H. W. GILLETT.

ELECTRIC FURNACE.

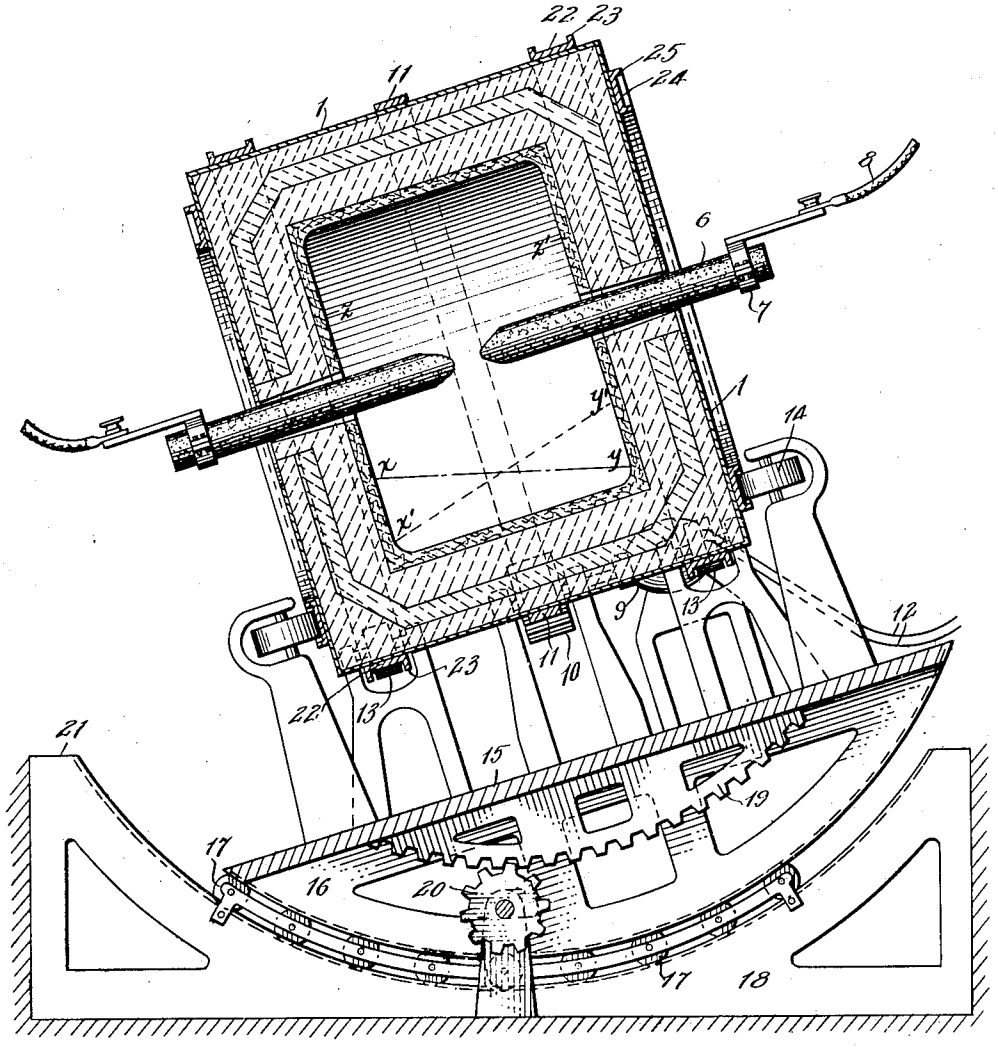
APPLICATION FILED MAR. 11, 1916.

1,201,225.

Patented Oct. 10, 1916.

5 SHEETS—SHEET 1.

Fig. 1.



