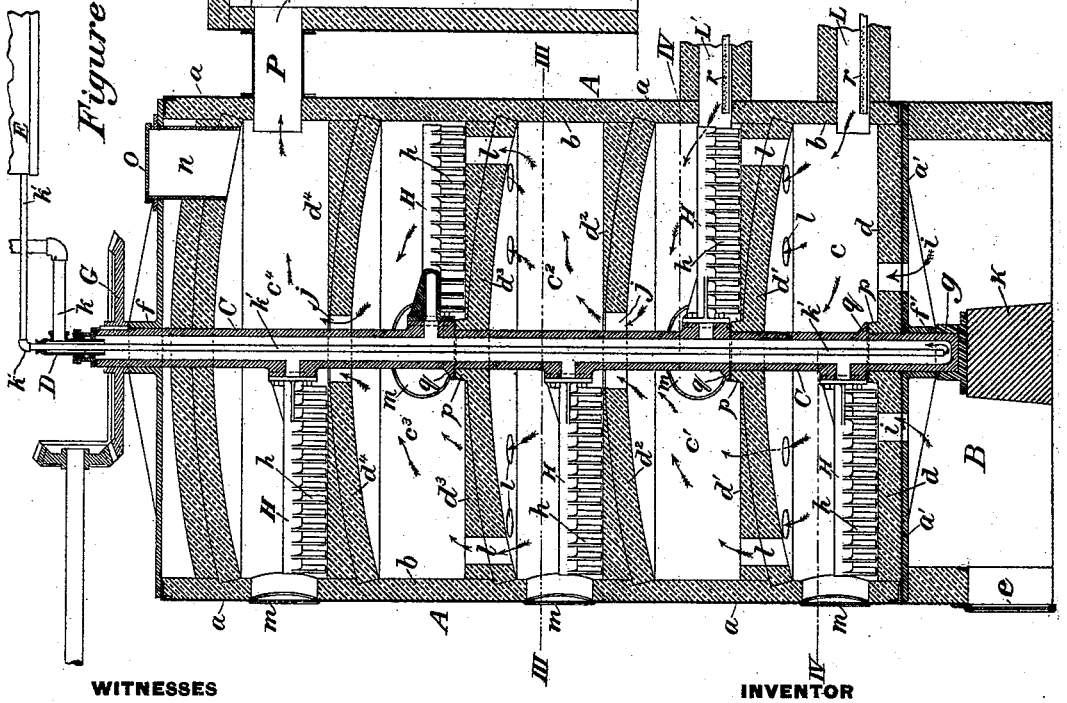


Figure 1.



WITNESSES

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Fig. 3.

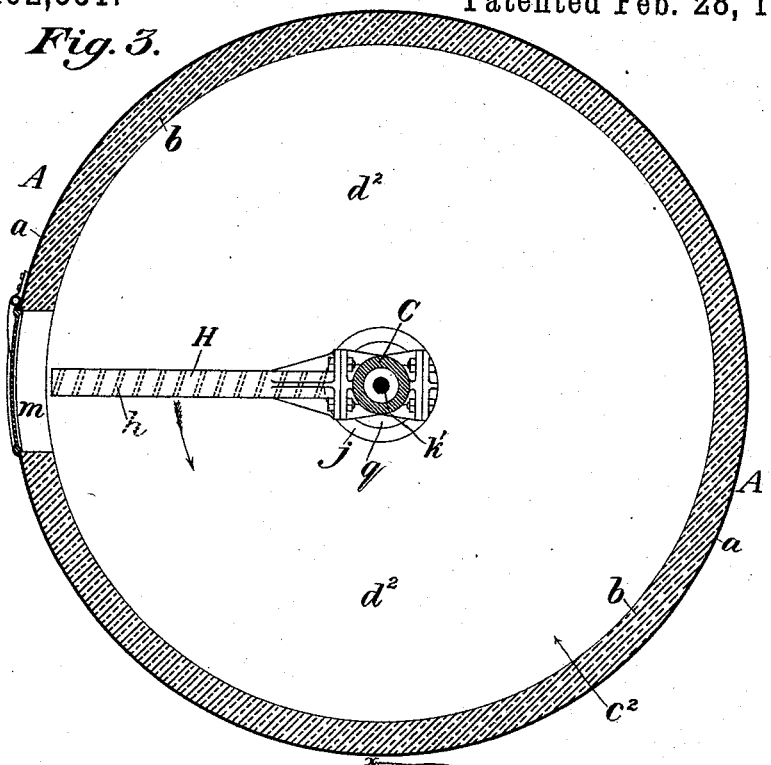

Fig. 4.

