July 4, 1933. E. F. NORTHRUP 1,916,434

INDUCTOR FOR FURNACES AND THE LIKE

Filed July 17, 1930

Fig. 1.

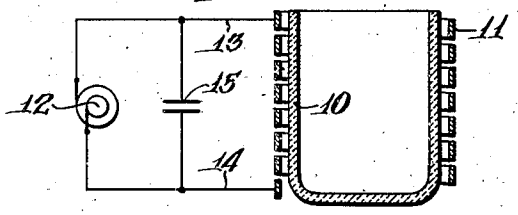


Fig. 1a.

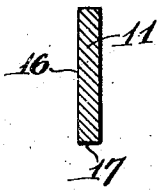


Fig. 2.

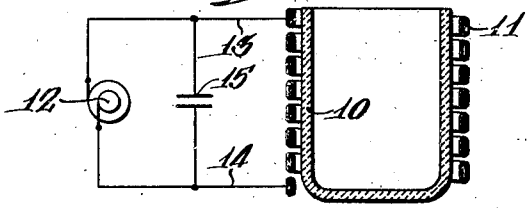


Fig. 2a.

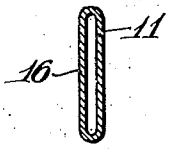


Fig. 3.

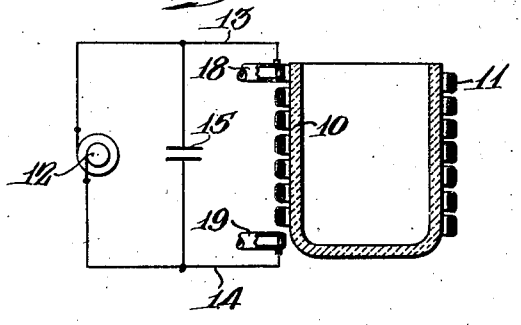
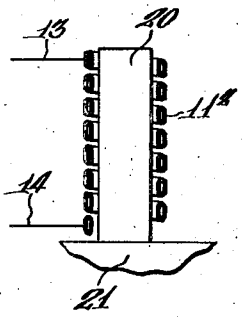


Fig. 4.



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Patented July 4, 1933 1,916,434

UNITED STATES PATENT OFFICE

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INDUCTOR FOR FURNACES AND THE LIKE

Application filed July 17, 1930. Serial No. 468,551.

My invention relates to the construction of electric induction furnaces, particularly coreless furnaces, and to methods of heating using such furnaces.

A purpose of my invention is to supply induced current to large induction furnaces evenly along the length of the furnaces without the necessity of connecting a plurality of turns or groups of turns electrically in parallel.

A further purpose is to construct an inductor coil suitable for heating billets to a forging temperature.

A further purpose is to heat a charge by passing current about it over a relatively wide spiral path.

A further purpose is to wind an inductor coil flatwise about the furnace crucible, adjusting the axial dimension of the individual turns so that a small predetermined number of turns will completely surround the crucible.

A further purpose is to wind an inductor coil from a metallic ribbon or strip of shorter cross sectional dimension in one direction than in another direction, placing the shorter cross sectional dimension transverse to the coil axis.

A further purpose is to construct an electric induction coil from flattened flatwound tubing, desirably cooling the tubing by passing a suitable medium through its interior from connections.

Further purposes will appear in the specification and in the claims.

My invention involves both methods and apparatus by which the methods may be carried out.

In the drawing I illustrate a few only of the numerous possible structures by which my invention might be embodied, choosing them from the standpoint of ease in manufacture, convenience in use and facility in illustration of the principles involved.

Figure 1 is a vertical central section, largely diagrammatic, of a furnace to which my invention has been applied.

Figure 1*a* is an enlarged transverse section of one of the turns of the inductor coil of Figure 1.

Figure 2 is a vertical central section of a somewhat different embodiment of my invention from that shown in Figure 1.

Figure 2*a* is an enlarged transverse section of one of the inductor coil turns of Figure 2.

Figure 3 corresponds generally to Figure 2, but shows connections for a cooling medium.

Figure 4 is a vertical central section of my invention applied to heating a billet.

In the past it has been usual to construct the inductor coils of coreless induction furnaces of flattened water cooled tubing edgewound so as to crowd a maximum number of turns into the space available about the charge. Flat winding has been proposed where pancake coils (that is, those wound in an increasingly larger spiral entirely in one plane) were to be used, as, for example, in my Patent No. 1,330,133 for oscillation spiral coil and connection, granted February 10, 1920.