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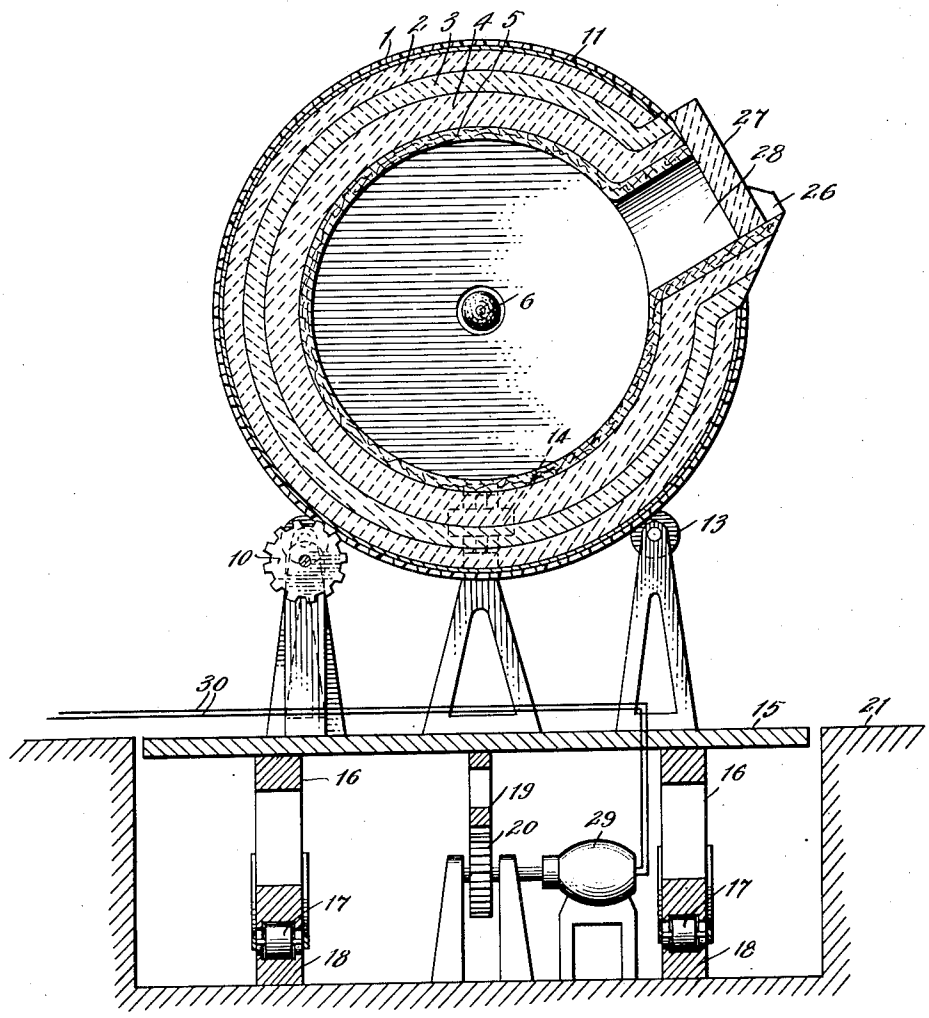
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5 SHEETS—SHEET 2.

Fig. 2.



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5 SHEETS—SHEET 3.

Fig. 3.

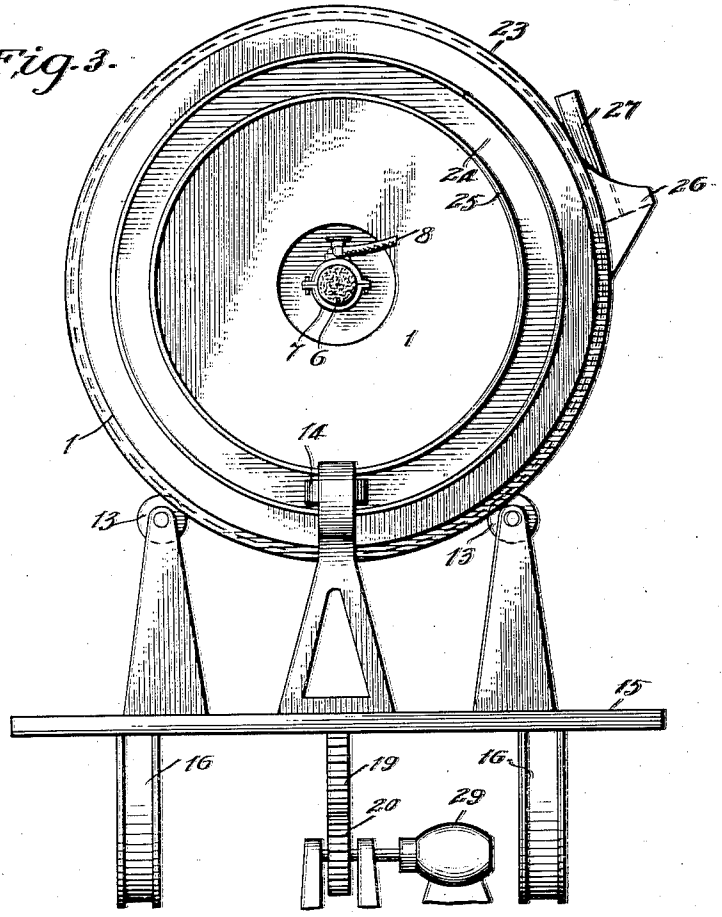
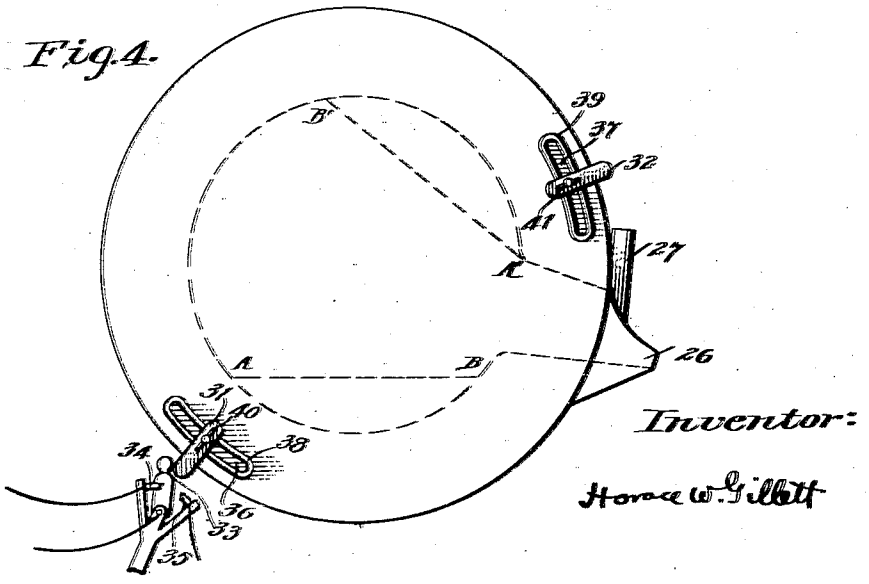


Fig. 4.



