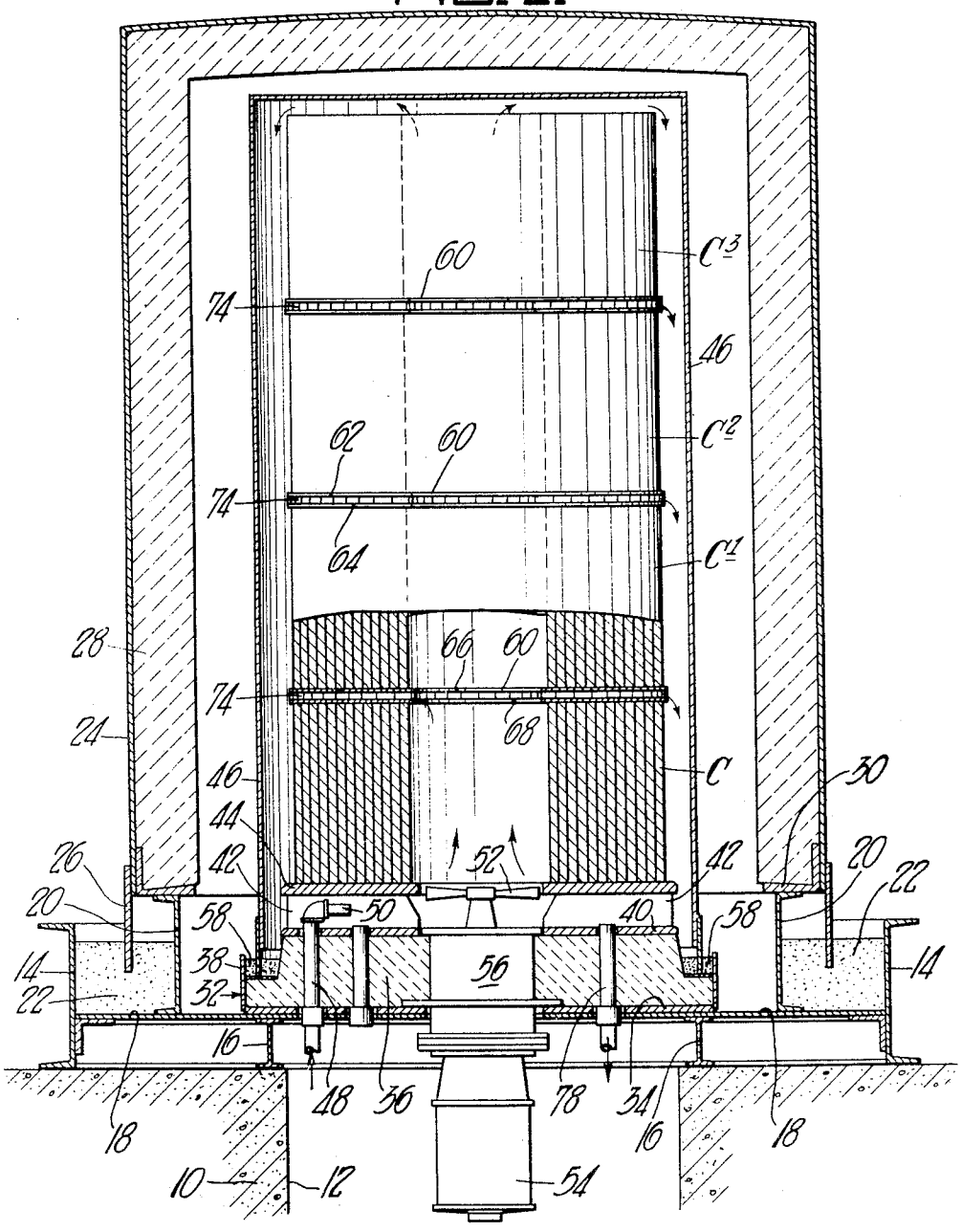
Nov. 22, 1949 W. H. DAILEY, JR 2,489,012

GAS CIRCULATING SEPARATOR

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FIG. 1.



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GAS CIRCULATING SEPARATOR

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FIG. 2.