In recent years the tendency has been to increase greatly the size of coreless induction furnaces, and simultaneously to reduce the number of inductor coil turns about these larger furnaces. Where the axial length of the furnace is increased or the number of turns in the inductor coil decreased, or both, the turns will be widely separated.

On account of the skin effect and the tendency of the current in the inductor to improve its coupling with the induced current, the current-carrying cross section with edgewise winding is very small, having axially but little greater length (because of the bend where there is water cooling) than the axial cross sectional dimension of the tube. Even where a number of edgewound turns are placed in parallel, the cross section for current-carrying purposes is interrupted by the insulation.

For larger furnaces a small number of turns only is ordinarily required. Where edgewise wound turns are used the spacing between the turns becomes excessive and the paths of corresponding induction within the furnace pool are correspondingly separated and more or less distinct instead of—as is most desirable—a substantially uniform band

of induced current throughout the range of the winding.

I plan to increase the axial dimension of the individual inductor coil turns so that they may be wound rather closely, and will still rather continuously surround the crucible to the height desired without the use of an excessive number of turns.

The same strip or tube which is edgewound to great advantage where a large number of turns is required, I find can be flatwound to secure a maximum of axial coverage per turn and a maximum of current-carrying capacity from the standpoints of skin effect and coupling.

In Figure 1 I show the crucible 10 of any desired form surrounded by an inductor coil 11 supplied with current from the source 12 through lines 13 and 14, and desirably having its power factor corrected by a suitable reactance 15.

As better seen in Figure 1*a*, the individual inductor coil turns are desirably of generally rectangular cross-section, and are wound flatwise, so that the greater dimension, that parallel to the side 16 extends axially with respect to the inductor coil, and the lesser dimension, that parallel to the side 17, extends transversely to the axis.

The number of turns about the crucible for a given flat conductor is, of course, limited by the axial space occupied by the individual turns and their insulation, but usually, of course, the number of turns and the cross section will be preliminarily determined and the flat strip or flattened tubing will be selected or manufactured accordingly.

Because of the high current values required in large induction furnaces, I prefer the structure of Figure 2 to that of Figure 1, since the inductor coil of Figure 2 conveniently may be cooled. The general external dimensions of the inductor coil turn, as best seen in Figure 2*a*, correspond generally to those of the turn shown in Figure 1*a*. The coil 11′ may be formed of hollow tubing flattened and flat-wound, that is, wound with the face 16 parallel to the axis of the coil.

Suitable connections may be made to the interior of the inductor coil as seen in Figure 3, where the cooling medium is supplied at 18 and removed at 19. The cooling medium may be supplied under pressure to increase the cooling capacity.

My invention may be very satisfactorily applied to the heating of billets prior to forging. The length of the billet is usually considerably greater than its cross-sectional dimension, so that, if edge winding of a small number of turns were used, the turns would be widely spaced, and current would be induced nonuniformly.

In Figure 4 I show a billet 20, resting upon a base 21 and surrounded by an inductor coil 11^2 of hollow flatwound tubing. Current is passed through the inductor to heat the billet to the forging temperature.

It will be evident that the current surrounding the charge is conducted through a relatively wide path, so that the induced current will be rather uniformly distributed throughout the charge.

I believe that the best application of my invention will be in coreless induction furnaces of considerable size. However, it is also applicable to other electrical windings, as for example reactors, where it is desired to employ fewer turns per unit axial dimension than have been used formerly.

While I consider that the generally rectangular external cross-section is most convenient, it will be understood that my invention may be embodied in coils having variant cross-sections but in which the general axial dimension is greater than the general transverse dimension.

In view of my invention and disclosure variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain part or all of the benefits of my invention without copying the structure shown, and I, therefore, claim all such in so far as they fall within the reasonable spirit and scope of invention.

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

1. In an electric induction furnace of large size, a helical inductor coil consisting of flattened flatwound tubing and connections for supplying liquid cooling medium to the interior of the tubing under pressure.

2. In an electric induction furnace of large size, a furnace crucible, a helical inductor coil surrounding the crucible, formed from flattened flat wound tubing, and adapted to be connected to a source of cooling medium under pressure.

EDWIN FITCH NORTHRUP.