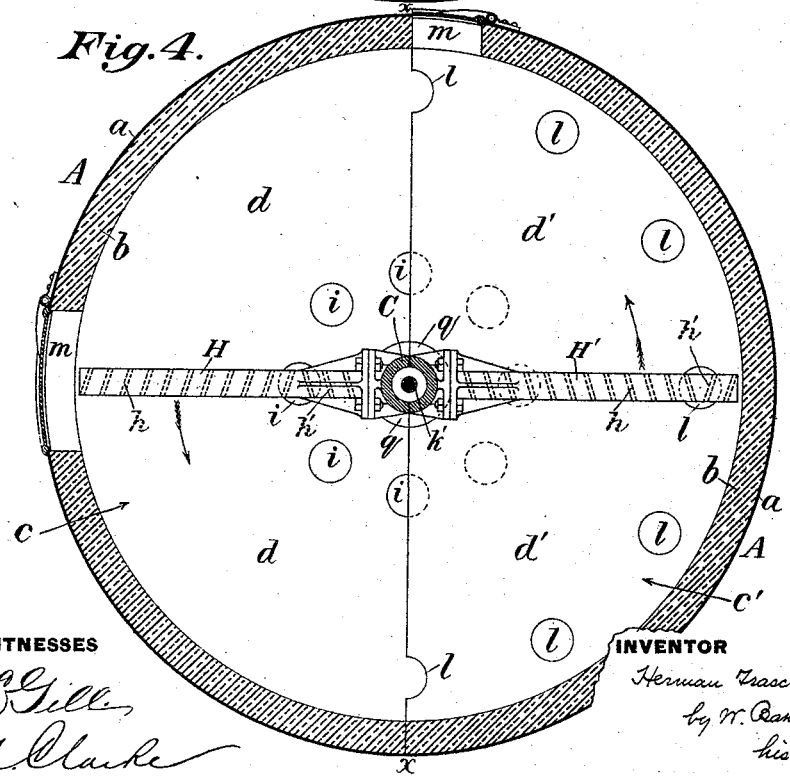

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Fig. 5.

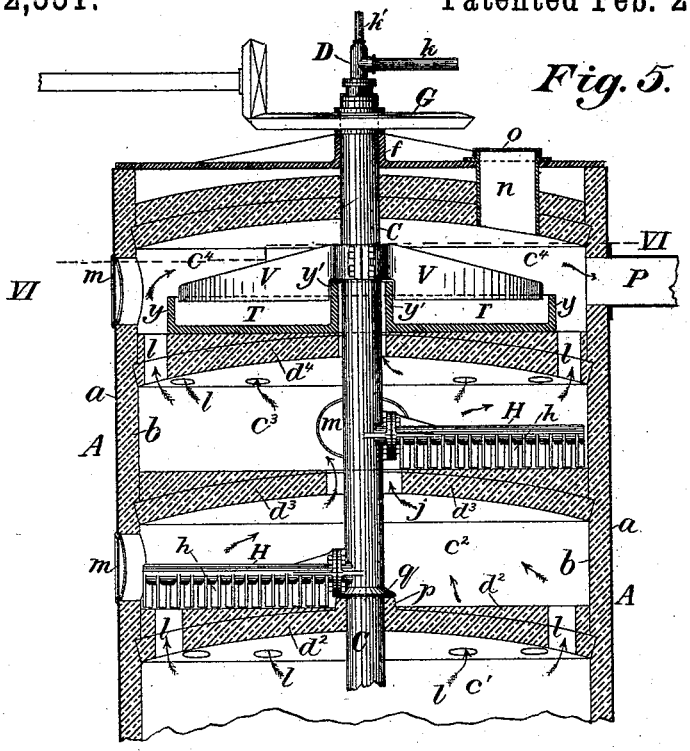

Fig. 6.

