July 14, 1942. F. W. BROOKE 2,290,028

ELECTRIC FURNACE STRUCTURE

Filed July 2, 1940 3 Sheets-Sheet 1

Fig. 1.

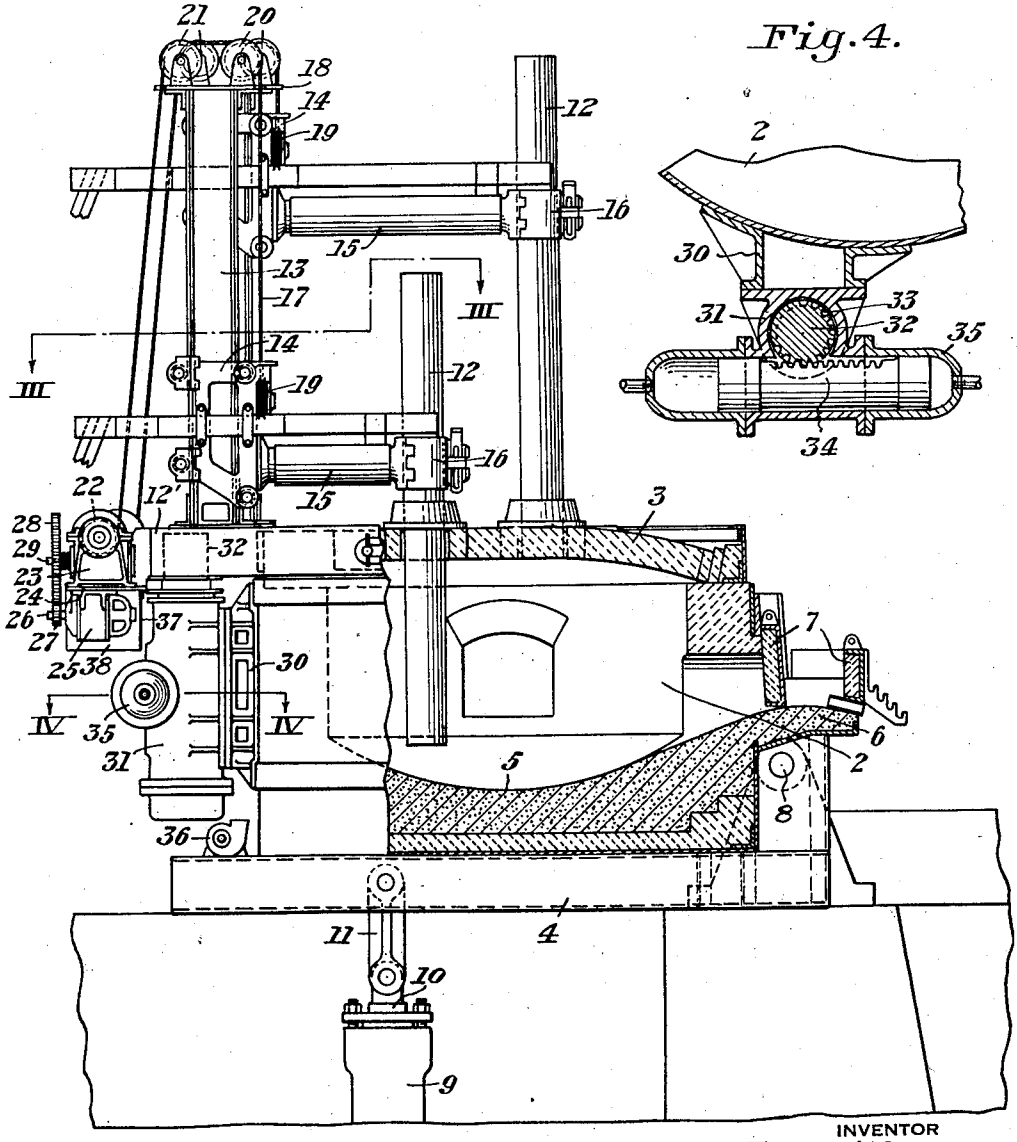


Fig. 4.