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5 SHEETS—SHEET 4.

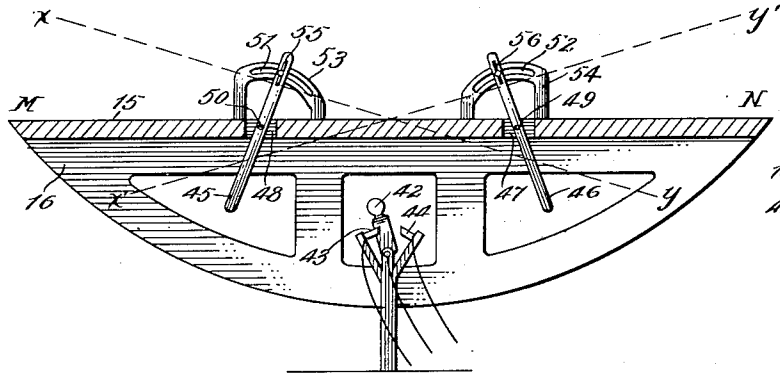


Fig. 5.

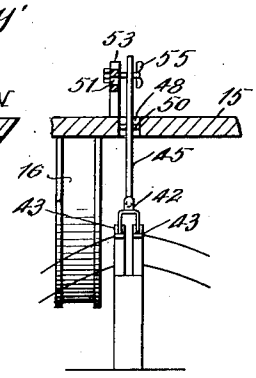


Fig. 6.

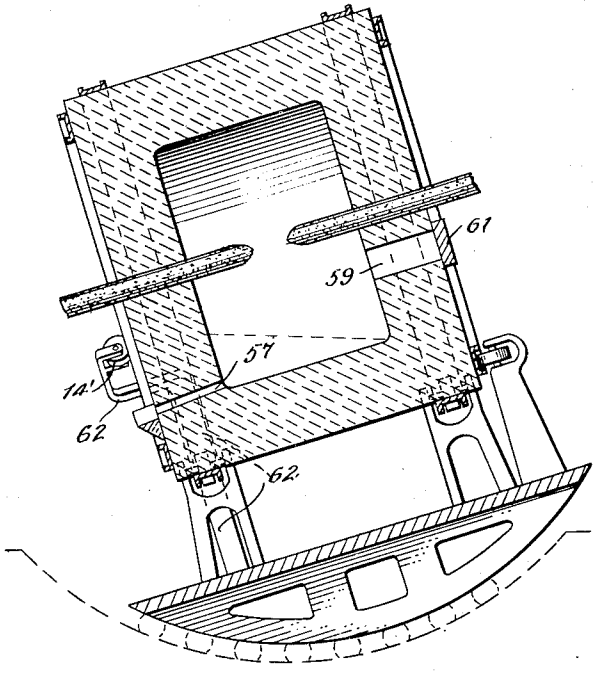
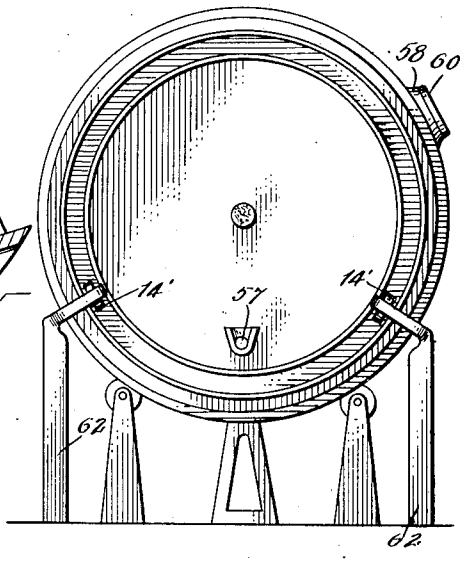


Fig. 7.

Fig. 8.