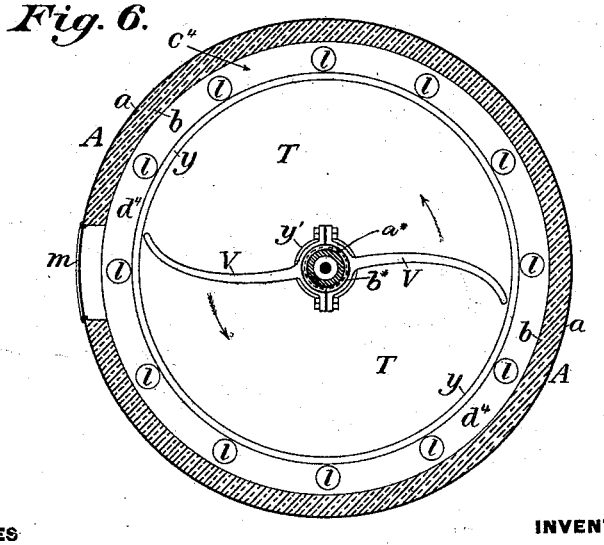

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Fig. 8.

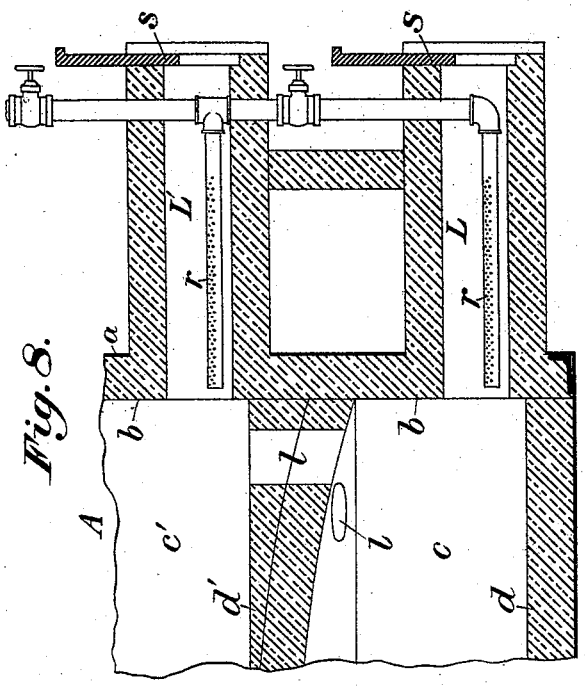

Fig. 9.

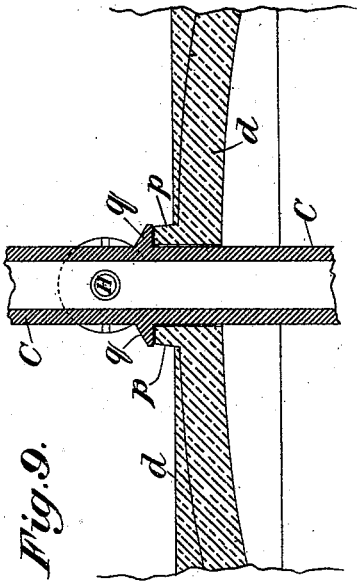

Fig. 10.

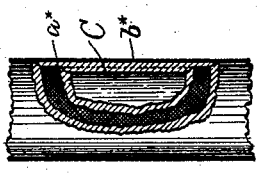

Fig. 7.

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UNITED STATES PATENT OFFICE.

HERMAN FRASCH, OF CLEVELAND, OHIO, ASSIGNOR TO THE SOLAR REFINING COMPANY, OF OHIO.

FURNACE FOR ROASTING, CALCINING, AND OXIDIZING METALS AND THEIR COMPOUNDS.

SPECIFICATION forming part of Letters Patent No. 492,551, dated February 28, 1893.

Application filed October 22, 1889. Serial No. 327,836. (No model.)

To all whom it may concern:

Be it known that I, HERMAN FRASCH, of the city of Cleveland, in the county of Cuyahoga and State of Ohio, have invented a new and useful Improvement in Furnaces for Roasting, Calcining, and Oxidizing Metals and their Compounds, of which the following is a full, clear, and exact description.