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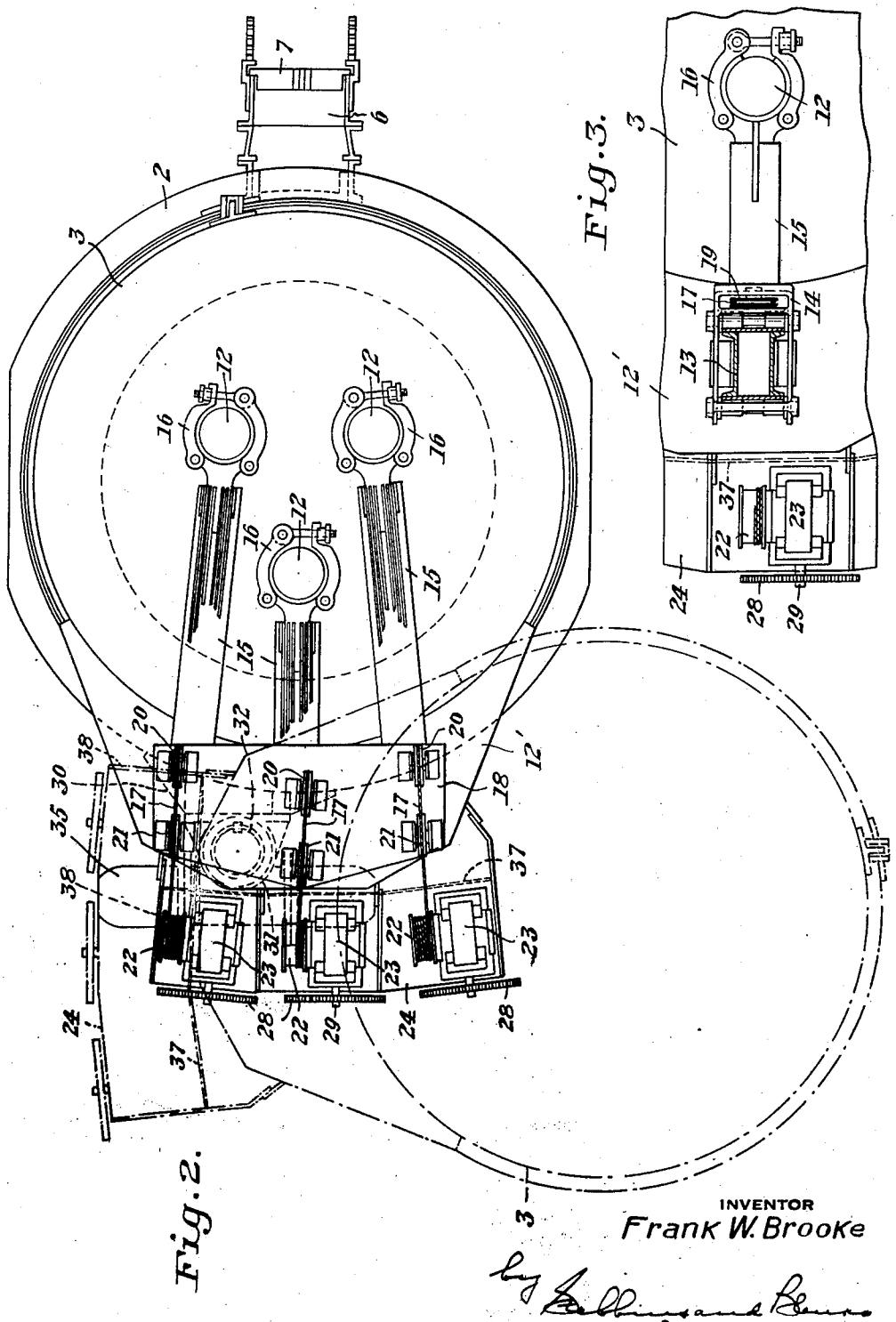


Fig. 2.

Fig. 3.

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Fig. 5.

