J. R. WYATT.

MULTIPHASE INDUCTION FURNACE.

APPLICATION FILED JULY 19, 1916.

1,235,630.

Patented Aug. 7, 1917.

2 SHEETS—SHEET 1.

FIG. 1.

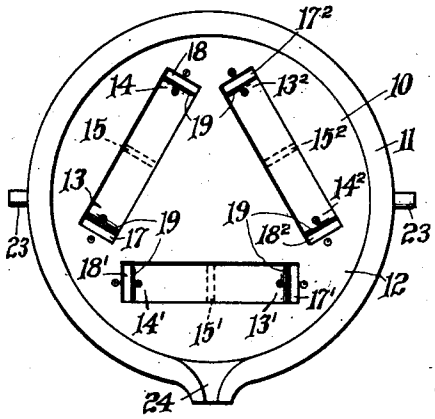


FIG. 2.

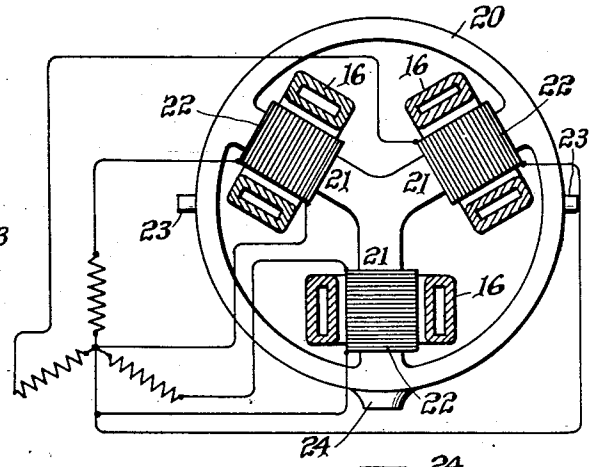


FIG. 3.

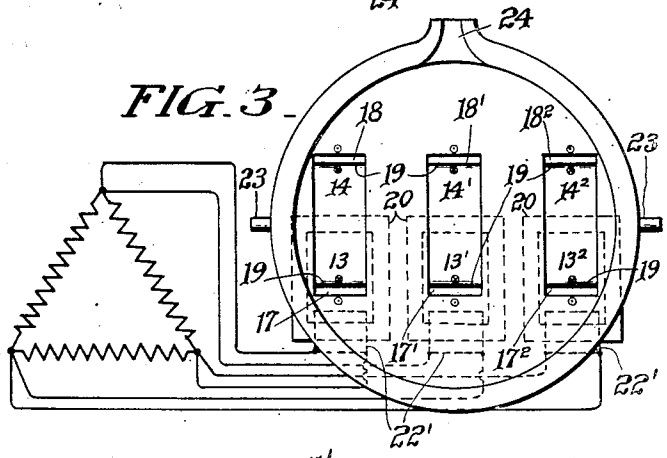


FIG. 4.

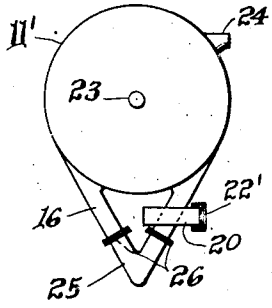
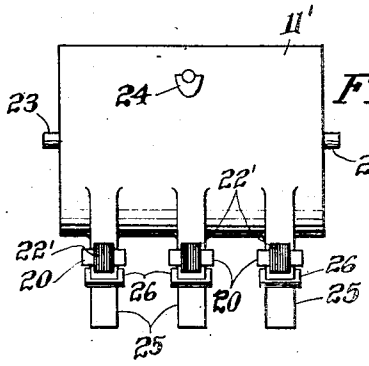


FIG. 5.



Witness

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2 SHEETS—SHEET 2.

FIG. 6.

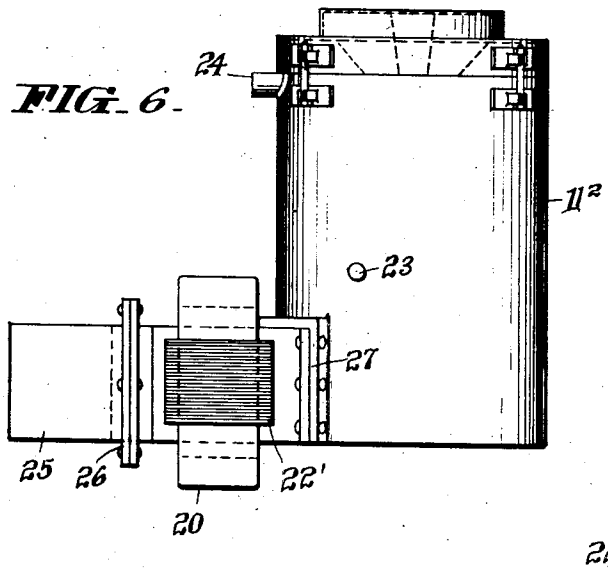


FIG. 8.

