Aug. 10, 1937. L. WILSON ET AL 2,089,843

METHOD AND APPARATUS FOR ANNEALING

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Fig. 1.

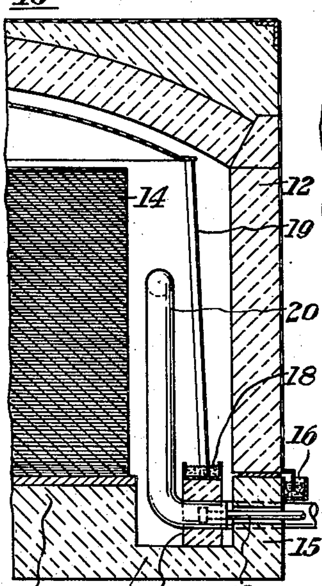

Fig. 2.

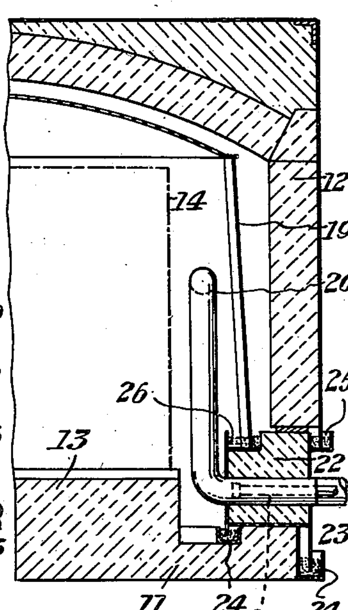

Fig. 3.

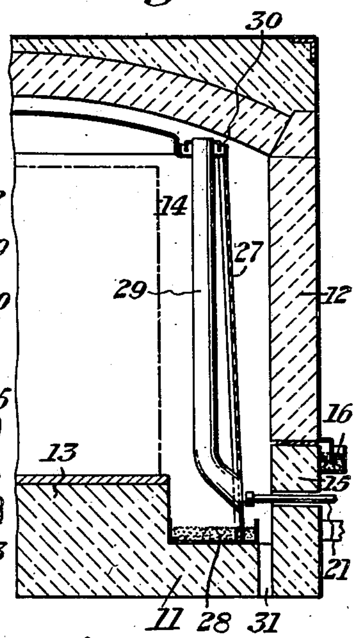

Fig. 4.

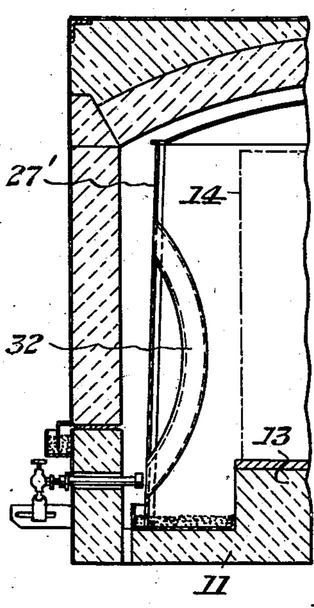

Fig. 1A.

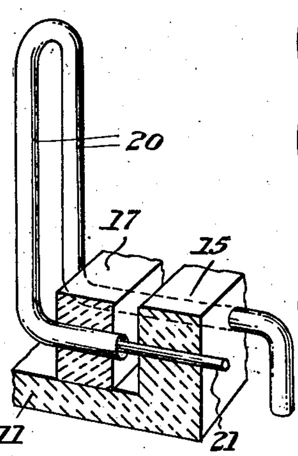

Fig. 5.

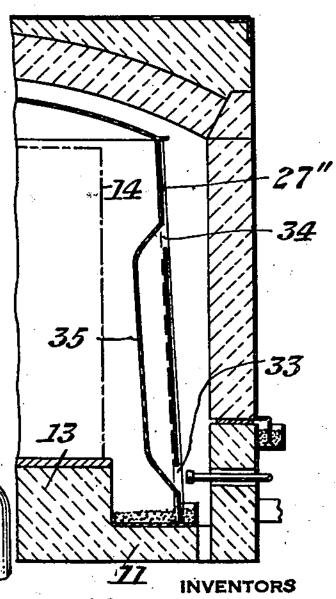

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Fig. 6.

