March 3, 1959 C. C. BLACKMAN 2,875,997

METHOD OF AND APPARATUS FOR HEATING COILS OF METAL ROD, WIRE OR THE LIKE

Filed Oct. 24, 1955

3 Sheets-Sheet 1

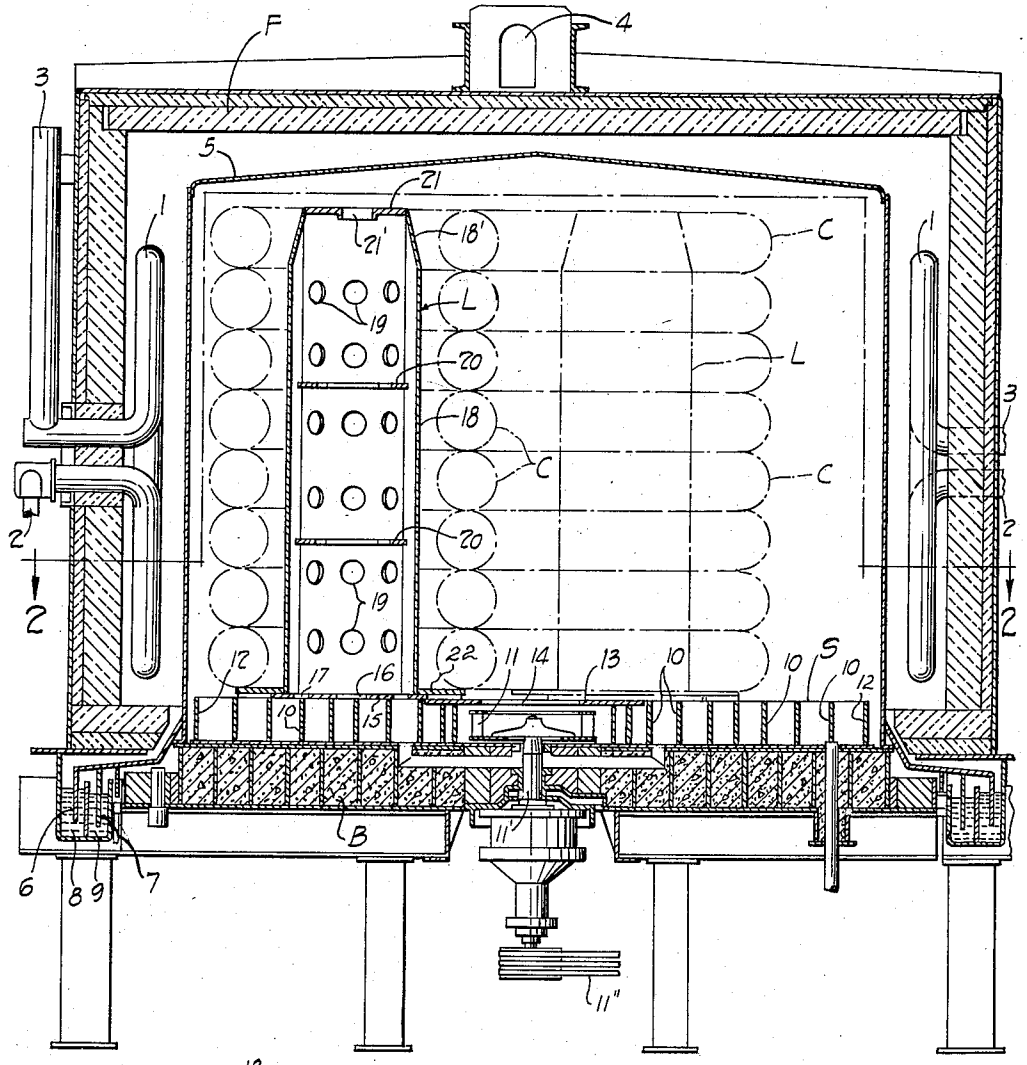


Fig. 1

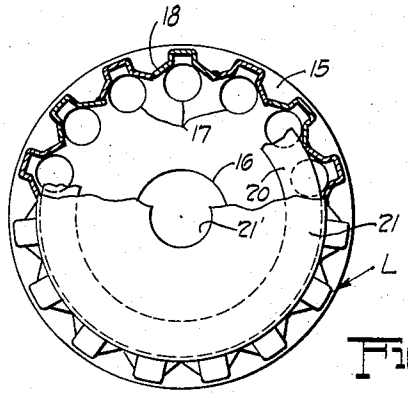


Fig. 4

INVENTOR.
CALVIN C. BLACKMAN
BY
Bosworth, Sessions, Herrstrom & Lawler
ATTORNEYS

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Filed Oct. 24, 1955 3 Sheets-Sheet 2