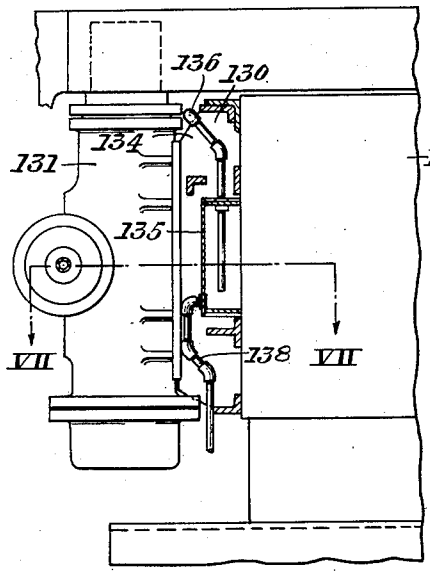


Fig. 6.

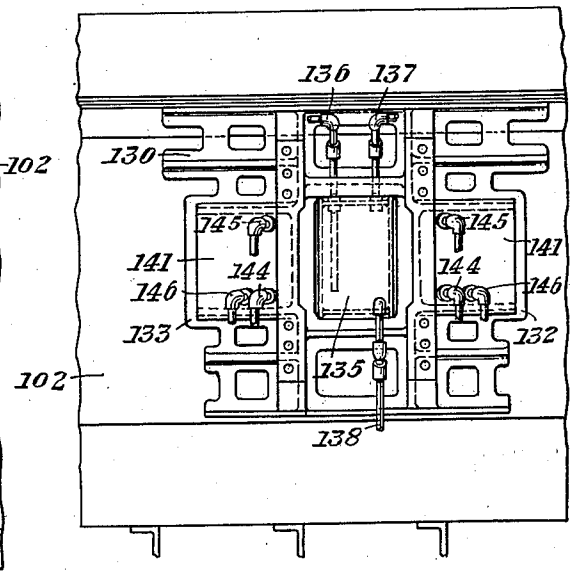
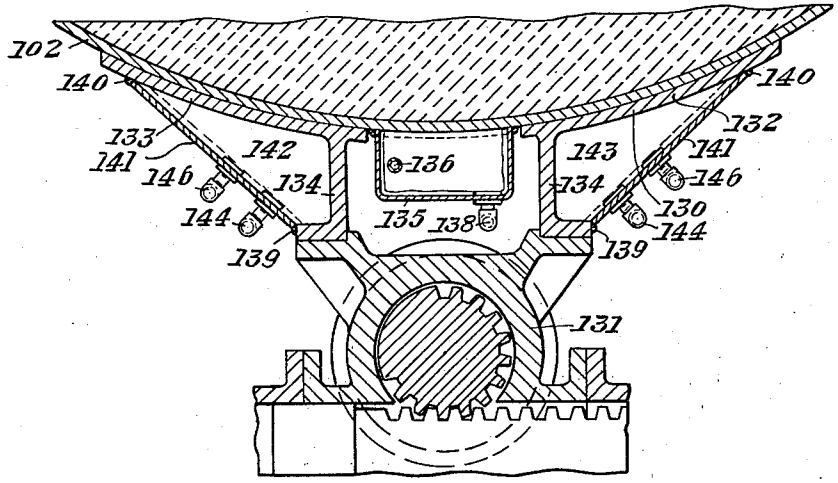


Fig. 7.



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2,290,028

UNITED STATES PATENT OFFICE

2,290,028

ELECTRIC FURNACE STRUCTURE

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Application July 2, 1940, Serial No. 343,574

4 Claims. (Cl. 13—9)

This invention relates to electric furnace structures and particularly to electric furnace structures of the type having a roof adapted to be swung generally horizontally relatively to the body of the furnace.

Electric furnace structures of the type mentioned have heretofore had certain disadvantages which have not been satisfactorily obviated. Such furnaces have been equipped with one or more electrodes carried by the furnace roof and mounted for generally vertical movement relatively thereto. Such movement of the electrodes have been controlled by a winch and cable, the winch being mounted on the floor of the furnace room or in an adjacent room and the cable extending from the electrode support over a mast and thence through a complicated system of sheaves to the winch drum. It is important to the satisfactory operation of an electric furnace of this type that there shall be no substantial motion of the electrodes relative to the furnace roof caused by the movements of raising the roof, swinging it horizontally to one side and tilting the furnace for the purpose of discharging its contents. In furnaces built heretofore it has been possible to approach this condition by reeving the electrode-operating cable over a complicated system of sheaves located at the various axes of movement of the furnace roof and of the furnace body. It has not, however, been possible to fully attain the desired condition, with the result that during any movement of the furnace or its roof there has been some substantial and unavoidable movement of the electrodes relative to the furnace roof.

