Dec. 11, 1928. 1,695,224

A. BESTA

HEAT TREATING FURNACE

Filed March 26, 1926 3 Sheets-Sheet 1

Fig.1.

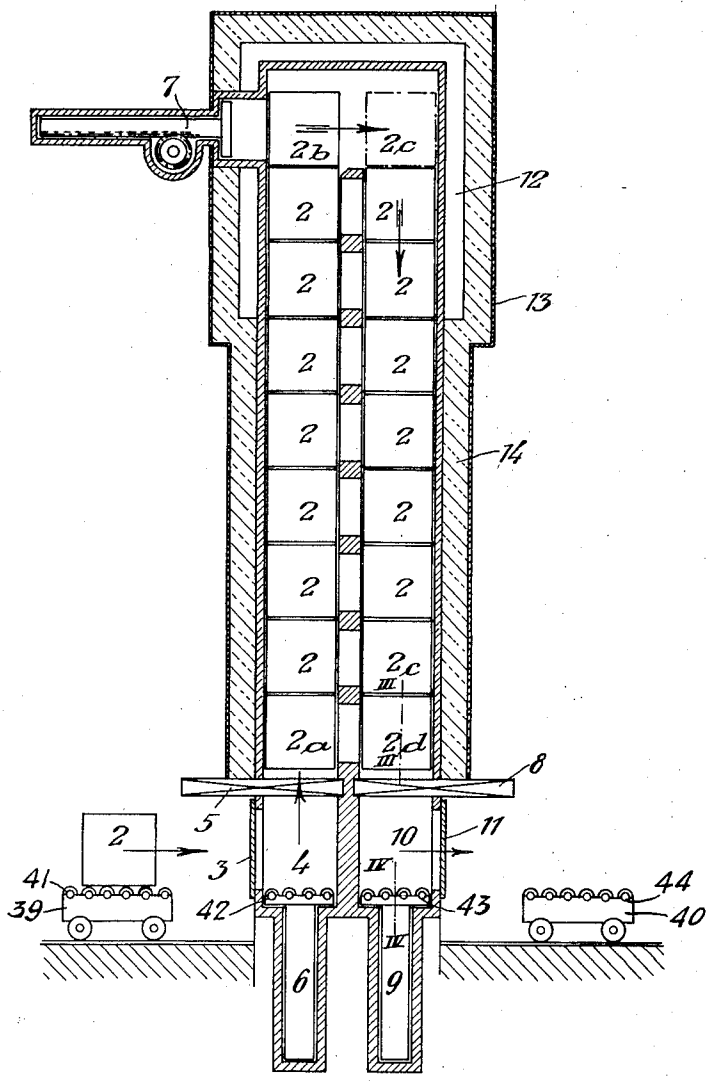

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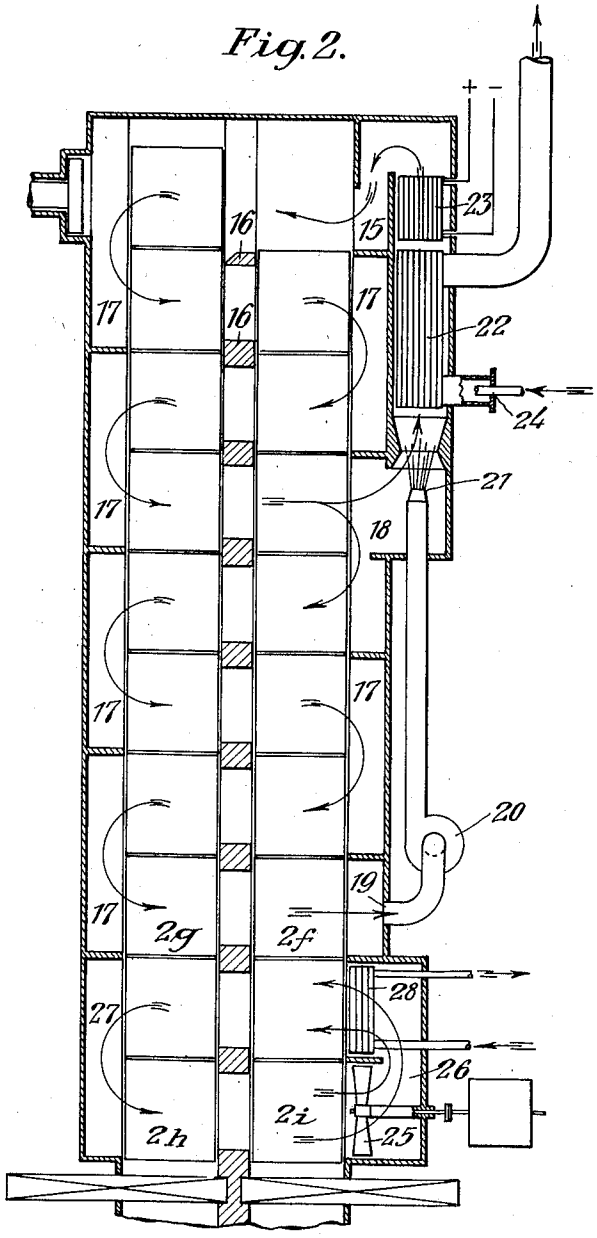
Fig. 2.