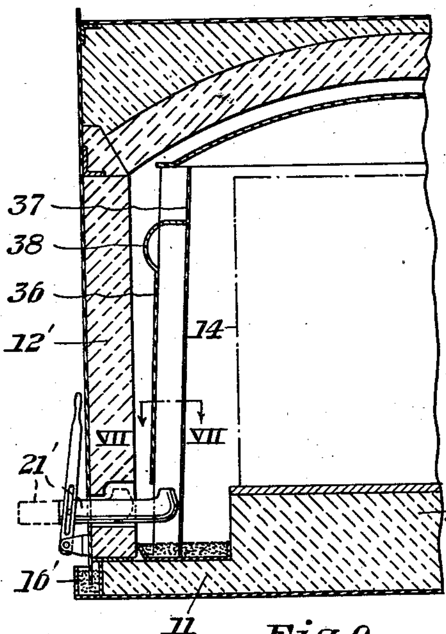


Fig. 7.

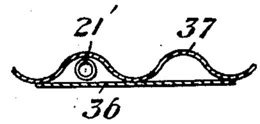


Fig. 8.

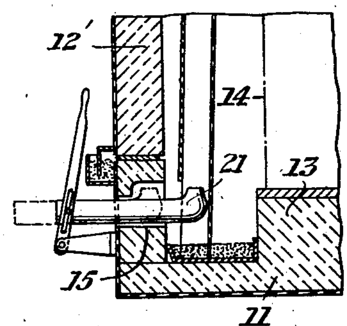


Fig. 9.

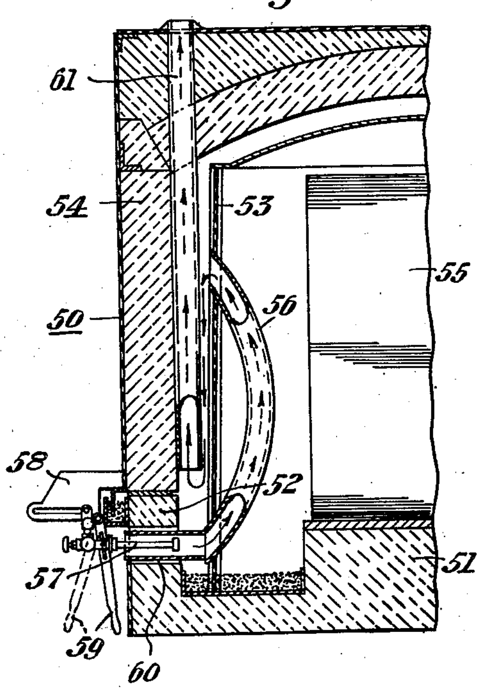
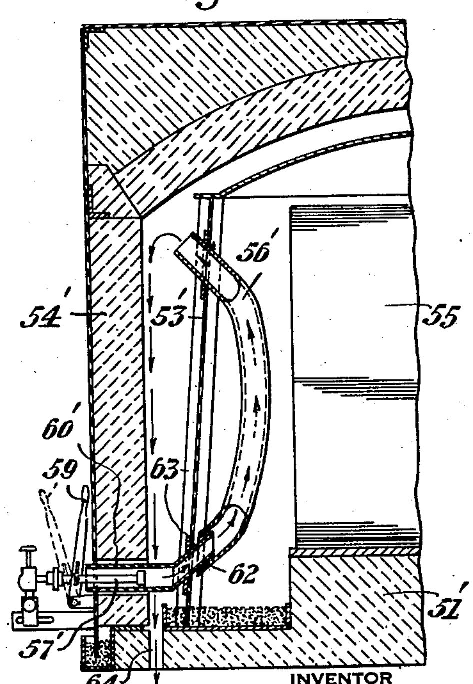


Fig. 10.



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2,089,843

METHOD AND APPARATUS FOR ANNEALING

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Application July 2, 1936, Serial No. 88,542

6 Claims. (Cl. 266—5)

This invention relates to the art of annealing and, in particular, to the annealing of sheets in stacks.

