No. 775,147. PATENTED NOV. 15, 1904.

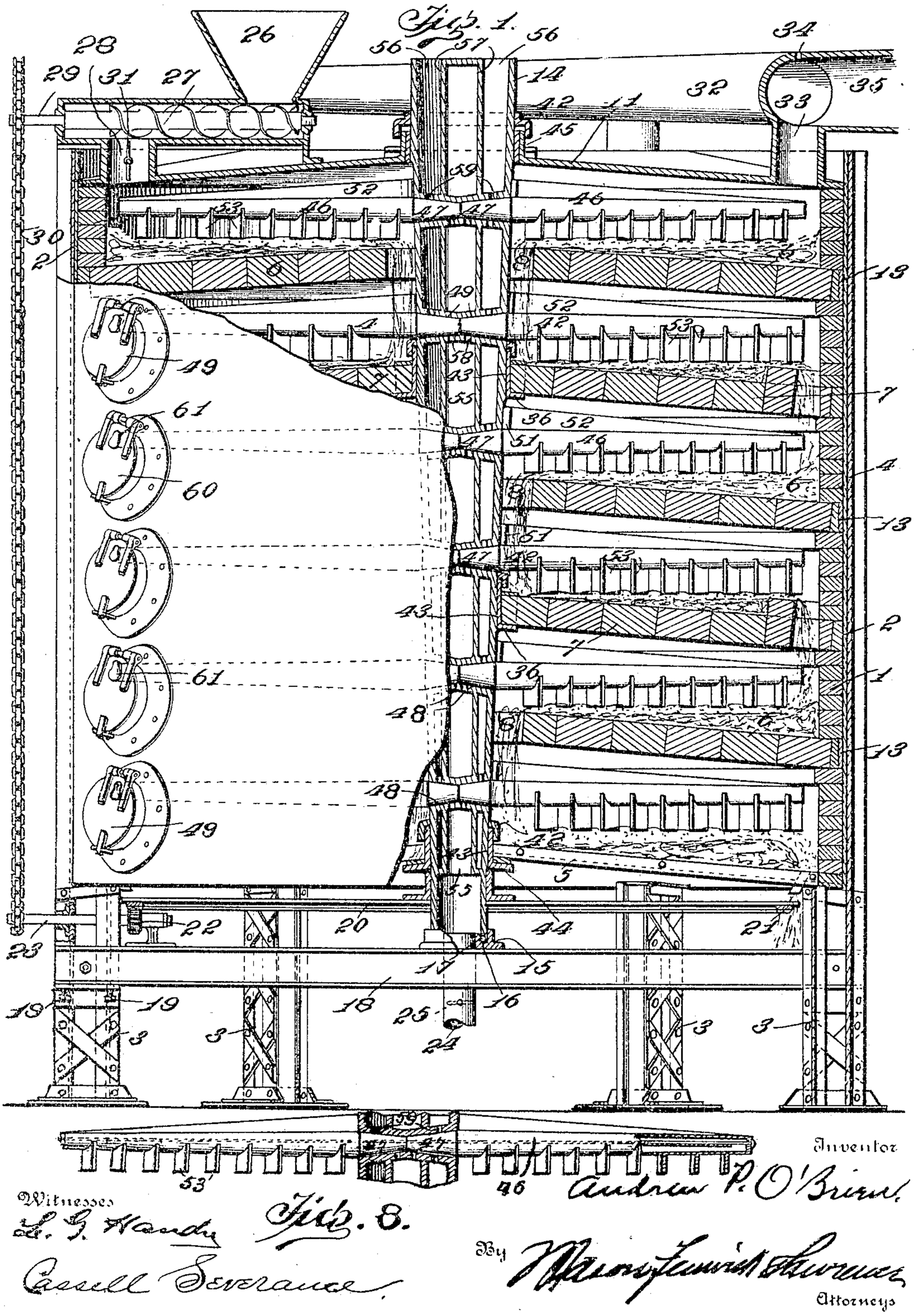
A. P. O'BRIEN.

ORE ROASTING FURNACE.

APPLICATION FILED APR. 3, 1903.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 1.



Witnesses
L. F. Handy
Cassell Severance

Inventor
Andrew P. O'Brien.

By Munn, Fennick & Severance
Attorneys

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NO MODEL. 3 SHEETS—SHEET 2.

Fig. 2.

