

(No Model.)

5 Sheets—Sheet 1.

A. HEIMBACH.
ORE ROASTING FURNACE.

No. 585,268.

Patented June 29, 1897.

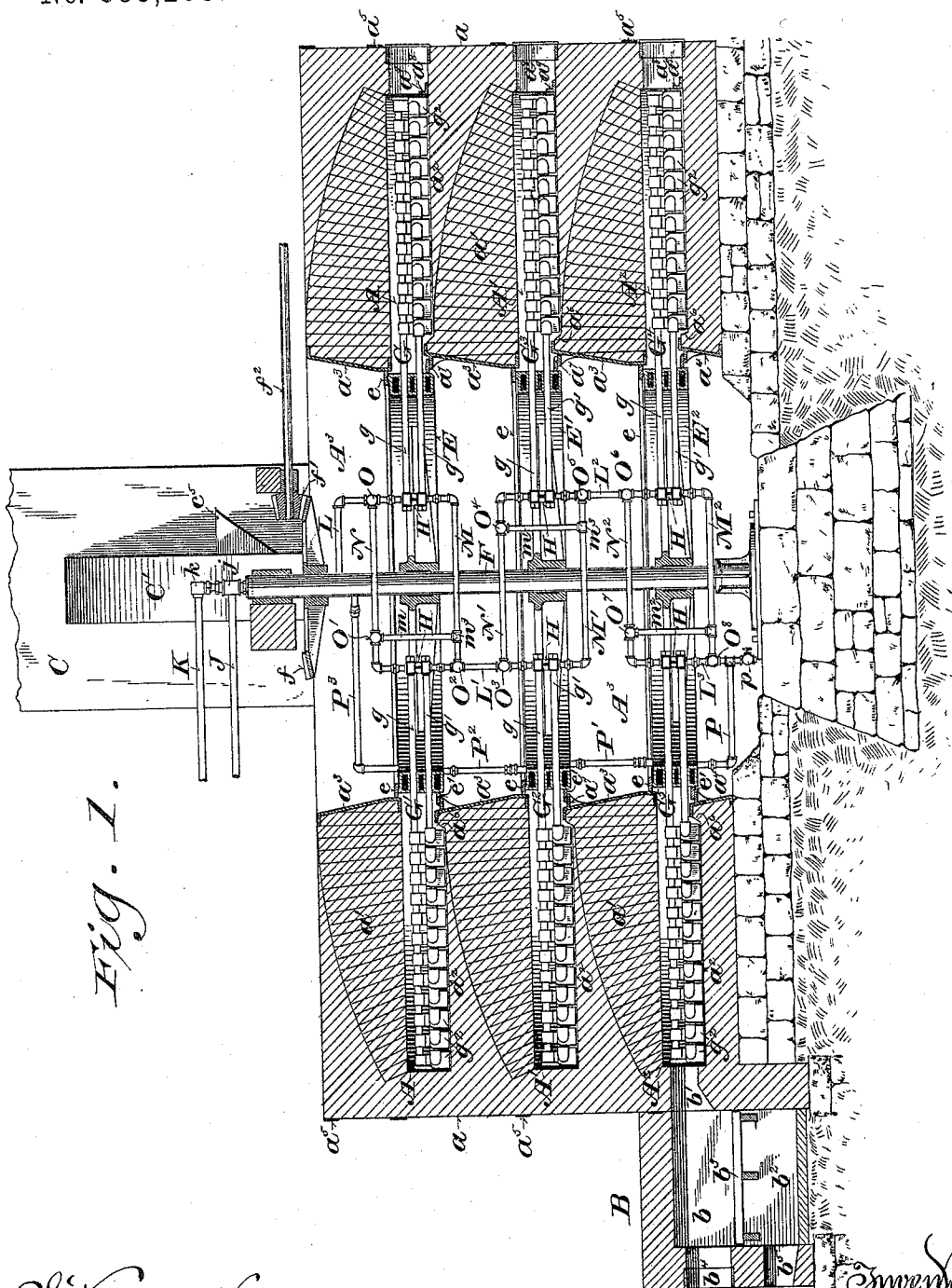


Fig. 1.

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(No Model.)

5 Sheets—Sheet 2.

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Fig. 2.