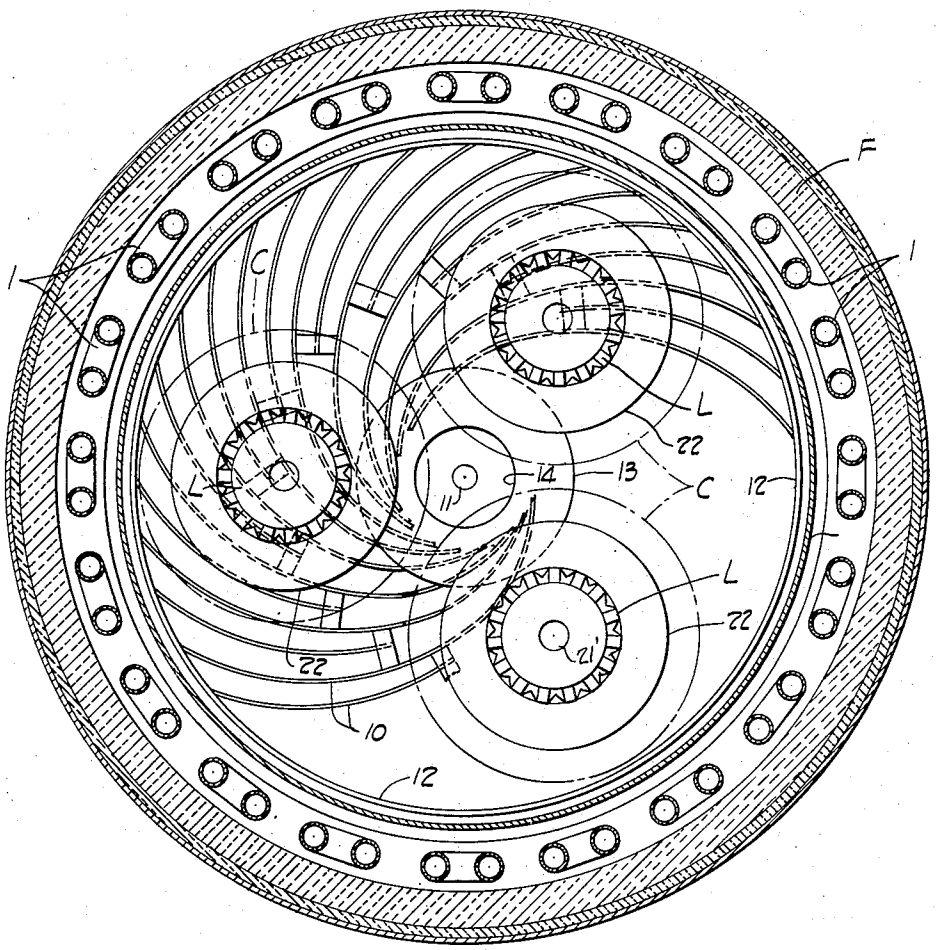


FIG. 2

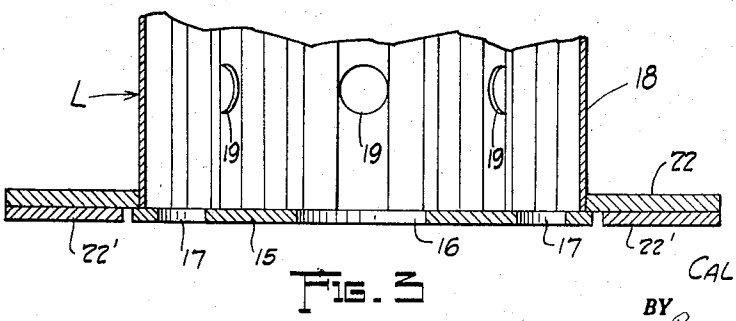


FIG. 3

INVENTOR.
CALVIN C. BLACKMAN

BY Bosworth, Sessions, Herstrom + Lawler
ATTORNEYS

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3 Sheets-Sheet 3

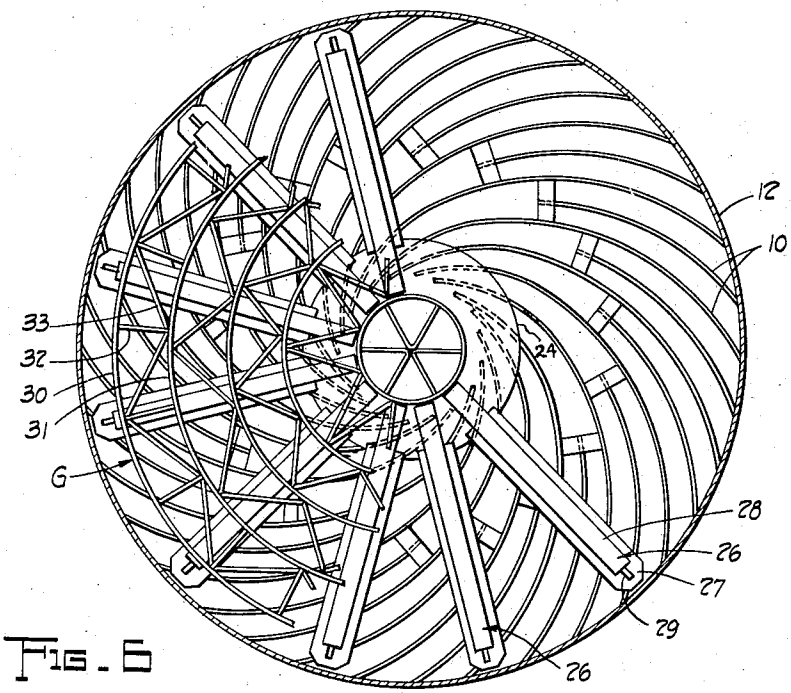


FIG. 6

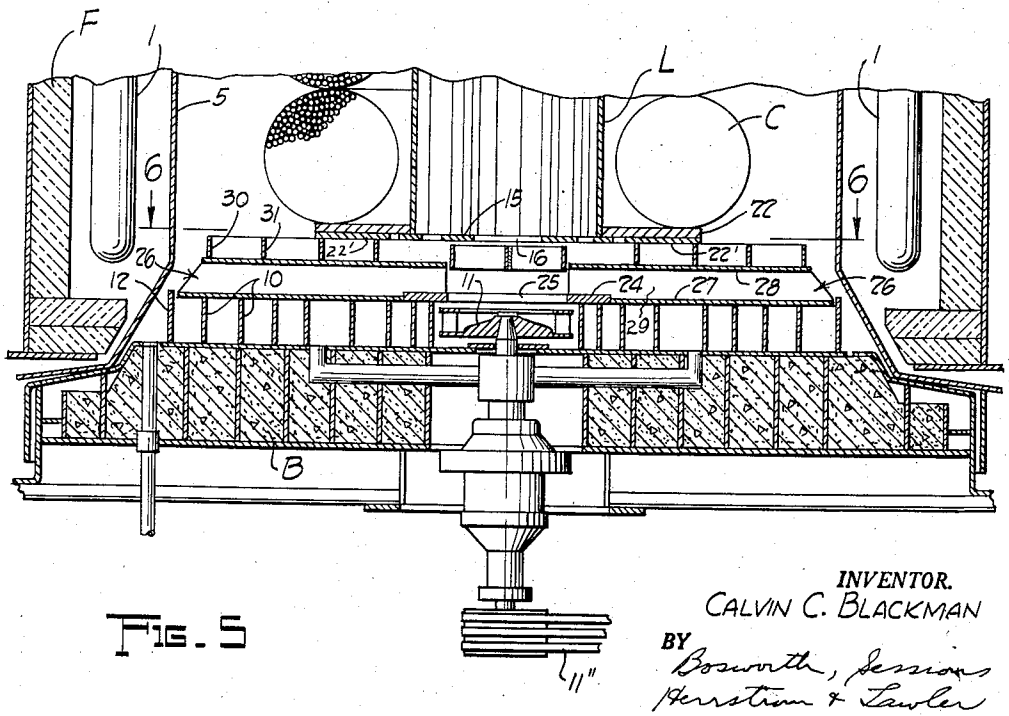


FIG. 5

INVENTOR.
CALVIN C. BLACKMAN

BY Bosworth, Sessions Herrstrom & Lawler

ATTORNEYS

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METHOD OF AND APPARATUS FOR HEATING COILS OF METAL ROD, WIRE OR THE LIKE

Calvin C. Blackman, Lakewood, Ohio, assignor to Lee Wilson, Rocky River, Ohio

Application October 24, 1955, Serial No. 542,190

7 Claims. (Cl. 263—40)

This invention relates to an improved method of and apparatus for heat treating coils of metal rod, wire, or the like, and more particularly to the annealing of stacks of such coils in bell-type furnaces.

The heating of coils of metal strip, wire and rod in bell-type furnaces for annealing or other heat treating purposes is extensively practiced in the ferrous and non-ferrous metal industries. In a widely used and successful embodiment of this type of furnace the coils are stacked one upon the other on a furnace base and an inner cover of relatively thin metal placed thereover