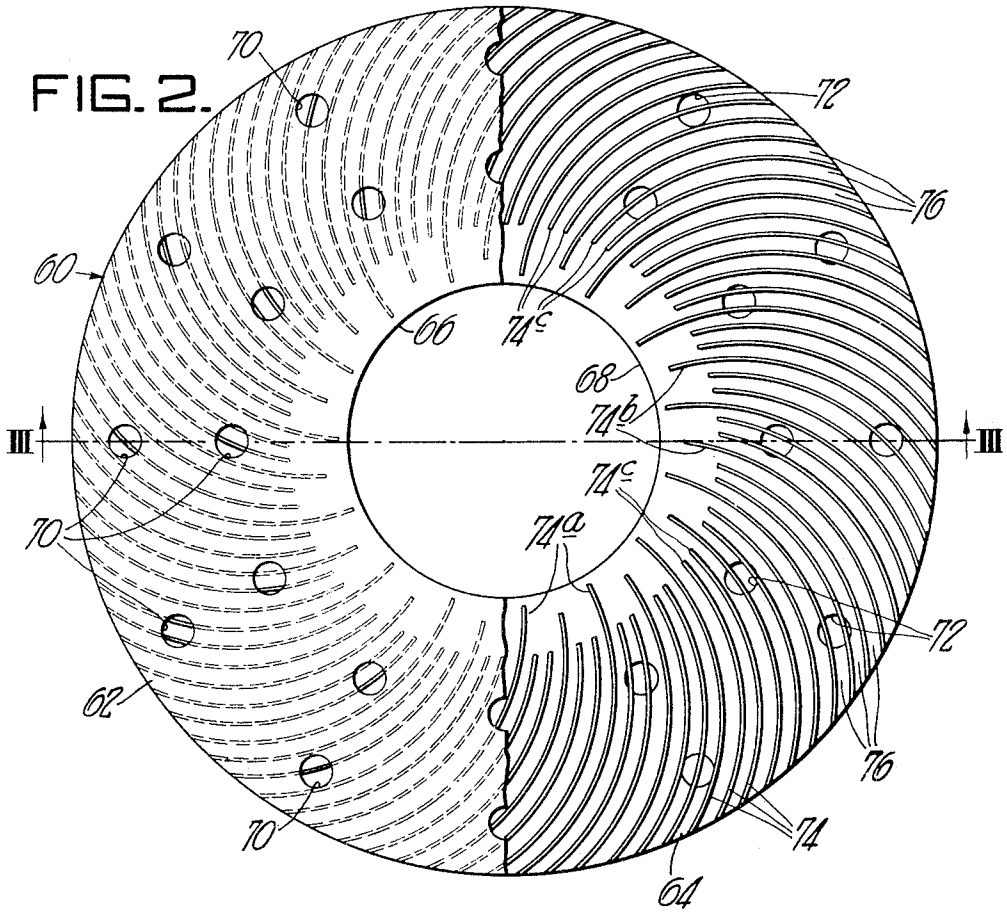
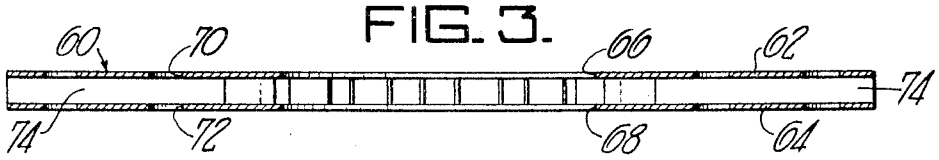


FIG. 3.



