Sept. 30, 1958 C. CONE 2,854,226

ANNEALING COVER FURNACE WITH IMPROVED INNER COVER SEAL

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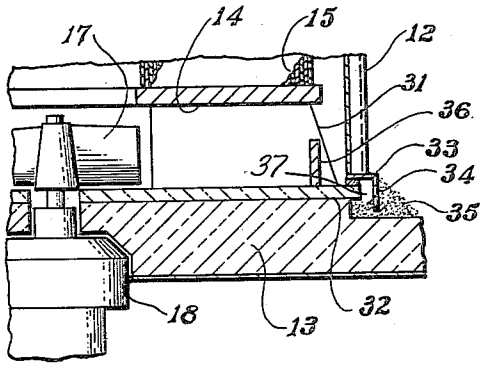


Fig 2

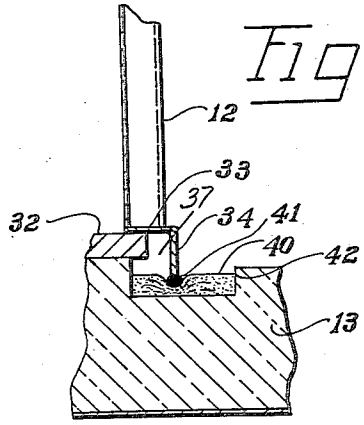


Fig 3

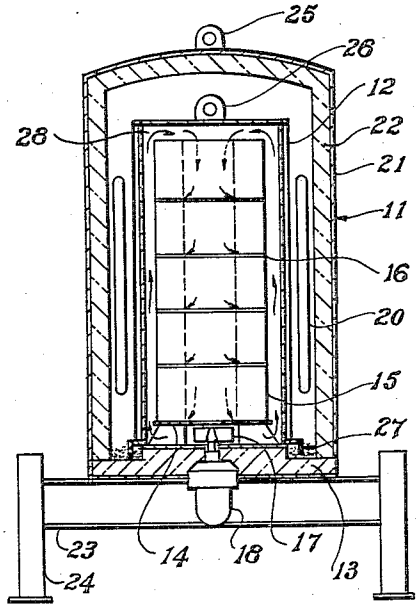


Fig 1

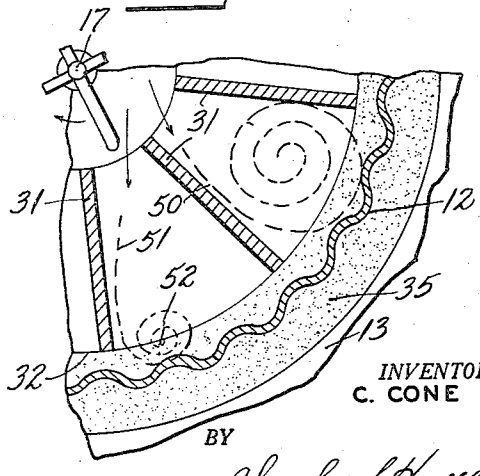


Fig 4

INVENTOR.
C. CONE

BY

Charles L. Haughey

ATTORNEY

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ANNEALING COVER FURNACE WITH IMPROVED INNER COVER SEAL

Carroll Cone, Toledo, Ohio, assignor to Surface Combustion Corporation, Toledo, Ohio, a corporation of Ohio

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5 Claims. (Cl. 263—40)

This invention relates to an annealing cover furnace and more particularly to such furnaces wherein the recirculation of atmosphere gas within the inner cover thereof is considerably accelerated to make convection heat transfer play a predominant part in the heating of the work charge.

In the development of furnaces for heating coils of strip material such as sheet steel, many innovations have been tried for obtaining maximum heating rates and uniformity of quality consistent with safe practices and cost of equipment. In Winder et al. 2,041,312, a radiant tube was fired down through the coil apertures to accelerate heating from within the coil, and thus greatly reduce heating time. Other features have now been adopted to obtain the same result, but bringing their own special problems. Hot fans in the bases, such as shown in Munford 2,252,673, were adopted to decrease stratification of heat within the inner cover, and thus to obtain uniformity of temperature in the charge from the top coil to the bottom coil. More recently it was discovered that if the power and efficiency of the fan were greatly increased, the inner annealing cover design improved and suitable coil separators used, convection heating greatly increased in proportion to radiant heating within the inner cover and especially on the coil strip edges, and heating times could be greatly reduced while temperature uniformity was much improved. This is discussed in my prior patent, Cone 2,600,094, and in coil separator patents such as Radlinski 2,678,815; Winder 2,671,656 and Cone 2,580,283.

With such increases in recirculation of atmosphere within the inner cover, the problem of adequately sealing the inner cover onto the base to contain the atmosphere has been much complicated by the tendency in such furnaces for the turbulent recirculating atmosphere gases to lift sand from the inner cover sand seals and distribute it through the separators, on the coils, and generally throughout the recirculation flow path, with resultant wear on the fan, separators and other furnace equipment, together with detrimental adherence of sand to the annealed strip, which caused considerable trouble in subsequent operations, such as rolling and plating.

