Nov. 5, 1940. M. C. BATES ET AL 2,220,797

ANNEALING FURNACE

Filed May 24, 1938 2 Sheets-Sheet 1

Fig. 1.

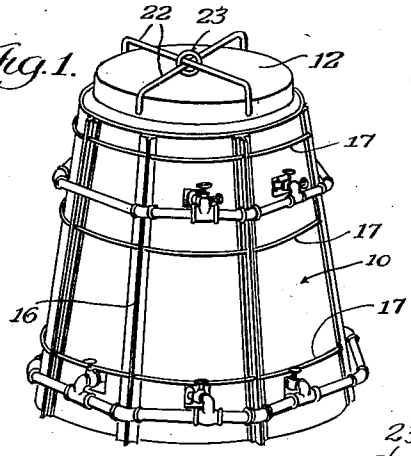


Fig. 5.

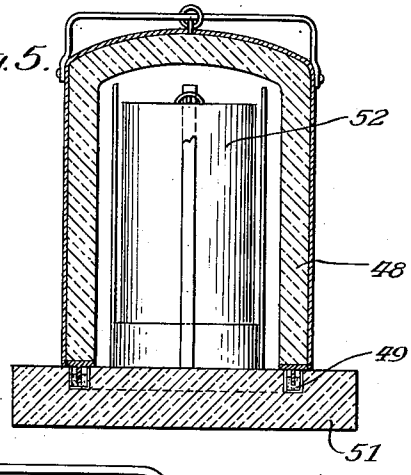
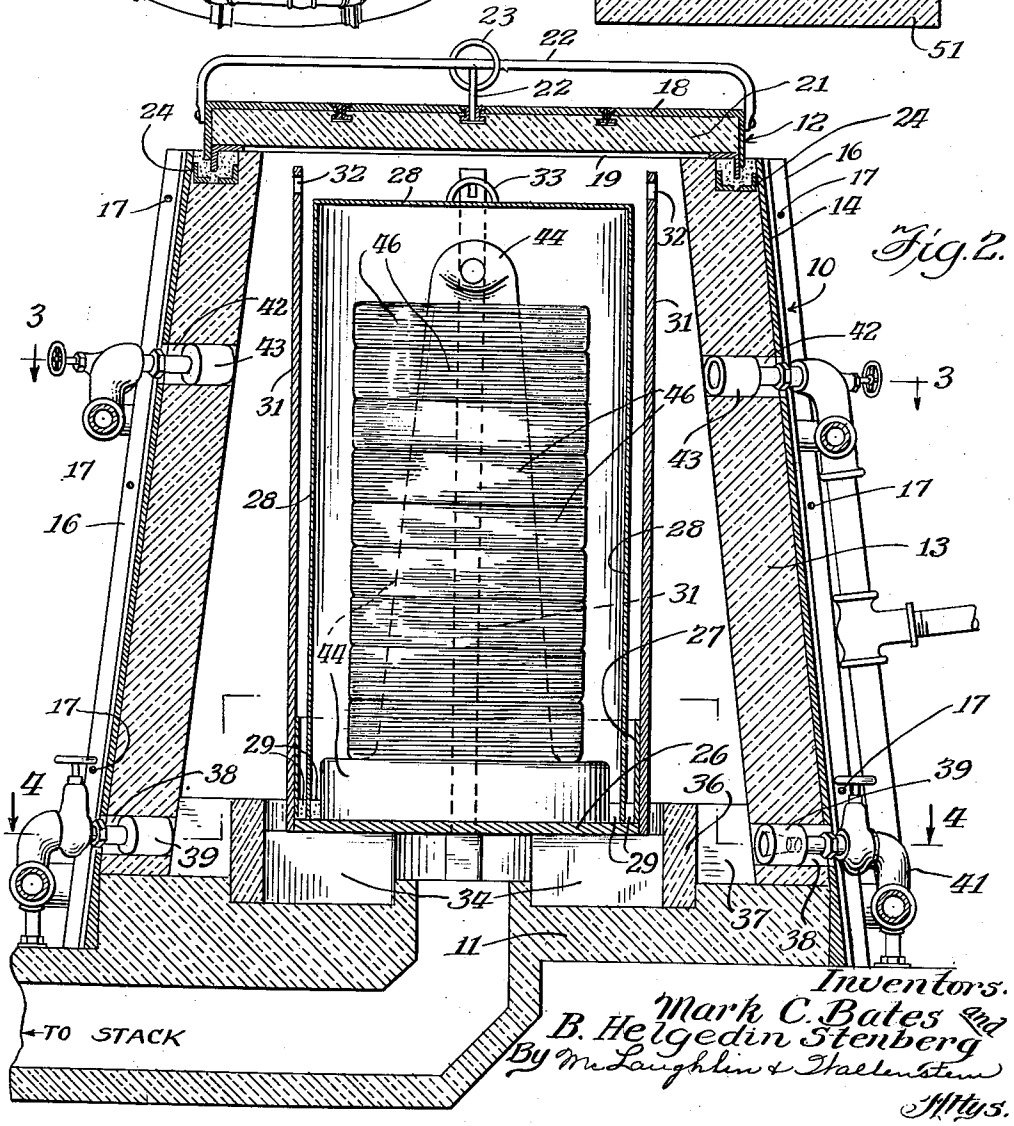


