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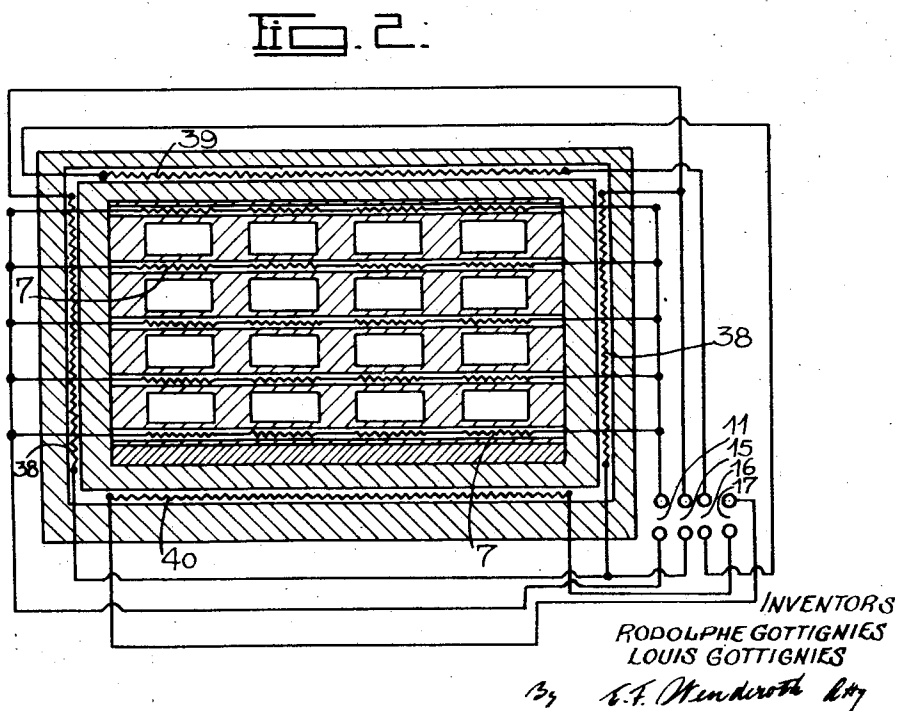
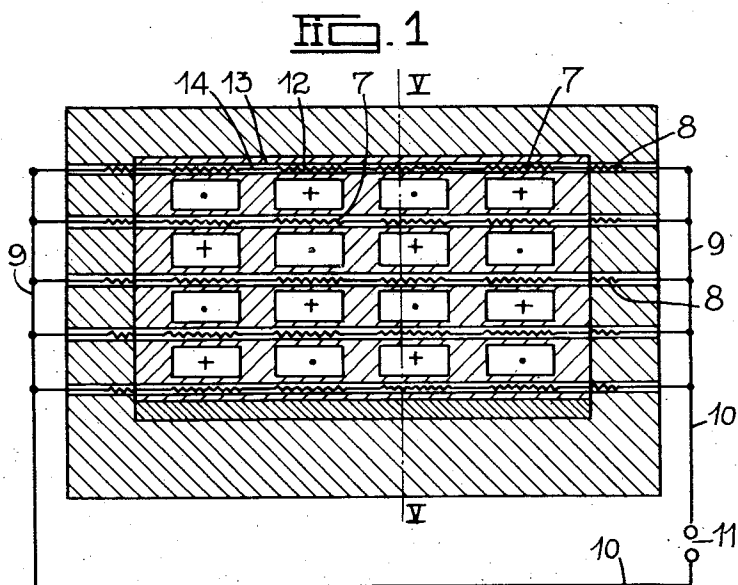
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2,279,511

TUNNEL FURNACE

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Fig. 3.

