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E. E. RICE ET AL

2,694,741

ELECTRICALLY HEATED ANNEALING FURNACE BASE

Filed June 17, 1953

3 Sheets-Sheet 1

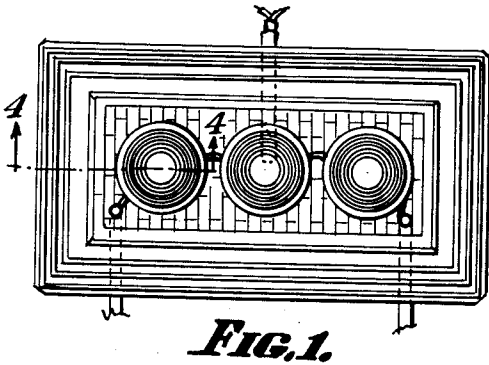


FIG. 1.

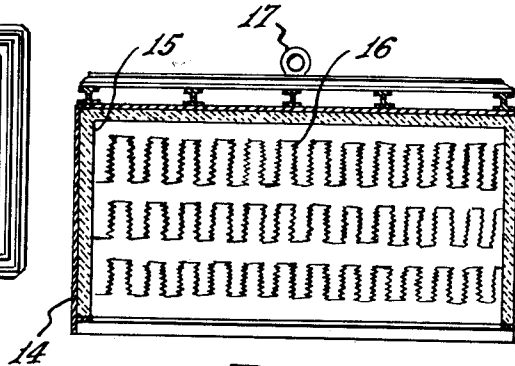


FIG. 3.

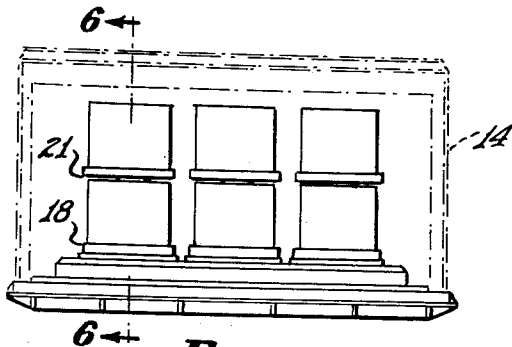


FIG. 2.

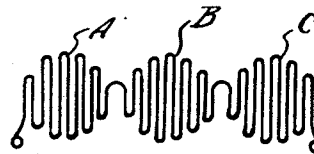


FIG. 5.

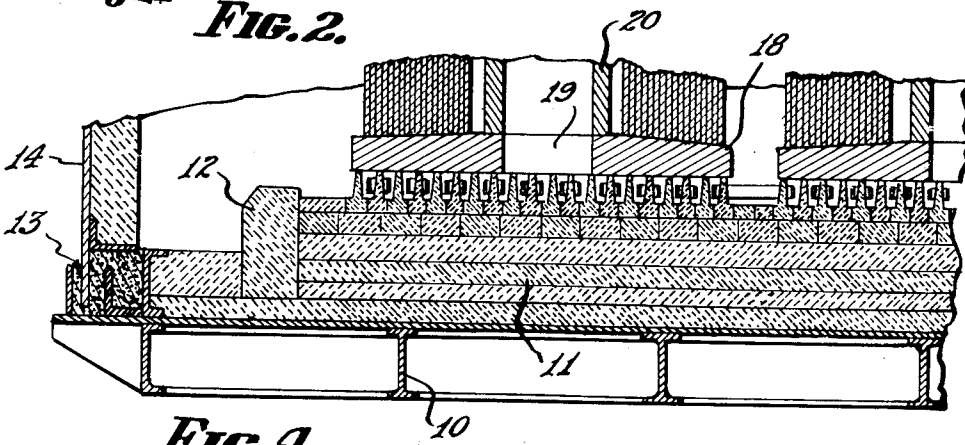


FIG. 4.

