No. 876,567. PATENTED JAN. 14, 1908.

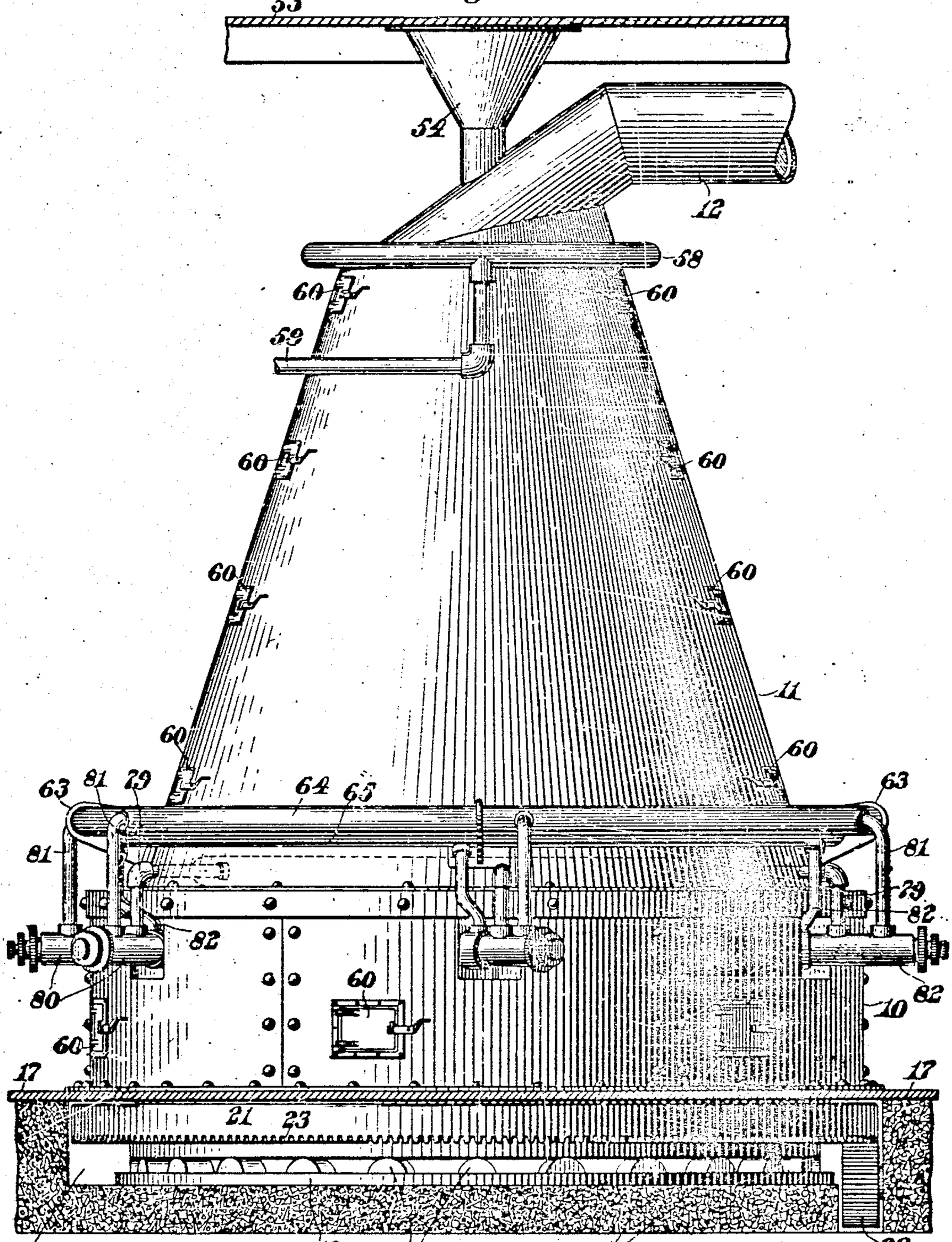
A. D. LEE.

FURNACE FOR ROASTING ORES.

APPLICATION FILED APR. 3, 1907.

4 SHEETS—SHEET 1.

Fig. 1.