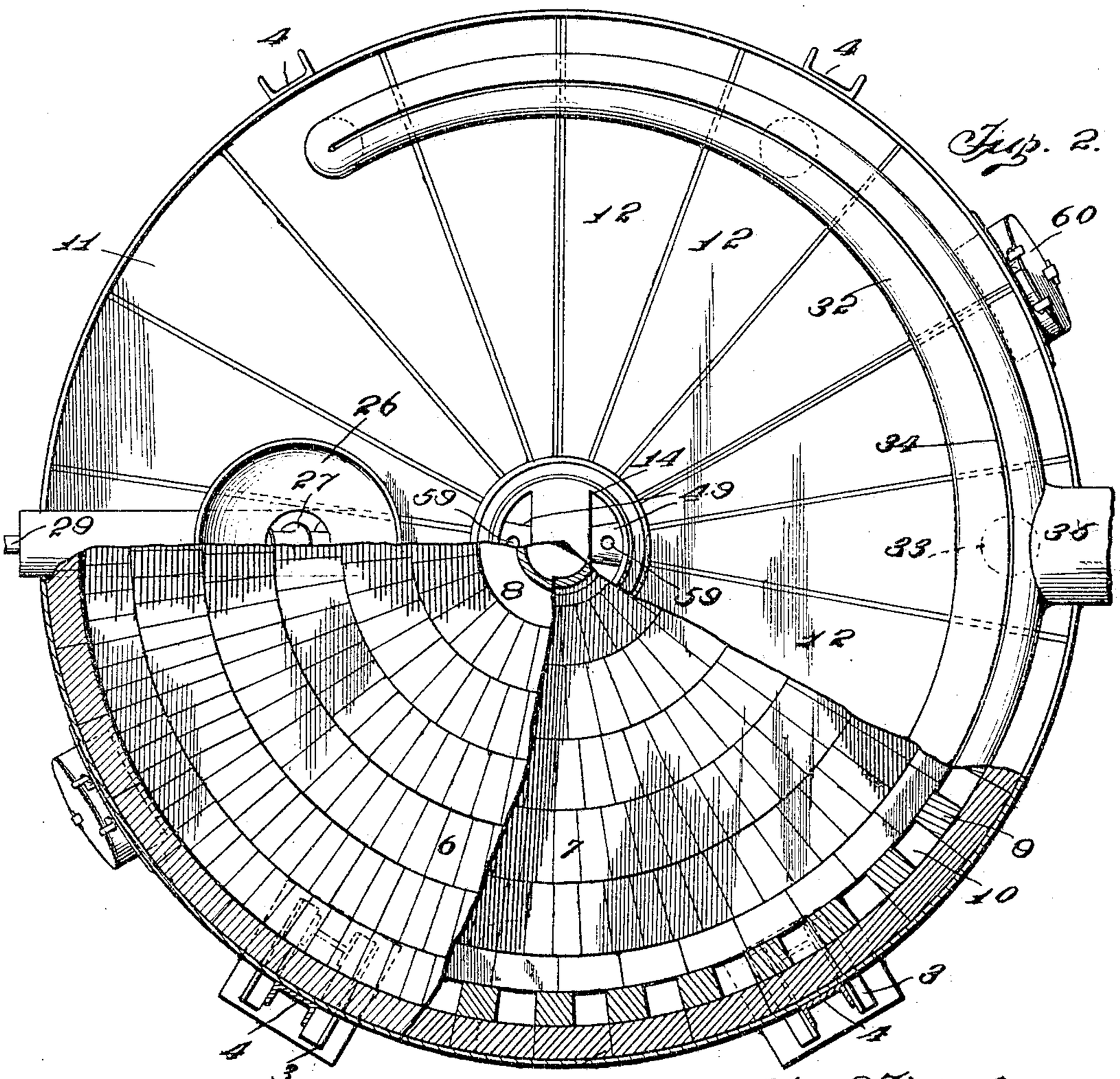
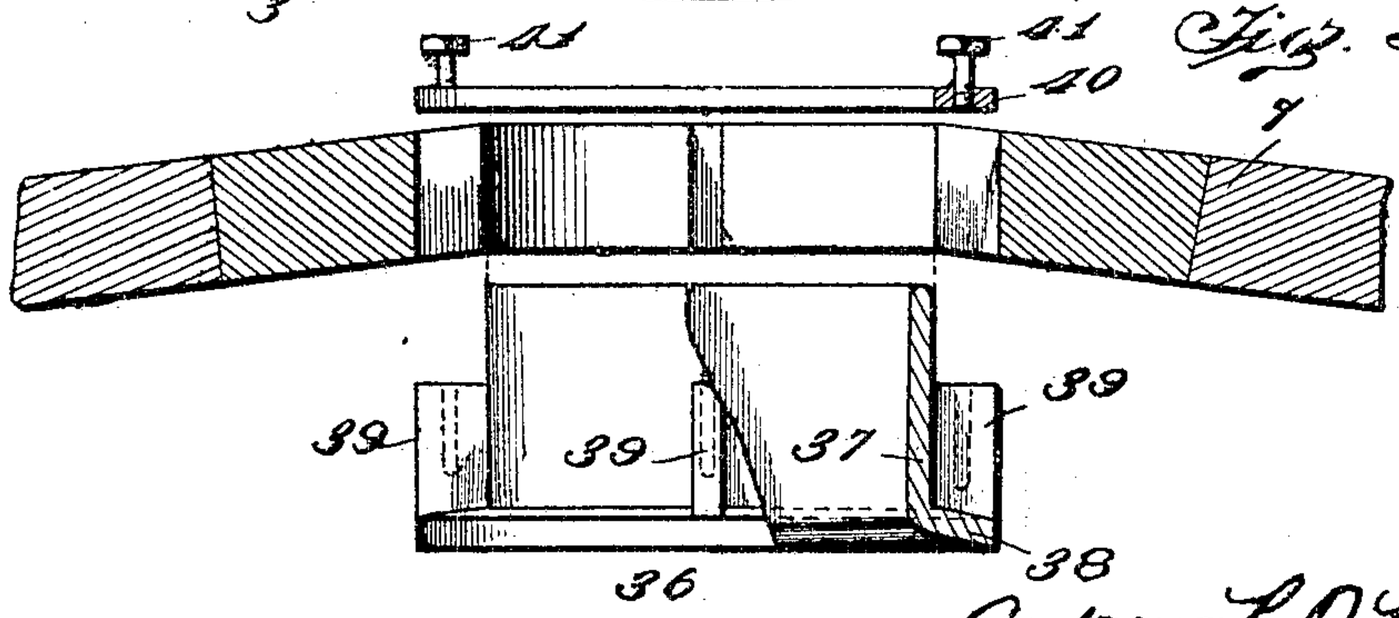


Fig. 3.



Witnesses
L. G. Handy
Casiell Severance

Inventor
Andrew P. O'Brien

By Mason, Fenwick & Lawrence

Attorneys

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NO MODEL. 3 SHEETS—SHEET 3.

Fig. 4.

