Patented Feb. 23, 1926. 1,574,376

UNITED STATES PATENT OFFICE.

WILLIAM J. DIEDERICHS AND ANSON HAYES, OF AMES, IOWA.

PROCESS FOR TREATING IRON.

No Drawing. Original application filed August 21, 1922, Serial No. 583,370. Divided and this application filed August 6, 1925. Serial No. 48,624.

To all whom it may concern:

Be it known that we, WILLIAM J. DIEDERICHS and ANSON HAYES, citizens of the United States of America, and residents of Ames, Story County, Iowa, have invented a new and useful Process for Treating Iron, of which the following is a specification.

The subject matter of this application was originally included in but has been divided from our application filed August 21, 1922, Serial Number 583,370.

The object of this invention is to provide a new and improved process for treating white cast iron whereby an iron is produced having greater tensile strength than white cast iron and also capable of being bent and stretched to a considerable degree before breaking.

This and other objects of the invention will be more clearly described in the specification and pointed out in the appended claims.

Any suitable type or form of furnace or so-called annealing oven may be employed in carrying out our improved process, and may be heated by any of the well known fuels such as gas, oil, or powdered coal burned in connection with air; or the heat may be secured electrically or by a combination of combustion and electricity, or in any other manner that may be desired so long as the desired temperatures and atmospheres are secured.

The iron used in this process is known as white cast iron, differing principally from ordinary gray iron in that while both contain carbon, the white cast iron contains the carbon wholly or principally in the form of carbid of iron represented by the formula Fe_3C, while gray cast iron contains the carbon to a greater degree in the form of graphite or graphitic carbon.

Through the use of this process we obtain a product having a higher tensile strength than white cast iron and under certain conditions of procedure also having considerable ductility or ability to bend and stretch, and which is very useful for certain purposes.

In carrying out our improved process we do not necessarily pack the white iron castings in boxes or pots containing the packing material, as is done on the ordinary malleabilizing process as referred to in our parent application above referred to. However this may be done at times if desired, but by omitting it considerable time may be saved. When the packing is omitted the white iron castings may be supported in any suitable manner in the furnace to prevent sagging and warping under the intense heat.

The process consists in heating for any length of time, raising the temperature of the white iron castings with convenient rapidity, either rapidly or slowly, to any point between the critical temperature of the material (about 740 degrees centigrade) and the point of incipient fusion, and holding at the chosen higher temperature for a period of fifteen minutes to five hours, or more. The actual time required will depend upon the temperature chosen, lower temperatures requiring longer times, and upon the chemical composition of the white iron being treated. In any case it is only desired to maintain the higher temperature until the massive cementite is practically all absorbed in the solid solution. We are satisfied that in most instances it would avail little to hold at the higher temperature for a longer period than about five hours, since practically all of the desirable change would have occurred in that time, especially if the high temperature employed is above 900 degrees centigrade; and that holding for longer periods would result only in a waste of time without corresponding benefit. If a high temperature of less than about 900 degrees centigrade is used the time required to practically complete the absorption of massive cementite into the solid solution will be very materially increased.

The material is then cooled either rapidly or slowly to a temperature in the neighborhood of the critical temperature, either within or outside of the heating furnace. This cooling may be accomplished, if desired, in successive steps and holding for an appreciable time at each successive step, until a temperature in the neighborhood of the critical has been reached. This may be carried out in practice by holding three or four furnaces at the various temperatures desired and transferring the material successively from one to the next, which would usually be done without lowering the temperature of the castings below that of the

next furnace during such transfer. We do not wish, however, to be limited to this method of cooling to the neighborhood of the critical temperature. The castings may be cooled in the furnace, or they may be removed and cooled to a temperature below that of the next temperature to which the material is to be treated, by quenching in any suitable material such as sand, cement, powdered mica or the like. The operations of heating and cooling may be repeated for any desired number of repetitions, that is to say the material may be alternately heated to a point above the critical temperature and cooled to a temperature in the neighborhood of the critical. It has been demonstrated by experiment that the resultant product is an iron possessing considerably greater strength than the white iron castings and also having a considerable degree of ductility. The number of repetitions or alternate heatings and coolings, as well as the rates of heating and cooling, may be varied in accordance with the properties desired in the product. Our experiments show that the variations above referred to in the treatment of the iron result in castings possessing (1) a high tensile strength, of 85,000 to 90,000 pounds per square inch, with no ductility; to (2) those having a strength of about 60,000 to 85,000 pounds per square inch or more, with two to eight percent elongation or more.

We have also found that by a combination of the high temperature followed by a repetition of alternate heating and cooling; or vice versa, that is alternate heating and cooling, with a heating to higher temperature following or interposed, we obtain a resulting material of the same properties as that obtained by either one of the methods individually.