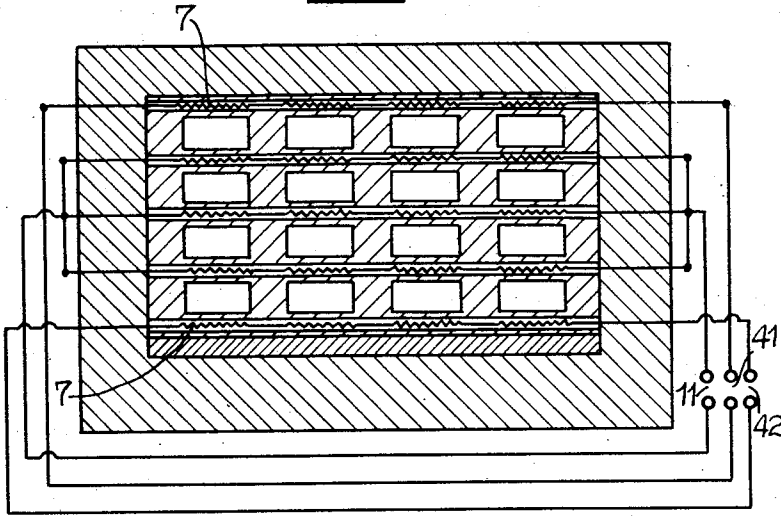
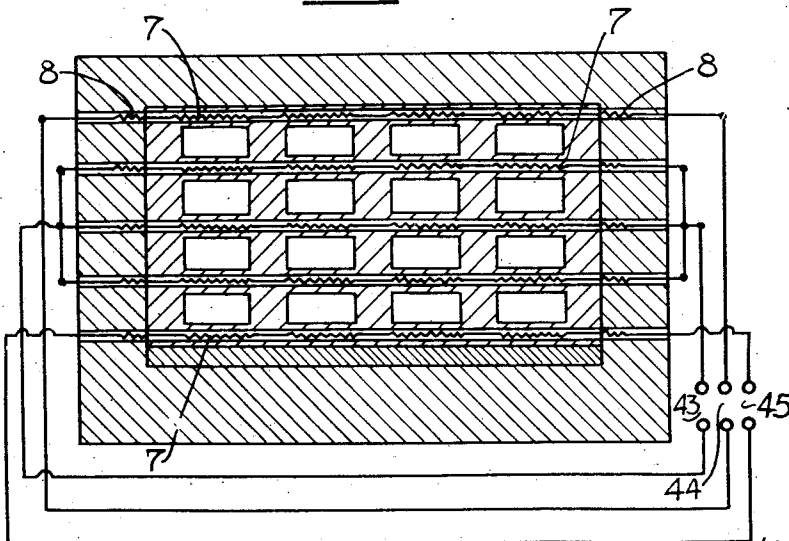


Fig. 4.



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Filed Sept. 1, 1939

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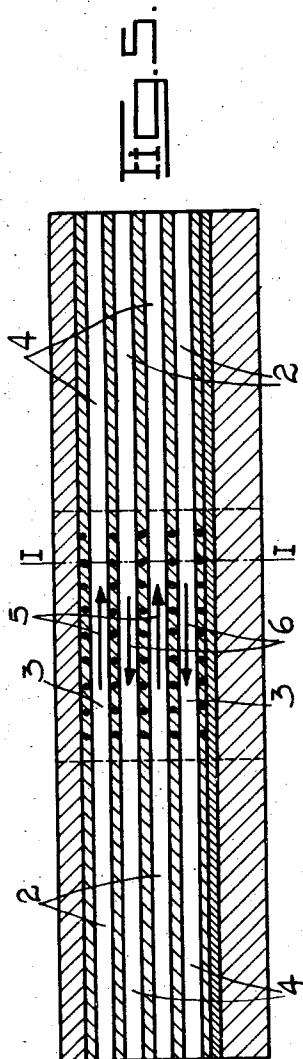


FIG. 7.

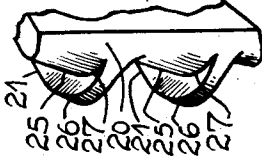
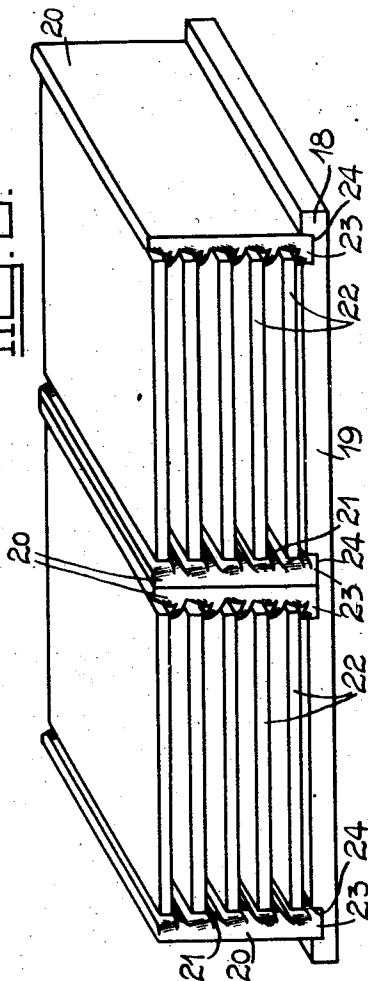


