

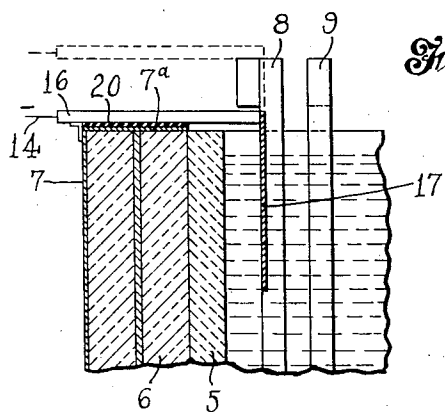
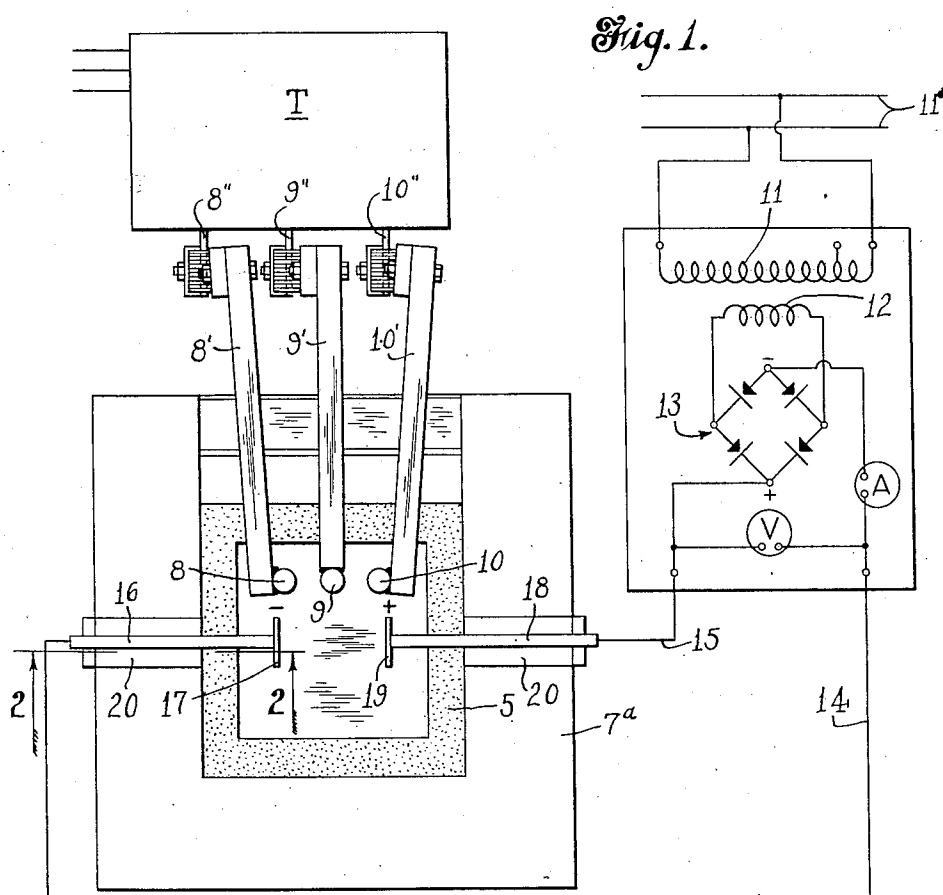
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METHOD OF TREATING HIGH-SPEED STEEL

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METHOD OF TREATING HIGH-SPEED STEEL

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This invention relates to a new method of treating high-speed steel, and more particularly to a method of hardening high-speed steel cutting tools and similar articles.

One of the objects which we have in view is to provide a method of heat treatment whereby the steel is hardened to a maximum degree.

Another object is to provide a method of treatment of high-speed steel involving the subjection of the steel to the action of a fused salt bath at a high temperature, in which incidental softening or deterioration of the surface of the treated object while in the salt bath can be insured against in a convenient and commercially practicable manner.

In the accompanying drawing:

Fig. 1 is a top plan view of a salt bath furnace installation such as can be employed in the practice of the invention; and

Fig. 2 is a vertical sectional view taken on line 2—2 of Fig. 1.

