J. ZELLWEGER.

RECUPERATIVE ZINC SMELTING FURNACE.

APPLICATION FILED FEB. 7, 1911.

1,028,417. **Patented June 4, 1912.**

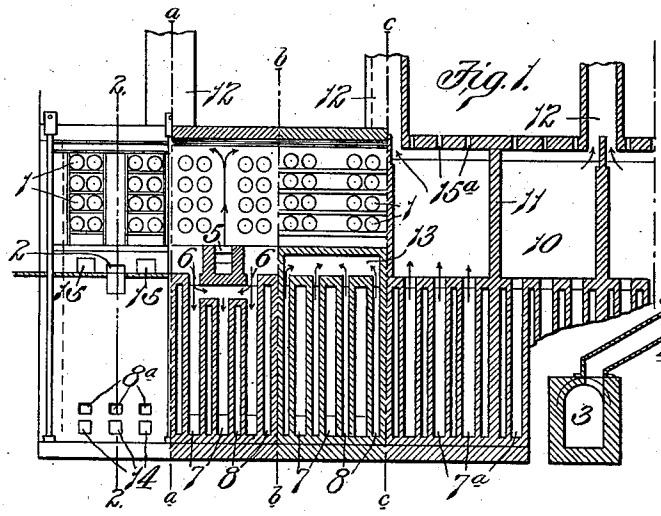

Fig. 1.

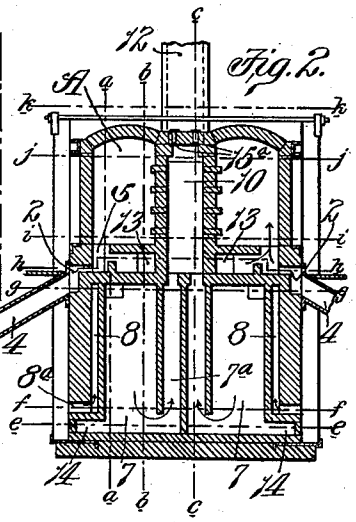

Fig. 2.

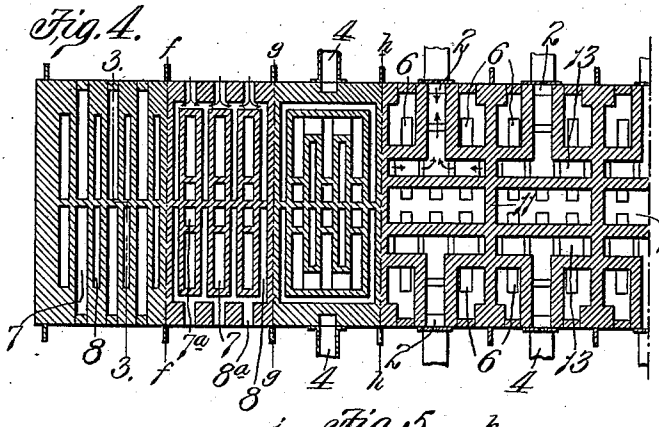

Fig. 4.

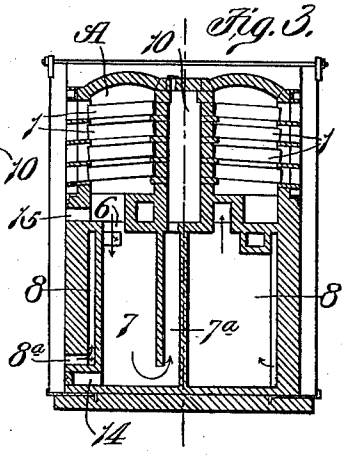

Fig. 3.

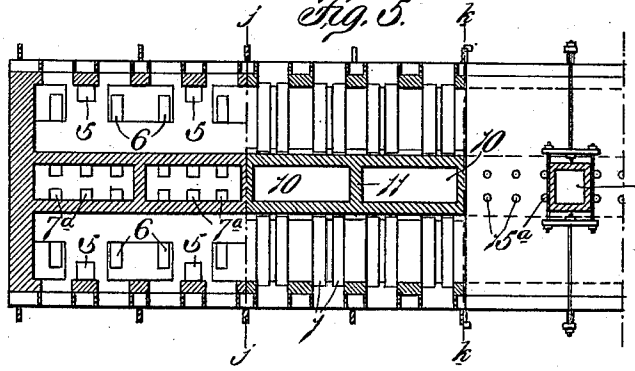

Fig. 5.