FIG. 6.



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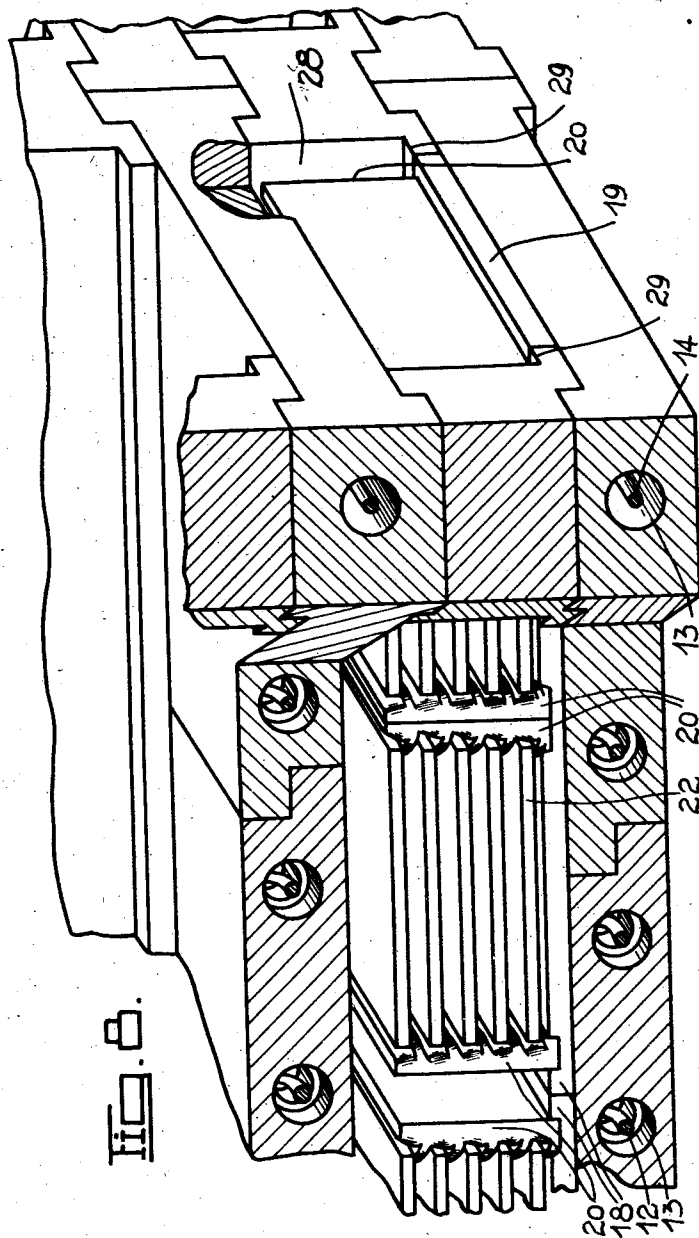
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Filed Sept. 1, 1939

