Oct. 16, 1928. 1,687,937

A. E. GREENE

ELECTRIC FURNACE AND ELECTRODE CRANE

Original Filed Nov. 20. 1920. 3 Sheets-Sheet 1

Fig. 1.

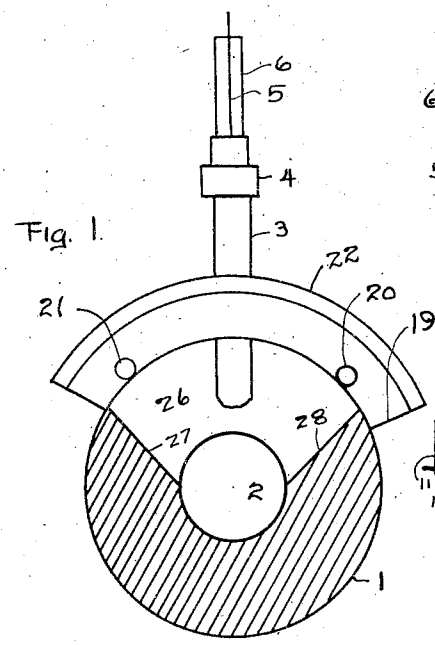
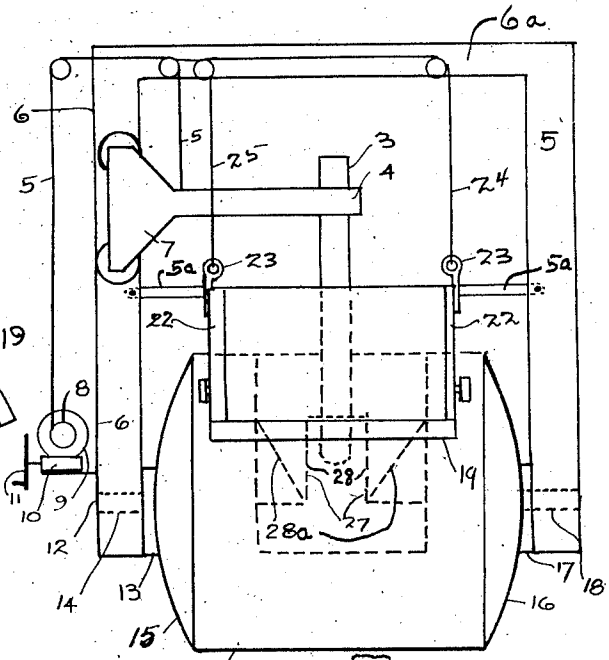


Fig. 2



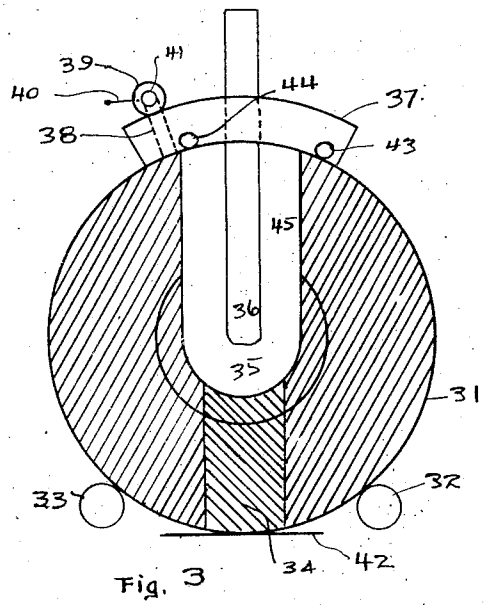


Fig. 3

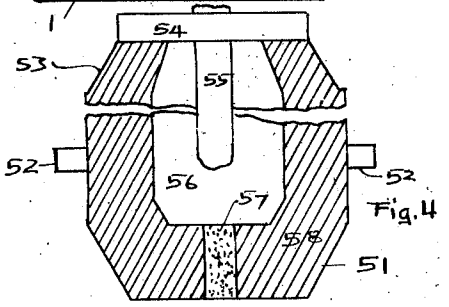


Fig. 4

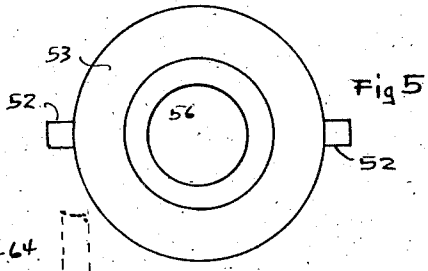


Fig 5

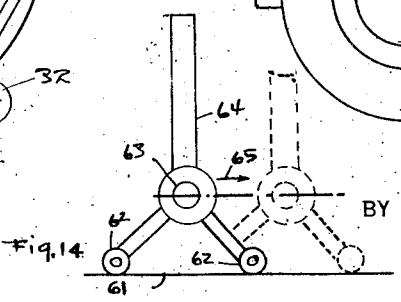


Fig. 14

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ELECTRIC FURNACE AND ELECTRODE CRANE