Fig. 2.



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Fig. 3.

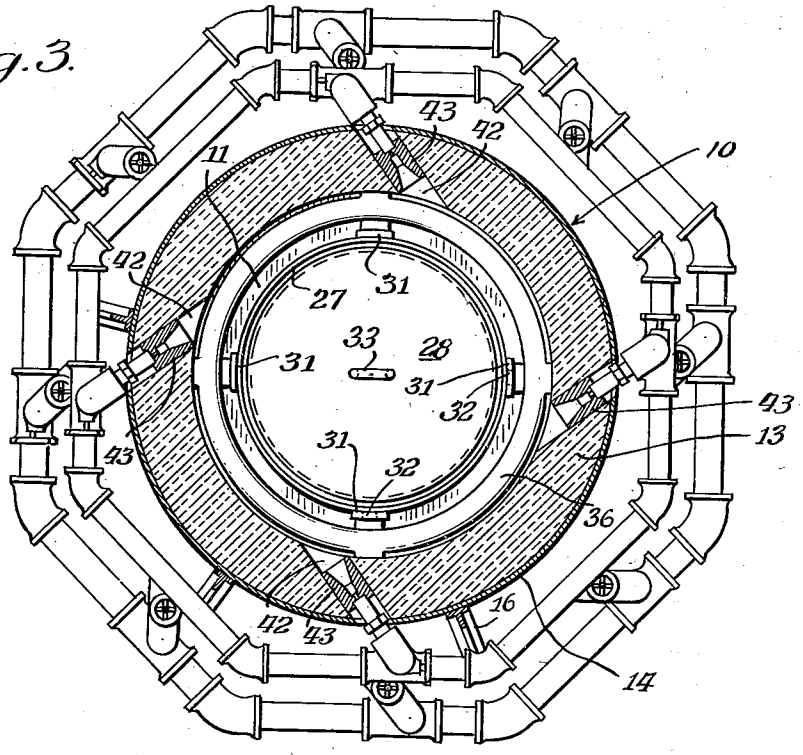
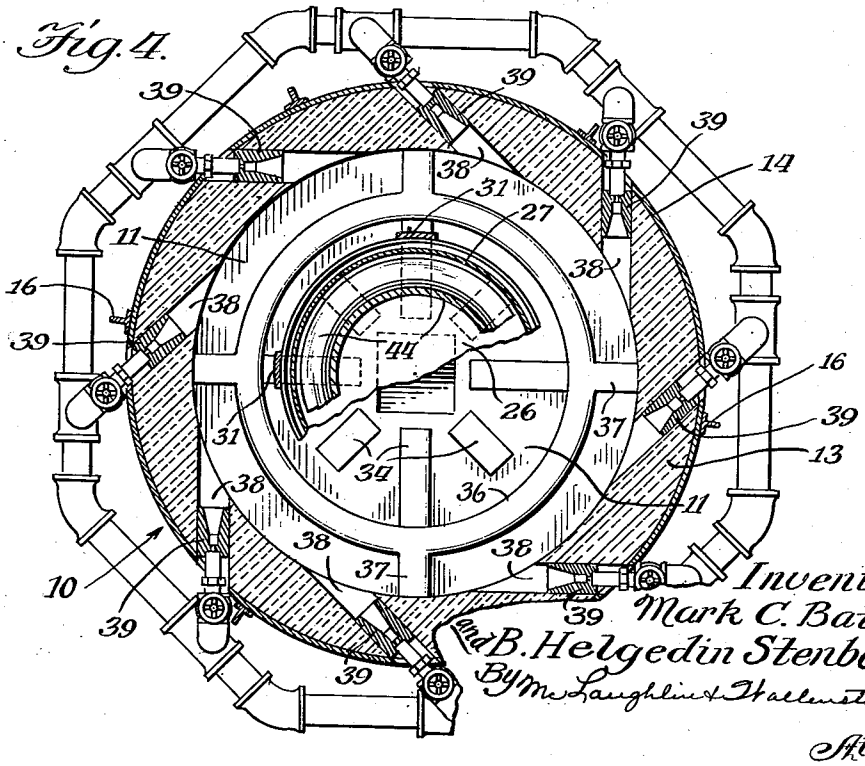


