United States Patent

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[54] **BELL-TYPE FURNACE**
12 Claims, No Drawings

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[51] **Int. Cl.** **F27b 11/10**
[50] **Field of Search** 266/5B; 263/40, 41, 42, 42R; 34/242

[56] **References Cited**

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ABSTRACT: An improved bell-type furnace which includes a base and a removable inner cover that rests on the base and forms with it an enclosed heating chamber. The base has an outer peripheral sealing trough which receives the lower end of the inner cover and acts to prevent the escape of gas which is circulated in the heating chamber. The gas is delivered to and discharged from the heating chamber by means of gas inlet and discharge pipes which extend into the base inner cover peripheral sealing trough. The base also includes a refractory pedestal which is enclosed by a gastight sheath. The sheath includes a bottom plate, an outer peripheral sidewall having an outer peripheral sealing trough adjacent its upper end, and an inner peripheral sidewall having an inner peripheral sealing trough adjacent its upper end. Means are provided to seal between the sheath bottom plate and the outer and inner sidewalls and between the sidewalls and the outer and inner troughs. The sheath further includes a top plate which has downwardly projecting outer and inner peripheral flanges that extend into the sheath outer and inner peripheral troughs. Lead, liquid at furnace operating temperatures, in the sheath troughs seals between them and the flanges of the top plate.

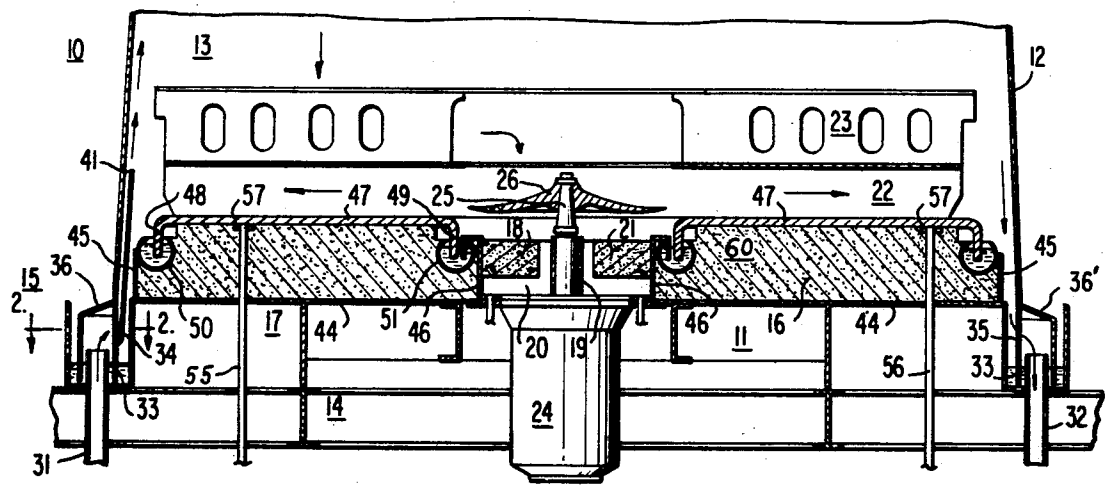
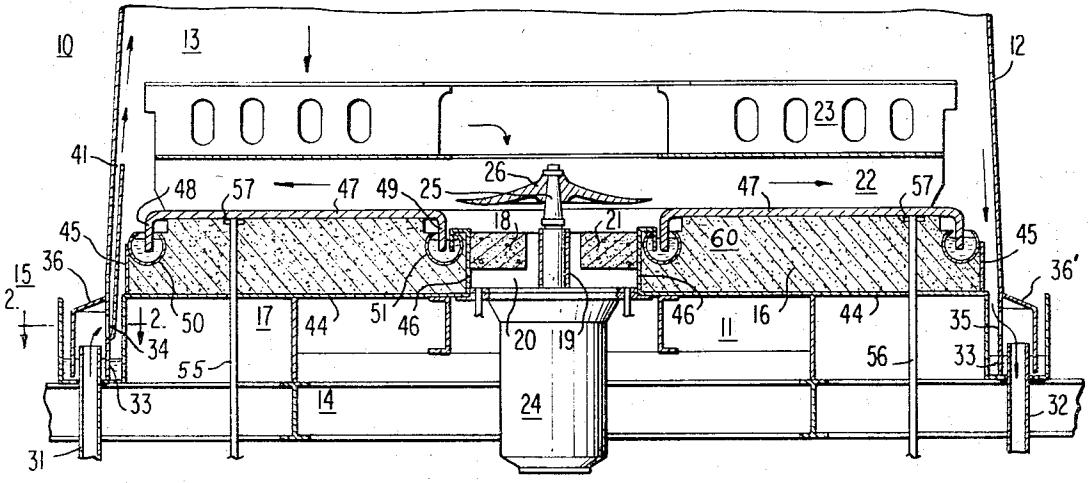


