Dec. 3, 1957 C. C. BLACKMAN 2,815,197

FURNACE CHARGE SUPPORT AND DIFFUSER

Filed July 28, 1955 2 Sheets-Sheet 1

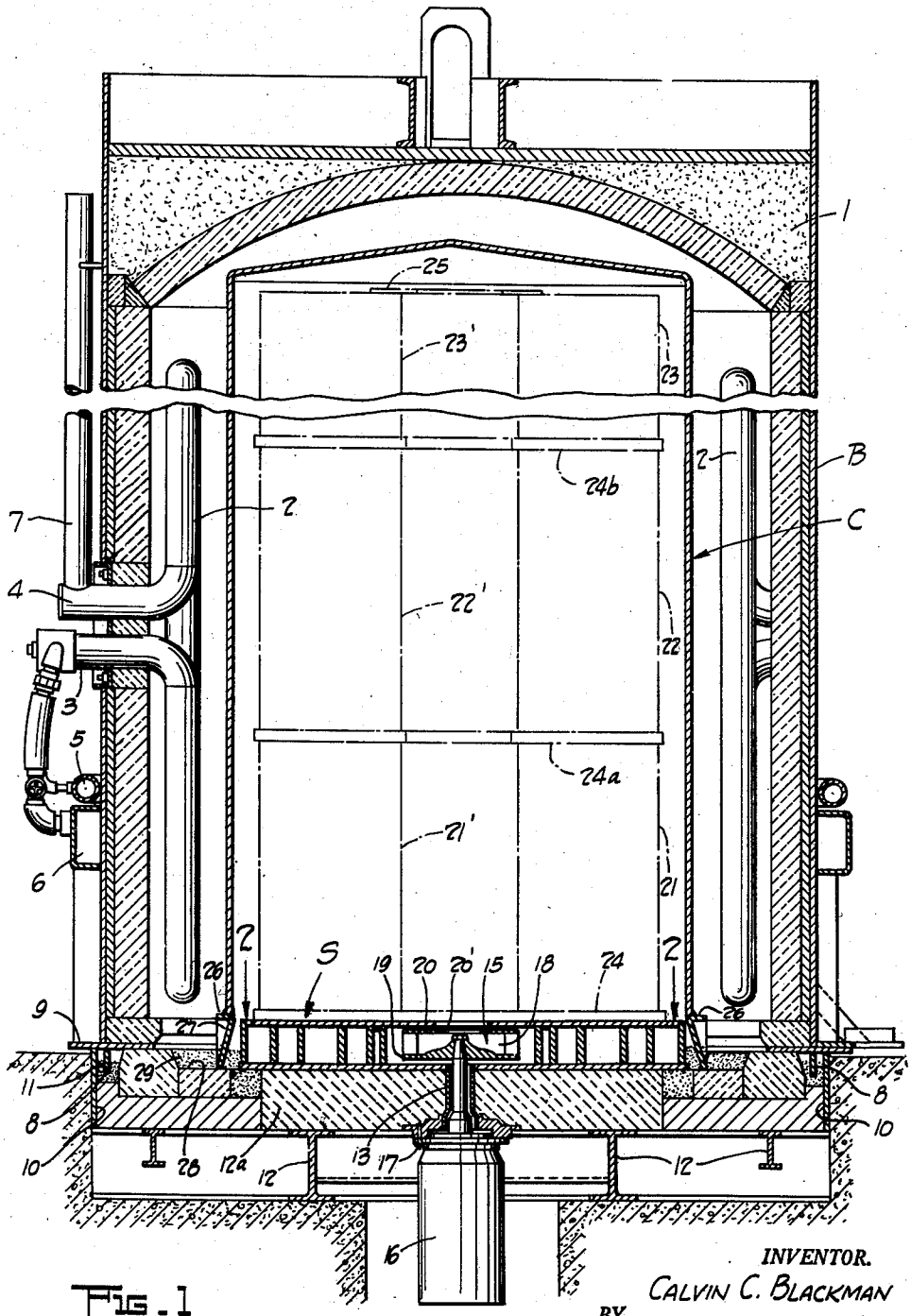


Fig. 1

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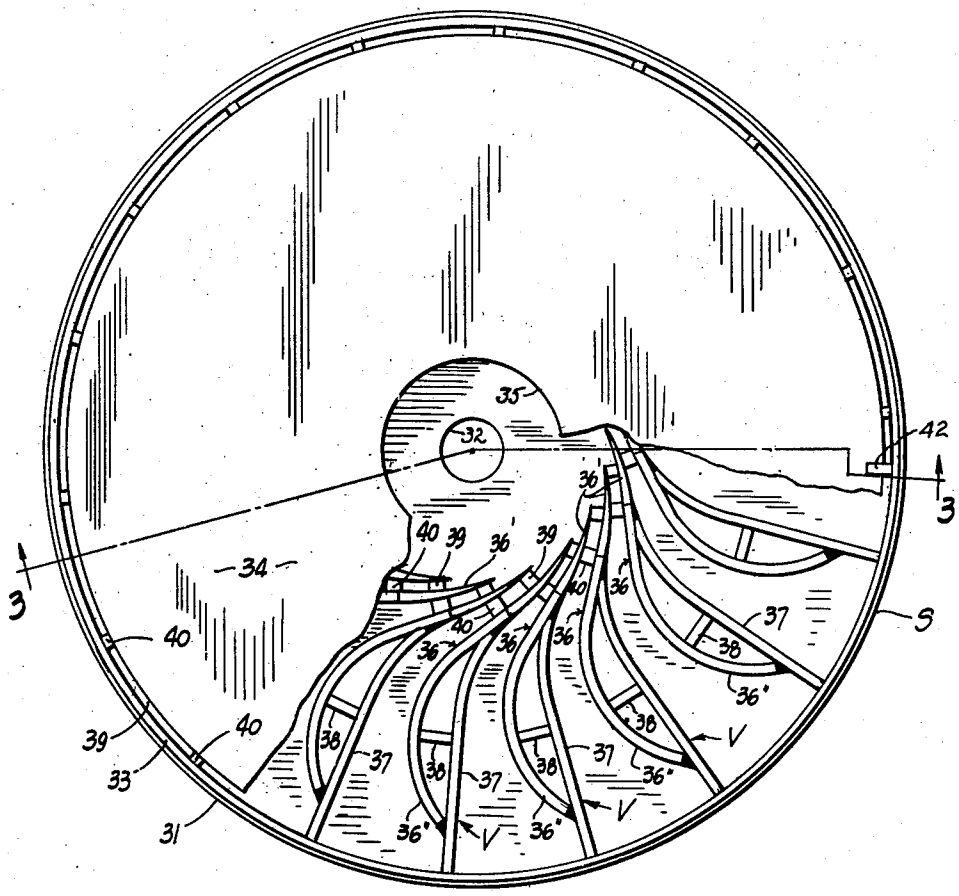


FIG. 2

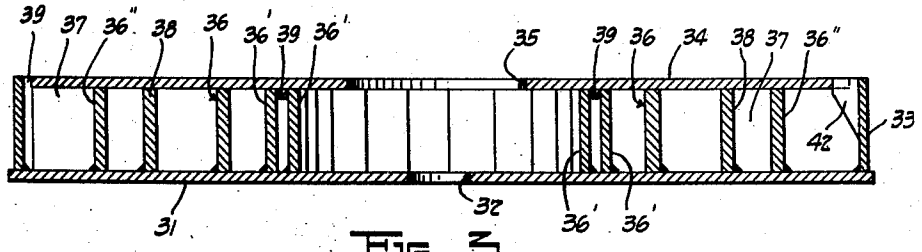


FIG. 3

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2,815,197

Patented Dec. 3, 1957

2,815,197

FURNACE CHARGE SUPPORT AND DIFFUSER

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Application July 28, 1955, Serial No. 524,950

5 Claims. (Cl. 263—47)

This invention relates to apparatus for heat treatment and more particularly to improvements in charge support and diffuser structures for bell-type furnaces.

