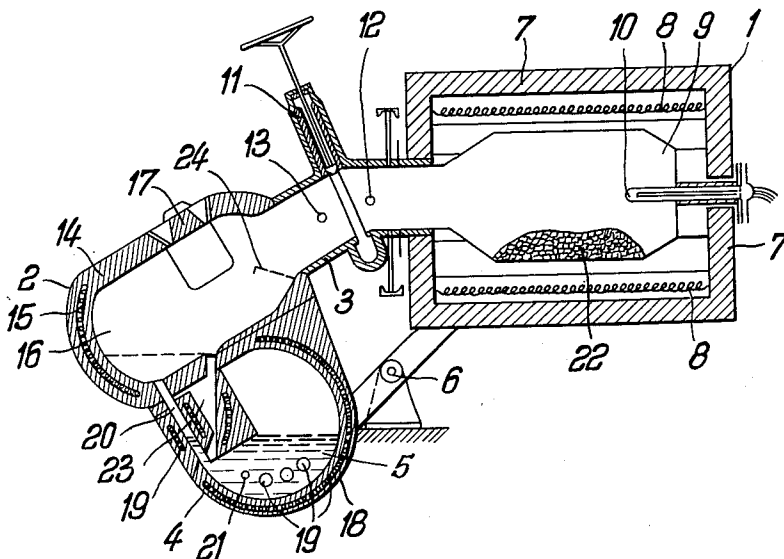


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HEAT-TREATING METALS

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HEAT-TREATING METALS

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This invention relates to the heat-treatment of metals, especially the tempering of metals using liquid quenching agents.

An object of the present invention is to provide a process in which the entire heat treatment of a charge of metal parts, in particular the annealing and quenching, may be performed in a vacuum without the charge being in contact with any other atmosphere in the interval between annealing and quenching.

Heat treatment of various metals and metallic alloys must be conducted in a high vacuum to obviate undesirable surface reactions or diffusion of gases. In known vacuum annealing and melting furnaces, the charge is held in the vacuum only during the high-temperature treatment, and the hardening or tempering of the charge takes place in an ordinary atmosphere. The usual quenching agents such as oil, water, saline solutions and the like cannot be used for quenching in a vacuum since, at the elevated temperatures required, these substances have an excessively high partial vapour pressure.

According to the present invention, I provide a process of heat treating a charge of metal parts, in which the entire treatment is conducted in two vacuum-sealed communicating chambers from which ambient atmosphere is excluded. During the treatment according to the invention, specified temperature and pressure conditions and a given sequence of gaseous atmospheres and vacuum conditions may be selectively provided within the sealed chambers. Annealing or preheating treatment takes place in one chamber, and quenching or cooling treatment in the other chamber which is equipped with a compartment for a liquid coolant, and the charge of metal is conveyed from the first-mentioned chamber to the other by tipping or tilting the chambers so as to cause the charge to move from the one chamber to the other one by gravity.

The advantage of the invention consists in the feature that, for instance in inter-stage annealing, parts heated in a vacuum may rapidly be cooled without coming in contact with the atmosphere, and that the cooling rate can be regulated by controlling the temperature of the quenching medium used. The metallic coolants to be used in accordance with the invention have a relatively low, partial vapour pressure and enable simultaneously satisfactory heat dissipation.

An embodiment of the invention will now be described with reference to the accompanying drawing which shows a diagrammatic, longitudinal sectional view of a heat treating apparatus useful for effecting the method.

Referring to the drawing, there is shown a treating chamber consisting of a heating zone defined by a vacuum furnace 1 connected to a quenching zone 2 by a vacuum-sealed connecting pipe 3. The quenching zone 2 has a compartment 4 for a quenching medium or liquid coolant not shown, communicating with the quenching zone 2 and arranged in such a manner that, when the apparatus as a whole is tilted about a pivot 6, the quenching medium 5 flows into the quenching zone 2. The connecting pipe 3 between the vacuum furnace 1 and the quenching zone 2 is arranged at such an angle that the axis of quenching zone 2 is inclined with reference to the axis of the furnace 1.