with a gas seal between it and the base. The furnace bell carrying the heating elements is then positioned over the inner cover and the heat generated by the heating elements is transferred to the coils. In the operation of these furnaces for annealing ferrous metals the heating chamber within the inner cover is customarily filled with a non-oxidizing atmosphere before the furnace is heated and a blower is mounted in the furnace base structure for circulating the atmosphere within the heating chamber to assist in the convection heating of the charge.

It is an object of the present invention to provide a bell-type annealing furnace of the type referred to in which the circulation of the furnace atmosphere within the heating chamber is effective to heat the charge more rapidly and efficiently than with previous furnaces of this type, particularly when the furnace is charged with one or more stacks of coils of rod or wire supported on loading spiders. Other objects of my invention include the provision of an improved method of circulating the atmosphere in a bell-type furnace whereby transfer of heat to the charge by convection is facilitated and a very rapid and efficient heating operation obtained; the provision of an improved furnace charge support and diffuser together with loading spiders so supported thereon that, in addition to the primary or main circulation of atmosphere in the heating chamber, a secondary circulation is induced in the chamber whereby the efficiency of heat transfer is substantially increased and the heating time correspondingly reduced; and the provision of a bell-type furnace structure which is adapted efficiently to heat different numbers of stacks of coils of wire, rod, or the like without change in the furnace structure or operation and with increased output for a given size furnace.

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

Figure 1 is a vertical cross-sectional view through a bell-type furnace in accordance with my invention and charged with three stacks of coils of wire or rod.

Figure 2 is a horizontal cross-sectional view of the furnace shown in Figure 1, taken substantially on line 2—2 of Figure 1, some of the diffuser vanes being omitted for the sake of clearness.

Figure 3 is a detached fragmentary vertical cross-sectional view showing the bottom end portion of one of the

loading spiders shown in Figures 1 and 2 with its stripper plate in coil supporting position.

Figure 4 is a plan view of the loading spider of Figure 3, partly in horizontal cross-section and on a somewhat reduced scale from that of Figure 3.