WITNESSES:

Geo. R. Cadson

Wells L. Church

INVENTOR

John Zellweger.

BY

Paul Bakewell

ATTORNEY

UNITED STATES PATENT OFFICE.

JOHN ZELLWEGER, OF ST. LOUIS, MISSOURI.

RECUPERATIVE ZINC-SMELTING FURNACE.

1,028,417. Specification of Letters Patent. Patented June 4, 1912.

Application filed February 7, 1911. Serial No. 607,214.

To all whom it may concern:

Be it known that I, JOHN ZELLWEGER, a citizen of the United States, residing at St. Louis, Missouri, have invented a certain new and useful Improvement in Recuperative Zinc-Smelting Furnaces, of which the following is a full, clear, and exact description, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to retort furnaces and particularly to zinc-smelting recuperative furnaces of the Belgian type, in which zinc ore is smelted in retorts that are supported only at their ends and which are heated by the combustion of fluid fuel with heated air.

One object of my invention is to provide means for regulating the temperature of a part of a furnace without affecting the temperature of adjoining portions of the furnace.

Another object is to provide means for producing and maintaining a strong plenum in the retort chamber.

Another object is to supply heat principally to those parts of the retort chamber which lose most heat.

Another object is to prevent uneven and excessive heating of the retorts. And another object is to provide access to all parts of the recuperative fire flues without interference with the operation of the furnace.

Other objects and desirable features of my invention will be hereinafter pointed out.

Figure 1 of the drawings is a combined front elevation and vertical sectional view of a recuperative zinc-smelting furnace constructed in accordance with my invention, the extreme left hand part of said figure being a front elevation of the furnace, the part to the right of the broken line *a*—*a* in said Fig. 1 being a vertical section on the line *a*—*a* of Fig. 2, the part to the right of the broken line *b*—*b* being a vertical section on the line *b*—*b* of Fig. 2, and the part to the right of the vertical line *c*—*c* being a vertical section on the line *c*—*c* of Fig. 2; Fig. 2 is a vertical transverse sectional view taken on approximately the line 2—2 of Fig. 1; Fig. 3 is a vertical transverse sectional view taken on approximately the line 3—3 of Fig. 4; Fig. 4 is a horizontal longitudinal sectional view of the recuperator, the extreme left hand portion of said figure being taken on the line *e*—*e* of Fig. 2, the part to the right of the line *f*—*f* of Fig. 4 being taken on the line *f*—*f* of Fig. 2, the part to the right of the line *g*—*g* being taken on the line *g*—*g* of Fig. 2, and the part to the right of the line *h*—*h* being taken on the line *h*—*h* of Fig. 2; and Fig. 5 is a horizontal longitudinal sectional view of the furnace chamber, the extreme left hand part of this view being taken on the line *i*—*i* of Fig. 2, the part to the right of the line *j*—*j* on the line *j*—*j* of Fig. 2, and the part to the right of the line *k*—*k* being taken on the line *k*—*k* of Fig. 2.

I have herein illustrated my invention embodied in a zinc-smelting furnace but I wish it to be understood that my invention is not limited to zinc-smelting furnaces as it is applicable to other kinds of retort furnaces.

Briefly described, the furnace herein shown, which represents the preferred form of my invention, consists of a retort chamber and a recuperator or air heating stove. The retort chamber is preferably arranged directly over the recuperator and it is of the usual construction, preferably with all the retorts in one continuous space. The burners, however, in which the fuel and air are combined, are arranged in the lower part of the retort chamber, and the fire ports through which the fire gases escape into the fire flues of the recuperator, are also located in the lower part of the retort chamber. The recuperator preferably consists of a number of vertically disposed fire flues and adjacent air spaces arranged in such a manner that the heat which passes from the outgoing fire gases through the walls of the fire flues, is absorbed by the air which passes upwardly through the air spaces to the burner and retort chamber. The upper ends of the fire flues communicate with the retort chamber, and the lower ends of said fire

flues communicate with an uptake flue or chamber which communicates with a chimney, and the lower and upper ends, respectively, of the air spaces communicate with the atmosphere and with a burner or combustion space for the fuel. The total number of fire flues and air spaces of the recuperator is preferably divided by partitions into sets, and each set is provided with a burner and a chimney connection separate from those of the others, this arrangement permitting local control of the heat in the retort chamber at different points.