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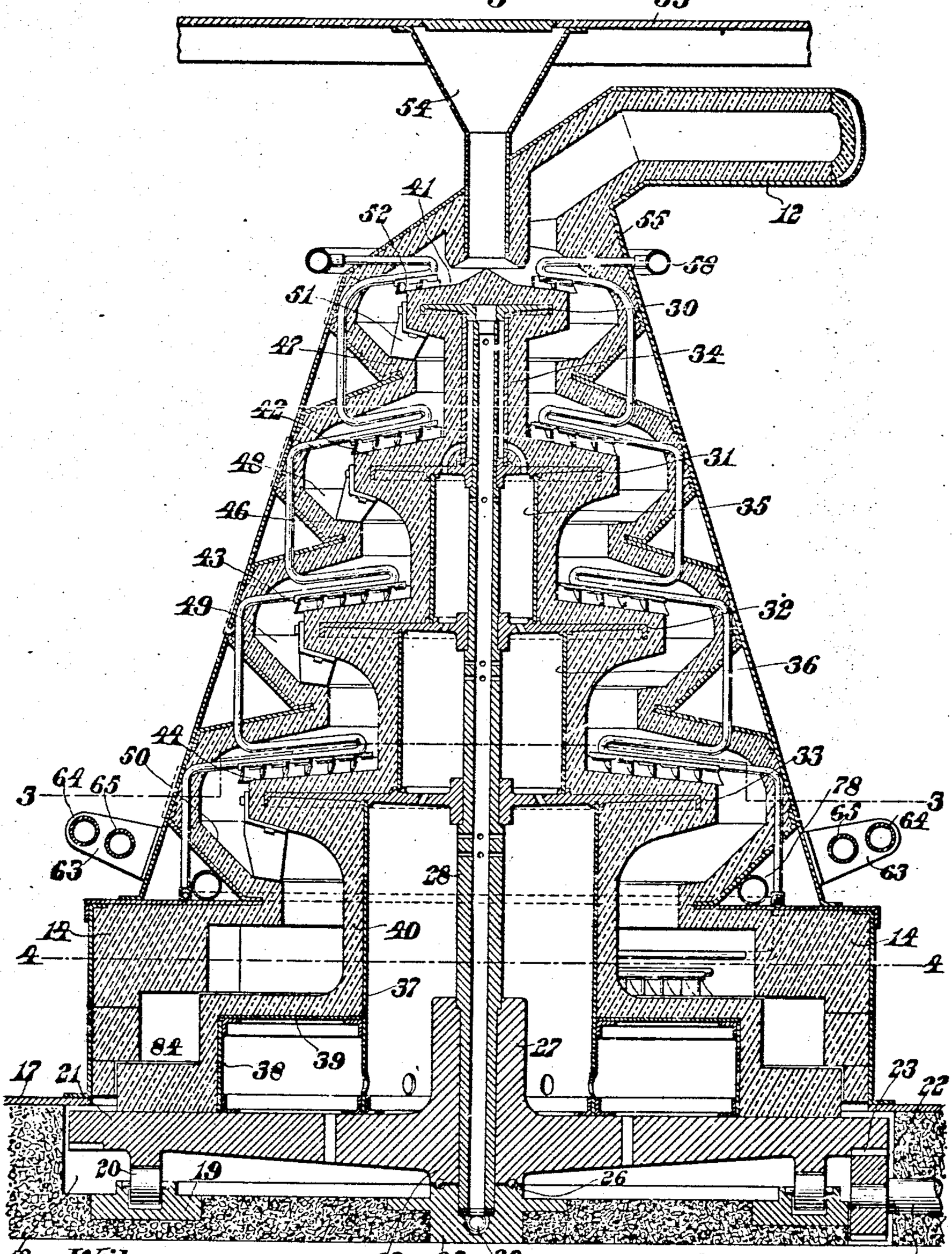
4 SHEETS—SHEET 2.

Fig. 2.