As an example of high-speed steel we may mention one, referred to as tungsten high-speed steel, containing, in addition to iron, 18% tungsten, 4% chromium, 1% vanadium, and 0.70% carbon. Another kind of high-speed steel referred to as an example is known as molybdenum type A, and this contains, in addition to iron, 4% of chromium, 2% of tungsten, 1% of vanadium, 8% of molybdenum, and 0.70% carbon.

For hardening steels of these and similar compositions where the objects to be hardened are, for example, cutting tools, we prefer to subject the tools to treatment in a salt bath furnace, the maximum temperature of the bath for hardening being say of the order of 2,350° F. The tools may be heated to this temperature in the furnace in which they receive their hardening treatment, but preferably a preheating furnace will be used for raising the tools to a temperature of say 1,500° F., and they will then be quickly transferred to another furnace, in which they are subjected to a still higher temperature, say 2,350° F., for hardening.

The furnace used for hardening will preferably be a salt bath furnace heated by liquid-immersed electrodes, the salt bath being contained in a ceramic pot. A furnace of this type is shown by way of example in Figs. 1 and 2.

The salt bath used for the heat treatment may contain, say, barium chloride 75%, barium fluoride 10%, and calcium fluoride 15%, as a bath of such composition, when used in the manner hereinafter described, gives excellent results. Another suitable bath contains barium chloride

85%, barium fluoride 5%, and calcium fluoride 10%; while a third bath, which is suitable for the purpose, contains 95% barium chloride, 2% barium fluoride, and 3% calcium fluoride. The salt charge requires a high temperature for fusing and provides a salt bath fluid at high temperatures only. A salt bath such as referred to is placed in the ceramic pot of the furnace and is heated by the passage of current into and between metal electrodes extending into the bath, these electrodes usually consisting of bars of nickel or bars of a nickel alloy containing chromium or of an alloy of iron and chromium. The electrodes may be three in number, and the heating current may be alternating three-phase current.

In the drawing, the ceramic pot of the furnace is shown at 5 and this pot may be square in plan, having an interior side dimension of 18 inches and say 20 inches deep, these dimensions being given merely by way of example. Such a pot will have a capacity of say from 500 to 600 pounds of salt. The pot is encased in a refractory block or furnace body generally indicated at 6, the latter element having a metal cover 7 (Fig. 2) extending over the sides and over the tops of the walls, one of the upper portions of the cover or casing being indicated at 7a.

Located adjacent one wall of the pot are three electrodes which are extended down into the bath, these electrodes being indicated at 8, 9 and 10, respectively, and each being suitably secured as by welding to an electrode shank extended over one wall of the pot and over the adjacent wall of the furnace body. The three electrode shanks or bars are indicated at 8', 9' and 10', and these shanks or bars are connected in an appropriate manner to the output leads 8'', 9'' and 10'' of a transformer T in a three-phase power circuit supplying alternating current.

In the treatment of the tools or other articles, they are placed in the salt bath, which is maintained at a temperature of say 2,350° F. by the current passing from each electrode to the other two in the three-phase sequence, and in so doing heating the intervening salt material and circulating the salt material within the pot so that substantially all portions of the bath in contact with the work are at a uniform temperature. To bring about this result it is preferred to have the three electrodes in planar arrangement adjacent one of the side walls of the pot as shown in the drawing. If high-speed steel tools are being treated, they will usually be strung on a wire loop and the loop suspended so that

all portions of the tools are within the bath. In case the articles are quite small, they may be placed in a perforate basket and the basket lowered into the bath. The treatment in the bath for hardening may consume say four or five minutes, after which the articles are removed.

Owing to the employment of the metal electrodes, and, under some conditions, to other causes, a certain amount of metal finds its way into the bath from extraneous sources and contaminates the bath. We have found that electrode-derived metal and other metal appearing in the bath as an impurity have an extremely prejudicial effect on the heat treatment. The metal such as nickel or chromium or iron, or the oxide of the metal, constituting an impurity of the bath, has a very strong tendency to break down the carbides, for example, tungsten carbide, molybdenum carbide, etc., of the steel, causing a chemical combination with the carbides and liberating carbon monoxide. When this reaction takes place, the steel is impaired, the same being of less than the necessary hardness and therefore unfit for the intended purpose.