I will first describe my improved apparatus as the same is used in desulphurizing and re-oxidizing of comminuted metallic bodies or metallic oxides which have become more or less deoxidized and converted into sulphides in the process of desulphurizing and refining petroleum and petroleum products, (such as Lima oil and its distillates,) and thereby fitting the compound for repeated use; and I will then explain the modification which I employ to adapt my improved apparatus to the oxidizing of metallic lead.

In the accompanying drawings Figure 1 is a vertical section through the axis of my furnace. Fig. 2 is a sectional plan view of the dust arresting chamber on the line II—II of Fig. 1. Fig. 3 is a horizontal cross-section on the line III—III of Fig. 1, showing one of the chambers of the furnace with its stirring arm. Fig. 4 is a horizontal cross-section on the line IV—IV of Fig. 1, showing one-half of each of two adjacent chambers of the furnace. Fig. 5 is a vertical section of the upper portion of my furnace showing a modification of construction adapting it to the oxidation of lead. Fig. 6 is a cross-section on the line VI—VI of Fig. 5. Figs. 7, 8 and 9 are details of construction on a large scale. Fig. 10 is an elevation of a portion of the central shaft of the furnace, showing the covering partly broken away and sectioned.

In the several figures like letters of reference indicate the same parts.

In the accompanying drawings A is the body of the furnace, preferably consisting of a cylindrical shell *a* of wrought iron (such as boiler plate riveted together) and lined inside with suitable refractory material such as fire brick *b*, which should be about eight inches thick, and closed at top and bottom, excepting as hereinafter described. The interior of this cylinder is divided by horizontal partitions *d d'*, &c., into stories forming chambers *c c'*, &c., of any convenient number depending upon the purpose for which the furnace is to be used and the amount of treatment required by the material to be acted upon therein. The horizontal partitions are of brick-work or refractory tile *d* and are flat and level on the upper side, but preferably arched on the under side, as shown in cross-section in Fig. 1. The bottom plate *a'* of the cylinder A rests upon the walls of a pit B of brick work, which forms a receptacle for the calcined material, and which is furnished with a suitable door *e* or doors through which the finished material is removed from time to time.

C is a vertical hollow revolving shaft of cast iron, say about eight inches external and five inches internal diameter, which is longer than the height of the cylinder A, and is placed in its center or axis, extending above the top through a stuffing box *f* and through the bottom through a stuffing box *f'*. This hollow shaft is closed at the lower end, and is supported by and turns on a step *g* secured to the block or pillar K in the interior of the pit B. Passages or vertical openings *i* extend through the bottom of the cylinder into the pit B, through which the calcined or oxidized material is discharged from the furnace and collected in the pit. Through these openings *i* air from outside enters the cylinder A to supply oxygen for the oxidation of the matter under treatment. The discharge openings *i* are preferably located near to the center of the cylinder A so as to collect the finished material near to the middle of the pit B. The vertical revolving shaft C is connected at its upper end outside of the cylinder A by a stuffing box with a stationary cap or water box D.

A water tank E which may be placed above the top of the furnace communicates by a pipe *k*, entering the top of the tank E with the interior of the cap D, and a pipe *k'*, connecting with the tank E at or near to its bottom, passes downward through the stationary cap D and through the interior of the hollow shaft C to a point near its lower end, which is closed, leaving room, however, for the free discharge of water into the hollow shaft C, as shown in Fig. 7. The effect of this arrangement is a continuous circulation of water from

the tank E through the pipe k', and thence up through the interior of hollow shaft C, outside of and around the pipe k' back to the tank E, through the pipe k. The purpose of this is to keep the hollow shaft and the stirring arms H, connected therewith sufficiently cool to prevent their melting or becoming warped by the heat.

As an additional protection to the central shaft C′ I coat it externally with fire clay, which is pulverized and made into a thick mortar and plastered onto the surface of the shaft. In order to keep this refractory coating in place, I wrap a piece of wire netting (indicated at a^* in Figs. 6 and 10) around the shaft and fasten it together at the piecing by wire, and then apply the fire clay (indicated at b^* in Figs. 6 and 10) on top of the wire netting, which performs the function of lathing.