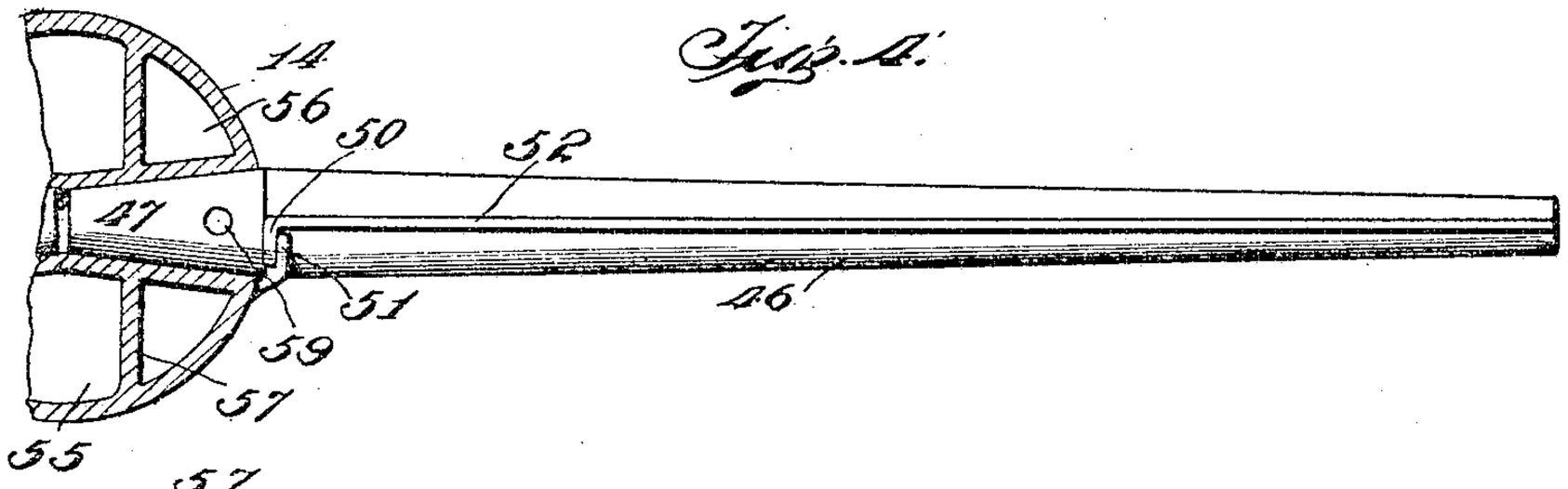


Fig. 5.

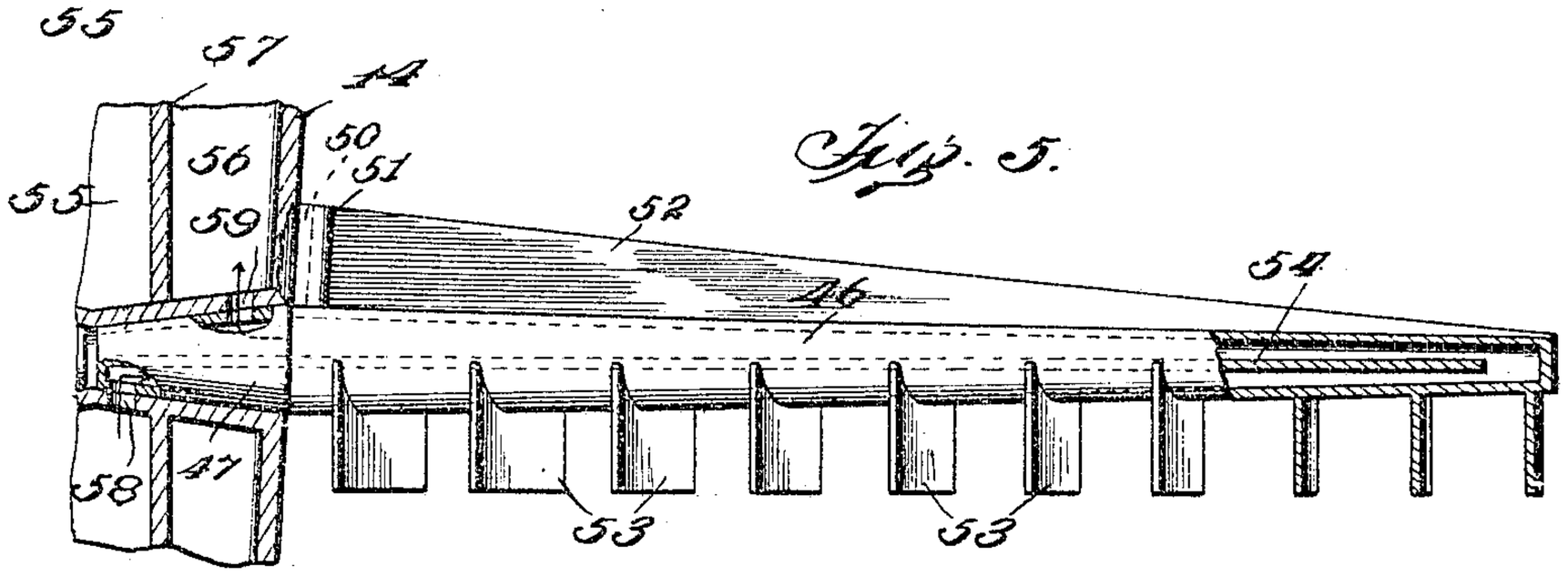


Fig. 6.