Figure 5 is a fragmentary vertical cross-sectional view of a modified bell-type furnace in accordance with my invention which is particularly adapted for heating a single centrally disposed stack of coils of wire or the like.

Figure 6 is a horizontal cross-sectional view taken substantially on line 6—6 of Figure 5 and illustrating the structural arrangement of the grating, grating support struts and diffuser vanes, some of the struts and part of the grating being omitted for the sake of clearness.

In Figure 1 the outer bell of the furnace is indicated generally at F. This is of usual form and, as illustrated, includes a plurality of combustion tubes 1 mounted around the inner wall of the bell and adapted to receive fuel and air through the inlet pipes 2 and to discharge products of combustiton through the exhaust pipes 3. This bell is adapted to be lifted from and placed in position on the furnace base B by means of the lifting eye 4. Also supported on the furnace base B is the inner charge cover 5 of relatively thin sheet metal and having annular depending sealing flange portions 6 and 7 which, when the inner cover is in position as seen in Figure 1, extend into corresponding troughs 8 and 9 in the base structure B which are filled with sand, water, or other suitable sealing material.

The upper surface of the furnace base structure B which is within the inner cover 5 is substantially flat and horizontal and supports the charge support and diffuser unit which is generally indicated at S. This unit S includes a plurality of diffuser vanes 10 extending spirally outwardly from points adjacent the center of the furnace structure and defining outwardly diverging passages through which the atmosphere within the inner cover 5 is forced by the centrifugal blower 11. At the outer ends of the vanes 10 a circumferential rim 12 may be provided to assist in supporting the vanes and directing the flow of atmosphere upwardly along the side wall of the inner cover 5. At the center portion of the charge support and diffuser unit S, a blower inlet plate 13 rests on the top edges of the inner ends of the vanes 10 which, as seen in Figure 1, are preferably notched out so that the top face of plate 13 is flush with the top edges of the vanes 10. Furnace atmosphere may enter the center inlet of the blower 11 through the inlet opening 14 in the plate 13 while the annular outer part of plate 13 constitutes a baffle portion which assists in directing the high velocity discharge from the blower 11 horizontally outwardly across the furnace base through the flow passages between adjacent vanes 10.

When this outwardly moving gas, which constitutes a part of the main flow path of the atmosphere within the furnace heat chamber, reaches the outer rim 12 of the charge support and diffuser S, it is diverted upwardly along the inner side walls of the inner cover 5. As these walls are maintained at high temperature by the combustion tubes 1, the atmosphere is heated as it moves upwardly to the top wall of the inner cover which directs it inwardly and down through the center area of the furnace and the inlet opening 14 back into the blower 11. The circulation of atmosphere just described is referred to herein as the main flow path and is that usually present in furnaces of this type.

As will presently appear, due to certain novel features of my furnace structure, an auxiliary or secondary flow of the furnace atmosphere is induced at locations where it is most effective in improving the rate of heat transfer to the furnace charge.

The upper face of the charge support and diffuser unit S, outwardly from the outer edge of the blower inlet plate **13** is entirely open or exposed to the furnace heating chamber within the inner cover **5**. In Figure 1 I have illustrated three loading spiders L symmetrically disposed on and supported by the top edges of the vanes **10** of the charge support unit S. Each of these spiders L, as best seen in Figures 1, 3, and 4, includes a base portion or plate **15** having a central opening **16** and a plurality of peripheral openings **17** formed therein. Secured to and extending upwardly from the base portion **15** and outside of the openings **17** is a tubular stem portion **18** which is preferably ribbed or corrugated as seen in Figure 4 and perforated by a plurality of holes **19** to permit the flow of atmosphere into the interior thereof. Spaced rings **20** serve to reinforce the tubular stem **18**, the upper end portion **18'** of which preferably tapers inwardly to facilitate placing the coils of wire or the like thereon and carries the top plate **21** which, as illustrated, is centrally apertured at **21'**.