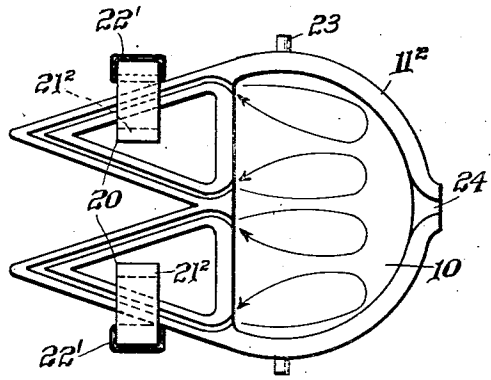


FIG. 7.

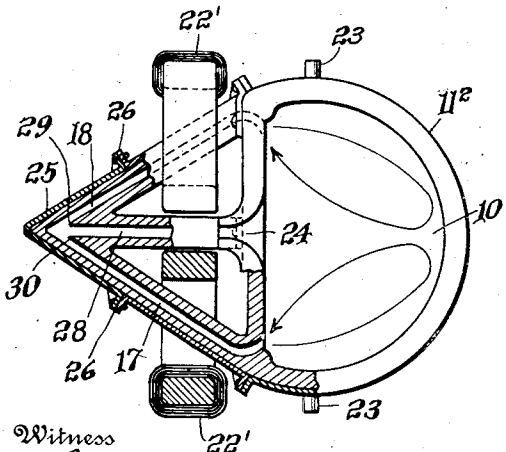
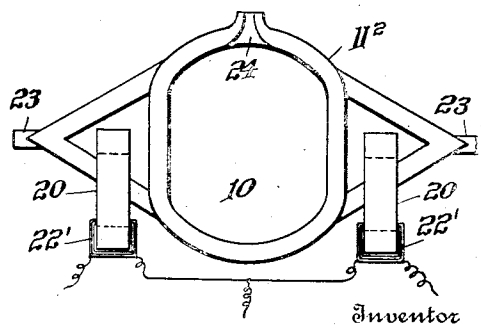


FIG. 9.



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UNITED STATES PATENT OFFICE.

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MULTIPHASE INDUCTION-FURNACE.

1,235,630. Specification of Letters Patent. Patented Aug. 7, 1917.

Application filed July 19, 1916. Serial No. 110,204.

To all whom it may concern:

Be it known that I, JAMES R. WYATT, a citizen of the United States, residing at 2024 S. 21st street, Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a certain new and useful Multiphase Induction-Furnace, of which the following is a specification.

The purpose of my invention is to intermingle to the best advantage the stirring effects from several heating channels in an induction furnace.

A further purpose of my invention is to distribute a plurality of heating channels in new coöperative relation to a furnace pool.

A further purpose of my invention is to combine a plurality of acute-angled heating channels in the mixing and heating of a furnace pool by combinations of motor effects, preferably using multi-phase current for this purpose, one phase for each channel. This secures uniformity in the molten fluxes combined, at the same time that the several phases of current are steadied and unbalancing avoided.

Further purposes of my invention will appear in the specification and claims hereof.

I have preferred to illustrate my invention by a few only of the various forms in which it may be applied, selecting forms varying in phase, number of channels and location of the channels to illustrate types of variations among many which may exist.

Figure 1 is a top plan view of a furnace embodying the preferred form of my invention.

Fig. 2 is a horizontal section of Fig. 1 taken through the three channels just above the transformer core. The electrical connections are shown diagrammatically.

Fig. 3 is a top plan view, also with diagrammatic electrical connections, showing a second form of my invention.

Figs. 4 and 5 are an end elevation and side elevation respectively of another construction.

Fig. 6 is a side elevation of a third form of my invention.

Figs. 7, 8 and 9 are top plan views, partly broken away, showing various ways in which two channels horizontally arranged may be located.

Similar numerals of reference indicate like parts.

This application is a division in part, plus additional matter of an application filed by me January 24, 1916, Serial No. 73,810 for induction furnace.

In all of the forms of my invention illustrated, I have intended to show the channels so arranged as to produce high motor effect by forming the bend in each channel outside of the pool at an acute angle with obtuse angled connections between the ends of the channel and the pool and have planned to use a channel having relatively great width parallel to the included transformer leg, as compared with the thickness of the channel perpendicularly thereto, making it possible for me to obtain a high power factor for the circuits at the same time that the motor effect in the acute angle is made a maximum. I recognize that the width dare not be so small as to give excessive fluid and frictional resistance to the heated metal flowing from the channel into the pool along the outer sides of the channel nor to the incoming cooler metal, taking its place and flowing along the inner sides of the channel.

