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ANNEALING

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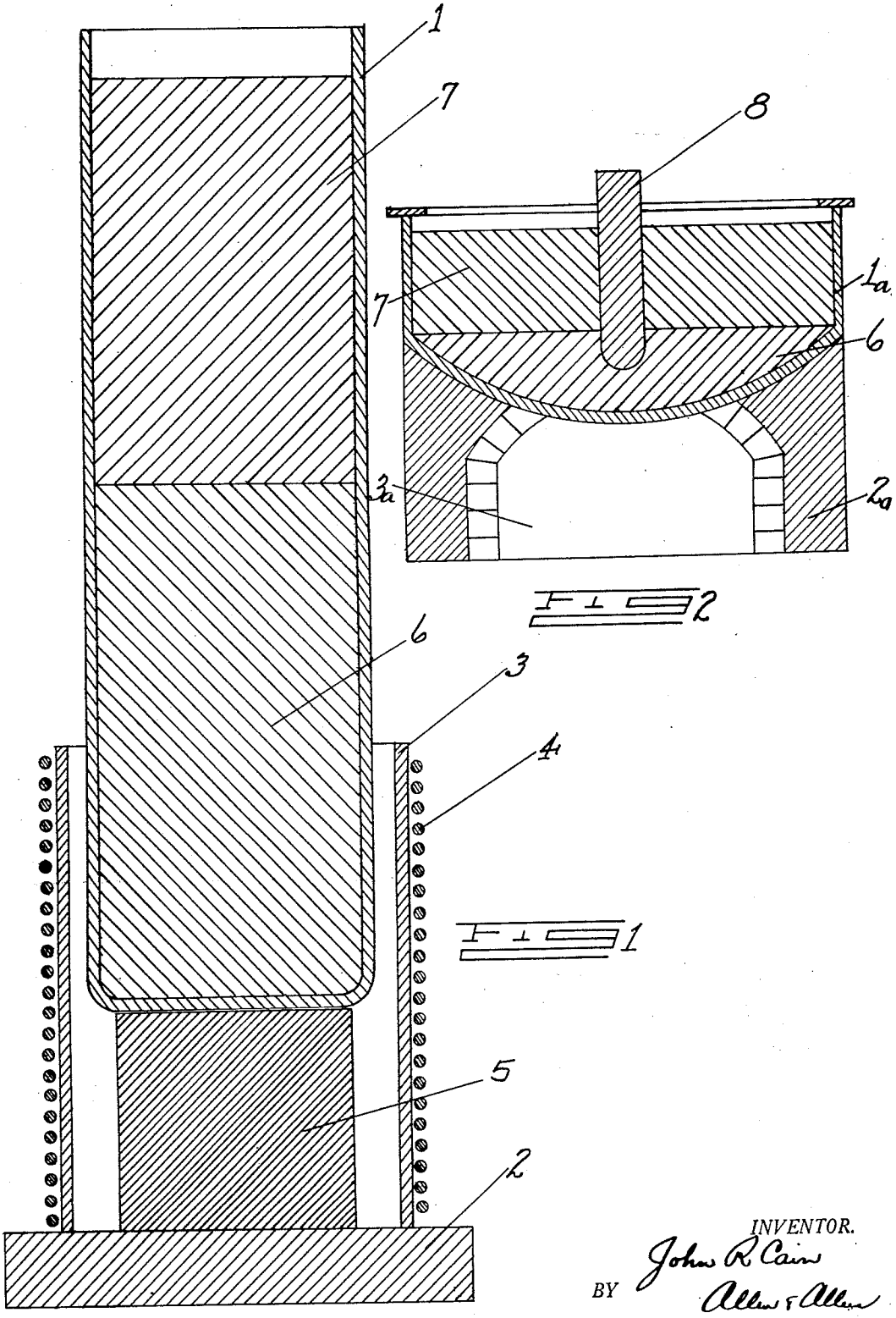


FIG 2

FIG 1

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UNITED STATES PATENT OFFICE

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ANNEALING

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My invention relates to that type of annealing which utilizes a hot bath of liquid into which the metal to be heat-treated is immersed, and it has particular reference to the use of substances which protect the metal from oxidation or scale during the annealing operation, and to the provision of a temperature gradient in the annealing bath, as will be described.