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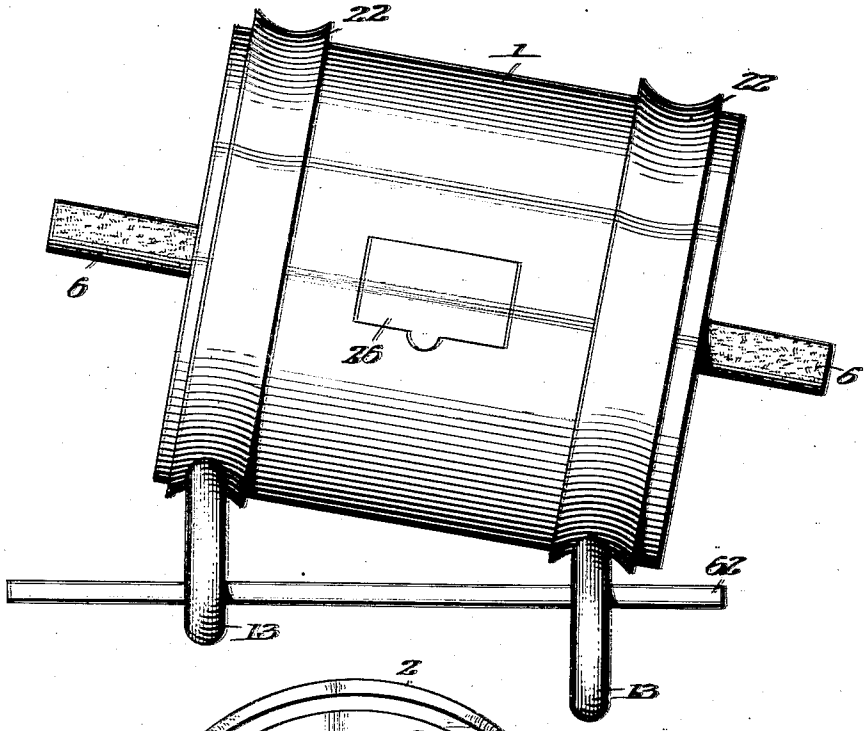
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1,201,225.

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5 SHEETS—SHEET 5.

Fig. 9.



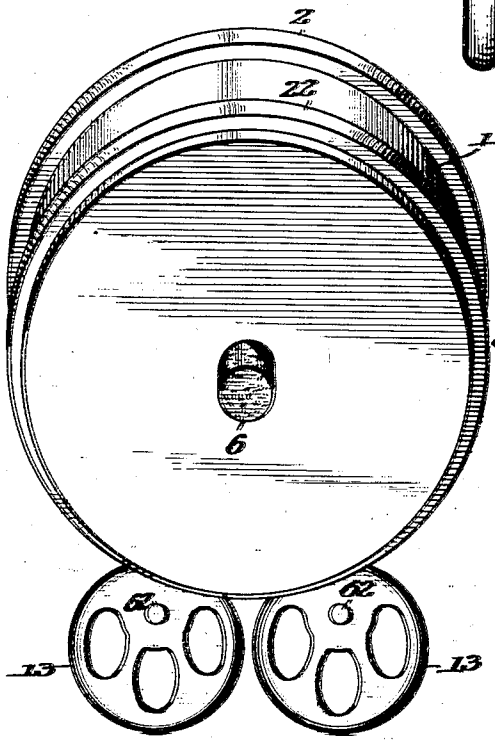


Fig. 10.

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UNITED STATES PATENT OFFICE.

HORACE W. GILLETT, OF ITHACA, NEW YORK.

ELECTRIC FURNACE.

1,201,225. Specification of Letters Patent. Patented Oct. 10, 1916.

Application filed March 11, 1916. Serial No. 83,686.

To all whom it may concern:

Be it known that I, HORACE W. GILLETT, a citizen of the United States, and a resident of the city of Ithaca, county of Tompkins, State of New York, have invented certain new and useful Improvements in Electric Furnaces, of which the following is a specification.

This invention relates to electric furnaces and more particularly to electric furnaces adapted to be rocked while running, of the indirect arc type, in which an arc is, or arcs are, struck between or among two or more electrodes, the arc or arcs being over the charge to be heated but not struck between electrode and charge.

More particularly, it relates to such furnaces when applied to the melting of alloys containing zinc, such as the various brasses, and German silver, or containing manganese as ferro-manganese.

One object of my invention is to provide means for more complete stirring of the charge and for more complete contact between the furnace walls and the charge in furnaces of the type described in pending application Serial No. 59868, filed November 5, 1915.

The furnace described in the above-mentioned application may be built with hearths of various shapes as spheroid or ovoid, but preferably in the form of a cylindrical drum, with the axis of the cylinder horizontal; arc electrodes entering on the horizontal axis and moving with the furnace, the whole being supported so as to be capable of rotation or oscillation about the axis. While my experience with such a construction has been mainly with such a drum oscillating back and forth through a nearly complete arc of a circle, it is of course to be understood that complete rotation as well is contemplated as within the scope of this disclosure and my use of the word "oscillate" is to be understood accordingly. In such a furnace, so oscillated, the charge is mixed to a certain extent, as the friction between the moving hearth and the charge tends to produce a circulation of the metal. The refractory hearth is washed by the charge over the circumference, save for the space occupied by the combined charging door and pouring spout. Or, if desired, the charging door could be made in the head of the drum, above the metal level and a tap hole provided in one end. By suitably closing this tap hole, the furnace might be rotated in one direction only instead of oscillated, in which case the whole circumference would be washed by the molten charge. However, the heads of the drum, in a furnace oscillated or rotated about a horizontal axis, are washed, by a charge of molten metal for example, only below the metal level, leaving a considerable end wall space which is heated by the arc and which conducts heat away to the outside of the furnace where it is lost. Moreover, in such a furnace, oscillated or rotated on a horizontal axis only, there is no tendency toward motion of the melt from side to side. It has been found, in the operation of such a furnace on alloys high in zinc content that, even with rapid oscillation, the stirring of the metal by oscillation or rotation on a horizontal axis, is not great enough to overcome completely the tendency toward overheating of the surface of the melt, so that when the furnace is operated to charge or to pour, too great losses of zinc, released from the superheated surface, may occur. A still more vigorous stirring of the melt to avoid local overheating is desirable. Such increased stirring can be produced by giving the furnace an added end to end motion. This can be done by any suitable means, such as mounting the furnace described in application Serial Number 59868, together with its supporting rollers and driving and reversing mechanism and motor on a platform, which platform is itself mounted on rockers, so that platform and furnace may be rocked by suitable mechanical means, such as an automatically reversing electric motor, a jointed piston arm or a rocker arm on a wheel. The furnace itself is thus given two oscillatory movements, one describing a complete or nearly complete arc of a circle about the axis on which the electrodes lie, and the other describing a smaller arc, less than 180°, about an axis perpendicular to the first axis and lying either in the same horizontal plane with it or parallel to that plane. The furnace may then be termed a doubly oscillating furnace. Or, the furnace with charging doors and pouring spout or tap-hole made tight enough to prevent leakage of the charge, may be rotated in one direction on the axis on which the electrodes