In Fig. 1 the pool 10 is formed by a cylindrical jacket 11 of refractory material, or outer metal with suitable refractory lining, and having the axis of the cylinder vertical. Beneath the pool and connecting at their ends with the bottom 12, I show three channels having branches 13, 14, 13′, 14′, 13^2, 14^2, meeting in acute angles 15, 15′, 15^2 and having their cross sections in proximity much wider than they are thick. The walls 16 are made of any suitable refractory, or casing lined with refractory material. In all of the illustrations I prefer to use metal pool jackets and metal casings for the channels, lined by a cementitious asbestos refractory rammed to place about a mold defining the channel and pool and subsequently carefully dried out after burning or otherwise removing the pattern.

The center lines of the two branches of each channel lie in a vertical plane, the planes being here shown as making angles of 60° with each other.

Where the channel branches 13, 14, 13′, 14′, 13^2, 14^2 connect with the bottom of the pool, as at 17, 18, 17′, 18′, 17^2, 18^2, the near

edges of the connections are chamfered, rounded, or the channel curved, as at 19, so that the effective electric connection through the channel and pool across the pool follows an obtuse-angled path at each channel connection with the pool avoiding here the motor-effect sought at the corners 15, 15′, 15², as motor effect originating at the pool ends of the channel forms a disturbing element opposing the flow produced by the motor effect at the corners 15, 15′, 15².

In each of the channels in this and in the other illustrations, the molten channel content is a conductor in which, as a secondary, current is induced by a transformer which embraces one of the branches. In Figs. 1 and 2 the transformer 20 is of ring type having "star" legs 21 upon each of which a coil 22 is located, the three-phase current connections being shown in star form also.

The induced flow of the electricity in the channels as secondaries has diverse direction upon opposite sides of the bends at 15, 15′, 15², resulting in a highly developed motor effect which is greatest at the corner and diminishes gradually toward the points of connection with the pool and which, therefore, having the portion in the rear always driving that nearer the furnace upon the outside part of the channel prevents interruption of the upwardly flowing heated channel metal by the stream of downwardly flowing cooler metal which takes its place. The speed of the downward flow of cooler metal depends in part upon the height of the hydraulic head exerting pressure upon it.

The outward flow of hotter metal from the channel ends into the pool is indicated by the heads of the arrows and the inward flow of cooler metal is indicated by the tails of the arrows. From this it will be evident that the triangular arrangement of the channels with adjacent terminals results in equidistant combined bands or whirls of flow from as near the edge of the pool as may be selected for the channel terminals toward the center and into the channels again. The effect might be compared with rolling rings of molten metal outside in, each part moving in the plane of its radius and the axis of the rings.

In operation I find it quite desirable to pour the initial charge from another furnace. The current is then turned on and heating of that charge and material added from time to time is effected by the secondary current. The combined motor effects quickly and thoroughly mix the hotter metal within the channel with that in the pool.

It will be evident that the extent of combination of flows due to adjoining channel outlets will depend in large measure upon the sizes of the channels, the nearness to each other of their adjoining outlets and the proximity of the outlets to the inner walls of the pool.

In the form in Fig. 3 the construction and connections are intended to be substantially the same as in Fig. 1, with the exception that the channels are parallel in location. The transformers are separate, each inclosing a channel and having the transformer windings 22′ upon the outside transformer leg. The three-phase current is here delta connected. Here the whirls from individual channels combine their elements into what might be termed whirl sheets extending a considerable part of the distance from one end of the pool to the other.

In the form shown in Figs. 4 and 5 the construction is intended to be substantially the same as in Fig. 3, except that the axis of the cylindrical furnace body 11′ forming the pool is horizontal and the channels depend from the side of the cylinder. The electrical connections may be of the star-type, as in Fig. 2, or of the delta-type, as seen in Fig. 3. Here the operation of the several channels upon the pool will be affected, if the channel terminals be near the edge of the pool, by the fact that the discharge from the channels will be nearly tangent to the inner walls of the pool.

In each of Figs. 3, 4 and 5 the channel planes are vertical, and the combined effect will be increased by bringing the adjoining outlets of different channels into the pool close to each other. It will also be affected by the size of the pool.

In all of these figures I have located trunnions 23 and pouring spouts 24 conventionally, without considering it necessary to show mechanism by which the actual turning of the furnaces is effected, since this is well known in the art.

There is an advantage in locating the spouts low enough and in such position that a large part of the content can be poured without beginning to drain the channels, because the draining of the channels immediately interrupts the secondary circuit and this interruption is undesirable, though not fatal.

Where a metallic channel casing 25 is used, it may be desirable also, as in Figs. 4 and 5 to interrupt the channels at some such points, as at 26, by joints which disturb the electrical conductivity of the channel casing for travel of secondary current and give opportunity for insertion of a transformer without separation of the transformer parts. The exact location and character of the joint will depend upon the shape, material and electrical, as well as mechanical design and must, with this suggestion, be left to the judgment of the engineer.