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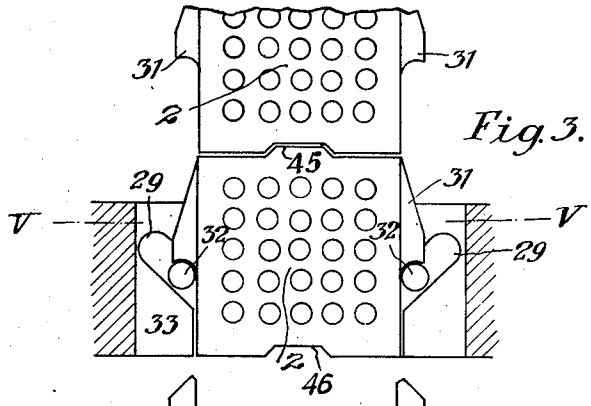


Fig. 3.

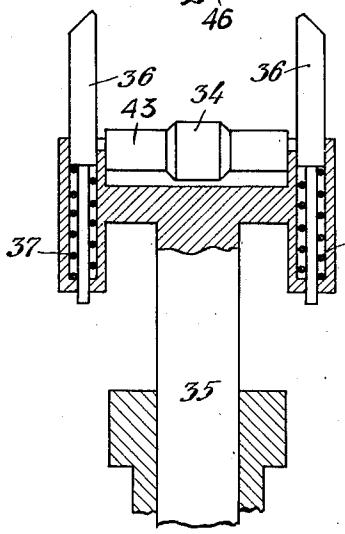
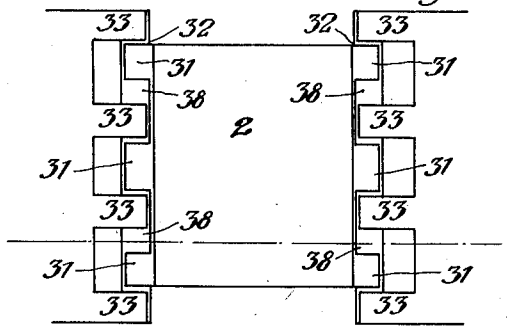


Fig. 4.

Fig. 5.



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Patented Dec. 11, 1928. 1,695,224

UNITED STATES PATENT OFFICE.

ADALBERT BESTA, OF DUISBURG, GERMANY.

HEAT-TREATING FURNACE.

Application filed March 26, 1926, Serial No. 97,715, and in Germany February 28, 1925.