The vacuum furnace 1 is equipped with an insulating

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jacket 7 and heating coils 8, and contains a vacuum heating zone 9. A thermo-couple 10 is vacuum-sealed into the zone 9 for controlling the temperature within the zone 9. The zone 9 is horizontal and vacuum-sealed to the connecting pipe 3 by its smaller end opposite the thermo-couple 10. The connecting pipe 3, as already stated, is bent at an angle, and is equipped with a vacuum-sealing stop valve 11. On each side of the stop valve 11, connections 12 and 13 are provided in the pipe 3, respectively for a vacuum gauge and for a pump, not shown. The connecting pipe 3 is similarly vacuum-sealed to the quenching zone 2, which is equipped with an insulating jacket 14 and heating coils 15 for compensating heat loss by radiation. The quenching zone 2 has an approximately cylindrical inner chamber 16 and is accessible from above through a charging hole 17. The neck of the quenching zone 2 contains a suitably-shaped grid or screen 24 for receiving the material after treatment.

The compartment 4 for the quenching medium 5 is below the quenching chamber 2 and is equipped with an insulating jacket 18 as well as heating and cooling elements 19. The interior of the compartment 4 is substantially spherical and communicates with the quenching zone 2 through a heatable connecting passage 20 in such a manner that in the normal position of the apparatus, as shown, it enters at the lowest point of the quenching zone 2. Thermo-couples 21 are also provided inside the compartment 4.

In operation, a charge of metal parts 22 is placed, for the purpose of annealing, in the vacuum zone 9. While the charge 22 is being heated therein, the fused metal quenching medium 5 to be used for quenching is held at the required working temperature in the compartment 4 by means of the heating and cooling elements 19 under control by the thermo-couples 21. After the charge 22 has been held in the vacuum zone 9 for the required period of time at the prescribed temperature, the whole apparatus is tipped or tilted about the pivot 6 so as to cause the quenching medium to flow out of its compartment 4 through the passage 20 into the quenching zone 2. The arrangement of the vacuum zone 9, quenching zone 16 and compartment 4 is such that the charge is discharged from chamber 9 only when a sufficient quantity of the quenching medium has entered the quenching zone 16. When the apparatus is returned to its initial position, as shown, after the annealing zone 9 has been emptied, the quenching medium flows through a passage 23 back into the compartment 4. The apparatus is then tilted until the charge 22 rests upon grid or baffle 24 and can be withdrawn without difficulty through the charging hole 17. While this takes place, the zone 9 is kept under vacuum by the vacuum stop valve 11. This permits reduction in the capacity of the pump connected to the apparatus on either side of the vacuum stop valve.

To permit carrying out difficult heat treatments, the grid or baffle 24 may be arranged in such a manner that it can be swung out of position until, on repeated tilting of the apparatus, repeated heating or annealing of the charge in the zone 9 and cooling in the zone 16 are performed.

Since the temperatures in the zones 9 and 16 and in compartment 4 are controlled by thermo-couples, the entire operation of any desired sequence of heat treating operations can be automatically controlled by regulating and control devices of known kind; including the temperature conditions and, with the help of pumps, pressure switches and valves, the pressure conditions, and the procedure whereby different atmospheres or a vacuum can consecutively be provided in the treatment chambers. The quenching medium may be molten metal or metallic alloys such as mercury, lead, Wood's metal or the like.

I claim:

1. A method of heat treating successive charges of metal parts in a continuous operation, comprising the steps of introducing a first one of said charges into a heating zone of a treating chamber; sealing and evacuating said chamber; heating said first charge in said heating zone to a predetermined temperature; transferring said heated charge to a quenching zone in said chamber spaced from, but communicating with, said heating zone; admitting a liquid coolant to said quenching zone for direct quenching contact with said heated charge; removing said coolant from said quenching zone while retaining the quenched charge therein; vacuum sealing said heating zone from said quenching zone after said charge has been transferred; discharging said quenched charge from said quenching zone after said vacuum sealing; introducing a second one of said successive charges into said heating zone, and repeating said steps.

2. A method as claimed in claim 1, wherein said heated charge is transferred from said heating zone to said quenching zone by gravity.

3. A method as claimed in claim 2, wherein said coolant is a metal.

4. A method of heat treating a metal part, comprising introducing said part into a heating zone of a treating

chamber; sealing and evacuating said chamber; heating said part in said zone to a predetermined temperature; transferring said heated part by gravity to a quenching zone in said chamber spaced from, but communicating with, said heating zone; admitting a liquid coolant to said quenching zone for direct quenching contact with said heated part; removing said coolant from said quenching zone by gravity while retaining the quenched part therein; transferring said quenched part by gravity back to said heating zone; heating it therein again and transferring the reheated part by gravity back to said quenching zone; vacuum sealing said heating zone from said quenching zone after said charge has been transferred; and discharging said quenched part from the quenching zone.

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