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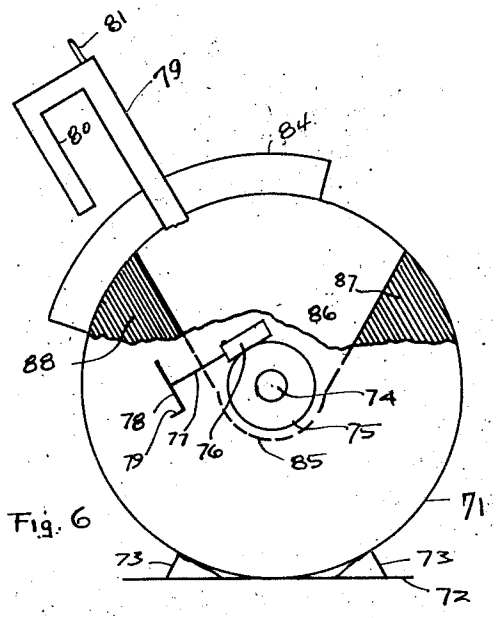


Fig. 6

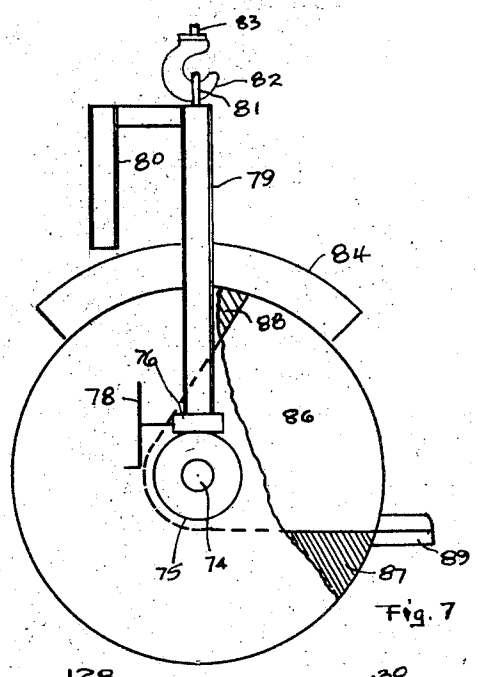


Fig. 7

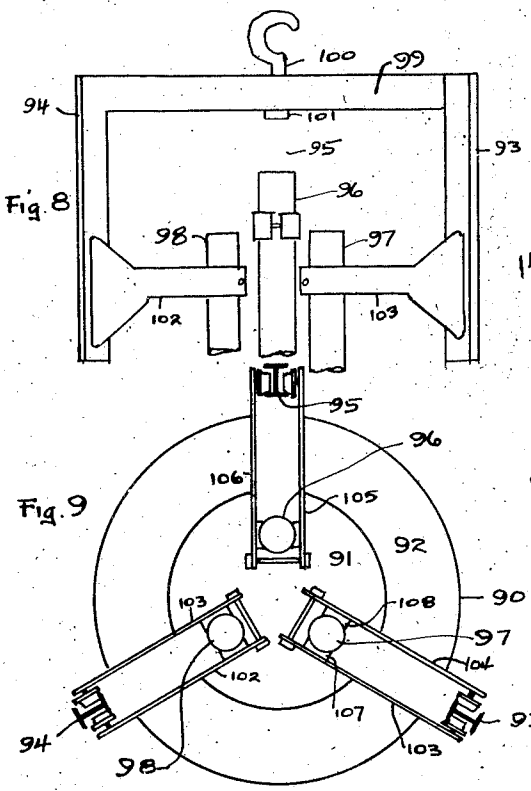


Fig. 8

Fig. 9

