March 12, 1963 C. C. BLACKMAN ET AL 3,081,074

APPARATUS FOR ANNEALING COILS OF STRIP METAL

Filed Dec. 19, 1957 4 Sheets-Sheet 1

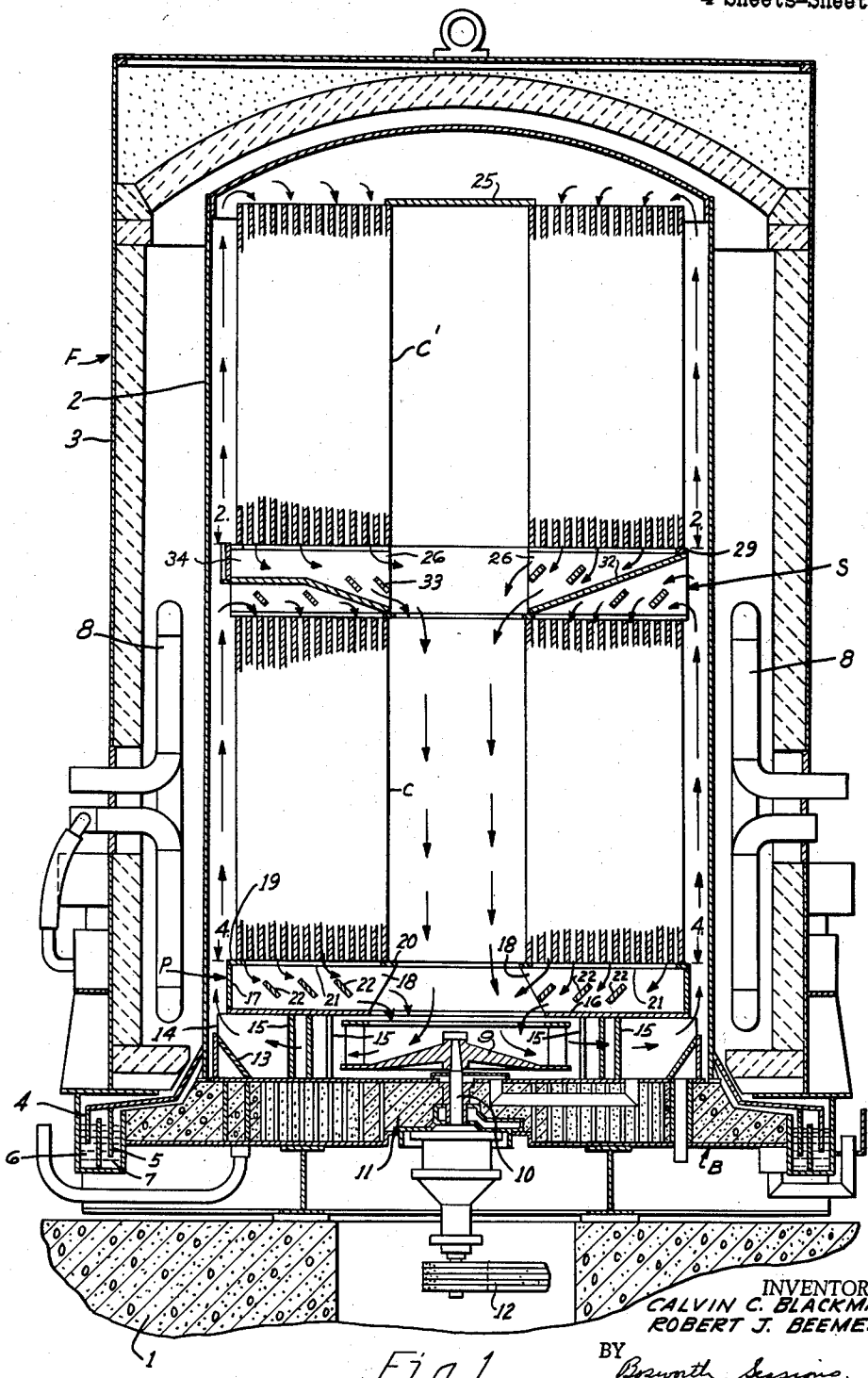



Fig. 1.

