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3,363,044

CHANNEL TYPE INDUCTION FURNACE

Filed May 3, 1965

2 Sheets-Sheet 1

Fig. 1

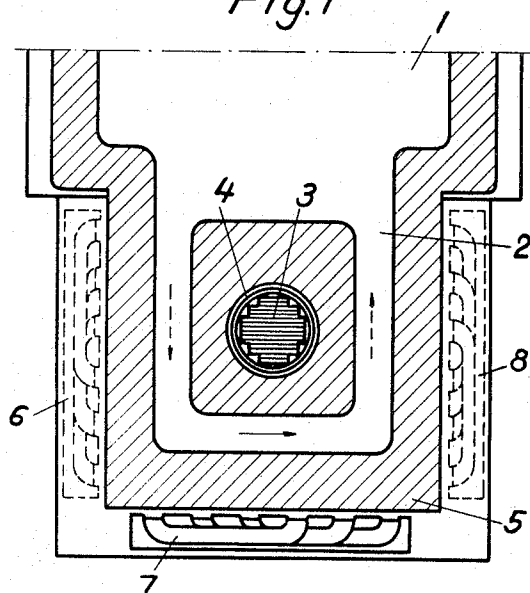
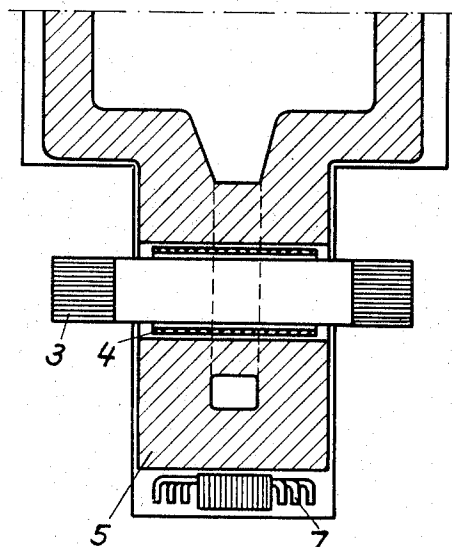


Fig. 2



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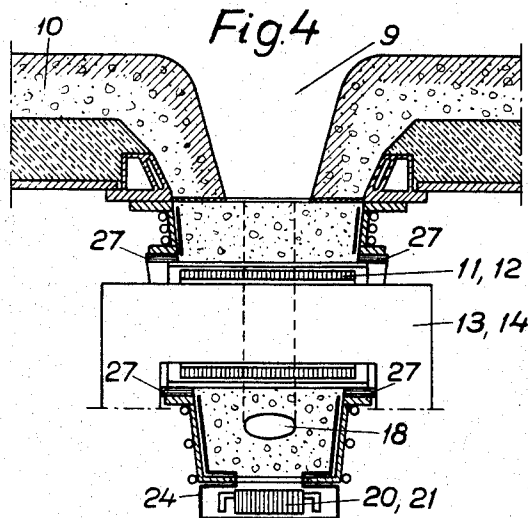
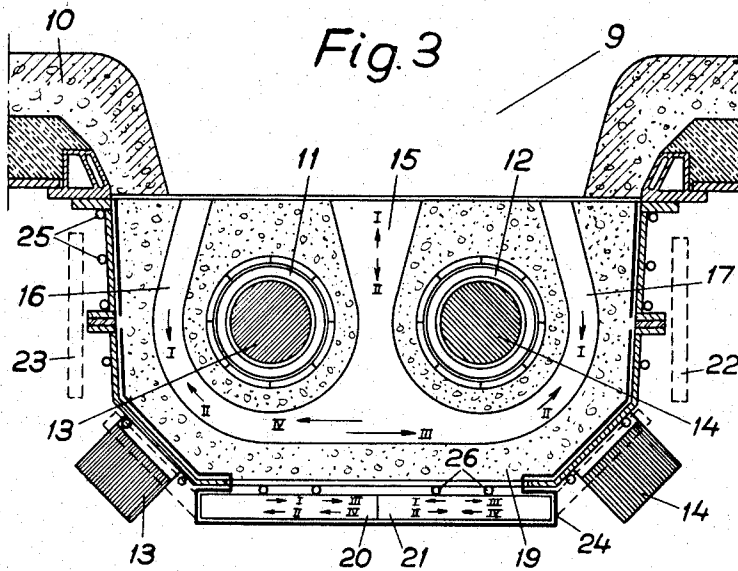


Fig. 5

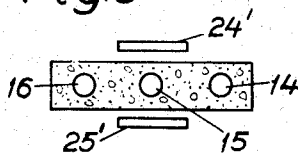
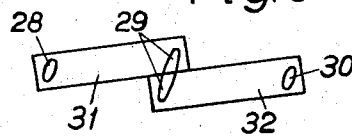


