May 28, 1940. W. E. MOORE 2,202,224

ELECTRIC FURNACE

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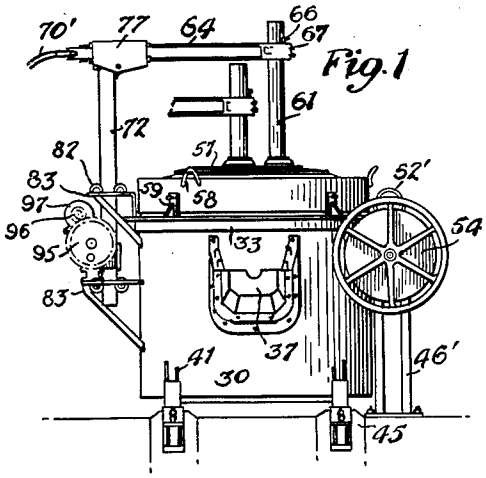


Fig. 1

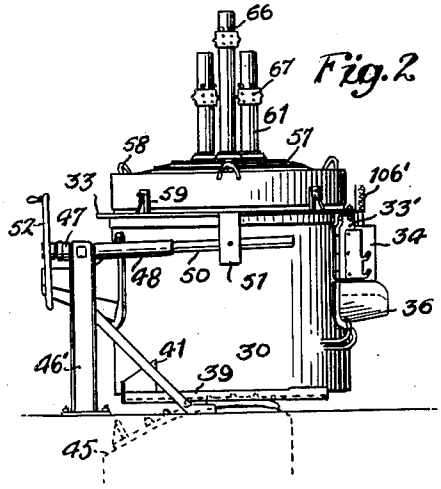


Fig. 2

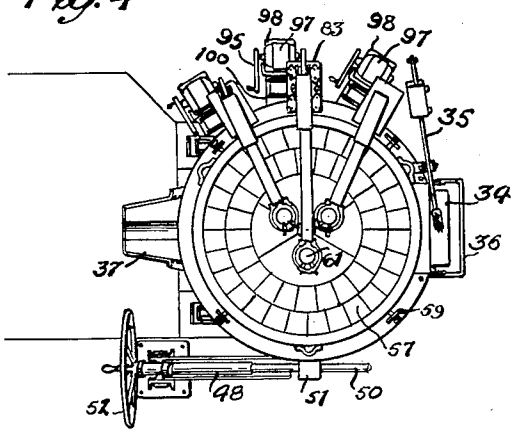


Fig. 4

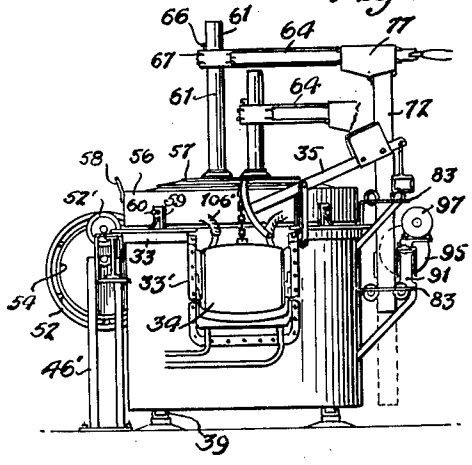


Fig. 3

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ELECTRIC FURNACE

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Fig. 5

