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METAL PART AND PROCESS OF  
HARDENING

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The present invention relates to a new and improved metal part and process of hardening same. While the invention in its broad aspects is not limited to any particular metal, it is particularly applicable where the metal part is made of steel, and hence will hereinafter be referred to as applied to steel or high speed steel parts.

An increase in the hardness of a steel part is commonly accompanied by a corresponding decrease in toughness. While a high degree of hardness may be desirable or even necessary in various steel parts, as for example in tools fabricated from high speed steel, the resultant decrease in toughness is objectionable in many instances, particularly at local surfaces or edges that are to be finished or shaped. For example, in some instances grinding hardened steel parts results in the formation of grinding cracks.

The primary object of the present invention resides in a novel process of hardening steel or metal parts which permits of selective local surface softening.

I have discovered that when steel, and especially high speed steel, is first plated with another metal, and then hardened throughout, as by heat treatment, there is produced on the surface of the steel and beneath the coat of metal plate, a thin relatively soft layer or skin of steel. This soft layer of steel does not appreciably reduce the hardness of the steel part as a whole, but does provide surface toughness.

The depth of the soft layer on the steel part beneath the metal plate should be sufficient to accomplish the desired result, namely to impart the desired degree of surface toughness, and is subject to some variation depending on the nature of the metal plate. Certain metals, such as chromium, cobalt and nickel, or alloys thereof, are particularly well suited in that they will produce a soft layer of appreciable depth beneath the plate sufficient to impart the desired degree of toughness.

In a more specific concept of the invention, I prefer to employ chromium as the plating metal, and high speed steel as the metal which is to be plated for the purposes herein set forth.

An important feature of the invention resides in the application by electrodeposition of chromium to selected local areas or surfaces that are to be toughened, while other areas or surfaces are left unplated. This provides surface toughness where needed, and retains the normal degree of surface hardness where unobjectionable, all without reducing the degree of hardness of the steel part as a whole.

To afford a specific illustration of the invention, one flat surface of a high speed steel part was plated with a layer of chromium .004 inch in depth which was deposited electrolytically at a temperature of 120° F. and at a current density of four amperes per square inch from a solution of 2.4 molar in chromic acid having a sulphate ratio of 105. The other surfaces of the part were left unplated. The plated part was then hardened by heating it to a temperature of approximately 2350° F. and then quenching it in oil. Vickers hardness tests showed low hardness values, averaging approximately 325, for depths of less than .010 inch beneath the original surface under the chromium plate, and showed relatively high hardness values, averaging approximately 750, for depths greater than .014 inch beneath said surface and for the unplated surfaces. It was found that the soft layer immediately under the chromium plate, up to a depth of .012 inch, was greatly enriched in chromium and suffered a loss in carbon. At a depth of .003 inch, the chromium content was 13%, representing an enrichment of 9%. It is believed that an austenitic condition was obtained in the soft underlying layer of steel. It will be understood that the invention is not limited to the specific details of the foregoing illustration, but that, apart from the plating of selected surfaces, the processes employed in the electrodeposition of the plate and in the heat treatment may be widely varied.

I claim as my invention:

1. The process of hardening a part made of high speed steel of uniform composition which consists in electrodepositing a thin adherent plate of chromium on a selected local portion of the surface of the part while leaving the remaining portion of said surface free of such plate, and then heating the part with the original composition of said remaining portion unaltered to a temperature above the critical temperature to effect a recrystallization of the steel, and then quenching the heated part to effect a general hardening throughout its entire mass without suffering any substantial change in composition except underneath said plate, said plate resulting in the formation of a thin underlying relatively soft low carbon chromium alloy layer beneath the original surface of the part.
2. A metal part comprising a fabricated body of high speed steel having a relatively soft thin integral layer of a low carbon chromium steel alloy on a portion of its surface, said body being hardened uniformly throughout its mass beneath

said layer, internally and on the remaining portion of said surface, said remaining portion having the same composition as the interior.