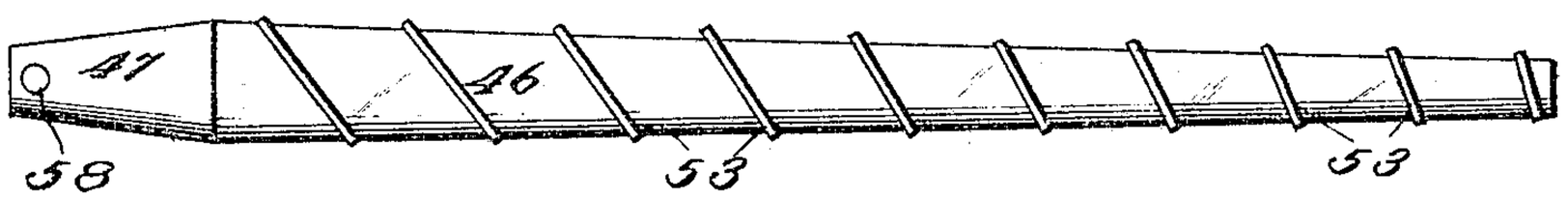
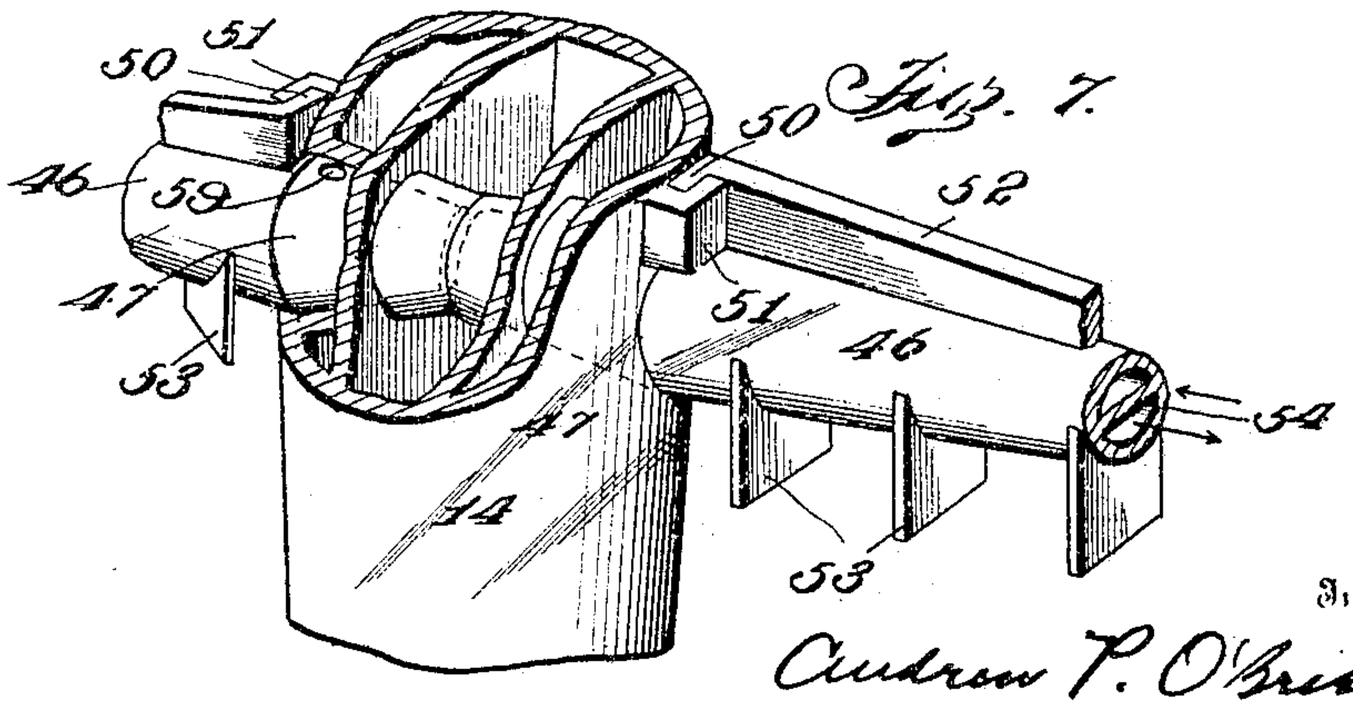


Fig. 7.



Witnesses
L. L. Handy
Caswell Deverance.

Inventor
Andrew P. O'Brien
By Mason Fenwick & Lawrence
Attorneys

No. 775,147. Patented November 15, 1904.

UNITED STATES PATENT OFFICE.

ANDREW P. O'BRIEN, OF RICHMOND, VIRGINIA.

ORE-ROASTING FURNACE.

SPECIFICATION forming part of Letters Patent No. 775,147, dated November 15, 1904.

Application filed April 3, 1903. Serial No. 150,955. (No model.)

To all whom it may concern:

Be it known that I, ANDREW P. O'BRIEN, a citizen of the United States, residing at Richmond, in the county of Henrico and State of Virginia, have invented certain new and useful Improvements in Ore-Roasting Furnaces; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to improvements in furnaces for roasting ores, and has for its object the general improvement of the details of construction whereby the results obtained by the use of the furnace are made more perfect.

With this object in view the invention consists in the improved construction, arrangements, and combinations of parts hereinafter fully described and claimed.

In the accompanying drawings, Figure 1 is a view, partially in vertical section and partially in side elevation, of a furnace constructed in accordance with my invention. Fig. 2 is a top plan view of the same, a portion of the top being broken away to show the floors within the furnace. Fig. 3 is an enlarged detail central sectional view of one of the floors or shelves in the furnace, showing the construction of one of the lutes applied to said floor. Fig. 4 is a detail view of one of the rabble or stirrer arms, the same being shown in position in the central shaft of the furnace. Fig. 5 is a detail view of one of said arms or rakes in side elevation, a portion being shown in section. Fig. 6 is a bottom plan view of said rake or stirrer-arm. Fig. 7 is a detail fragmentary view of a portion of the furnace-shaft, showing the rabble arms or rakes secured thereto. Fig. 8 is a detail view, partially in elevation and partially in section, showing the manner of securing rabble arms or rakes to the shaft of the roasting-furnace by means of a rod.

This invention is designed to improve that class of furnaces which are intended for roasting ores which are provided with a series of substantially horizontal shelves or floors of brick or other similar material having discharge-openings in each floor for delivering material to the floor below, the discharge-openings being alternately at the circumference and at the center of the floors, such a furnace being also provided with a central shaft carrying rabbles or rakes for stirring the ores upon the floors and tending to move the ores from one floor to the other.