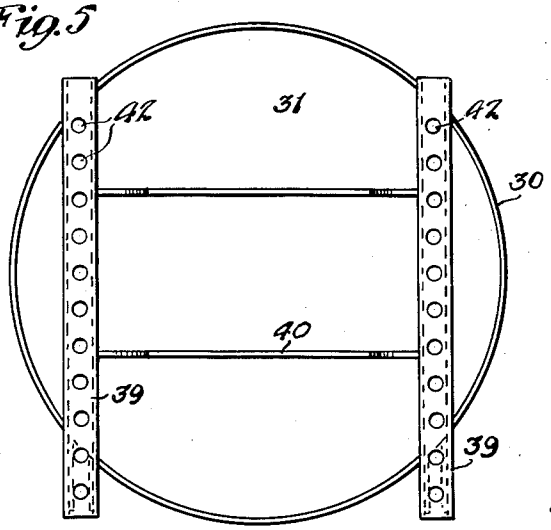


Fig. 8

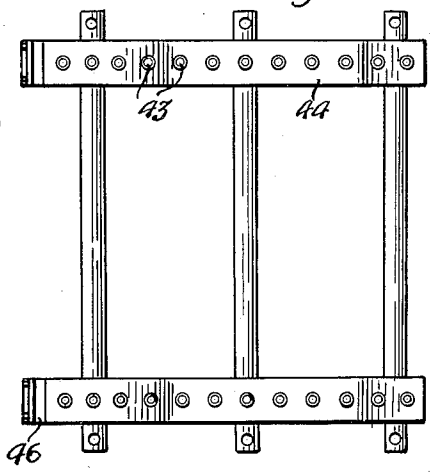


Fig. 6

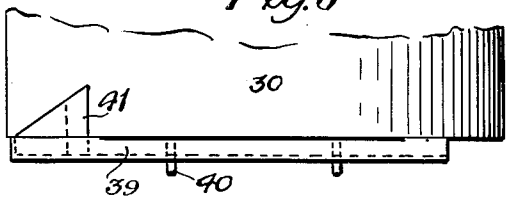


Fig. 9

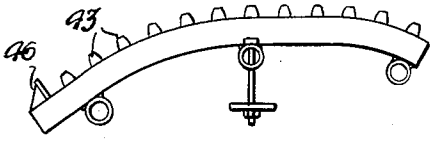


Fig. 7

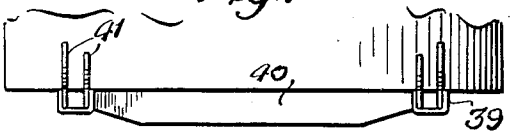


Fig. 11

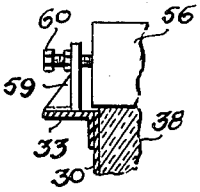


Fig. 12

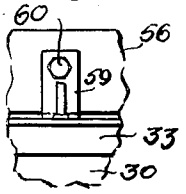
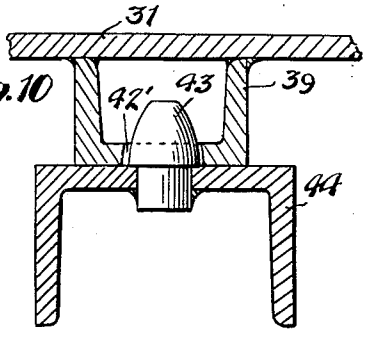