FIG. 1



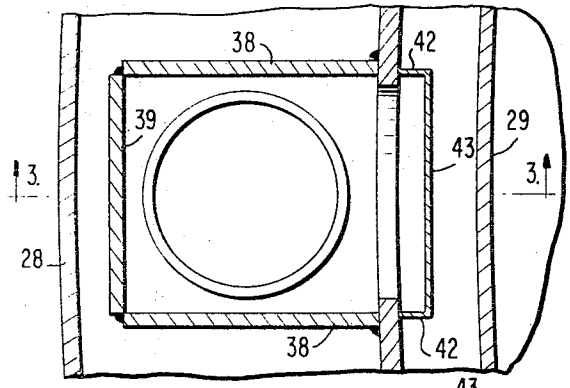
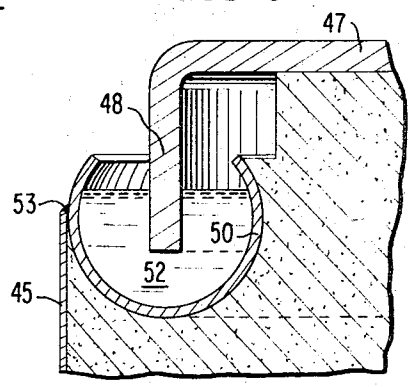


FIG. 2

FIG. 4



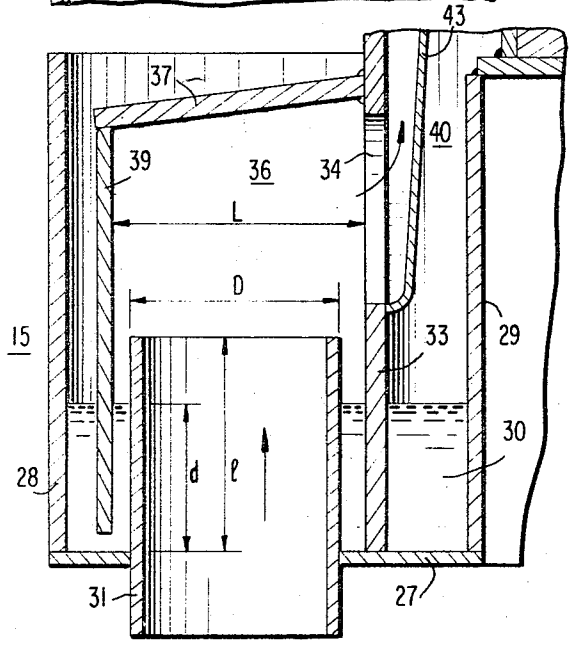
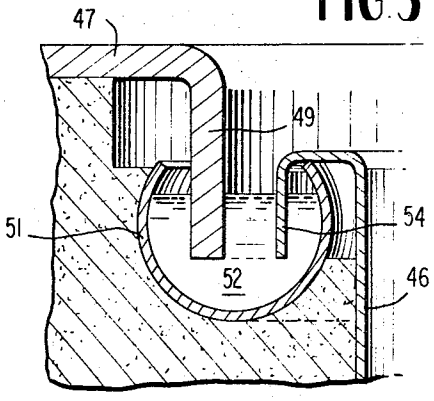


FIG. 3

FIG. 5



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BELL-TYPE FURNACE

BACKGROUND OF THE INVENTION

This invention relates to bell-type furnaces for annealing and/or chromizing of metal products and more particularly to an improved base and inner cover for such a furnace.