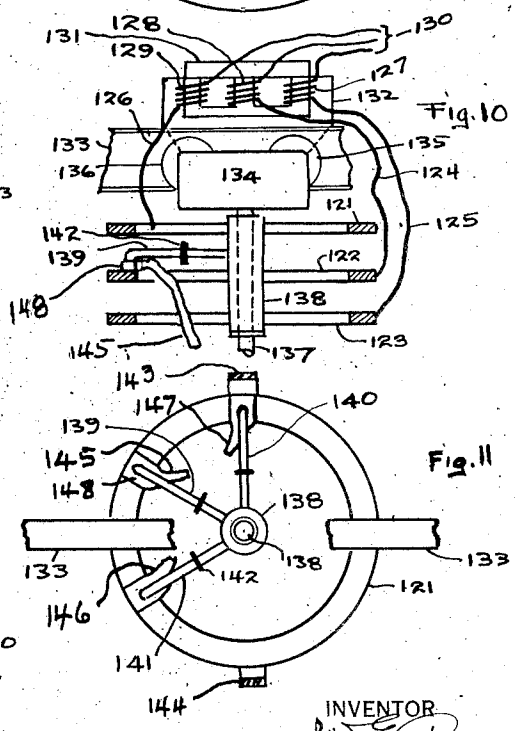


Fig. 10

Fig. 11

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ELECTRIC FURNACE AND ELECTRODE CRANE

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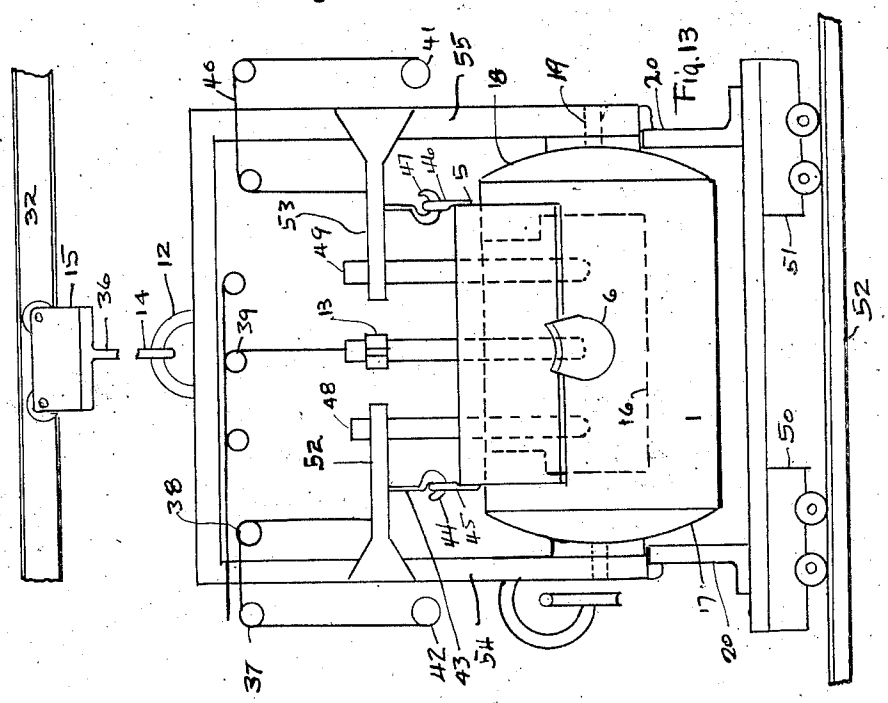