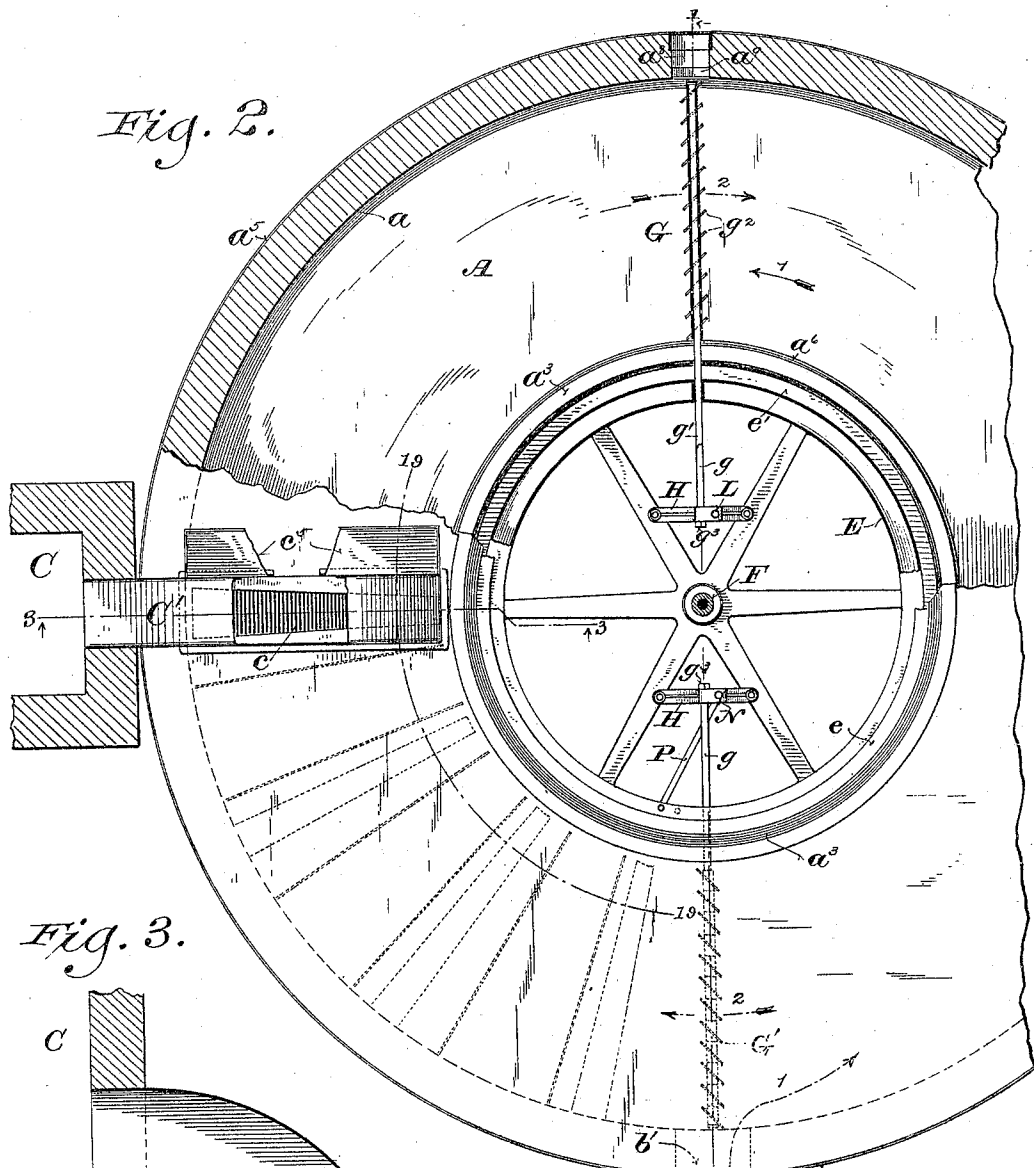
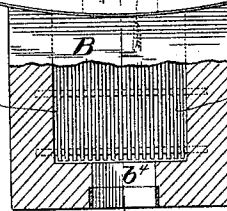
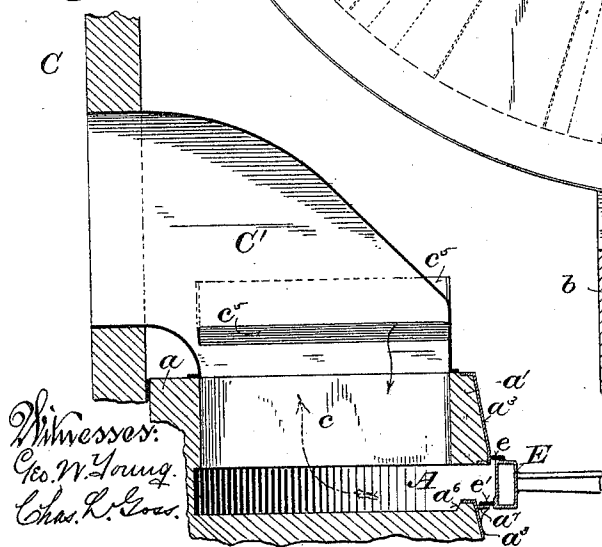


Fig. 3.



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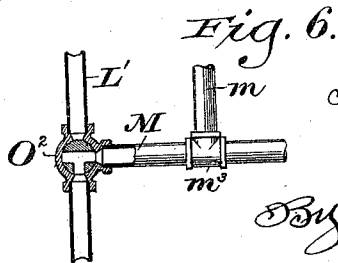
5 Sheets—Sheet 3.

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Patented June 29, 1897.



Fig. 4.



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Fig. 6.