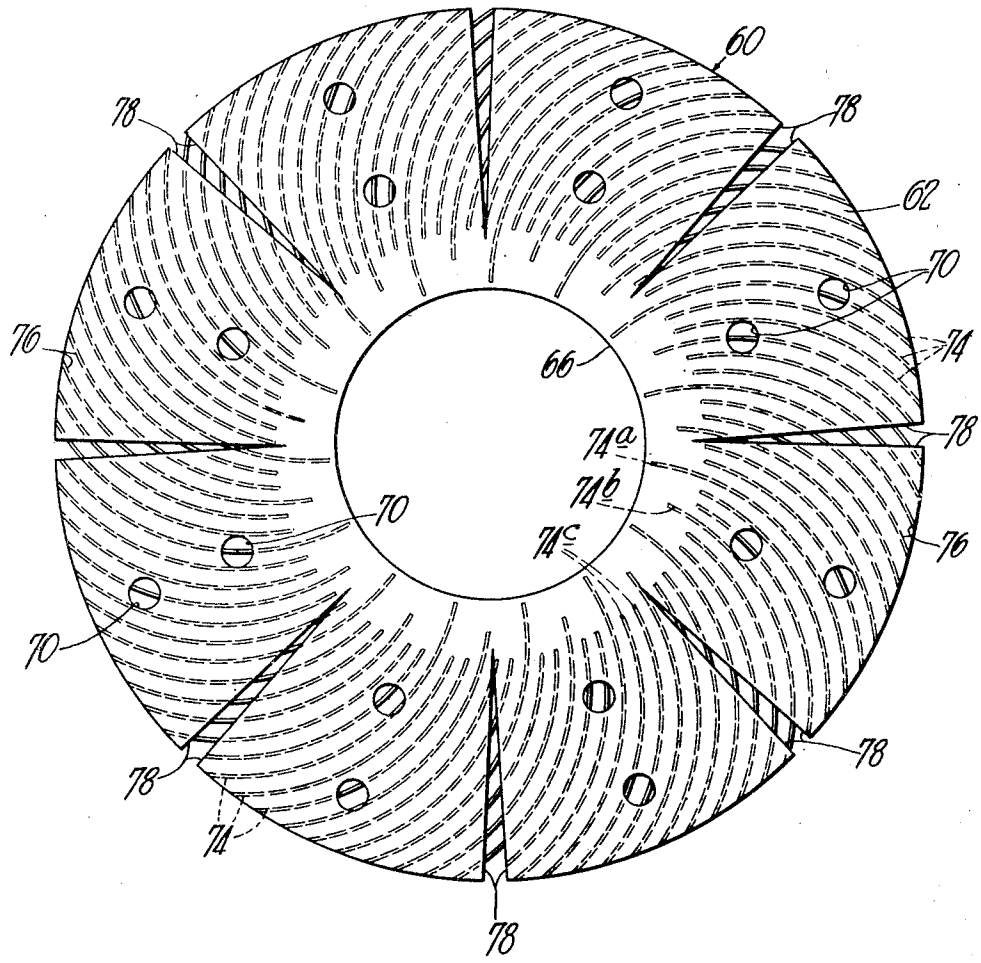
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GAS CIRCULATING SEPARATOR

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FIG. 4.



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GAS CIRCULATING SEPARATOR

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FIG. 5.