In the present application the furnace, as illustrated in the drawings, is formed with a cylindrical casing 1, preferably of fire-brick or other similar material, which is inclosed, preferably, in a smooth metallic shell 2. This shell and casing are supported upon suitable standards 3, which are built up, preferably, of channel or angle irons placed in any desired manner. The shell is protected and supported at suitable intervals by vertically-extending channel-beams 4, which project upwardly from the supports 3 outside the shell 2 to the top thereof. These channel-beams, while holding the shell in position, are sufficiently flexible to accommodate themselves to any expansion or contraction of the shell under the influence of heat in the furnace. The bottom of the casing is preferably closed by a floor, preferably metal, as 5, the said floor being preferably formed of a series of segmental plates secured together in any suitable manner. Above the lower floor 5 at suitable intervals are arranged a series of floors or shelves 6 and 7. The floors 6 are secured at their outer edges to the casing 2 and are supported in position by said casing, while at their inner central portions the said floors 6 are formed with cylindrical openings, as 8, which surround the central shaft of the furnace. These apertures 8 afford means for the ores roasted to pass to the shelf or floor below at the center of the furnace. The floors or shelves 7, upon the other hand, fit snugly around the central shaft of the furnace, and, while they are supported by the casing 2, are only attached to the same at intervals, as at 9, (shown in Fig. 2,) so that discharge-apertures 10 are formed around the outer edge of the said floors 7 for depositing roasted ores upon the next floor beneath. The floors 6 and 7 are alternated, as shown in Fig. 1, so that the ores in passing from one floor

to the other are discharged first at the center of the furnace and then at the casing, so that the ores pass back and forth over the floors from the top to the bottom of the furnace. The floors 6 and 7 are preferably formed of fire-brick, as illustrated in Figs. 1 and 2. The top of the casing 2 is closed by a cover or top, preferably of metal, as 11, the said cover being formed in segments, as 12. (Shown in Fig. 2.) The segments are applied together, as shown in said figure, around the central shaft and within the shell 2 of the furnace. To protect the shell 2 from the tendency to expansion due to the weight of the floors 6 and 7, I employ a band, as 13, opposite the periphery of each floor 6. These floors 6 with the central apertures are not supported or braced in any way at the center of the furnace, except by the arch shape given to the floors, and said arched formation is dependent upon the shell and casing for its maintenance in proper position. The reinforcing-bands 13 will thus greatly strengthen the structure and prevent the said floors from having a spreading action or strain upon the casing or shell.

Mounted centrally of the furnace is a tapering hollow shaft 14, which is made long enough to project above and below the furnace proper, the lower end of said shaft 14 resting upon suitable bearings mounted at the base of the machine. These bearings preferably consist of an annular member 15, having an annular groove or runway 16 formed on the upper surface thereof. Ball-bearings, as 17, are located in said runway and receive the lower end of the hollow shaft 14 for movably supporting the same in place. The ring or bearing member is supported at its edges upon curved I-beams 18, which extend to the standards or supports 3 at the bottom of the furnace. The ends of these I-beams 18 rest upon adjusting-screws 19, so that the said beams may be raised or lowered, as required, to properly adjust the ring-bearing 15 and so as to hold the said shaft 14 in proper position with respect to its bearing at the center of the floors 7 of the furnace. Where the shaft passes through the floors 7 suitable lutes are provided, as will be hereinafter described, for insuring a tight though movable joint between the shaft and the alternate floors 7. The adjustment of the shaft with relation to said lutes is an important feature in a furnace of this character, since upon the degree of perfection in the joints made by the said lutes depends the result attained in roasting ores to a considerable degree. By the adjustment, therefore, of the supporting-beams 18 the relation of the shaft to the said lutes can be accurately controlled.

The shaft 14 is rotated by means of a plate 20, which is secured to said shaft near its lower end and is formed upon its under surface with a circular rack, as 21, which engages an actuating-pinion 22, carried by a shaft 23. The shaft 23 is mounted in suitable bearings upon the base of the furnace and projects outside the same, so as to receive actuating means for driving it. The operation of the shaft 23 will of course cause the rotation of the plate or disk 20, and thereby revolve the shaft 14 within the furnace. The plate 20 is preferably a comparatively thin sheet-steel plate, so that it possesses some flexibility and will accommodate itself to the expansion and contraction of the shaft 14 under the varying degrees of temperature to which it may be exposed. The edge of the plate 20 is left free except where it engages the pin 22 for permitting the said plate to thoroughly accommodate itself to any changes due to temperature. The interior of the shaft 14 is hollow, and the said shaft is maintained in a comparatively cool condition by passing air upwardly therein. This air is preferably admitted to the lower end of the shaft 14 by any suitable pipe, as 24, which enters through the hollow ring-bearing 15, as indicated in Fig. 1. The said pipe 24 is provided with a damper 25 for controlling the flow of air through the same.

The ore which is introduced into the furnace is deposited in a hopper 26 upon the top of the furnace, which delivers the said ore into a conveyer 27. This conveyer is preferably a spiral or screw conveyer, the screw being mounted in a cylindrical casing leading from the bottom of the hopper 26 to a discharge-passage 28, which leads into the top of the furnace. The shaft 29 of said screw projects outside the casing and may be connected by a sprocket-chain 30 with the shaft 23, so as to be moved in conjunction therewith. It is sometimes desirable to remove the screw-conveyer 27 for repairs, or in the event of the conveyer becoming clogged in any way and in order to be able to accomplish such removal and repair while the furnace is in operation I provide a damper 31 in the discharge-passage 28, so that the said passage may be closed when it is necessary to operate upon the conveyer. By this means the gases within the furnace will not be permitted to pass out through the passage-way 28. Of course when the conveyer is in operation the inlet 28 will be closed and sealed by the material surrounding the screw of the conveyer.

The gases of the furnace are collected in a duct 32, mounted upon the top of the furnace, the said gases gaining access to said duct through a series of vertical passages 33, extending upwardly from the top of the furnace. The duct 32 is preferably segmental in form. The interior of the duct 32 can be reached by a segmental slot 34, formed in the top of said duct and extending from one end thereof to the other, so that every portion of said duct can be easily reached for cleaning or other purposes. When the furnace is in use, the segmental slot 34 is closed in any suitable man-

ner, preferably by sealing it with asbestos, cement, or some like material. When the duct is to be cleaned, the cement is removed. The gases collected in the duct 32 are led to any suitable point through an outlet 35.