In the form shown in Figs. 6 and 7 the channels are closed, as in the previous fig-

ures, but are horizontal, with a furnace body 11^2 giving a considerable static head of pool above the channel. The channel casing is here connected with the pool jacket by any suitable flanges and retainers, at 27.

As the height of head of the pool above the channel may vary between any limits set by the designer, so may it also be omitted and the channels be open and at the level of the pool, as in Fig. 8. Other differences between the Figs. 7 and 8 lie in the fact that Fig. 7 uses a metallic casing for the channel and jacket for the pool, whereas Fig. 8 uses a refractory material of uniform composition for the entire crucible, requiring that one of the transformer legs 21^2 be separable so that it can be placed about the channel.

Another difference between the forms of Figs. 7 and 8 is that the adjoining channel sides are united in a common channel 28 in Fig. 7, whereas, the channels are distinct in Fig. 8. Uniting the channels into one shorter channel has some advantage in two-phase work, because of the differing electrical requirements of the common path, conveniently met here by the construction which shortens the channel 28, as compared with channels 17 and 18 as 1 to 1.4. Because of the opposing forces from the two angles having their inner points at 29 and 30, the flow of metal within channel 28 would not be as sharply and clearly defined as within the channels 17 and 18.

Except for the difference in height of the pool, the position of the spout and the division of the casing in one and absence of division line in the crucible of the other, Fig. 6 would serve as side elevation of either of Figs. 7 and 8.

The spout has been shown at the left in Figs. 6 and 7, on the same side as the channel, a form which offers advantages in permitting the secondary circuit to be maintained during pouring of the heats though it may require that the molds be placed after tilting has begun.

The trunnions 23 have been shown at the sides of the furnace bodies in all the figures except Fig. 9, where they are located in line with the ends of the channels; but differing purposes and pouring arrangement would cause variation in the application of my invention in this as in other particulars.

In Fig. 9 the location of the channels at opposite ends results in the metal coming out from the channels in directions almost directly opposite at the two sides of the pool. If the distance between be not too great, these two fluxes of molten metal will tend to "scour" the outer (cooler) part of the pool, turning the metal there toward the center, and the two streams will mutually divert each other. The action may be varied by the contour given the inner surface of the pool between these two points.

It will be obvious that the combination of two series of loops of outwardly and inwardly flowing molten metal each loop reaching and leaving the pool at nearly the same points will cause a more powerful, as well as different ultimate flow that could be secured by the channels separately.

It will be evident that the number of channels used in Figs. 4 and 5 should most desirably agree with the number of phases of current used or the sum of the phases where different circuits are employed.

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

1. In an induction furnace, a furnace body adapted to contain a pool, in combination with walls forming a plurality of channels meeting the pool in a generally upward direction and multi-phase transformer means for applying a different phase of the current to the induction of current as secondary in each of the channels.

2. In an induction furnace, a furnace body adapted to contain a pool, walls forming a plurality of channels beneath the pool in triangular arrangement and having the bends in the channels outside of the pool of acute angle form, in combination with transformer means for inducing flow of electricity in the content of each of the channels as a secondary.

3. In an induction furnace, a furnace body adapted to contain a pool, walls forming three channels connecting therewith, contiguous connections of different channels being located near the apices of a nearly equilateral triangle, in combination with a three-phase transformer embracing one leg of each channel.

4. In an induction furnace, a furnace body adapted to contain a pool, in combination with walls forming a plurality of upwardly directed acute-angled channels placed parallel to each other and having their connections with the pool well below the surface of the pool.

5. In an induction furnace, a body adapted to contain a pool, in combination with walls forming a plurality of acute-angled channels connected with the furnace body at both ends at substantially the same height well below the surface of the pool and a multi-phase transformer corresponding in phase to the number of channels and embracing one side of each channel.

6. In an induction furnace, walls forming a furnace pool, in combination with walls forming two acute-angled channels outside of the pool, having contiguous branches of the two channels united in a common channel shorter than the more remote channel

branches, in combination with two-phase, transformer means for inducing current in the channels, as secondaries.

7. In an induction furnace, walls forming a furnace body adapted to contain a pool, in combination with walls forming channels on opposite ends of the pool, trunnions at the ends, a spout located at the side of the pool between the channels and transformer means for inducing flow of current as secondaries in the two channels.

8. In an induction furnace, walls forming a furnace body adapted to contain a pool, in combination with walls forming channels at opposite sides of the pool, connecting with it at the channel ends and acute-angled outside of the furnace body, directing flow of hot metal from the outside of opposite channels toward each other near the outside of the pool, and transformer means for inducing current in the contents of the two channels as secondaries.

JAMES R. WYATT.

Witnesses:
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Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."