A further disadvantage in structures of the type mentioned has been in the inability to properly control the electrodes. Such control is ordinarily effected by means of automatic electric contactors responsive to changes in current drawn by the arcing electrode, which, in turn, control the rotation of the electrode winches. In order to effect proper control of the electrodes it is necessary that the time interval elapsing between a change in the arc current and the corresponding correction movement of the electrode be reduced to a minimum. In the furnace structures heretofore in use, however, it has been necessary to use quite long cables in order to extend from the electrode carrying arm over the top of the mast and thence about the various sheaves necessarily employed at the axes of the various movements of the furnace and roof and thence to the winch. The result of the utilization of such long cables and of the sheave arrangement above mentioned is that an undesirably long time lag intervenes between the commencement of rotation of the cable drum on the winch and the commencement of movement of the electrode. Such time lag is due mainly to stretching or taking up slack in the cable. This time lag has ranged up to about one second, which presents a very serious disadvantage from the standpoint of practical operation of the furnace.

For example, in melting down a charge of scrap the surface of the charge, which forms one pole of the arc, shifts, this shifting ordinarily being gradual but sometimes being relatively rapid. If, for example, shifting of the charge during melting results in increase of the gap between the end of the electrode and the charge to a distance greater than that which the arc will span the arc is extinguished and has to be drawn anew. In order for the electrode to properly follow the surface of the charge as that surface changes during melting, and particularly when portions of the surface of the charge shift relatively rapidly, it is necessary that the electrode respond very quickly to current variations due to the change in the length of the gap between the end of the electrode and the charge. Oftentimes a very quick response of the control mechanism and almost immediate movement of the electrode will enable the electrode to follow the change in the surface of the charge quickly enough to avoid extinguishing the arc. The time lag which occurs in taking up slack and stretching the cable in furnaces of the type mentioned may often be sufficient to prevent the electrode from following the change of the surface of the charge quickly enough to avoid extinguishment of the arc. Consequently the time lag due to taking up slack and stretching of the cable is quite material from the practical standpoint.

Electric furnaces are equipped with a time-delay overload relay which opens the main circuit breaker and so cuts off the power when current fluctuations occur which are not promptly compensated for by the electrode control mechanism. Sometimes the time lag above mentioned due to cable stretching and taking up of slack in furnaces of the type under discussion results in opening of the main circuit breaker in the supply line and, of course, the attendant extinguishing of the arc. When this occurs it is necessary to throw in the circuit breaker by hand and draw a new arc. Because of the time-delay feature of the overload relay this undesirable opening of the circuit breaker can be avoided by prompt re-

sponse of the electrode to changes in the arc current.

Consequently tilting and swinging roof furnaces having their electrodes controlled by cables extending to winches at points remote therefrom have not been fully satisfactory from the practical standpoint. In addition to the disadvantages above pointed out difficulty has been encountered because of undue heating from the heat of the furnace of the means for moving the roof to and from open position, as well as rapid destruction of the refractory lining of the furnace at the point of attachment of this means. Heretofore the furnace roof has been moved vertically and horizontally by means of an hydraulic cylinder attached to the steel shell of the furnace body in close proximity thereto. This construction has resulted in overheating of the hydraulic cylinder and has prevented the free escape of heat from the surface of the furnace shell at this point, resulting in overheating and rapid destruction of the furnace lining.

I have devised an electric furnace structure obviating all of the disadvantages above mentioned. I provide an electric furnace comprising a body and a roof adapted to be moved to open position generally horizontally relatively to the furnace body, an electrode support carried by the roof, an electrode carried by the support and generally vertically movable relatively thereto and means also carried by the roof of the furnace separately from the electrode support for generally vertically moving the electrode. I preferably mount on the furnace roof itself the cable drum about which the electrode controlling cable is wound. In a preferred form of structure I provide a support connected with the edge of the furnace roof, a winch carried by such support and having a cable drum about which the electrode operating cable is adapted to be wound and means such as an electric motor for operating the winch drum. I have found that the electric motor for operating the cable drum on the winch can be mounted on the furnace roof without being damaged by the heat of the furnace by the provision of guard means for guarding the motor from the heat of the furnace when the roof is open and when the roof is closed.