Fig. 13

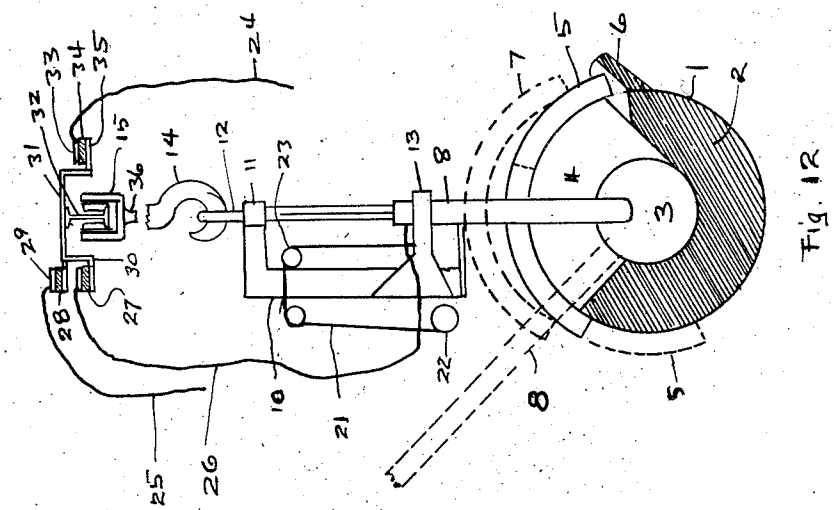


Fig. 12

INVENTOR

BY

ATTORNEY

Patented Oct. 16, 1928. 1,687,937

UNITED STATES PATENT OFFICE.

ALBERT E. GREENE, OF MEDINA, WASHINGTON.

ELECTRIC FURNACE AND ELECTRODE CRANE.

Application filed November 20, 1920, Serial No. 425,470. Renewed May 12, 1923.

My present invention relates to electric furnaces and more particularly to improvements in electrode crane mechanism not only for electrodes but also for roofs and in certain modifications for the vessel itself, and my invention also relates to improvements in transmission of electric power for electric furnaces more particularly in connection with cranes.

One object of my present invention is to provide an improved roof construction to simplify both the mechanical construction of furnace and roof, and also to materially simplify charging and discharging of the furnace contents.

One object of my invention is to provide a simple and efficient electrode crane mechanism adapted for use in furnaces already built as for example it may be desired to utilize the shell of a rotating brass furnace to make an electrode furnace in accordance with my invention.

Another object of my invention is to provide means of raising the electrodes out of the furnace chamber and then moving the roof from over the furnace chamber so that charge may be put in; and another object of my invention is to provide a new and very simple and efficient type of roof movable around the center of rotation of the supporting mechanism or furnace shell.

Another feature of my invention relates to the method of raising or lowering arch shaped roofs and other roofs by means of an electrode crane built in accordance with my present invention.

Still another feature relates to means of supporting the roof frame on a circular shell and of causing the frame to move or slide or roll around the shell.

Another feature of my invention relates to connecting the electrode crane member to the center or trunnions of a cylindrical furnace and providing a worm gear whereby the angle of the electrode crane with respect to the normal vertical axis of the shell may be varied or controlled, and more particularly when a rolling cylinder furnace is rolled over for pouring, this mechanism may be used to regulate the position of the electrodes and furnace roof.

Another feature of my invention relates to means of attaching the furnace roof to the electrode holder trolleys for purpose of raising the roof.

Another feature of my invention consists in means of maintaining the electrode crane in a vertical position while tilting a furnace which can be revolved or rolled over on a track.

Another feature of my invention relates to the means of rolling the roof around the furnace for purposes of charging the furnace chamber without entirely removing the electrode but with a special construction of furnace chamber.

Another feature of my invention relates to the construction of electrode frame cranes for supporting a number of electrodes, particularly three electrodes, and in certain instances the relative arrangement and location of electrode holder trolley members.

Another feature relates to the means of carrying or conveying the electrode cranes; and in certain cases of conveying the furnace and all either on an overhead track or on a rail track on the floor level.

Another feature relates to carrying the electric power to the movable electrode crane, and in certain cases to attaching the furnace transformer or auto transformer on the crane member and transmitting the power at standard voltages higher than used on the furnace.

One feature relates to the means of passing the current thru movable contacts to permit motion of the furnace either around a swivel crane hook or along a horizontal path.

Still another feature of my invention consists in bringing the current to the furnace at standard transmission voltage, for example 440 volts and attaching the furnace transformer to the furnace and there supplying the desired voltage to the electrodes.

My invention will be better understood by reference to the annexed drawings.

Fig. 1 is a sectional elevation of a cylindrical furnace provided with revolving roof on rollers, and showing the furnace in section.

Fig. 2 is a side view of the furnace of Fig. 1 showing the electrode crane and means of lifting roof.

Fig. 3 a sectional elevation of a cylindrical furnace on rollers or a track and fitted with a roof covering a shaft, and showing means of moving the roof frame by a gear and rack mechanism.

Fig. 4 shows a section of a converter which has been converted into an electric furnace in accordance with my invention.

Fig. 5 is a plan view of the top of the furnace of Fig. 5.