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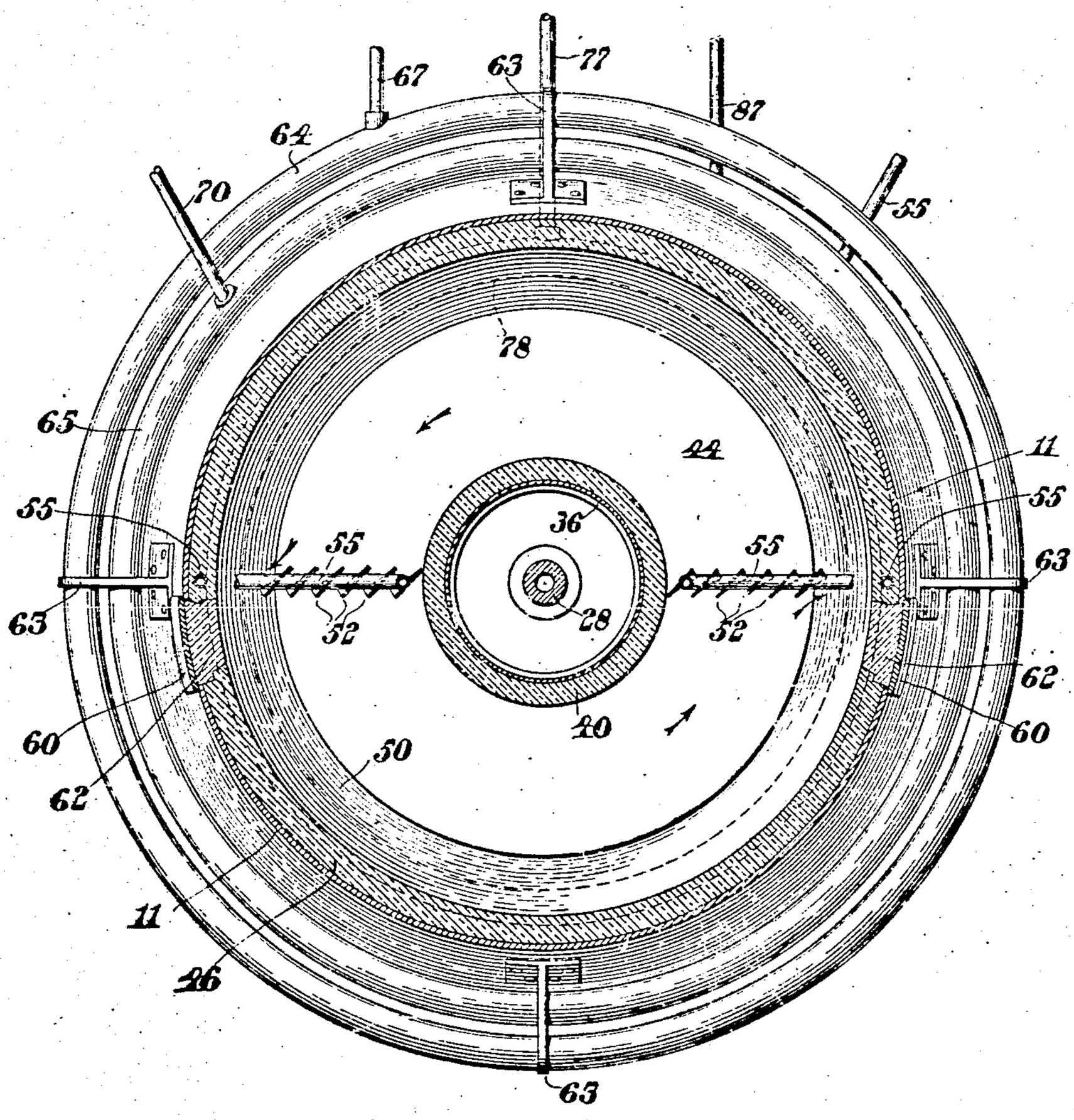
4 SHEETS—SHEET 3.

Fig. 3.