Fig. 4.



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ANNEALING FURNACE

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Application May 24, 1938, Serial No. 209,715

5 Claims. (Cl. 266—5)

Our invention relates in general to furnaces, specifically furnaces for treating metals, such as in the form of wire and the like, for the purpose of annealing them.

When metals are formed by any of the usual processes such as drawing, rolling. casting, swedging or the like, strains are left in the metal which result in non-uniformity, or the metal as a whole is metallurgically in an undesirable condition because of the hardness resulting from breaking down the crystal structure when work is performed on it. Improved manufacturing methods have made it possible to process the metal in a rapid succession of steps from the ore to the finished article so that production is carried out in a fraction of the time heretofore required. As has been stated many times, however, annealing operations still comprise a "bottle neck" in that the otherwise smooth flow of metal articles from ingot to shipping floor is still slowed up because of imperfect annealing methods and equipment. Among the principal problems in annealing, of course, are the time factor and the cost element, but additional problems arise because of non-uniform application of heat which results in the production of a non-uniform product and scaling of the metal article, which produces an inferior final result and often a large number of rejected parts. While our invention contemplates the improvement of annealing technique generally, it is principally concerned with improvements in annealing furnaces and associated structures particularly suitable for annealing wire and similar articles but also capable of use in still other annealing operations.

The principal object of our invention is the provision of improved annealing equipment.

Another object is the more even application of heat to metal articles and the like during the process of annealing.

Another object is the provision of an improved furnace design particularly suitable for use in annealing operations.

Still further objects look to a decrease in the time usually required for annealing, decrease in over-all costs, including the amount of fuel employed, decrease in scaling, and production of a more uniform product.

Other specific objects and features of our invention will be apparent from a consideration of the following detailed description taken in conjunction with the accompanying drawings wherein

Fig. 1 is an elevational view of an annealing furnace constructed in accordance with our invention, the figure being of relatively reduced size to conserve space,

Fig. 2 is a vertical sectional view taken through a furnace constructed in accordance with our invention and also illustrating the arrangement of the annealing pot within which the material is supported during the annealing operation,

Fig. 3 is a transverse sectional view taken along the line 3—3 of Fig. 2,

Fig. 4 is a similar section taken along the line 4—4 of Fig. 2, and

Fig. 5 is a sectional view shown in reduced scale showing a feature employed for cooling the annealing pot and contents after they are withdrawn from the furnace.

