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ELECTRIC FURNACE

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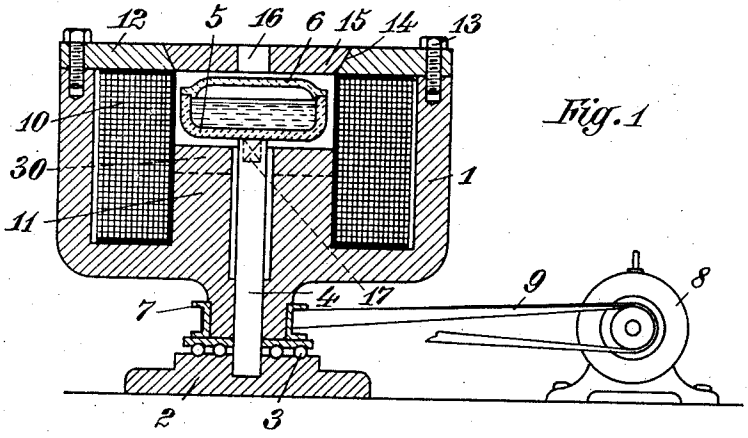


Fig. 1

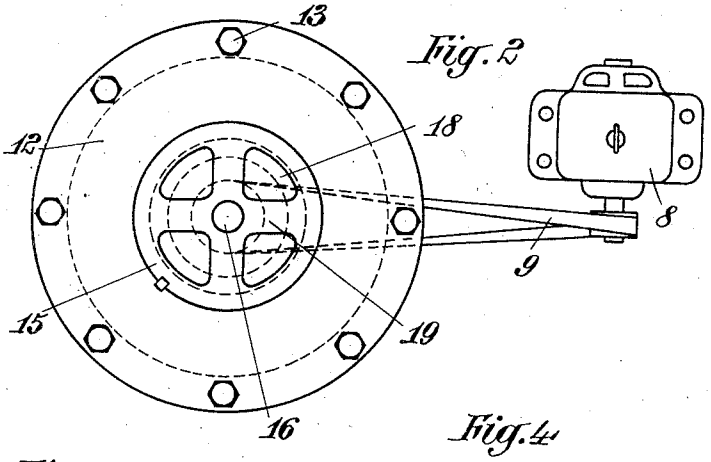
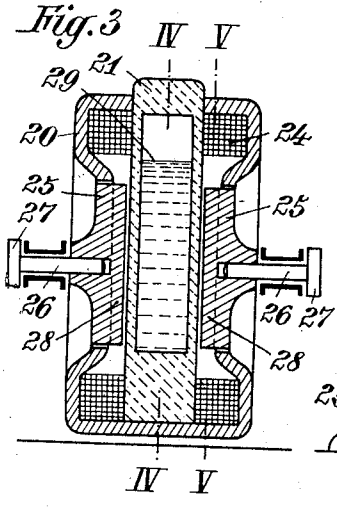
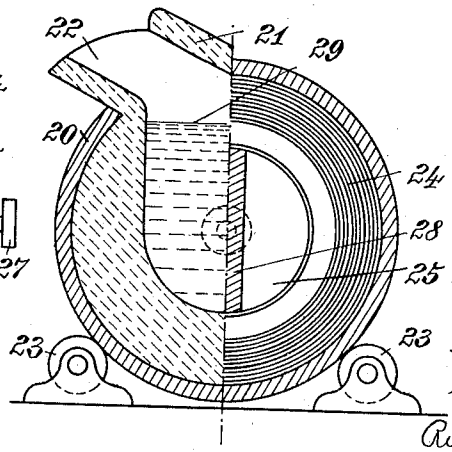


Fig. 2

Fig. 4

Fig. 3





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ELECTRIC FURNACE

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10 Claims. (Cl. 13—26)

The known coreless induction furnaces are operated by two-phase or multi-phase current. In order to increase the induction effect the operating current is caused to act in coils which are arranged over laminated iron cores. Furnaces of this kind have considerable disadvantages, the cost of installation, in particular, being very high. Further, high frequency furnaces require expensive condenser plants while line frequency furnaces must be provided with a very large power installation because the power factor is very low.

An object of the present invention is to avoid these disadvantages. The invention enables induction furnaces to be operated with small and inexpensive power installations without a source of heavy current being necessary. In accordance with the invention, the current necessary for the production of the heat for melting is not supplied to the furnace, as in the known furnaces, from the outside, but is produced in the material itself to be melted. In order to carry this novel idea into effect, provision is made for the material to be melted to be permeated by a field of lines of magnetic force and a relative movement is caused to take place between the material to be melted and this field of lines of magnetic force. By this means induction currents, namely eddy currents, which heat the material are set up in the material itself. By means of one or more pairs of rotary magnet poles alternating currents can be produced in the material itself having a frequency which is proportional to the speed of revolution of the poles. Further, by the arrangement of a unipolar magnet, a direct current can also be produced in the material. Either permanent magnets or electro-magnets can be employed. If electromagnets are employed they can be energized either by direct current or by alternating current or by a combination of both.

