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J. CHURCHWARD.

ART OF HEAT TREATMENTS OF STEEL ALLOYS.

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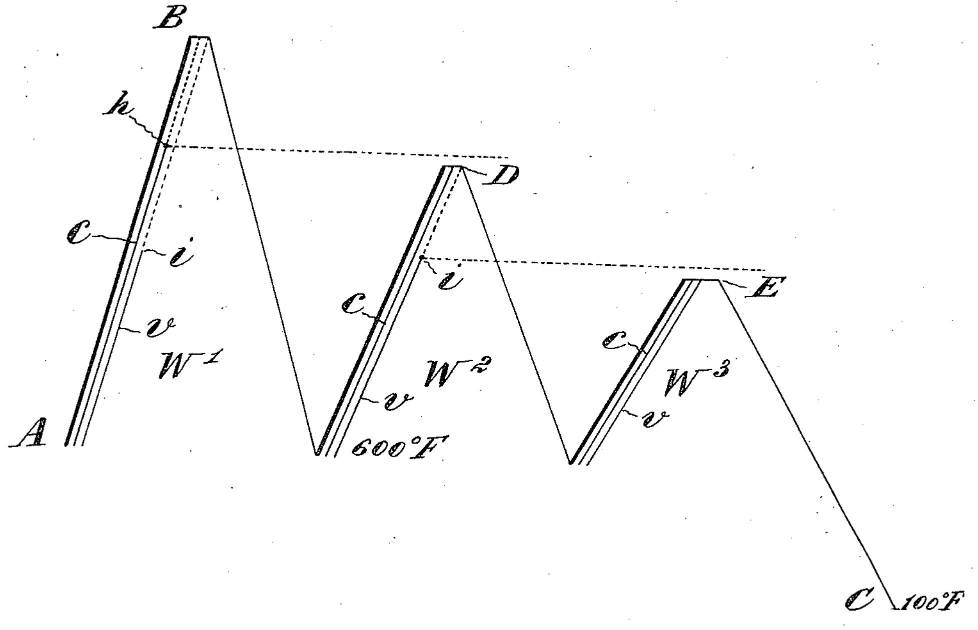

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ART OF HEAT TREATMENTS OF STEEL ALLOYS.

No. 855,756. Specification of Letters Patent. Patented June 4, 1907.

Application filed February 6, 1907. Serial No. 356,066.

To all whom it may concern:

Be it known that I, JAMES CHURCHWARD, a subject of the King of Great Britain, residing in the borough of Manhattan, in the city, county, and State of New York, have invented certain new and useful Improvements in the art of Heat Treatments of Steel Alloys, of which the following is a specification.

This invention relates to annealing and heat treating steel alloys, especially in the form of armor-plates and other large pieces or castings. And it has for its object to produce steel of extraordinary toughness, and in an especially favorable condition for quenching or tempering. The novel treatment of the metal increases its ductility and capability for extension or stretching under strains.

The invention consists, broadly, in subjecting the mass of metal to a series of heats or heat-waves of successively decreasing maximum temperatures designed to affect the alloying metals in the order of their respective retardation points, the first heat or heat-wave being carried to the annealing temperature of the mass of metal and each successive heat or heat-wave to a temperature a little below the retardation point of the corresponding alloying metal, and slowly cooling the mass of metal after each successive heat or heat-wave.

To facilitate understanding the process of the present application reference may be had to the accompanying drawings, wherein—the figure is a diagram illustrating the passage of three heat-waves through a mass of steel alloy.

The process indicated in the drawing and embodying the present invention, will now be described, premising that such heat-wave treatment, or treatment by successive heatings and coolings, is especially useful in treating steel alloys, as the retardation points of temperature of the alloying metals vary, and the heat-wave treatment enables the said alloying metals to be restored after their segregation, as will be fully explained, before the mass shall be finally cooled down. For example I will assume that the steel alloy being treated contains small percentages of two alloying metals, viz: chromium and vanadium.