As set forth in my application for patent on "Process of heat treating copper and its commercial alloys", Serial No. 116,723, filed June 17, 1926, I have discovered that for the annealing of certain metals which undergo a change in crystalline structure at comparatively low temperatures, a bath of hydrocarbon oil heated to the required temperature is particularly advantageous in that, to economy and ease in handling, there is added absolute protection from oxidation and scale and an action which I believe to be of a reducing character, in that copper oxide coatings are apparently freed of their oxygen content.

The provision of heat in my oil annealing processes may be applied either to the oil containing vessel or to the metal being treated where it is paramagnetic, by the use of an electrical induction heater.

I have found that hydrocarbon oil is not readily heated by convection (internal heat transfer) currents, and this property makes such oil of particular value in my present process.

It is the object of my process to be described herein to permit the annealing of metal objects in baths of molten metal at temperatures higher than are possible with hydrocarbon oil or other fluid, while at the same time securing for my metal objects the protection from oxidation and scale and the advantages of the reducing atmosphere which I have found that hydrocarbon oil gives.

It is a further object of my invention to provide in an annealing apparatus a temperature gradient such that, starting with cold metal objects, I can gradually heat them up to the proper temperature for introduction into the hot zone of my annealing apparatus while at the same time protecting them effectively, then anneal them at the proper temperature for the proper length of time, and finally withdraw and cool them gradually under conditions of equal protection.

It is a further object of my invention to provide in an annealing apparatus zones of varying but comparatively constant temperatures so that the same apparatus will serve for annealing operations carried on at different temperatures and will be adapted to a wide range of articles and materials.

I accomplish my objects by that certain construction and arrangement of parts to be hereinafter more specifically pointed out and claimed.

In the drawings:—

Figure 1 illustrates diagrammatically an annealing apparatus for the handling of small articles, while

Figure 2 illustrates, also diagrammatically, an apparatus suitable for the semi-continuous annealing of metal sheets such as sheets of brass or iron.

Referring to Figure 1, I have shown a vessel 1 for holding the liquid media in which I propose to do my annealing. The lower part of this vessel is placed within a furnace or other source of heat, preferably a resistance electric furnace, which I have illustrated diagrammatically as consisting of a base 2 and refractory core 3, wound with nichrome wire 4. It will be understood that the furnace will be suitably housed and insulated after the best practices in that art. I may, if desired, support my vessel upon a block of refractory material 5, so that the lowermost part of my vessel is located in the hottest part of the furnace.

I place within the vessel 1 a mass of lead which will be melted by the heat and will form a body of liquid 6, extending both within and without the heating region of the furnace. Above this I place a body of hydrocarbon oil 7.

This apparatus is suitable for the annealing of brass or alloy objects or of thin sheets of iron or steel. The lead is maintained in its lowermost position at a temperature sufficient

to accomplish the heat-treating effects desired upon the particular metal. There will be some tendency for the temperature of the molten lead bath to be evened by convection currents as well as conduction, but I find that convection currents in baths of molten lead do not operate with sufficient rapidity to bring about any very marked equalization of temperature.

Furthermore, the upper end of that portion of the vessel 1, which contains the molten lead, is situated outside of the furnace and the loss of heat due to radiation is quite sufficient to offset the temperature-equalizing effects of conduction and convection. Thus there will be a considerable even temperature gradient from the bottom of the vessel to the top of the column of molten lead so that above this column of molten lead I may maintain a column of hydrocarbon oil 7 in such a way that a temperature gradient exists throughout it also.

I may vary the length of my vessel 1, and consequently the lengths of the columns of lead and oil, in any manner desired to secure the necessary temperature gradient. The lengths of these columns will naturally vary with the size of the vessel 1, thickness and thermo-conductivity of its walls, and atmospheric or other conditions surrounding the upper part of the vessel, as well as with the degree of heat desired in the lower part of the lead column. It will be obvious, however, that the other factors remaining constant, the heat of the furnace may be so regulated as to give not only a proper annealing temperature in the annealing zone, but a correct and gradual temperature gradient throughout the entire annealing apparatus.