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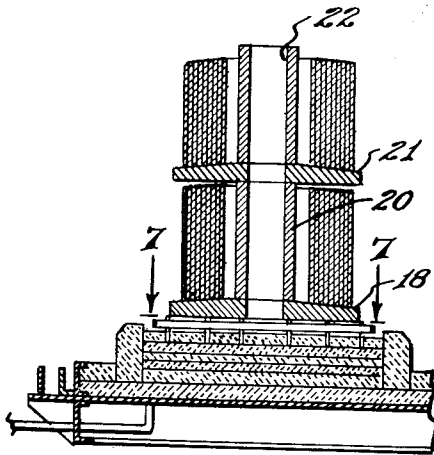


FIG. 6.

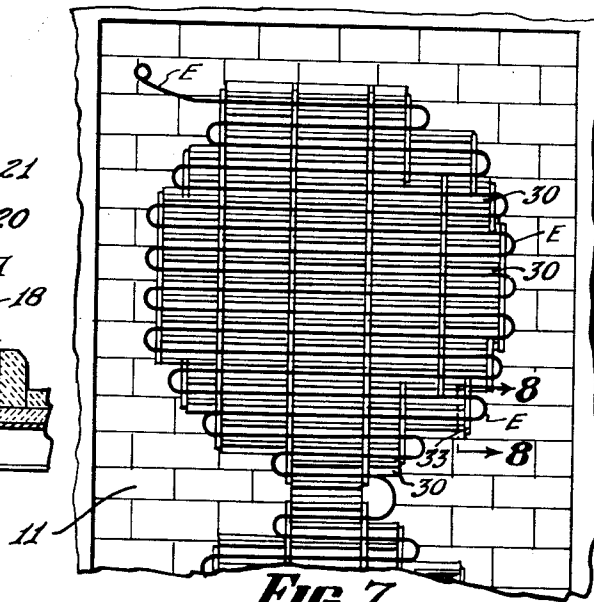


FIG. 7.

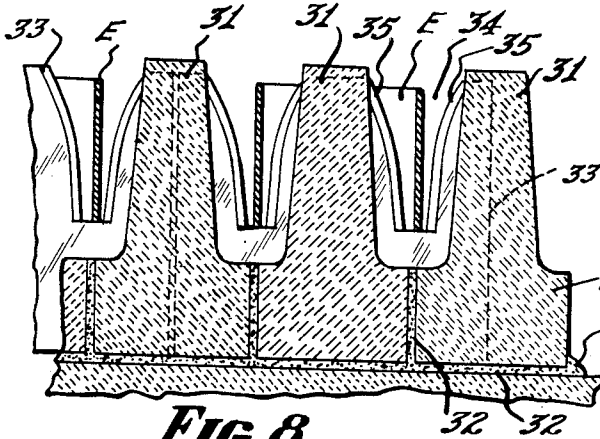


FIG. 8.

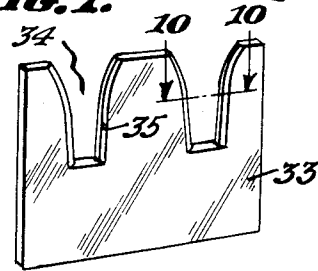


FIG. 9.



FIG. 10.

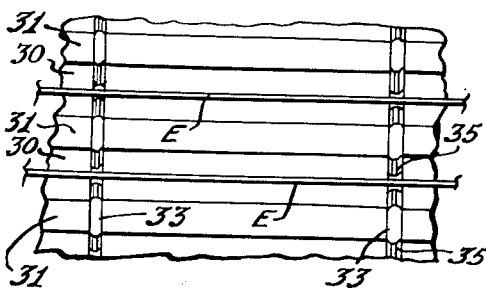


FIG. 11.

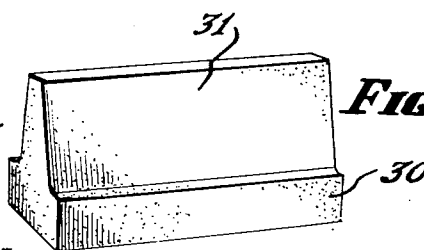


FIG. 12.