At or near the upper end of the hollow vertical shaft C is keyed a gear wheel G, or other mechanical device for communicating rotary motion thereto from some suitable prime motor. Also to the vertical shaft C is bolted a series of revolving stirring arms H, one at least of such arms being so placed on the shaft C as to be located horizontally within each of the horizontal chambers c c', and so also as to distribute the weight of the arms around their supporting shaft C so as to equalize the strain thereon. These stirring arms H are constructed as shown by an enlarged view in Figs. 3 and 4, the horizontal part having a cavity which communicates with the cavity or interior of the vertical shaft C, so that water may enter them and keep them sufficiently cool. The under side of each arm H has a series of fingers h which extend downward vertically so far as nearly to touch the upper surface of the horizontal partition d, which forms the under side of the chamber. By this means the material undergoing treatment in the furnace is not only continually stirred, but is also, as I shall proceed to explain, gradually pushed either toward the center or toward the circumference of the cylinder A, as may be desired. The shape and arrangement of the fingers h on the stirring arms H are shown by dotted lines in Figs. 3 and 4. The fingers h are integral with the corresponding arms H H′ which are bolted or similarly fastened to the shaft C and have each its cavity in communication with the interior of the shaft.

In Fig. 3 the fingers h are all inclined in one direction, and so that when the arm H is revolved in the direction of the arrow in Fig. 3 the material under treatment is gradually pushed toward the center of the cylinder A, while on the arm H′ shown on the right hand side in Fig. 4, most of the fingers are inclined in the opposite direction to that of the fingers on the arm H in Fig. 3, so that the revolution of the arm H′ in the direction indicated by the arrow will push the material toward the holes l l, &c., near the circumference of the cylindrical chamber.

Fig. 4 represents on the half of the figure to the right of the line x—x the stirring arm H′ and the holes l l near the circumference of one chamber, and the other half of the figure to the left of the line x—x shows the stirring arm H and the holes i i, &c., near to the center of the chamber.

By reference to the section of the cylinder A in Fig. 1 it will be seen that the openings i in the bottom of the cylinder and the holes in each alternate partition above it, are near the center, while in the intermediate partitions the holes l are near the circumference, of which arrangement Fig. 4 is an illustration, by means of which the material under treatment, if charged into the furnace, (as in Fig. 1,) near the circumference of the cylinder is carried gradually toward the center where it drops through the hole j into the next lower chamber, in which it is pushed as the arm H revolves toward the circumference and through the holes l, l, and so on alternately, until it reaches and is delivered from the lowest chamber through the holes i i into the pit B. As the openings l are near to the circumference of the cylinder, but not close thereto, the arms H′ which are located in those chambers (see Fig. 4) have a few of the fingers h' near to the outer extremity of the arm turned in the reverse direction, so as to prevent the packing of the material against the walls of the cylinder, and force it to pass through the holes l into the chamber below, while in the next adjoining chamber (see the other half of Fig. 4) the holes i being near the center, a few fingers h' at the inner end of the stirring arm H are reversed, so as to push the loose material from the center toward the holes.

In those partitions (d' and d^3) in which the holes l are near to the circumference of the cylinder I make provision to prevent the loose material from passing down between the shaft C and the partition, because if it did so it would escape treatment in all of the chambers excepting the top one. This provision consists of an annular flange p of brick work around the shaft C, on the horizontal partition d and a collar q cast with or shrunk on the shaft C, the under face of which is level and parallel with and nearly touches the upper face of the flange p, while the upper side of the collar q inclines downward, as shown in Fig. 9. Thus without any frictional contact of the inner surface of the flange q or of the partition d with the surface of the shaft C I effectually prevent the dropping of the material through the spaces around the shaft C, without undergoing treatment in the chambers.

In the side of the cylinder A is a series of man-holes m normally closed by suitable doors, these man-holes opening into the several chambers c c', &c., to give access thereto in case of necessity.

At the top of the cylinder A is the charging hole n through which the material to be subjected to treatment in the furnace is in-

troduced. This opening *n* is ordinarily closed by a suitable cap or door *o*.

At one side of the furnace cylinder A I place a couple of horizontal fire chambers L L′, one above the other, (see Fig. 8,) one L communicating with the lowest chamber *c* of the furnace, and the other L′ with the chamber *c′* next above it. Into each of these fire chambers is introduced a finely perforated pipe *r* through which is introduced petroleum or other hydrocarbon liquid or fluid (such as natural gas) as fuel. The liquid passing through the fine perforations of the pipe as a spray is ignited and furnishes sufficient heat for the purposes of my apparatus. The purpose in having two fire chambers is to employ more or less heat, as may be desired, by lighting one or both of them, it being desirable not to employ too intense a heat at the commencement of the operation.