The mass of steel alloy to be annealed is placed in a furnace heated to any point desired, and the temperature gradually raised to the annealing temperature of stock steel, say 2,000° F., and then lowered gradually to 600° F. or even down to atmospheric temperature. This constitutes the first wave, W^1 in the drawing. In raising the temperature to this extent however, we have carried it above the retardation points, so-called, of the alloying metals chromium and vanadium. These points are indicated, respectively in the drawing, by *h*, on the chromium line *c*, and *i*, on the vanadium line *v*. Above these points in the first wave the lines *c* and *v* are represented as broken to indicate that by carrying the heat-wave above these retardation points the alloying metals have been subjected to microscopical segregations which will require restoration. The setting of the alloys in a segregated state is effected during the fall in temperature of the first heat-wave. The temperature of the mass is now raised again to a point a little below the retardation point of chromium, indicated at D in the drawing, and then again reduced to from about 600° F. to atmospheric temperature; this constitutes the second heat-wave W^2, of the drawing. The temperature is now again raised, but this time only to a point a little below the retardation point of vanadium, indicated at E in the drawing, and then lowered again gradually to from about 100° F. or atmospheric temperature.

There should be as many heat-waves as there are metals in the alloy, if these have different, or materially different, retardation points.

It should be understood that the plurality of heat-waves or heatings need not follow each other in a rapid or continuous manner; there may be intervals of any length of time between them.

It may be explained in addition to what has already been said, that the retardation point, so-called, of any alloyed steel is a point in temperature (below the melting point) up to which it may be heated before the alloying metals will cease to actively assimilate with the stock and a few degrees before microscopic segregations begin. A segregated condition of the metal having once been reached, the metal must be restored in order to again put its molecular construction in its best form. This point or temperature of retardation varies under different conditions; for example in the case of manganese it varies from 1675° F. to 2100° F., the difference depending on the alloy, or metals or elements, in the alloy. The rising temperature in the wave causes the particles of the steel to absorb the segregations of the alloys; the falling temperature of the wave sets them within the particles where they were when the temperature began to fall.

By stock steel, as this term is herein used, is meant the ordinary manganese-carbon-steel.

In order that those skilled in the art may be able to carry out the invention without experimenting an example is given below in which the ingredient elements are supposed to be chemically pure. The carbon in the alloy may be anywhere from .20% up to .60%. The alloying metals and their proportions in this illustration are—

Manganese, by weight,	.25
Chromium, " " ,	3.00
Vanadium, " " ,	.25
Iron, " " ,	96.50
	100.00

The mass of alloyed steel, or the casting therefrom, will be first heated up to its best annealing point, 2000° F., if .60% carbon is used, and when of a uniform temperature throughout, the mass will be maintained at that temperature for 30 minutes. It is then cooled slowly, say to about atmospheric temperature, and at this point, in the treatment the manganese, chromium and vanadium will show, under the microscope, segregations, in the form of colored films around and on the sides of the particles of the mass, the colors being of a prismatic character. During this heating, and at a temperature of about 1200° F. in the above wave or heating, the vanadium reached its retardation point. By this phrase, retardation, is meant that at this point the alloying metal will have stopped its action in assimilating with the particles of the mass; and when the heat is carried beyond this point the alloying metal begins to leave the particles and segregate around them as described. By assimilation I mean the re-entry of the alloying metal into intimate union with the stock steel. At a temperature of 1675° F. we find the retardation point of the manganese, and as soon as the temperature rises above this point this alloying metal will begin to segregate. When the temperature rises to from 1700° F. to 1750° F. the retardation point of chromium will be reached, and as the temperature rises above this point this alloying metal will begin to segregate; so that when the annealing temperature shall have been reached, all three of the alloying metals will show segregations. The second heat wave is now begun, and the temperature of the mass raised to about 1650° F.—a little below the retardation points of the chromium and manganese—and is permitted to remain at that temperature for from 20 to 30 minutes, when the mass is again cooled down slowly. This restores the manganese and chromium. By the phrase restores is here meant that these alloying metals have again entered and become a part of the particles and no segregation thereof can be seen with the microscope; but the films of the vanadium can still be plainly seen. The third heat wave is now begun, and the temperature of the mass gradually raised to 1125° F. which is about 50° F. below the retardation point of vanadium; and this temperature is maintained for about 15 minutes, when the mass is again slowly cooled. A microscopical examination will now show that all traces of segregation of the vanadium have disappeared, this alloying metal having been restored by this third heating or wave. As in this case the metals manganese and chromium have retardation points that do not vary more than about 30° F. to 50° F. both may be restored by a single heating, or heat wave, as explained above; a little longer time only is required. Where other elements, as adulterations or chemical elements exist in small proportions in the mass, some changes take place in the several retardation points of the alloying metals; in the above explanation the metals are supposed to be pure. Also, when the number of the alloying metals is increased there is likely to be a variation in the retardation points. So that in order to be able to treat each run of metal, the retardation point of each alloy in the mass must first be determined; and this is a process well understood by metallurgists and those skilled in the art.