Bell-type furnaces are commonly employed in the steel industry for annealing stacks of coils of strip steel. In furnaces of this type, where heating is accomplished largely by convection, a fan or blower is mounted in the base which supports the stack of coils and a protective cover is customarily placed over the stack of coils in order that a non-oxidizing atmosphere may be maintained thereabout. Leakage of atmosphere between the bottom of the inner cover and the furnace base is prevented by a suitable sand seal.

In the operation of such coil annealing apparatus, difficulty has been experienced in the past because the atmosphere which is discharged by the fan adjacent to the inner cover sand seal would at times, because of non-uniform pressure distribution, cause eddy currents or a circumferential or spiral movement of the furnace atmosphere adjacent the sand seal and pick up sand therefrom and carry same up into the furnace with resultant damage to the coils, etc.

In my pending United States patent application, Serial No. 426,987, filed May 3, 1954, I have described and claimed a charge support and diffuser which overcomes the difficulties above referred to. The present application may be considered to be a continuation-in-part thereof.

It is among the objects of the present invention to provide a charge support and diffuser for bell-type coil annealing furnaces which will provide an adequate support for the coils to be annealed, which will efficiently reduce the velocity pressure created by the fan and convert same to static pressure, and which at the same time will substantially eliminate rotary movement or non-uniform pressure conditions of the furnace atmosphere adjacent to the sand seal such as would result in pickup of sand. A further object of the invention is the provision of a rugged, long-lived charge support and diffuser which will support heavy furnace charges under high temperature conditions without serious warping or distortion of the parts and which may be economically constructed and will give long and trouble-free service.

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

Figure 1 is a vertical cross-sectional view through a bell-type furnace for the convection heating of coils of strip metal in which my improved charge support and diffuser is incorporated;

Figure 2 is a horizontal cross-sectional view taken substantially on line 2—2 of Figure 1, with part of the cover plate broken away to show the vane construction; and

Figure 3 is a vertical cross-sectional view taken substantially on line 3—3 of Figure 2.

Referring now to Figure 1, the furnace bell B consists of a generally cylindrical, suitably insulated structure having a closed top portion 1 and an open bottom. Supported

within bell B are a plurality of combustion heating tubes 2 which, as illustrated, are oval in shape. Each tube has an inlet end 3 and an outlet end 4 projecting through the wall of the bell B. A fuel burner is mounted in the inlet 3 and fuel such as gas may be supplied from a gas manifold 5. Combustion air is supplied from the air manifold 6. The products of combustion from the tube 2 pass out through the outlet 4 and upwardly through the stack or discharge pipe 7. Other heating means may of course be employed.

An annular flange 8 depends from the base ring 9 of the bell B and, when the bell is in heating position as seen in Figure 1, the flange 9 rests upon a supporting ring 10 which is a part of the steel base structure 12 and the flange 8 projects down into the body of sand 11 forming a sand seal to prevent the undesired admission of air into the bell.

The steel base structure 12 is refractory lined and supports the charge within the furnace. It includes a suitable load carrying portion 12*a* having a hole 13 centrally disposed relative to the bell B and adapted to receive the rotating shaft 14 of the centrifugal blower type fan 15. The drive motor 16 for the fan 15 is mounted in a trench or well beneath the support portion 12*a* and is suspended therefrom as by bolts 17.