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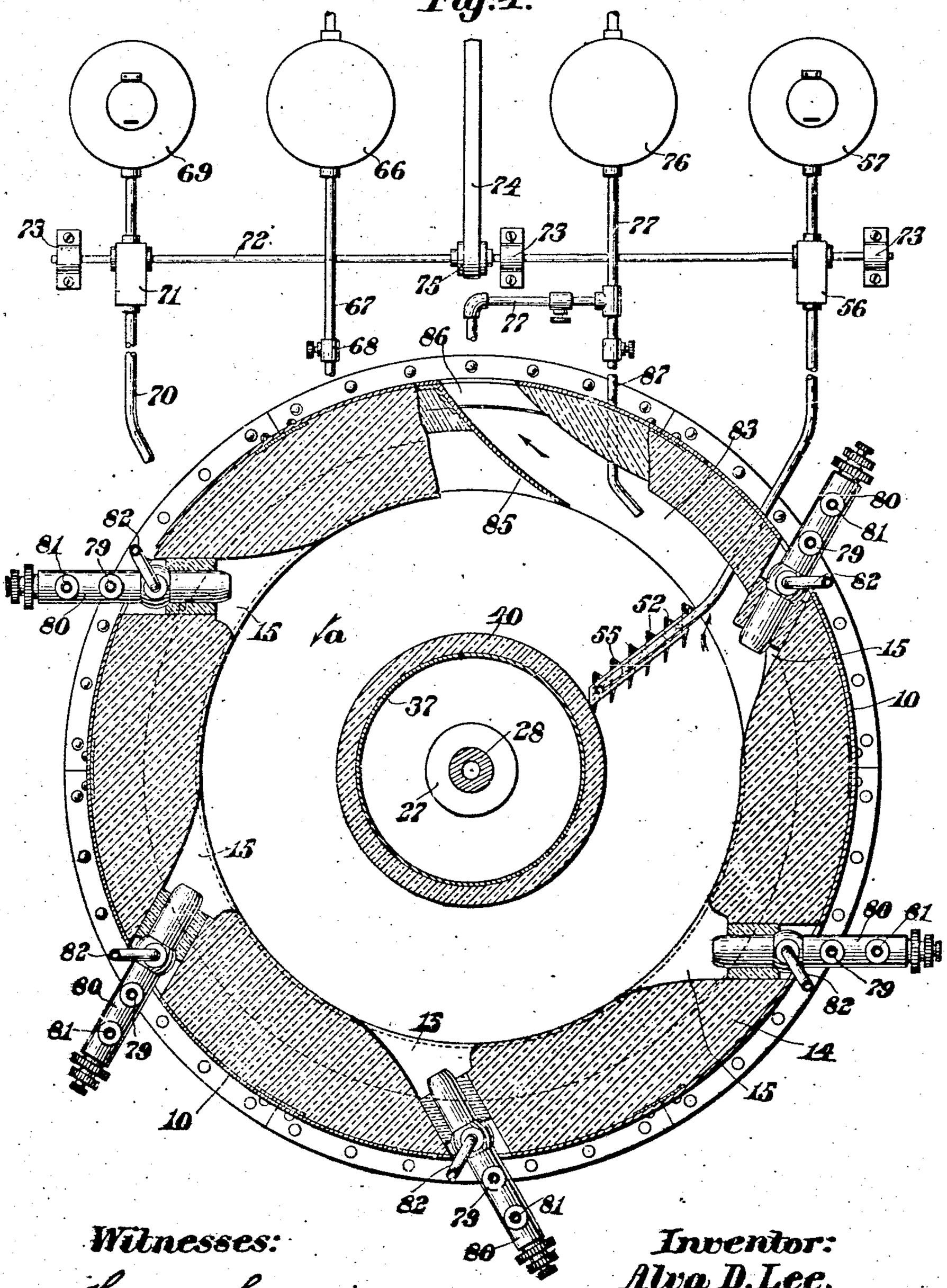
4 SHEETS—SHEET 4.

Fig. 4.



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UNITED STATES PATENT OFFICE.

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FURNACE FOR ROASTING ORES.

No. 876,567. Specification of Letters Patent. Patented Jan. 14, 1908.

Application filed April 3, 1907. Serial No. 366,065.

To all whom it may concern:

Be it known that I, ALVA D. LEE, a citizen of the United States of America, and a resident of Brookline, in the county of Norfolk and State of Massachusetts, have invented certain new and useful Improvements in Furnaces for Roasting Ores, of which the following is a specification.

This invention relates to roasting furnaces and has for its object the production of a furnace which may be charged with ore from the top and which will thoroughly mix the ore as it passes from the top to the bottom so that the greatest amount of the surface of said ore will be presented to the action of the products of combustion as they pass from the bottom of the furnace to the outlet at the top.

The invention consists in certain novel features of construction and arrangement of parts which will be readily understood by reference to the description of the drawings and to the claims hereinafter given.

Of the drawings: Figure 1 represents an elevation of a furnace embodying the features of this invention. Fig. 2 represents a vertical section of the same. Fig. 3 represents a horizontal section on line 3—3 on Fig. 2, and Fig. 4 represents a horizontal section on line 4—4 on Fig. 2.