lie and oscillated through an arc of a circle on an axis perpendicular to that axis and lying either in the same plane with it or parallel to that plane. The endwise tilting of the furnace due to the oscillating on the rockers, produces an end-to-end motion in the charge, stirs it and prevents local overheating. It also washes the end walls with the charge, thus increasing the thermal efficiency of the furnace, and increasing the life of the refractories in the end walls.

While the above description deals with a single-phase furnace, having but two electrodes, centrally located in the ends, it is obvious that the invention also applies to multiphase furnaces, in which more than two electrodes may be used.

The mechanism by which the furnace is rocked from end to end may be adjustable so that the charge may be made, in the extreme position of the furnace, to cover the end wall as nearly as possible without running into the hole through which the electrode is introduced, whether a large or small charge be used.

After the heating of the charge is completed, the double oscillation is stopped with the electrodes horizontal and the furnace is then tilted on the axis of the electrodes to pour as in the usual forms of tilting furnaces. Or, if what would be in a stationary furnace a tap-hole, is used in one end, the furnace may be stopped in such a position that the tap-hole is directly below the electrode, but that the end of the furnace bearing the tap-hole is at the uppermost position of its endwise motion. By then rocking so as to lower the tap-hole end, the charge may be poured out, using the tap-hole as a spout. Or, by stopping the oscillatory motions with the tap-hole below the electrode but with the furnace end bearing the tap-hole at the bottom of its endwise motion, the metal may be tapped out from below the surface. By suitably tilting the furnace on the rockers, the hydraulic head may be kept low while still drawing metal from below the surface, thus making it easier to stop the flow when desired.

My improved furnace differs from the one described in application Serial No. 59868 in that the axis on which the electrodes lie and about which the furnace is circumferentially oscillated or rotated is no longer substantially horizontal, but said axis is itself kept in motion and continually changes its angular displacement from the horizontal. This continual displacement from the horizontal may be obtained by any suitable means, such as the mounting of the furnace and driving and supporting mechanism on a platform resting on rockers, or swinging on trunnions. Or the end-to-end motion may be obtained by supporting the furnace on four or more eccentric gear wheels or rollers or similar supports, running on suitably shaped gears or in suitably shaped tracks on the furnace shell, so placed as to give the furnace an endwise motion as well as a circumferential motion, in which case the axis of circumferential motion will not continually lie in a vertical plane as in the case when rockers are used, but will describe the whole or a portion of a double cone, that is, two cones each having its apex at the middle point of the regular axis of the cylinder. Various other means of producing continual displacement of the axis about which the furnace is oscillated or rotated, by which two distinct motions are produced, the charge mixed to prevent local overheating and the refractory lining brought practically wholly in contact with the charge might be used without departing from the spirit and scope of my invention.

Figure 1 is a vertical sectional elevation of my furnace construction taken along the axis of the electrodes, which are shown in elevation. Fig. 2 is a sectional elevation of the refractory cylinder and actuating mechanism therefor, taken along a plane passing through the central portion of the cylinder, located at a ninety degree angle from that in which the plane of Fig. 1 lies. Fig. 3 is a side elevational view, similarly positioned to that constituting Fig. 2, designed especially to show the roller supports for the refractory cylinder and the mechanism for causing its rotation about its axis. Fig. 4 is a diagrammatic side elevation, showing the possible use of intermittent reversing mechanism on the rotatable refractory cylinder. Fig. 5 is a side elevational view of the portions of the automatic reversing mechanism supported from the base of the furnace mechanism, adapted to coöperate with the complementary parts on the refractory cylinder. Fig. 6 is an end elevational view of the automatic reversing members. Fig. 7 is a sectional elevation of the refractory cylinder taken through its axis, showing the location of the tap hole in one end of the refractory cylinder, instead of through its curved side wall. Fig. 8 is a sectional elevation along a plane perpendicular to the axis of rotation of the refractory cylinder, showing especially the positioning of rollers against the ends of the cylinder so as to resist end thrust. Fig. 9 is a diagrammatic showing and Fig. 10 an end view of a modified form of construction in which the regular axis of the cylinder describes a double cone.