Generally considered, we produce a furnace of circular cross section and arranged to support an annealing pot in a vertical position within the furnace so that substantially the entire outside surface of the pot is in contact with hot gases within the furnace. We employ a plurality of rows of burners disposed around the furnace in such a manner as to fire tangentially of the annealing pot, at least one row of burners firing against an imperforate breast wall. In the preferred design an upper cover is provided which is removable for insertion of the annealing pot and contents, and the exhausted gases from the burners are withdrawn through a lower central flue in order to produce a more even application of heat and generally provide a more desirable and convenient structure. The preferred method of heating the furnace is by the use of pre-mixed vaporized fuel and air produced by means of the apparatus and method shown in French Patents Nos. 2,122,684 and 2,123,887, respectively. The apparatus defined in the French patent is known to the trade under the name "Vapofier." Pre-mixed or aspirated gas may be employed, however, without change in the design of the furnace, although the results are not quite so satisfactory. The circular breast wall at the bottom of the furnace prevents the flame from the burners from coming into direct contact with the annealing pot so as to cause uneven application of heat, and also produces a swirling action of the exhaust gases which is communicated to substantially all of the body of gases within the circular orifice between the annealing pot and furnace wall so that the flame from the upper row or rows of burners is also prevented from coming into direct contact with the annealing pot and local over-heating is also prevented in the region of the upper burners. This

is indicated by the very unusual uniformity in the application of heat and also by the fact that the annealing pot shows substantially no scaling such as would occur if the flame were to be projected directly against it.

Referring now to the drawings: we provide a circular side wall 10, bottom 11 and removable top cover 12. The side wall comprises a layer of insulation 13 which may be fire brick or other suitable refractory material, a sheet metal outside cover 14, vertical supports 16, and re-enforcing hoops 17. Naturally, the specific construction of these parts may be modified in any suitable way to provide a circular wall having suitable support and suitable heat insulating properties.

The removable cover 12 comprises two frame members 18 and 19 nested as shown with a substantial layer of heat insulating material 21 between them, the heat insulating material being preferably a usual type of refractory such as employed in furnace structures. Cross bails 22 are provided with a loose lifting ring 23 for removing the cover vertically. An annular channel is provided at the top edge of the side wall by the provision of a channel member 24 which is suitably secured as by welding to the metal support portions of the side wall. This channel is adapted to be filled with sand or other suitable sealing material, and the projecting annulus of the member 19 by seating itself into the sand in the channel forms a seal which positively excludes air at the jointure between the removable cover and the side wall.

The metal to be annealed is supported within an annealing pot which comprises a material supporting member having an imperforate bottom 26 and side wall 27 and an imperforate inverted cover 28. As shown, the inverted cover rests within the hopper and a layer of sand or suitable sealing material 29 is provided to exclude air in the annular space where the bottom of the inverted cover engages the hopper. A plurality of lift bars 31 are secured to the hopper portion of the annealing pot and are provided with top openings 32 in which a hook or suitable implement may be engaged to lift the entire annealing pot out of the furnace when the cover 12 has been removed. A lift ring 33 is provided on the upper end wall of the inverted cover 28.

A plurality of radial piers 34 are provided at the bottom of the furnace on which the annealing pot rests, thereby furnishing a firm support but still allowing ample space so that substantially the entire lower outside area of the annealing pot may be swept with hot gases while the burners are in operation. As shown in Fig. 4, only some of the radial piers are long enough to act as spacers for a circular breast wall 36, the center ones leaving still more space for the passage of hot gases. Blocks 37 disposed between the outside of the breast wall and the furnace wall also serve to position the breast wall 36. The piers 34, the breast wall 36 and the blocks 37 are all carried on the furnace bottom 11 and are all formed of suitable insulating material such as refractory brick or the like.