As is clearly seen in Figures 1, 3 and 4, the outer edge of the base portion **15** of each spider L projects outward slightly beyond the outer periphery of the stem portion **18** and each spider is provided with a stripping plate **22** having a loose fit on the stem **18** and adapted, as indicated in Figures 1 and 5, to support the coils carried on the spider and facilitate removal thereof from the furnace when the annealing operation is finished. Secured to the bottom face of each stripping plate **22** is a plurality of radially extending support bars or ribs **22'** which, when the spiders are positioned on the furnace charge support S, rest upon the top edges of the vanes **10** and transmit the load to the vanes.

A plurality of coils of wire, rod, or the like C are stacked on each of the spiders L. These coils are shown in phantom lines, it being understood that they are somewhat irregular in shape and, under the heat applied during the annealing operation, will settle down and shift their positions to a certain degree but will be maintained in stacked arrangement by the tubular stems **18** of the loading spiders.

When the furnace has been charged as illustrated in Figures 1 and 2 and heat applied by the combustion tubes **1**, the blower **14**, which is mounted on a vertical shaft **11'** and driven by any suitable means such as belt drive **11''** from an electric motor (not shown), discharges gas at high velocity outwardly through the passages formed between the diffuser vanes **10**. When this gas reaches the side wall of the inner cover **5** it flows upwardly (absorbing heat therefrom), inwardly across the top of the cover **5**, and down through the central space between the three loading spiders L and their stacks of coils C. As the gas moves downwardly in the center portion of the heating chamber it passes through the inlet opening **14** in the blower inlet plate **13** and is again picked up by the blower **11**, thus maintaining the main or primary flow path of the circulation of the furnace atmosphere.

The gas which moves horizontally through the passages between the vanes **10** is traveling at a very high velocity. As noted above these passages are open on top to the interior of the heating chamber and the loading spiders merely rest upon the top edges of the vanes **10**. Thus the stacks of coils are in vertically spaced exposed relation to the top of furnace base structure B. The rapid flow of gas through the outwardly diverging passages between the vanes **10** induces a secondary or auxiliary circulation of furnace atmosphere around and in direct contact with the convolutions of the coils C into the interior of the spider stem **18** through the holes **19** and then downwardly through the holes **16** and **17** in the spider base portion **15** into the outwardly moving main high-velocity streams between the vanes **10**. This auxiliary or secondary induced circulation through and around the coils of rod or wire greatly increases the transfer of heat thereto and thus substantially reduces

the time required to bring them up to annealing temperature.

Although I have illustrated three loading spiders and three stacks of coils in the furnace of Figures 1 and 2, it will be understood that a larger number of smaller diameter coils could be supported on spiders on the furnace base. Furthermore, in some instances it may be desirable to anneal only a single large coil in the furnace and I have illustrated a charge support and diffuser arrangement in Figures 5 and 6 which is particularly adapted for practicing my invention when only a single loading spider and a stack of relatively large diameter coils is centrally located in the heating chamber.

As the furnace bell, inner cover, base structure, blower, diffuser vanes, etc. are substantially the same in the apparatus of Figures 5 and 6 as those described in connection with Figures 1 and 2, the corresponding elements have been identified by similar reference characters. In like manner the loading spider L seen in Figure 5 and the stripping plate **22** associated therewith is the same as that previously illustrated although somewhat larger to accommodate the larger diameter coils.

A blower inlet plate **24**, generally similar to plate **13** of Figures 1 and 2, is supported on the top edges of the diffuser vanes **10** and has its central opening **25** centered with the blower **11** to provide an inlet thereto. A plurality of radially extending spacing struts **26** rest upon the top edges of the vanes **10** and extend out from the center opening **25** to the outer rim **12** of the diffuser structure. As seen in Figure 6, each of these struts has a relatively wide bottom flange **27** and a narrow top flange **28** connected by vertical web member **29**. On top of the radial struts **26** is a grating structure G built up of a plurality of concentric rings **30**, **31**, etc., spaced apart by radial and diagonal webs indicated at **32** and **33** in Figure 6. Thus the grating G comprises an open structure which permits free flow of atmosphere vertically therethrough but possesses sufficient strength and rigidity to support the load of the furnace charge.