The inlet ports to the upper ends of the fire flues and the outlet ports from the bottom of said flues are accessible through clean-out holes in the front wall of the furnace, and clean-out holes are also provided for the uptake flues with which the lower ends of the fire flues communicate. The fire flues are preferably oblong shape in cross section and are so arranged that the larger dimensions of same extend at approximately right angles to the front of the furnace to facilitate access for cleaning purposes.

The drawings illustrate a block of two equal furnaces built back-to-back in the usual manner but as both furnaces are of the same construction I will only refer to one furnace in the description of my invention.

Referring to the drawings, A designates the retort chamber or furnace chamber which preferably consists of one large chamber which extends the entire length of the furnace, and while I prefer not to use vertical partitions for positively separating or cutting off one portion of the chamber A from an adjacent portion, still said chamber is virtually divided into different sections, corresponding to the separate sets of fire flues and air ducts described above and forming separate sections of the recuperator. Each of these chamber sections has its own separate burner and chimney connection, so that the nature and volume of the fire therein can be regulated to meet the requirements of the group of retorts in that section, in a manner nearly independent of the condition pertaining to adjacent groups of retorts. The retorts 1 are arranged in horizontal tiers and preferably in vertical groups, as shown at the extreme left hand portion of Fig. 1, and fuel ports 2 are formed in the front wall of the furnace chamber adjacent the bottom of said chamber and at points approximately in the center of each group of retorts, thereby virtually dividing the furnace chamber A into a number of different sections, each of which is provided with a separate and distinct means for supplying fire to the retorts therein.

Burners 5 are arranged in the bottom of the retort chamber A adjacent the front wall of said chamber, as shown in Fig. 2, and means is provided for supplying fuel and heated air to the burners, the air-supplying means being hereinafter described and the fuel-supplying means consisting of branch flues 4 that lead from a fuel supply conduit 3 to the fuel ports 2. The retorts are preferably so arranged that the flames from the burners will not impinge directly against any of the retorts but will pass upwardly through an open space between the retorts of each section on account of the greater lightness due to the greater heat of the flame gases than the cooler fire gases in the retort chamber, the fire gases spreading when they strike the top of the furnace chamber and thence flowing laterally around the retorts and downwardly to the bottom of the furnace chamber to the discharge fire ports 6, as indicated by the arrows in Fig. 1.

The recuperator is arranged under the furnace chamber A and consists of a number of vertically disposed fire flues 7 and air ducts or flues 8 arranged adjacent the fire flues, preferably between them. Said fire flues are preferably arranged at right angles to the front wall of the furnace, as shown in Fig. 4, and the lower end of each fire flue communicates with an uptake flue 7^a that leads to a common collecting chamber 10 provided with a chimney 12, the fire escaping from the retort chamber through the fire ports 6 in the bottom of said chamber and traveling downwardly through the fire flues and up through the uptake flues 7^a to the collecting chamber 10, as indicated by the arrows in Figs. 2 and 3. The collecting chamber 10 is preferably arranged between the two furnaces so that the fire gases from both furnaces will pass into same, and is provided with vertical partitions 11 that divide it into separate sections, each pair of sections having a common chimney 12, as shown in Fig. 1.

The air ducts or flues 8 of the recuperator are provided with admission ports 8^a which are formed in the front wall of the recuperator adjacent the lower ends of said air flues, as shown in Figs. 2 and 3, and the upper ends of said air ducts communicate with air-collecting chambers 13, as shown in Fig. 1. A separate air-collecting chamber 13 is provided for the air ducts of each section of the recuperator, and each of said air-collecting chambers has an outlet into the burner 5 which heats the section of the furnace chamber A with which the air-collecting chamber coöperates. I also prefer to provide the front wall of the recuperator with clean-out openings 14 and 15, as shown in Figs. 2 and 3, that give access to the fire flues and fire outlet ports 6 so as to enable them to be cleaned out without shutting

down the furnace. Said clean-out openings are normally closed by plugs or closures of any preferred design, and as they provide a means for preventing the fire flues from becoming clogged by clay and fumes, the furnace can continue in operation uninterruptedly. I also prefer to form clean-out openings 15ª in the top of the collecting chamber 10 so as to enable the uptake flues 7ª to be cleaned out.

