April 3, 1934. C. L. STEVENS 1,953,445

METHOD OF HEAT TREATING ARTICLES

Filed April 25, 1932

Fig. 1.

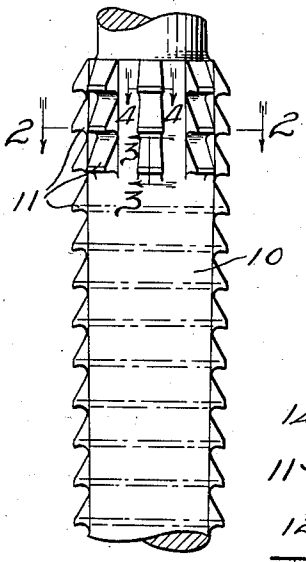
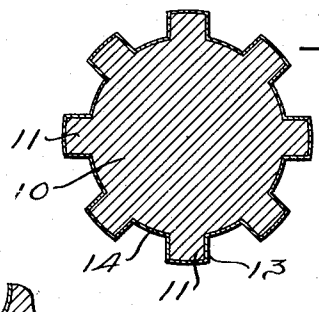



Fig. 2.



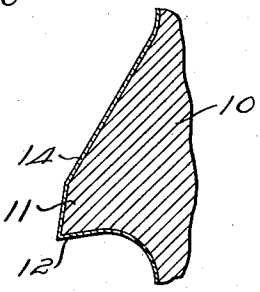




Fig. 3.

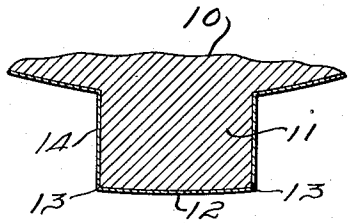
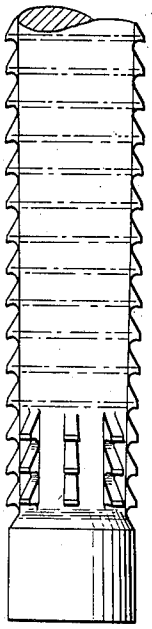



Fig. 4.



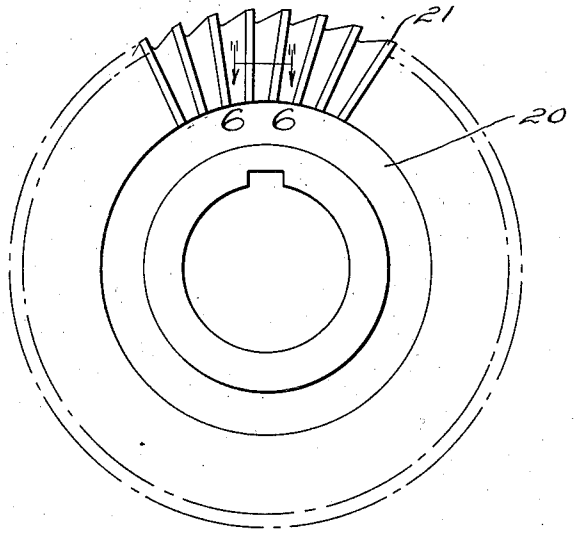
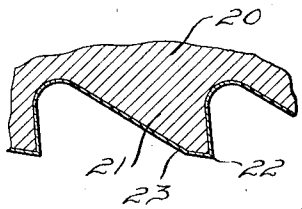



Fig. 5.

Fig. 6.




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# UNITED STATES PATENT OFFICE

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## METHOD OF HEAT TREATING ARTICLES

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Application April 25, 1932, Serial No. 607,339

3 Claims. (Cl. 148—7)

This invention relates to a method of heat-treating tools and like objects and particularly to such objects as are formed from so-called high speed steel, the principal object being the provision of a method of heat-treating the same which will result in a product of higher quality being formed, which will permit economy in the heat treatment of tools or the like, and which will eliminate to a great extent the relatively large proportion of scrap now resulting in the heat treatment of certain tools and other articles.

The invention is particularly adaptable for use in connection with tools having relatively sharp cutting edges and particularly to such tools of relatively intricate shape and conformation and accordingly which resist ready grinding of the cutting surfaces after they have been hardened.

As is well known to those skilled in the art, after a tool or like article formed from high speed steel is machined to substantially finished dimensions, it is necessary to heat such tool to approximately 2350 degrees F. and then quench it, either in liquid or in air, in order to obtain the desired hardness of the material.