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Filed Sept. 1, 1939

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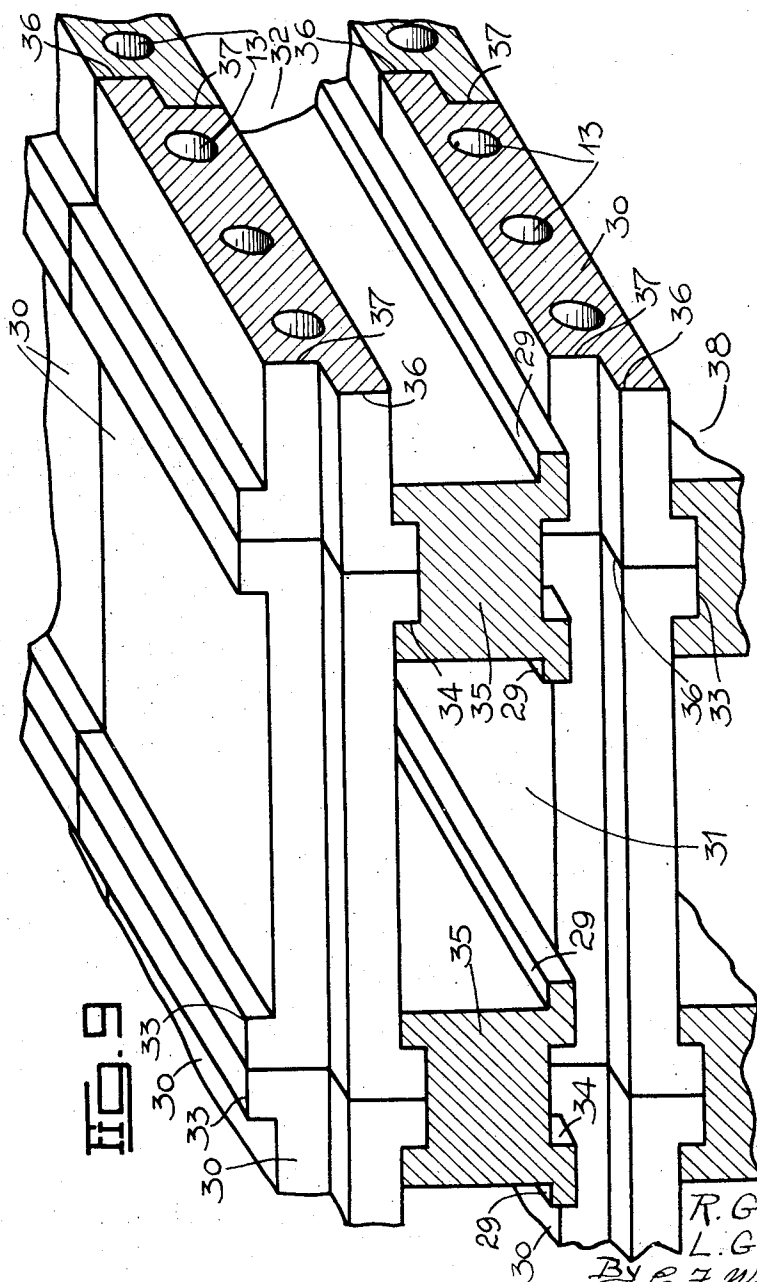


FIG. 9

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2,279,511

TUNNEL FURNACE

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Gottignies, Watermael-Boltsfort, BelgiumApplication September 1, 1939, Serial No. 293,116
In Belgium September 3, 1938

2 Claims. (Cl. 13-22)

The present invention relates to a furnace for the thermal treatment of ceramic products comprising a certain number of superposed tunnels and juxtaposed tunnels, in which the products to be treated which traverse successively in each tunnel a pre-heating zone, a cooking zone and a cooling zone move in certain tunnels in a sense opposite to that in which the products move in the tunnels adjacent to that under consideration.

In furnaces of this type, the products move in opposite senses either in all the juxtaposed tunnels or in all the superposed tunnels. The recovery of the heat from the emerging products is thus imperfect. To improve it the present invention contemplates a furnace in which in two contiguous tunnels either juxtaposed or superposed the products move in opposite senses.

The present invention has also for its object an electric tunnel furnace in which each tunnel is heated by means of resistances placed in the walls of the tunnel.

The calorific losses through the exterior walls of such a furnace spoil its thermal uniformity. To maintain the same according to the present invention the exterior walls of the furnace are provided with heating means which develop sufficient heat to compensate the calorific losses through said walls.

These heating means can be of various kinds. One can either employ existing resistances and augment the current which passes through them or replace the existing resistances by others capable of developing more heat for the same current or, finally, provide supplementary resistances.