The air in the recuperator becomes heated by contact with the hot walls of the fire flues and consequently becomes lighter than atmospheric air and passes upwardly through the air ducts or flues 8 into the air-collecting chambers 13 and into the burners, thereby producing a plenum in the chamber A. Fresh air continues to flow uninterruptedly through the air ducts or flues of the recuperator so that a steady current of hot air is supplied continually to the burners of the furnace chamber, said hot air burning the fluid fuel and thus producing a very hot flame in the furnace chamber. The heat in this flame is the sum of the heat from the fuel and of the heat brought back to the furnace chamber by the air which passes through the recuperator. Consequently, this recuperated heat not only represents a direct saving of heat and fuel, but it also increases the efficiency and the temperature of the flame in the furnace chamber or retort chamber A. The recuperator is preferably built comparatively high, and as the fresh air is introduced at the bottom of same, it produces in the air ducts of the recuperator a high hot air column which creates a plenum in the furnace chamber and exerts a pressure on the gases in said furnace chamber, thereby excluding all cold air and preventing cold air from flowing in by action of the stack draft. The combined action of this hot air column and of the flames in the furnace chamber causes the fire gases in said chamber to descend into the fire flues of the recuperator where they come under the influence of the draft created by the chimneys which communicate with the collecting chambers 10, the recuperator being so designed that the supply of fresh air is ample and its flow and rise is but little obstructed.

In the block of furnaces herein shown, a collecting chamber 10 coöperates with one group of retorts of one furnace and also one group of retorts in the other furnace. If it is desired to regulate the heat in each group separately, then the collecting chambers 10 can be divided by vertical longitudinal partition walls into two separate collecting chambers, one for each recuperator section, and each of these chambers may be provided with a damper for controlling the outlet of the fire gases into the chimney. If it is desired to collect the fire gases from all groups of retorts into one large chimney standing separate from the furnace, the small chimneys and partition walls between the several collecting chambers are omitted, thus producing one continuous chimney flue on top of the recuperator arranged between the retort chambers of the furnaces and extending the entire length of the block of furnaces, a suitable chimney being connected to one or both ends of said chimney flue. If a more accurate regulation is desired, partition walls can be arranged in the furnace chamber between the separate groups of retorts but since such partition walls would be exposed to intense heat on both sides and would have no way to cool off, it is doubtful if such a construction would be practicable for commercial purposes.

In order to obtain a maximum of metal from the charge in the retorts, it is essential that the distillation of the zinc proceed at a uniform rate and that the temperature increase gradually during the process. Both of these conditions are complied with by providing the retort chamber with a recuperator and a steady flow of fuel gas or oil. When the retorts are charged they and the entire furnace are cooled down, and the recuperator furnishes air which is only moderately hot. Gradually, the recuperator accumulates heat and increases the temperature of the ingoing air which travels through the air ducts of the recuperator, and toward the end of the operation this increase has to be checked so as to prevent injury to the furnace and retorts from excessive heat.

By constructing the furnace in the manner above described I am able to regulate the temperature of one portion of the furnace without affecting the temperature of an adjoining portion because separate and distinct means is provided for supplying heat to different sections of the retort chamber and for carrying off the hot fire gases from said sections. Furthermore, I obtain a strong plenum in the retort chamber by maintaining vertical columns of heated air in communication with the air-collecting chambers with which the burners communicate. Another desirable feature of such a furnace is that the greatest part of the fire gases is circulated near the front wall of the retort chamber, which loses most heat, by reason of the fact that the burners and fire-outlet ports are so arranged that the flames travel in close proximity to said front wall. And still another desirable feature is that the various clean-out openings are so arranged that the flues which are most likely to become clogged can be cleaned out easily without shutting down the furnace.

Having thus described my invention, what

I claim as new and desire to secure by Letters Patent is:

1. In a retort furnace, a recuperator provided with an air-collecting chamber, a burner arranged in communication with said air-collecting chamber, a group of vertically disposed air ducts communicating at their upper ends with said air-collecting chamber and at their lower ends with the atmosphere, fire flues arranged in proximity to said air ducts, and outlet ports communicating with the upper ends of said flues and through which fire gases escape from the retort chamber.