The use of cover type furnaces for annealing sheets has become quite general. Usually one furnace cover is applied successively to a plurality of charge supporting bases. In order to release the heating cover after heating the charge to annealing temperature, for disposition over successive charges, it has become the practice to employ what are known as inner covers. These are simply open-bottomed boxes of light plate which are placed over the charge before the heating cover or furnace bell proper is lowered onto the base. The function of the inner cover, of course, is to prevent access of the atmosphere to the material after removal of the heating cover.

Such inner covers inevitably constitute an obstacle to the transmission of heat from the heating means of the furnace cover to the charge itself. The use of inner covers, therefore, slows down the heating process, as compared to the speed of heating which might be obtained in the absence of the covers. In spite of this objection, however, the use of inner covers is an advantage in that it permits the heating cover to be used more efficiently, i. e., it operates as a heating means substantially one hundred per cent of the time and is not relied on to protect the charge while it cools.

We have invented a method and apparatus for annealing which retains the advantage of the inner covers, but overcomes the disadvantage to their use. Our invention permits the charge, although enclosed within a protective cover, to be heated as rapidly as if there were no inner cover used in the present practice but, at the same time, we utilize the protective cover to enclose the charge during cooling and release the heating cover so that it may be used in heating other charges. We provide for exposing the charge directly to the heat radiated by heating means suitably mounted in any one of several ways. Radiant tubes may be disposed on or within the inner covers, and may either be separately formed or constitute a portion of a wall of the protective cover. Several embodiments of the invention are illustrated in the accompanying drawings. In the drawings,

Fig. 1 is a partial transverse section through a furnace having heat exchange or radiant tubes mounted so as to project within the space enclosed by the inner cover when it is lowered into place;

Fig. 1*a* is a diagrammatic view illustrating a detail;

Fig. 2 is a similar view showing a slight modification;

Fig. 3 is a similar view showing heat exchange tubes mounted on and within the inner cover;

Fig. 4 shows a modification of this principle;

Fig. 5 is a similar view illustrating heat exchange tubes formed on a wall of the inner cover;

Fig. 6 shows a slight modification of this principle;

Fig. 7 is a partial sectional view along the line VII—VII of Fig. 6; and

Fig. 8 is a view similar to Fig. 6 illustrating a further modification.

Fig. 9 is a partial transverse sectional view of a slightly different construction; and

Fig. 10 shows a further modified construction.

Referring now in detail to the drawings and first to Figure 1, a cover type furnace 10 comprises a base 11 and an insulating cover 12. The base 11 includes a pier 13 for supporting a charge 14 which may be a stack of sheets. A peripheral flange 15 extends around the edges of the base 11 and is adapted to receive the lower edge of the cover 12 for supporting the latter. A seal 16 closes the joint between the base and cover.

The base 11 is also provided with a low wall 17 disposed between the flange 15 and the pier 13. A sealing channel 18 is carried on top of the wall 17 for cooperation with the lower edge of a protective cover 19. Heat exchange tubes 20 are mounted in the wall 17 and are provided with burners 21 connected to any suitable fuel source through appropriate control mechanism such as valves. The tubes 20 are of U-shape and the ends of the tubes opposite those in which the burners 21 are positioned extend outwardly through the wall 17 and the flange 15 and thence downwardly to a sub-floor exhaust duct (not shown). This feature of construction is shown clearly in Figure 1*a*.

In using the apparatus of Figure 1, the covers 12 and 19 are raised and the charge 14 disposed on the pier 13. The burners 21 are then lighted and the covers 19 and 12 lowered in succession. Combustion gases traversing the tubes 20 heat the latter to radiant condition and heat is transmitted directly therefrom to the charge 14. When the charge has been heated to the desired temperature, the burners are extinguished and the cover 12 is moved to the next succeeding base 11 to enclose a charge disposed thereon. The cover 19 protects the charge 14 from the atmosphere as it cools. While the construction of Fig.

1 requires separate heating tubes for each base, the additional cost thereof is more than offset by the saving in heating time which is made possible. The permanent mounting of the radiant tubes, however, is a slight inconvenience in placing or removing a charge.