Fig. 6 shows an end view of a cylindrical furnace provided with trunnions and an electrode crane attached to and movable around the trunnions and showing the roof as moved around the circumference of the cylinder to leave the charging opening open.

Fig. 7 shows an end view of the same furnace, likewise partly in section, and showing the furnace hanging on the electrode crane and rotated by means of the gear into the final pouring position.

Fig. 8 shows a modification of electrode holder crane carrying three electrodes and hung on a swivel hook.

Fig. 9 shows the upright members which carry the trolley electrode holders of the furnace crane of Fig. 8, this plan view being in section where the top of the crane has been removed; and this view also showing the outline of a furnace beneath into which the electrodes may extend.

Fig. 10 shows a crane beam with embedded type transformer mounted thereon and a movable trolley operating on said beam and carrying contact rings and adapted for supplying current to a three phase electrode circuit beneath, as for example the electrode crane of Fig. 8.

Fig. 11 shows a plan view partly in section of the apparatus of Fig. 10.

Fig. 12 shows a view in section and elevation of a cylindrical furnace with roof which can be raised.

Fig. 13 shows a front view of the furnace of Fig. 12 and shows the electrode crane apparatus attached to the trunnions of the furnace and also supporting members resting on a car or truck beneath on which the furnace may be operated.

Fig. 14 is a view in elevation of a movable electrode crane, having a vertical member for carrying the electrode holder arm, and movable horizontally on a track.

These and other applications of the invention will now be described.

I have shown in the several figures various views and embodiments of the movable roof features of my invention and will now refer to these particular features in greater detail. In Fig. 1 I have shown a cylindrical furnace with a chamber inside in refractory lining and this chamber 26 between the side lines 27 and 28 increases in dimensions toward the top. The shell 1 contains the lining and makes the chamber 2 and the roof is held in a frame between end pieces 19 and side pieces 22 the latter curved to correspond to the radius of the furnace shell. The frame is filled with brick forming an arch or is rammed full of refractory material. In this figure the roof frame is shown supported on rollers 20 and 21 which enable it to roll around the circumference of the furnace shell. In Fig. 2 the roof frame is shown connected with cables 24 and 25 which can be wound up on the drum 8 at the end of the furnace to raise the roof to facilitate its movement around the shell. The roof frame may be connected to the upright crane members 5 by latch members 5^a whereby the roof frame is caused to move with the electrode crane members 5 as the latter move around on the trunnions 14 and 18 as centers. Movement of the frame around the trunnions may be controlled by a worm gear not shown in this figure but similar to the gear shown in Fig. 7. The roof frame of Fig. 6 and Fig. 7 operates to move around the circular shell in the same manner as already described.

The furnace of Fig. 7 may be charged by rotating the roof back until the chamber is sufficiently open; this may be done by fixing the shell by means of suitable blocks 73 so that it cannot move when resting on the supporting track member 72 and then revolving the electrode crane back which takes the roof with it as shown in Fig. 6. The chamber 86 of the furnace may be charged when the roof is back as shown in Fig. 6. If desired the furnace may then be rolled forward until it assumes somewhat similar position to that shown in Fig. 7 and it may then be charged from a lower level.

The furnace as shown in Fig. 7 may be rotated into that position while held on an overhead carrier and this motion of the furnace may be caused by movement of the worm gear 76 by the hand wheel 78. When the furnace is held by means of the hook 82 or other similar means and the shell does not rest on a supporting rail as in Fig. 6, then the shell of the furnace in Fig. 7 may be revolved while the roof remains in the same position relative to the electrode crane as shown in Fig. 7.

When the furnace is supported as in Fig. 7 and it is desired to turn the furnace over on the trunnions it may be desirable to raise the roof slightly from contact with the part of the furnace on which it normally rests and this may be accomplished as shown in Figs. 12 and 13,—for example the electrode holder trolleys 52 and 53 may be used to lift the

roof frame by means of hooks 44 and 47 which engage links or hooks attached to the roof frame 5 and then by winding up the cables which connect with the electrode holders on drums 41 and 42 the roof frame may be lifted and take some position as shown at 7 in Fig. 12.

The difference between Figs. 13 and 2 is that a single top electrode is shown in Fig. 2 whereas a three electrode furnace is shown in Fig. 13. Another difference is that a truck is shown in Fig. 13 but this and other details will be subsequently described.