In the use of my improved furnace for some purposes for which it is adapted it will not be necessary to employ any furnace heat whatever, in which case the doors *s* of the fire chambers L L′ are closed so as to prevent the entrance of an undue amount of air. Thus when the furnace is used to revivify and reoxidize material which has already been employed in the desulphuration of petroleum, a separate fire is not required because the material undergoing treatment is not only charged with sulphur which needs to be burned out, but also is impregnated more or less with petroleum which ignites and furnishes the requisite heat. So also in the calcination of pyrites if the furnace has once been heated, the sulphur eliminated from the pyrites will ordinarily suffice to maintain the necessary temperature in the furnace.

Leading from the upper chamber of furnace A is an outlet P for the escape of the products of combustion of the gaseous fuel, if such be used, or of the sulphurous fumes evolved where the furnace is employed for desulphurizing, or of any fumes, acid vapors, volatile matter, or waste products of combustion. Through the outlet P the fumes, products of combustion, &c., pass through an outside chamber or series of chambers M M′ M″ placed intermediately between the furnace A and chimney N.

In Fig. 1 is a vertical section and in Fig. 2 is a horizontal section of the chambers M M′ M″. These chambers are divided from each other by partition walls *t* and *v*. The outlet P from the furnace enters at or near the top of the first chamber M. Arched openings *w* at the bottom of the walls *t*, and *w″* at the bottom of wall *u*, and a similar passage way *w′* at top of the wall *v* force the products of combustion passing through the outlet P from the furnace to traverse the chambers M M′ M″ up one and down the other, as indicated by the arrows until they emerge through the passage ways *w″* into arched passages Q Q′ connecting with the chimney or stack N. Baffle plates *x x*, &c., which may be made of sheet iron suspended from the roof of the second and third chambers M′ M″ serve to intercept and detain the fumes, &c., as they pass through the chambers and cause the deposit in the chambers of fine particles of material under treatment and other matters which are carried out of the furnace by the current of air passing through the apparatus, and which would otherwise be lost, or which are preferably prevented from escaping into the open air. The narrow baffle plates *x* are disposed vertically and form slotted partitions across the chambers in which they are placed, the slots in one partition being opposite the solid parts in the adjacent partitions.

The chimney N serves to keep up an upward draft of atmospheric air through the oxidizing chambers of the furnace, and as the air enters chiefly from below (at the openings *i i* in the pit B), and passes upward in a circuituous course through the same openings *i j l* through which the material under treatment drops down from chamber to chamber, the heated material is brought into close and intimate contact with the air, by which it is effectually oxidized—the downward current of hot comminuted material meeting with the upward current of air.

My improved furnace, as I have described it, is especially adapted to the oxidation and revivification of metallic sulphides, which have been produced in the treatment of certain classes of petroleum with comminuted metallic oxides for the purpose of desulphurizing the oil; the result of treatment in my furnace being the elimination of the sulphur and the reconversion of the sulphides into oxides. But my furnace is also applicable for other purposes, as, for example, the oxidation of molten lead in the manufacture of the oxide of lead. For this purpose I construct the furnace in the manner already described, excepting that the topmost chamber c^4 instead of having a stirring arm H, is provided with a stationary annular iron pan T, which rests upon the floor of the chamber surrounding the vertical hollow shaft C. The openings *l* in the partition d^4 or floor of this topmost chamber c^4, which furnish a passage for the partially oxidized lead, or lead ash, formed in this upper chamber c^4, are situate near to the circumference of cylinder A and just outside of the circumference of the pan T.

The outer wall *y* of the pan T is lower than the inner wall *y′* which surrounds the shaft C, and instead of the stirring arm H (used in the other chambers) I substitute a skimmer V which is attached to and rotates with the shaft C. This skimmer has two or more blades which enter the pan T dipping into the molten metallic lead contained therein, as shown in Fig. 5.