The heating resistances of the tunnels can be disposed in any manner; they can be transverse, longitudinal, horizontal or vertical. However, when the furnace comprises more than two tunnels it becomes difficult to place the resistances longitudinally since one cannot make the connections pass through the lateral walls of the furnace. In this case according to an advantageous form of embodiment of the invention, the resistances are placed transversely in the roof and the floor of each tunnel.

Another object of the invention is a support for ceramic tiles to be fired.

The present invention contemplates a support which comprises a plate on which are mounted solid walls furnished with projections on which the tiles rest. The solid walls furnished with projections enable a support for tiles to be provided of small bulk while ensuring good mechanical rigidity. The tile is placed on projec-

tions which extend over nearly all the width of the vertical walls and ensure the guidance thereof.

The present invention furthermore relates to a tunnel furnace for the thermal treatment of ceramic products.

This treatment calls for special precautions. Thus the products must be cooled slowly. A rapid cooling of the products leads to fractures and other faults. It is therefore necessary to avoid air currents which may arise in the tunnels these air currents arising as soon as, for any reason, there exists a difference in atmospheric pressure between the two extremities of the furnace.

To this end the furnace according to the invention comprises screens placed transversely to the tunnels so as to obstruct same practically completely, these screens moving with the products to be treated.

In an advantageous embodiment these screens are formed by two solid walls of the supports according to the invention.

The invention also has for object a tunnel furnace for the treatment of ceramic products in which the walls are formed so as to avoid products harmful to the products to be treated, or in the case of an electric furnace, harmful to the resistances, passing from one tunnel to another or from one tunnel to the channel in which a heating resistance is placed.

To this end the furnace comprises according to the invention walls formed from refractory elements making the one within the other so as to ensure complete isolation between the different cavities of the furnace.

The present invention relates, moreover, to a tunnel furnace in which it is sought to remedy the damages which arise in the products to be treated when the latter catch on the lateral walls after having deviated from the ways which they should follow. To this end according to the invention the furnace comprises projections serving for the lateral guidance of the products which are displaced in the tunnels.

The drawings attached to the present description represent by way of non-limiting example various forms of embodiment of the objects of the invention.

Figure 1 is a diagrammatic representation in transverse section on the line I-I of Fig. 5 of one form of embodiment of a furnace according to the invention.

Figure 2 is a modification of Figure 1.

Figure 3 is another modification of Figure 1.

Figure 4 is yet another modification of Figure 1.

Figure 5 is a longitudinal section on the line V—V of Figure 1 represented on a reduced scale.

Figure 6 is a perspective view of a support for tiles to be fired according to the invention.

Figure 7 is a detailed view on a larger scale of a part of the support represented in Figure 5.

Figure 8 is a perspective view with parts broken away of one of the tunnels of the furnace in which are placed the supports according to Figures 5 and 6.

Figure 9 is a perspective view with parts broken away of a tunnel of a furnace.

In the different figures the same references indicate corresponding elements.

The furnace represented in Figures 1 and 5 comprises a certain number of superposed tunnels and juxtaposed tunnels. The products to be treated, enamelled ceramic tiles for example, circulate in these tunnels and traverse successively in each tunnel a pre-heating zone 2, a cooking zone 3 and a cooling zone 4 (Figure 5). In order to recover the heat from the emerging products the products are caused to circulate in opposed senses not only in contiguous superposed tunnels as indicated by the arrows 5 and 6 of Figure 5, but also in the juxtaposed tunnels. Thus in Figure 1 in the tunnels marked with a point the products circulate in a direction towards the observer and in those marked with a cross they move away from the observer.

This arrangement enables an excellent recovery of the heat to be obtained.

In the thermal treatment of certain products, for example for the enamelling of ceramic tiles, it is indispensable for the products circulating in the various tunnels to encounter the same temperature conditions.

This is easily achieved for the passages which are not adjacent to the walls. But for those which are adjacent to the latter it is necessary to compensate the calorific losses through the walls.

In the electric furnace according to the invention, this result is achieved by providing in the exterior walls of the furnace heating means which compensate the calorific losses through the walls. These means can be of various types.

In Figure 1 is represented a tunnel furnace in which each tunnel is heated by means of resistances 7 disposed transversely in the roof and floor of the tunnel. These various heating resistances are identical, but there have been provided in addition supplementary resistances 8 placed in the lateral exterior walls of the furnace, each resistance 8 being placed in extension of one of the resistances 7 and connected in series with same.