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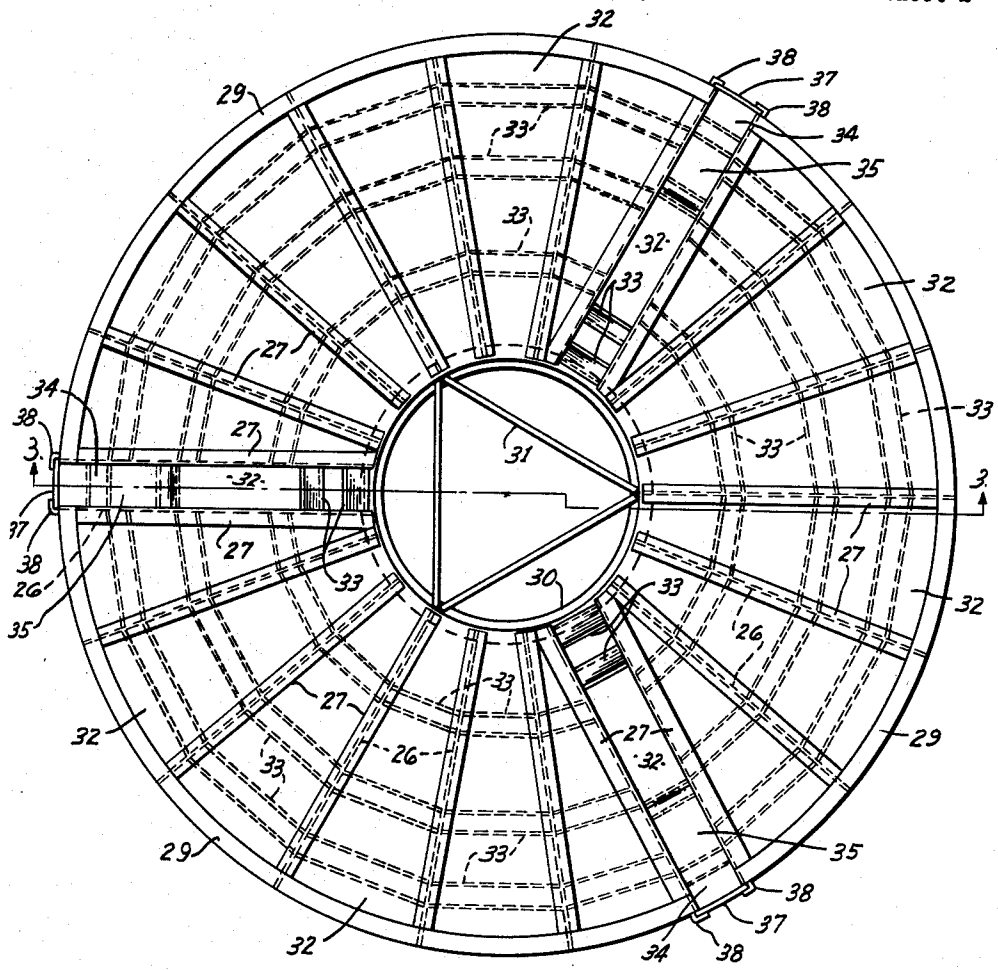



Fig. 2

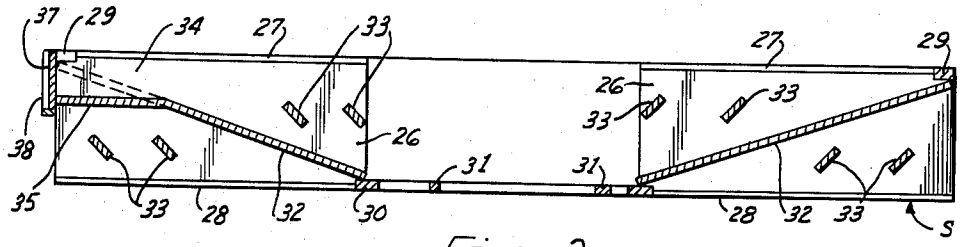



Fig. 3

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APPARATUS FOR ANNEALING COILS OF STRIP METAL

Filed Dec. 19, 1957

4 Sheets-Sheet 3

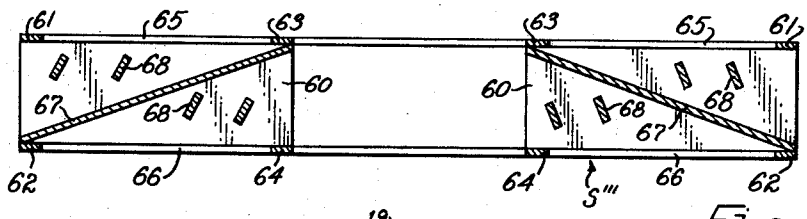



Fig. 10.