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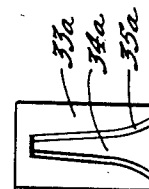
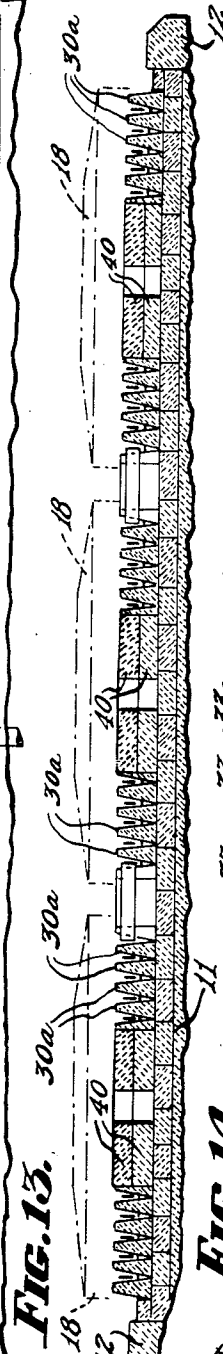
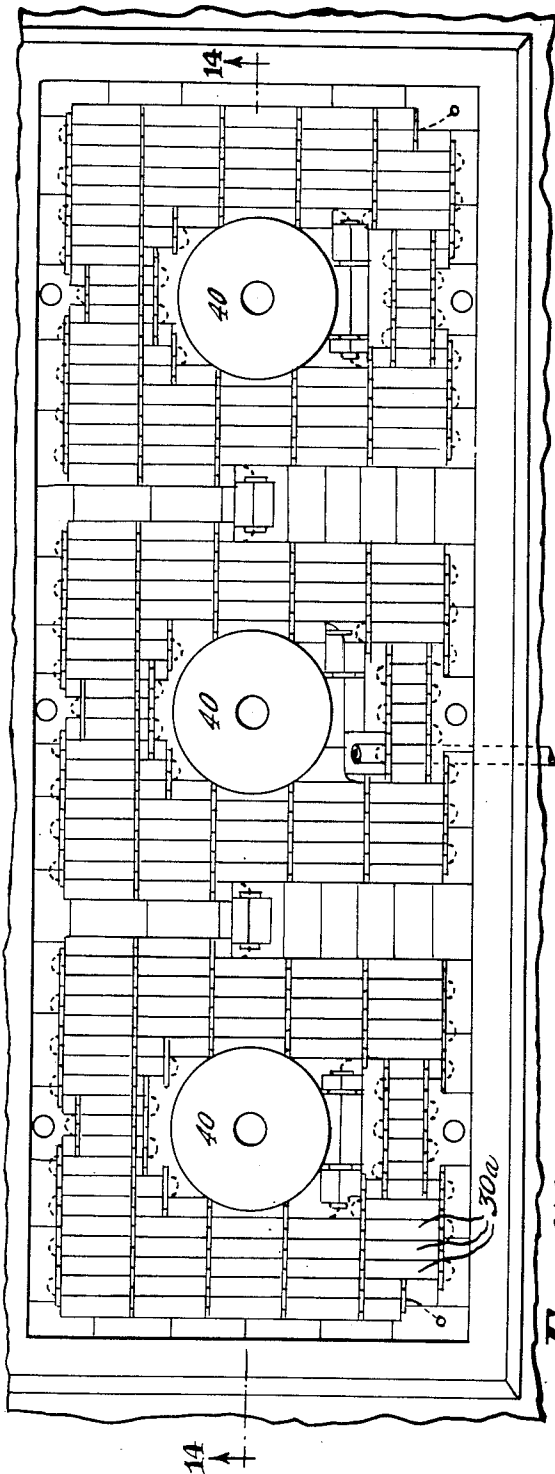


FIG. 16.

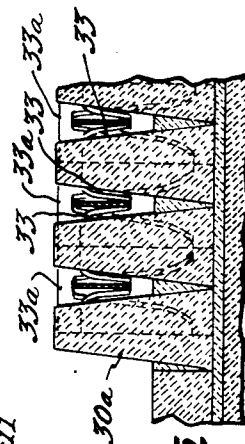


FIG. 15.

FIG. 14.