The fan 15 consists of a plurality of curved or radial extending blades 18, an imperforate bottom plate 19 and a top plate 20 having an intake opening 20′ in the center thereof. When this fan is rotated by the motor 16 the furnace atmosphere will be drawn downwardly through the opening 20′ in plate 20 and discharged outwardly by the blades 18. When discharged, the atmosphere will have a high velocity pressure and will be discharged in a more or less tangential direction depending on fan characteristics and with a spiral or circulating motion relative to the center of the fan shaft 14.

In Figure 1 my improved charge support and diffuser is indicated generally at S and, as will appear later, it efficiently distributes the gas discharged by the fan 15 in the desired manner and also forms a support for the coils which are to be heat treated. These coils are indicated in phantom lines in Figure 1 and include a bottom coil 21 which rests on the top of the spacer 24 which in turn rests on top of the charge support S, intermediate coil 22, and top coil 23. Spacers 24*a* and 24*b* are indicated between the adjacent ends of the coils. These spacers may take any suitable form and are adapted to permit the flow of atmosphere between the ends of the coils. Central openings are provided in each of these spacers and are preferably substantially the same diameter as the central openings 21′, 22′, and 23′ of the coils.

In order to maintain the desired non-oxidizing atmosphere during the annealing operation and more efficiently heat the coils, an inner cover C is employed. This cover is in the form of a cylinder closed at its top end and open at its lower end and made of relatively light gauge heat resisting metal. It is placed over the stack of coils as illustrated in Figure 1 and has a reinforcing ring 26 at its lower open end and a downwardly projecting flange 27 extending therefrom. A suitable annular recess portion 28 is formed in the furnace base refractory structure and contains a body of sand 29. When in position as seen in Figure 1 the bottom edge of flange 27 of inner cover C extends into the sand 29, providing a sand seal which prevents the entry of air into and the escape of non-oxidizing gas from the inner cover. Suitable openings, not shown, are provided through the support portion 12*a* of the base structure for conducting non-oxidizing gas to and discharging same from the space defined by the inner cover C.

As seen from the above description the stack of coils **21**, **22** and **23** is supported on the charge support and diffuser structure S. This unit is best seen in Figures 2 and 3 and consists essentially of a circular base plate **31** supported on portion **12***a* of the furnace base structure and having a central opening **32** therein to accommodate the drive shaft **14** of the fan **15**, an outer vertical circular enclosing rim **33**, a plurality of diffuser vanes generally indicated at V, and a circular top cover and coil supporting plate **34**. The center portion of top plate **34** is provided with a circular opening **35** which is preferably somewhat smaller in diameter than the diameter of the inner opening **21'** in the bottom coil **21**. This opening **35** permits atmosphere to flow downwardly through the center of the stack of coils and enter the fan inlet opening **20'** in the top plate **20** of the fan.

The function of the circumferentially spaced vanes V is to support the top plate **34** and also the entire load of the coils which are stacked thereon. A further function of the vanes V is to control the flow of the gas discharged from the fan **15**. As is seen in Figure 2, each of the vanes V has its inner end lying substantially on a circle which is concentric with the center of fan shaft **14**. As the vanes are all alike, only one will be described in detail, it being understood that the others are of similar construction, form and arrangement. Each vane V includes an inner wall member **36**, the inner end portion **36'** of which extends generally spirally outwardly relative to the center of the fan shaft **14**. A reversely curved outer end portion **36''** of inner wall member **36** extends from the outer end of the spiral inner portion **36'** to a point adjacent the outer periphery of the charge support unit. Each vane structure V also includes an outer wall member **37** which joins and is secured to the inner wall member **36** at approximately the outer end of the spiral inner end portion **36'** thereof. This outer wall portion extends outwardly in a substantially radial direction relative to the center of fan shaft **14** and abuts at its outer end the enclosing rim **33**. It will be noted from Figure 2 that the outer end of the outer end portion **36'** of the inner wall member **36** adjoins and is secured to outer wall member **37** near the outer end thereof and that the outer wall member **37** extends generally chordally across the reversely curved outer end portion **36'**, thus forming an enlarged portion of the vane intermediate its inner and outer ends. One or more (only one being shown) reinforcing and spacing members **38** are preferably positioned between members **36** and **37** at approximately the place of greatest distance therebetween and serve to stiffen and strengthen the vane structure against distortion and warpage in use.