Mounting of the cable drum on the furnace roof reduces the necessary length of the cable sufficiently that the small amount of slack taken up or stretching of the cable upon rotation of the winch drum does not result in a time lag great enough to adversely affect the operation of the furnace. The time lag due to taking up slack and stretching of the cable in my improved furnace is but a small fraction of a second and the result is a close control of the electrodes and elimination of interruptions in operation due to excessive time lag between initiation of rotation of the cable drum and movement of the electrode. Also the elimination of the complicated system of sheaves at the axes of movement of furnace and roof eliminates the unavoidable changes in cable length heretofore encountered as above mentioned. Moreover, I find it possible by reason of the simplified cable and sheave arrangement to effect a substantial saving in cost of the furnace.

I also obviate the disadvantages heretofore arising by reason of undue heating of the means for moving the furnace roof and of the overheating of the furnace lining adjacent thereto by providing cooling means intermediate the body of the furnace and the means for moving the furnace roof. Such cooling means provide for removing heat so that the furnace lining adjacent thereto does not become unduly overheated and the means for moving the furnace roof is maintained at such a temperature that it will operate properly. I prefer to employ a fluid cooling medium. Such medium may be gaseous or liquid. In one preferred embodiment I provide one or more cooling chambers through which I circulate cooling water. In another embodiment I provide a passageway for the circulation of air. The cooling means is preferably employed in connection with the mounting means for the roof operating mechanism and I prefer to use as such mounting means a hollow casting through which or through a portion of which the cooling fluid may be passed.

This subject matter is disclosed and claimed in my copending application Serial No. 423,811, filed December 20, 1941.

Other details, objects and advantages of the invention will become apparent as the following description of certain present preferred embodiments thereof proceeds.

In the accompanying drawings I have shown certain present preferred embodiments of the invention, in which

Figure 1 is a central vertical cross-sectional view through a tilting swinging roof electric furnace, the furnace being shown in its normal or untilted position and with its roof in operative position thereon;

Figure 2 is a top plan view of the furnace shown in Figure 1 and showing in dot and dash lines the outline of the roof swung horizontally relatively to the furnace body so that the furnace body is substantially entirely upwardly open;

Figure 3 is a horizontal cross-sectional view taken on the line III—III of Figure 1;

Figure 4 is a horizontal cross-sectional view taken on the line IV—IV of Figure 1;

Figure 5 is a fragmentary elevational view partly in vertical cross section showing a modified structure;

Figure 6 is a face view of a portion of the structure shown in Figure 5 showing the means for holding the roof operating mechanism in place on the furnace, the roof operating mechanism itself being removed to enable a clear showing of the holding means; and

Figure 7 is an enlarged fragmentary horizontal cross-sectional view taken on the line VII—VII of Figure 5.

Referring now more particularly to the drawings, there is shown an electric furnace structure comprising a furnace body designated generally by reference numeral 2 and a furnace roof designated generally by reference numeral 3. The furnace shown is of the type used in melting scrap and for analogous uses. The body 2 of the furnace may be of standard construction, being mounted upon a framework 4 and having a hearth 5, a pouring lip 6 and doors 7. The furnace is of the tilting type, being mounted for tilting movement about trunnions 8 for tapping. The furnace is tilted by any suitable tilting mechanism such, for example, as a hydraulic ram 9, whose piston 10 is connected through a link 11 with the frame 4 supporting the furnace. When the furnace is tilted for tapping the entire body and top of the furnace tilt together and with them, of course, everything carried thereby.

The furnace top or roof 3 is of the swinging type, being adapted to be first lifted out of

contact with the top of the body of the furnace and then swung in a generally horizontal plane to a position substantially clear of the body of the furnace to permit charging or cleaning of the interior of the furnace. The furnace is equipped with three electrodes 12 whose relative positions may be as shown in Figure 2. These electrodes are all similarly supported and operated, so that description of the supporting and operating mechanism of any one thereof applies to all three. Each of the electrodes is carried by the member 12' through a mast 13 rigidly connected with the member 12' which also carries the roof 3. An electrode carrier 14 is mounted on the mast 13 for vertical movement up and down the mast and has an arm 15 carrying the electrode 12. The end of the arm 15 has a clamp 16 for gripping the electrode.