The method used hitherto for annealing materials, more particularly metals take a considerable amount of time and, where large quantities of materials are concerned, necessitate the provision of extensive annealing plants, if the material or metal is to be annealed in a neutral gas. The present invention relates to a method which has very considerable advantages over the annealing methods used hitherto, as regards output, space required and efficiency. In the new method the materials or metals to be treated are superposed on one another in layers in a suitable apparatus, are forced upward either vertically or at an angle, are heated while being so forced upward, are moved aside when they have reached the top and are thereupon conveyed downwards either vertically or at an angle and are cooled while being so conveyed. Preferably the pieces of material or metal are put into containers which travel through the annealing apparatus in the manner described. The material to be passed through the apparatus is forced upwards by means of a charging device and is conveyed downwards by a delivery device. If the annealing is to be carried out in the inert gases, a closing member is provided above the charging device and another above the delivery device, so that the other part of the annealing apparatus can be shut off when the material is being introduced and delivered to the charging device or delivering device. The spaces in which the charging and delivery devices are housed are capable of being shut off to the outside, so that after the closing members have been opened, the material to be annealed is conveyed upwards or downwards without any danger of the outer air mixing with the inert gas. After the material to be annealed has been placed on the charging device, the space is closed to the outside and is placed under vacuum, so that the air in the said space is removed. The spaces thereupon filled with inert gas, the upper closing member is opened and the material to be annealed is forced upwards, after the material being annealed, which lies at the top, has been displaced to the side. By means of the delivery device the material is thereupon conveyed downwards and the closing member on this side is closed so that the material can be led away to the side after the lower space has been opened. The space containing the delivery device is then closed again, is evacuated and is filled with inert gas. When the charging and delivery spaces are being evacuated the pressure must be observed at the closing member which shuts off both ways between the upper closure and the lower closure for ascertaining whether the closing members close tightly so that no inert gas can be removed by suction with the air. The upwardly conveyed material which is being annealed is heated at the highest part of the annealing furnace. In order to obtain a uniform temperature, the hot annealing gases are circulated in the top part of the apparatus in such a manner that there will be the same temperature everywhere. The gas is preferably caused to flow downward in such a manner that the downwardly conveyed flow of gas is so divided that a portion of the said gas is passed by the action of a blast through heaters and returned to the apparatus at the top, while the other portion is conveyed downwards giving off heat to the material or metal, as it is conveyed upwards or downwards, whence, cooled down to a certain temperature it is conveyed by mechanical means to the blast arrangement located in front of the heater. Should the stream of gas emerging at the bottom still have too high a temperature for the purposes of mechanical conveyance, it may be cooled down by suitable cooling devices before entering the mechanical conveying device. Between the mechanical conveying device and the blast producing device the conveyed gas may be heated in heaters to such an extent that behind the blast producing device it will be only necessary to heat the gas for accurate temperature regulation. The amounts of heat required for heating up the inert gas are supplied to the heaters by the giving off of combustion heat or by the production of electrical resistance heat or by these two methods of supplying heat. As the purely electrical method of heating is uneconomical owing to the high costs involved, the greater part of the heat required may be produced by combustion heat and the electric heating be used only for accurately regulating the annealing temperatures. In order that the material to be annealed by be passed through rapidly, the inert gases are preferably circulated in the lower part of the annealing furnace independently of the upper part by mechanical means with or without cooling

means, in order that the material or metal parts to be removed from the furnace are cooled and can be moved as quickly as possible, giving up their heat to the material or metal parts introduced into the furnace. The water of condensation formed can be conveyed away from the cooler in any suitable manner. The containers used for the conveyance of the material or metal parts are preferably so constructed that the gases can be freely circulated in the annealing furnace. Thus for instance two opposite sides may be provided with apertures and the material to be annealed be laid in layers in the containers in such a manner that the inert gases sweep through the containers either heating or absorbing heat or giving off heat. In order that the conveyors for the material to be annealed may be conveniently superposed on one another, they are preferably made box-shaped and are provided with lateral lugs for preventing them from sliding down. In the case of the ascending boxes one or more shafts which roll on inclined supports are pushed aside by the lateral lugs on the boxes until, on the boxes being raised still further, the shafts slip under the lugs, so that the boxes are held up, on the lifting means moving back again. For conveying the boxes downwards two, four or more spring supported means are provided forcing the shafts back, which, when the discharging means are performing their upward motion, engage under the supporting shafts, are stressed until the discharging means raised the box, thereupon push the released shafts aside and prevent the shaft from engaging under the lugs on the box, so that, on the discharging means being lowered, the shafts will only arrest the next box. In order that the annealing furnace can be erected in a simple manner, the guides in which the boxes slide with the gas conveying passages and the heating devices are built up of superposed parts having a circular periphery and fastened together. For preventing gas losses a pressure tight metal sheathing is placed around the entire apparatus, which is separated by an insulating layer from the built up sections lying within it, so that as little heat as possible will be lost by radiation. For saving operating costs and for shortening the duration of the process the successive operations of the the apparatus and devices may be carried out entirely or in part automatically. Preferably the regulation of the annealing temperature is also effected automatically in dependence on the gases emerging from the heaters, for which purpose the temperature prevailing within the furnace may also be used. Combustion gases may be used as the inert gases, more particularly when employing the deflecting method, so that the annealing furnace can be directly heated. In the accompanying drawings, Sheets I to III, a constructional example of the invention is shown. Fig. 1 on Sheet I shows a sectional elevation of an annealing furnace working according to the new method, in which there is no provision of means for guiding heating gases, and in which the upper chamber is electrically heated. Fig. 2, Sheet II, is a sectional elevation through another constructional form of the furnace representing the arrangement for the deflecting method. This form of the furnace is provided with inserted guides for heating gases. In the case of this furnace the heating is effected by circulating hot gases in the upper part of the furnace, with branch currents of the hot gases towards the central part of the furnace, the figure showing the way the gases are guided, the heaters, and the mechanical means for conveying the gases and the coolers. Figs. 3 to 5 on Sheet III show the construction of the annealing boxes, the means for holding the boxes in position and the charging and delivering means, Fig. 3 being a section on the line III—III in Fig. 1, at right angles to the plane of the drawing, Figure 4 a section on the line IV—IV in Fig. 1 in the same plane as the discharging device, and Fig. 5 a section on the line V—V in Fig. 3.