Fig. 6



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3,363,044

CHANNEL TYPE INDUCTION FURNACE

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3,309/65

10 Claims. (Cl. 13—29)

In electrical furnaces, where the melt space (the hearth) is connected to one or several U-shaped channels in which the current necessary for heating is generated by means of induction, electrodynamic forces are operative, which are produced in the melt existing at the channels so that in each opening where the ladle or ducts of the channel run into the hearth a similarly large quantity of melt flows out and back into the channel depending on the pinch effect in the ducts. The melt in the channel thus moves at least principally not in a one-direction circulation, which means that in some part of the channel the melt is completely or to a great extent standing still. The greatest temperature rise is usually produced in furnaces with vertical or almost vertical channels situated below the hearth and the construction in the lowest part of the channel. However, great temperature rises can also occur in other parts of the channel or channels. Such overheating can give rise to uneven wear on the walls of the channel so that chemical reactions take place between the melt and the wall material or oxides are formed which are collected in the channel and gradually obstruct it with a further local rise in temperature as a consequence. Since these furnaces are intended for continuous operation, it is essential that every reason for stoppage of operation is eliminated. These stops usually cause penetration or obstruction in the channel so that this must be considered to be the part of the furnace most liable to damage.

Attempts have been made to remedy these disadvantages by providing the heating coil in front of the channel with a number of stirring coils, but this is relatively complicated since the space is limited and the stirring force must either be relatively low or there is also the risk of undesired heating. The flux of the heating coil also causes heating losses in these inner stirring coils in such positions. Besides, the flux from the stirrer will to a certain extent be shielded by the heating coil.

The invention refers to a channel type induction furnace with at least one inductor unit containing at least one coil, an iron core and at least one channel going round the coil of the ordinary type with two lateral channels debouching in the hearth and a bottom channel which connects the lateral channels. The invention is characterised in that at least one electromagnetic stirrer is placed on the outside of the inductor unit. By this arrangement there is the advantage that conventional stirrers, known for example in arc furnaces, can be used and provided with effective cooling without requiring the inductor unit to be specially large. The stirrer does not substantially influence the flux from the heating coil. The stirring direction can be varied and the inductor unit can, without being reconstructed, be provided with further stirrers, for example near the lateral channels, placed outside the inductor.

A particularly preferable embodiment is constituted by an inductor unit with two coils and double channels with a common central channel and each having its own lateral channel, a bottom channel connecting the central and lateral channels, and one or two iron cores passing through the coil or coils. The embodiment is characterised in that near the bottom channel is arranged at least one stirrer

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and/or at least one stirrer near one or both lateral channels or near the central channel. In this embodiment the obstacles can easily be overcome which normally prevent unidirectional flow in the channels. With a suitable choice of stirring direction or directions, a direction can be produced from the hearth into the central channel, towards the hearth in the lateral channels or vice versa or also from the hearth in one and towards the hearth in the other lateral channel. Alternation between different current directions can also be made quickly with the object of preventing overheating in the channels and of making the heating of the melt effective and at the same time also producing stirring in the hearth, useful for the metallurgical process. Such stirring can also be produced without current in the heating coils, for example for cleansing the channels or for effecting certain metallurgical processes in the hearth.

The arrangement is exemplified in the accompanying drawings, of which FIGS. 1 and 2 show two side views of a single channel inductor with a stirrer and FIGS. 3 and 4 a corresponding view of a double channel inductor. FIG. 5 shows an alternative stirred positioning and FIG. 6 a special channel formation.

In FIGS. 1 and 2 a melt space 1 or a furnace hearth is shown, to which one or several channel inductors are connected, here a single channel inductor with two lateral channels a bottom channel, together forming a channel 2 communicating with the hearth 1. A coil 4 arranged on an iron core 3, fed with the network frequency, induces the heating current in the channel 2, and, outside of the outer part of the furnace lining 5, an electromagnetic, one or multi-phase fed stirrer is arranged, fed with network frequency or with lower frequency. The stirrer is either placed below the bottom channel (at 7) or near one or both the lateral channels 6, 8 or also near all three channels.

The stirrer 6, 7, 8 can be plane wound, constructed in principle as the stator of an asynchronous machine, or coil wound, and in both cases provided with water or air cooling. The arrows in the different channels in FIG. 1 show one stirring direction of the melt in the channel, but the stirring direction can of course be altered to the opposite direction or alternate between two directions. The stirrer can of course also be fed with extra low frequency (0.4–10 cycles per second) (multi-phase) with the object of effecting motoric stirring. The inductor unit can also be made to be exchangeable, for example according to Patent No. 3,100,237.

In FIGS. 3–4 a double channel type inductor is shown, which is placed in a furnace body 10, enclosing the melt space (the hearth) 9. The inductor unit is of double channel type and is provided with twin coils 11, 12, one or two phase fed and placed on one or two (see FIG. 3) iron cores 13, 14. The channels consist of a common central channel 15 and two lateral channels 16, 17 and one bottom channel 18 connecting these three channels. In the case shown the shape of the channel is made like an ω , but it can of course also be made as a double rectangle. The central channel 15 is shaped with an upwardly enlarged cross section and all corners of the bottom channel 18 are rounded in order to allow high speed flow of the melt. The central channel 15 can also be made with constant cross section.