In line with the breast wall 36 and substantially equally spaced around the periphery of the furnace wall 10 we provide a plurality of tangential openings 38 within which burners 39 preferably of a high velocity type are inserted. These burners fit snugly into the openings 38 so as substantially completely to seal the openings and prevent the admission, of secondary air. As already explained, a pre-mixture of fuel and air preferably is burned so that there is no need for the admission of secondary air to obtain complete combustion and the fuel mixture admitted is burned substantially completely with unusual high efficiency. Suitable piping 41 is employed for the delivery of combustible mixture to the burners, it being unnecessary to explain in detail the arrangement of the piping as any suitable connections may be employed which will result in the delivery of substantially uniform amounts of fuel and air mixture to the separate burners.

Above the openings 38 and also tangentially arranged are additional openings 42 containing burners 43. This arrangement is substantially the same as described in connection with the lower group of burners except that the burners 43 do not fire against a breast wall but tangentially directly into the annular space between the furnace wall and the annealing pot.

The annealing pot obviously may contain any suitable type of material to which heat is to be applied. In an installation heretofore employed the furnace has been employed for annealing wire with very unusual results and in order to completely illustrate one application of our invention we show more or less schematically a charge of wire as it is preferably carried within the annealing pot. A standard 44 is provided on which coils of wire 46 are stacked, a base being provided on the standard for supporting it upright. The base is so dimensioned as to be spaced somewhat away from the inside wall of the portion 27 of the hopper, and preferably it is this space in this form of installation which is filled with sand for sealing the connection between the inverted cover 28 and the supporting member which together comprise the annealing pot. The standard is provided with an opening near the top for the engagement of a hook or other suitable tool whereby when the annealing pot is removed from the furnace and the inverted cover 28 taken off, the entire charge of wire may be removed.

The temperatures at which materials are annealed vary somewhat depending upon the nature of the product and so in the further description of our invention we shall consider the application of heat to wire so that the wire will be at the preferred annealing temperature, namely 1200 degrees F. When wire is heated to this temperature it cannot be removed immediately from the furnace or scaling will result and also strains will be produced because of unequal cooling. When the annealing operation has been completed, the wire, of course, may be allowed to cool in the furnace, but for production purposes it is advisable to remove the wire from the furnace as soon as possible so that another charge may be introduced. For this purpose we provide a separate insulating cover 48 arranged to provide a seal in an annular recess 49 in a floor 51 which comprises a heat insulating medium such as fire brick. The annealing pot which we indicate more or less schematically at 52 is withdrawn from the furnace, placed centrally of the annular recess 49 and the insulating cover 48 immediately placed over it. This arrangement retains the heat so that the wire may cool slowly and uniformly and substantially the identical results obtained as if the annealing pot and contents were allowed to remain in the furnace during cooling.

The manner of charging the furnace and firing it are believed obvious from the preceding description. In actual operations we have placed temperature recording devices in various places in the annealing pot and on the outside of the annealing pot but within the furnace and have found a remarkable result to be obtainable. In the first place, taking the temperature within the furnace but outside of the annealing pot when the design was to anneal wire at 1200 degrees F. showed that the temperature within the furnace but outside the annealing pot was only 1210 degrees F., that is, a temperature drop of only 10 degrees across the wall of the annealing pot. Furthermore, the temperature found within the annealing pot was of uniformity such that no measurable temperature variation was found to exist anywhere; that is to say, within the limits of accuracy of the best measuring instruments available for the purpose, the temperature was absolutely uniform at 1200 degrees F. during the annealing operation.

We further found that complete annealing was obtained of a charge of two tons of wire in six hours using only thirty-three gallons of oil per charge. This is contrasted with the best previous results obtained on a coal fired furnace employed heretofore for a given operation because of the supposed advantages of uniformity and low cost obtained with coal. In the coal fired furnace twelve to fifteen hours was required to carry on an annealing operation and 1500 pounds of very high grade coal were employed, so that the actual cost of fuel when employing oil was in the neighborhood of 50% of the cost of coal. Furthermore in the coal fired operation the annealed wire showed a 20% variation whereas the wire annealed by means of our invention showed substantially no variation which could be measured on the usual equipment employed for test purposes. Another advantage in our furnace is that the annealing pot is not scaled appreciably, even at the point where the top row of burners is fired without the use of a breast wall. Thus, the pot life is increased tremendously, a uniform product obtained and the proportion of rejected products resulting from scaling, non-uniformity and the like is reduced to practically zero.