A preferred form of my invention is shown in Fig. 1, a sectional elevation made through the electrodes in which is provided a cylindrical shell 1 having a lining which may be of any refractory or refractories suitable for the use to which the furnace is to be put. For brass melting

a stratified lining, consisting of a layer 2 of kieselguhr brick, or red building brick, a layer 3 of a heat insulating brick, less refractory than firebrick but of lower heat conductivity, another layer 4, of firebrick, and an inner layer 5, of asbestos cement which will stand 1700° C. before fusion, or of carborundum, is suitable. Closely fitting into holes in the centers of the heads of the drum are adjustable arc electrodes 6, which are preferably capable of endwise adjustment but otherwise stationary in respect to the furnace and partaking of the motion of the furnace. These electrodes may be of carbon or graphite, and for use in melting alloys high in zinc, as yellow brass, they may be cored with a mixture of carbon and sodium silicate, or with one of carbon sodium silicate and calcium fluorid, or with other well known materials, which give a "flaming" arc, that is, one which is not so liable to rupture, which can be drawn out longer and which is easier to regulate than the ordinary carbon arc in an atmosphere of zinc vapor. The electrodes are held in place and adjusted longitudinally to start, stop, and regulate the arc, by suitable well known means not shown, such means as are shown in application Serial No. 59868, being applicable to this furnace. The electrodes are connected by clamps 7 to cables or other flexible conductors 8 which allow freedom of motion to the furnace and are in turn connected to a source of electric energy, not shown. The body of said furnace is substantially the same as is shown in detail in application Serial Number 59868. The circumferential oscillatory motion is imparted to the furnace by suitable means such as various well known systems of mechanical gearing, or, preferably by an automatically reversing motor 9 which drives a gear 10 which meshes with a gear 11 on the furnace. The motor 9 receives its power through flexible leads 12, so placed that they allow the rocking motion of the platform to be made without injury to them. The furnace body may be supported on four or more idlers 13 and the end thrust, due to the endwise motion, is taken up by two or more other idlers 14. The furnace body, driving gear, and supporting idlers may all be mounted on platform 15 which is supported on two or more rockers 16 which rest on roller bearings 17 on curved supports 18. The rockers and all that is supported by them may be moved back and forth by suitable means such as a toothed gear segment 19 attached to the platform 15 meshing with a gear 20 which is driven by another automatically reversing motor not shown in Fig. 1. The platform 15 is preferably at the floor level when in its median position 21 and the supporting and driving means below the platform are placed in a pit. Hoop-like tracks 22, with flanged edges 23 serve as bearing surfaces for the shell to rest on upon the idlers 13, and ring-like tracks 24 on the ends of the shell, also with flanged edges 25, give similar contact surfaces for the end thrust idlers 14. The single rollers of the idlers 13 or 14 or both may be replaced by double roller cradles, or some or all of the idlers may be supplied with springs which allow for irregularities in the bearing surfaces from expansion or other causes, according to well known practice in the support of rotary kilns. Or the furnace may, if desired, be supported on trunnions, the shafts of which are hollow and are of large enough size to allow the electrodes to pass through them.

Fig. 1 shows the furnace tilted on the rockers into one extreme position. The metal level X Y takes the position X′ Y′ at the other extreme position. If the furnace is turned 180° about the axis on which the electrodes lie and then rocked on the other axis to the extreme positions, the metal reaches in turn the points Z and Z′, so that the only parts of the refractory lining not washed by metal are a portion about the combined charging door and pouring spout and small rings about the holes through which the electrodes enter, these rings being left unwashed to prevent danger of the charge entering the electrode holes. These rings are so small that they are effectually shielded from the arc by the shadows of the electrodes. By adjusting the rate of endwise oscillation the end-to-end motion and hence the agitation of the charge may be varied at will.

Fig. 2 is a vertical cross section of the furnace taken midway between the drum heads when the platform 15 is in its median position. A pouring spout 26 is provided, and a tightly fitting cover 27, opened and closed by suitable means not shown, closes the charging door 28.

The rocking mechanism below the platform is driven by suitable means, such as an automatically reversing electric motor 29 which is connected by the flexible leads 30, so placed as to allow freedom of motion without injury, to a source of electric power.

Fig. 3 is an end view of the furnace with the platform 15 in its median position showing how the shell 1 rests on the supporting idlers 13 and against the end thrust idlers 14, the latter in the ring-shaped track 24 with flanged edges 25, and the former in the hoop-shaped tracks of which the flanged edge 23 only is visible.

The automatic switches and operating mechanism by which the reversing motors are made to reverse, not shown in Figs. 1, 2, and 3, are shown in Figs. 4 and 5.