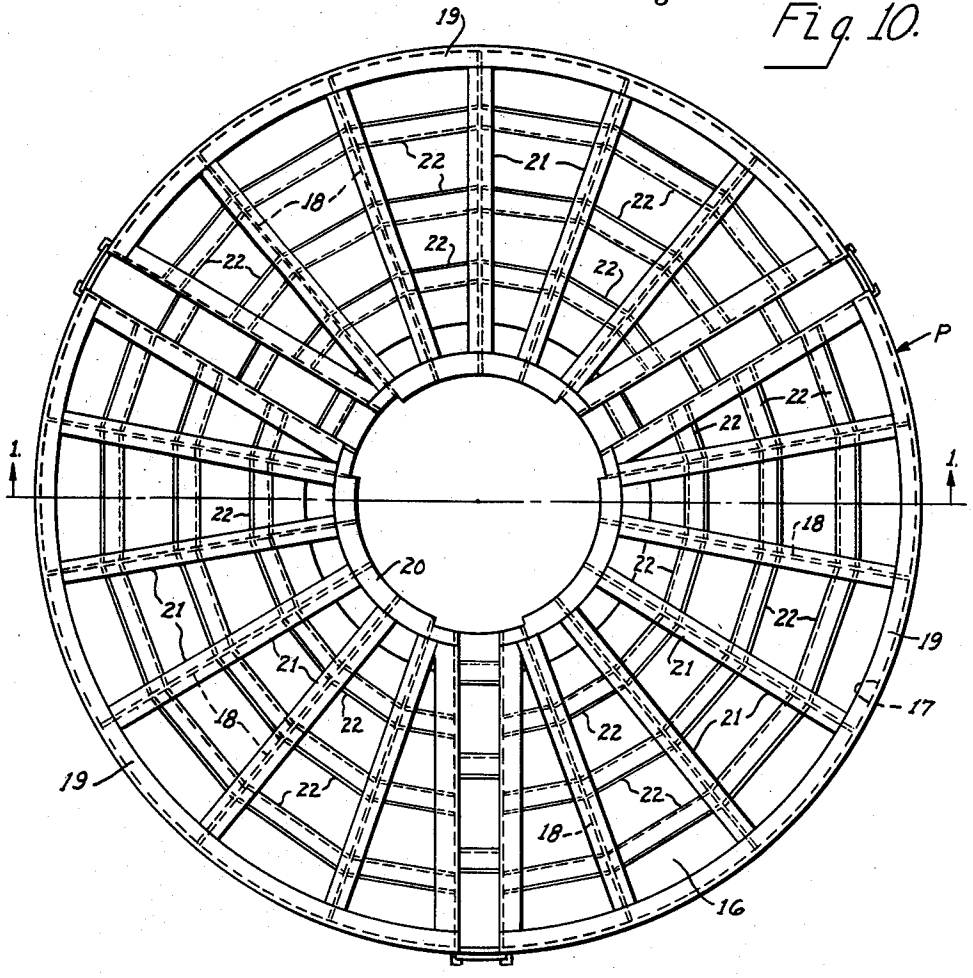



Fig. 4.

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4 Sheets-Sheet 4

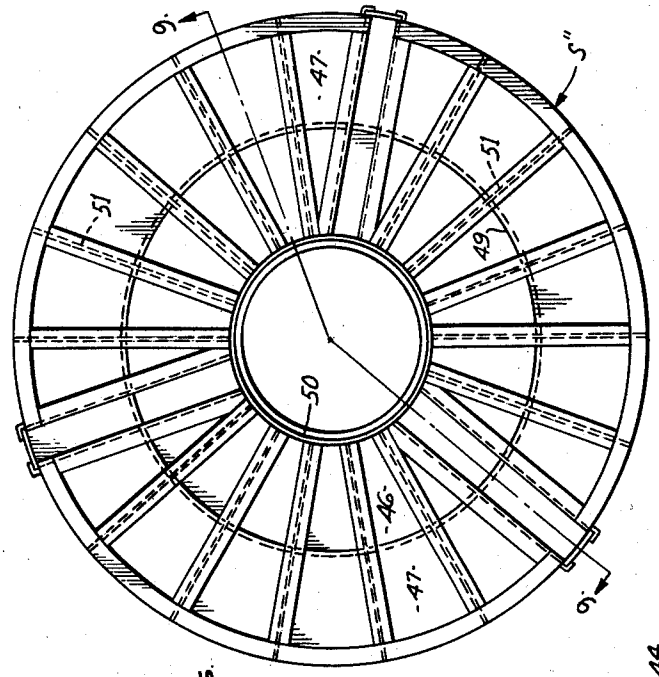



Fig. 8.

