2 Sheets—Sheet 1.

S. WETHERILL.

FURNACE FOR OBTAINING METALLIC ZINC DIRECTLY FROM THE ORE.

No. 22,758. Patented Jan. 25, 1859.

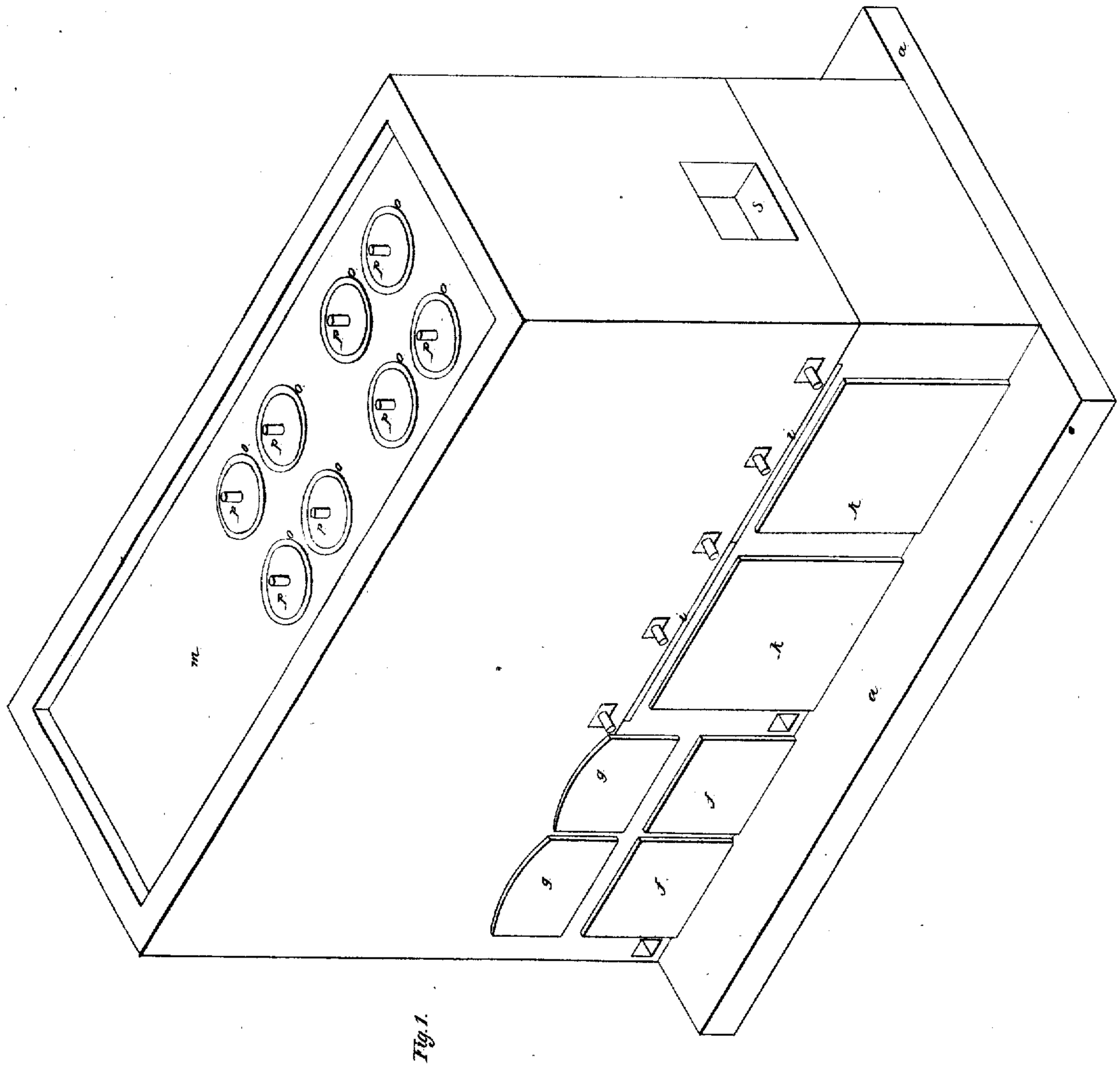

Fig. 1.

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2 Sheets—Sheet 2.

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Fig. 2.