Fig. 10



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Fig. 13

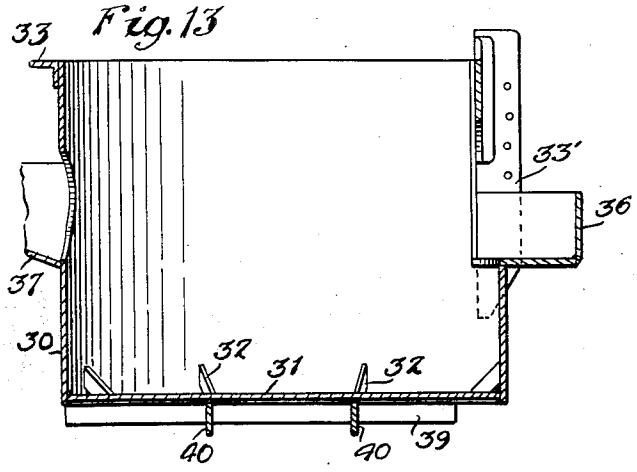


Fig. 14

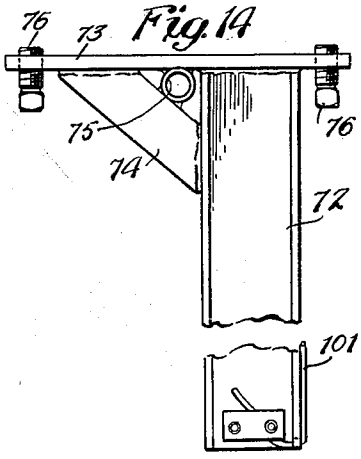


Fig. 15

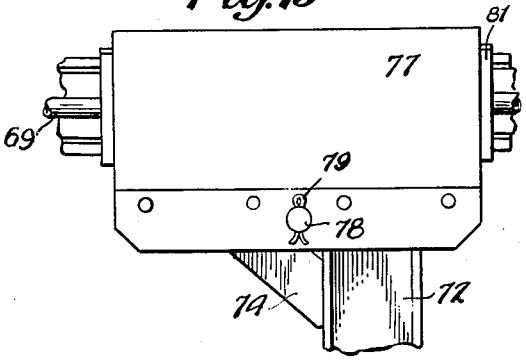


Fig. 19

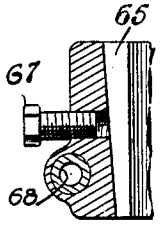
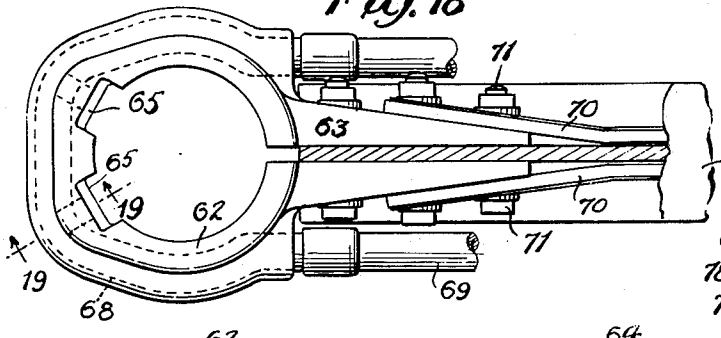


Fig. 18



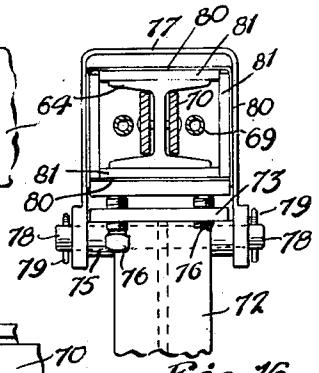


Fig. 16

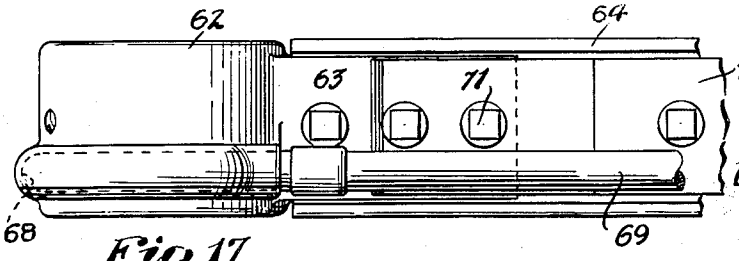


Fig. 17

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ELECTRIC FURNACE

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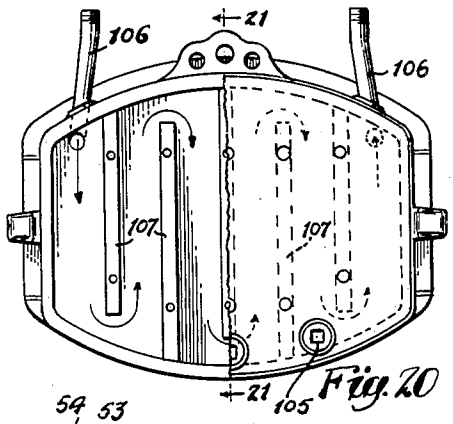