Similar characters designate like parts throughout the several figures of the drawings.

In the drawings, 10 represents a cylindrical casing having secured to the top thereof a conical casing 11 in axial line therewith. The upper end of the conical section 11 terminates in an outlet 12 through which the products of combustion are permitted to pass from the interior of the furnace. The casing 10 has secured to its interior face a lining 14 of firebrick through which extends the tangential openings 15 in each of which is mounted an oil burner. Beneath the floor 17 on which said casing 10 is mounted and in the bottom of a well 18 is mounted an annular bed 19 in a channel of which is mounted a plurality of rollers 20 on which the disk member 21 is adapted to be revolved by means of the pinion 22 meshing with the gear teeth 23 on the under face of said revoluble member 21.

The pinion 22 is mounted upon a shaft 24 revolved in any suitable manner. The bed 19 is embedded in concrete and at the center of said tube is embedded in a similar manner a support 25 carrying a plurality of anti-friction members 26 upon which rests the hub 27 of said revoluble member 21. The hub of this disk-like member 21 has mounted therein a hollow cylindrical shaft 28 extending upwardly in axial line with said hub 27. The central hole of this shaft 28 communicates with an inlet pipe 29 through which a cooling agent may be admitted to the bore of said shaft 28 to be utilized as hereinafter described. To the upper end of the shaft 28 is secured a disk 30 and intermediate the hub 27 and the disk 30 are other disk members 31, 32, and 33 each of which is of greater diameter than the disk next above.

Interposed between the disks 30 and 31 is the tubular member 34 of greater diameter than the exterior of that portion of the shaft 28 which passes through the same in axial line therewith. In like manner a tubular member 35 of larger diameter is interposed between the disks 31 and 32 while another still larger member 36 is interposed between the disks 32 and 33. Between the disk 33 and the revoluble member 21 is a cylindrical casing 37 and outside of this is a still larger cylindrical casing 38 connected to the casing 37 by means of the plate 39.

To the exterior of the disks 30, 31, 32, and 33 and the tubular casings 34, 35, 36, 37, and 38 and the plate 39 is secured a covering 40 of firebrick or similar material capable of withstanding the intense heat of the furnace. That portion of the covering 40 which is above the disk members 30, 31, 32, and 33 has its upper face inclined to form suitable shelves 41, 42, 43, and 44, the outer edge of each of which extends further from the axis of the shaft 28 than the shelf immediately above.

The casing 11 has secured to the interior face thereof a plurality of inwardly extending annular plates 45 each pair of which are secured together at their inner edges intermediate the shelves 41, 42, 43, and 44. These plates 45 have secured thereto a lining 46 of firebrick or similar material capable of withstanding the intense heat of the furnace. This lining 46 extends to the top of the casing 11 and is continued through the outlet pipe 12. The lining 46 forms a plurality of inclined shelves 47, 48, 49, and 50 extending inwardly beneath the projecting shelves 41, 42, 43, and 44 of the revoluble central member. Each of these projecting shelves 41, 42, 43, and 44 has secured to the outer and under

face thereof a plate 51, the lower edge of which coöperates with the top of a shelf 47, 48, 49, and 50 so that as the member 21 revolves about its axis these plates 51 will scrape the ores or other material collected upon the shelves 47, 48, 49, and 50 and force them therefrom permitting them to drop onto the shelf immediately below forming part of the revoluble central member. Coöperating with each of these shelves 41, 42, 43, and 44 of said revoluble central member are a plurality of fixed inclined blades 52 which, as the central member with the shelves 41, 42, 43, and 44 revolve, scrapes the ore from said shelves and causes it to drop from each of said shelves onto the fixed shelf immediately below. The ore admitted to the furnace is charged from a floor 53 above the furnace through the charging cone 54 which delivers the ore to the furnace in axial line with the revoluble shaft 28 so that as the ore passes through the charging cone 54 it is delivered upon the inclined shelf 41 and scatters radially thereon to be scraped therefrom by the blade 52 as the shelf revolves. These mixing blades 52 are secured to pipes 55 extending inwardly from the interior of the casing 11. The lower end of the pipe 55 is connected to a suitable pump 56 which forces water or some other cooling agent from a suitable tank 57 through the pipes 55 on either side of the interior of the casing 11, said pipes passing through the casing at its upper end and communicating with an annular pipe 58 on the exterior of said casing from which the waste water is discharged through the pipe 59. Access to the various shelves on the interior of the casing 10 and 11 is secured through openings in the exterior of the casing which are normally kept closed by the doors 60, the inner face of which is protected by firebrick 62 in a well-known manner.