The shaft 14, as heretofore intimated, engages the shelves or floors 7 at their central portions, the said shelves being provided with lutes 36 of improved construction. These lutes have been illustrated in their preferable form in Fig. 3, where they will be seen to consist of a cylindrical body portion 37, provided with a lower annular outwardly-extending flange 38, adapted to fit upon the under surface of the inner row of brick forming the shelf or floor 7. At intervals around the lute are upwardly-extending lugs 39, projecting through or between the bricks, and a clamping-ring 40 is applied above the said lugs and upon the surface of the inner row of floor-bricks. Screws or bolts 41 are preferably employed for clamping the said rings 40 to the lugs 39, said bolts passing into said lugs. By this means the lutes are firmly clamped to the inner edge of the floors 7, while the central body portion 37 of each lute extends a short distance above the clamping-ring 40. A lute-cover or annular overhanging flange 42 is carried by the shaft 14 opposite each of said lutes, so that a sealed joint may be formed between the movable shaft and the lute at each of said floors. The outer surface of the shaft is preferably made vertical, as at 43, where the said shaft passes through each of the lutes 36. The taper of the shaft is made sufficiently great so that the lute-covers 42 of the shaft will be small enough to pass through the openings next above them in the floors 7, and by this arrangement the shaft can always be removed from its position in the furnace without interfering with any of the lutes or the floors, and of course the said shaft can be placed in position again with equal facility. The upper and lower lutes, which are applied at the bottom floor 5, and the cover or top 11 of the furnace can be removed or put in position from the outside of the furnace and are always sufficiently cool to be manipulated while the furnace is in use. The lower lute, which is applied to the floor 5, preferably consists of a simple flanged ring 44, which is secured to the segmental plates forming the said bottom 5 and is engaged at its upper edge by the lower lute-cover 42, carried by the shaft 14. The said lute 44 may be secured by bolting or riveting, or in any other desired manner, to the bottom floor 5. The lute 45, carried by the cover 11 of the furnace, may be of similar construction to the lute 44, but of course is much larger than the same to accommodate the size of the shaft 14 at its upper end.

The shaft 14, as is common in furnaces of this character, carries a series of radiating arms, which are, technically speaking, "rabbles" or "rakes." The rakes or rabbles 46 in the present instance are formed of hollow tapering shells, provided with inwardly-tapering inner ends 47, which extend and snugly fit into correspondingly-tapered sockets 48, formed in the shaft 14. Each of the rakes 46 can be inserted into its socket by endwise longitudinal movement, the said rakes rotating with the shaft after they have been placed in position through doors or openings 49, formed in the casing and shell of the furnace. A door 49 is provided opposite the space between each set of floors in the furnace, so that when the shaft 14 stands with its sockets 48 in alinement with said doors the rakes 46 can be inserted through the said doors and their ends 47 placed in the sockets 48. The inner ends 47 of the rakes, which are placed in the shaft 14 from opposite sides thereof, preferably abut or approximately abut, as shown in the drawings, and the said rakes can be held together by passing a rod through each pair of them, the said rods extending from one end of one rabble or rake 46 through to the end of the opposite rabble or rake 46. Such rods would preferably be formed with end portions which overhang the ends of the rakes. I preferably, however, lock the rakes in position by forming a hooked portion 50 at the inner ends of the rakes, the said hooked portions engaging correspondingly-formed hooked lugs 51 upon the outer surface of the shaft 14. While the hooks 50 may be secured or formed in any manner, they are preferably carried by the inner ends of strengthening-ribs 52, which I prefer to form upon the upper surface of the rakes. These ribs 52 may be tapered from the inner end to the outer end of the rakes, as shown in Figs. 1, 5, and 7 of the drawings, and greatly stiffen and strengthen the rabbles or rakes 46. The under side of each rake is provided with a series of blades or stirrers 53, set at an incline, the incline being such that the ore upon the floors engaged by said blades will be worked either inwardly or outwardly upon said floor, according to the location of the discharge-apertures leading from said floor. The tendency of the ore engaging said blades will be to rotate the rakes, and the hooks 50, carried by the rakes, are so located that they will be driven by such rotation against the hooked lugs 51 upon the shaft. Thus the said hooks will always be held in locked position under the action of the rakes upon the ore in the furnace. The lugs 51 will also prevent the rates from being disengaged or accidentally displaced from their sockets 48 in the shaft 14. The blades 53, carried by each of the rakes, may be arranged in any desired manner; but I preferably arrange them, as shown in Figs. 1 and 5, so that the angle at which said blades are set increases from one end of the rake to the other. Thus, as shown in Fig. 6, the inner blades are set at a less