2. In a retort furnace, vertically disposed fire flues arranged in such a manner that fire gases will travel downwardly through same, uptake flues that communicate with the lower ends of said fire flues, and a chamber communicating with the uptake flues that lead from a group of fire flues for collecting the exhaust gases from said flues.

3. In a retort furnace, a plurality of approximately straight vertically disposed unobstructed fire flues standing side by side with air spaces between them and arranged in groups, outlet ports communicating with the upper ends of said flues and through which fire gases escape from the retort chamber, a chimney or similar device communicating with the lower ends of said fire flues of each group, said air spaces communicating at their lower ends with the atmosphere, and a single burner communicating with the upper ends of the air ducts of each group.

4. In a retort furnace, groups of approximately straight vertically disposed and unobstructed fire flues, a chimney or similar device communicating with the lower ends of the flues of each group so that exhaust fire gases will travel downwardly through said flues, clean-out openings in the front wall of said furnace located adjacent the upper and lower ends of the fire flues of each group, air spaces adjacent said fire flues whose lower ends communicate with the atmosphere, and a single burner which is supplied with air from the upper ends of the air spaces of each group.

5. A retort furnace having a furnace chamber and a number of recuperator sections, each of which comprises means for causing the heat in the fire gases going out of a certain part of the furnace chamber to heat air which is admitted to the same part of said chamber from which said fire gases escaped.

6. A retort furnace having a number of separate and distinct recuperators, each of which comprises a group of fire flues and a group of air spaces arranged adjacent to the fire flues, the fire flues and air spaces of each recuperator being arranged in such a manner that the heat from the outgoing fire gases operates to heat the ingoing air, exhaust fire gas ports communicating with the fire flues of the respective recuperators, and separate burners, each of which coöperates with the gas spaces of one recuperator.

7. A retort furnace composed of a number of separate sections, each of which comprises a plurality of vertically disposed fire flues, air spaces arranged adjacent said fire flues and having their lower ends communicating with the atmosphere, a burner cooperating with the upper ends of the air spaces of each section, outlet ports communicating with the upper ends of said fire flues, and a collecting chamber communicating with the lower ends of said fire flues.

8. In a retort furnace, a plurality of burners, a separate group of vertical fire flues coöperating with each burner, and air spaces arranged adjacent said flues so as to cause the heat from the outgoing fire gases to be transferred to the ingoing air.

9. In a retort furnace, a recuperator composed of a number of separate sections each of which has a set of vertical fire flues for the outgoing fire gases from said section and a set of air flues arranged in proximity to said fire flues for supplying air to said section.

10. In a retort furnace, a recuperator composed of a number of separate sections, each section of said recuperator consisting of a number of vertical fire flues, air spaces arranged between said fire flues and communicating at their lower ends with the atmosphere, a collecting chamber communicating with the lower ends of said fire flues, a collecting flue communicating with the upper ends of said air spaces, and a burner cooperating with said collecting flue.

11. In a retort furnace, separate sets of comparatively high, vertically disposed air ducts or flues communicating at their lower ends with the atmosphere, an air-collecting flue for each set communicating with the upper ends of all of the air flues of such set, a single burner coöperating with each of said air-collecting flues, and means for heating the air that travels upwardly through said air flues.

12. In a retort furnace, separate sets of comparatively high, vertically disposed air ducts or flues communicating at their lower ends with the atmosphere, an air-collecting flue for each set communicating with the upper ends of all of the air flues of such set, a single burner coöperating with each of said air-collecting flues, and separate sets of outlet fire flues arranged in proximity to said air ducts so that the heat from the outgoing fire gases which travel through same will operate to heat the air which enters said air-collecting flue through said air ducts.

13. In a retort furnace, vertically disposed fire flues, outlet ports communicating with the upper ends of said flues and through which fire gases escape from the retort chamber, a collecting chamber, uptake flues which lead from the lower ends of said fire flues to said collecting chamber, air ducts arranged in proximity to said fire flues and communicating at their lower ends with the atmosphere, and an air-collecting flue communicating with the upper ends of said air ducts.

In testimony whereof I hereunto affix my signature in the presence of two witnesses, this third day of February 1911.

JOHN ZELLWEGER.

Witnesses:
WELLS L. CHURCH,
GEORGE BAKEWELL.