Bell-type furnaces generally comprise a base upon which the metal, usually in coil form, is stacked, a removable inner cover which sets on the base and forms with it a heating chamber, and a refractory lined outer cover that is disposed over the inner cover. Heating units in the outer cover furnish heat for the chamber. A gaseous atmosphere is piped to the heating chamber where it is circulated by means of a fan mounted in the base. To prevent the escape of the gaseous atmosphere from the heating chamber and to prevent infiltration of air into the chamber, means are provided to seal between the base and the inner cover. The gaseous atmosphere supplied to the heating chamber during an annealing cycle is nonreactive while during at least a portion of a chromizing cycle the gaseous atmosphere supplied is reactive and contains chlorine. The chlorine-containing reactive gaseous atmosphere is corrosive and to prevent its infiltration into the furnace base, the base is provided with a gastight sheath that forms a chamber and surrounds a porous cast refractory pedestal. The elements of the sheath are joined and sealed by welding to protect against such infiltration. To further insure against the possibility of the reactive gaseous atmosphere entering the base sheath, a nonreactive sealing gas, at a pressure higher than that of the reactive gaseous atmosphere in the heating chamber, is piped into the sheath chamber to pressurize it.

In the usual construction a bell-type furnace base comprises a bottom plate, a refractory pedestal, and a top plate, all of annular shape. Outer and inner peripheral side plates extend between the bottom and top plates and form a chamber which is occupied by the refractory pedestal. Extending across the opening in the bottom plate and bolted to it is the fan which circulates the gaseous atmosphere in the heating chamber. A trough extending around the outer periphery of the base is adapted to hold sealing means and to receive the lower end of the inner cover which extends downwardly into the sealing means. A number of conduits, including the gaseous atmosphere gas inlet and discharge pipes and thermocouple conduits, extend through the base and are welded to its top and bottom plates.

The temperature within the inner cover of a bell-type furnace during an annealing cycle reaches simple 1200°—1400° F. and during a chromizing cycle the temperature rises as high as about 1750° F. Alternate heating and cooling of the furnace causes considerable expansion and contraction of the base top plate. Such expansion and contraction of the top plate requires that the gaseous atmosphere inlet and discharge pipes and thermocouple conduits be fabricated with liquid metal seals which allow these members to shift position to a limited extent. In addition, portions of the base are fabricated of a metal, such as Inconel, (T.M.) having high strength at elevated temperatures. However, despite various means that have been adopted to compensate for expansion and contraction of the base elements during furnace operation there is relatively frequent failure of the welds joining the pipes and conduits to the base, as well as failure of the welds joining the elements of the base. In addition, the top base plates sometimes crack or split, generally in a radial fashion. Failures of this nature result in high maintenance and replacement costs and require that the furnace be taken out of service for extended periods while repairs are being made to the base. In addition, the pipes and conduits which extend through the base and into the area beneath it tend to clutter the area and cause difficulties in maintaining other furnace components.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a bell-type furnace which is more simple to construct and less costly to maintain than such furnaces presently in service.

Another object of this invention is to provide an improved bell-type furnace base which has gaseous atmosphere inlet and discharge pipes that do not pass through the base top plate.

A further object of this invention is to provide a bell-type furnace base sheath which is gastight and has a top plate that is not rigidly connected to other sheath elements so that it is able to expand and contract with relative freedom.

The objects of this invention are achieved by providing a bell-type furnace with a base that has the gaseous atmosphere inlet and discharge pipes extending through the base outer peripheral sealing trough. The base refractory pedestal is enclosed by a gastight sheath. The sheath includes outer and inner peripheral troughs adjacent the upper ends of the sheath outer and inner sidewalls and means to seal between the outer sidewall and the outer trough and the inner sidewall and the inner trough. The base sheath top plate has outer and inner peripheral flanges which project downwardly into the outer and inner sheath troughs which contain means to seal between the top plate flanges and the troughs.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring to the drawing:

FIG. 1 is a vertical sectional view through a portion of a bell-type furnace embodying the present invention.