The losses through the lateral walls of the furnace are thus compensated. The different assemblies comprising two resistances 8 connected in series with the corresponding resistances 7 are connected in parallel by conductors 9 and fed by the intermediary of conductors 10 by means of a source of current 11 passing finally through various regulating means not shown. The resistances 8 can also be fed independently of the resistances 7. The calorific losses through the walls being constant for a given temperature in the interior of the tunnels, the heating of the resistances 8 may be maintained constant and that of the resistances 7 modified according to the tonnage of the products which circulate in each tunnel in a given time. The resistances 7

take the form of helices 12 of resistance wire housed in channels 13 formed in the floor and the roof of the tunnels. In order to avoid too great heating of the partitions between the tunnels or of the wire over the part in the thickness of the partitions, through the latter a helix is replaced by a straight wire 14 or by a spiral of very great pitch.

The calorific losses through the walls can be compensated by other means.

Thus in Figure 2 there is shown a furnace in which as well as the resistances 7 there are provided in the various exterior walls of the furnace resistances 38, 39 and 40 fed by means of sources of current 15, 16 and 17 independent of the source which feeds the resistances 7.

The resistances 38, 39 and 40 enable the compensation of the respective losses through the lateral walls, the uppermost wall and the lowermost wall of the furnace to be achieved.

By virtue of the independent feeding of the various heating resistances practically perfect thermal uniformity of the furnace is obtained.

There has been shown a single coil for each of the resistances 38, 39 and 40. They may, of course, be divided into several coils placed longitudinally or transversely in the walls. One may also (Figure 3) not provide supplementary resistances but feed those resistances 7 which are placed in the floor of the upper tunnels and in the roof of the lower tunnels independently of the others by means of current sources 41 and 42. Advantageously the resistances fed by the sources 41 and 42 are heated so as to compensate the losses through the upper and lower exterior walls of the furnace. One may also replace the resistances 7 of the roof of the upper tunnels and the floor of the lower tunnels by other of less ohmic value and feed all these resistances in parallel.

Naturally one may employ equally well the combination of several of the arrangements described.

Thus in Figure 4 there is represented a furnace in which there is used at the same time the arrangements represented in Figures 1 and 3.

The different arrangements comprising two resistances 8 connected in series with the corresponding resistances 7 are no longer connected all in parallel but are fed by means of sources 43, 44 and 45 which enables the upper and lower resistances of the furnace to be heated to advantage.

It will be understood that Figures 1, 2, 3 and 4 are purely diagrammatic arrangements. Particularly, no means of master control connected between the sources and the resistances which they feed have been shown.

Figures 6 and 7 relate to a support 18 for ceramic tiles to be fired.

This support comprises a plate 19 on which are mounted solid walls 20 provided with projections 21 which extend over the whole of the width of the walls 20 or over a part thereof and on which rest the tiles 22.

These walls are provided with feet 23 placed in the notches 24 of the corresponding form arranged in the plate 19. The feet 23 and the notches 24 need not extend over the whole width of the plate 19 so as not to weaken unduly the latter by the notches 24. The tiles which rest on the feet 23 prevent same from leaving the notches 24 and the walls 20 from rocking.

The walls 20 are thus mounted in a removable

manner which enables one of them to be replaced as soon as it has deteriorated which avoids the necessity of replacing the whole of the support.

There are represented on the drawings four walls 20 mounted on the same base 19 which can thus carry two piles of tiles. One can obviously provide supports only carrying two walls 20 and a single pile of tiles.

However, the arrangement shown has the advantage of reducing the number of joins in the line of products to be circulated in the tunnels.

Between the projections 21 the wall 20 presents a part 25 (Figure 7) inclined in a sense such that the distance between the walls is greater at the level of the upper face of the tiles than at their lower face. This arrangement is particularly advantageous in the case of enamelled tiles. In practice the latter are covered with enamel on their upper face and on the upper part of their side faces, the latter not being able by virtue of the inclination of the part 25 to come into contact with the latter. Thus is avoided any sticking of the tile to the support.