To the exterior of the casing 11 is secured the brackets 63 supporting an annular air tube 64 and an annular oil tube 65, air being supplied to the tube 64 from the compressed air holder 66 through the pipe 67 which is provided with a suitable valve 68 therein. The oil tube 65 is supplied with oil from the oil tank 69, said oil being forced into said tube 65 under pressure through a pipe 70 by means of the pump 71.

The pumps 56 and 71 are both driven by a shaft 72 mounted in bearings 73 and driven by a belt 74 upon a pulley 75 secured thereto. A tank 76 containing steam is connected by a line of piping 77 to an annular tube 78 within the casing 11 immediately above the casing 10. The steam admitted to this annular tube 78 is subjected to the intense heat of the furnace and superheated thereby. Radiating from this annular tube 78 are a plurality of pipes 79 each of which communicate with an oil burner 80 extending into an opening 15, said burner being supplied with compressed air through the pipe 81 from the annular tube 64 while oil from the annular tube 65 is delivered to said burner through the pipe 82. This burner forms no part of the present invention and may be of any well-known construction. The mouth of the burner 80 extends into the tangential passages 15 and delivers a flame directly into the path of the ore which is carried upon the shelf 39 of the revoluble central member, the path of movement of said ore being in the direction of the arrow "*a*" on Fig. 4.

The firebrick lining 14 of the casing 10 at its upper level projects over the shelf 39 except at one point, 83, where it is cut away to permit the ore upon the shelf 39 to pass downwardly upon the shelf 84, the ores on the shelf 39 being deflected into this cut-away portion by means of the curved blades 52.

The ore upon the shelf 84 is carried with the revoluble member about its axis and in so doing comes into contact with the deflecting plate 85 by which the ore is deflected through the exit 86 and discharged from the furnace. From the steam pipe 77 extends a valved pipe 87 the mouth of which extends into the trench above the shelf 84 permitting a jet of steam to act upon the ore before its final discharge from the furnace to disintegrate it and remove therefrom any volatile metals such as sulfur and arsenic which may be included therein.

The fixed blades 52 co-acting with the shelves 41, 42, 43, and 44 are curved similar to a plowshare so that as the ores are moved against them the ores will be turned upon the shelves causing a thorough mixture of the ores and continually bringing new surfaces to the action of the heat passing through the furnace.

The plates 51 upon the revoluble member co-acting with the shelves 47, 48, 49, and 50 simply act as scrapers to remove therefrom any ore which may have landed upon these shelves and cause it to be discharged onto the revoluble shelf beneath.

The casing is made conical in shape so that as the heat generated in the casing 10 passes upwardly through the annular passages between the revoluble member and the lining 46 the same proportion of heat is practically maintained at the top as at the bottom owing to the smaller area.

The flames from the burners 80 pass upwardly in the form of a vortex around the revoluble member to the outlet at the top, these flames passing in the opposite direction to the movement of the ore on its way to its discharge outlet at the bottom. This action subjects the ore to an intense heat throughout its movement in the furnace, the ore being continually passed transversely through the flames by the action thereon of the various blades and scrapers. This makes a very

effective roasting furnace which permits of a continuous supply of ore to be fed to the top where it is immediately subjected to the intense heat from the burners passing through the tortuous passages on its way to the outlet 12, the ore in passing downwardly being tumbled from one shelf to another, first upon a movable shelf and then upon a fixed shelf, being turned over when on the movable shelves by means of the curved blades 52 and thereby thrown upon inclined fixed shelves from which they are scraped by means of a movable blade 51. This operation is repeated several times as the ores pass from the top to the bottom where they are delivered into any suitable receptacle (not shown).

The advantages to be derived from a furnace of this construction and the operation thereof it is believed will be fully apparent without any further description.

Having thus described my invention, I claim:

1. In a roasting furnace provided with an ore inlet at the top, the combination of a hollow revoluble member beneath said inlet; a plurality of projecting shelves secured thereto at various levels; a plurality of cylindrical casings surrounding said revoluble member between said shelves; and means for supplying heat to the bottom of said furnace.