FIG. 2 is an enlarged plan section, taken on the line 2–2 of FIG. 1, illustrating the lower end of the removable inner cover, the base outer peripheral trough, and the gas inlet pipe of the furnace of FIG. 1.

FIG. 3 is a cross-sectional view taken on the line 3–3 of FIG. 2.

FIG. 4 is an enlarged detail view of a portion of the furnace of FIG. 1 illustrating one manner of sealing between a base sheath sidewall, sealing trough, and flanged top plate.

FIG. 5 is an enlarged detail view of a portion of furnace of FIG. 1 illustrating an alternate manner of sealing between a base sheath sidewall, sealing trough, and top plate.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawing there is shown in FIG. 1 a portion of a bell-type furnace **10** having base **11** and removable inner cover **12** which forms heating chamber **13** with the base. The base comprises a supporting framework **14**, outer peripheral trough **15**, annular refractory pedestal **16**, sheath **17** forming chamber **60** and enclosing the pedestal, and core section **18**. Core section **18** is provided with a central vertically extending sleeve **19** and comprises an annular cooling chamber **20**, which surrounds the sleeve, and an annular refractory portion **21**. Mounted upon base **11** is diffusion chamber **22** which is surmounted by plenum chamber **23** that supports coils of metal to be treated in heating chamber **13**. Secured to the bottom of the base is fan assembly **24** having shaft **25** which extends upwardly through core sleeve **19** and has impeller **26** at its upper end.

As shown in FIG. 3, base outer peripheral trough **15** has bottomplate **27**, outer sidewall **28** and inner sidewall **29**, which extends upwardly to the bottom of base sheath **17**. Trough **15** is partially filled, to a depth *d*, with a suitable sealing material **30**, such as sand or woods metal. Extending upwardly through trough bottom plate **27**, on opposite sides of the furnace, are gaseous atmosphere inlet and discharge pipes **31** and **32**, respectively. Pipes **31** and **32** are spaced from trough sidewalls **28** and **29**, respectively, for purposes hereinafter described, and extend above trough bottom plate **27** a distance *e* which is greater than depth *d* of sealing material **30** in trough **15**.

Removable cover **12** has its lower end **33** extending into sealing means **30** in trough **15**. Spaced from inner cover lower end **33** and on opposite sides of the cover are gas inlet and discharge openings **34** and **35** respectively, which cooperate with gaseous atmosphere inlet and discharge pipes, **31** and **32**, respectively, in trough **15**. Gas inlet and discharge enclosures **36** and **36'**, respectively, each having an open bottom, extend outwardly from the lower end **33** of the inner cover and

downwardly from around openings 34 and 35, respectively. Each enclosure comprises a top plate 37, side plates 38, and outer plate 39, which is spaced from inner cover 12 a distance L that is greater than the outside diameter D of inlet and discharge pipes 31 and 32, respectively. Extending inwardly from inner cover lower end 33 and upwardly from around the bottom of inner cover gas inlet opening 34 is duct 40 which extends along the inner surface of the inner cover to a location above base 11. Duct 40 has an open upper end 41 and comprises sidewalls 42 and inner wall 43.

As indicated by the arrows in FIGS. 1 and 2, gaseous atmosphere from a source, not shown, passes through inlet pipe 31, inlet enclosure 36, inner cover gas inlet opening 34 and duct 40 into heating chamber 13. The gaseous atmosphere is circulated within heating chamber 13 by means of fan impeller 26 and passes from the heating chamber through inner cover discharge opening 35, discharge enclosure 36', and discharge pipe 32.