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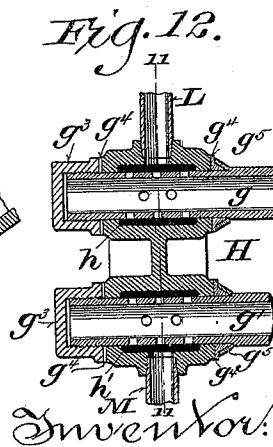
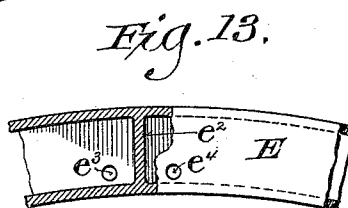
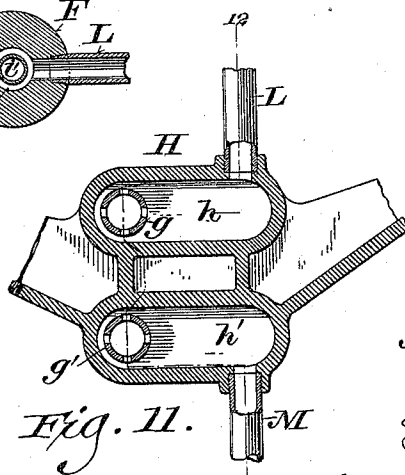
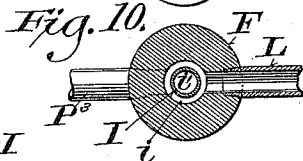
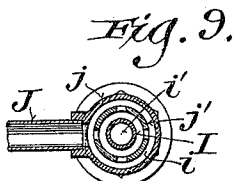
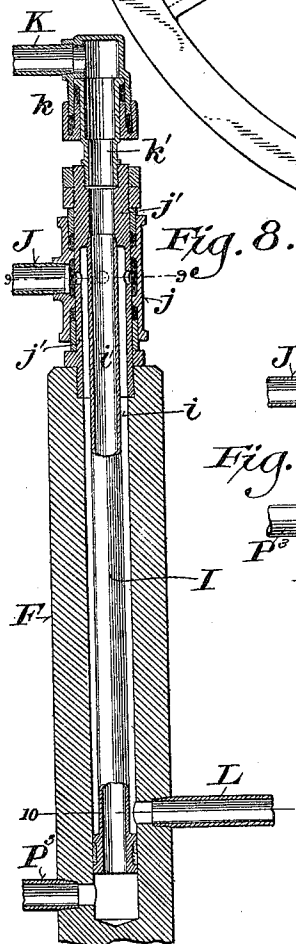
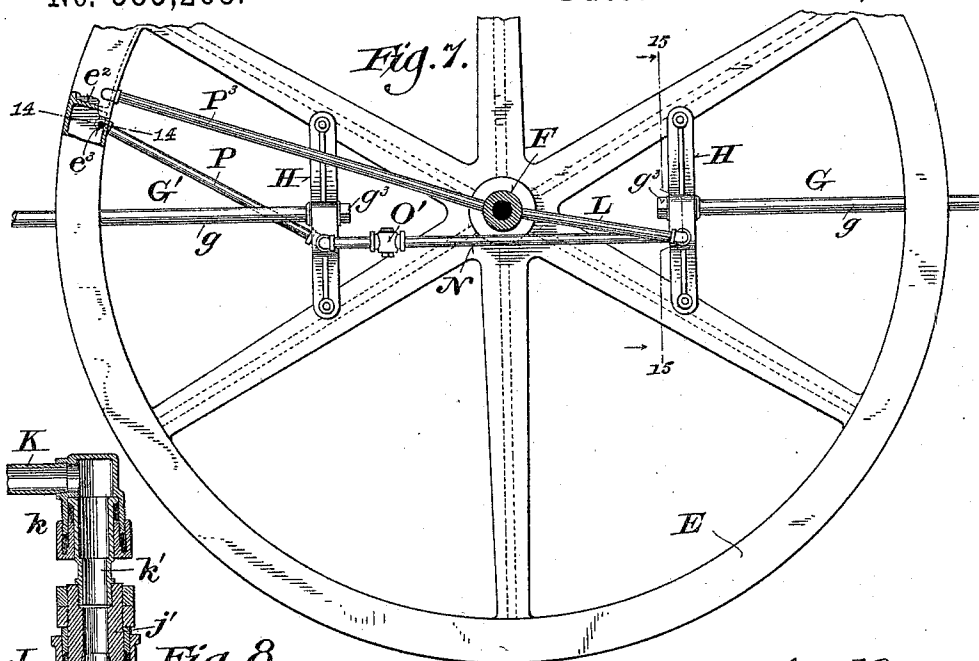
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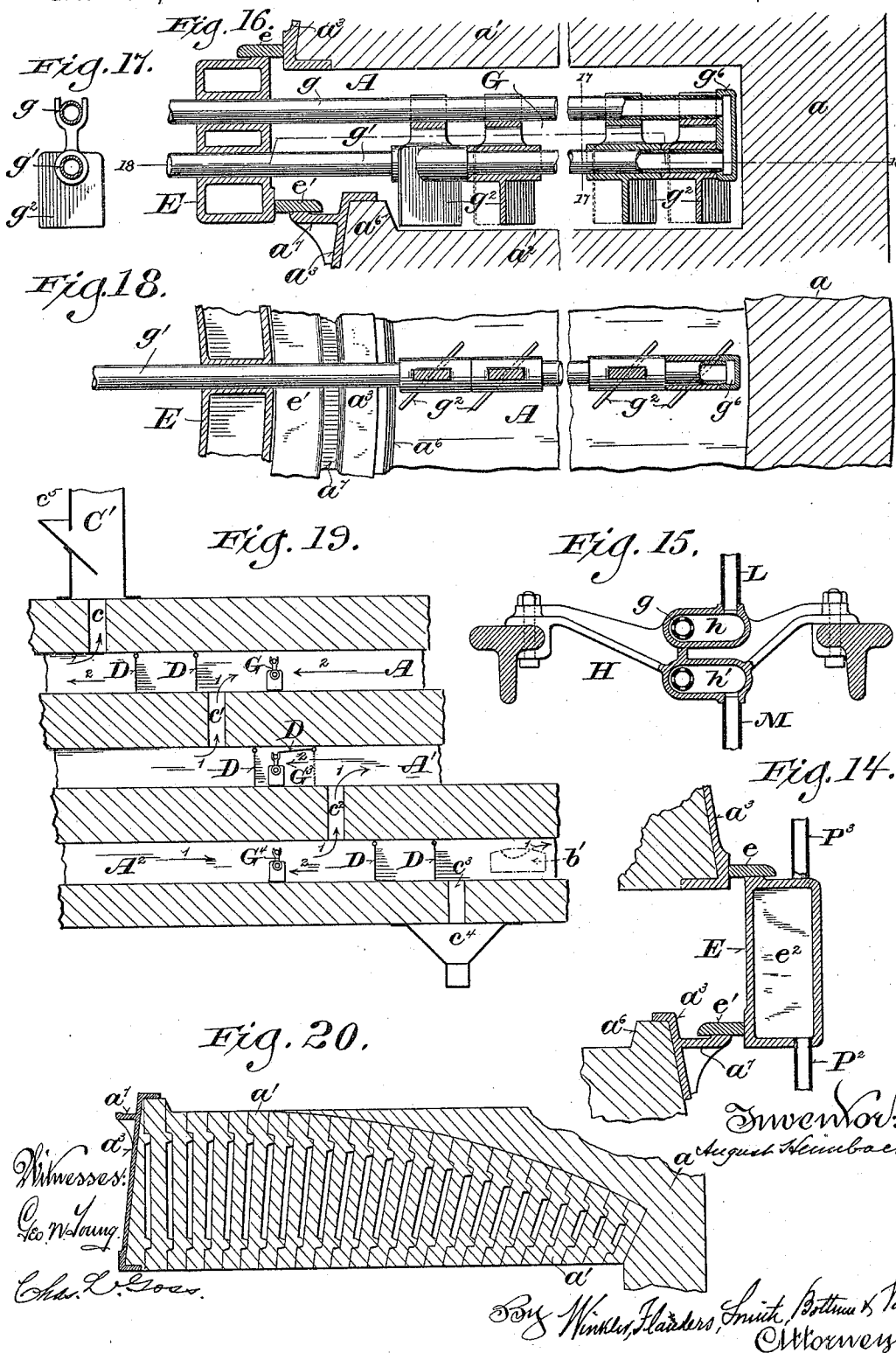
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A. HEIMBACH.
ORE ROASTING FURNACE.