2. In a roasting furnace provided with an ore inlet at the top, the combination of a revoluble member beneath said inlet provided with a plurality of projecting shelves at various levels, each shelf being of greater diameter than the one above it; a casing surrounding said revoluble member; and means for supplying heat to the bottom of said furnace.

3. In a roasting furnace provided with an ore inlet at the top, the combination of a revoluble member beneath said inlet provided with a plurality of projecting shelves at various levels, each shelf being of greater diameter than the one above it; a casing surrounding said revoluble member; fixed blades secured to the casing coöperating with each shelf; and means for supplying heat to the bottom of said furnace.

4. In a roasting furnace provided with an ore inlet at the top, the combination of a revoluble member beneath said inlet provided with a plurality of downwardly inclined projecting shelves at various levels and of various diameters; a casing surrounding said revoluble member; and means for supplying heat to the bottom of said furnace.

5. In a roasting furnace provided with an ore inlet at the top, the combination of a revoluble member beneath said inlet provided with a plurality of projecting shelves at various levels; a casing surrounding said revoluble member; an annular extension on said casing beneath each shelf; and means for supplying heat to the bottom of said furnace.

6. In a roasting furnace provided with an ore inlet at the top, the combination of a revoluble member beneath said inlet provided with a plurality of projecting shelves at various levels; a casing surrounding said revoluble member; an annular extension on said casing beneath each shelf; a plurality of blades on said revoluble member coöperating with each extension.

7. In a roasting furnace provided with an ore inlet at the top, the combination of a revoluble member beneath said inlet provided with a plurality of projecting shelves at various levels; a casing surrounding said revoluble member; an annular extension on said casing beneath each shelf, the inner wall of each of which is at a greater distance from the axis of said revoluble member than that of the extension above.

8. In a roasting furnace provided with an ore inlet at the top, the combination of a revoluble shaft; a casing mounted thereon having radial arms at various levels; a fire-brick exterior covering for said casing and said arms forming a plurality of shelves; an exterior furnace casing; and means for supplying heat to said furnace.

9. In a roasting furnace provided with an ore inlet at the top, the combination of a hollow revoluble casing having radial arms at various levels; a fire-brick exterior covering for said casing and said arms forming a plurality of shelves of successively greater diameters from top to bottom; an exterior furnace casing; and means for supplying heat to said furnace.

10. In a roasting furnace provided with an ore inlet at the top, the combination of a hollow revoluble casing having radial arms at various levels; a fire-brick exterior covering for said casing and said arms forming a plurality of inclined shelves of successively greater diameters from top to bottom; an exterior furnace casing; and means for supplying heat to said furnace.

11. In a roasting furnace provided with an ore inlet at the top, the combination of a hollow revoluble shaft; a casing surrounding said shaft and revoluble therewith having radial arms at various levels; a fire-brick exterior covering for said casing and said arms forming a plurality of inclined shelves; an exterior furnace casing; an interior facing of fire-brick for said exterior casing; and means for supplying heat to said furnace.

12. In a roasting furnace provided with an ore inlet at the top, the combination of a hollow revoluble shaft; a casing surrounding said shaft with which it revolves and separated therefrom by an annular space said casing having radial arms at various levels; a fire-brick exterior covering for said casing and said arms forming a plurality of inclined shelves; an exterior furnace casing; an interior facing of fire-brick for said exterior

casing having inward extensions beneath each revoluble shelf; and means for supplying heat to said furnace.

13. In a roasting furnace provided with an ore inlet at the top, the combination of a hollow revoluble shaft; a casing surrounding said shaft with which it revolves and separated therefrom by an annular space said casing having radial arms at various levels; a fire-brick exterior covering for said casing and said arms forming a plurality of shelves; an exterior furnace casing; means for supplying heat to said furnace; and means for supplying a cooling agent to the interior of said revoluble casing.

14. In a roasting furnace provided with an ore inlet at the top, the combination of a hollow revoluble casing having radial arms at various levels; a fire-brick exterior covering for said casing and said arms forming a plurality of shelves; an exterior furnace casing; means for supplying heat to said furnace; means for supplying a cooling agent to the interior of said revoluble casing; a base; anti-friction members between said base and revoluble casing; and means for revolving said casing.

