Patented Dec. 30, 1941

2,268,053

UNITED STATES PATENT OFFICE

2,268,053

HEAT TREATMENT OF HIGH-SPEED STEEL

Frank P. Miller and Walter A. Reese, Meadville, Pa., assignors to McCrosky Tool Corporation, Meadville, Pa., a corporation of Pennsylvania

No Drawing. Application June 16, 1939, Serial No. 279,580

2 Claims. (Cl. 148—15)

The present invention relates to the treatment of high speed steel, and more particularly to the conditioning of tools fabricated from high speed steel alloys.

It is the object of the present invention to simplify the heat treatment of high speed steel tools in order to realize manufacturing economies, while at the same time obtaining tools having higher cutting efficiency as well as secondary hardness than those attainable with the treatments of the prior art.

It is a further object of the present invention to combine the quenching and drawing or tempering steps in the heat treatment of high speed steel tools in order to obtain the requisite characteristics of hardness without diminishing the toughness or impact value of the steel. A still further object is to avoid the danger of minute fractures in the molecular structure of the steel due to sudden and wide fluctuations in temperature. In accordance with the present invention decarburization and "soft skin" are effectively avoided.

Other objects, purposes and advantages of the invention will appear from the more detailed description of the invention following hereinafter.

The present invention is applicable principally to that class of alloy steels which are designated as high speed steels which are characterized by their capability of retention of their hardness and toughness at a red heat which renders such steels useful in the special application of tools where at times the cutting edge is raised and maintained at a red heat by frictional resistance resulting from cutting metals at high speeds. Such alloy steels are well known in the art, which may contain in various proportions and combinations, tungsten, chromium, vanadium, cobalt and molybdenum.

Heretofore, the heat treatment of such steels or tools fabricated therefrom usually involved a preheating of the steel at about 1500° to 1700° F. with or without a preliminary warming. Following this preheating, the alloys were heated to a high temperature ranging from 2200° to 2450° F. depending upon the grade of steel undergoing treatment and the purpose for which the tool was intended. After a uniform heat, dependent in time upon the size and shape of the material being heated, the steel was quenched directly in a quenching medium of various types, usually in warm oil and sometimes in an air blast. In a few cases high speed steel tools are quenched in a molten salt or lead bath at varying temperatures, but in all cases after the quench the tools are allowed to cool down either to room temperature or to a warm condition between 200° and 300° before being drawn. The purpose and importance of the drawing or tempering operation are well known to those versed in the art. It refines and toughens the structure of the steel, removes strains caused by the high heat and subsequent quench, and it produces a secondary hardness in the steel. The drawing is done in a hot air furnace or in a molten bath. The drawing temperature varies from 900° to 1200° and the time from one to four hours, depending on the analysis of the steel, the size of the tool, and the purpose for which the tool is intended.

The operations and treatments outlined above are expensive, time-consuming and require a substantial amount of equipment. Unless each of the operations is performed in a critically careful manner, the possibility exists of a whole batch of tools being spoiled with the attendant loss of the labor and material which had gone into the fabrication of the tool to that stage. It is the purpose of the present invention to simplify the procedure outlined above, reduce the cost of the manufacturing steps and at the same time to produce a superior product, which has uniformly favorable characteristics.

In accordance with the present invention, the usual preheating step of the tools formed from a suitable high-speed steel is executed at a temperature range approximating 1500–1650° F. with or without a preliminary warming. Then the usual rapid heating to a high temperature of the tools from 2200–2450° F. is executed. The treatment following the high heating step constitutes the essence of the present invention and operates as a combination of the quenching and drawing operations which are so correlated in the same bath to produce improved tools at a lower cost. The tools, which may be disposed in a basket, are quenched in a fused salt bath at a temperature of about 900–1200° F. and are permitted to remain in this bath for the drawing operation. It is preferable to adjust the fused salt bath at a slightly lower temperature than the intended drawing temperature at the time of the introduction of the tools into the bath and thereafter the temperature of the bath can be raised to the desired drawing temperature, which is maintained during the drawing period of from one to four hours. This practice exercises an improved effect upon the grain structure of the steel. Of course, this raising of the temperature is not essential, and in actual practice, the quench may be executed directly by immersion in the salt bath at a preferred drawing temperature of about

1050° F. and the basket of tools may be left therein for the drawing period. A raising of the temperature of 40° or 50° following the introduction of the tools in the bath operates to give a refining effect to the molecular structure of the steel. Our preferred practice is to quench at about 975° to 1000° F. and after the basket is filled with tools to raise the temperature to 1025° to 1050° F. for the drawing period.