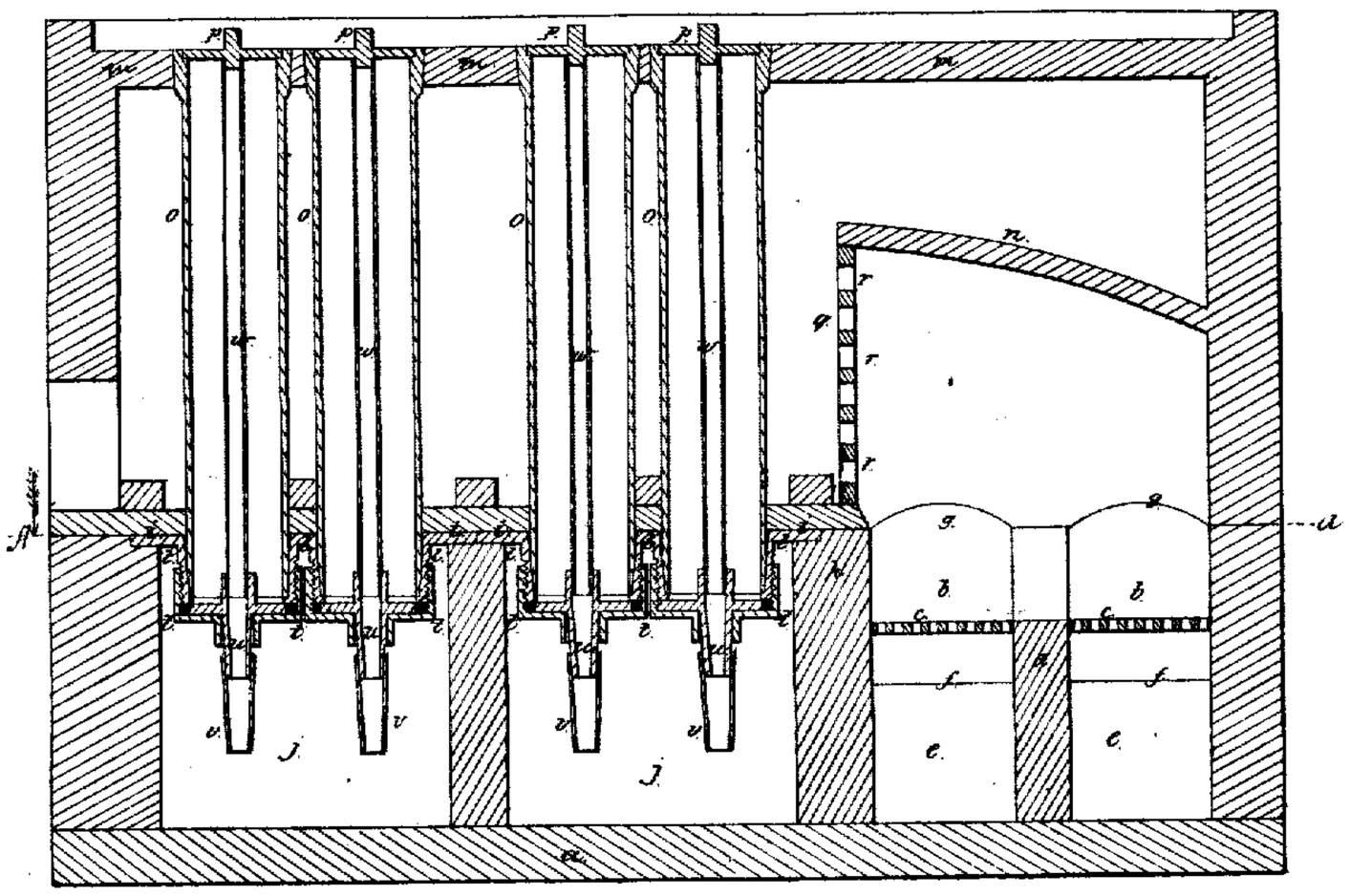
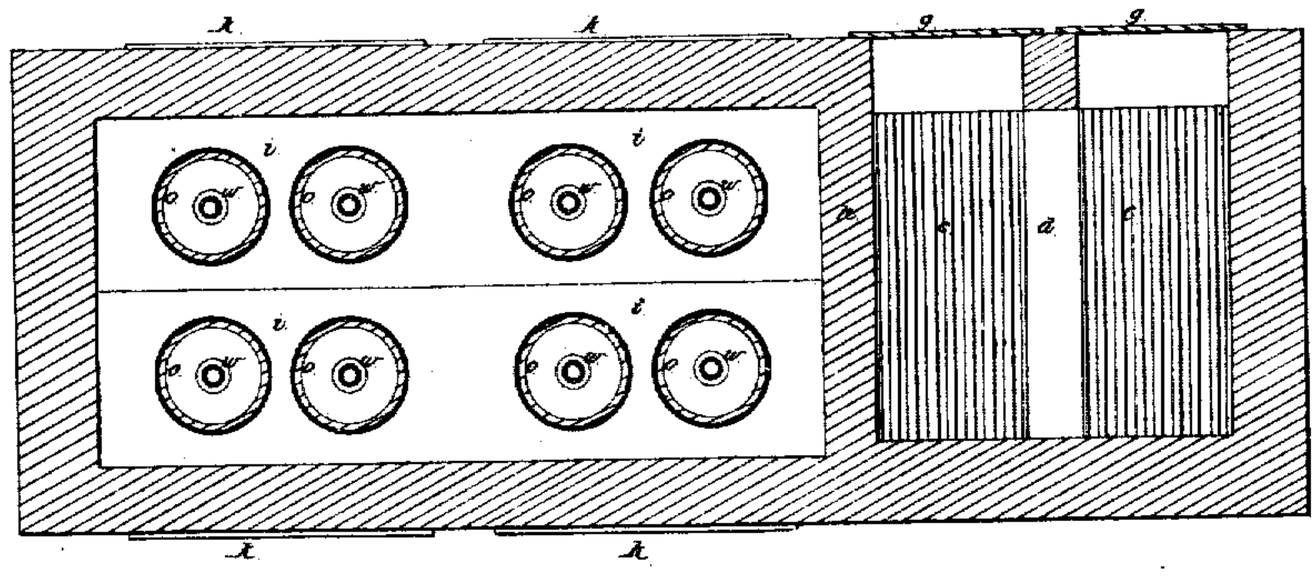