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ELECTRICALLY HEATED ANNEALING FURNACE BASE

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Application June 17, 1953, Serial No. 362,280

14 Claims. (Cl. 13—25)

This invention relates to an electrically heated annealing furnace base and is a continuation-in-part of our co-pending application, Serial Number 302,074, filed August 1, 1952, and now abandoned. In the treatment of various kinds of steels they are sometimes subjected to what is known as a box anneal where the steel pieces are suitably disposed upon a refractory base, and thereupon a box-like structure is lowered over the steel pieces. Means are provided to heat the interior of the box and sometimes special atmospheres are introduced into the box.

In connection with the annealing of steel coils certain additional problems arise which are not encountered in connection with sheets. Furthermore, where these coils are of silicon steel, the additional problem arises that the annealing temperatures are above 2000° F., and that these high temperatures necessitate electric heating.

There have been annealing bases in the art where heat was provided in the base. This has generally been accomplished by means of tubes through which steam was passed, and heating of the coils was accomplished by radiation.

There have also been bases for annealing furnaces where electric heating was provided, but this type of structure is not satisfactory at the high temperatures encountered with silicon steel and with the tremendous loads where silicon steel coils are stacked on top of each other, as is the present practice.

With the foregoing considerations in mind, it is an object of the present invention to provide a base for an annealing furnace which will have a high strength so that it will readily support double-stacked heavy coils.

It is another object of the invention to provide for electric heating elements in the base and to dispose the heating elements in such a way that the heating elements will not be burned out either by contacting the low heat absorbing refractory material of the base which would cause failure because of the inability of the base material to absorb the high heat, or because of a short circuit, which would result in the liberation of excess heat. The supporting structure for the heating element is so arranged that a high and efficient heat transfer by radiation is accomplished.

It is still another object of the invention to make it possible to use conductive or somewhat conductive material for the base by providing insulating means to space the electrical element from the load-bearing refractories.

These and various other objects of the invention, which will be pointed out in greater detail hereinafter, or which will be apparent to one skilled in the art upon reading these specifications, we accomplish by that certain construction and arrangement of parts, of which we shall now disclose certain exemplary embodiments.

Reference is here made to the drawings forming a part hereof, and in which:

Figure 1 is a plan view of an annealing furnace base according to our invention with the cover removed;

Figure 2 is a front elevational view of the same showing the annealing cover in broken lines;

Figure 3 is a longitudinal vertical cross sectional view through an annealing cover showing the heating means in the walls thereof;

Figure 4 is a fragmentary cross sectional view on a greatly enlarged scale taken on a line 4—4 of Figure 1;

Figure 5 is a diagram showing the arrangement of the heating element in the base;

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Figure 6 is a cross sectional view on an enlarged scale taken on a line 6—6 of Figure 2;

Figure 7 is a fragmentary plan view of the base without the spools or coils stacked thereon, as seen substantially on the line 7—7 of Figure 6;

Figure 8 is a fragmentary cross sectional view on a greatly enlarged scale taken on the line 8—8 of Figure 7;

Figure 9 is a perspective view of an insulating element;

Figure 10 is a cross sectional view taken on the line 10—10 of Figure 9;

Figure 11 is a perspective view of one of the refractory base elements;

Figure 12 is a fragmentary plan view similar to Figure 7 on a greatly enlarged scale;

Figure 13 is a plan view of a modification of an annealing base according to the invention, with the cover removed;

Figure 14 is a cross sectional view taken on the line 14—14 of Figure 13;

Figure 15 is a fragmentary enlarged view of a portion of Figure 14; and

Figure 16 is an elevational view of a modified insulating element.

By way of illustration, we have disclosed an annealing furnace of a size arranged to accommodate three stacks of standard coils, the stacks each comprising two coils one on top of the other. It will be understood that the annealing furnace and its base may be designed for any desired number of stacks, and the showing herein is by way of example only.

Reference is made to Burdette, U. S. Patent No. 2,490,412, as to details of the spool and supporting column whereby the two coils are stacked one on top of the other.