Fig. 20

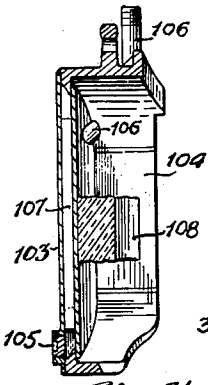


Fig. 21

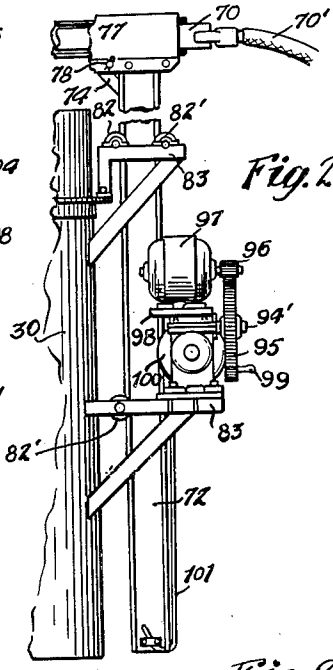


Fig. 22

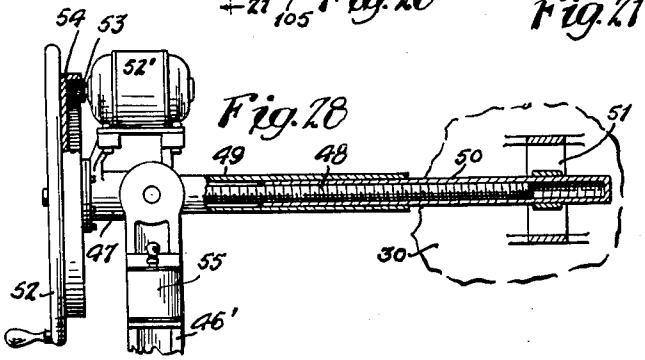


Fig. 28

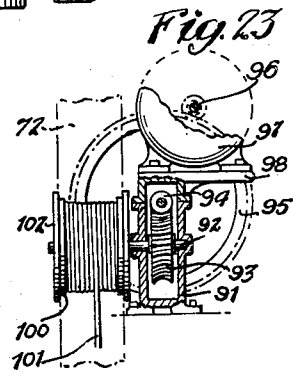


Fig. 23

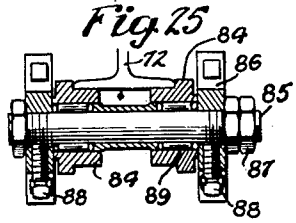


Fig. 25



Fig. 26

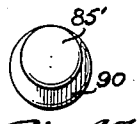


Fig. 27

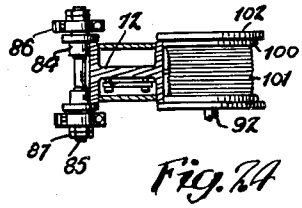


Fig. 24

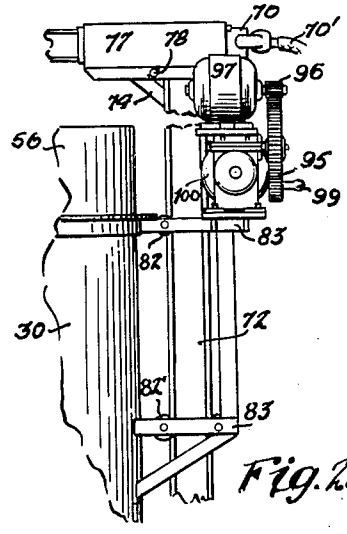


Fig. 29

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Attorney

Patented May 28, 1940

2,202,224

UNITED STATES PATENT OFFICE

2,202,224

ELECTRIC FURNACE

William E. Moore, Pittsburgh, Pa., assignor to Pittsburgh Research Corporation, Pittsburgh, Pa.

Application January 31, 1936, Serial No. 61,810

4 Claims. (Cl. 263—33)

The present invention relates to improvements in furnaces and more particularly to electric furnaces of the type used in metallurgical operations although not necessarily restricted to this use.

An important object of this invention is the provision of an electric furnace for metallurgical operations which can be made in any size or capacity but which is particularly well adapted for the smaller capacity furnaces, being inexpensive to produce and to operate. Small furnaces of this type having a capacity of one-half to one and a half tons, for example, can be run at a very low demand cost whereas large furnaces require a large demand cost when operated at low tonnages in times of reduced output. The furnace of the present invention may be made in small sizes to be operated in conjunction with a large furnace, as a bleeder unit or for operation with its own substation as a separate melting furnace.