We believe that it has not been appreciated heretofore that contamination of the bath to a relatively slight extent is highly prejudicial. We find that a contamination of the bath by metal and metallic oxides such that the metal and/or oxides is 5% of the weight of the bath represents too great a contamination for successful hardening treatment, and in our procedure, we endeavor to keep the contamination under 5% by weight, and it is preferred to keep it under 1%. Therefore, in the preferred practice, before the contamination reaches 1% the bath is given a scavenging treatment for the removal of the metal impurities. While other means may be used for the purpose, we prefer to remove the impurities by interrupting heat treating operations and cleansing the bath by plating the contaminating metal on to a cathode in the bath, and then removing such cathode before heat treating operations are resumed.

In removing the impurities we prefer to use an apparatus such as shown in the drawing, where a transformer primary 11 is connected to a suitable source such as a single phase 110 v. circuit 11', and has associated therewith a secondary 12 connected to a rectifier 13 by means of which direct current can be caused to pass through circuit legs 14 and 15. Connected to leg 14 is an electrode shank 16 having at one end a cathode plate 17 of suitable metal extended down into the bath, while to leg 15 is connected an electrode shank 18 attached at one end to an anode plate 19 immersed in the bath. It will be readily seen that in plating out the impurities so that they are deposited on the cathode plate 17, direct current is established in the circuit, including the legs 14, 15, the electrode shanks 16 and 18, the cathode and anode plates 17 and 19, respectively, and the salt bath into which these electrodes are extended. Preferably the electrode shanks 16 and 18, when positioned for operation, are laid across the top of the furnace in the manner shown, with insulating elements interposed between them and their respective supporting surfaces, one of such elements being indicated by way of example at 20 in Fig. 2, and being constituted by a sheet of insulating material laid on the top of the furnace body and having the electrode shank 16 laid upon it. When the removal of the impurities has been completed, the cathode and anode are removed from the bath, and with an ap-

paratus such as illustrated this can be readily done, it being merely necessary to lift the corresponding electrode shanks off of the furnace block and place them in a suitable location until their use is again required.

The voltage in the plating circuit will be relatively low, say from 3 to 5 volts, and the amperes will be preferably within the range from 25 to 50.

In carrying out our improved process, the bath will be heated say to 2,350° F., and the bath being fresh and clean, that is to say, devoid of any contaminating metal, operations are begun, the work being placed in the bath in the manner previously described and left there during the requisite time for the hardening treatment. Repeated batches of material will be treated, each batch requiring say 5 minutes treatment. At first, frequent chemical analyses of the bath are made with the object previously stated, namely, that at no time should the metal contamination by weight exceed the selected limit, for example, 1%. Shortly before this limit is reached, heat treatment operations are suspended, and the scavenging of the bath effected by placing the plating electrodes in position and closing the plating circuit. This circuit is closed during the necessary interval for the complete elimination of the metallic constituent of the bath. In some cases it may be necessary to carry on the plating step for 10 minutes, for example, while in other cases it may be necessary to continue through one hour, for example. The plating is facilitated by the character of the bath and its high temperature, the salts remaining molten throughout the plating. Analysis is made so that plating is not discontinued until all or substantially all of the contaminating metal is removed. This contaminating metal is, of course, deposited upon the cathode 17, and after the plating operation is complete, the plating electrodes are removed from the furnace in the manner previously indicated, their removal being for the purpose of preventing any metal from or in connection with them entering the bath while the heating electrodes are being used. After being removed from the bath, the plating electrodes should be entirely cleared of metal or other deposits adhering thereto before these electrodes are again used.

By following the procedure described, the heat treating effect of the salt bath upon the high-speed steel is greatly enhanced. Hardening can be effected in a shorter time than heretofore, and the steel is given maximum hardness. It is also possible to secure much more uniform results upon the different batches of steel being treated, which is very desirable.

After some experience has been gained with an installation such as described, the proper time interval between the scavenging steps or operations can be ascertained without the need of such frequent analyses of the bath as are required at first. The amount of steel which requires treatment in a given time by a given furnace must, of course, be taken into consideration. Obviously, more frequent scavenging treatments are required where the furnace is used in a heavy schedule of production. Where there is a heavy schedule it has been found in practice that a scavenging of the bath in the manner described may be necessary several times in a 24 hour period. This can be readily effected by the procedure herein described, whereby the plating out of the contaminating metal can be done conveniently and in a comparatively short time. It is an important advantage of the invention that

this can be done conveniently and relatively quickly so as to eliminate any tendency on the part of the operator to continue the heat treatment after the bath has been contaminated beyond the limit which has been set.