15. In a roasting furnace provided with an ore inlet at the top, the combination of a hollow revoluble casing having radial arms at various levels; a fire-brick exterior covering for said casing and said arms forming a plurality of shelves; an exterior furnace casing; means for supplying heat to said furnace; an ore exit at the bottom of said furnace; and a deflector coöperating with said revoluble member to secure the discharge of the ore through said exit.

16. In a roasting furnace provided with an ore inlet at the top, the combination of a hollow revoluble casing having radial arms at various levels; a fire-brick exterior covering for said casing and said arms forming a plurality of shelves; an exterior furnace casing; means for supplying heat to said revoluble casing; and a plurality of burners at the bottom of said furnace adapted to direct their flames into the path of movement of said ore.

17. In a roasting furnace provided with an ore inlet at the top, the combination of a hollow revoluble casing having radial arms at various levels; a fire-brick exterior covering for said casing and said arms forming a plurality of shelves; an exterior furnace casing; means for supplying heat to said furnace; means for supplying a cooling agent to the interior of said revoluble casing; an ore exit at the bottom of said furnace; and a deflector coöperating with said revoluble member to secure the discharge of the ore through said exit.

18. In a roasting furnace provided with an ore inlet at the top, the combination of a hollow revoluble casing having radial arms at various levels; a fire-brick exterior covering for said casing and said arms forming a plurality of shelves; an exterior furnace casing; means for supplying heat to said furnace; means for supplying a cooling agent to the interior of said revoluble casing; a base; anti-friction members between said base and revoluble casing; means for revolving said casing; an ore exit at the bottom of said furnace; and a deflector coöperating with said revoluble member to secure the discharge of the ore through said exit.

19. In a roasting furnace provided with an ore inlet at the top, the combination of a revoluble member beneath said inlet provided with a plurality of projecting shelves at various levels, each shelf being of greater diameter than the one above it; a casing surrounding said revoluble member; fixed blades secured to the casing coöperating with each shelf; means for applying a cooling agent to said fixed blades; and means for supplying heat to the bottom of said furnace.

20. In a roasting furnace provided with an ore inlet at the top, the combination of a hollow revoluble member beneath said inlet; a casing revoluble therewith but separated therefrom by an annular space provided with a plurality of projecting shelves at various levels; a casing surrounding said revoluble member; a plurality of openings through said casing at various levels to afford access to said shelves; closures therefor; and means for supplying heat to the bottom of said furnace.

21. In a roasting furnace provided with an ore inlet at the top, the combination of a revoluble member beneath said inlet provided with a plurality of projecting shelves at various levels; a casing surrounding said revoluble member provided with a plurality of inwardly projecting shelves; and a plurality of burners tangentially located and adapted to direct their flames in the path of movement of the ores on said shelves.

22. In a roasting furnace provided with an ore inlet at the top, the combination of a revoluble member beneath said inlet provided with a plurality of projecting shelves at various levels; a conical casing surrounding said revoluble member provided with a plurality of inwardly projecting shelves; and a plurality of burners adapted to direct their flames in the path of movement of the ores on said shelves.

23. In a roasting furnace provided with an ore inlet at the top, the combination of a revoluble member beneath said inlet provided with a plurality of projecting shelves at various levels; a casing surrounding said revoluble member provided with a plurality of inwardly projecting shelves; and a plurality of burners tangentially located and adapted to direct their flames in the path of movement of the ores on said shelves and

pass to the outlet at the top in the form of a vortex.

24. In a roasting furnace provided with an ore inlet at the top, the combination of a means for passing the ore from the top to the bottom in a distorted helical path; and tangential devices extending through the walls of said furnace and adapted to project flames into the interior thereof in such a manner as to cause the products of combustion to be forced from the bottom of the furnace to the top thereof in the path of movement of said ore.

25. In a roasting furnace provided with an ore inlet at the top, the combination of a means for passing the ore from the top to the bottom in a distorted helical path; and tangential devices extending through the walls of said furnace and adapted to project flames into the interior thereof in such a manner that the products of combustion will be forced from the bottom of the furnace to the top in the path of movement of said ore and in the opposite direction.

Signed by me at Boston, Mass., this 27th day of March, 1907.

ALVA D. LEE.

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