Fig. 4 shows diagrammatically how

fingers 31 and 32 projecting from one end of the furnace shell may be made to throw a reversing switch 33 so as to make electrical contact either at the switch terminals 34 or 35. The wiring of the switch 33 and motor 9 (Fig. 1) is so done that when contact 34 is closed and 35 open, the motor revolves in such direction that the furnace shell turns counter clock-wise, and when contact 34 is open and 35 closed, it revolves in the opposite direction and the shell turns clock-wise. In the diagram the furnace is shown with the finger 31 closing contact 34 and opening 35. The metal level is then at A B. From this position the shell turns counter clock-wise till the metal level is at A′ B′ when finger 32 throws the switch 33 so that contact 34 is opened and 35 closed, when the shell turns clock-wise till the metal level reaches A B again. In order to be able to wash the whole circumference of the lining save that from A′ to B, *i. e.* the width of the charging door and pouring spout, whether a normal, large or small charge, with consequent different depths of metal, the fingers 31 and 32 are mounted in slots 36, 37 in suitable frames 38, 39, so as to be movable, and held at any desired point by the wing nuts 40, 41. If fingers 31 and 32 are moved closer together, the furnace will rock farther in both directions and a smaller charge can still be made to reach the points B and A′. If fingers 31 and 32 are moved farther apart, the furnace will not rock so far in either direction and a larger charge can be used without passing the points B′ and A′. In order to tilt the furnace for pouring so that the metal will run out of the spout 26, finger 31 is turned, after loosening the wing nut 40, so that it no longer projects beyond the shell or engages the switch 33. By then throwing the switch 33 by hand to make contact with 34, the spout can be depressed into pouring position and by throwing 33 to make contact with 35, raised again so that metal does not flow from the spout.

Fig. 5 shows a side view and Fig. 6 a cross section of an automatic reversing device by which the tilting of the platform 15, and hence the end-wise motion of the furnace, is controlled. This is analogous to the method used to control the circumferential oscillation of the shell. A reversing switch 42 with contacts 43 and 44 is so wired to the motor 29 (Figs. 2 and 3) that when contact 43 is closed and contact 44 open, as shown, the platform rocks counter clockwise and when 43 is open and 44 closed, clockwise.

The fingers 45 and 46 are so placed that the line M N of the platform 15 may rock clockwise till it reaches the position X Y (corresponding to the metal level X Y in the furnace shell, Fig. 1) when finger 46 closes contact 43 and opens 44, when the platform rocks counter clockwise to the position X′ Y′ (corresponding to the metal level X′ Y′ in the furnace shell, Fig. 1), when finger 45 opens contact 43, closes 44 and starts the reverse motion. These fingers may pass through holes 47—48 in the platform, be pivoted at 49, 50 and be adjusted in the slots 51, 52 in the frames 53, 54, and held in place by the wing nuts 55, 56. By moving the lower ends of fingers 45, 46 together, a greater throw can be obtained and the same metal level reached with a smaller charge, or by moving them apart, a lesser throw for a larger charge, may be had. The frames 38, 39 (Fig. 4) and 53, 54 (Fig. 5) may be graduated to show the proper position of the fingers for any given charge. By using motors 9 and 29 which are capable of adjustment as to speed of rotation, the rates of both oscillatory motions can be controlled and any desired degree of stirring of the charge obtained. Either or both oscillatory motions can be given to the furnace by many other well known mechanical means without deviating from the spirit and scope of my invention.

If it is desired to tap the metal from below the surface instead of pouring over a spout, the spout may be omitted, and a tap hole 57 provided in one end, closed by a suitable plug as shown in Figs. 7 and 8. Charging doors 58, 59, closed by tightly fitting covers 60, 61 may be provided either on the circumference, as 58, or in one or both ends, so placed as to be above the metal level at all times, as 59, or in all of these locations. Of course both a pouring spout on the circumference and one or more tap holes on one or both ends may be provided in the same furnace and any of them used in discharging the furnace. When tap holes are provided, the single end thrust idler 14 of Figs. 1 and 3, if the idler supporting system is used, is preferably replaced by two end thrust idlers 14′ so placed as not to be in the way when tapping, and the supports 62 for these have their bases so placed as not to extend beyond the end of the shell so as to leave a clear space below the tap hole. When using the tap hole a false cover may be placed over the exposed ends of the rocker tracks in the pit so as to protect them from spilled metal.

A guard rail should, in all cases, be placed about the pit to prevent danger of a workman getting a foot caught between the rocking platform and the edge of the pit.

One method of mounting the furnace shell to give endwise motion to the charge is shown in Fig. 9 in which the shell 1 is provided with annular tracks 22 resting on eccentric supporting rollers 13, driven by shafts 62 which are connected by gearing (not shown) so that these rollers always maintain the same relative position to each other. The electrodes 6 and the combined

charging door and pouring spout 26 are also shown. While Fig. 9 shows a friction drive, it is obvious that the tracks and rollers may be gears if desired. Or, the shell may be driven by a gear meshing with a geared ring about the circumference of the shell at its middle point. Another method of imparting endwise motion to the charge is by making the tracks eccentric to the hearth and supporting them on non-eccentric rollers.

I claim:

1. An electric arc furnace comprising a substantially cylindrical refractory hearth, said hearth being mounted to oscillate circumferentially about its regular axis, arc electrodes between which the arc is struck passing through the ends of said hearth and oscillating therewith, said hearth being also mounted to oscillate in endwise fashion about a horizontal axis substantially perpendicular to the said regular axis.