No. 585,268.

Patented June 29, 1897.



UNITED STATES PATENT OFFICE.

AUGUST HEIMBACH, OF BUTTE, MONTANA.

ORE-ROASTING FURNACE.

SPECIFICATION forming part of Letters Patent No. 585,268, dated June 29, 1897.

Application filed March 11, 1893. Serial No. 465,591. (No model.)

To all whom it may concern:

Be it known that I, AUGUST HEIMBACH, of Butte, in the county of Silver Bow and State of Montana, have invented certain new and useful Improvements in Ore-Roasting Furnaces; and I do hereby declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it pertains to make and use the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

My invention relates generally to that class of furnaces employed for roasting, desulfurizing, calcining, and cloridizing ores, which operations may all be comprehended and will be hereinafter referred to under the more generic term "roasting," and it belongs to that particular class of ore-roasting furnaces which are constructed in circular or annular form and in which the ore is distributed, constantly turned, and gradually moved forward from inlet to outlet by plows or stirrers. Its main objects are to economize space and fuel, to prevent loss of heat, to utilize as fuel the sulfur contained in sulfur-bearing ores for continuing the operation of roasting without the use of other fuel, to utilize the entire floor-space of the furnace, to prevent access of outside air to the material in its passage through the furnace, to prevent the overheating of the stirrers and associated mechanism, to provide for the removal of any of the stirrers without interfering with other working parts of the furnace, except temporarily, and generally to improve the construction and arrangement of this class of furnaces.

It consists of certain novel features in the construction and arrangement of the component parts of the furnace hereinafter particularly described, and pointed out in the claims.

In the accompanying drawings like letters designate the same parts in the several figures.

Figure 1 is a vertical medial section of a furnace embodying my invention. Fig. 2 is a partial horizontal section of the furnace. Fig. 3 is a vertical section of the smoke-flue connection and inlet or feed opening of the furnace on the line 3 3, Fig. 2. Fig. 4 is a

view, on an enlarged scale, partly in vertical section and partly in elevation, of the connections by which the stirrers and water-jackets are supplied with water. Figs. 5 and 6 are sectional details showing different positions of certain three-way cocks for shutting off water from a stirrer. Fig. 7 is a plan view of one of the water-jackets and its connections. Fig. 8 is a vertical medial section, on an enlarged scale, of the upper end of the shaft carrying the water-jackets and stirrers, showing the water feed and discharge connections. Fig. 9 is a horizontal section on the line 9 9, Fig. 8. Fig. 10 is a like section on the line 10 10, Fig. 8. Fig. 11 is an enlarged vertical longitudinal section, on the line 11 11, Fig. 12, of a portion of one of the chambered cross-heads in which the inner ends of the stirrer-arms are secured. Fig. 12 is a vertical section on the line 12 12, Fig. 11. Fig. 13 is an enlarged detail view, partly in plan and partly in horizontal section, of a portion of one of the annular water-jackets, showing the division-wall on one side thereof and its inlet and outlet openings. Fig. 14 is an enlarged vertical cross-section, on the line 14 14, Fig. 7, of one of the water-jackets, the packing-rings, and adjacent portions of the furnace. Fig. 15 is a vertical section on the line 15 15, Fig. 7, showing one of the chambered cross-heads in which the inner ends of the stirrer-arms are secured, partly in elevation and partly in section. Fig. 16 is an enlarged vertical section, taken in a radiating plane, of a portion of one side of the furnace, showing one of the stirrers partly in side elevation and partly in section. Fig. 17 is a cross-section of one of the stirrers on the line 17 17, Fig. 16. Fig. 18 is a horizontal section on the line 18 18, Fig. 16. Fig. 19 is a vertical section taken in a plane indicated by the line 19 19, Fig. 2, and showing the arrangement of the inlet and outlet or feed and discharge openings of the furnace and the intermediate openings by which the several annular chambers communicate with each other and the relative arrangement of the gravitating doors by which the draft is prevented from passing directly through said openings from floor to floor; and Fig. 20 is a sectional detail showing an arch as constructed of interlocking tile or brick.