The roof structure which I have described may be applied to different types of furnace; for example I may modify a steel converter shell so as to round the top in such manner that a circular roof may be attached to a trunnion crane and when the electrode is lifted out of the chamber, the roof may be revolved around the trunnions so as to recharge the vessel; but my roof crane mounted on the trunnions is applicable to lifting the roof up by the same or similar means to the means shown in Fig. 13 and until it may be moved out of the way for charging. Thus my invention is not limited to round roofs altho round roofs present extremely simple and efficient construction.

I may mount the electrode crane on an overhead carrier as shown in Fig. 12 and attach the roof frame to this carrier or to the electrode crane as shown in Fig. 13 without using the trunnions.

In supplying current to the furnace electrodes I have developed certain useful improvements relative to the combination of a movable crane or trolley which holds the furnace, or in certain cases a truck on wheels supporting the furnace, with a conductor system along the line of the carrier. My object in this construction is to provide means of moving the heating unit without disconnecting the electrical contact with the conductor system the broad details of which have been disclosed in my copending application Serial Number 422,618, filed Nov. 8, 1920.

The further object of this construction is to attach the furnace to the electrode crane and move it from one position to another while keeping the current on or at least with the connections between the furnace electrodes and the conductor system along the path of the carrier still in contact. Thus with the furnace of Fig. 12 and Fig. 13 I may run the furnace out to any suitable location where it may be charged with the material to be treated, I may then run it into some suitable location for carrying out the main heating process and then, with current still on the electrodes or with contact between them and the supply lines still holding, I may run the furnace along to various positions for pouring its contents and provide such heat as necessary from time to time by the electric circuit thru the electrodes. In Figs. 10 and 11 I have shown what I call contactor rings. These consist of three circular conductors shown in section at 121, 122, and 123 each ring being independently supported by an arm such as 139 and an arm 144 extending down from the trolley 134 and also extending up to the transformer shown at 131 above, the latter serving to supply the low voltage current to these rings for further use thru the electrodes. Beneath the trolley proper is a shaft 137 on which is a sleeve 138 which in turn has arms 139, 140 and 141 extending out and holding contact shoes as shown at 148 from which lead the flexible conductors to the furnace electrodes beneath. The flexible conductor from the shoe 148 is shown at 145. The arm 139 is provided with an insulating joint 142 which may be a flange coupling with asbestos or ebony wood separating the two flanges and with suitable insulated bolts holding the flanges together. The other arms 140 and 141 may also be properly insulated in the same manner. When the furnace turns on the swivel hook holding the electrode frame, such as the hook shown in Fig. 7, the arms like 139 cause the shoes to swing around the contactor rings but at all times keeping contact with the supply system.

The transformer 131 is mounted on the trolley 134 by means not shown. This transformer is represented as a three phase transformer having three separate windings 128, 127, and 129 on separate legs for the separate phases. The three lines 130 represent the leads to the supply wires running along the path of the beam 133 and not shown. The construction for carrying these wires would be similar to the end view of the heavy trolley bus bars shown in Fig. 12 each conductor being separately mounted and insulated and then shoes mounted from the moving trolley adapted to make contact with the trolley wires so that the transformer is energized at all times when desired. The windings have been shown here diagrammatically. They are more fully described in copending applications but for simplicity here they are thus shown to represent an auto transformer and the secondary or heavy current conductors are shown at 124, 125 and 126 leading to the separate contactor rings from whence the current goes to each respective electrode.

In Fig. 8 and Fig. 9 I have shown a modification of electrode crane carrying three electrodes for three phase current supply. This electrode crane may be used to drop three electrodes into a chamber such as shown at 90 in Fig. 9 which chamber may be a furnace or a ladle or any container to be heated with or without charge therein.

In Fig. 8 the hook 100 is shown above for mounting on any suitable crane or support. This hook 100 holds a member 99 which in turn carries upright members shown at 93 and

94 and 95. These may be vertical I beams. On these beams operate electrode trolleys 102, 103 and 105 which in turn hold electrodes 98, 97 and 96. The mechanism for raising and lowering the electrodes on their respective beams is not shown but may be similar to the hoisting cable and drum described elsewhere in this specification.

In Fig. 8 the corresponding elements may be seen, corresponding parts carrying the same number. For example the I beam 93 is shown carrying the trolley 103 and operating up and down the I beam on wheels which may be seen engaging the inner surfaces of the trolley.