The base portion **15** of the spider L rests upon the top of gating G with its central hole **16** coaxially disposed relative to the opening **25** in the blower inlet plate **24** but spaced thereabove. Also supported on the grating G and carried by the loading spider L is a stripping plate **22** which carries the stack of coils C.

In the operation of the apparatus of Figures 5 and 6 the main flow of atmosphere circulated by the blower **11** is outwardly through the outwardly diverging passages between the diffuser vanes **10**, upwardly along the side walls of the inner cover **5** and down through the center of the spider L, the opening **16** in the base portion of the spider, the opening **25** in the blower inlet plate, and back to the blower **11**. Due however to the fact that the passages between the vanes **10** are open on top and the struts **26** and the grating G do not interfere materially with vertical downward flow therethrough, the high velocity outward movement of gas in the passages between the vanes **10** induces a secondary or auxiliary circulation of atmosphere downwardly through and around the strands of the coils C on the outside of the tubular stem **18** of loading spider L, through the grating G, and past the struts **26** and back into the main flow path in the passages between the vanes **10**. Thus, due to the added flow of atmosphere through and between the convolutions of the coils which is effected by the induced circulation more rapid heating and more efficient overall furnace operation is obtained than in prior furnaces in which the induced secondary circulation was not present.

Although I have described the illustrated embodiment of my invention in considerable detail it will be understood that variations and modifications may be made in the various structural elements of my improved apparatus and in the steps of my method without departing from the spirit of my invention. I do not therefore wish to be limited to the exact structures and procedures herein

described but claim as my invention all embodiments thereof coming within the scope of the appended claims.

I claim:

1. In a bell-type furnace, a base structure, a charge support and diffuser carried by said base structure, a rotary blower supported in said base structure, said charge support and diffuser having an opening in which said blower is disposed, a plurality of radially extending upwardly projecting diffuser vanes having their inner ends forming said opening and an annular blower inlet plate supported on the inner portions of said vanes coaxially with said blower, the passages between adjacent vanes being closed on the bottom, diverging outwardly, and, beyond said blower inlet plate only, being open on top, and a loading spider having a base portion and an upwardly projecting stem portion, said base portion being supported by and resting directly on said vanes of said charge support and diffuser and said stem portion being disposed radially outwardly of said inlet plate and extending upwardly from said base portion and adapted to receive coils of wire or the like.

2. In a bell-type furnace, a base structure, a charge support and diffuser carried by said base structure, a rotary blower supported in said base structure, said charge support and diffuser having an opening in which said blower is disposed, a plurality of radially extending upwardly projecting diffuser vanes having their inner ends forming said opening and an annular blower inlet plate supported on the inner portions of said vanes coaxially with said blower, the passages between adjacent vanes being closed on the bottom, diverging outwardly, and, beyond said blower inlet plate only, being open on top, and a loading spider having an apertured base portion and an upwardly projecting tubular stem portion, said base portion being supported by and resting directly on said vanes of said charge support and diffuser and said tubular stem portion being disposed radially outwardly of said inlet plate and having an apertured wall extending upwardly from said base portion and adapted to receive coils of wire or the like.

3. In a bell-type furnace, a base structure, a charge support and diffuser carried by said base structure, a rotary blower supported in said base structure, said charge support and diffuser having an opening in which said blower is disposed and a plurality of radially extending upwardly projecting diffuser vanes having their inner ends forming said opening, a blower inlet plate supported on the inner ends of said vanes, the passages between adjacent vanes being closed on the bottom, diverging outwardly and being closed on top at their inner end portions and open on top at their outer end portions, and a loading spider having an apertured base portion and an upwardly projecting tubular stem portion, said base portion being supported by and resting on said vanes and said stem portion being disposed above said open top portion of the passages therebetween, said tubular stem having an apertured wall extending upwardly from said base portion and adapted to receive coils of wire or the like.