Referring to Figs. 1, 2, 19, and 20, my improved furnace preferably comprises a number of annular chambers A, A', and A², arranged one above another and inclosed on three sides by an outer circular wall *a*, spherical arches *a'* *a'*, and floors *a*² *a*². The lower floor is supported upon a stone or other suitable foundation, while the upper floors are carried by the arches *a'*. The arches abut at the outside against the wall *a* and at the inside against annular flanged castings *a*³, the lower floor *a*² abutting at the inside against a similar casting *a*⁴. The annular chambers open inside into a central pit or well A³, in which are placed the supporting, driving, and water connections of the stirrers. The outer wall of the furnace is surrounded by iron or other suitable bands *a*⁵ *a*⁵ to receive the outward thrust of the arches and floors. The arches are preferably constructed, as shown in detail in Fig. 20, of interlocking brick or tile.

By the method of constructing and supporting these arches hereinbefore set forth their under surfaces, constituting the crowns or ceilings of the annular chambers, are brought close to and parallel with the floors of said chambers. This is of especial importance in roasting sulfur-bearing ores in order to utilize the sulfur contained in the ore for carrying on the operation without other fuel, it being necessary to reduce the space as much as possible in which the material to be treated is inclosed and to prevent exposure of the ore to the outside air from the time it enters the furnace until it is discharged therefrom, in order to properly regulate the supply of oxygen to produce sulfurous-acid gas. The several floors *a*² *a*² are slightly raised around their inner edges, as shown at *a*⁶ *a*⁶, Fig. 1, to retain the material thereon.

B is a fireplace for supplying the necessary heat to start the furnace when sulfur-bearing ores are treated, the fuel for continuing the operation when once in progress being afforded by the sulfur contained in such ores and the supply of other fuel being discontinued. In the treatment of other ores the necessary heat is supplied by said fireplace alone, in which wood, coal, or other suitable fuel is burned.

b represents the combustion-chamber of the fireplace, which communicates through an opening *b'* with the lower chamber A².

*b*² is the ash-pit, *b*³ the grate, *b*⁴ the feed-door through which fuel is supplied to the fireplace when a fire is maintained therein and the draft of air by which the necessary quantity of oxygen is admitted into the furnace to maintain the proper combustion therein is regulated, and *b*⁵ is the ash-pit door through which the necessary draft for maintaining the fire in the fireplace is afforded.

The construction and arrangement of the spherical arches in connection with the iron rings *a*³ *a*³ are such as to make the arches self-sustaining and to afford unobstructed circu-

lar openings from the pit or well A³ into the several annular chambers A, A', and A² for the passage of the stirrer-arms.

C is the chimney or smoke-stack, located at one side of the furnace and connected by a flue or pipe C' through an opening *c* with the upper chamber A. The upper chamber A communicates with the next chamber A' below it through a similar radiating opening *c'* in its floor, the chamber A' with the lower chamber A² through a like opening *c*², and a similar discharge-opening *c*³ is provided in the floor of the lower chamber and opens into a hopper *c*⁴.

*c*⁵ is a feed-hopper opening into the side of the smoke-flue C', through which the material is fed into the furnace by suitable mechanism.

The several openings above mentioned are arranged as indicated and shown in Figs. 2 and 19, and to prevent the draft from passing directly from one chamber to another through the opening between them without first passing entirely or nearly around each annular chamber, without obstructing the free and continuous advance movement of the stirrers, I provide each chamber between the several openings *c*, *c'*, *c*², and *c*³ with a pair of gravitating doors D D, placed transversely or radially across said chamber and hinged at their upper edges to the crown or ceiling of said chamber. By this means the draft is compelled to pass in the direction indicated by the arrows 1 1 completely or nearly around each chamber before it can escape through the opening therefrom into the next chamber above or finally into the smoke-flue.

Referring to Figs. 4 and 7, E, E', and E² are hollow rings or water-jackets which constitute the rims of and may be cast with wheels that are fixed upon a vertical shaft F, supported in suitable bearings centrally in the well or pit A³. These water-jackets are located opposite and near to the several circular openings from the annular furnace-chambers into the well A³. To produce and maintain tight joints between these water-jackets and the adjacent walls of the furnace, so as to exclude outside air from the annular chambers and to prevent the escape of heat therefrom, I provide the annular packing-rings *e* and *e'*, which may be formed in two or more sections in the direction of their length. The rings *e* are faced on their under sides to closely fit faced portions of the upper sides of the water-jackets, upon which they loosely rest, and are turned on their outer edges to accurately fit the adjacent bored surfaces of rings *a*³ *a*³. The rings *e'* are faced on the under side to fit the upper faced surfaces of inwardly-projecting horizontal rims *a'* *a'* of the rings *a*³, upon which they loosely rest, and are turned on their inner edges to accurately fit the adjacent turned or faced portions of the outer sides of said water-jackets. By this means nearly air-tight joints are produced and maintained between

the water-jackets and adjacent walls of the furnace, the packing-rings accommodating themselves to any settling or deflection of the movable or stationary parts and to inaccuracies in workmanship.