With further reference to Figs. 6 and 7 I will enumerate the numbered parts for possible reference. The shell in Fig. 6 is supported on a track 72 which may be a railroad rail. Another such rail would be under the other end of the furnace and it might roll over on these rails as described in my U. S. Patent 1,279,149. Blocks 73 may be shoved against the shell on the track to keep it from rolling over. The shell is shown at 71. It may be provided with the usual construction of ends for example a dished boiler head and with trunnions as shown at 74. The lining is shown partly in section at 87 and 88. The heating chamber 86 is shown as widening toward the top but if desired this widening may only be for the electrode to move around on the trunnions as centers. On the trunnion 74 is shown a worm gear housing 75 and worm housing 76 and hand wheel shaft 77 with hand wheel 78 and handle 79. The dotted line 85 represents the bottom of the furnace chamber 86. The upright 79 is shown cut off in Fig. 6 but in Fig. 7 it connects with the worm gear housing so as to turn around the trunnion when the worm gear is operated. A link 81 is shown for taking the crane hook 82 which may be on a swivel 83. The beam 80 is a third beam for use of third electrode as shown in Fig. 13. The same numbers in Figs. 6 and 7 represent the same corresponding parts.

In Figs. 1 and 2 is shown a single top electrode furnace and the same numbers here also represent the same corresponding parts. Altho a bottom electrode is not shown in the section of Fig. 1 this is because the bottom may be of carbon in which case the terminal is the shell. The shell 1 in these figures is carried on the electrode crane on the ends of the members 5 and 6 which in turn are held by a cross arm above 6^a. On one upright 6 is shown a trolley electrode holder 7 holding an electrode 3 by clamp 4. The arm of the trolley has a cable 5 attached for lifting or lowering it by winding the cable over the sheaves onto the drum 8 which drum is operated by a worm gear shown at 9 and 10 and hand wheel 11. The roof is shown in a frame 22 consisting of curved members and end pieces 19. Hooks 23 are shown with cables 24 and 25 which may also be wound up on the drum 8 to lift the roof. Roller wheels 20 and 21 are shown for letting the roof roll around the cylindrical surface of the top of the shell or other track member corresponding thereto. The roof frame may roll around the shell on these rollers being pulled along with the members 5 and 6 by the latch members 5^a. This construction of roof and electrode crane may be used with a trolley like 7 on both upright members. The dotted lines in Fig. 2 show the outline of the chamber opening inside the refractory lining. The dimension of the chamber in the direction of the axis of the cylinder varies; it is only wide enough for the electrode in front along the line 28 of Fig. 1 and the same width in back along the line 27; the dotted line 28^a representing the slanting walls half way between front and back. The dished heads are shown at 15 and 16, and the trunnions at 13 and 17.

Fig. 3 shows a section of a cylindrical shell 31 upright on rollers 32 and 33 or on a track 42. A bottom electrode of carbon or other conducting material is shown at 34. The chamber or crucible 35 is at the base of the shaft 45. An electrode 36 is shown thru the roof 37 in the shaft 45. Rollers 43 and 44 are shown for movement of the roof around the shell 31. A bracket 38 is shown in section lines back of the roof frame and a member 39 on shaft or pin 41 is intended to represent a gear to mesh with a rack on the roof frame 37 for the purpose, by means of the lever 40, of moving the roof around the shell; teeth of the gear meshing with teeth of the rack, altho the teeth are not shown.

Fig. 14 shows a standard 64 supported on a track 61 which may be one side of the upright frame of an electrode crane. The trunnion of a rolling cylinder furnace may extend thru the hole 63. Legs are shown terminating in wheels 62 which roll along the track. Movement of this member along the track is represented in the direction of the arrow 65 and the dotted outline shows a possible position, such as might be taken when the crane rolls along the track while attached to the trunnion of a rolling cylinder furnace all the while maintaining an upright position.

Fig. 4 and Fig. 5 have already been described as a modified converter. Instead of dropping a single electrode as 55 in Fig. 4 into the chamber of the converter, an electrode crane such as shown in Figs. 8 and 9 may be dropped or lowered into the furnace chamber and arcs drawn to the charge, or with proper voltage control the heat may all or largely be generated in the charge itself.

In Fig. 13 a truck is shown on wheels at each end of a car supporting the furnace. Standards 20 are shown. These may support the bases of the upright members 53 and 54 so that the connection to the overhead car-

rier can be disconnected and then the electrode holding frame would remain upright by suitable connection to the standards 20; and the furnace could then be rotated as desired.