Another object of this invention is the provision of an electric furnace which takes up a minimum of space, which is easily operated, strong and durable, and which is economical in operation.

Other objects and advantages of this invention will be apparent during the course of the following description.

In the accompanying drawings, which form a part of this specification and wherein like characters of reference denote like parts throughout,

Figure 1 is an elevation of a furnace embodying this invention,

Figure 2 is an elevation at right angles to Figure 1,

Figure 3 is an elevation at right angles to Figure 2,

Figure 4 is a top plan view of the furnace,

Figure 5 is a bottom plan view of the tilting runner in place on the furnace shell,

Figure 6 is a side elevation of the tilting runner showing its position on the furnace.

Figure 7 is an end elevation thereof,

Figure 8 is a top plan view of the tilting rocker pedestal,

Figure 9 is a side elevation thereof,

Figure 10 is a cross sectional view through the tilting runner and pedestal in their operative position,

Figure 11 is a detail of the roof clamping and adjusting screw,

Figure 12 is a view taken at right angles to Figure 11,

Figure 13 is a cross sectional view through the furnace shell with its lining removed,

Figure 14 is a side elevation of the electrode supporting column, parts being broken away,

Figure 15 is a side elevation of one of the swiveling cuffs connecting an electrode arm to one of the electrode supporting columns,

Figure 16 is an end elevation thereof,

Figure 17 is a side elevation of one of the electrode clamps, showing its connection to the electrode supporting arm,

Figure 18 is a top plan view thereof, parts of the arm being broken away,

Figure 19 is a sectional view on the line 19—19 of Figure 18,

Figure 20 is a front elevation of the water cooled furnace door,

Figure 21 is a cross sectional view on the line 21—21 of Figure 20,

Figure 22 is a side elevation of one of the electrode supporting columns showing the hoisting gear in place,

Figure 23 is an elevation of the hoisting gear at right angles to Figure 22, parts being broken away,

Figure 24 is a top plan view of the hoisting reel and guide roller showing their positions with respect to the electrode supporting column which is shown in section,

Figure 25 is a longitudinal sectional view of one of the guide rollers,

Figure 26 is a side elevation of an eccentric shaft for adjusting the guide roller,

Figure 27 is an end elevation thereof on a somewhat larger scale,

Figure 28 is a side elevation of the tilting mechanism, parts being broken away and other parts being shown in section, and,

Figure 29 is a side elevation of one of the electrode columns showing another position of the hoisting mechanism with respect thereto.

In the drawings, wherein for the purpose of illustration is shown a preferred embodiment of this invention and referring particularly to Figures 1 to 9, the numeral **30** designates the crucible shell of a furnace embodying this invention. This shell is preferably of plate steel and cylindrical in shape and has a flat bottom **31** also of plate steel welded to the inner wall of the shell and further secured thereto by suitable diagonal braces **32** welded to the bottom **31** and to the inner walls of the shell, as indicated in Figure 13. A bezel ring **33** surrounds the top of the furnace shell to strengthen the shell, and is interrupted at the charge door by a water-cooled door frame

33'. A door 34 is slidably arranged in the door frame and is counterbalanced by the usual sector arm and counterweight indicated at 35. The door seats in a refractory lined extended door sill 36. A tapping spout 37 is arranged diametrically opposite the charge door and is also refractory lined. The entire shell is lined with a suitable refractory material in the usual manner, as indicated at 38 in Figure 11.

A pair of spaced flat rockers or runners 39 are secured by welding or other suitable means, to the underside of the furnace shell, as best shown in Figures 5, 6 and 10 and are connected by suitable spacing members 40 also secured to the underside of the shell. Brackets 41 connect the ends of the rockers to the outer periphery of shell 30 and brace the rockers. The rockers or runners 39 are U-shaped in cross-section and are each provided with a series of spaced openings 42 adapted to correspond with and receive suitable teeth 43 secured at spaced intervals on curved rocker tracks 44 which are preferably embedded or otherwise mounted on a concrete or other foundation 45. The rocker tracks are curved as shown in Figures 2 and 9 so as to roll the furnace in a manner to move the center of gravity of the furnace substantially in a straight line, which insures easy tilting. The rocker tracks 44 are also curved at their rearward ends to permit sufficient back-tilt of the furnace for slagging. The teeth 43 are extended the full length of the rocker tracks, and the forward ends of the tracks are provided with suitable abutments or stops 46 which engage the ends of the runners 39 to prevent overtilting of the furnace.