All the mechanism thus far described may be of standard construction, so it is unnecessary to describe the same in detail. The present invention, as indicated above, has to do with the means for controlling the movement of the electrodes and the means for cooling the operating mechanism and the furnace wall.

A cable 17 has one end fastened to a plate 18 at the top of each of the masts 13 and passes thence downwardly about a sheave 19 journaled in the electrode carrier 14, thence upwardly to the top of the mast and over sheaves 20 and 21 and thence downwardly to a cable drum 22 forming part of a winch designated generally by reference numeral 23. The winch 23 is mounted upon a support 24 carried by the edge of the member 12'. Fastened to the bottom of the support 24 underneath the winch 23 is an electric motor 25. The shaft 26 of the motor 25 carries a pinion 27 meshing with a spur gear 28 on a shaft 29 forming a portion of a worm gear speed reducer through which the cable drum 22 is rotated. When the motor 25 is rotated in one direction the cable drum winds up the cable 17 and raises the electrode 12. When the motor 25 operates in the opposite direction the cable drum 22 pays out the cable 17 and the electrode 12 moves downwardly by gravity, such movement being controlled by the cable drum. The cable passes directly from the electrode support over the top of the mast and about the cable drum and is so short that slack take-up and stretching of the cable is not a factor of importance in operation of the furnace. All sheaves except those specifically described above and shown in the drawings are preferably eliminated. By mounting the winches in the manner described above they will at all times follow the movements of the furnace and the roof. This construction makes it possible to move either the furnace as a whole or the roof alone without producing any substantial movement of the electrodes relative to the roof, this being accomplished without resorting to any complicated system of sheaves or method of reeving the cable.

The means for initiating operation of the motor 25 may be such as are well known in the art. There is standard automatic electric furnace operating mechanism controlled through changes in current brought about by changes in the distance betwen the end of the electrode and the bath or charge. The particular furnace shown in the drawings is designed for operation by three-phase current, although the invention may equally be applied to furnaces of other types.

Mounted on the side of the furnace body 2 in the form of structure shown in Figures 1 to 4, inclusive, is a hollow casting 30 which carries a vertical cylinder 31. Within the cylinder 31 is a piston 32 which carries the member 12'. A portion of the piston is provided with teeth 33 with which cooperates a fluid actuated rack 34 mounted in a cylinder 35 carried by the cylinder 31. When the top of the furnace is to be opened fluid is admitted to the bottom of the cylinder 31, which fluid raises the piston 32 to raise the furnace roof so that it clears the furnace body. During this raising movement the teeth 33 of the piston 32 which are sufficiently elongated in the direction of the axis of the piston 32 simply slide in the teeth of the rack 34. After the furnace roof has been raised a predetermined amount it is swung laterally about the axis of the piston 32 as a pivot by actuating the rack 34 by admitting fluid to the right-hand end of the cylinder 35 viewing Figure 4. This piston, cylinder and rack mechanism for opening the furnace roof is of standard construction and is not per se claimed as novel herein. However, the openings in the hollow casting 30 provide passageways for the circulation of fluid therethrough to counteract the tendency of the heat of the furnace to excessively heat the cylinders 31 and 35, and to counteract the tendency toward overheating of the furnace lining adjacent the casting 30. While the natural draft may be relied upon, it is desirable to position a fan or blower 36 on the frame 4 which blows air up through the hollow casting 30. This provision is found to effectively counteract the tendency of the heat of the furnace to excessively heat the cylinders 31 and 35 and the mechanism cooperating therewith. At the same time the furnace wall is sufficiently cooled to prevent overheating of the refractory furnace lining in this area, thus materially prolonging its useful life.