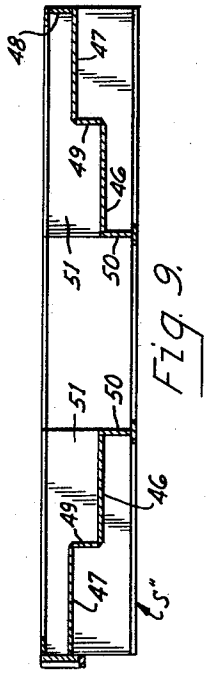



Fig. 9.

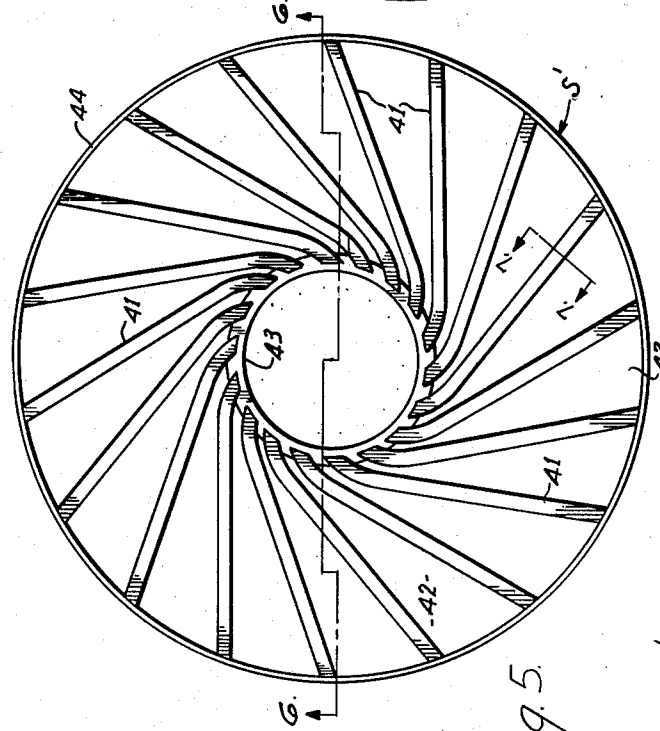



Fig. 5.

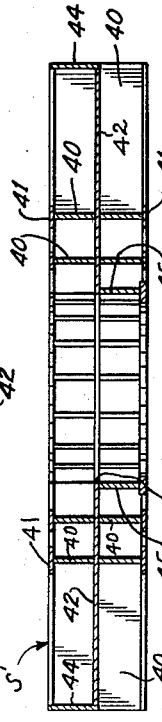



Fig. 6.

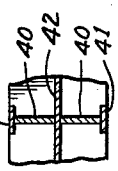



Fig. 7.

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# 3,081,074
# APPARATUS FOR ANNEALING COILS OF STRIP METAL

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Filed Dec. 19, 1957, Ser. No. 703,905
4 Claims. (Cl. 263—47)

This invention relates to the annealing of coils of strip metal and more particularly to apparatus for carrying out the annealing of open coils by moving heated gas vertically through the passages between the laps.

In the copending United States patent application of Lee Wilson and Edwin A. Corns, Serial No. 639,939, filed February 13, 1957, the assignee being the same as in the instant case, a method of and apparatus for annealing coils of strip metal is disclosed wherein a tight wound coil is recoiled into an open coil having spaced apart laps, and the open coil is then heated by forcing hot gas vertically through the passages.

It is among the objects of the present invention to provide means for supporting an open coil on a furnace base whereby adequate support will be provided while permitting flow of gas vertically through the passages in the coil with a minimum of resistance. Another object of our invention is the provision of coil spacing means whereby two or more coils may be stacked one upon the other with their axes vertical and heated gas is directed in a manner to effect the desired flow through the passages in the stacked coils. Other objects of our invention include the provision of coil support and coil spacer means for use in the annealing of open coils by convection heating from high velocity gases which are of rugged design and construction and which may be economically fabricated and maintained in service.