For example, with certain brasses or alloys I may prefer to start with an initial temperature in the upper limit of the hydrocarbon oil column of, say 200 to 250 degrees centigrade. The temperature progressively increases downward until in the lower portion of the lead bath a temperature of 800 to 850 degrees centigrade is reached. In annealing copper, brass, bronze or other alloy articles, it will be obvious that when these are immersed in the oil and lowered to the bottom of the vessel, the temperature thereof will gradually be raised from 250 to 800 degrees centigrade.

The heat treatment at this point may be continued for as long as desired, after which the articles are withdrawn slowly and are cooled down through the column of liquids until where they emerge from the surface of the hydrocarbon oil they have fallen to 250 degrees centigrade or less, so that no scaling or oxidation need be feared.

Those familiar with the art of annealing will recognize that this apparatus is capable not only of providing sufficient degree of heat for heat-treating operations, but of providing means whereby this heat may be gradually applied and gradually withdrawn to secure the desired changes in the crystalline structure of metals or alloys.

It will be apparent also that during the heating operation my metal objects are protected from oxidation and scaling and are surrounded by what amounts to a reducing atmosphere in the hydrocarbon oil. From this, they pass to the lead bath and are given the required heat treatment and are subsequently cooled under conditions of equal protection by re-passage through the hydrocarbon oil.

As pointed out above, the hydrocarbon oil acts in part as a heat insulator, so that it is even less affected by convection currents or conduction of heat than is the lead.

I prefer to employ hydrocarbon oil which can stand degrees of heat up to 400 degrees centigrade; but it is possible for the lead at the juncture of the two liquid columns to be at a temperature somewhat higher than this, for, unless the heat is excessive, there will simply occur some ebullition at the surface of the lead tending to restore the evenness of the temperature gradient and tending to protect the body of the hydrocarbon from further ebullition or decomposition. Unless the heat of the lead bath is excessive, therefore, or the column of hydrocarbon oil 7 very short, such ebullition as results in volatilization of the hydrocarbon oil will simply result in the production of bubbles which will be condensed before they reach the surface of the oil so that actual losses of material are unimportant. It will be further obvious that the body of hydrocarbon oil protects the surface of the column of lead from oxidation.

In Figure 2 I have illustrated diagrammatically an apparatus comprising a different form of vessel 1*a*, supported upon a base 2*a*, above a furnace 3*a*, which may be fired by coal, fuel oil, etc. The vessel 1*a* is of generally rectangular shape but has a cylindrical bottom such as will facilitate the passage of sheets introduced into the vessel at one side beneath a baffle 8, dipping down into the liquids contained in vessel 1 and up again on the other side of said baffle. The vessel will contain a body of liquid lead 6 and a body of hydrocarbon oil 7 superposed thereon. To secure the necessary temperature gradient, the columns of metal and oil may be varied at will, by changing the depth of the vessel 1.

The function of the baffle is to provide a means for the positive submergence of metal articles to the hot zone of the annealing apparatus. It further tends to divide the annealing chamber and, to a degree, prevent convection and conduction of heat.

It will be obvious that my invention is not limited to a combination of lead and hydro-

carbon oil, but may be employed in many ways with many substances.

In achieving a proper temperature gradient I may find it advisable to employ more than two liquids, all or none of which may be of a metallic character; or in addition to hydrocarbon and metal, I may prefer to use also a column of liquid formed by the fusion of a metallic salt or other chemical compound.

It will be obvious to those skilled in the art that in employing molten metals for annealing purposes the metals should be of such character with reference to the metal articles to be annealed as will have no tendency at the temperatures used to form an alloy therewith.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is:—

A heat treating process comprising maintaining a temperature gradient in a liquid annealing medium ranging from a temperature at least as high as that necessary to effect the desired heat treatment to a temperature at least as low as will permit withdrawal of a heat treated article to the air without danger of the formation of scale or oxide thereon, advancing an article from a cooler portion of said liquid medium to a heat treating zone therein, holding said article in said zone for a length of time necessary to effect a desired heat treatment, then withdrawing said article from said zone through a cooler portion of said liquid, said liquid medium comprising a plurality of immiscible heat resistant liquids.

JOHN R. CAIN.