Fig. 2 shows a construction which is not subject to the last mentioned objection. The construction of Fig. 2 includes a base 11, and a cover 12, the base having a pier 13 for receiving a charge 14. Extending around the periphery of the base 11, removably resting thereon, and adapted removably to support the cover 12, is a ring or frame 22. This element, like the base and cover is composed of refractory bricks assembled within a fabricated enclosure of structural members and plates. It includes inner and outer sealing flanges 23 adapted to cooperate with channels 24 containing suitable sealing material. The frame 22 is also supplied with a sealing channel 25 adapted to cooperate with a flange depending from the cover 12. It is also provided with a sealing channel 26 adapted to receive the lower edge of a protective cover 19.

Radiant tubes 20 are mounted in the frame 22 with burners 21, in the same manner as in the wall 17 of Fig. 1.

The structure of Fig. 2 may be used in the same manner as that of Fig. 1, the advantage of the construction being that the ring or frame 22 and its tubes 20, may be removed when placing or removing a charge.

Fig. 3 shows a modified construction wherein each base is again provided with its own set of radiant tubes, but in this case they are mounted on and in the protective cover which thereby also becomes a heating cover, the outer cover serving merely to insulate against heat loss. In Fig. 3, the base 11 has a peripheral upstanding wall or flange 15 as in Fig. 1 in which burners 21 are disposed. A novel form of protective cover 27 has its lower edge disposed in a sealing channel 28 carried on the base between the pier 13 and the wall 15. The cover 27 is provided with a plurality of heat exchange tubes 29, the lower ends of which extend through suitably shaped openings in the wall of the cover adjacent the lower edge thereof. The upper ends of the tubes project through the top of the cover, but are freely floating relative thereto to permit expansion and contraction. Seals 30 close the spaces between the tubes 29 and openings in the top of the cover through which they project. The lower ends of the tubes 29 are in alinement with the burners 21.

When the charge 14 has been placed and the burners 21 lighted, the covers 27 and 12 are successively lowered into place. The hot combustion gases flow upwardly through the tubes 29 and heat the latter to radiant condition. The heat thereof is directly transmitted to the charge which is disposed closely adjacent the tubes. The base 11 is provided with a plurality of discharge ports 31 whereby the combustion gases issuing from the upper ends of the tube 29 pass downwardly between the cover 27 and the cover 12. This has two desirable results; in the first place, the interior surfaces of the walls of the cover 12 are heated thereby; in the second place, a small portion of the burned gases is entrained with the fuel and air mixture issuing from the burners 21 for combustion in the tubes 29. This reduces the maximum combustion temperature and protects the tubes from excessive heat. The ports 31 may open into a common exhaust duct (not shown).

When the charge has been heated to the proper temperature and the cover 12 moved onto the next pass, a circulation of air through the tubes 19 is created by natural draft due to their heated condition. This accelerates the cooling of the charge to a temperature at which it is safe to remove the protective or heating cover.

Fig. 4 shows a slight modification of the structure of Fig. 3 which is substantially identical therewith except for the shape of the radiant tubes. In Fig. 4, I employ parabolic tubes 32 both ends of which are secured to the side walls of the inner cover 27′ as by welding. Because of the shape of the tubes, expansion and contraction thereof do not introduce any severe strains, but merely vary the amount of curvature in the tubes.

Fig. 5 illustrates a still further modification of tube construction. In Fig. 5 holes 33 and 34 are formed in the walls of the cover 27″. Suitably shaped channel members 35 are secured as by welding to the walls of the inner cover with their ends overlapping the holes 33 and 34. The channel members 35, together with the portion of the side walls of the cover enclosed thereby constitute heat exchange tubes. The gases traversing the passages defined thereby heat the channel members 35 and the walls of the cover from which heat is radiated to the charge.

Fig. 6 illustrates a slightly different embodiment of the principle disclosed in Fig. 5. The side walls of the protective covers are usually corrugated for increased rigidity. By making the corrugations of sufficient depth, they themselves may form parts of ducts or passages for the heating gases. As shown in Figs. 6 and 7, a plate 36 overlies adjacent corrugations in the side walls of an inner cover 37. A "blister" 38 pressed out of the upper end of the plate 36 provides a connection between the passages defined by the adjacent corrugations and the plate itself. The cover 12′ is provided with a plurality of retractible burners 21′, which are movable into and out of alinement with one of the passages formed by the corrugations and the plates 36. After the charge and heating cover have been placed, and the burners lighted, the cover 12′ may be lowered into position on the base 11 and the burners advanced to the solid line position of Fig. 6. The gases produced by combustion of the fuel-air mixture supplied to the burners from any suitable source flow upwardly through one corrugation and downwardly through the adjacent corrugation and thence into the space between the heating and insulating covers. Suitable exhaust ports in the base (not shown) provide for the final discharge of the gases from the furnace.