The above and other objects of our invention will appear from the following description of several embodiments thereof, reference being had to the accompanying drawings in which:

FIGURE 1 is an illustrative vertical cross sectional view of a bell type furnace in which our improved bottom coil support and plenum chamber is used and in which our improved coil spacer and support is employed between two superimposed open coils;

FIGURE 2 is a plan view of the coil spacer shown in FIGURE 1, taken substantially on line 2—2 of FIGURE 1;

FIGURE 3 is a vertical cross sectional view taken substantially on line 3—3 of FIGURE 2;

FIGURE 4 is a plan view of the bottom coil support and plenum chamber, taken substantially on line 4—4 of FIGURE 1;

FIGURE 5 is a plan view of a modified coil spacer which may be employed to separate the coils of a stack which is being subjected to open coil annealing as disclosed in said copending application of Lee Wilson and Edwin A. Corns, Serial No. 639,939;

FIGURE 6 is a vertical cross sectional view taken substantially on line 6—6 of FIGURE 5;

FIGURE 7 is a fragmentary vertical cross sectional view taken substantially on line 7—7 of FIGURE 5;

FIGURE 8 is a plan view of another modified form of coil spacer, made in accordance with our invention;

FIGURE 9 is a vertical cross sectional view taken substantially on line 9—9 of FIGURE 8; and

FIGURE 10 is a vertical cross sectional view generally similar to FIGURE 3 but illustrating a modification of the form of coil spacer shown in FIGURE 3.

Referring to FIGURE 1, the furnace structure F includes a base B mounted on a suitable foundation 1 and adapted to support the usually relatively thin metal closed top cylindrical inner cover 2 and the furnace bell



3. At the lower end of the inner cover 2 are annular sealing flanges 4 and 5 which extend into corresponding troughs 6 and 7 in the base B. The troughs are filled with sand or liquid to provide a suitable gas seal at the bottom of the inner cover. A plurality of radiant heating tubes 8 are mounted in the side wall of the furnace bell 3 and are connected to suitable sources of fuel and air. When the furnace is in operation, these radiant tubes are heated to high temperature by combustion of the fuel therein, and the heat is transferred to the inner cover 2 and from the inner cover to the atmosphere within the inner cover.

In accordance with the procedure described in the above referred to copending Lee Wilson and Edwin A. Corns patent application, the atmosphere within the inner cover is forced at high velocity vertically through the passages between the laps of an opened coil, then adjacent to and in contact with the inner surface of the inner cover where it is heated, and back through the coil, etc. until the desired annealing temperature is reached. This gas movement is effected by a centrifugal fan or blower 9 mounted on a vertical shaft 10 which projects down through the portion 11 of the base B. The fan 9 may be driven by any suitable means, such as the belts 12, and a charge support and diffuser 13 directs the gas discharged from the periphery of the fan 9 outwardly and upwardly through the annular opening 14 at the periphery of the charge support and diffuser 13. Included in the diffuser structure are a plurality of radially extending vanes 15 which have their inner ends adjacent the outer periphery of the fan 9, their outer ends at the outer periphery of the diffuser assembly, and their upper edges lying in a common horizontal plane slightly above the top of the fan 9 and forming a support for the furnace charge

Carried on the charge support and diffuser 13 and resting on top of the vanes 15 is a plenum chamber generally indicated at P. The unit P acts as a coil support and includes an annular base plate 16 having a central opening substantially equal in size to the top inlet of the fan 9 and disposed coaxially therewith, an outer generally cylindrical wall member 17, and a plurality of circumferentially spaced vertically extending coil supporting web members 18 secured to and supported by the base 16 and outer wall 17. Reinforcing rings 19 and 20 extend around the plenum chamber unit P at the outer and inner peripheries thereof and at the top of the webs 18. bearing strips 21 are preferably carried on and form the top edges of the webs 18 and extend between the rings 19 and 20. As clearly seen in FIGURES 1 and 4, angularly disposed struts 22 extend between and assist in stiffening and supporting the vertical webs 18. As will appear later these struts also assist in guiding and directing the flow of gas as it emerges from the passages between the laps of the bottom coil being treated.