A further object of this invention is to provide for the melting of mixed materials in apparatus of this kind in a crucible having a unitary chamber adapted to hold the mixed material to be heated in a concentrated compact.

A furnace having a uni-polar magnet is particularly advantageous. This type of magnet enables an annular magnetic field or circuit in which the direction of the lines of force is similar to be produced. If the melting chamber be situated in the interior of the magnetizing coil the greatest density of the lines of force is produced in the melting chamber. If the magnetic field is rotated, a direct current voltage which always maintains its direction is produced in each conductor which the lines of force cut, that is to say in the material to be melted. In the case of unipolar dynamo machines this voltage is taken by means of brushes to slip rings. If these slip rings are closed by an external circuit then direct current is produced.

In the apparatus of the present invention the E. M. F. produced is used to produce currents, which are used up in the conductor itself in order to heat the conductor, that is to say the current is also to be consumed at the place where it is produced.

In accordance with a further feature of the invention, provision is also made so that the magnetic field does not extend uniformly over the whole of the material to be melted but that zones are formed which are as free as possible from lines of force and, therefore, as free as possible from induction. By this means the formation of the currents which effect the heating within the material is considerably facilitated.

It has, moreover, been determined that it is possible to allow only a part of the magnets, for example the poles, to rotate and to allow the remaining parts of the magnetic casing and the entire winding to remain stationary. By this means the construction of the new furnaces is considerably simplified, since it is not then necessary to balance and move a heavy and complicated body.

Two preferred forms of construction of the new furnace are illustrated by way of example in the accompanying drawing, in which:—

Figure 1 is a vertical section through a unipolar furnace having a rotary magnetic casing and coil;

Figure 2 is a plan thereof;

Figure 3 is a longitudinal section through a furnace having two pole wheels rotating about horizontal axes, and

Figure 4 is a section in part along the line IV—IV and in part along the line V—V of Figure 3.

Referring to Figures 1 and 2 of the drawing, the furnace consists of a pot-like magnet casing **1** which is revolubly mounted on the base plate **2**, so that it can rotate about a vertical axis. The casing rests on the base plate through the intermediary of ball bearings **3** and is guided by means of a vertical stationary spindle **4** which also carries the crucible **5** having a unitary chamber adapted to hold the material to be heated in a concentrated body and is provided with a cover **6**. The casing is provided with a belt pulley **7** by which it is driven from a motor **8** by means of a belt **9**.

An annular coil 10 is arranged in the casing 1. A core 11 which is provided with a central bore projects into the coil and this core is either made in one piece with the casing or is in magnetic connection therewith. The magnetic casing is closed by a cover plate 12 which is magnetically and mechanically connected thereto by means of bolts 13. A yoke 15 having an opening 16 is inserted in an aperture having conical walls 14 which is provided in the cover plate 12. After the yoke plate has been removed the crucible 5 can be lifted upwards, for example by means of a crane, which is not illustrated in the drawing. The crucible is firmly connected to the stationary spindle 4, for example by means of a pin 17 but is capable of being removed. The yoke plate is rigidly connected with the cover plate. It is also provided with apertures 18 (see Figure 2) so that when seen from above it has the appearance of a spoked wheel. Opposite the spoke-like pole pieces 19 which form the one pole corresponding projecting pole-pieces 30 are provided on the core 11. The magnet system thus has a circuit of magnetic conducting material which leads the flux through the material to be heated, the flux concentrations therein being made non-uniform by the position and shape of the pole pieces.

In the form of furnace illustrated in Figures 3 and 4 the magnet casing 20 is constructed in the form of a drum having a horizontal axis. The drum 20 encloses from both sides the hearth 21 which is of relatively narrow and high construction. It is provided with a charging and working opening 22. In order to be able to tilt the furnace it is mounted on rollers 23. Two coils 24 between which the hearth 21 is located are arranged in the magnet casing 20. The coils are connected in such a way that they form a uni-polar magnet. In this furnace the casing 20 and the coils 24, as well as the hearth 21, remain stationary during operation. Only the pole wheels 25 rotate, being mounted for this purpose on axes 26 and driven for example directly from motors which are not illustrated and are connected to the couplings 27. Each pole wheel 25 is provided with pole pieces 28 which cover only part of the adjacent faces of the chamber and extend into proximity to the chamber in a similar manner and similar purpose as pole pieces 19 and 30 in Figs. 1 and 2 as described above. The pole wheels 25 can be rotated either in the same direction or in opposite directions.