4. In a bell-type furnace, a base structure, a charge support and diffuser carried by said base structure, a rotary blower supported in said base structure, said charge support and diffuser having an opening in which said blower is disposed and a plurality of radially extending diffuser vanes having their inner ends forming said opening, the passages between adjacent vanes diverging outwardly and being open on top at their outer portions only, a loading spider having an apertured base portion and an upwardly projecting tubular stem portion, said base portion being supported by and resting on said vanes of said charge support and diffuser and said tubular stem having an apertured wall extending upwardly from said base portion and adapted to receive coils of wire or the like, a blower inlet plate on said charge support and diffuser disposed above said blower and having a central blower inlet opening and an outer baffle portion disposed to close the top of the inner end portions of said passages, said stem portion of said loading spider being disposed above said open outer end portions of said passages, and a charge cover mounted on said furnace base structure and forming a heating chamber thereon, said blower being adapted to draw atmosphere in said chamber down through said blower inlet opening in said baffle plate and discharge same outwardly through said passages between said diffuser vanes whereby atmosphere is drawn down into said passages between said vanes adjacent said loading spider and radially outwardly of said blower inlet plate.

5. In a bell-type furnace, a base structure having a substantially flat upper surface, a charge support and diffuser carried by said base structure, a centrifugal blower supported in said base structure, said charge support and diffuser having an opening in which said blower is disposed and a plurality of radially extending upwardly projecting diffuser vanes having their inner ends forming said opening, the passages between adjacent vanes being completely closed on the bottom and open on top at their outer portions only, a plurality of loading spiders each having an apertured base portion and an upwardly projecting tubular stem portion, said base portions being supported by and resting on said vanes of said charge support and diffuser in spaced relation to said opening therein, said tubular stem portions each having an apertured wall extending upwardly from the base portion and being adapted to receive a stack of coils of wire or the like, a blower inlet plate on said charge support and diffuser disposed above said blower and having a central blower inlet opening and an outer baffle portion disposed to close the top of the inner end portions of said passages between said vanes, said stem portions of said loading spiders being disposed above said open outer end portions of said passages, and a charge cover mounted on said furnace base structure and forming a heating chamber thereon, said blower being adapted to draw atmosphere in said chamber down through said blower inlet opening in said baffle plate and discharge same outwardly through said passages between said diffuser vanes whereby atmosphere is drawn down into said passages between said vanes adjacent said loading spiders and radially outwardly of said blower inlet plate.

6. The method of circulating the atmosphere in a bell-type furnace having a heating chamber, a base structure, and a blower supported by said base, which includes the steps of discharging atmosphere in a main flow path horizontally outwardly from said blower across said furnace base with decreasing velocity and increasing static pressure, directing said atmosphere upwardly around the peripheral wall of said furnace heating chamber, drawing said atmosphere downwardly in the central portion of said heating chamber into the blower inlet, supporting a stack of coils of wire or the like in radially outwardly spaced relation to said blower inlet and in vertically spaced exposed relation to said furnace base structure whereby said atmosphere discharged horizontally outwardly from said blower passes through the space between said base structure and the bottom of said stack of coils, and maintaining the velocity of flow of said outwardly discharged atmosphere at a rate which will induce a secondary downward flow of atmosphere adjacent said stack of coils into said main horizontal flow path.

7. In a bell-type furnace, a base structure, a charge support and diffuser carried by said base structure, a rotary blower supported in said base structure, said charge support and diffuser having a central opening in which said blower is disposed, a plurality of radially extending upwardly projecting diffuser vanes having their inner ends forming said opening, and an annular blower inlet plate supported on the inner portions of said vanes coaxially with said blower, the passages between adjacent

vanes being closed on the bottom, diverging outwardly and, beyond said blower inlet plate only, being open on top, a loading spider having a base portion and an upwardly projecting stem portion, and grating means for supporting said base portion above and in spaced relation to the top edges of said vanes of said charge support and diffuser, said stem extending upwardly from said base portion and being adapted to receive coils of wire or the like.

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