In speaking of the critical temperature of the material it should be borne in mind, as is well known in metallurgy, that the critical temperature can be, and is, undercooled by a rapid cooling, and therefore will be reduced by heating to a temperature above the critical and cooling fairly rapidly; so that in thereafter heating to the critical temperature, it is obvious that a lower actual temperature will be involved than the original critical temperature. The language of this specification and the appended claims is used with this fact in mind and should be so construed.

As a concrete example of what we have obtained in our experiments, we give the following by way of illustration only. Bars of white cast iron were heated at 1000 degrees centigrade for one hour, were cooled to 850 degrees centigrade with the furnace and held at such temperature for six hours, and then were cooled in the furnace to below the critical temperature. The material upon test showed a tensile strength of 62,600 pounds per square inch and an elongation of five percent in two inches.

Likewise by way of illustration, bars were alternately heated in the furnace to 850 degrees centigrade and cooled in the furnace to about 650 degrees centigrade, for a number of repetitions. After thirteen such heatings and coolings the bars showed a tensile strength of 70,500 pounds per square inch with five percent elongation in two inches; and after seventeen repetitions they showed 71,500 pounds per square inch with five and one-half percent elongation.

A series of experiments were conducted with white cast iron bars at various temperatures and with different rates of cooling. First they were heated three hours at 927 degrees centigrade, cooled to 849 degrees in forty-five minutes and left at that temperature for three hours and then cooled to 649 degrees at the rate of 3.6 degrees per minute. The overall time required was eight hours, and the bars showed a tensile strength of 74,400 pounds per square inch and four percent elongation in two inches. Next, bars were heated three hours at 982 degrees centigrade, cooled to 899 degrees in forty-five minutes and left at that temperature for three hours and then cooled to 649 degrees at the rate of 2.8 degrees per minute. The overall time required was nine hours, and the bars showed a tensile strength of 69,000 pounds per square inch and four and one-half percent elongation. Then bars were heated three hours at 982 degrees centigrade, cooled to 849 degrees in eighty minutes and left at that temperature for six and one-half hours, then cooled to 649 degrees at the rate of 2.2 degrees per minute. The overall time required was thirteen hours, and the bars showed a tensile strength of 60,380 pounds per square inch and an elongation of six per cent. Finally, bars were heated three hours at 982 degrees centigrade, cooled to 899 degrees in sixty minutes and left at that temperature for three hours, then cooled to 649 degrees at the rate of 1.7 degrees per minute. The overall time required was ten and one-half hours, and the bars showed a tensile strength of 56,600 pounds per square inch and an elongation of eight and one-half per cent in two inches. Attention is called to the gradation of properties produced as the final rate of cooling was made slower.

We claim as our invention—

1. The process for the heat treatment of castings from white cast iron which consists in (1) subjecting the casting to a temperature above the critical temperature of the material for a period of from fifteen minutes to five hours or more but only until the iron carbid present is practically all absorbed in the solid solution, which means

that in irons of commercial composition the combined carbon is reduced to approximately nine-tenths of one percent; (2) the cooling of the casting to a lower temperature in the neighborhood of the critical temperature; and (3) the cooling of the casting at a rate not less than about seven degrees centigrade per hour.

2. The process for the heat treatment of castings from white cast iron which consists in (1) the subjecting of the casting to a temperature above the critical temperature of the material for a period of from fifteen minutes to five hours or more but only until the iron carbid present is practically all absorbed in the solid solution, which means that in irons of commercial composition the combined carbon is reduced to approximately nine-tenths of one percent; (2) the cooling of the casting to a lower temperature in the neighborhood of the critical temperature; and (3) the cooling of the casting through a range from about 770 degrees to about 650 degrees centigrade at a rate not less than about seven degrees centigrade per hour.

3. The process for the heat treatment of castings from white cast iron which consists in (1) subjecting of the casting to a temperature above the critical temperature of the material; (2) cooling of the casting to a temperature in the neighborhood of the critical temperature by successive steps and holding for an appreciable time at each successive step, until a temperature in the neighborhood of the critical has been reached; and (3) cooling the casting to a lower temperature at a rate not less than about seven degrees centigrade per hour.

4. The process for the heat treatment of castings from white cast iron which consists in (1) subjecting of the casting to a temperature above the critical temperature of the material for a period of from fifteen minutes to five hours or more, but only until the iron carbid present is practically all absorbed in the solid solution; (2) cooling of the casting by successive steps and holding at each successive step for an appreciable time, until a temperature in the neighborhood of the critical temperature has been reached; and (3) the cooling of the casting to a lower temperature, at a rate not less than about seven degrees centigrade per hour.

5. The process for the heat treatment of castings from white cast iron which consists in (1) the subjecting of the casting to a temperature above the critical temperature of the material; (2) the cooling of the casting to a temperature in the neighborhood of the critical temperature; (3) a repetition of the above named steps, alternately; and (4) the cooling of the casting at a rate not less than about seven degrees centigrade per hour.

Signed at Des Moines, in the county of Polk and State of Iowa, this 18th day of June, 1925.

WILLIAM J. DIEDERICHS.
ANSON HAYES.