Base sheath 17, for reasons hereinafter disclosed, is designed to be gastight. As shown in FIG. 1, base sheath 17, which encloses refractory pedestal 16, comprises annular bottom plate 44, outer sideplate 45, which extends upwardly from adjacent the outer periphery of the bottom plate, inner sideplate 46, which extends upwardly from adjacent the inner periphery of the bottom plate, and top plate 47 having downwardly extending outer and inner peripheral flanges 48 and 49, respectively. Outer and inner sideplates 45 and 46 are secured to bottom plate 44 by welding the members together to form gastight joints. Partially embedded in refractory pedestal 16, adjacent its upper outer and inner peripheries, are annular sheath troughs 50 and 51, respectively. Troughs 50 and 51 contain a mass of sealing material 52, such as lead, which is liquid at furnace operating temperatures. Top plate outer flange 48 extends downwardly into sealing material 52 in sheath outer trough 50, and top plate inner flange 49 extends downwardly into sealing material 52 in sheath inner trough 51, thereby providing a gastight joint between top plate 47 and troughs 50 and 51. As shown in detail in FIG. 4 sheath outer sideplate 45 is joined to sheath outer trough 50 by means of weld 53 which serves to make this joint gastight. In place of a weld to seal between a trough and a sideplate a modified form of construction is shown in detail in FIG. 5. Sheath inner sideplate 46 is provided, adjacent its upper end, with flange 54 which extends inwardly of the sheath and downwardly into sealing material 52 in sheath inner trough 51, thus providing a gastight seal between sideplate 46 and inner trough 51. Sheath gas inlet pipe 55 and discharge pipe 56 extend, on opposite sides of the sheath, through bottom plate 44 into sheath chamber 60 and through refractory pedestal 16 to channel 57 which extends in a circle in the top of pedestal 16, adjacent the underside of top plate 47. A nonreactive sealing gas, such as hydrogen, is introduced into channel 57 of sheath chamber 60 through sheath gas inlet pipe 55 at a pressure higher than that of the reactive gaseous atmosphere circulated through heating chamber 13. This sealing gas flows through channel 57 in the top of pedestal 16, pressurizes sheath chamber 60, and is discharged from it through pipe 56. Thus, should there be a failure of any type in the members, joints, or seals of base sheath 17, nonreactive sealing gas will escape from the sheath chamber. Because of the higher pressure of the sealing gas there will be no infiltration of the reactive gaseous atmosphere from the heating chamber into the sheath or through it to the area beneath the base.

The various features of the above described bell-type furnace combine to provide a furnace which is superior in many respects to those presently in use. The positioning of the gaseous atmosphere inlet and discharge pipes in base peripheral trough 15 and the alterations to the inner cover to accommodate these pipes is a significant improvement. These pipes are now at a location which is substantially cooler than it is in the vicinity of the sheath top plate so they are no longer exposed to the considerable expansion and contraction which previously resulted in their failure. It will be apparent that other pipes and conduits, such as those used for thermocouples, can also be brought into the furnace through base peripheral trough 15, so that such pipes and conduits can be neatly spaced around the base periphery rather than cluttering up the area beneath the base sheath. An existing base can easily be modified to place the gas inlet and outlet connections in the base peripheral trough, and a removable inner cover can be altered to include gas inlet and discharge openings 34 and 35 and their respective enclosures. A new inner cover may be constructed with a diameter sufficiently large that its lower end will extend into the base peripheral trough in the space between trough outer sidewall 28 and inlet and discharge gas pipes 31 and 32. By designing base sheath 17 to incorporate a top plate 47 having a peripheral flanges 48 and 49 which extend downwardly into sealing material 52 in sheath troughs 50 and 51, respectively, the top plate is free to expand and contract during a furnace operating cycle. By doing away with the weld joints which exist in present bell-type furnaces between the base sheath top plate and sideplates the problem of maintaining these joints is eliminated. When replacement of the sheath top plate is necessary a new one can be installed with a minimum amount of time and labor. This, in itself, is a significant improvement if comparison is made with the time, labor and expense of material required to rebuild base sheaths of existing furnaces.