Fig. 3.



Witnesses:

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SAMUEL WETHERILL, OF BETHLEHEM, PENNSYLVANIA.

IMPROVEMENT IN FURNACES FOR DISTILLING ZINC.

Specification forming part of Letters Patent No. 22,758, dated January 25, 1859.

To all whom it may concern:

Be it known that I, SAMUEL WETHERILL, of Bethlehem, in the State of Pennsylvania, have invented certain new and useful Improvements in Furnaces for Obtaining Metallic Zinc Directly from the Ore; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, making part of this specification, in which—

Figure 1 is a perspective view of the furnace; Fig. 2, a longitudinal vertical section taken in the plane of one series of retorts, and Fig. 3 a horizontal section taken at the line A *a* of Fig. 2.

The same letters indicate like parts in all the figures.

My invention relates to the construction of furnaces for the reduction of the ores of zinc to the metallic state; and the leading object of my said invention, with a view to economy, is to effect this in vertical retorts, so that the process may be continuous without the necessity of cooling down and reheating the retorts for each charge. Three methods have heretofore been practiced: First, by means of horizontal retorts; second, by means of muffles; and, third, by means of pots. All these methods are attended with serious difficulties.

The leading objections to the method by horizontal retorts are, first, the retorts are necessarily very small in diameter and very short, or the weight of the charge would break them, as they cannot be made of iron to stand the heat, and therefore requiring to be made of porcelain or other analogous material; second, even with these small tubes a large percentage of them is broken or distorted in figure at each operation; third, as they have to be taken out and replaced for every new charge, it causes great loss of heat, and the consequent variable temperatures, giving rise to sudden shrinkage, assist to break retorts, disfigure the orifices, and permit escape of part of the products; fourth, each portion of zinc as liberated from the ore is compelled to travel through incandescent ore, or through open spaces in the upper part of each retort, caused by the settling of the ore, giving rise to the formation of considerable amount of blue powder, which necessarily has to be worked over in the next charge; fifth, as there is but one exit for metallic zinc for the whole internal contents of each retort, each particle is exposed to the continuous action of heat up to the time of its final exit; sixth, the mode of charging these retorts renders it impracticable to have all their parts evenly compacted with ore, that in the lower part being assisted by the weight of the ore, while the upper part is less solid, from the impossibility of ramming severely without distending and breaking the retorts; seventh, the greater portion of heat, being applied at the lower side of the retort, can exercise its ascending influence for only a short distance—that is, equal to the diameter of the retort.

The second method by means of muffles, called the "Silesian process," with the escape from their upper part, and then descending to a trap for the reception of the metallic product, has many difficulties, not only those already noted, each operating in degree, but the difficulties arising from the configuration of these muffles, both as to their manufacture and their discharge, a portion of the metal being always so exposed as to lead to the production of blue powder.