The problem of sand distribution is further complicated in those atmosphere gas recirculating systems provided with coil bases having vanes which disperse the gas into a multiplicity of swirling streams. As the streams leave the vane tips and start to rise, vortices are sometimes formed over the exposed sand forming centers of decreased pressure which result in the lifting and distribution of said sand.

This invention is directed to the solution of this sand seal problem in a manner that still allows a beneficial minor leakage of atmosphere gas through the inner cover seal, but effectively prevents the high velocity recirculation gas from distributing sand within its flow path.

Various solutions to this problem have been attempted with only minor success. A more obvious attempt to

rectify this problem has been to replace the sand with a different type sealing medium. Such a medium would have to have high thermal resistance since it would be within the furnace itself. Furthermore, the medium would have to be sufficiently resilient to provide a reasonably gas-tight seal with all the rim of the inner cover despite irregularities in this rim due to manufacture, warpage, and dents due to handling. On the other hand, such material would have to be strong enough to withstand the weight of the inner cover without permanent deformation or injury. No material was found possessing all these qualities and at a reasonable price.

Another attempt to rectify the problem has been to place a deflector at the extremities of the base vanes to direct the wind upward away from the sand. In order to be effective as a means to eliminate raising the sand such deflector would have to be of such height as to restrict and virtually "choke" the passage thereby resulting in a wastage of fan horsepower.

Steel shot, lead, and various liquids have been experimented with. The disadvantage with liquids was vaporization at higher furnace temperatures. To overcome this, the trough containing the liquid was removed to a region distant from the furnace chamber and thus be subjected to lower temperatures. Such an installation was considerably more expensive, however, had a high initial cost, was clumsy to handle, and required frequent repair.

In the cases where the inner cover seal is far removed from the region of the furnace chamber, the greater length of the inner cover or its flange increases the alloy material cost. This increased length is also a disadvantage where steel mill space is limited or at a premium. The present invention overcomes these disadvantages by providing a construction which permits the overall space requirements of the inner cover to be held to a minimum. This construction also permits surrounding the seal with insulating material, thus detecting heat losses through said seal.

For a consideration of what I believe to be novel and my invention, which has presented an effective solution to this problem that has long plagued the art, refer to the attached drawings, the specification and claims.

Referring to the drawing:

Figure 1 represents a cross-section of a typical cover-type annealing furnace incorporating the present invention;

Figure 2 illustrates a more detailed view of the seal shown in Figure 1;

Figure 3 shows a variation of the invention with the use of a new sealing medium and flange arrangement;

Figure 4 is a fragmentary sectional plan of the base of a cover-type annealing furnace illustrating the vortex action of the swirling gases.

The cover-type annealing furnace of Figure 1 comprises an outer cover **11**; an inner, corrugated cover **12**; a base **13**; an inner base **14** on which coils **15**, separated by coil separators **16**, rest; a fan **17** with a driving unit **18**; and heat sources **20**, which will preferably be gas fired radiant tubes. Outer cover **11** consists of a metal casing **21** and insulation **22**. Outer cover **11** and inner cover **12** are provided with crane hook receptacles **25** and **26** respectively to enable their placement and removal by an overhead crane. Beams **23** and **24** support this furnace. The proposed inner seal is located at **27**. This will be more fully described in connection with Figures 2 and 3. Circulating gases follow the path described by arrows **28**.

In Figure 2, parts of fan **17**, driving unit **18**, inner base **14**, base **13**, coil **15**, and inner cover **12** are shown. A seal, not shown, is placed between base **13** and driving unit **18** as disclosed in my prior Patent Number 2,694,157. Vertical ribs **31** extend radially between base plate **32** and

inner base 14, supporting the latter. In addition, they are slanted out toward the perimeter of base plate 32 to function as a guide for positioning the inner cover 12. The horizontal strip 33 is formed as a ring, conforming with the bottom rim of inner cover 12 and producing a gas-tight joint therewith. This strip 33 supports the weight of cover 12 on the annular rim of the base plate 32 and forms a sufficient seal therewith to substantially eliminate gas turbulence adjacent the sealing medium 35. Flange 34, attached to the outer edge of strip 33, penetrates sealing medium 35, such as sand, and forms therewith a seal. The sand is piled on base 13 and against flange 34. The arrangement will allow some of the inert gas supplied to the inner cover to leak out to the volume defined between the inner cover 12 and outer cover 11 and yet prevents exposure of the sealing medium 35 to the swirling action of the circulating gases. The volume of such leakage can be controlled by the depth of sand. This situation is desirable since it allows contaminants in the circulating gases to be removed. If this seal is made in a completely gas-tight manner, then a conduit must be placed between the volume defined by the inner cover 12, and the volume between inner cover 12 and outer cover 11. Such conduits frequently become plugged and require periodic cleaning. A wind deflector 36 is employed if desired. This is a substantially upright metal plate, attached to base plate 32, that serves to deflect circulating gases away from the seal and also serves as stiffeners for ribs 31.