Between the inner ends of adjacent vanes V are spacer plates **39** and **40** which are relatively thin in cross-section so as to offer minimum resistance to flow of gas and which serve to stiffen and support the single thickness inner end portions **36'**.

As is clearly seen in Figure 2, the reversely curved outer end portion **36''** of each vane is adjacent but spaced from the generally radially extending outer wall member **37** of the next vane. Thus the vanes V provide a plurality of outwardly diverging flow paths for the atmosphere discharged by the fan **15**, the inner portions of these flow paths extending generally spirally in the same direction while the outer portions thereof extend generally radially by virtue of the form and disposition of the elements **37** and **36''** of the adjacent vanes.

The arrangement of the vane structures described herein provides an exceedingly strong and rigid support for the cover plate **34** and the load carried thereon. The reinforced double walled structure of the individual vanes not only provides efficient and effective flow paths for the gas discharged by fan **15** but also forms a reinforced structure which will carry heavy loads under high temperature conditions without warping or distortion which would interfere with the proper flow of gas through the diffuser.

With the contour of the gas flow paths provided by my vane arrangement, the velocity pressure of the gas is efficiently converted to static pressure and the rotary component of movement substantially eliminated so that the gas is moving substantially radially when it is discharged upwardly through the slot **39** between the outer edge of cover plate **34** and the rim **33**.

Spacer blocks **40** are mounted on the outer ends of the vanes and serve to center the cover plate **34** to insure uniform width for the slot **39**. A notch **41** may be formed at one point in the periphery of cover plate **34** to fit over a lug **42** (see Figure 3) which is welded to the rim **33**. This arrangement prevents rotation of the top or cover plate **34** relative to the rest of the diffuser structure S.

In order to facilitate entry of gas from the fan **15** into the flow paths between the diffuser vanes V, the inner ends of the vanes are preferably tapered as clearly seen in Figure 2. This reduces resistance and provides maximum discharge area for the fan.

When a furnace equipped with my furnace charge support and diffuser is in operation, furnace atmosphere will enter the inlet **20'** of the fan **15** and be moved circumferentially and outwardly at high velocity into the flow paths between the vanes V of the diffuser. In these flow paths the gas velocity pressure will be converted to static pressure, it being noted that the rate of divergence of the flow paths between adjacent vanes increases toward the outer periphery of the diffuser, thus assisting in reducing the velocity pressure of the gas. Further, the direction of movement of the gas is changed from a whirling or rotating path to a substantially radial direction and when it reaches the rim **33** the gas is forced upwardly through the annular slot **39** into the inner cover C and around the coils supported therein. Sand in the seal portion **28—29** will not be picked up because eddy currents and rotary movement have been effectively eliminated. As the gas moves upwardly within the cover C a portion thereof will pass between the coils through the spacers **24**, **24***a*, and **24***b*, and some will move up over the top of coil **23** and down through the top plate **25** which has a central opening sized to pass a definite flow. Thus with my improved coil support and diffuser an efficient circulation of gas is maintained which greatly assists in the convection heating of the coils.

Although I have described the illustrated embodiment of my invention in considerable detail it will be understood that modifications and variations may be made in the specific form and arrangement of my improved charge support and diffuser. Accordingly, I do not wish to be limited to the particular structure herein shown and described but claim as my invention all embodiments thereof coming within the scope of the appended claims.