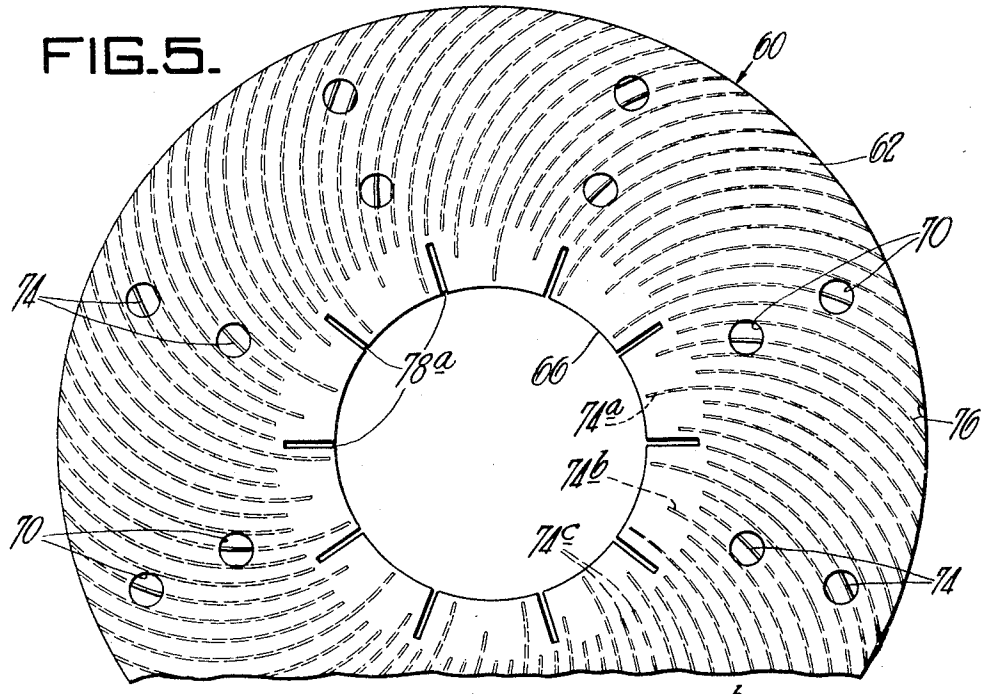
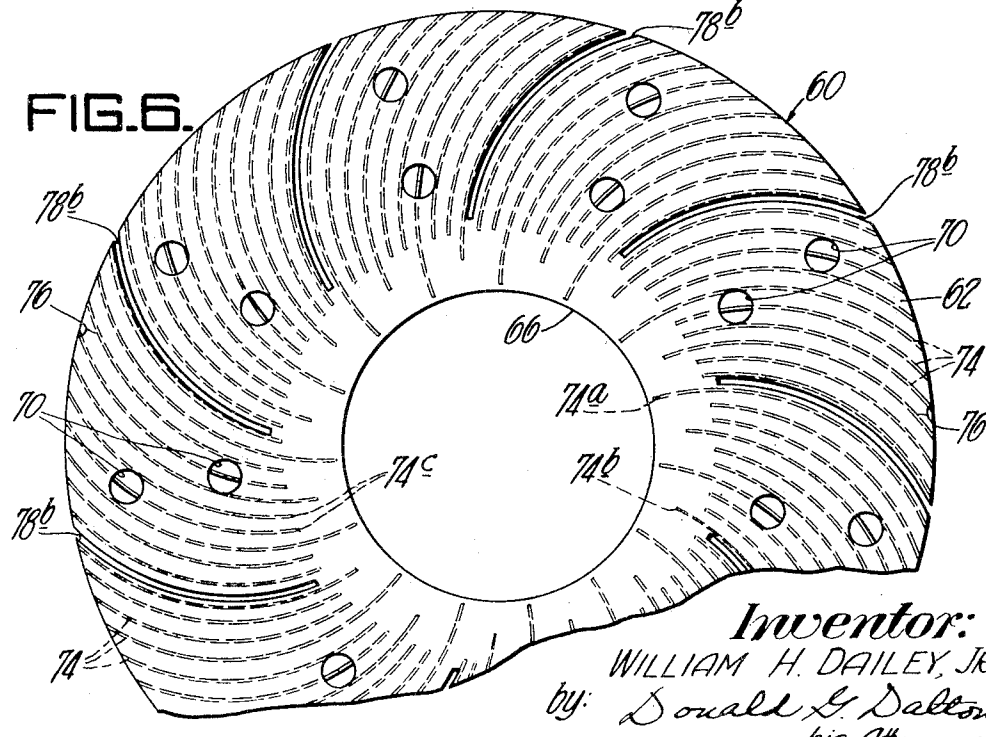


FIG. 6.



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UNITED STATES PATENT OFFICE

2,489,012

GAS CIRCULATING SEPARATOR

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Application December 28, 1946, Serial No. 719,103

7 Claims. (Cl. 263—47)

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This invention relates to improvements in gas circulating separators for coil annealing furnaces and is a continuation-in-part of the invention disclosed in application Serial No. 624,788, filed October 26, 1945, now abandoned.

Annealing of strip material in coiled form is generally performed by radiant tube, bell type furnaces, enclosing a series of inner covers placed over vertically piled coils. Refractory pedestals support the piles of coils, and circular steel plate separators are placed between coils to prevent damaging the edges. Deoxidizing gas atmosphere is piped into the inner covers through the coil stand and circulates through the open metal casting supporting the charge, upwardly through the open inner centers of the piled coils, emerging at the top and flowing thence in a downward direction between the outer surfaces of the coils and the inner cover until it again enters the base casting or is forced out through the sand seal at the base of the inner cover. In order to improve this circulation of gas, electric circulating fans are installed in the coil stand.