Supported on the top of the plenum chamber P is an open coil C. This consists of a long strip of relatively thin metal which has been re-coiled from a tightly wound condition to an open condition in which the laps of the coil are spaced apart from each other a substantial distance, preferably from about one-half to about three times the strip thickness, to provide unimpeded vertical passages between the laps of the coil. If only a single coil C is to be annealed in the furnace, it is only necessary to place a top cover plate, such as seen at 25 in FIGURE 1, on top of and covering the central opening in the coil C and then start the blower 9 whereupon the atmosphere will be circulated from the blower radially outwardly and through the annular passage 14, upwardly between the inner cover 2 and the outer surface of the coil C and then downwardly through the passages between the laps of the coil and back into the fan inlet through the plenum chamber unit P.

However, if two or more coils are to be annealed in the furnace at the same time, it is necessary to provide means for directing the furnace atmosphere vertically through the laps of each of the coils to be annealed, and in order to accomplish this result, we provide coil spacers such as that indicated at S in FIGURES 1, 2 and 3. As best seen in FIGURES 2 and 3, the coil spacer S comprises a plurality of radially extending vertical web members **26** having top bearing strips **27** and bottom bearing strips **28** forming their upper and lower coil engaging edges respectively. An outer reinforcing ring **29** is disposed at the upper outer corners of the webs **26**, and an inner bottom reinforcing ring **30** is disposed at the lower inner corners of the webs **26**. The diameter of the inner ring **30** is approximately equal to the inner diameter of the coils being annealed, and the inner ends of the webs **26** lie substantially on this circle.

Stiffening bars **31** may be provided to add rigidity to the structure, and the inclined baffle wall **32**, which is generally annular in form, extends circumferentially between the adjacent webs **26** and, as illustrated, has its outer periphery disposed substantially at the upper outer corners of the webs **26**, and its inner periphery disposed approximately at the lower inner corners of the webs. Thus it may be said that the baffle wall means **32** has one periphery disposed at the top common plane in which the upper edges of the webs **26** lie in its other periphery disposed at the bottom common plane in which lie the lower edges of the webs **26**. Extending between each pair of webs **26** are a plurality of reinforcing and stiffening struts **33**. These are secured to the adjacent webs between the top and the bottom edges thereof and extend generally circumferentially of the coil spacer assembly S. As best seen in FIGURES 1 and 3, they are inclined downwardly and inwardly so as to assist in directing the flow of gas in a generally radially inwardly and downwardly direction as will be more fully referred to later.

In our copending United States patent application Serial No. 701,092, filed December 6, 1957, now Patent No. 2,988,349, we have described and claimed an improved apparatus for supporting and handling open coils, and the coil spacer S and plenum chamber P illustrated herein incorporate radial slots or troughs to accommodate the coil lifting bars that are disclosed and described in our said copending application. In FIGURES 2 and 3 these radial slots or troughs are seen at **34**, and it will be noted that at the troughs **34** a portion **35** of the baffle wall **32** is extended horizontally to form the bottom of the trough, the sides of which are formed by the adjacent and parallel webs **26**. Removable sliding closure plates **37** are adapted to be disposed at and close the ends of the troughs **34**, guideways **38** being mounted at the outer ends of troughs **34** to hold plates **37** in position during annealing. As fully explained in our copending application, these plates **37** are removed when a coil is being placed on or removed from the coil support.

Referring to FIGURE 1, the coil spacer S is disposed on the top of the open coil C which in turn rests on and is supported by the bottom plenum chamber P. The coil spacer S is coaxially disposed on the coil C so that center openings therein are aligned. The baffle wall **32** in effect divides the coil spacer S into top and bottom chambers, the top chamber being open on top over substantially its entire area, except for the vertical webs **26**, and being closed around the outer periphery of the coil because the baffle wall **32** extends substantially to the common plane of the top edges of webs **26** which engage and support the lower edges of the strip of the upper coil C'. When the furnace atmosphere is forced downwardly through the passages of the laps of the coil C', it emerges at the bottom of said passages into the upper chamber of the spacer S and is directed by the baffle wall **32** inwardly into the center opening in the spacer S and thence downwardly through the center opening in the coil C into the inlet of the fan **9**. The top cover plate **25** is positioned over the center opening in coil C' before the inner cover **2** is placed in position, and it prevents furnace atmosphere from flowing directly through the center opening in the upper coil C'.