Heretofore, in bringing such tools up to the desired temperature before quenching, a workman particularly skilled in this branch of the art has been employed and the criterion of the proper temperature in such cases is usually accepted to be indicated by an apparent sweating of the steel when it reaches the critical temperature. In the past, it has been essential that as soon as the steel first exhibits a tendency to sweat the tool must be immediately withdrawn from the furnace and quenched. Otherwise, it has been found the surface of the tool will be de-carbonized or oxidized to such an extent as to thereafter make it necessary to machine the tool down to the material not so affected and still maintain the desired limit of size on the tool. The ordinary practice in connection with such tool is to leave an excess of material of a thickness from between 10 to 15 thousandths of an inch which it is expected will be oxidized during the heat treatment and will be removed during the subsequent machining operations to bring the tool to size. Where the tool includes cobalt as an alloy it has been found that such heat treatment burns out the cobalt content of the alloy to a much greater depth than does the carbon content and, consequently, greater damage will occur unless extreme skill and care is employed in handling the same. In fact, it is a common occurrence to find that the cobalt has been burned out to a depth as great as $\frac{1}{32}$ of an inch, thus destroying the beneficial result of the cobalt in the alloy over this depth.

Furthermore, in case of certain tools having a relatively intricate design of cutting edge and such as to resist ready grinding of the same after the hardening treatment, it has not been possible to employ high speed steels for the reason that in order to bring them to proper finished condition it would be necessary, were they formed of high speed steel, to remove the oxidized exterior coating resulting after the heat-treatment before quenching.

In accordance with the present invention, I provide such high speed steel tools or the like with a protective coating during the heat-treatment operation before quenching, this coating being resistant to the temperatures to which the tool is subjected up to the required critical temperature, and accordingly, preventing the surface of the tool from being oxidized and thus losing the beneficial alloying constituents thereof. The result is that the precise moment at which the tool must be removed from the furnace for quenching is not nearly as critical as in cases where such coating is not employed, and consequently permits the employment of less skilled labor for performing the operation and the assurance that the surface of the tool will not be materially oxidized during the heat treatment. Accordingly, it further permits the tool to be machined to substantially finished condition, for example .001" oversize, before the heat treatment, and in many cases it will be found unnecessary for any subsequent machining operation where the tool has previously been machined to finished form. Accordingly, the process permits the employment of high speed steel in the production of tools of the class above described having cutting edges of intricate design resisting ready grinding of the same after heat treatment.

The particular coating which I employ for such tools in order to prevent oxidization of the surface thereof during the heating of the same prior to quenching is metallic chromium, preferably applied directly to the surface of the article by an electrolytic process of any suitable type. I have found that chromium strongly resists oxidization up to a temperature of substantially 2400 degrees F. and serves as an admirable protection to the surface of tools during heat treatment up to a temperature of at least 2375 degrees F. In view of the fact that high speed steel should be heated to 2350 degrees F. before quenching in order to obtain the desired characteristics of hardness and toughness, it will be apparent that a

chromium coating on the tool will thus effectively preserve the characteristics of the surface of the tool up to the desired temperature.

Accordingly, the specific object of the present invention is to provide a process of hardening tools and the like formed from high speed steel comprising in providing such tools or the like with a coating of metallic chromium, thereafter heating such tools to their critical temperature and then quenching them.

Referring to the drawing, I show by the way of illustration two different forms of tools in connection with which the present invention is admirably suited for use in the hardening of the same.

In the drawing, in which like numerals refer to like parts throughout the several different views,

Figure 1 is a fragmentary side elevational view of a broach of the type employed for broaching a multiple splined opening in an object such as a gear employed in connection with the transmissions of conventional automobiles.

Fig. 2 is an enlarged sectional view taken on the line 2—2 of Fig. 1.

Fig. 3 is a still further enlarged view of a tooth of the broach shown in Fig. 1 taken as on the line 3—3 of Fig. 1.

Fig. 4 is an enlarged view of a tooth of the broach shown in Fig. 1, taken as on the line 4—4 of Fig. 1.

Fig. 5 is a side elevational view of a milling cutter of a well known type.

Fig. 6 is an enlarged fragmentary sectional view taken as on the line 6—6 of Fig. 5.

Tools of the type shown in the drawing, are preferably formed from high speed steel and, because of their relatively numerous independent cutting edges, are relatively expensive to produce because of the large amount of labor involved in their make-up. Most of the labor is involved prior to the time when such tools reach a stage of completion at which they are ready to be hardened, and accordingly, it will be apparent that if such tools are spoiled during the hardening process, a considerable loss results.