Heat for annealing is obtained from the radiant tube furnace and is transmitted through the inner covers to the coils principally by radiation. Heat transfer through coiled material is much slower than through solid material due to the presence of insulating air layers between convolutions, and when annealing high stacks of coils this causes a slow and uneven heat transfer since most of the heat applied is radiated from the inner cover to the outside convolutions of the coils.

The chief object of the present invention is to provide means to speed up the heat transfer to all coils in a stack, and cause a uniform rate of heat transfer between each coil and the separator at all points along the curved paths of gas flow defined by the curved vanes of the separator.

Another object of the invention is to improve annealing performance by providing novel separator means between vertically piled coils which will direct circulation of the hot annealing atmosphere over a heat transfer surface in such manner that the amount of heat input is uniform over the entire area between piled coils.

A further object is to provide means whereby piled coils can be raised to the required temperature quickly and evenly in a shorter length of annealing time than possible by the old practice of piling coils with flat plates or discs between them.

Another more specific object is to slit or cut away the top and bottom plates of the separator elements in such manner that different areas or

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segments thereof may move relatively to one another under the influence of expansion and contraction so as to avoid fracturing the welded joint or other union between said plates and the upright vanes associated therewith which define a multiplicity of gas passages.

For a more complete understanding of the invention, reference should be made to the following detailed disclosure, the accompanying drawings, and the appended claims.

In the drawings:

Figure 1 is a vertical longitudinal section through an annealing furnace equipped with the improved gas circulation separators herein claimed.

Figure 2 is an enlarged plan view of the improved gas circulating separator with the top plate broken away to show the shape and arrangement of the gas passages formed between the vanes separating the top and bottom plates of the separator.

Figure 3 is a transverse section on line III—III of Figure 2, but with the vanes uncut or shown in vertical elevation.

Figures 4, 5, and 6 are plan views of gas circulating elements similar to that shown in Figure 2 but modified to permit the different areas or segments thereof to move relatively to one another under the influence of expansion and contraction.

Referring in detail to the drawings, reference numeral 10 represents any suitable masonry foundation having a chamber 12 therein for giving access to the under side of the annealing furnace. Suitably supported on the foundation is a structural steel marginal frame formed of channels or other rolled structural sections 14. Spanning the space between the members 14 are a plurality of floor beams 16 to which are secured a steel or other metal floor 18. Spaced from the marginal frame members 14 above the floor are channel members 20, the space between the outer members 14 and the members 20 being partially filled with a gas sealing medium 22 such as sand. An outer annealing furnace cover 24 is provided which at its lower end carries a downwardly projecting lip 26 which enters the sand seal 22. The outer cover is formed with a refractory lining 28 of conventional form and is equipped with a bottom frame 30 which takes its bearing on the channel members 20. The outer cover will be equipped with any conventional annealing furnace heating means such as radiant tubes which, forming no part of the present invention, are not further shown.

Resting on the floor 18 of the furnace proper is a stand indicated as a whole at 32. This stand includes a bottom plate 34 supporting a body of refractory material 36 which is partially enclosed by an outer ring 38 welded or otherwise secured to the base plate 34. Seated on top of the stand is an intermediate plate 40 having upstanding ribs 42 on which rests a top plate 44, the parts 40, 42 and 44 jointly constituting a stool loosely resting on the stand 32, this stool being adapted to have stacked on top thereof a plurality of coils of flat steel strip such as indicated at C, C^1, C^2, and C^3. In the drawings I have illustrated only four such coils, located in a vertical pile, but in practice it will be understood that there will usually be many more, since present-day practice involves piling the coils one on top of another to a height of ten feet or more. Each stack of coils is adapted to be enclosed by an inner sheet metal cover 46. A deoxidizing gas is adapted to be introduced by way of supply pipe 48 and discharged through a laterally extending nozzle 50 into the passageway defined by the ribs 42 and the top and bottom plates of the stool. A fan impeller 52 is adapted to be driven by any conventional form of fan mechanism 54 which may be secured to a housing 56 which in turn is secured to the bottom plate 34 of the stand.