Each alloying metal has a definite tone of color and may be recognized in its segregated condition in the alloyed steel by microscopic comparison with the pure metal.

Only an example dealing with pure metals can be given herein; by using ferros in place of the pure alloying metals variations will occur.

A simple mode of determining the retardation point of an alloy, is to take a piece of the metal in the form of a thin bar; heat it to a certain temperature; cool it and then break it. If on microscopic examination no films or segregations show, the segregating point has not been passed. And so on repeating until films and segregations do appear; each successive heating being carried a little beyond the last. When the films begin to appear the retardation point in temperature will be from 35° F. to 50° F. below this, there being a period of rest or inaction between the retardation and segregation points.

While the metal may be raised to the exact retardation point any temperature within 100° F. below the retardation point will be operative and come within the broad scope of my invention.

Having thus described my invention, I claim—

1. The herein described method of annealing and heat-treating alloyed steels, which consists in subjecting the mass of metal to a series of heats or heat-waves of successively decreasing maximum temperature designed to affect the alloying metals in the order of their respective retardation points, the first heat or heat-wave being carried to the annealing temperature of the mass of metal and each successive heat or heat-wave to a temperature a little below the retardation point of the corresponding alloying metal, and slowly cooling the mass of metal after each successive heat or heat-wave.

2. The herein described method of heat treatments and annealing alloyed steels, which consists in subjecting the mass of metal to a series of heats or heat-waves of successively decreasing maximum temperatures designed to affect the alloying metals in the order of their respective retardation points, the first heat or heat-wave being carried to the annealing temperature of the mass of metal and each succeeding heat or heat-wave to a temperature within 100° F. below the retardation point of the corresponding alloying metal, and slowly cooling the mass of metal after each successive heat or heat-waves.

3. The herein described method of heat-treating alloyed steels, which consists in subjecting the mass of metal to a series of heats or heat-waves of successively decreasing maximum temperatures designed to affect the alloying metals in the order of their respective retardation points, the first and each successive heat or heat-wave being carried to temperatures a little below the retardation point of the corresponding alloying metal, and slowly cooling the mass of metal after each successive heat or heat-wave.

4. The herein described method of heat-treating alloyed steels, which consists in subjecting the mass of metal to a series of heats or heat-waves of successively decreasing maximum temperatures designed to affect the alloying metals in the order of their respective retardation points, the first and each successive heat or heat-wave being carried to a temperature within 100° F. below the retardation point of the corresponding alloying metal, and slowly cooling the mass of metal after each successive heat or heat-wave.

In witness whereof I have hereunto signed my name this 31st day of January 1907, in the presence of two subscribing witnesses.

JAMES CHURCHWARD.

Witnesses:
William J. Firth,
H. G. Hose.