In the annealing furnace shown in Fig. 1 on Sheet I the annealing boxes 2 filled with material or metal parts are conveyed to the furnace on trolleys 39, provided with anti-friction rollers 41 and introduced through the closing door 3 into the charging space 4, where it rests upon anti-friction rollers 42 on the top of a charging device 6. After the door 3 has been closed the space 4 is evacuated and thereupon filled with inert gas. After the closing member 5 has been opened the annealing boxes are raised by the charging device 6 into the position 2^a. The boxes are automatically arrested in this position, so that after the charging device 6 has been lowered the sliding member 5 can be closed. The annealing box which is in the position 2^b is thereupon pushed by the pressure applying means 7 into the position 2^c, the sliding member 8 at the bottom opened and the annealing box which is in the position 2^d is received upon rollers 43 on the top of a discharging device 9 and lowered by means of the discharging device 9 into the discharging space 10. Means are provided for automatically holding the annealing box 2^c in the position 2^d while the lowest box is being lowered. The sliding member 8 is thereupon closed and the door 11 of the discharging device opened, so that the annealing box can be removed laterally from the rollers 43 on to rollers 44 on the top of a trolley 40, which removes it. After the annealing box has been removed the door 11 is closed, the space 10 evacuated and thereupon filled with inert gas. In this way one annealing box

after another is passed through the furnace. The heating space 12 is located in the upper part of the furnace. The inner part of the furnace is separated from the outer sheathing 13 by an insulating layer 14. In Fig. 2 on Sheet II the deflection method of the heating gases is illustrated. The hot gases enter the upper part of the furnace at 15 and are guided downwards by the middle bridge members 16 and all the flues 17, being passed through or around the annealing boxes. In the lateral flue 18 the stream of gas divides, one portion being guided downwards in the direction of the arrow, having a heat equalizing effect on the ascending and descending annealing boxes and becoming cooled at the same time, after which it is conveyed to a blower 20 which forces it to the blast producing arrangement 21. The second part of the stream of gas is drawn by suction from the lateral flue 18 to the blast producing device 21 and is passed to the heaters 22 and 23, where it is heated and passed into the furnace again at 15. The heater 22 is heated by the gas burner 24. The heater 23 is heated electrically and is used for accurately regulating the temperature of the gases entering the annealing furnace at 15. In the lowest part of the furnace gases are continuously deflected in one direction by the blower 25 through the lateral flues 26 and 27 and through the annealing boxes located in front of the said flues, the said gases being cooled in the cooler 28, after which they pass into the annealing box 2^f, the material in which is still in a hot state, thence into the boxes 2^g and 2^h which are filled with cooled material, give off heat to the same and are passed through the box 2^i which is filled with hot material to the blower 25. By this way of deflecting the gas the downwardly conveyed material can be rapidly cooled, if it should still be too hot to be discharged, so that only a short time need be provided for passing through the furnace. Through the exchange of heat, which takes place in the middle of the furnace between the descending and ascending material, by the branched off stream of gas which flows downwards and by the deflection of the hot gases in the upper part of the furnace the time taken for passing the material through the furnace is also considerably reduced and the material thoroughly annealed. As the apparatus is built up vertically, it does not occupy much floor space. Owing to the utilization of the heat of the descending material, the compact vertical construction of the furnace and the possibility of efficiently insulating the hottest parts of the furnace, the method becomes very economical. In Fig. 3 on Sheet III the arrangement 29 for holding the annealing boxes 2 on the charging side of the furnace is shown. The annealing boxes 2 are provided with a plurality of lugs 31, which, on the boxes ascending, push the shafts 32 aside until the shafts engage under the lugs and prevent the boxes from sliding downwards. In Fig. 4 the discharging mechanism is shown which discharges the boxes downwardly from the suspending device shown in Fig. 3. The discharging device 9 comprises a plunger 35, the upper part of which is provided with rollers 43 and with lateral means 36 for pressing the rollers back, which means, on the discharging device being raised, bear against the shaft 32, so that on the discharging device continuing to rise, the springs 37 become stressed to such an extent that the rollers 34 lift the boxes 2. The disengaged shafts 32 are forced aside and the members 36 slide into the recesses 38 (Fig. 5) and lock the shafts 32 in position, so that, on the discharging device returning, the lowest box can be moved downwards without obstruction. On the boxes being lowered, the shafts 32 run inwardly over the lugs 31 and engage under the lugs of the next higher box, which is to be held in position.