2. An electric arc furnace comprising a substantially cylindrical refractory hearth, adjustable arc electrodes passing through the ends of said hearth and rotating therewith, said hearth being mounted to rotate about its regular axis, and being mounted to oscillate about a horizontal axis substantially perpendicular to the said regular axis.

3. An electric arc furnace comprising a substantially cylindrical refractory hearth, arc electrodes passing through the ends of said hearth and oscillating therewith, said hearth being mounted to oscillate about its regular axis, said hearth being also mounted to oscillate in such manner that the regular axis describes a portion of a double cone.

4. An electric arc furnace comprising a substantially cylindrical refractory hearth, adjustable arc electrodes passing through the ends of said hearth and rotating therewith, said hearth being mounted to rotate about its regular axis, said hearth being also mounted to rotate in such a manner that the regular axis describes a double cone.

5. An electric arc furnace comprising a substantially cylindrical refractory hearth, axially arranged arc electrodes therein, means for rotating the hearth about its axis, and means for contemporaneously oscillating the hearth and its electrodes about an axis perpendicular to its axis of rotation.

6. An electric arc furnace comprising a substantially cylindrical refractory hearth, arc electrodes passing through the ends of said hearth, and means for contemporaneously oscillating the hearth and its electrodes about its own axis and about an axis substantially perpendicular thereto.

7. In an electric arc furnace, in combination with a substantially cylindrical refractory hearth, electrodes axially arranged through the walls thereof, means for supporting said hearth in position to rotate about its axis, means for positively imparting rotative movement thereto, means for supporting the hearth and its supporting means in position to oscillate, about an axis substantially perpendicular to said axis of rotation of the hearth, and means for actuating the hearth and its immediately supporting parts about said last named axis as a center.

8. In an electric arc furnace, the combination of a substantially cylindrical refractory hearth provided with axially arranged electrodes, and a plurality of means for contemporaneously causing the oscillation of said hearth about axes substantially perpendicular to one another.

9. In an electric arc furnace, in combination with a substantially cylindrical refractory hearth, electrodes axially arranged through the walls thereof, and means for causing the rotative movement of the hearth about its own axis, contemporaneously with its oscillation about an axis substantially perpendicular to its axis.

10. In combination with a substantially cylindrical refractory hearth, axially arranged electrodes extending into the interior of said hearth from opposite sides thereof, and a compounded support therefor adapted to contemporaneously oscillate the hearth about a plurality of axes substantially perpendicular to one another.

11. In an electric arc furnace, in combination with a rotatable cylindrical hearth member provided with axially arranged electrodes, means for actuating the hearth about its axis, and means for contemporaneously imparting to said hearth a crosswise oscillatory movement.

12. The combination of a substantially cylindrical rotatable hearth member, axially arranged electrodes capable of movement lengthwise of their axis, means for rotatively actuating said hearth member, and means for contemporaneously imparting a transverse rocking movement thereto.

13. An electric arc furnace having, in combination with a substantially cylindrical refractory hearth, means for rotatably actuating the same about an axis variantly approximating the horizontal, means for, at the same time, oscillating the same about an axis substantially perpendicular to its axis of rotation, and means for introducing and maintaining a high degree of temperature within said refractory hearth at its rotative center during its period of movement.

14. In an electric arc furnace, in combination with a substantially cylindrical refractory hearth, means for rotatively actuating the same about a movable axis whose median position is substantially horizontal, means for introducing a high degree of temperature within said hearth above the proposed level of the metal to be treated therein, and means for rocking said hearth about an axis sub-

stantially perpendicular to its axis of rotation while its rotative movement is in progress.

15. An electric arc furnace having in combination a substantially cylindrical hearth member, electrodes axially arranged through the end walls thereof, and means for contemporaneously oscillating the hearth member about a plurality of axes substantially perpendicular to one another.

16. An electric arc furnace, having in combination with a refractory hearth member disposed for rotation about angularly variant axes, whose mean is substantially horizontal, means for rotatively actuating the same, means for imparting a transverse rocking movement thereto contemporaneously with its rotative movement, and means for introducing a high degree of heat adjacent the axial center of the hearth during its rotative period.

17. In an electric arc furnace the combination of a refractory cylindrical member disposed for rotation about axes substantially parallel with the horizontal, means for imparting thereto a transverse rocking movement, means for intermittently rotating the cylindrical member to and fro about its axis, and axially disposed electrodes, whereby a high degree of heat may be generated within the cylindrical member during its actuation.

18. In an electric arc furnace, in combination with a substantially cylindrical refractory hearth, electrodes axially arranged through the walls thereof, means for rotatively actuating the same, means for intermittently reversing the direction of rotation of said cylindrical hearth, and means for imparting a transverse rocking movement thereto at the same time that its rotative actuation is in progress.

19. An electrical arc furnace having in combination with a substantially cylindrical hearth member, axially arranged arc electrodes therein, means for contemporaneously oscillating said hearth member about a plurality of axes substantially perpendicular to one another, and means for automatically reversing the direction of each of such oscillatory movements at desired time intervals.

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