The unusual uniformity obtained in heating the wire or other metal articles which may be supported in the annealing pot is unquestionably due, in large part, to the uniform movement and distribution of hot gases within the furnace and the fact that substantially the entire outside surface of the annealing pot is swept continuously by these gases. The piers which support the annealing pot engage only a relatively small proportion of the bottom thereof, but on account of their position and the movement of the gases these piers are substantially of the same temperature as the hot bases, that is to say, they certainly are not at a relatively high temperature such as to cause local heating where they engage the pot.

The tangential arrangement of the bottom row of burners so positioned as to direct their flames against the outside circumference of the breast wall and the fact that the gases in expanding can only escape upwardly from the channel-like recess between the furnace wall and breast wall, produces a rapid swirling and generally upward movement of the exhaust gases which apparently persists at least as far upwardly as the top row of burners because no evidence can be found that the flame from the top row of burners actually impinges against the outer surface of the annealing pot. We have not determined in detail the path of the gases as they move upwardly and then downwardly again to pass out through the central bottom flue but theoretical calculations and investigations show clearly that the gases rise in a swirling or spiral fashion and that there is a movement of gases over substantially the enetire outer surface of the annealing pot. That this is clear is evidenced partly by the fact that only the bottom row of burners may be employed with substantially equivalent results as the two rows particularly if the height of the furnace be decreased somewhat. The additional top row of burners, however, does result in greater uniformity in a relatively high furnace, and if the height is still somewhat further increased it is possible to increase the number of rows of burners providing they are positioned so that the swirling movement of the gases will continue to have the effect of keeping the flame therefrom out of contact with the annealing pot.

Shaping the furnace in the form of a truncated cone apparently has certain advantages in maintaining uniformity of heating as well as imparting greater rigidity from a structural standpoint. While substantially vertical side walls may be employed, we prefer to use the sloping type as shown.

The furnace of our invention may be built in different sizes providing, of course, that the size be not decreased or increased to such an extent that the same relative performance may not be obtained. Friction tending to restrain the movement of hot gases in the manner described, must be taken into consideration and also certain aspects of practicability as those skilled in the art will understand. That our disclosure may be complete in this respect, however, we wish to point out that we have obtained very good results with a furnace standing approximately nine feet from the floor with the other dimensions in proportion, substantially as shown in the drawings and in which the annealing pot carries a charge of approximately two tons of metal.

We employ the term "tangential" to define the position of the burners notwithstanding the fact that the burners are not directly tangential to either the furnace side wall, the breast wall or the annealing pot, although as clearly shown in Figs. 3 and 4, the flame projected by the burners is substantially generally tangential to the breast wall at the bottom row of burners and the annealing pot at the upper row of burners.

What we claim as new and desire to protect by Letters Patent of the United States:

1. In an annealing furnace of the character described, a circular side wall, a furnace bottom having a flue therein, a removable cover, means including a plurality of piers for supporting an annealing pot so as to permit circulation of hot gases substantially around the entire outer surface thereof, an imperforate circular breast wall seated on the furnace bottom and positioned between said piers and the circular furnace side wall, a plurality of burners projecting tangentially through said side wall in a position in line with said breast wall, whereby flame from said burners is directed tangentially against said breast wall and hot combustion gases have a whirling motion imparted thereto, and a second row of burners projecting tangentially through said furnace wall above said breast wall in sub-

stantially the same direction as said first-mentioned row of burners, whereby combustion gases from said second row of burners have a whirling motion imparted thereto at least in part by the movement of combustion gases from said first-mentioned row of burners, and whereby the second row of burners are prevented from locally overheating the annealing pot.