angle than the outer blades, and the space between the edges of said blades diminishes from the outer end inwardly. Thus the action of the inner blades, which have the least movement, is increased by the angle of the blade over the outer blades of each rabble, which have a greater range of movement. The blades of the rabbles or rakes are set to correspond with the discharge of the floors over which they travel, so that some of the rakes will tend to work the ore toward the center of the furnace over the floors that have the central openings, while the other rakes will tend to work the ore outwardly upon the floors which have peripheral discharge-apertures, the rotation of the shaft continuously feeding the ores first inwardly and then outwardly in the furnace. The said rakes are preferably formed hollow in order that air may circulate through them as well as through the hollow shaft 14. To insure a thorough circulation of air through said hollow rakes, I preferably construct each rake with a central partition, as 54, which extends from the inner end of each rake to a point near the outer end thereof, a space being left at the outer end for establishing communication between the upper and lower compartments of said rake formed by said partition. When the rake-arms are provided with such a partition, the shaft 14 is preferably formed with a central compartment 55 and outer compartments 56 by means of vertically-arranged partitions 57 in said shaft. The inner ends of each of the rakes are also formed with inlet-apertures 58 and outlet-apertures 59, which coincide with corresponding apertures formed in the walls of the sockets 48. The apertures 58 are formed so as to communicate with the central recess or passage 55 of the shaft 14, while the outlet-apertures 59 establish communication with the outer passages 56 of said shaft 14. It will thus be apparent that air passing upwardly through the shaft 14 in the central passage 55 thereof will enter each of the rakes 46 through these apertures 58. The air will thence pass outwardly in the said rake in the lower compartment thereof and around the outer end of the partition 54, backwardly through the upper compartment of the rake, and will find an outlet through the apertures 59, passing into the outer passage-way 56 of the shaft. It will thus be seen that a perfect circulation of air can be had not only through the shaft 14, but through every one of the rake-arms, insuring the maintenance of said shaft and rake-arms at a properly-reduced temperature to protect them against excessive heat attained within the furnace for accomplishing the roasting of ores therein. While the apertures 58 and 59 have been shown in the upper and lower walls of the rake-arms, it will of course be apparent that they may be applied at other points in the said rake and that the partition 54 may be arranged in a vertical or other plane within said arm, the construction being such that the compartment in each arm may receive air from any compartment formed in the shaft and may deliver the air into any other compartment formed in the shaft, all within the spirit of the invention.

The capability of inserting and locking in position the rakes without having to raise or lower their ends to effect such locking makes it possible to arrange the floors 6 and 7 within the furnace closer together than is generally possible in such furnaces, and this increases the effectiveness of the furnace in roasting ores and tends to a more economical operation of the same. The doors 49, through which the rake-arms can be inserted and removed, are preferably of an elliptical form, with the longest diameter in a horizontal plane, as shown in Figs. 1 and 2. Hinged doors 60 are supported by suitable hinges at their upper edges and hang in an inclined plane when closed, so as to insure a perfect closing of the doorways 49. The hinges are so disposed also that when the doors are thrown into their open position the doors can fall back of the vertical plane and will remain open until they are closed again. Each of the doors 60 is formed with a sight-hole 61, suitably covered, the said sight-hole being located opposite the upper portion of the doorway 49, so that the banking of cinders against the door will not prevent the use of the sight-hole. The doors are located at points opposite the space between the floors, so that when the roasting process is going on the cinders in the furnace can bank up and nearly close the door-openings, thus protecting the metal parts of the doors and their surrounding casings from excessive heat. After the ores have passed through the furnace they may be discharged at the bottom thereof through apertures in the floor or in the casing, as may be desired.

From the above description it will be evident that the furnace is possessed of many improved features which coöperate for the economical handling of ore and the effective roasting of every portion of the same.

Having thus fully described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. A roasting-furnace comprising a casing, a hollow shaft mounted therein, vertically-arranged parallel flat partitions dividing the shaft into vertical compartments, rabble-arms extending into said shaft and through the compartment-walls, the said rabble-arms having internal air-passages for leading air from one compartment in the shaft through the rabble-arms to another compartment in the shaft.

2. An ore-roasting furnace, comprising a casing, a series of arched floors mounted therein, and reinforcing-bands arranged at the peripheries of said floors for preventing their

spreading tendency from acting upon the casing of the furnace, substantially as described.

3. An ore-roasting furnace, comprising a casing, having a series of floors, a rotating shaft mounted therein, a comparatively thin disk secured to said shaft for rotating it, gearing engaging the said disk for turning the same, the said disk being more or less yielding or flexible to accommodate itself to the expansion or contraction of the shaft under the action of different degrees of temperature, substantially as described.

4. An ore-roasting furnace, comprising a casing having ore-floors, a rotating shaft mounted therein, a disk secured to the shaft and free at its outer edge, the said disk having more or less of a springing action to accommodate itself to the contraction and expansion of the shaft, gear-teeth carried by the said disk and gearing for engaging the said disk to rotate the shaft, substantially as described.

5. An ore-roasting furnace, comprising a casing, a shaft rotatably mounted within the casing, a bearing supporting the lower end of said shaft, cross-beams carrying the said bearing, and adjusting-screws supporting the said beams for controlling the adjustment of the shaft within the furnace, substantially as described.

6. An ore-roasting furnace, comprising a casing, a hollow shaft mounted therein, a hollow ring bearing engaging the lower edge of said shaft, said ring bearing having an annular runway, antifriction means mounted therein engaging the lower end of the shaft, and adjustable means for supporting the said ring bearing, together with means for introducing air through the ring bearing into the shaft, substantially as described.

7. A roasting-furnace comprising a casing, a vertical tapering shaft revolubly mounted therein, vertical chord-walls extending upwardly through the said shaft and forming the same into compartments, hollow rabble-arms having their inner ends extending into the shaft through the chord-walls, the inner ends of said arms being formed with apertures communicating with the compartments of the shaft for leading air from one compartment through the arms to another compartment in the shaft.

8. An ore-roasting furnace, comprising a casing, a series of ore-carrying floors mounted therein, a shaft rotatably mounted in the furnace, and lutes at the inner edge of some of said floors for forming a sealed joint with the shaft, said lutes comprising a body portion having an annular flange for engaging one surface of the floor, a clamping-ring for engaging the other surface of the floor, and means for drawing the ring toward the said flange for clamping the lute firmly about the inner edge of the floor, substantially as described.

9. In a furnace for roasting ores, the combination with a rotatable shaft and ore-floors mounted in the furnace, of a lute for sealing a joint between the floors and the shaft, comprising a cylindrical body portion having an annular flange for engaging one face of the ore-floor, lugs projecting upwardly therefrom, a collar or washer for engaging the other surface of the floor, and bolts or rivets for drawing and securing said washer to said lugs and clamping the lute upon the inner edge of the floor, substantially as described.