The furnace base may be mounted on a structural steel framework indicated generally at 10. On top of this structural steel framework there is provided a refractory base built up of several layers of refractory brick of conventional form, and indicated generally at 11. A coping wall of refractory material is indicated at 12, and conventional sand or other sealing structure is indicated generally at 13. A fragment of the annealing cover is shown at 14 in Figure 4. As is well known, when the annealing cover 14 is placed in position, an element projecting downwardly from the edges thereof enters into a sand pocket formed in the base to provide a seal so that special atmospheres may be provided within the furnace during the processing of the steel. The various elements just described forming no part of the present invention will not be described further. Similarly, the details of the annealing cover will not be entered into in detail, although from Figure 3 it will be apparent that the cover is lined with a refractory material, as at 15, and is provided with heating coils 16 on its inside walls. Suspension means whereby the cover may be emplaced and removed are indicated at 17.

In view of the fact that this particular furnace is arranged for three stacks of coils which are circular in projection on the horizontal plane, the heating elements which are arranged in a zig-zag pattern may be arranged to provide three generally circular outlines which will fall under the three stacks of coils as indicated in Figure 5 at A, B and C, or they may be in substantially rectangular formations as shown in Figure 13.

In placing the coils on the base the lowermost coil of each stack will be placed upon a stool or base 18, which has a central hole 19 and a column 20 will be placed thereon to support an upper stool upon which an upper coil may rest. The upper stool is indicated at 21. The upper stool may also be provided with a column as at 22 so that the stack may be made higher, and so that the stools may be interchangeable.

On top of the various layers 11 of refractory material we lay a final layer of refractory elements which may conform to the circular outline of the projection of the stools 18 upon the base as in Figures 1 to 12, or which may be arranged in a rectangular configuration as in Figure 13. One form of these elements is shown in detail in perspective in Figure 11 and in this form they

comprise a rectangular base portion 30, above which there is the upwardly extending tapered dividing tongue 31. From a consideration of Figure 8 it will be clear that when a plurality of the members 30—31 are placed side by side and secured in position by a suitable mortar, as at 32, they will provide a series of upwardly, opening, flaring channels within which the electrical heating element may be disposed. From Figure 8 it will be clear that heat exchanged by radiation from the heating element E may be accomplished through a fairly wide angle because of the flare of the space between adjacent portions 31.

Instead of the special refractory elements 30—31 just described, we may use ordinary arch brick as shown at 30a in Figures 13 to 15 inclusive. These arch bricks, because they can be machine cast, are less expensive and have better physical characteristics than the members 30—31.

In order to prevent the heating element E from coming into contact with the refractory portions 31 which would tend to cause them to burn out, we have provided holders or spacers of insulating material, as shown in Figures 9 and 10 and indicated generally by the numeral 33. The members 33 have upwardly, opening, flaring slots indicated at 34 and the edges of the slots are chamfered, as best seen at 35 in Figure 10. The relationship between the members 33 and the refractory members 30—31 is perhaps best seen in Figures 8 and 12. In Figure 8 it will be observed that the bottom of the slots 34 is above the portions 30 of the refractory members so that the heating element E is spaced from the bottom of the wide slot between the members 31. The chamfered edges 35 of the slots 34 prevent the heating element E from falling laterally into contact with the portions 31. By virtue of the chamfered edges only a very small interference with heat radiation is occasioned by their presence. The chamfers 35 permit radiation to both sides of the elements 33.

As seen in Figure 12 the elements 33 are provided in spaced relationship between each set of the members 30—31.

In some cases it may be desirable, in addition to the spacers 33, to provide a supplementary spacer 33a as shown in detail in Figure 16, and disposed as best seen in Figure 13. The use of the members 33a further insures that the ribbon of heating element will not tip and contact the brick. The members 33a are slotted as at 34a and the edges of the slots are chamfered as at 35a.

As clearly seen in Figure 7 the members 30—31 or 30a are placed upon the refractory floor 11, only to the extent of providing a roughly circular base upon which the member 18 may rest, and by which the member 18 and the coils may be supported. It will be clear that the looping of the heating element E back and forth, as best seen in Figures 5 and 7, permits the heating element to expand longitudinally with the expansion being taken up by the loops at the end of the respective courses. If there should be any buckling of the heating element, the element will not come into contact with the refractory material 31 by virtue of the spacing members 33, which are of a suitable insulating material, such as porcelain, for example.