The tilting mechanism which is best shown in Figures 2, 4 and 28 comprises a standard 46' rigidly secured to the floor and having a swiveling ball bearing thrust block 47 arranged at its upper end and supporting a tilting screw assembly comprising a tilting screw 48, a concentric sheath 49 and a thrust sleeve 50 engaging the screw and adapted to telescope with the sheath 49 and screw 48. The thrust sleeve 50 is swiveled in a suitable bracket 51 on the side of the furnace shell adjacent the top thereof. A hand wheel 52 is secured to the tilting screw and may be rotated in either direction to operate the screw and move the thrust sleeve 50 to tilt the furnace either forward or backward. While the furnace may be tilted by hand, a tilting motor 52' may be mounted on the swivel block 47 and provided with a pinion 53 to engage an internally toothed ring gear 54 on the hand wheel. The tilting motor is controlled by a control box 55 on standard 46' and the motor moves with the tilting mechanism. The furnace may therefore be readily tilted by hand or by means of the motor 52.

The roof of the furnace is illustrated in Figures 1 to 4, 11 and 12 and comprises a metal flanged roof ring 56 supporting a refractory arched roof 57. The roof is removably arranged on the furnace crucible and may be lifted by means of suitable loops 58 arranged at the top of the ring 56. By reference to Figure 11 it will be seen that the weight of the roof is carried by the crucible refractories 38, and is free to rise and fall therewith. Four brackets 59 are secured to the top of the bezel ring 33 and are each provided with a centering bolt 60, shown in detail in Figures 11 and 12 to engage the outer periphery of the roof ring. By adjusting the bolts 60, the furnace roof may be properly centered in place upon the top of the crucible.

The electrodes 61 are carried by suitable water cooled clamps of electrically conducting material such as copper, and these clamps are illustrated in detail in Figures 17, 18 and 19. The electrode clamps each comprise a ring 62 having a split shank 63 adapted to receive the web of the electrode arm 64 and be bolted thereto. A pair of spaced vertical keyways 65 are provided on the inner surface of the bore of the ring 62 and are provided with inclined surfaces. Suitable wedges 66 are forced into the keyways 65 to engage the electrode and clamp it in the ring, and suitable bolts or set screws 67 are carried by the ring to engage the wedges and hold them in set position to insure a good electrical contact with the clamp. The set screws 67 also force the wedges into closer engagement with the electrode and prevent accidental displacement thereof.

A cooling water pipe 68 is cast into the clamping ring and while it may be arranged in any desired position on the ring it is preferably disposed adjacent the lower portion of the ring, as indicated in Figures 17 and 19 as this is normally the hottest portion of the ring. Water circulating pipes 69 are connected to cast in pipe 68 and circulate cooling water therethrough to prevent overheating of the clamp.

The electrode arm 64 seen in Figures 16, 17 and 18 is preferably in the form of an H-beam the web of which extends into the split portion of the shank 63 and the flanges of which overlie the shank. The arm 64 may be of any other desired cross-section and if desired, may be of electrically conducting material such as copper or brass. It is preferred, however, to form the arm of steel to give the necessary strength for carrying the electrode, and to reinforce the arm with copper or other electrically conducting bars 70 placed within the flanges of the arm and bolted thereto. The shank 63 is tapered, and the ends of bars 70 diverge to receive the shank to which they are secured by suitable bolts 71. The electric current is conducted to the clamps 62 by bars 70.