The lower end of the inner cover 46 enters a body of sealing material such as sand or the like, indicated at 58, retained in an annular seat portion between the refractory body 36 and the outer shell 38 of the coil stand.

A particular feature of the herein claimed invention relates to the provision of means for speeding up the annealing operation of vertically stacked coils, and to this end I interpose between each of the adjacent coils of the pile an improved gas circulating separator indicated as a whole in the drawings by reference numeral 60. Each gas circulating separator is formed of a pair of spaced plates 62 and 64 of circular form, formed with registering central apertures 66 and 68. The plates are provided with a plurality of rows of perforations 70 and 72, and are separated from one another by a multiplicity of vanes 74 which, as best shown in Figure 2, are preferably of an especially curved shape as viewed in plan, so as to define a multiplicity of curved gas passages 76. As clearly shown in the drawings, the vanes 74 are of varying lengths. The longest vanes, indicated at 74^a, extend from a point immediately adjacent the central aperture in an arcuate direction toward the outer periphery of the plate. Somewhat shorter vanes 74^b extend from a different radial point to the outer peripheries. Located between the longest vanes 74^a and the vanes of intermediate length 74^b is a pair of shorter vanes 74^c. The relative position and disposition of the vanes and the curvature thereof is such that as the gas flows, for example, from the central region outwardly, a swirling motion will be imparted to the body of gas. Thus the gas circulated through the apparatus will be broken up into a multiplicity of different whirling streams. The arrangement is intended to give substantially uniform gas velocity and a substantially uniform ratio of heating surface to the projected area over the entire upper and lower face of each separator plate, thus insuring a uniform heat input to all parts of the end edges of each convolution of coils in the pile.

For best results I have determined that the heat transfer per unit of projected area of the end of the coil should be the same at all points over the end coil surface, to insure uniform heat treatment of all parts of the coil.

For coils of relatively small outside diameter such, for example, as those in which the outside diameter is not over two and one-half times the inside diameter, I have determined that the gas velocity and amount of heat transfer surface per unit of projected area may be kept uniform over all points, by the use of especially curved vanes, as herein shown and described. The curvature of the vanes 74 and the construction and arrangement thereof is such that the gas velocity is substantially uniform at all radial points in the passages defined by said vanes. Thus the rate of heat transfer is also substantially uniform at all radial points of each separator. It is contemplated, however, that for coils of larger diameter, for example, those over two and one-half times the inside diameter, the separators may be so constructed and arranged that the heat transfer rate is maintained substantially uniform over all parts of the projected area by so designing the curvature of the vanes that the gas velocity will be enough greater near the exit end of the separator to compensate for the temperature drop of the gas flowing in the passageway between the vanes.

The contour of each vane as viewed in plan starts in a radial direction at the inner portion of the coil, and is so designed that for each point on the curve the cosine of the angle of deviation from the radial direction is equal to the ratio of the inside radius of the coil divided by the outside radius at the point in question. For practical purposes the curvature of the vanes will be laid out graphically in the manner just described, and a combination of arcs will be drawn very closely approximating the true theoretical curvature. Such a combination of arcs will greatly facilitate the formation of the vanes by conventional types of metal bending or forming equipment, but of course special forming templates may be used to produce the exact curvatures as determined by the calculations above referred to.

The presence of the holes 70 and 72 aids in the removal of gases given off by the convolutions of coils during the heating, and exposes end portions of the coil convolutions to the hot annealing gases circulating through the separator. With the fan impeller 52 circulating in one given direction, the deoxidizing gas will be forced upwardly in the direction of the arrows in Figure 1, through the central void in each of the coils in the pile, and the gas will then flow laterally, in a multiplicity of separate streams, through the many passageways defined by the curved vanes 74, 74^a 74^b and 74^c. The flow will then be downward between the outside of the coils and the inner face of the inner cover 46, some of the gas escaping through the sand seal 58 or through outlet pipes 78 extending through the coil stand. By reversing the direction of rotation of the fan, the flow of gases may also be reversed so that they will flow upwardly between the inner cover and the outside convolutions of the coils, thence inwardly through the passageways of the separators and downwardly through the central void of the coils, thence past the fan impeller and out through the central opening in the housing of the fan-supporting structure.