10. In an ore-roasting furnace, the combination with a rotating shaft and ore-floors surrounding the said shaft, of lutes for sealing the joints between the shaft and the floors, each lute comprising a ring member having a horizontal flange extending along the under surface of the floor and a vertical flange projecting above the floor and bearing upon the shaft, a ring or washer surrounding said vertical flange and engaging the upper surface of the floor for clamping it against the lower flange of the ring and lute-covers secured to the shaft and overhanging the said vertical flanges to complete the seal.

11. An ore-roasting furnace, comprising a casing, a hollow tapering shaft mounted therein, flat parallel vertical partitions arranged in the shaft and extending from one side to the other thereof, a series of tapering curved walls mounted in the shaft at suitable intervals and supported by the said partitions forming sockets, and rabble-arms for operating within the casing provided with supporting end portions for removably engaging the said sockets.

12. An ore-roasting furnace, comprising a casing, having a series of ore-floors mounted therein, a shaft rotatably mounted in the furnace, rabble-arms or rakes carried by the said shaft, sockets being formed in the shaft for receiving the inner ends of said rakes, and means capable of locking the said rakes in position through said means being brought into engagement by the rotation of the rake about its axis, substantially as described.

13. An ore-roasting furnace comprising a casing and ore-floors, a rotating shaft mounted therein, said shaft being provided with sockets having smooth curved inner faces, rabble-arms provided with end bearings for fitting in said sockets, lugs projecting from the rabble-arms just outside the sockets and projections upon the shaft for engaging said lugs to prevent the rabble-arms from turning in the sockets.

14. An ore-roasting furnace, comprising a casing and ore-floors, a shaft rotatably mounted therein and provided with a series of sockets, rabble-arms or rakes for engaging said sockets, hooked lugs formed on the shaft, corresponding hooked lugs carried by the rakes, and blades for stirring the ore in the furnace, the action of the said blades upon the ore tend-

ing to lock the said hooked lugs and prevent the displacement of the rakes, substantially as described.

15. An ore-roasting furnace, comprising a rotatably-mounted shaft therein, rabble-arms or rakes carried by said shaft, the inner ends of said arms engaging sockets in the shaft, a longitudinal strengthening-rib formed upon each of the said rakes having an upset end, a lug carried by the shaft opposite each of said rakes for engaging the upset end of said rib and locking the rake in position, substantially as described.

16. An ore-roasting furnace, having a rotatable shaft mounted therein, rabble-arms or rakes carried by the said shaft, a series of blades carried by each rake for stirring ore in the furnace, each blade being progressively set at different angles from one end of the arm to the other, whereby the action of the blades upon the ore will be varied from one end of the rake to the other, substantially as described.

17. An ore-roasting furnace, comprising a suitable casing, a rotatable shaft mounted therein, rakes carried by the said shaft, a series of blades mounted upon each rake, the said blades being progressively closer together from one end of the rake to the other, substantially as described.

18. An ore-roasting furnace, comprising a casing, a hollow shaft mounted therein, vertical walls arranged in the shaft and extending from one side of the shaft to the other and thus forming vertical compartments in the shaft and removable rakes or rabble-arms carried by the shaft, the ends of the rakes extending through the walls of the shaft and the partitions.

19. An ore-roasting furnace comprising a casing, a hollow shaft mounted therein, vertically-arranged partitions within the shaft extending from the wall of the shaft upon one side to the wall of the shaft upon the opposite side so as to form vertical compartments, a series of tapering socket-walls extending through the shaft-walls and the partitions provided with apertures communicating with the shaft compartments, hollow rabble-arms having apertured ends fitting in said sockets, the arms when in place affording air connection from one compartment of the shaft through the said arms to another compartment in the shaft.

20. An ore-roasting furnace, comprising a suitable casing and ore-floors arranged therein and a hollow shaft mounted centrally of the furnace, transverse partitions formed in the said hollow shaft, a series of socket-walls supported by the walls of the shafts and by the partitions, the outer ends of said sockets being open, hollow rabble-arms having tapering ends capable of fitting into said sockets, a partition in each rabble-arm for forming passageways therein, the said rabble-arms having apertures for communicating with the compartments in the shaft and means for locking the rabble-arms against rotation in the sockets.

21. An ore-roasting furnace, comprising a casing, and means for roasting ore within the same, a gas-collecting pipe arranged above the furnace, means for leading the gas from the furnace to said collector, an elongated slot being formed in said collector for reaching every portion of its interior, substantially as described.

22. An ore-roasting furnace, comprising a casing, and means for roasting ores therein, a gas-collector at the top of the furnace, comprising a segmental casing, a series of pipes leading from the furnace to the said segmental casing at different points, a segmental slot being formed in the said casing, extending from one end thereof to the other for reaching every portion of said collector, substantially as described.

23. The combination of the shaft having oppositely-arranged sockets, and arms extending through the sockets and abutting at the ends, said arms having partitions and inlet and discharge ports communicating with the shaft.

24. The combination of the shaft having inwardly-projecting bosses with sockets and ports in said bosses, arms extending into said bosses and having ports communicating with those of the bosses and other ports nearer the inner ends of the arms, a flue communicating with the inner ports, and another flue communicating with the ports in the bosses.

25. The combination of the shaft having sockets oppositely arranged, and arms extending through the sockets and abutting at the ends, said arms being provided with inlet and outlet ports and supply and discharge flues or channels, the inlet-ports of the arms connecting with the supply-flue and the outlet-ports with the discharge-flue, substantially as set forth.

26. In a roasting-furnace, the combination of a series of superimposed hearths having concentric openings a rotatable hollow shaft extending through said openings and divided internally by a longitudinal partition joined at its edges to the wall of the shaft to form inlet and outlet passages for a cooling fluid extending longitudinally of the shaft, and stirring-arms carried by the shaft and having a longitudinal outwardly-extending passage connecting with the inlet-passage of the shaft and a return-passage connecting with the outlet-passage of the shaft, substantially as described.

In testimony whereof I hereunto affix my signature in presence of two witnesses.

ANDREW P. O'BRIEN.

Witnesses:
G. W. TAYLOR,
E. R. MITCHELL.