Upon the conclusion of the necessary drawing period, the tools are removed and cooled to room temperature and are then washed in boiling water, or in acetic acid solution, or otherwise cleaned of any salts that may cling to the tools. The tools are then ready for the finishing grinding operation.

In lieu of a single period of immersion of the tools in the combined quenching and drawing salt bath, several successive short drawings instead of one long draw may be executed by raising the basket of tools into the atmosphere for a few minutes until the tools cool down to approximately 700° to 900° F. whereupon they may be submerged again into the bath. This operation may be repeated several times and four of such successive handlings have been found advantageous without involving an undue amount of labor. Thus four drawing periods of one hour each may be executed in lieu of one long drawing period or any number of draws greater than one may be employed.

The salts used for the combined quenching and tempering are of a chloride carbonate cyanide composition the function of which are to have and maintain the proper temperature range without decomposing, to be neutral both to the container and the materials undergoing treatment, to be free from fuming at the operating temperature, and to have high solubility to permit a clean washing at the termination of the treatment. The fused salt bath of proper composition effects no decarbonization of the tools despite their long period of submersion therein.

The treatments outlined above are characterized by the fact that at no time are the tools cooled to room temperature which necessitates a complete reheating treatment for the final conditioning of the tools. The heating treatments in accordance with the invention are executed expeditiously and continuously from the initial preheating operation to the final cleaning operation. The fact that the quenching and the drawing operations are performed in the same bath, simplifies the actual operative steps, and in addition reduces the capital investment and the consequent operating costs, since one furnace performs the function of two. Of course, it is perfectly practicable for more than one furnace to be utilized, particularly in the drawing operations which are composed of a series of successive short draws, in which case, the initial quench may be executed in the fused salt bath nearest to the high heat furnace and following the first withdrawal after a drawing period of approximately an hour, the basket of tools may be submerged in a second furnace to make room for the highly heated tools coming from the first furnace for the purpose of speeding up production. Of course, the furnaces employed in the present invention for the preheat and high heat operations may be fitted with devices known in the art for controlling the atmospheres in these furnaces, as well as the temperatures thereof to develop the proper heat treating conditions.

The heat treating operation in accordance with the present invention is continuous from the preheating step clear through to the completion of the drawing process without allowing the tools to cool down to room temperature or, in fact, below 800° to 500° F. In view of the minimum exposure of the work to the atmosphere in the course of the continuous operations, a minimum amount of scaling or decarburization takes place. The tools have no contact with the atmosphere from the initiation of the quenching operation. If the tools are raised from the salt bath into the air during the drawing period, as previously described, a sufficient coating of molten salt will cling to the tools to insulate them entirely from the air during that time and thus prevent any decarburization.

The high speed steel tools produced in accordance with the present invention have a Rockwell C hardness which averages from one to one and one-half points higher than tools produced by the usual methods of the prior art. Hardnesses of C–65 and C–67 by the use of a quenching temperature of 980° to 1000° and a drawing temperature of 1040° to 1050° are obtained. These advantages result from the novel treatments outlined above.

Furthermore, the treatments in accordance with the present invention exclude any possibilities of objectionable strains being set up in the tools which may arise from the practices of the prior art when the tools are plunged suddenly into the drawing bath of approximately 1000° to 1100° F. from room temperature. The sudden expansion of the tool creates strains which show up later in checks or cracks in the tool. With the use of a combined quenching and drawing operation the temperature of the tools never drops below 800° to 500° F. until the conclusion of the heat treatment, and thus sudden shocks to the metal with the attendant undesirable effects are avoided.

What we claim is:

1. The method of heat treating high speed steel which comprises heating the steel to a high temperature, in the range of from 2200° to 2450° F., quenching and drawing the steel in a fused bath at a lower temperature approximating 1000° to 1100° F., in a plurality of stages of extended periods of submersion in the fused bath totaling a plurality of hours and interrupted by short intervals of withdrawal therefrom for cooling to a temperature in the range of approximately 700° to 900° F., and finally withdrawing the steel from the fused bath for cooling preparatory to the finishing operations.

2. The method of heat treating high speed steel tools which comprises heating the tools to a high temperature in the range of from 2200° to 2450° F., quenching the highly heated tools in fused salt bath at a temperature in the vicinity of 1000° F., raising the temperature of the fused bath to a higher degree for drawing the tools at a temperature approximating 1050° F. by a plurality of extended submersions in the fused bath totaling a plurality of hours interrupted by short intervals of withdrawal therefrom for cooling in the range of approximately 700° to 900° F., and withdrawing the tools from the fused bath for final cooling.

FRANK P. MILLER.
WALTER A. REESE.