While we have described a preferred procedure, it is to be understood that various changes in the details can be made without departure from the principles of the invention or the scope of the claims.

What we claim is:

1. The method of treating high-speed steel for hardening which comprises heating a salt bath to a temperature in excess of 2,000° F., the salt bath being substantially devoid of metal contamination, immersing the steel in the bath and subjecting it to the bath temperature during a period sufficient to heat the steel to the desired extent, the treatment being repeated on different batches of steel in the same bath, analyzing the bath for metal contamination, and scavenging the bath of contaminating metal so that the percentage by weight of contaminating metal in the treating bath does not exceed 5%.

2. The method of treating high-speed steel for hardening which comprises heating a salt bath to a temperature in excess of 2,000° F., the heating effect being produced by metal electrodes extended into the bath, treating batches of metal successively by immersing them in the bath during certain time intervals, the bath as initially used being substantially free of metal, analyzing the bath for metal contamination from the electrodes and elsewhere as the heat treatments proceed, and cleansing the bath of contaminating metal so that at no time does the metal contamination of the bath treating the metal exceed 5%.

3. The method of treating high-speed steel for hardening which comprises heating a salt bath to a temperature in excess of 2,000° F., the heating effect being produced by metal electrodes extended into the bath, treating batches of metal successively by immersing them in the bath during certain time intervals, the bath as initially used being substantially free of metal, analyzing the bath for metal contamination from the electrodes and elsewhere as the heat treatments proceed, and cleansing the bath of contaminating metal so that at no time does the metal contamination of the bath treating the metal exceed 1%.

4. The method of treating high-speed steel for hardening which comprises heating a salt bath to a temperature in excess of 2,000° F., the salt bath being substantially devoid of metal contamination, immersing the steel in the bath and subjecting it to the bath temperature during a period sufficient to heat the steel to the desired extent, the treatment being repeated on different batches of steel in the same bath, analyzing the bath for metal contamination, and scavenging the bath of contaminating metal so that the percentage by weight of contaminating metal in the treating bath does not exceed 5%, the scavenging being effected by plating by means of an anode and a cathode introduced into the bath, and the anode and cathode being removed from the bath before heat treatments are resumed.

5. The method of treating high-speed steel for hardening which comprises placing the materials for a salt bath in a ceramic pot, heating the bath electrically by means of bath-immersed metal electrodes to a temperature in excess of 2,000° F., immersing the steel in the bath and subjecting it to the bath temperature, the treatment being repeated on different batches of steel in the same bath, analyzing the bath for metal contamination, and scavenging the bath of contaminating metal so that the percentage by weight of contaminating metal in the treating bath does not exceed 5%, the scavenging being effected by plating by means of an anode and a cathode introduced into the bath, the anode and cathode being removably associated with the rim portion of the pot by means of suitable supporting members while the anode and cathode are in operation, and the anode and cathode being removed from the bath after complete removal of metal impurities within the bath and before heat treatments are resumed.

6. In the process of treating high-speed steel for hardening in which the steel articles are immersed in a bath of salts heated to a high temperature for fusing and fluid only at a high temperature, the step of plating out metal impurities from the bath using the salts while in a fused condition as the electrolyte.

7. In the process of treating high-speed steel for hardening which involves the immersion of steel articles in a highly heated bath of salts which are molten at high temperature only, the heating being effected by metal electrodes extending into the bath, the steps of analyzing the bath for metal impurities, and plating out the impurities, using the molten salts as an electrolyte, before the metal impurities reach 5% by weight of the bath.

8. The method of treating high-speed steel for hardening which comprises fusing a charge of salts which are solid at ordinary temperatures and providing a molten salt bath at a temperature in excess of 2,000° F. by the use of heating electrodes extending into a pot containing the charge, treating the steel in the salt bath, and scavenging the bath of contaminating metal so that the weight of contaminating metal does not exceed 5%, the scavenging being effected by electroplating using the bath in a molten state as the electrolyte and a suitable anode and a suitable cathode introduced into the bath, said anode and said cathode being removed before heat treatments are resumed.

9. In the process of hardening articles of high-speed steel which comprises immersing the articles in successive batches in a highly heated bath which is fluid only at a high temperature and comprises salts suitable for the treating of high-speed steel, the step of plating out metal impurities in the bath between the treatment of certain batches, using the treating bath while molten as the electrolyte.

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