Fig. 8 shows a construction similar to that of Fig. 6 except that the burners are mounted on a peripheral wall 15′ extending upwardly from the base instead of on the cover itself.

Fig. 9 illustrates a furnace 50 comprising a base 51 having an upstanding wall 52 extending around the edge thereof. A protective cover 53 and an insulating cover 54 cooperate with the base in the manner already indicated to enclose a charge 55. The cover 53 has heat exchange tubes 56 arranged therein in about the manner shown in Fig. 4. Burners 57 are retractably mounted on the cover 54 on brackets 58 and have operating levers 59 for advancing and retracting them. Burner tubes 60 are positioned in the wall 52 in alinement with the burners whereby they match up with the lower ends of the tubes 56. Exhaust ducts 61 extend downwardly through the insulating cover 54 to a level below the upper ends of the tubes 56. The downward flow of exhaust gases along the walls of the cover 54 is thus obtained without the necessity of openings through the base.

Fig. 10 shows a similar construction except that the heat exchange tubes 56' include the expansion joints 62. The burner structure and mounting of Fig. 10 is similar to that of Fig. 9 except that the burners 57' and the burner tubes 60' extend through the side walls of the insulating cover 54'.

The upper ends of the tubes 56' are welded to the wall of the cover 53'. The lower ends hang free to embrace short tube sections 63 welded to and extending upwardly from the lower portion of the walls of the cover 53'. Heating gases are exhausted from the space between the covers 53' and 54' in the manner indicated in Fig. 3, i. e., through ports 64 in the base 51'.

The several alternative constructions and methods disclosed are similar in that they all expose the charge directly to the radiations from the ducts through which the heating gases pass. As already pointed out, this accelerates the heating and thereby increases the amount of material which it is possible to anneal with a single set of equipment. This saving in time is reflected in a lower cost of fuel per ton of material treated. Time savings of as much as 15 to 20 per cent can be obtained.

Various changes in the several methods and apparatus disclosed may be made without departing from the spirit of the invention or the scope of the appended claims.

We claim:

1. The combination with a base capable of supporting a charge of material during heat treatment, of a protective cover, a seal on the base cooperating therewith whereby said cover is effective when placed over the charge to exclude the atmosphere therefrom while cooling, an insulating cover dimensioned to be placed over the protective cover while heating the charge to confine the heat therein, conduits for heating gases extending along said protective cover, a portion at least of the walls of the conduits being directly exposed to the charge for radiation of heat thereto, and means for delivering hot gases to said conduits.

2. The combination with a base capable of supporting a charge of material during heat treatment, of a protective cover, a seal on the base cooperating therewith whereby said cover is effective when placed over the charge to exclude the atmosphere therefrom while cooling, an insulating cover of a size to be placed over the protective cover while heating the charge to confine the heat therein, conduits mounted on said protective cover and extending inwardly of the outer boundaries thereof, for conveying hot combustion gases close to the charge, and burners discharging into said conduits.

3. The apparatus defined by claim 2 characterized by an exhaust port in said base adjacent said burners, the ends of the conduits adjacent the burners being open to the space adjacent said port whereby said burners induce recirculation through the conduits of a portion of the gas which has previously passed therethrough.

4. In a method of heating material enclosed within inner air excluding and outer heat-insulating covers, the steps including conducting hot gases to the space within the first mentioned cover and confining the gases out of contact with the material.

5. The method defined by claim 4 characterized by conducting said gases into said space adjacent the bottom of the air-excluding cover and out of said space adjacent the top thereof and thence downwardly along the wall of said heat-insulating cover.

6. The method defined by claim 4 characterized by conducting said gases into said space adjacent the bottom of the air-excluding cover and out of said space adjacent the top thereof, and inducing recirculation of a portion of the gases that have previously traversed said space with the gases entering the space for the first time.

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