Each of the water-jackets is formed or provided on one side with a transverse partition e^2 and on opposite sides thereof with water supply and discharge openings e^3 and e^4 , one in the bottom and the other in the top of said jacket, as shown in Figs. 7 and 13.

The shaft F is provided near its upper end with a bevel-gear f , which is engaged and driven by a pinion f' on a horizontal shaft f^2 , connected by any suitable means (not shown) with a source of power. The water-jacket wheels each carry two stirrers G G' G^2 G^3 G^4 G^5 , projecting radially therefrom on opposite sides into the annular chambers A A' A^2 .

Referring to Figs. 16, 17, and 18, in connection with Figs. 1 and 4, each stirrer consists of two tubular arms g and g' and a series of inclined stirrer-blades g^2 g^2 , secured thereon so as to extend approximately across the entire width of the annular furnace-chambers. The arms g and g' pass through and are supported in sleeved openings in the water-jackets and are secured at their inner ends in chambered cross-heads H H , attached to the spokes of the water-jackets, as shown in Figs. 7, 11, 12, and 15, the upper arm g communicating through perforations with the chamber h and the lower arm g' communicating in like manner with the chamber h' in said cross-head. These arms are slightly reduced to fit the openings through which they pass in said cross-heads and are secured therein by cap-nuts g^3 g^3 , tight joints being produced by suitable packing-rings or washers g^4 g^4 , interposed between said cross-heads, the nuts g^3 , and the metallic rings or washers g^5 g^5 . The outer ends of each pair of arms are connected and communicate with each other through a hollow cross-piece g^6 . The stirrer-blades g^2 are each formed with a horizontal sleeve, which encircles the lower arm, and above it with an open sleeve or forked support, which embraces the upper arm. They are set at an inclination to the axes of said arms, the inclination of the blades on opposite sides of the furnace being in opposite directions with reference to the advance movement of the stirrers, so as to alternately move the ore outwardly and inwardly on each of the floors.

Water or any other suitable cooling medium is supplied to and caused to circulate through the several stirrer-arms and water-jackets by connections which will now be described.

Referring to Figs. 4 and 8, the upper end of shaft F is bored longitudinally, and in it is inserted a tube I, which forms therewith an outer annular feed-passage i and an inner discharge-passage i' .

J is the supply-pipe, which is coupled to a double stuffing-box j , encircling a sleeve j' , secured to and turning with the upper end of

shaft F. It communicates through perforations in the sleeve j' with the annular passage i .

K is the discharge-pipe, which is coupled with the stuffing-box k and communicates through a gland or extension k' of sleeve j' with the passage i' in tube I.

All the water connections above mentioned, except the supply and discharge pipes J and K and the stuffing-boxes j and k , turn with shaft F.

The feed-passage i is connected by a pipe L with the upper chamber h in the cross-head H of stirrer G. The lower chamber h' of said cross-head is connected by pipes M, m , and N with the upper chamber in the cross-head H of stirrer G' , and in like manner the cross-heads H of the remaining stirrers are connected *seriatim* with the lower chamber h' in the cross-head H of the stirrer G' by pipes L', M', m' , N', L², M², m^2 , and N². The lower chamber h' in the cross-head H of the last stirrer G^5 in the series is connected by pipes L³ and P with the lower water-jacket E², which is in turn connected on the opposite side of its partition e^2 by a pipe P' with the water-jacket E' next above it. The upper water-jacket G' is connected in like manner with the water-jacket E' by a pipe P² and with the discharge-passage i' in shaft F by a pipe P³. The pipe N connects with the pipe L, the pipe N' with the pipe L', and the pipe N² with the pipe L². The pipe M connects with the pipe L', the pipe M' with the pipe L², and the pipe M² with the pipe L³, and the pipes M and N, M' and N', and M² and N² are connected by vertical branch pipes m , m' , and m^2 . Three-way cocks O, O', O², O³, O⁴, O⁵, O⁶, O⁷, and O⁸ are provided at the junctions of the pipes L and N, m and N, L' and M, L' and N', m' and N', L² and M', L² and N², m^2 and N², and L³ and M² for the purpose of shutting off the water from any one of the stirrers and diverting it through the others. A cock p is provided at the lower end of pipe L³ for the purpose of draining the water from the stirrers and water-jackets.

I do not wish to be understood as limiting myself to the specific arrangement of the water-supply connections above described, as any arrangement of the pipes and valves whereby the water-supply may be cut off from any one or more of the stirrers and allowed to circulate through the others comes within the spirit and intended scope of my invention.

In one side of the furnace openings a^8 a^8 are made through the wall a into the several annular chambers for the purpose of removing the stirrers therefrom. These openings are closed by suitable doors, and removable angle-iron guards a^9 are provided at their inner orifices to retain the ore or pulp in its proper course upon the floors of the annular chambers.

My improved furnace operates as follows: The ore or pulp being fed into the hopper c^5

falls through the smoke-flue C' and the opening c upon the floor of the upper chamber A and is gradually and continuously moved forward in the direction indicated by the arrows 2 2 in Figs. 2 and 19 by the inclined blades g^2 of the stirrers G and G', which turn it alternately inwardly and outwardly toward and from the center of the furnace and finally discharge it through the opening c' upon the floor of chamber A', in which it is in like manner turned and carried around by the stirrers G^2 and G^3 to the opening c², through which it is discharged into the lower chamber A². From the lower chamber, in which it is carried around in like manner by the stirrers G^4 and G^5 , it is discharged through the opening c³ into the hopper c⁴, whence it may be removed in any convenient manner.