Below the bottom channel 18 outside the furnace lining 19 a stirrer 20, 21 is placed of considerable length on both sides of the symmetrical plane of the inductor unit, possibly also completely or partly extending beyond the sides of the inductor (see dashed lines). The stirrer can be a single stirrer or can be divided into two parts 20, 21 or several parts, divided at the symmetrical plane or divided into several sections with reversible stirring directions not dependent on each other. The inductor unit can alter-

natively be provided with one, two or several stirrers 22, 23, placed at the sides of the inductor, or also combined with parts 20, 21. Alternatively the inductor unit can be provided with one or two stirrers 24', 25', for the central channel 15, which can be seen schematically by FIG. 5, which is a horizontal section through an inductor unit. The inductor unit is surrounded by a shield 24, consisting of one or several plates or a non-ferromagnetic material which is also a good electrical conductor, such as copper or aluminium. The shield 24 extends along the wall of the inductor unit but outside the stirrer 20, 21 in the longitudinal (FIG. 3) as well as in the transverse direction (FIG. 4), but inside the magnetic casing of the inductive stirrer. The advantage of this is that the main flux from the coils 11, 12 and the leak flux from the cores 13, 14 do not give any damaging influence to the stirrer. No losses emanating from these fluxes or damaging effects on the working of the stirrer worth mentioning are produced. The shield 24 preferably also extends along the sides of the inductor in order to prevent the losses which may arise in the magnetic material.

Beside the heating coils 11, 12, leak flux laminations 27 are arranged so that the leak flux can be conducted past the stirrer and directly to the iron core 13, 14 concentrated as near to the coils 11, 12 as possible. This leak flux has been substantially concentrated around the coils 11, 12 (see FIG. 4).

The inductor unit according to FIGS. 3 and 4 is also exchangeable during operation, for example shaped according to the above mentioned patent. The inductor unit is usually provided with water cooling, see the tube 25 in FIGS. 3 and 4. In the stirrer the cooling tube also serves for cooling of the inductor. See 26.

The stirring direction in the stirrer according to FIG. 3 can be used in the following way:

Direction I in the parts 20 and 21 gives downward flow in the channels 16 and 17 and upward flow in the central channel 15.

Direction II gives the opposite flow direction. Direction III, i.e. the same direction in 20 and 21 gives downward flow in the left lateral channel 16 and right-hand direction in the bottom channel 18, and upward flow in the right-hand lateral channel 17.

Direction IV gives the opposite flow direction. The condition in the central channel 15 in alternatives III and IV is that only an insignificant flow is produced in this central channel, predominantly upward directed.

In FIG. 6 a channel type embodiment with a large cross section in the central channel 29 and smaller sections in the lateral channels 28 and 30 is shown. The two stirrers 31 and 32 when positioned according to this figure will operate as if each of them were influencing a single channel.

In the furnace body 10 a large number of inductors can be placed with different inclinations relative to the vertical plane through the longitudinal axis of the furnace. All these or certain of them can be provided with stirrers according to the above. Other variations can also be feasible within the scope of the following claims.

We claim:

1. Submerged resistor type induction furnace with a hearth and at least one inductor unit comprising at least one coil with an iron yoke and at least one melt loop

around the coil, said loop having at least two lateral channels running from the hearth and at least one bottom channel connecting said lateral channels, at least one electromagnetic stirrer positioned on the outside of the inductor unit, said stirrer being separate from said coil.

2. Furnace in accordance with claim 1, in which said stirrer is placed outside the bottom channel of the inductor unit.

3. Furnace in accordance with claim 1, having at least two stirrers, each of said stirrers being positioned outside one of the lateral channel of the inductor unit.

4. Submerged resistor type induction furnace with at least one inductor unit comprising at least two coils, at least one iron yoke threading said coils, melting loops encircling said coils, each of said loops having a lateral channel, and having a central, common channel extending between said coils and a bottom channel connecting the lower ends of the lateral channels and the lower end of the bottom channel, said central and lateral channels extending from the bottom channel to the hearth, at least one stirrer positioned on the outside of said inductor unit and below the bottom channel being placed, said stirrer extending at both sides of a plane through the central axis of said central channel, said stirrer being separate from said coil.

5. Furnace in accordance with claim 4, at which said stirrer is divided into two parts on each side of the plane through the central channel, each part having reversible stirring directions.

6. Furnace in accordance with claim 4, in which two additional stirrers are located adjacent the inductor unit and outside each of the lateral channels, each of said additional stirrers having reversible stirring directions.

7. Furnace in accordance with claim 4, in which the stirrer below the bottom channel extends to points outside the lateral channels of the inductor unit.

8. Furnace in accordance with claim 4, in which additional stirrers are located outside the inductor unit on both sides of the central channel with reversible stirring directions.

9. Furnace in accordance with claim 4, in which a shield of non-magnetic material is arranged at the bottom of the inductor unit inside the magnetic parts of the stirrer.

10. Furnace in accordance with claim 4, in which a laminated core with axial extensions for concentration of the flux is provided around the heating coils.

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