It is understood that my invention is not limited to cylindrical furnaces, nor to the number of electrodes, nor to the specific construction of carriers or crane members.

What I claim is:

1. In combination a movable electric heating furnace, a carrier therefor, electric conductors along the line of said carrier, movable electric current contacting members attached to said furnace said contact members maintaining electrical connection between the furnace members and the source of supply of current.

2. In combination, an electric furnace, a separately mounted vertical mast movable horizontally with respect to the furnace, a trolley member engaging said mast and movable along the latter, an arm attached to said trolley and an electrode clamp on said arm, and means for raising and lowering said arm to adjust the electrode height.

3. An electric furnace comprising a cylindrical shell of approximately horizontal axis, said shell having an open top, a refractory lining forming a heating chamber, a roof frame holding a refractory roof covering said chamber, and an electrode crane carried by said furnace having means of regulating the elevation of the electrodes and means of moving said roof frame from over the top opening of said furnace chamber.

4. A cylindrical electric furnace having a metal shell, a refractory lining, a top opening in said shell covered by a refractory roof held in a frame, an electrode hole thru said roof, and an electrode holder apparatus mounted on said furnace and adapted to move around the circumference of the furnace whereby said electrode may be lifted above the level of the furnace and then roof and electrode moved out of the way so that access may be had into the chamber of said furnace to charge or discharge material.

5. A cylindrical furnace comprising a cylindrical shell, metal ends, trunnions on said ends, an electrode holder mounted on said trunnions, a lining in said shell, an opening into the inner chamber formed by said lining, means of lowering an electrode into said opening on said electrode holder, and means of raising said electrode and moving it around on the trunnions out of the way for charging into said opening.

6. An electrode crane comprising vertical members for guiding electrode holder trolleys, a frame holding said vertical members in relation to each other, means of raising or lowering the electrode holders on said upright members, each electrode holder having independent means of regulation, and means of carrying said crane on a suitable overhead carrier.

7. An electric furnace in combination with a carrier to support said furnace, means of moving said furnace from place to place on a track, conductors along said track and means of leading current from said conductors to the electrodes of said furnace without disconnecting the circuit when the furnace is moved.

8. In combination, an electric melting furnace comprising a cylindrical shell with its axis substantially horizontal and means for tilting the shell about said axis or an axis parallel thereto, an opening thru the top of said shell into a furnace chamber within for electrodes to enter said chamber, and a removable roof covering an opening into said chamber for charging material therein.

9. An electric furnace in combination, said furnace having a shell of general cylindrical shape mounted to tilt about its axis and with said axis substantially horizontal, an opening in the upper part of said shell thru the refractory lining within, a movable roof for closing said opening, a plurality of electrode holes thru the refractory material for electrodes to enter the chamber, means for removing said electrodes and for charging the furnace thru the roof hole.

10. The combination comprising an electric furnace, means to support said furnace, means to move said furnace, a roof for said furnace, electrodes passing through said roof, travelling contact means to supply electric current to said electrodes, means to independently withdraw and adjust any of said electrodes, means to move said roof and electrodes away from the opening of said furnace, and means to tilt said furnace.

11. An electric furnace apparatus, comprising a truck adapted to run along a track and to carry said furnace, the latter comprising a chamber for holding molten metal and a pouring spout and means for tilting said furnace to pour the metal, and a current collecting trolley on said truck.

12. In combination, an electrric heating apparatus comprising a truck, a conductor mounted along the path of said truck, a contacting member for taking current from said conductor to parts on said truck, and electric heating means on said truck comprising an electric transformer and a furnace chamber for generating heat by current from said transformer.

13. In combination, electric heating apparatus comprising an overhead track, a carrier running thereon, a furnace supported thereby, a conductor along said track, means for collecting current from said conductor and using it in electric heating means in conjunction with said furnace.

14. An electric furnace apparatus comprising in combination, a furnace with refrac-

tory lining, means of generating heat therein electrically and heating molten metal, a carrier for said furnace, transformer means mounted on said carrier for supplying heat within said furnace, means for supplying current to said transformer from conductors along the path of movement of the carrier, and means for tilting the furnace and maintaining connection by flexible leads between the heating means and the supply of current.

In witness whereof I hereunto subscribe my name this 18th day of November, A. D. 1920.

ALBERT E. GREENE.