The ore or pulp in its passage through the several chambers, as above explained, is subjected without interruption to the heat furnished by the fireplace B or produced by the combustion of the fuel contained in the ore itself. The draft entering the lower chamber through the opening b' traverses the several chambers in the direction indicated by the arrows 1 1, Figs. 2 and 19, passing from one chamber to another above through the openings c² and c', and finally passes out from the upper chamber through the opening c and the flue C' into the smoke-stack C. The draft and heat are prevented from passing directly from one chamber to another through said openings by the doors D D, which swing freely and open one at a time to permit of the passage of the stirrers, as shown in Fig. 19. By this means waste of heat is effectually prevented without obstructing the continuous movement of the stirrers, but one of each pair of doors being opened at any given time by the passage of the stirrers.

It is obvious from the foregoing description, in connection with the drawings, that the stirrers are inclosed in their entire circuit through the several annular chambers, and are not exposed, as in some furnaces of this class, to the outside air at any point, but are prevented from being burned or overheated by the constant circulation of water through their arms. It will also be observed by the construction and arrangement herein shown and described that practically the entire floor-space of the furnace is utilized, and that the outside air is excluded from the roasting-chambers, and escape of heat therefrom is prevented by the swinging doors arranged in pairs between the several openings from and into said chambers, and by the water-jackets and packing-rings closing the circular openings from said chambers into the central pit or well. The construction of the arches a' a' is also such as to prevent the dissipation of the heat within the furnace and to cause it to act to the best advantage upon the material contained therein, the ceilings or crowns of the several chambers being brought as close as practicable to and paral-

lel with the floors. Water or any other cooling medium is constantly fed while the furnace is in operation, from any suitable fixed reservoir or source of supply (not shown) by the pipe J, through the passage i in shaft F, from which it passes *seriatim* through the arms of the several stirrers, thence through the several water-jackets to the passage i' in shaft F, whence it is discharged through pipe K. Should it be necessary or desirable to remove any of the stirrers, for the purpose of repairs or otherwise—as, for instance, the stirrer G—the three-way cock O is given a quarter-turn to the left, disconnecting pipe L from the stirrer G and connecting it with pipe N, and the cock O' is turned into the position in which it is shown in Fig. 5. The cooling medium will then flow first through the stirrer G', thence through the stirrer G^2 , and so on through the remaining stirrers, except stirrer G, which may then be removed through the opening a⁸ and the operation of the furnace continued without it.

To disconnect the stirrer G', the cock O' is turned into the position in which it is shown in Fig. 5 and the cock O² is turned into the position in which it is shown in Fig. 6. The cooling medium will then pass directly from the stirrer G to the stirrer G^2 , and the stirrer G' may be removed. By similar manipulation of the other three-way cocks any of the remaining stirrers may be disconnected and removed.

I do not wish to be understood as limiting myself to the exact details of construction and arrangement shown and described, inasmuch as they may be variously changed and modified within the spirit and intended scope of my invention.

I claim—

1. In an ore-roasting furnace, the combination of an annular chamber provided with feed and discharge openings and a pair of gravitating doors extending transversely across said chamber between said openings, one of said doors being arranged to close before the other is opened substantially as and for the purposes set forth.

2. In an ore-roasting furnace, the combination of a series of annular chambers arranged one above another and communicating one with another through intermediate openings, the upper chamber being provided with a feed-opening and the lower chamber with a discharge-opening, and gravitating doors arranged in pairs between the openings from and into each chamber, one door of each pair being arranged to close before the other is opened substantially as and for the purposes set forth.

3. In an ore-roasting furnace, the combination of a series of annular chambers located one above another and communicating with each other through openings, the upper chamber being provided with a feed-opening and the lower chamber with a discharge-opening, a fireplace communicating through an open-

ing with the lower chamber, a smoke-stack with which the upper chamber is connected, stirrers arranged to traverse the several chambers, and self-closing doors arranged in pairs between the openings into and from each chamber, one door of each pair being arranged to close before the other is opened substantially as and for the purposes set forth.

4. In an ore-roasting furnace, the combination of a horizontal annular chamber having adjacent feed and discharge openings, a rotary stirrer projecting radially into said chamber, and a pair of gravitating doors hinged to the ceiling of said chamber between said openings, so as to prevent direct communication between them and at the same time permit of the passage of said stirrer, substantially as and for the purposes set forth.

5. In an ore-roasting furnace the combination of an annular chamber opening inside into a circular pit, a rotary wheel having a circular rim which closes the opening from said chamber into said pit, one or more stirrer-arms projecting from the rim of said wheel into said chamber, and packing-rings loosely interposed between said rim and the adjacent walls of the furnace, substantially as and for the purposes set forth.

6. In an ore-roasting furnace, the combination of an annular chamber, a rotary wheel, the rim of which closes the inner side of said chamber, a stirrer projecting from said wheel into said chamber and packing-rings loosely interposed between said rim and adjacent fixed parts of the furnace, one ring resting upon the upper side of said rim and fitted at its outer edge to the adjacent surface, and the other resting upon a fixed horizontal ledge or flange and fitted at its inner edge to the outer surface of said rim, substantially as and for the purposes set forth.

7. In an ore-roasting furnace, the combination of an annular chamber, a rotary stirrer and a hollow ring closing the inner side of said chamber and having inlet and outlet connections for a cooling medium, substantially as and for the purposes set forth.

8. In an ore-roasting furnace, the combination of an annular chamber, a rotary stirrer and a hollow ring closing the inner side of said chamber and provided with inlet and outlet connections for a cooling medium and with a partition between said connections, substantially as and for the purposes set forth.