The coil spacer S is open around its outer periphery below the outer edge of baffle wall **32** and reinforcing ring **29**. Furthermore the bottom of the coil spacer S is open except for the vertical webs **26** and the bearing strips which form the bottom edges thereof, if such are employed. Thus furnace atmosphere may enter radially into the spacer S from the outer periphery thereof and be directed by baffle wall **32** down into the tops of the passages between the laps of the bottom coil C by virtue of the pressure differential created by the fan **9** between the top and bottom of the coil C.

The circulation of the atmosphere within the inner cover when two coils C and C' are being annealed is clearly illustrated by the arrows in FIGURE 1. The atmosphere is moved radially outwardly by the fan **9** through the annular passage **14** of the charge support and diffuser **13**. As the base plate **16** and outer wall portion **17** of the plenum chamber P together form in effect a baffle wall having its outer periphery at the upper plane of the charge support and its inner periphery spaced inwardly and downwardly therefrom, the gas leaving the annular opening **14** is baffled away from the bottom of coil C and moves upwardly between the inner cover **2** and the outside of the coil C. When the coil spacer S is reached, a part of the upwardly moving gas flows inwardly between the webs **26** and below the baffle wall **32** and necessarily moves downwardly through the passages between the laps of the bottom coil C. When this gas emerges at the bottom of the coil C, it is directed by the baffle wall **16—17** of the plenum unit P into the inlet of the fan **9** for recirculation.

The parts and the passages of our apparatus are so proportioned that a volume of gas substantially equal to that which enters the top of the coil C moves on upwardly between the inner cover **2** and the outside of the upper coil C'. This gas is forced downwardly into the passages between the laps of the upper coil C' because the center opening of coil C' is closed by the cover plate **25**. When the gas which has entered the top of coil C' emerges from the bottom thereof, it is directed by the baffle wall **32** into the center of the spacer S and from thence downwardly through the center opening in coil C into the fan inlet for recirculation.

From the above it will be observed that, by use of our improved coil spacers and/or bottom plenum chamber, one or more open coils may be annealed in a furnace with substantially uniform heating of each of the coils. It will be understood that the heat source illustrated (the radiant tubes 8) is not necessarily drawn to scale and that such tubes, or other heat source, are so located, and of such size, that the gas is so heated as it moves upwardly between the inner cover and the outside of the coils C and C' that both coils receive heat in substantially the same degree and at substantially the same rate.

Although we have illustrated the flow of atmosphere within the inner cover as being upwardly between the inner cover and the outside of the coils and downwardly through the passages between the laps of the coils, this flow might be reversed by providing a fan which would draw atmosphere in through the annular opening **14** in the charge support and diffuser **13** and direct it upwardly through the center opening in the plenum chamber P and the center openings in the coils C and C'. If more than two coils are to be annealed at the same time, spacers S would be disposed between each pair of adjacent coils.

The exact form and arrangement of the coil support units, i.e., the bottom plenum P and the coil spacers S may be varied without departing from our invention and in FIGURES 5–10 we have shown several different embodiments of such modified coil spacers.

The coil spacer of FIGURES 5–7 consists of a plurality of vertical webs **40** which are disposed in generally spiral

radial arrangement. These webs may have bearing strips **41** at their top and bottom edges, but it will be understood that in some cases these bearing strips may be omitted. A horizontally extending annular baffle member **42** is disposed about midway of the height of the webs **40** and extends from their inner to their outer ends. The baffle member **42** has a circular center opening **43** therein and has at its outer periphery an annular vertical extension portion **44** which extends up to the top common plane of the webs **40** of the coil spacer unit S'. A similar vertical annular extension portion **45** extends downwardly from the inner edge of the baffle portion **42** substantially to the common plane of the lower edges of the webs **40**. With the arrangement just described the baffle wall means is made up of the annular member **42**, the outer portion **44**, and the inner portion **45** which together provide a baffle wall having its outer periphery substantially at the top common plane of the coil engaging web members and its inner periphery substantially at the bottom common plane of the coil engaging web members. When a spacer S' is disposed between two coils that are superimposed for annealing, the atmosphere flow is directed in the same manner as was previously described in referring to coil spacer S.