The particular arrangement and dimensions of base plate 32, strip 33, flange 34, and sealing medium 35 are interrelated to form a plenum or equalizing chamber 37. The swirling gas streams which escape through the seal formed by cooperating elements, base plate 32 and strip 33, tend to form vortices which result in areas of unequal pressure. The plenum chamber 37 affords opportunity for the gas streams of increased pressure to expend themselves, thus equalizing the overall static pressure on the seal and virtually eliminating lifting and disrupting of the sealing medium.

Figure 4 illustrates the vortex action of the swirling gases as they are recirculated by the fan 17 in a furnace where granular material 35 is exposed to the path and effect of such gases. As the gases leave the fan 17 they impinge upon and are diverted by the vertical ribs or vanes 31. The ribs 31 impart a swirling motion to the gases as indicated at 50 and 51. Should the vortex of the swirling gases occur, as frequently it does, at a point over the exposed granular sealing material or sand 35 as indicated at 52, particles of said sand are lifted and distributed with said gases.

Figure 3 discloses a seal similar to that of Figure 2 except that a different sealing medium 40 and a foot 41 are employed. The sealing medium is refractory at temperatures exceeding 2000° F. and is essentially composed of alumina silicate. This is commercially available in compressed block, granular, and matted fiber forms under several brand names.

It is preferable to allow a minimum weight on this material to prevent injury by shearing or permanently deforming and yet form a reasonably gas tight seal. Also oxides forming on metal in contact with this sealing medium cause it to tend to adhere to that metal. Under such conditions, raising cover 12 will pull all or a portion of the medium 40 out of trough 42. To prevent this, an oxidation-resistant metal must be used. Tests have shown that higher grade stainless steel such as 25–12 stainless steel comprising 25% chrome and 12% nickel or 35–15 stainless steel comprising 35% nickel and 15% chrome cause no adhesiveness between the metal and medium. Lower grade stainless steel such as 18–8, comprising 18% chrome and 8% nickel, form some oxides and consequently produce this condition. However, if such surfaces are first oxidized, then cleaned with hydrochloric or nitric acid, no further oxidation occurs. In actual practice, these are cleaned with acid after two or three furnace loads or heats and thereafter no further oxides are formed.

To meet these conditions, foot 41 is provided that may be either the lower portion or all of flange 34. This foot 41 may be of various designs including that of the flange 34 itself. The design used will be determined by the degree of gas-tightness desired with a given weight transmitted by flange 34 or foot 41 to the sealing medium 40. In general, for a given weight, a design allowing more of the surface of foot 41 to contact the sealing medium 40 will provide a more gas tight seal. Furthermore, such a design will allow medium 40 to be subjected to a greater weight without injury. Foot 41 is made of an oxidation-resistant metal in at least that portion contacting sealing medium 40.

The length of flange 34 is determined by assuring the foot 41 will contact sealing medium 40 deeply enough to allow a small leakage, as desired, but not so deep as to permanently deform or break down this medium 40.

Other variations will be apparent from this disclosure, this being but a preferred form of my invention.

I claim:

1. In a recirculating atmosphere furnace having a base, and inner cover on said base forming therewith an atmosphere containing heating chamber, a refractory lined heating cover disposed on said base and over said inner cover and adapted to supply heat to said inner cover for heating work therein, and means for recirculating atmosphere within said inner cover and in said heating chamber, the combination which comprises: an annular rim on said inner cover; a rim portion on said base forming a seat for said annular rim for supporting substantially all of the weight of said inner cover around the periphery thereof, and forming with said annular rim a first gas seal; an annular trough on said base and concentrically around said rim, within said heating cover, and containing a sealing material; and a depending, substantially vertical flange on said inner cover and extending downwardly into said sealing material but short of the bottom of said trough to form a second gas seal between said flange and sealing material.

2. A furnace according to claim 1, wherein: the dimensions of said annular rim, said depending flange, said rim portion on the base and said sealing material, are so inter-related and said first and second gas seals are spaced apart to form a plenum chamber between said first and second seals for equalizing pressure of any gases escaping through said first gas seal.

3. A furnace according to claim 1, wherein: said sealing material is a fibrous compact, and said flange is long enough to form substantial gas sealing contact with said compact around the periphery of the flange, but not long enough to permanently deform the compact.

4. A furnace according to claim 3, wherein: said sealing material is a metallic oxide fiber, and the foot of the depending flange in contact with said compact is formed of a metal alloy which is resistant to oxidation in the atmospheres and at the temperatures to which it is exposed in the furnace.

5. A furnace according to claim 4, wherein: said flange foot is composed of a metal alloy of the class consisting of 25–12 stainless steel, and 35–15 stainless steel, and 18–8 stainless steel.

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