9. In an ore-roasting furnace, the combination of an annular chamber, a rotary annular water-jacket closing the inner side of said chamber and provided with feed and discharge connections and a partition between them, and a stirrer carried by said water-jacket and projecting into said chamber, substantially as and for the purposes set forth.

10. In an ore-roasting furnace, the combination of an annular chamber and a hollow stirrer arranged to traverse said chamber and comprising a number of connected passages

provided without said chamber with separate supply and discharge connections for a cooling medium whereby a constant circulation of the cooling medium through said stirrer is insured, substantially as and for the purposes set forth.

11. In an ore-roasting furnace, the combination of an annular chamber and a rotary stirrer arranged to traverse the same and comprising a vertical shaft having separate inlet and outlet passages for a cooling medium, two tubular arms each connected at one end with a passage in said shaft and communicating at their opposite ends with each other, and blades or wings mounted upon said arms, substantially as and for the purposes set forth.

12. In an ore-roasting furnace, the combination of an annular chamber, a rotary wheel provided with a hollow rim which closes the inner side of said chamber, and tubular stirrer-arms carried by said wheel and provided within said chamber with wings or blades, said hollow rim and stirrer-arms being provided with feed and discharge connections whereby a cooling medium may be circulated through the same, substantially as and for the purposes set forth.

13. In an ore-roasting furnace, the combination of an annular chamber provided with feed and discharge openings, a rotary wheel provided with a hollow rim which closes the inner side of said chamber, and two stirrers, each comprising two tubular arms carried by said wheel and projecting radially therefrom into said chamber, in which they are provided with wings or blades and communicate with each other through hollow connections, said hollow rim and stirrers being provided with supply and discharge connections, whereby a cooling medium may be continuously circulated through the same, substantially as and for the purposes set forth.

14. In an ore-roasting furnace, the combination of an annular chamber provided with feed and discharge openings, a pair of gravitating doors extending transversely across said chamber between said openings, a rotary annular water-jacket closing the inner side of said chamber and provided with a partition on opposite sides of which it has supply and discharge connections, stirrers each comprising two tubular arms carried by said hollow rim and projecting therefrom radially into said chamber, in which they are provided with wings or blades and a hollow connection, and connections with said hollow rim and stirrers whereby a cooling medium may be constantly circulated through the same, substantially as and for the purposes set forth.

15. In an ore-roasting furnace, the combination of an annular chamber provided with feed and discharge openings, a number of gravitating doors normally closing said chamber between said openings, a rotary wheel mounted upon a vertical shaft in the opening

inside of said chamber, and stirrers carried by said wheel and projecting on opposite sides thereof radially into said chamber, in which they are provided with wings or blades inclined in opposite directions with reference to their advance movement on opposite sides of the furnace, substantially as and for the purposes set forth.

16. In an ore-roasting furnace, the combination of an annular chamber and a hollow stirrer projecting from the inside into said chamber and provided with detachable connections for the supply and discharge of a cooling medium, said chamber being provided in its outer side with an opening through which said stirrer may be removed, substantially as and for the purposes set forth.

17. In an ore-roasting furnace, the combination of an annular chamber, a wheel having a hollow rim which closes the inner side of said chamber, and tubular stirrer-arms passing radially through sleeved openings in said rim into said chamber and secured at their inner ends in chambered cross-heads attached to said wheel, substantially as and for the purposes set forth.

18. In an ore-roasting furnace, the combination of an annular chamber, a wheel mounted on a vertical shaft in the opening inside of said chamber and provided with a hollow rim which closes the inner side of said chamber, tubular stirrer-arms projecting through said rim into said chamber and secured at their inner ends in chambered cross-heads carried by said wheel, and supply and discharge connections made through passages formed in said shaft with said hollow rim and stirrer-arms, substantially as and for the purposes set forth.

19. In an ore-roasting furnace, the combination of a series of horizontal annular chambers arranged one above another, hollow stirrers carried by a vertical shaft in the opening inside of said chambers and detachably connected therewith, and connections with said stirrers provided with cocks arranged to

disconnect either of said stirrers, substantially as and for the purposes set forth.

20. In an ore-roasting furnace, the combination of a series of annular chambers arranged one above another around a central pit or well, a corresponding number of rotary wheels mounted upon a central vertical shaft in said pit and having hollow rims arranged to close the inner sides of said chambers opening into said pit, hollow stirrers detachably connected with said wheels and projecting therefrom into said chambers, and supply and discharge connections made through separate passages in said shaft with said hollow rims and stirrers and provided with valves or cocks by which either stirrer may be disconnected, substantially as and for the purposes set forth.

21. In an ore-roasting furnace, the combination of a number of annular chambers arranged one above another around a central well or pit, a corresponding number of wheels mounted upon a central vertical shaft in said pit and provided with hollow rims arranged to close the openings from said chambers into said pit and each provided on one side with a partition and on opposite sides thereof with supply and discharge openings, and stirrers comprising tubular arms passing through the rims of said wheels into said chambers, in which they are connected by hollow couplings and are provided with wings or blades, and supply and discharge connections made through separate passages in said central shaft with the several stirrer-arms and hollow rims and connecting them in series, whereby a cooling medium may be constantly circulated through them, substantially as and for the purposes set forth.

In testimony that I claim the foregoing as my own I affix my signature in presence of two witnesses.

AUGUST HEIMBACH.

Witnesses:

W. C. THOMAS,
A. W. RAND.