Electrode columns 72 are arranged to be raised and lowered, and support the electrode arms 64, being insulated therefrom. The columns may be of any suitable cross-section such as a simple H-beam, or the H-beam, may be boxed in, as indicated in Figure 24, for greater strength. A rectangular platform 73 is arranged at the top of each column 72 and is supported in a horizontal position by diagonal brace 74. A sleeve 75 is rigidly secured transversely of the lower side of the platform 73 centrally thereof and projects a slight distance beyond the side edges of the platform as indicated in Figure 16. A pair of set screws 76 is arranged at each end of the platform 73 for a purpose to be hereinafter described. A substantially inverted U-shaped hood 77 has thickened lower edges provided with central openings to receive a pivot pin 78 adapted to extend through sleeve 75 and to be secured by means of cotter keys 79 or the like. The hood is pivotally secured to the platform 73 by means of pivot pin 78.

The arm 64 is adapted to extend through the pivoted hood 77 and is insulated and spaced from the hood and from the platform 73 by means of insulating strips 80 of asbestos or the like and pieces 81 of suitable board such as ebony board, as shown in Figure 16. Additional boards or strips of wood or other suitable material may be arranged above or below the arm 64 and insulating material or at the sides thereof to fill up any space between the insulating material and the

walls of the hood, if desired. By tightening up on bolts or set screws **76** the arm **64** is securely clamped in the hood. The pivoted hood **77** assures a rigid clamping of the arm to the platform **73**. The bars **70** extend beyond hood **77** and are connected to a source of electric current by suitable conductors **70'**.

The columns **72** seen in Figures 1, 3, 14 and 22 are each adjustable vertically to raise and lower the electrodes, and are guided by suitable rollers **82** and **82'** supported by upper and lower brackets **83** secured to the furnace shell **30**. Each of the rollers comprises a pair of adjustably spaced roller members **84** held apart by the column **72** and rotatably mounted on shaft **85** which in turn is secured to suitable brackets **86** by adjusting nuts **87** and set screws **88**, as indicated in Figure 25. Roller bearings **89** may be provided to reduce friction. The rollers **82'** which are mounted on opposite sides of the columns **72** are preferably adjustable transversely of the roller axis, as well as longitudinally thereof. The transverse adjustment may be obtained by forming the roller shaft **85'** with an eccentric body portion **90** to receive the roller members **84** as shown in Figures 26 and 27. Adjustment of the roller members toward and away from the columns is effected by rotating shaft **85'**.

The vertical adjustment of columns **72** is preferably effected by electric winches Figures 1, 2 and 22 which are preferably mounted on the lower of the brackets **83** which is the coolest position for the winches and one which places them out of the operator's way. If desired, however, these winches may be located on the upper of the brackets **83**, as indicated in Figure 29. Each of the winches consists of a worm gear casing **91** provided with a central shaft **92** on which a worm gear **93** is mounted. A worm **94** engages worm gear **93** and is mounted on a horizontal shaft **94'** arranged at a right angle to shaft **92** and which extends through the casing **91**. A relatively large gear wheel **94** is mounted to turn with the worm shaft **94'** exteriorly of the casing **91**. A small pinion gear **96** meshes with large gear **95** to rotate the large gear and is in turn operated by a suitable electric motor **97** mounted on a platform **98** which may be formed integrally with the top of casing **91**. A suitable handle **99** may be connected to the large gear wheel **95** for manual rotation thereof.

Worm gear shaft **92** extends outwardly beyond casing **91** in which it is journaled and passes in proximity to column **72**. A suitable reel **100** is mounted on shaft **92** to turn therewith and a cable **101** is wound on reel **100** and is connected at its end to the lower end of column **72** as indicated in Figure 22. Preferably reel **100** is arranged in contact with the column and has its sides provided with radially extending annular flanges **102** adapted to extend past the edges of column **72** so that reel **100** serves as a roller to engage the column, as indicated in Figures 22, 23 and 24.

The furnace charge door **34** may be of the usual refractory lined type of sliding door. It is preferred, however, especially in the larger furnaces, to use a water cooled door of the character illustrated in Figures 20 and 21. The charge door is exposed to the intense heat of the interior of the furnace, and unless some cooling means is provided will become overheated and warped. The door illustrated in Figures 20 and 21 has two spaced forward walls **103** separated by a vertical flange on the rim casing portion **104** of the door. The door casing and forward walls have a curvature corresponding to the curvature of the furnace shell, and the parts are preferably permanently secured together by welding. Access to the space between walls **103** is obtained through suitable screw plugs **105**. Cooling water circulating pipes **106** extend into the space between walls **103** to circulate water therethrough, and may be connected to a source of cooling water supply by means of suitable flexible connections **106'** permitting free movement of the door. The space between the walls **103** is formed into a tortuous channel by means of partitions **107** alternately extending from the bottom and top of the space between the walls **103**. The partitions are spaced at one end from the top or bottom of the door space to provide a tortuous path for the circulation of cooling water, and indicated by the arrows in Figure 20. The inner wall **103** is preferably backed up with refractory material **108** which is shown as broken away to disclose the door construction.