The shape of the revolving blades of the skimmer is shown in Fig. 6; and as they rotate in the direction of the arrow in that figure they skim off the scum which floats on the top of the melted metal, and which is im-

perfectly oxidized lead, and push it over the edge of the outer wall y of the pan T, causing it to drop through the holes l in the partition d^4 or bottom of chamber c^4. This imperfectly oxidized lead is then subjected to the heat and stirring action of the arms H in the successive chambers of the furnace, and being brought into contact with atmospheric air becomes more and more completely oxidized as it passes down through the chambers, and thus a rapid and thorough oxidation of the lead is effected, so as very greatly to lessen the time, labor and expense now necessary for the production of oxide of lead.

My apparatus although specially designed and adapted for the purposes indicated in the foregoing specification, is also capable of successful use for various other purposes in the arts, where the oxidation, calcining, carburation or reduction of ores and other substances is to be effected. I therefore do not desire to limit my invention to apparatus used for the special purposes above indicated.

In this specification I have spoken of the treatment of the substance by oxidation by means of atmospheric air; but my apparatus may be used for treating substances with other gaseous or volatile fluids as hydrocarbon vapor or gas for the purpose of deoxidation or carburation; and I so desire to be understood when I speak in the specification and claims of the use of atmospheric air in connection with my improved furnace. I have also described my furnace as being cylindrical, as that is the most economical and convenient shape, but the shell of the furnace might be made of polygonal shape (as square, hexagonal, &c.) without departing from the principles of my invention, and I desire my claims to be so understood.

What I claim as my invention is—

1. In combination with the furnace cylinder divided into a number of chambers by horizontal partitions, a hollow vertical shaft provided in the several chambers with hollow arms having depending stirring fingers integral with said arms, which latter are bolted or similarly fastened to the said shaft at different points along its length and having each its cavity in communication with the interior of said shaft, and means for circulating water through said shaft, substantially as described.

2. In combination with a furnace, a chamber or series of chambers communicating with the outlet for products of combustion and other fumes and provided with narrow vertically disposed baffle plates forming slotted partitions across said chambers with the slots in one partition opposite the solid parts in the adjacent partitions, substantially as described.

3. In combination with a furnace, two chambers one having its inlet at the bottom and its outlet at the top and the other the inlet at the top and the outlet at the bottom, and each provided with narrow vertically disposed baffle plates forming slotted partitions across the chamber, said chambers being in communication with said furnace through the outlet for the fumes therefrom, substantially as described.

4. In a furnace for oxidizing molten lead or analogous purpose, a tank or vessel for holding the molten lead, and a revolving skimmer placed centrally therein, and constructed substantially as described for discharging therefrom the scum or partially oxidized metal; substantially as described.

5. A tank or vessel for holding molten lead, provided with means for heating the same, in combination with a vertical shaft passing through the said tank or vessel, and the rotary skimmer mounted on said shaft, said skimmer and said tank or vessel being arranged to effect the removal of the oxide or scum from the molten lead and the discharge of the same from said tank or vessel while the molten lead is retained in the said tank or vessel, substantially as described.

6. In a furnace for oxidizing molten lead and analogous purposes, divided by horizontal partitions into a series of stories forming oxidizing chambers, communicating with each other for the passage downward of the material undergoing oxidation and upward of an oxidizing atmosphere and furnished with means for agitating the material, and causing it to pass downward as described, and a fire chamber or chambers for heating the furnace, a tank for holding molten lead or other oxidizable metal, arranged above said oxidizing chambers and a revolving skimmer therein arranged continuously to remove the oxide or scum from the metal and discharge it into oxidizing chambers; substantially as described.

7. In combination with a series of oxidizing chambers communicating with each other and provided with stirrers therein, a tank for holding molten metal provided with a mechanical skimmer arranged therein to discharge the scum or oxide from the said tank or vessel while the molten metal is retained therein, and a fire chamber or chambers for heating the said oxidizing chambers and tank, said tank being arranged with its discharge in communication with the said oxidizing chambers so that the said oxide or scum passes therefrom into the said oxidizing chambers, substantially as described.

In testimony whereof I, the said HERMAN FRASCH, have hereunto set my hand this 28th day of August, in the year of our Lord, 1889.

HERMAN FRASCH.

Witnesses:
F. W. LOTHMAN,
W. BAKEWELL.