The third method, known as the "English process," by pots with descending tubes, is difficult and expensive, each charge being small and their diameter great, while their altitude is comparatively slight. There is no provision for the escape of the zinc from the whole charge, except the mouth of the tube at the bottom of the pot. All the other faults belonging to the previously-described methods connected with the handling and manipulation, and consequent change of temperature and waste of heat, apply with equal force to this method.

The object of my invention was to avoid the difficulties presented by these several methods, and this was to be attained by, first, a configuration of furnace which would not contain the elements of its own destruction, and in which all horizontal parts of any material breadth might be made of metal, and so located that its strength or stiffness might be relied on to maintain the figure of the furnace without itself being destroyed by alteration of figure from heat; second, such an arrangement of fire-places as would enable a portion of the fire to be cleansed and renewed while another portion was active, thus maintaining an equal and steady action of heat on the retorts; third,

such a construction of retort as would prevent the weight of the charge from altering its figure; fourth, the means of preventing ingress of atmosphere or exit of zinc vapor at any but the desired point—a vertical position of retort—so that the filling would be assisted by the weight of the ore, and the weight of the charge would always tend to carry the charge, as gradually reduced, to the bottom, leaving the vacant space above, while the discharge should always be from the charge toward the bottom, to prevent the production of blue powder; fifth, an easy escape for the zinc, as fast as separated from the ore, from any and all parts of a vertical retort of considerable size at one and the same time; sixth, having the retorts unrestrained, to avoid breakage by change of temperature, the ability to discharge the retorts without removing them from the furnace, and also to recharge them without any useless loss of heat during the filling; and, finally, the provision, by caps and otherwise, of controlling the receiving and discharging ends of the retort, so as to admit of easy luting, and all parts capable of setting to a fit, to replace shrinkage, wastage, &c.

In the accompanying drawings, *a* represents the base of the furnace, which is in the form of a parallelogram of any suitable length and breadth. At one end is formed the fire-chamber *b*, with two grates, *c c*, separated by a wall, *d*, which divides the ash-pit into two separate compartments, *e e*, each provided with a suitable door, *f*. Above these doors, in the side wall, are the two doors *g g*, for giving access separately to the two grates which, together with the upper surface of the division-wall *d*, form the bottom of the one fire-chamber for the two fires. By this means a continuous heat can be maintained, as the fires can be separately stocked and fed, and the blast or draft can be shut off from either grate while it is continued through the other.

Back of the fire-chamber, and in the direction of the length of the furnace and on a level with the top of the bridge-wall *h*, are placed four or more plates, *i i i i*, arranged in pairs, resting on the foundation-walls and leaving open spaces or chambers *j j* below—one under each pair—and provided with doors *k k*, for giving access to the lower end of the retorts, and for the reception of suitable vessels for catching the metallic zinc. These plates are cast with sockets *l l* to receive the lower end of and with a slight inner flange to sustain the retorts. After these plates are put in place the end and side walls of the furnace are built up to the required height, the inner surface (in common with all other parts exposed to a high temperature) being constructed of fire-brick or other refractory material to resist the heat, and the top *m* extends from side to side the whole length, the top being beveled a little below the top of the end and side walls, as a matter of convenience, to form a sort of reservoir for the material to be charged into the retorts. Just over the fire-chamber there is an arch, *n*, to form the roof of the fire-chamber. The retorts *o o* are of a cylindrical bore, and with the outer surface of the lower end slightly tapering to enter freely the sockets *l* in the plates *i*, into which they are to be luted to prevent access of atmospheric air, and the upper end is formed to receive a cover, *p*, which is also to be luted for the same purpose. The upper ends of these retorts pass up through the roof *m*, and rest entirely by their lower end on the flanges of the sockets, so that they will not be strained or injured in any way by unequal expansion and contraction. The bridge-wall *h* is carried up to the arched roof *n*, as represented at *q*, and pierced with numerous holes, *r*, for the passage of and to break and diffuse the flame and gaseous products of combustion, which, passing through these apertures, circulate among and around the series of vertical retorts, and finally escape to a suitable chimney through an aperture, *s*, at the back end and near the bottom of the retort-chamber. The lower ends of the retorts are closed up, except a small central discharge-aperture, by caps *t*, which fit the lower ends of the sockets *l* below the plates *i*, either by a threaded or tapered slide-joint or in any other suitable manner which can be luted or otherwise made to exclude atmospheric air. These cups are each provided with a hanging teat, *u*, to receive a prolonge, *v*, by a slip-joint, and the teat I prefer to apply by means of a flange on its upper end resting on the bottom of the cup, so that when the cups are applied and luted to the sockets the teat, with its upper flange, is also secured and luted. The upper flanged surface of the teats is formed with a slight socket to receive the lower end of a central tube, *w*, of small diameter, which extends to the top of the retorts, and is there held in a central position by a central pin on the inner side of the retort-cap. These tubes are pierced with numerous small holes all around and from end to end. The outer walls should be provided with suitable openings for observing the inside of the structure.