3. The process of hardening a relatively high speed steel part of uniform composition which consists in electrodepositing a thin adherent plate of cobalt on a predetermined surface area thereof while leaving the remaining surface area unplated with such metal, and then heating the part with the original composition of said remaining portion unaltered to a temperature above the critical temperature of the steel to effect a recrystallization of the steel, and then quenching the heated part to effect a substantially uniform hardening thereof throughout its mass and beneath the plate subject only to the local surface effect of the cobalt.

4. A metal part comprising a fabricated body of high speed steel having a thin adherent plate of cobalt on a portion of its exterior and a thin integral layer of relatively low carbon steel beneath said plate, said body being hardened uniformly throughout its mass beneath said layer, internally and on the remaining portion of said exterior, said remaining portion having the same composition as the interior.

5. The process of hardening a part made of steel which consists in electrodepositing a thin adherent plate of chromium on the surface of the part, then heating the part to a temperature above the critical temperature to effect a recrystallization of the steel, and then quenching the heated part to effect a general hardening throughout its entire mass, said plate resulting in the formation of a thin underlying layer of steel immediately beneath the original surface of the part relatively softer than the rest of said mass.

6. The process of hardening a part made of steel which consists in electrodepositing a thin adherent plate of chromium on a selected local portion of the surface of the part while leaving the remaining portion of said surface free of such plate, then heating the part with the original composition of said remaining portion unaltered to a temperature above the critical temperature to effect a recrystallization of the steel, and then quenching the heated part to effect a general hardening throughout its entire mass without suffering any substantial change in composition except underneath said plate, said plate resulting in the formation of a thin underlying layer immediately beneath the original surface of the part relatively softer than said remaining portion of said surface and the rest of said mass.

7. The process of hardening a part made of steel which consists in electrodepositing a thin adherent plate of a metal, selected from the group consisting of chromium, cobalt, nickel and alloys thereof, on a selected local portion of the surface of the part while leaving the remaining portion of said surface free of such plate, and

then heating the part with the original composition of said remaining portion unaltered to a temperature above the critical temperature of the steel to effect a recrystallization of the steel, and then quenching the heated part to effect a general hardening throughout its entire mass without suffering any substantial change in composition except underneath said plate, said plate resulting in the formation of a thin underlying relatively soft low carbon layer immediately beneath the original surface of the part.

8. The process of hardening a part made of steel which consists in electrodepositing a thin adherent plate of a metal, selected from a group consisting of chromium, cobalt, nickel and alloys thereof, on the surface of the part, then heating the part to a temperature above the critical temperature of the steel to effect a recrystallization of the steel, and then quenching the heated part to effect a general hardening throughout its entire mass without suffering any substantial change in composition except underneath said plate, said plate resulting in the formation of a thin underlying layer immediately beneath the original surface of the part relatively softer than the rest of said mass.

9. A metal part comprising a fabricated body of high speed steel having on a portion of its surface a relatively soft thin integral layer of a relatively low carbon alloy of steel with a metal selected from a group consisting of chromium, cobalt and nickel, said body being hardened uniformly throughout its mass beneath said layer, internally and on the remaining portion of said surface, said remaining portion having the same composition as the interior.

10. A metal part comprising a fabricated body of high speed steel having a relatively soft thin integral layer of a low carbon nickel steel alloy on a portion of its surface, said body being hardened uniformly throughout its mass beneath said layer, internally and on the remaining portion of said surface, said remaining portion having the same composition as the interior.

11. The process of hardening a part made of high speed steel of uniform composition which consists in electrodepositing a thin adherent plate of nickel on a selected local portion of the surface of the part while leaving the remaining portion of said surface free of such plate, and then heating the part with the original composition of said remaining portion unaltered to a temperature above the critical temperature to effect a recrystallization of the steel, and then quenching the heated part to effect a general hardening throughout its entire mass without suffering any substantial change in composition except underneath said plate, said plate resulting in the formation of a thin underlying relatively soft low carbon nickel alloy layer beneath the original surface of the part.

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