Another modified coil spacer S'' is illustrated in FIGURES 8 and 9. This spacer is substantially the same as that shown in FIGURES 2 and 3 except that the baffle wall, instead of being formed as an inclined annular plate **32** consists of a pair of vertically offset radially spaced horizontally disposed annular rings **46** and **47** which are connected by vertical rings **48**, **49** and **50** to form a baffle wall which extends from the upper common plane of the webs **51** at the outer periphery of the spacer S'' to the bottom common plane of the webs **51** at the inner periphery of said spacer unit. The operation of spacer S'' is also substantially the same as spacer S.

In some cases it may be deemed desirable to have the baffle wall means of the coil spacer or plenum unit so arranged that its inner periphery is disposed at the upper common plane of the webs while its outer periphery is disposed at the lower common plane of the webs. Such a spacer is generally indicated at S''' in FIGURE 10. This spacer includes a plurality of radially extending vertical web members **60** connected together by an upper outer ring **61**, a lower outer ring **62**, an upper inner ring **63** and a lower inner ring **64**. The upper and lower coil engaging edges of the webs **60** may also carry bearing strips **65** and **66** generally similar to bearing strips **27** and **28** seen in FIGURES 2 and 3. An inclined baffle wall **67**, which is generally annular in form, extends circumferentially between the adjacent webs **60** and has its outer periphery disposed substantially at the lower outer corners of the webs **60** and its inner periphery disposed approximately at the upper inner corners of the webs. Extending between each pair of adjacent webs **60** are a plurality of reinforcing and stiffening struts **68** which are secured to the adjacent webs between the top and bottom edges thereof and are preferably inclined to assist in directing the flow of gas through the spacer.

Although we have described the illustrated embodiments of our invention in considerable detail, it will be understood that variations and modifications may be made in the form and proportion of the apparatus employed to carry out our invention. Accordingly we do not wish to be limited to the specific structures herein illustrated and described but claim as our invention all embodiments thereof coming within the scope of the appended claims.

We claim:

1. A coil spacer for spacing apart open coils during annealing comprising, a grid structure including a plurality of radially extending web members, said web members having lower edges lying in a bottom common plane and adapted to rest on the top of a coil to be annealed and upper edges lying in a top common plane and adapted to support a second coil resting thereon, and baffle wall means disposed intermediate said common planes and dividing said spacer into separate non-communicating upper and lower plenum chambers, said baffle wall means having a central opening and an inner and an outer periphery and having one periphery at said top common plane and its other periphery at said bottom common plane, said peripheries being offset radially from each other relative to the center of said spacer.

2. A coil spacer for spacing apart open coils during annealing having an outer periphery and including, a plurality of circumferentially spaced radially extending web members having their outer ends disposed at the outer periphery of the spacer, said webs having their lower edges lying in a common bottom plane and adapted to rest on the top of a coil to be annealed and their upper edges lying in a top common plane and adapted to support a second coil resting thereon, and baffle wall means intermediate said common planes and having a central opening therein, said baffle wall means forming separate non-communicating upper and lower plenum chambers and extending from the outer periphery of said spacer at said top common plane and having said central opening lying in said bottom common plane.

3. A coil spacer for spacing apart open coils during annealing having an outer periphery and including, a plurality of circumferentially spaced radially extending web members having their outer ends disposed at the outer periphery of the spacer, said webs having their lower edges lying in a common bottom plane and adapted to rest on the top of a coil to be annealed and their upper edges lying in a top common plane and adapted to support a second coil resting thereon, and baffle means intermediate said common planes and having a central opening therein, said baffle wall means forming separate non-communicating upper and lower plenum chambers and extending from immediately adjacent the outer periphery of said spacer at said bottom common plane and having said central opening lying in said top common plane.

4. A coil spacer for spacing apart open coils during annealing having an outer periphery and including, a plurality of circumferentially spaced radially extending web members having their outer ends disposed at the outer periphery of the spacer and their inner ends forming a central opening in and lying at the inner periphery of the spacer, said webs having their lower edges lying in a common bottom plane and adapted to rest on the top of a coil to be annealed and their upper edges lying in a top common plane and adapted to support a second coil resting thereon, and baffle wall means extending inwardly from said outer periphery of said spacer intermediate said common planes and having an opening therein aligned with said central opening formed by the inner ends of said web members, said baffle wall means forming separate non communicating upper and lower plenum chambers and extending from said top common plane to said bottom common plane and having said opening lying in one of said common planes, the outer periphery of said baffle wall means lying in the other of said common planes.

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