Figures 4, 5, and 6 illustrate alternative constructions for the top and bottom plates 62 and 64 of the gas circulating separator elements indicated

as a whole in the drawings by the reference numeral 60. In the construction of Figure 4 I have illustrated a plurality of tapered or wedge-shaped slits or cut-away portions 78 converging inwardly from the circumference of the top and bottom plates. In Figure 5 I have shown a plurality of simple radial kerfs or saw cuts 78^a extending outwardly from the central openings 66 of the top and bottom plates. In Figure 6 I have illustrated a plurality of curved slits 78^b which are approximately or substantially parallel to the vanes 74^a, 74^b or 74^c. The purpose of interrupting the top and bottom separator plates by either the tapered slits 78 or the radial slits 78^a or the curved slits 78^b is to permit different areas or segments of the respective plates to move relatively to one another under the influence of expansion or contraction so as to avoid transmitting a strain to the welded joints or unions between the said plates 62 and 64 and the upright vanes 74^a, 74^b and 74^c associated with these plates.

In have demonstrated by an actual reduction to practice that the provision in said plates of slits or cut-away portions overcomes the problem of warping or distorting the top and bottom plates and also relieves or prevents strains due to expansion and contraction which tend to break the welded union between the top and bottom plates and the vanes. It will also be understood that different parts of the vanes are adapted to bend under the influence of expansion and contraction and thus relieve the strain at the points of welded union between the vanes and the top and bottom plates.

While I have described quite precisely a practical embodiment of the invention which an actual reduction to practice has demonstrated to be highly desirable, it will be understood that I am not limited thereto, since various modifications and substitutions of equivalents may be made by those skilled in the art within the scope of the appended claims.

I claim:

1. A gas circulating separator adapted to be interposed between the individual coils of a vertical pile of coils being annealed, comprising spaced plates separated by a plurality of curved vanes defining gas circulating passages between said plates, the vanes being joined to the plates at the top and bottom edges and said plates having a plurality of cut-away portions adapted to compensate for expansion and contraction of the flat plates and to permit them to move relatively to one another and also to permit the said vanes to bend under the influence of such expansion and contraction rather than to break or weaken the joints uniting the vanes to the plates.

2. A gas circulating separator adapted to be interposed between the individual coils of a vertical pile of coils being annealed, comprising spaced plates separated by a plurality of curved vanes defining gas circulating passages between said plates, the vanes being joined at their top and bottom edges to said plates by bodies of welded metal, said plates having a plurality of slits therein adapted to permit expansion and contraction of the plates without warping them and to permit said vanes to bend under the influence of expansion and contraction rather than to break the welded joints uniting the vanes to the plates.

3. The gas circulating separator according to claim 2 is further characterized in that said slits are of acute angular form converging inwardly from the periphery of said plates.

4. The gas circulating separator according to claim 2 is further characterized in that said slits are radial kerfs extending outwardly from the axial region of said plates.

5. The gas circulating separator according to claim 2 is further characterized in that said slits are curved kerfs substantially parallel to said vanes.

6. A gas circulating separator adapted to be interposed between the individual coils of a vertical pile of coils being annealed, comprising a pair of spaced centrally apertured plates having a plurality of rows of perforations therein, said plates being co-extensive with the base of the coils, and a plurality of vanes secured at their top and bottom edges to said plates, said vanes being curved in a generally radial direction and being spaced apart to define curved gas circulating passages between the plates.

7. A gas circulating separator adapted to be interposed between the individual coils of a vertical pile of coils being annealed, comprising a pair of spaced centrally apertured plates, said plates being co-extensive with the base of the coils, and a plurality of vanes secured at their top and bottom edges to said plates, said vanes being curved in a generally radial direction and being spaced apart to define curved gas circulating passages between the plates.

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