Referring to the broach 10 indicated in Figs. 1 to 4 inclusive, it will be noted that it is provided on its exterior with cutting teeth 11 arranged in axially extending circumferentially spaced rows. As best illustrated in Fig. 3, each tooth 11 is provided with a sharp cutting edge 12 and, as best shown in Fig. 4, the corners 13 of the cutting edges 12 are preferably maintained as sharp as possible. Accordingly, as is well understood by those skilled in the art, the cutting edge 12 and particularly at the corners 13, is particularly susceptible to oxidization during heat treatment, this oxidization being at the point requiring greatest accuracy and highest resistance to wear in the finished article. In accordance with the present invention, I provide a coating 14 of metallic chromium for these surfaces. While the coating 14 may be provided only on those surfaces which maintain the accuracy of the tool during operation, it will of course be apparent that ordinarily it will be cheaper and more convenient to coat the entire surface of the article by simply placing it in a suitable electrolytic bath and applying the coating in the usual manner. I have found that the coating of chromium may be from one-half of one-thousandth to one-thousandth of an inch thick and satisfactory results will be obtained, this coating preferably being applied directly to the surface of the article without the addition of any coating such as copper or nickel which I have found to be a disadvantage rather than an advantage.

The milling cutter 20 illustrated in Figs. 5 and 6 includes teeth 21 having cutting edges 22 extending axially of its periphery and continuing radially down the sides of the same. The cutting edges and corners of such teeth are subject to the same troubles in heat treatment, prior to quenching, as the teeth on the broach previously described and, accordingly, I provide such teeth with a coating 23 of metallic chromium in the same manner as above described in connection with the broach illustrated in Figs. 1 to 4, inclusive.

Considering these tools to be formed from high speed steel and to have been provided with a coating of metallic chromium in the manner described, the tools are placed in a suitable furnace, preferably in a non-oxidizing or substantially non-oxidizing atmosphere, and gradually their temperature is increased to approximately 2350 degrees F., at which time they are removed from the furnace and quenched in any suitable or conventional manner. Although a non-oxidizing or substantially non-oxidizing atmosphere in the furnace is preferable, particularly in those cases where only part of the object is provided with a protective coating, it is to be understood that this is not at all essential in connection with the present invention, but is in accordance with conventional practice, and this hardening feature is an important advantage of the present invention. During the heat treatment it will be found that the greatest proportion of the chromium coating will have become oxidized and burned off but will have protected the surface of the tool to such an extent as to have substantially prevented oxidization of the steel itself. Any oxidization of the steel which might occur generally does not exceed a depth of one-thousandth of an inch. Where necessary or convenient, the tool may then be ground to final dimensions and is ready for production, and in cases where the shape of the tool is such that its cutting edge resists ready grinding and the tool has been brought to substantially finished dimensions prior to hardening, the tool will then be in a position for immediate use.

In the foregoing specification, it will be apparent that, although I have referred to such tools or other articles as being formed from high speed steel, it will be obvious that the term "high speed steel" employed herein broadly denotes that class of steel and steel alloys generally designated as "high speed steel", such as those commonly employed for metal cutting operations and some of which may contain little, if any, iron (Fe), and accordingly, the term "high speed steel" is to be so interpreted in the specification and in the following claims. Furthermore, while I have described the invention as being particularly adaptable for use in connection with cutting tools formed from high speed steel, many instances will be found where its use may be beneficial in connection with articles not formed from so-called high speed steel, and which may be heated to not over 1750 degrees F. before quenching and, accordingly, I do not wish to limit myself in this respect.

Formal changes may be made in the specific embodiment of the invention described without departing from the spirit or substance of the broad invention, the scope of which is commensurate with the appended claims.

I claim:

1. The method of hardening a high speed steel cutting tool having a cutting edge so as to prevent destruction of the surface layer of said tool at and proximate to such edge, comprising providing the surface of said tool at and proximate to said edge with a coating of metallic chromium not substantially exceeding .001 of an inch in thickness, heating said tool to above 1850 degrees F., and then quenching it.

2. The method of hardening a high speed steel cutting tool having a cutting edge so as to prevent destruction of the surface layer of said tool at and proximate to such edge, comprising providing the surface of said tool at and proximate to said edge with a coating of metallic chromium, heating said tool to above 1850 degrees F., and then quenching it, said chromium coating being of such thickness as to be substantially non-alloying with the metal of the tool and serving a temporarily useful purpose only during said heating.

3. The method of hardening a high speed steel cutting tool having a cutting edge so as to prevent destruction of the surface layer of said tool at and proximate to such edge during the heating treatment, comprising providing the surface of said tool at and proximate to said edge with a relatively thin coating of metallic chromium, heating said tool to above 1850 degrees F., and then quenching it, the thickness of said chromium coating being such that it is substantially destroyed during said heating.

CLAUD L. STEVENS.