I claim:

1. A charge support and diffuser for bell type furnaces including a base plate having a central opening adapted to accommodate a fan shaft, a plurality of spaced vane structures secured to said base plate, the outer end of each of said vane structures being disposed adjacent the outer periphery of said base plate and the inner end of each of said vane structures being disposed substantially on a circle concentric with and spaced outwardly from said central opening in said base plate, each of said vane structures comprising an inner wall member and an outer wall member, said inner wall member having a spirally extending center portion and a reversely curved outer portion, said outer wall member engaging and being secured to the outer end of said inner wall member and extending in spaced relation to said reversely curved outer portion of said inner wall member, the inner end portion of said outer wall member engaging and being secured to said spirally extending portion of said inner wall member.

2. A charge support and diffuser for bell type furnaces including a base plate having a central opening adapted to accommodate a fan shift, a plurality of spaced vane

structures secured to said base plate, the outer end of each of said vane structures being disposed adjacent the outer periphery of said base plate and the inner end of each of said vane structures being disposed substantially on a circle concentric with and spaced outwardly from said central opening in said base plate, each of said vane structures comprising an inner wall member and an outer wall member, said inner wall member having a spirally extending center portion and a reversely curved outer portion, said outer wall member engaging and being secured to the outer end of said inner wall portion and extending in spaced relation to said reversely curved outer portion of said inner wall member, the inner end portion of said outer wall member engaging and being secured to said spirally extending portion of said inner wall member, and a spacer member secured to and extending between said inner and outer wall members.

3. In a charge support and diffuser adapted for use in a bell type furnace and having a centrally apertured base plate, an annular top plate, and a circumferential rim at the outer periphery of said base and top plates; a plurality of circumferentially spaced vane structures disposed between said base and top plates, each of said vane structures comprising a single thickness inner end portion extending generally spirally outwardly from a point spaced outwardly from the central aperture of said base plate and an enlarged double walled portion extending outwardly from said inner end portion, one wall of said double walled portion having a reverse curvature relative to said spirally extending inner end portion and the other wall extending generally radially relative to said central aperture in said base plate and chordally of said one wall, said reversely curved wall of each of said vane structures being adjacent said radially extending wall of the next vane structure whereby a plurality of outwardly diverging flow paths are provided, the inner portions of said flow paths extending generally spirally and the outer portions generally radially.

4. In a charge support and diffuser adapted for use in a bell type furnace and having a centrally apertured base plate, an annular top plate, and a circumferential rim at the outer periphery of said base and top plates; a plurality of circumferentially spaced vane structures disposed between said base and top plates, each of said vane structures comprising a single thickness inner end portion extending generally spirally outwardly from a point spaced outwardly from the central aperture of said base

plate, a single thickness outer end portion extending substantially radially inwardly from said circumferential rim, and an enlarged double walled central portion between said inner and outer end portions, one wall of said double walled portion having a reverse curvature relative to said spirally extending inner end portion and the other wall extending generally radially relative to said central aperture in said base plate and chordally of said one wall, said reversely curved wall of each of said vane structures being adjacent said radially extending wall of the next vane structure whereby a plurality of outwardly diverging flow paths are provided, the inner portions of said flow paths extending generally spirally and the outer portions generally radially.

5. In a charge support and diffuser adapted for use in a bell type furnace and having a centrally apertured base plate, an annular top plate, and a circumferential rim at the outer periphery of said base and top plates; a plurality of circumferentially spaced vane structures disposed between said base and top plates, each of said vane structures comprising a single thickness inner end portion extending generally spirally outwardly from a point spaced outwardly from the central aperture of said base plate, a single thickness outer end portion extending substantially radially inwardly from said circumferential rim, an enlarged double walled central portion between said inner and outer end portions, one wall of said double walled portion having a reverse curvature relative to said spirally extending inner end portion and the other wall extending generally radially relative to said central aperture in said base plate and chordally of said one wall, and a reinforcing member extending transversely between said walls of said double walled portion, said reversely curved wall of each of said vane structures being adjacent said radially extending wall of the next vane structure whereby a plurality of outwardly diverging flow paths are provided, the inner portions of said flow paths extending generally spirally and the outer portions generally radially.

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