In Figure 13 we have shown how the members 30—31 or the members 30a may be placed in a hollow rectangular formation. The structure is made still stronger by the use of central blocks 40 of refractory material to bear a portion of the load of the stools 18 and the columns 20 and thus of the upper coils. This arrangement does not detract from the heating characteristics of the base because there is no metal to be heated at the center of the coil.

By the construction disclosed herein the coils within the furnace are not heated only by radiation from the walls of the annealing cover, as has been general in the past, but are also heated by radiation to the bases 18, and by conduction from the bases 18 edgewise through the coils. The edge heating of the coils makes it possible for the inside convolutions of the coils to be heated as rapidly, or nearly as rapidly as the outermost convolutions so that a substantial and valuable reduction in annealing time and improvement in uniformity is achieved. The anneals for silicon steel coils are operations covering several days, and we have found that the annealing time can be reduced by as much as 20%

or more because of the better and more uniform heating of the coils resulting from the base heating arrangement disclosed herein. The necessary heat may be provided by an electrical input of about 10 watts per square inch, and under these conditions the life of the heating element E is perfectly normal. The construction disclosed, particularly involving the use of the spacing elements 33 and 33a, makes it possible to use Carborundum for the members 30—31 or 30a, which is advantageous because Carborundum is an excellent load-bearing refractory material, although it is a semi-conductor. Since the material of the members 30—31 or 30a does not come in contact with the heating element it is perfectly permissible to use a semi-conductor for the material of the base and thus to take advantage of the high heat conducting capacity of such materials.

It will be clear that numerous modifications may be made without departing from the spirit of the invention, and we, therefore, do not intend to limit ourselves otherwise than as set forth in the claims which follow.

Having now fully described our invention, what we claim as new, and desire to secure by Letters Patent, is:

1. An annealing furnace base having heating means therein, comprising a sub-base of refractory brick and an upper layer of refractory elements, said last named elements having rectangular bases and upwardly narrowing dividing portions, said last named elements being disposed in courses with their bases adjacent each other to provide between said courses upwardly facing flaring slots, and transverse separator members of insulating material disposed between the elements of said courses, and providing upwardly facing flaring slots aligned with said first mentioned slots, but being of less width and depth, and a ribbon of electrical resistance material sinuously disposed in said slots between said courses and supported by the slots in said separator members.

2. A structure according to claim 1 wherein the refractory elements of said upper layer have side walls which are inwardly offset above their bases, and themselves taper upwardly.

3. A structure according to claim 1 wherein the refractory elements of said upper layer are trapezoidal in cross section.

4. A structure according to claim 1 wherein the slots in said transverse separator members are provided with chamfered edges.

5. A structure according to claim 1 wherein supplementary transverse separator members are disposed between the elements of said courses, providing downwardly facing flaring slots also aligned with first mentioned slots.

6. A structure according to claim 5 wherein the slots in said transverse separator members and said supplementary transverse separator members are provided with chamfered edges.

7. A structure according to claim 1 wherein said courses are of different lengths and are arranged to provide a substantially circular heating area for the annealing of coils.

8. A structure according to claim 1 wherein said courses are of different lengths and are arranged to provide a substantially rectangular heating area with a central substantially circular supporting area devoid of a heating element.

9. A structure according to claim 1 wherein said refractory elements are of a semi-conductive material having high compressive strength.

10. A structure according to claim 9 wherein said refractory elements are of Carborundum.

11. A structure according to claim 1 wherein said transverse separator members are of porcelain.

12. A structure according to claim 1 wherein said refractory elements are of semi-conductive material having a high compressive strength and wherein said transverse separator members are provided with chamfered edges.

13. A structure according to claim 12 wherein said courses are of different lengths and are arranged to provide a substantially circular heating area for the annealing of coils.

14. A structure according to claim 12 wherein said courses are of different lengths and are arranged to provide a substantially rectangular heating area with a central substantially circular supporting area devoid of a heating element.

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