By reference to Figure 10 it will be seen that the teeth **43** are arranged to extend through the openings **42** at one side thereof, to leave a space **42'** on the side adjacent the center of the furnace. Any tendency of the rockers **39** to spread, due to the weight of the furnace, will be allowed for by the space **42'** so that no binding of the runners on tracks **44** will result.

It will be seen that the furnace of this invention is not only economical to make but takes up a minimum amount of space. The flat crucible bottom while inexpensive to make, is strong, and greatly reduces the height of the furnace. The flat runners **39** also greatly reduce the effective height of the furnace as they may be arranged at a point immediately above the floor level, as indicated in Figures 1 and 2. The furnace is easy to tilt and operate, and may be made in large or small sizes, although particularly well adapted for small size furnaces. The tilting may be effected manually by the hand wheel **52** or it may be effected by means of motor **52'**. When the motor is provided, either the motor or hand wheel may be used. The winch motors **97** are preferably used for raising and lowering the electrode columns, but this movement may also be effected by use of the hand crank **99**. The reel **100** serves in the dual capacity of reel and column roller, while the rollers may be adjusted toward and away from the columns by means of the eccentric shafts **90**.

The use of the pivoted cuffs **77** assures a secure connection between arms **64** and columns **72** while the set screws **60** permit a ready adjustment and centering of the roof ring. The roof ring is free to rise and fall with expansion and contraction of the crucible refractories **38**, and the arch construction of the roof refractories permits expansion and contraction without breakage.

While the preferred embodiment of this invention has been shown and described, it is to be understood that various changes in the size, shape and arrangement of parts may be resorted to without departing from the spirit of this invention or the scope of the subjoined claims.

Having thus described my invention, what I claim and desire to protect by Letters Patent is:

1. In a furnace of the character described, a furnace crucible, rocker tracks and runners associated with said crucible to permit tilting thereof, a standard arranged adjacent said fur-

nace, a sleeve pivotally supported by said standard, an internally screw-threaded thrust sleeve pivotally secured to said furnace crucible and adapted to telescope with the first named sleeve, a tilting screw extending through the first named sleeve and operatively engaging the threads of the thrust sleeve, and means to rotate said tilting screw.

2. In a furnace of the character described, a furnace crucible, rocker tracks and runners associated with said crucible to permit tilting thereof, a standard arranged adjacent said furnace, a sleeve pivotally supported by said standard, an internally screw-threaded thrust sleeve pivotally secured to said furnace crucible and adapted to telescope with the first named sleeve, a tilting screw extending through the first named sleeve and operatively engaging the threads of the thrust sleeve, means to rotate said tilting screw, said means comprising a wheel connected to the screw, a ring gear on said wheel, a pinion engaging said ring gear, and an electric motor carried by said first named sleeve to move therewith and operatively connected to said pinion.

3. In a furnace of the character described, a furnace crucible, a pair of flat runners secured to the bottom of said crucible, spacing means connecting said runners, a pair of curved, spaced rocker tracks arranged to engage said runners and support the furnace crucible, and members on said tracks to engage said runners and prevent slippage of the runners on the tracks.

4. In a furnace of the character described, a furnace crucible having a flat bottom, a pair of flat runners secured to the bottom of said crucible, spacing means connecting said runners, a pair of curved, spaced rocker tracks arranged to engage said runners and support the furnace crucible, teeth arranged at spaced intervals on the surface of said rocker tracks and adapted to engage recesses in the runners, and a stop member on one of the rocker tracks to engage a portion of the corresponding runner and prevent overtilting of the furnace crucible.

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