Each of the annealing boxes 2 is preferably provided with a projection 45 at the top and a recess 46 at the bottom, adapted to fit over the projection at the top of the box below it. The rollers 41, 42, 43 and 44 are provided with parts 34 of larger diameter, capable of engaging in the said recesses.

What I claim is:

1. Apparatus for the heating and subsequent cooling of materials, and more particularly for the annealing of metals, comprising chambers filled with a gas that behaves neutrally with respect to the materials, an upwardly directed delivery device located only at the lower part of the apparatus for introducing the materials into the apparatus in a loosely superposed condition without employing a chain conveyor, means for guiding the materials upwards in the apparatus, means for heating the materials on their upward path through the apparatus, a pushing device fitted into the wall of the apparatus for moving the materials sideways at the highest part of the apparatus and then downwards, means for guiding the materials downwards through the apparatus from the highest point, means for cooling the materials during their downward travel, and a discharging device located only in the lower part of the apparatus.

2. Apparatus for the heating and subsequent cooling of materials, and more particularly for the annealing of metals, comprising means in the upper part of the apparatus for heating the materials to the desired temperature by circulating heating gases, means in the central part of the apparatus for exchanging heat between the materials that are being carried upwards and the materials that are being carried downwards, and means in the lower part of the

apparatus for cooling the materials that are to be discharged.

3. A furnace for successively heating and cooling materials and more particularly annealing metals by means of a gas which behaves neutrally with respect to the said materials and metals, comprising in combination a casing, a plurality of box-shaped containers for the material capable of being superposed on one another in the said furnace, means for raising the containers on the charging side in the said furnace and for lowering them on the discharging side, lateral lugs on the containers, inclined members on the walls of the furnace, shafts capable of resting on the said inclined members and of being forced upwards and outwards by the lugs of the ascending containers and of thereupon engaging under the said lugs on the upward movement of the container continuing and of holding the containers suspended, on the means for raising the containers moving downward again, as set forth.

4. A furnace as claimed in claim 3, and comprising on the discharging side a plurality of resilient members capable of pushing the said shafts back and of engaging under the said shafts on the lowering means being raised and locking the shafts in the pushed back position and, on the lowering means being lowered, of arresting the next container as it descends, as set forth.

5. A furnace as claimed in claim 3, and comprising means for introducing the containers into the furnace, means for raising the introduced containers in the furnace, means for lowering the containers in the furnace, means for removing the lowered containers out of the furnace, rollers on the means for introducing, raising, lowering and removing the containers, projections on the tops of the containers, recesses in the bottoms of the containers capable of engaging in the said recesses and a part of larger diameter on the rollers capable of engaging in the said recesses, as and for the purpose set forth.

6. Apparatus for the heating and subsequent cooling of materials, and more particularly for the annealing of metals, comprising a heating, heat-exchanging and cooling chamber, means for introducing materials into said chamber at the bottom, means for raising said materials to the top of the chamber, means for lowering said materials from the top to the bottom of the chamber, means for removing said materials from said chamber at the bottom, means in the upper part of said chamber for heating the materials to the desired temperature by circulating heating gases, means in the central part of said chamber for exchanging heat between the materials that are being carried upwards and the materials that are being carried downwards, and means in the lower part of said chamber for cooling the materials that are to be discharged.

7. Apparatus for the heating and subsequent cooling of materials, and more particularly for the annealing of metals, comprising a heating, heat-exchanging and cooling chamber, means for introducing materials into said chamber at the bottom, means for raising said materials to the top of the chamber, means for lowering said materials from the top to the bottom of the chamber, means for removing said materials from said chamber at the bottom, means for causing inert gases to travel through said chamber, means for deflecting said gases in the upper part of said chamber, means for dividing the downwardly deflected stream of gas and passing a portion of it upwards, heaters for said upwardly deflected portion, a blast-producing device for passing said upwardly deflected portion through said heaters, means for passing the other portion of the divided stream of gas around the ascending and descending materials so as to give off a portion of its heat to the ascending materials and absorb heat from the descending materials, mechanical conveying means for passing this second portion of the divided stream of gas to the blast-producing device, and means in the lower part of the chamber for cooling the materials that are to be discharged.

In testimony whereof I have signed my name to this specification.

ADALBERT BESTA.