2. In an annealing furnace of the character described, a circular furnace side wall having the general outline of a truncated cone, a top cover adapted to be removed to allow insertion of an annealing pot therein, means for sealing said cover and side wall, a bottom having a flue therein, an annealing pot adapted to contain metal articles, said pot being of generally cylindrical shape and having smaller outside dimension than minimum inside dimensions of the furnace body, means for supporting said annealing pot within said furnace out of contact with inside side, bottom and top surfaces thereof so that substantially the entire outer surface of said annealing pot is exposed to furnace atmosphere, a circular breast wall disposed between said annealing pot and circular furnace wall, and a plurality of rows of burners projecting non-radially through the circular furnace wall, at least one of said rows of burners being in line with said breast wall whereby to impart a swirling motion to all of the hot gases between the outside annealing pot surface and the inside surface of the furnace.

3. In an annealing furnace of the character described, a circular furnace side wall having the general outline of a truncated cone, a top cover adapted to be removed to allow insertion of an annealing pot therein, means for sealing said cover and side wall, a bottom having a flue therein, an annealing pot adapted to contain metal articles, said pot being of generally cylindrical shape and having smaller outside dimension than minimum inside dimensions of the furnace body, means for supporting said annealing pot within said furnace out of contact with inside side, bottom and top surfaces thereof so that substantially the entire outer surface of said annealing pot is exposed to furnace atmosphere, a circular imperforate breast wall seated on the bottom of the furnace between the side wall of the furnace and said annealing pot, a plurality of burners projecting through the side wall of the furnace so as to direct their flame tangentially of the breast wall, and a second row of burners positioned above said first-mentioned plurality of burners in a position to direct their flames substantially tangentially of the outside wall of the annealing pot and in substantially the same direction as said first mentioned row of burners, said breast wall imparting a swirling motion to exhaust gases from the bottom burners, and said swirling motion of the gases preventing the flame from the upper burners coming into such direct contact with the annealing pot as to cause local overheating thereof.

4. In an annealing furnace, a circular side wall, a furnace bottom having a central flue therein, a circular breast wall lying on the bottom of the furnace and spaced from said side wall, a plurality of piers resting on the furnace bottom within said breast wall and radially disposed with respect to said flue, an imperforate sealed annealing pot of circular cross section, a removable cover whereby said annealing pot may be inserted vertically and set on said piers, said annealing pot being spaced from the bottom, top, and side walls of the furnace, a row of burners extending through the furnace wall in position to fire tangentially against said breast wall, a second row of burners above the breast wall set tangentially to fire into the space between the furnace wall and annealing pot, and means for delivering a combustible mixture of air and oil vapor to said burners.

5. In an annealing furnace, a circular side wall, a furnace bottom having a central bottom flue therein, a circular breast wall lying on the furnace bottom and spaced from said side wall, a plurality of piers resting on the furnace bottom between said breast wall and said central bottom flue, the upper surface of said piers on which an annealing pot rests being only slightly below the upper limit of said breast wall, an imperforate sealed annealing pot of circular cross section resting on said piers so that substantially the entire annealing pot projects above said breast wall, a removable cover for the furnace whereby said annealing pot may be inserted vertically and set on said piers, said annealing pot being spaced from the breast wall to allow an annular opening for the passage of hot gases to the flue, and the annealing pot being spaced from the bottom, side wall and cover whereby substantially the entire outside surface thereof may be in contact with the furnace atmosphere, and a plurality of burners projecting tangentially through said furnace wall to fire into the space between the furnace wall and side wall of the annealing pot, at least a major proportion of said burners being directed against said breast wall, the parts being so constructed and arranged that during operation of the furnace substantially all of the furnace atmosphere is caused to swirl about the entire outside surface of the annealing pot whereby to prevent local overheating of any portion of the annealing pot and maintain substantially uniform annealing temperatures therein.

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