UNITED STATES PATENT OFFICE.

HEINRICH KRAUTSCHNEIDER, OF BERLIN, GERMANY.

PROCESS AND APPARATUS FOR ANNEALING AND TEMPERING METALS.

No. 899,452. Specification of Letters Patent. Patented Sept. 22, 1908.

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To all whom it may concern:

Be it known that I, HEINRICH KRAUTSCHNEIDER, engineer, a subject of the German Emperor, residing at Berlin, 30 Culmstrasse, Germany, have invented a certain new and useful Process and an Apparatus for Annealing and Tempering Metals and Metallic Products; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

In the treatment of metals and metallic products, uniform annealing of such products at a certain temperature which must be maintained exactly constant, plays a very important part. Thus, for instance, in tempering steel or other alloys that can be tempered, the maintenance of the exact temperature and uniform distribution of the heat over single pieces to be annealed or tempered is of the utmost importance. Unequal heating of pieces of metal with unsymmetrical cross sections leads to contraction of the heated parts during the cooling, giving rise to internal strains etc.

Furnaces of all kinds do not sufficiently insure uniform heating or tempering for the above purpose. The well-known method of heating the articles to be tempered in fusible baths of metallic salts, metallic oxids and similar metallic compounds has the great advantage in principle of providing for free heating by radiation. The application of this process of annealing or tempering by means of fusible baths presents however great practical difficulties. In order by external heating to raise the temperature of the bath consisting of metallic salts or the like, to the extent required, that is to say to 800°–870° C. the method now employed is to expose iron vessels (crucibles etc.) filled with fusible flux to direct heating in furnaces. Owing to the high temperature to which the outer walls of the crucibles are exposed the metal of which the crucibles are composed is soon destroyed and such destruction is accelerated on the one side by the action of the combustion gases and on the other side by the generally oxidizing influence of the flux. In addition to this, it must be remembered that annealing furnaces of this kind are very inefficient as regards the consumption of fuel, and do not allow the temperature of annealing to be regulated in the exact and reliable manner required for the purpose in question.

This invention relates to an annealing process in which the above drawbacks are obviated, and to an apparatus for carrying out said process. According to this process, the article to be tempered or annealed is heated to the desired temperature in a non-metallic fusible bath heated directly by electric currents of sufficient strength.

The advantages of this annealing process are obvious. First of all, it is possible to regulate the temperature electrically in a very convenient manner; then loss of heat can be reduced to a minimum by this internal electric heating, and finally the current used in the furnace serves as an exact measure of the temperature of the fusible flux, as the conductivity of the latter increases very quickly with the temperature.

In carrying out this process, it is preferable to use furnaces made of refractory material which is not dissolved by the molten flux (such as magnesite or the like). The walls of the furnace must at the same time be properly insulated, so as to prevent radiation of heat outwards. For preventing radiation losses, the furnace is preferably closed at the top except for a charging opening through which the articles to be annealed are introduced and removed.

The heating of the flux, which must take place before the furnace is started, so as to get sufficient conductivity, is effected by electric current of sufficient strength supplied by means of suitable electrodes. The electrodes must be made of some material which is a sufficiently good conductor and which is refractory such for instance as iron, carbon, etc. The electrodes are arranged in the furnace in such positions as to result in uniform heating of the bath by the current.

The bath preferably consists of substances which do not chemically attack the articles to be tempered, or at least to a very insignificant extent. Baths can also be used which at the temperature in question can yield carbon to the articles to be annealed, and thus increase their contents of carbon, as for instance in the case of steel. Some of the substances which may be used to yield carbon to the article to be annealed are oxalate of calcium and carbids of various metals.

Suitable substances which can be used for the fusible bath are fluorids, carbids, car-

bonates, etc., such fluxes having at the temperature in question a comparatively great conductivity. Thus for instance a flux of $6NaCl + Na_3AlFl_6$ has at 850° C. a specific resistance of approximately 0.35 ohms per cubic centimeter.

For the purpose of defining the bath employed by me, I have designated the same as a non-metallic bath, thereby excluding baths of molten metal which would be inoperative for the purposes of my invention. By the term non-metallic bath, I mean baths such as hereinbefore specified or such as are similar in composition or effect.

If the flux is basic, the material of which the furnace is made must also be basic; if the flux is acid, it must be also acid, so as not to be attacked by the flux.

The electrodes are preferably arranged interchangeably so that they may be replaced by new ones when corroded after a certain amount of use, as such corrosion cannot be avoided. It is preferable to use alternating current for heating, so as to avoid electrolysis in the bath.

For regulating the strength of the current in the latter case, transformers could be used with adjustable primary winding, and also choking coils.

What I claim as my invention and desire to secure by Letters Patent is:

1. The herein described process of heating metals, which consists in inserting the objects to be heated in a fusible non-metallic bath heated by an electric current, and regulating said current to maintain the bath at the required temperature, the current passing through both the bath and the immersed portion of said objects.

2. The herein described process of heating metals, which consists in producing a molten non-metallic bath by means of an electric current, inserting the objects to be heated in said bath, and maintaining the required temperature of the bath by regulating the said heating current, the current passing through both the bath and the immersed portion of said objects.

3. The herein described process of heating metals, which consists in inserting the objects to be heated into a fused bath formed of a conductor whose conductivity increases with the temperature, and passing an electric current through said bath, and thereby heating said objects to the desired temperature.

4. The herein described process of heating metals, which consists in inserting the objects to be heated into a fused non-metallic bath, and passing an electric current through said bath, whereby the temperature of the bath is maintained, and also passing the current through the objects themselves, whereby their resistance also serves as a heating means.

5. The herein described process which consists in introducing iron or steel articles into an electrically heated fusible non-metallic bath which yields carbon to the article.

6. A bath for heating metals, to any desired temperature up to a white heat, while retaining said metals solid, consisting of fused conductive material whose conductivity increases with increase of its temperature, said material being inert toward the metal to be heated, and means for passing an alternating current through said bath.

In testimony whereof, I have hereunto set my hand and affixed my seal, in the presence of the two subscribing witnesses.

HEINRICH KRAUTSCHNEIDER. [L. S.]

Witnesses:
WOLDEMAR HAUPT,
HENRY HASPER.