The retorts are made of kaolin mixed with ground fire-brick, fire-clay, or other analogous material, and being placed in a vertical position, passing down through the crown and lower plate of the furnace, and resting solely upon a flange at the bottom of the sockets in the bed-plate leaves them free to yield to unequal expansion and contraction. The top of the cover may be luted after it is charged with fire-clay, to prevent the admission of atmosphere, while the lower ends are luted in the sockets before described. The upper end of the central perforated tube is stopped with a ball of clay, and within the tube may be placed a rod, which, by being carbonized, as a natural result of its position will leave sufficient space for the descent of zinc, which may pass through the small holes from any and all parts of the retorts.

Below the prolonge before described may be placed a pan of water, into which the zinc, as it

passes down the center tube in drops, may fall. This central tube may be freed from below by passing up a rod of iron to disengage any metal hanging on its inner surface, or any particles of ore which may have found their way through the holes in the tube. This may be done when the rod of wood is not used within the tube, or, after its wastage or combustion, when used, while it occupies the tube in a carbonized state, being touched from below by the rod of iron, assists to disturb any pellicles of metal resident on the inner side of the tube. These retorts may be arranged in the furnace in parallel rows, or they may be placed "quincunx" with flame-deflectors on the inside of the furnace-walls, if desired.

Mode of operating the furnace: After arranging the parts below the bed-plate, as has been before described, and inserting the retorts, the perforated tubes are placed in their central position, and the retorts are then filled with a mixture of crushed ore and anthracite coal or other analogous material, and in such proportion as may be found necessary in practice. The upper caps are then put on and luted with fire-clay, the fires having been previously lighted and retorts brought to the required heat before charging. As soon as the heat pervades the contents of the retort and a small quantity of carbonic oxide has been exhaled from the prolonge, the white zinc flame will make its appearance, and immediately the exit of metallic zinc commences, continuing uninterruptedly until the metal is reduced from the ore, and this is denoted by the zinc metal ceasing to drop. The lower cup, with its teat and prolonge, is then removed, the cap taken from the top of the retort, and the center or perforated tube drawn out. The removal of this cap and perforated central tube permits the exhausted charge of the retort to fall out by its own weight; but this may be assisted, if found necessary, by inserting a poker or other appropriate instrument. The lower cup is then replaced and luted, as before, and the central tube put in so as to be in connection with the exit-tube in the center of the cup, a new charge of mixed ore and coal is poured in from the top, the cover of the retort replaced and luted, and the process continued as before.

From the foregoing it will be seen that after the small quantity of atmospheric air which occupies the interstice between the particles composing the charge and the bore of the perforated tube is driven out by the heat and the first evolution of gas from the ore, no more atmospheric air can enter, because the apparatus is closed and luted above and the space in the perforated tube and the teat and prolonge is at all times filled with zinc vapor, which, however, does not escape in any considerable quantity at the lower opening, except as coalesced metal, and that in consequence blue powder cannot be produced.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The employment of vertical retorts with movable caps at top and movable cups at bottom, substantially as described, in combination with the fire-chamber of a furnace, and suitable chamber for the circulation of heat, substantially as described, when applied to the reduction of the ores of zinc to the metallic state, as set forth.

2. In combination with retorts for the reduction of the ores of zinc to the metallic state, the mode of mounting the vertical retorts by having them sustained by their lower ends resting in suitable sockets, substantially as described, and unconfined at their upper ends, whereby they are free to yield to unequal expansion, as set forth.

3. In combination with retorts for the reduction of the ores of zinc to the metallic state, the employment of two fires with separated ash-pits, substantially as described, whereby the fires can be separately cleansed and stocked to admit of applying a continuous heat to the retorts, as set forth.

4. In combination with vertical retorts for the reduction of the ores of zinc to the metallic state, the employment of perforated central tubes, substantially as described, for the discharge of the metallic vapors from the charge, and the condensation thereof to the metallic state, as described.

5. The combination of the vertical retorts, the perforated central tubes, and the movable cups and appendages at bottom, and the movable caps at top, substantially as herein described, all concurring in the more ready charging of the retorts, the working of the charge, the escape and condensation of the metallic vapor to the metallic state, and the delivery thereof, and the discharge of the residuum from the retorts and the recharging of them, as set forth.

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