The hearth 21 is constructed in such a manner that it can be filled up to the level 29 so that a part of the melting bath lies above the magnetic field which is formed between the two pole wheels. These upper layers have a damping effect on the tendency of the melting bath to follow the rotation of the magnetic field.

What we claim is:—

1. In an induction furnace, a stationary magnet system, a relatively narrow and high crucible adapted to be filled to such an extent that a part of its contents lies outside the magnetic field of said magnet system, said system comprising two pole wheels rotatable about a horizontal axis on each side of the crucible, and poles arranged on said pole wheels and rotatable therewith.

2. In an electric furnace, a crucible having a unitary chamber adapted to hold the material in a concentrated body, a magnet system, said system comprising a stationary magnet and rotatable poles for directing concentrated magnetic flux through said crucible chamber, and means for rotating said poles relative to the crucible chamber.

3. In an electric furnace, a crucible having a unitary chamber adapted to hold the material in a concentrated body, a magnet system including a stationary magnet and a rotatable pole, said pole being located adjacent the crucible for directing concentrated magnetic flux through the crucible chamber, said pole having projecting pieces providing non-uniformity of concentration of the flux passing through said chamber, and means for rotating said pole relative to said crucible chamber to produce non-uniform electrical potential in the material in the crucible chamber.

4. In an electric furnace, a crucible having a unitary chamber adapted to hold the material in a concentrated body, a magnet system, said magnet system including poles of dissimilar polarity disposed on opposite sides of the crucible chamber for directing concentrated magnetic flux through the crucible chamber, said poles having projecting parts extending toward the crucible for providing non-uniformity of concentration of the flux passing through the crucible, the projecting parts of each pole being of similar polarity, and means for rotating said poles.

5. In an electric furnace, a crucible having a unitary chamber adapted to hold the material in a concentrated body, a magnet system, said magnet system including a stationary magnet, and poles of dissimilar polarity disposed on opposite sides of the crucible chamber for directing concentrated magnetic flux through the crucible chamber, said poles having pieces projecting toward the crucible, adjacent pieces of each pole being of similar polarity, and means for rotating the poles.

6. In an electric furnace, a crucible having a unitary chamber adapted to hold the material in a concentrated body, a magnet system, said magnet system including a stationary magnet, and poles of dissimilar polarity disposed on opposite sides of the crucible chamber for directing concentrated magnetic flux through the crucible chamber, the faces of said poles toward the crucible having openings formed therein for providing non-uniformity of concentration of the flux passing through the crucible, and means for rotating said poles, whereby movement of the non-uniform flux with respect to the material to be heated in the crucible generates non-uniform electrical potential in said material and the material is heated by the heat of resistance to the flow of current produced by said potential.

7. In an electric furnace, a crucible having a relatively narrow and high unitary chamber adapted to hold the material to be heated in a concentrated, compact body, a magnet system comprising a stationary magnet, and a pair of rotatable poles disposed on opposite sides of the crucible and adapted to direct concentrated magnetic flux through the crucible chamber, the portion of the crucible chamber adapted to hold the material extending outside the field of concentrated magnetic flux, and means for rotating the poles.

8. In an electric furnace, a crucible having a single unitary chamber adapted to hold the material to be heated in a concentrated body, a magnet system having a circuit of magnetic material provided with a gap, said chamber being located in said gap, said magnetic circuit including magnetic conductors on opposite sides of the body of material having portions extend-

ing into closer proximity to the chamber than other portions for producing non-uniformity of magnetic flux in the material in said crucible chamber, and means for moving said conductors relative to said crucible chamber and the material contained therein to produce non-uniform electrical potential in the material in the crucible chamber whereby said material is heated by local flow of eddy currents from points of high potential to points of low potential in the material.

9. In an electric furnace, a crucible having a single unitary chamber adapted to hold the material to be heated in a concentrated body, a rotatable magnet system including a circuit of magnetic conducting material provided with a gap, said chamber being located in said gap, said circuit including pole pieces extending only partially over opposite sides of the crucible and in proximity thereto for producing non-uniformity of the magnetic flux in the material in said crucible, and means for rotating said pole pieces relative to said chamber to move the magnetic flux relative to the material to be heated in the chamber to produce non-uniform electrical potential in the material whereby the material is heated by local flow of eddy currents from points of high potential to points of low potential in the material.

10. In an electric furnace, a crucible having a unitary chamber adapted to hold the material in a concentrated body, a rotatable magnet system having a circuit of magnetic material provided with a gap, said chamber being located in said gap, said circuit having pole pieces adjacent the chamber extending only partially over a side of the chamber and into proximity thereto for producing non-uniformity of magnetic flux in the material in said crucible, adjacent pole pieces being of similar polarity, and means for rotating said magnet system relative to said chamber to move the non-uniform magnetic flux relative to the material to be heated to produce non-uniform electrical potential in the material in the crucible chamber and eddy currents, the resistance of flow of which heats the material.

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