We claim:

1. In a furnace having a base and a removable cover thereon forming therewith a heating chamber through which a gaseous atmosphere is circulated, the combination comprising:
   - A. a base sheath comprising;
     1. an outer peripheral sideplate,
     2. an inner peripheral sideplate,
     3. an outer peripheral trough adjacent the upper end of said outer peripheral sideplate,
     4. means to provide a seal between said outer peripheral trough and said outer peripheral sideplate,
     5. a top plate having:
        - a. an outer peripheral flange extending downwardly into said base sheath outer peripheral trough,
     6. means in said base sheath outer peripheral trough to seal between said top plate outer peripheral flange portion and said sheath outer peripheral trough, and
     7. means to seal between said inner peripheral sideplate and said top plate.

2. In a furnace having a base and a removable cover thereon forming therewith a heating chamber through which a gaseous atmosphere is circulated, the combination comprising:
   - A. a base peripheral trough, extending around said base, said trough having;
     1. a bottom,
     2. outer and inner sidewalls,
   - B. removable cover sidewall means having the lower end thereof extending downwardly into said base peripheral trough;
   - C. means in said trough to seal between the lower end of said removable cover and said trough;
   - D. means extending into said trough through the bottom thereof, for introducing said gaseous atmosphere into said heating chamber; and
   - E. means extending out of said trough, through the bottom thereof, for discharging said gaseous atmosphere from said heating chamber.

3. The apparatus of claim 2 wherein said gaseous atmosphere introducing and discharging means are spaced from said base peripheral trough outer sidewall.

4. The apparatus of claim 2 wherein said removable cover sidewall means has first and second openings adjacent the lower end thereof and first enclosure means surrounding at least the top and side portions of said first opening and second enclosure means surrounding at least the top and side portions of said second opening, each said first and said second enclosure means extending outwardly from said removable cover sidewall means and downwardly into said trough below the surface of said sealing means therein.

5. The apparatus of claim 4 wherein said removable cover sidewall means has a third enclosure means on the inner surface thereof surrounding the bottom and side portions of said first opening, said third enclosure means having an open top end.

6. The apparatus of claim 5 wherein said third enclosure means has the open top end thereof at an elevation at least as high as the top of said furnace base.

7. In a furnace having a base and a removable cover thereon forming therewith a heating chamber through which a gaseous atmosphere is circulated, the combination comprising:

A. a base sheath comprising;
1. an outer peripheral sideplate,
2. an inner peripheral sideplate,
3. an outer peripheral trough adjacent the upper end of said outer peripheral sideplate,
4. means to provide a seal between said outer peripheral trough and said outer peripheral sideplate,
5. an inner peripheral trough adjacent the upper end of said inner peripheral sideplate,
6. means to provide a seal between said inner peripheral trough and said inner peripheral sideplate,
7. a top plate having:
a. an outer peripheral flange extending downwardly into said base sheath outer peripheral trough,
b. an inner peripheral flange extending downwardly into said base sheath inner peripheral trough, and
8. means in said base sheath outer and inner peripheral troughs to seal between said top plate outer peripheral flange portion and said sheath outer peripheral trough and between said top plate inner peripheral flange portion and said sheath inner peripheral trough.

8. The apparatus of claim 7 wherein at least one of said means to provide a seal between said outer peripheral trough and said outer peripheral sideplate and between said inner peripheral trough and said inner peripheral sideplate is a weld.

9. The apparatus of claim 7 wherein at least one of said means to provide a seal between said outer peripheral trough and said outer peripheral sideplate and between said inner peripheral trough and said inner peripheral sideplate is a flange extending from adjacent the upper end of one of said sideplates downwardly into said peripheral trough adjacent thereto.

10. The apparatus of claim 7 wherein said base sheath includes a bottom plate which extends between said outer and inner peripheral sideplates and a refractory pedestal is enclosed by said sheath.

11. The apparatus of claim 7 wherein said sealing means in said sheath outer and inner peripheral troughs is liquid at furnace operating temperatures.

12. The apparatus of claim 11 wherein said sealing means in said sheath outer and inner peripheral troughs is lead.