The motors 25 are shielded from the heat of the furnace by a plate 37 connected at its top with the support 24 and which is interposed between the motors and the body of the furnace when the furnace roof is in closed position. There is also a plate 38, also connected with the support 24, and which is interposed between the body of the furnace and the motors 25 when the roof is in open position. I have found that by provision of the plates 37 and 38 to shield the motors from the direct heat of the furnace the winches and motors can be mounted on the edge of the furnace roof without being deleteriously affected in operation of the furnace.

Figures 5, 6 and 7 show a modified structure for maintaining the roof operating mechanism in place on the furnace. There is shown a furnace body 102 mounted on the side of which is a hollow casting 130 which carries a vertical cylinder 131. The mechanism within and cooperating with the cylinder 131 may be identical with that within and cooperating with the cylinder 31 in the form of structure shown in Figures 1 to 4, inclusive, so will not be further described.

The casting 130 has portions 132 and 133 lying against the furnace body 2 and has generally vertically extending outwardly projecting spaced flanges 134. The casting 130 is also suitably ribbed and provided with cut away portions for strength and lightness, as shown in Figure 6. Welded directly to the furnace body 102 intermediate the flanges 134 is a cooling receptacle 135 in the form of a five-sided metal box. A portion of the furnace body furnishes the sixth

side to close the box. Cooling water is adapted to be circulated within the box 135, the water entering through an inlet conduit 136 and leaving through an outlet conduit 137. A clean out and draining conduit 138 opening into the bottom of the box 135 is also provided. Normally the conduit 138 is closed.

Welded to the outer extremity of each of the flanges 134 at 139 and to each of the portions 132 and 133 at 140 is a plate 141. The top and bottom edges of each plate 141 are also welded to generally horizontally projecting ribs or shelves formed in the casting 130 so that two cooling chambers 142 and 143 are thus formed. Cooling water is circulated through each of these chambers, being admitted to each thereof through an inlet 144 and discharged through an outlet 145. Each of the chambers 142 and 143 has a normally closed clean out and draining conduit 146.

Thus in the structure shown in Figures 5, 6 and 7 there are provided three cooling chambers each having separate means for circulating cooling water or other cooling fluid therethrough. One of the cooling chambers is welded directly to the furnace body and the other two are formed in the casting 130 by welding plates 141 thereto. The structure of Figures 5, 6 and 7 has been found highly satisfactory in use and is at present the preferred structure for supporting the roof operating mechanism and providing cooling means adjacent the connection of the supporting means with the furnace body.

Certain of the details of the structure indicated in the drawings, as for example, the means for conducting the arc current to the electrodes, are not specificaly described as these details may be in accordance with standard practice. It is to be understood that the word "cable" as used in the claims contemplates any suitable flexible elongated member which can be used for the purpose herein described.

While I have shown and described certain present preferred embodiments of the invention, it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied within the scope of the following claims.

I claim:

1. An electric furnace comprising a furnace body, a roof normaly disposed over the body and swingable laterally in opening and closing movements, an electrode carried by the roof and means including a motive unit carried by the roof and swingable therewith and at all times laterally offset from the body for imparting operative movements to the electrode.

2. An electric furnace comprising a furnace body, a roof normally disposed over the body and swingable laterally in opening and closing movements, a plurality of electrodes carried by the roof and means including a plurality of motive units, one for each electrode, carried by the roof and swingable therewith and all at all times laterally offset from the body for imparting operative movements to the electrodes.

3. An electric furnace comprising a furnace body, a roof, a plurality of electrodes carried by the roof, means including a plurality of motive units, one for each electrode, carried by the roof for imparting operative movements to the electrodes and a generally upright pivot at the side of the body upon which the roof is mounted for laterally swinging movement, the pivot being so constructed and arranged relatively to the motive units so that upon swinging of the roof to open position all of the motive units move to positions offset from the body.

4. An electric furnace comprising a furnace body, a roof, three electrodes carried by the roof, three winches also carried by the roof, cable extending betwen each electrode and one of the winches so that each winch controls operative movements of one of the electrodes and a generaly upright pivot at the side of the body upon which the roof is mounted for laterally swinging movement, the pivot being generally interposed between the body and one of said winches when the roof is disposed over the body and being so constructed and arranged that upon swinging of the roof to open position all of the winches move to positions offset from the body

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