Moreover, in order to avoid striking the edges of the projections 21 and the parts 25 when placing the tiles on the support, the projections 21 are rounded at their extremities at 26 and the parts 25 are rounded at 27.

Figure 8 shows how the supports are placed in a tunnel furnace.

It shows a tunnel 28 in which are enclosed supports 18 placed in such manner that the walls 20 are disposed transversely to the tunnel 28. The dimensions of the walls 20 such that tunnel 28 is almost completely obstructed by same. The walls 20 thus constitute screens which enable the avoidance of currents of air which may cool the products to be treated at the wrong time.

When the line of support in a tunnel is pushed by hand or mechanically it may happen that certain of the said supports are diverted laterally, the tiles may thus strike against the lateral partitions of the tunnels and be damaged.

To cure this inconvenience the tunnel 28 is provided with projections 29 (Figure 8) serving for the lateral guidance of the products which pass through the tunnels.

Figure 9 shows the various refractory parts which form a tunnel.

Refractory plates 30 form the roof and the floor of a tunnel 31. The channels 13 drilled through the plates 30 enable the heating resistances to be accommodated. The plates 30 end in projections 33 which extend in the longitudinal direction of the tunnel.

The projections 33 of two juxtaposed plates 30 are housed in a groove 34 of corresponding form arranged in a refractory part 35 forming the partition between two contiguous tunnels. Isolation of the passage 31 from the channels 13 is thus assured and the possibility of noxious vapours reaching the resistance coils is avoided.

On the other hand the plates 30 are provided on their transverse faces in relation to the passage 31 with a projection 36 and a groove 37. Two contiguous plates 30 thus easily mate, the projection 36 of one being located with the groove 37 of the other.

In this manner there is also assured a sufficient isolation so that the dusts due to the crumbling of the refractory parts cannot pass from a tunnel 32 for example to a tunnel 38 situated

below same and fall on the enamelled tiles which circulate in the latter tunnel.

For the rest one may join the parts 35 between them by a joint of the same type as that which has just been described.

The refractory parts 35 are provided with projections 29 adjacent the floor of the tunnel and serving for the lateral guidance of the products to be treated as has already been stated.

The projections 29 can equally be provided in the plates 30 instead of being in the parts 35.

The different apparatuses and arrangements described and represented are only particularly forms of embodiment of the objects of the invention. One can, without departing from the limits thereof, apply thereto various modifications. One can, for example, cause the products to circulate in different senses in the superposed tunnels and in the juxtaposed tunnels of a furnace which is not heated electrically. One can also apply the arrangements represented in Figures 8 and 9 to furnaces which are not electric.

In the same way the furnaces described can be used for other purposes than the enamelling of ceramic products.

The heating resistances 7 have been represented as transversely disposed.

One may likewise place them longitudinally or yet again vertical in the lateral partitions of the tiles.

The furnaces represented in the drawings comprise four tunnels in height and four tunnels in width but it is well understood that these characteristics of the invention apply to a furnace comprising any number of superposed tunnels and any number of juxtaposed tunnels.

In the drawings there have only been shown elements of the furnaces indispensable for the understanding of the characteristics of the invention. The manner of heating the furnace particularly has not been represented in detail nor has the manner in which the connecting conductors are connected to the resistances in practice.

What we claim is:

1. Tunnel furnace comprising a plurality of tunnels, electric heating resistances arranged in rectilinear channels in the walls of said tunnels for heating the latter, and supplementary heating resistances in the exterior walls for generating sufficient heat as to maintain substantially the same temperature in the same transversal plane of all passages despite the thermal losses through said exterior walls, the supplementary resistances being arranged in those of the exterior walls, which are at right angles to the direction of said rectilinear channels.

2. Tunnel furnace comprising a plurality of tunnels, electric heating resistances for heating the latter and arranged in rectilinear channels in the walls of said tunnels and transversely thereof, and supplementary heating resistances in the exterior walls for generating sufficient heat as to maintain substantially the same temperature in the same transversal plane of all passages despite the thermal losses through said exterior walls, each channel containing, in addition to the resistances for heating the tunnels, the corresponding supplementary resistances arranged in those of the exterior walls which are parallel to the direction of said tunnels and at right angle to the direction of said channels.

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