

UNITED STATES PATENT OFFICE

2,032,912

PROCESS OF SURFACE HARDENING OF METALS BY CEMENTATION WITH ANTIMONY

Michael George Corson, Woodside, N. Y., assignor to General Electric Company, a corporation of New York

No Drawing. Application October 31, 1932, Serial No. 640,507

5 Claims. (Cl. 148-4)

Hardening of metals by a process of surface cementation has been applied, so far, to iron only. In the case of iron, surface hardening has been achieved by cementing the outside layers of an article made of iron with either aluminum (calorizing), or chromium (chromizing) and especially with carbon.

The present invention consists in applying an analogous process to the hardening of a number of other technically used metals, which in the present case may be properly designated for the purpose of identification as a group, as "metals and alloys, capable of being worked by pressing and cutting tools and melting between 750° and 1550° centigrade". This group will embrace in the order of increasing melting points

(A) Silver pure, sterling and other wrought alloys of silver;

(B) Gold and its alloys;

(C) Copper, alpha and beta brasses, alpha and duplex tin bronzes, copper-silicon alloys, cupronickels and cupro-manganese alloys;

(D) Nickel, monel-metal, nickel-manganese alloys, nickel-chromium alloys, other nickel base alpha type alloys;

(E) Cobalt and its workable alloys;

(F) Iron and its alloys.

The element which I propose, according to the present invention, to use for obtaining surface hardening phenomena in the metals above listed, is antimony. It can be applied, for instance, by immersing the articles to be surface hardened in a mixture of powdered antimony metal with antimony-oxide (SbO_2) and heating this mixture with the immersed articles to a suitable temperature not much different from that used in "calorizing" under which name the process of surface cementation of iron with aluminum is known in the arts.

I prefer, however, first to electroplate the article in question with a well regulated amount of antimony, for which purpose a number of antimony-plating solutions can be used. The article thus plated is next heated to a convenient temperature anywhere from 400° to 620° centigrade, the lower range being used for the cementation of silver and the upper for nickel and cobalt. By suitably regulating the temperature of the cementation process, the thickness of the layer of antimony electroplated and the time of heat-treatment, the depth of cementation and the nature of the layer cemented can be widely controlled. To illustrate: A silver article is plated with a layer of antimony .05 mm. thick. The plated article is heated for one hour to 475° centi-

grade in an atmosphere of a neutral or reducing gas (to prevent the oxidation of the thin layer of antimony). The result is a surface layer about .12 mm. thick of a composition close to the formula Ag_3Sb of a rather high hardness. If, however, the same plated piece is heated for eight hours at 425° centigrade a much thicker layer of cemented silver results, but its hardness is much lower because it represents only a saturated solid solution of antimony in silver. The same situation applies to all other metals of the group.

The process can also be applied locally by preventing the electroplated antimony from depositing on or adhering to spots which are to remain soft and uncemented.

Again, if the base metal is made to contain appreciable amounts of manganese, from one to ten per centum, which is possible for all the metals listed and all their commercial alloys, the cementation process will result in articles which can be made highly permeable to magnetic forces either uniformly or locally, due to the formation of a ternary compound of the base metal with antimony and manganese.

Further again, in cases where the hardened layer contains phases (constituents) the composition of which is a direct function of temperature, a further hardening effect can be obtained by quenching the heat-treated antimony-cemented article from the temperature of the cementation process and reheating to 250-350° centigrade.

Having so described the present invention, I wish to claim:

1. The process of hardening articles made of workable metals and alloys having melting points between 750° C. and 1550° C. which comprises coating said articles with antimony, heating the coated articles at a temperature between 400° C. and 620° C. to thereby produce a hardened layer consisting of antimony and said metals or alloys and containing phases the composition of which is a direct function of temperature, quenching said articles, and reheating to 200° C. to 350° C.

2. A process of obtaining articles with a hardened, magnetically permeable surface, by making these articles of workable metals and alloys identified by having their melting points within the range of 750° to 1550° C., and by containing from one to ten per centum of manganese, which comprises electroplating them with antimony, subjecting the electroplated pieces to a heat treatment between 400° and 620° C., to thereby cause the antimony to diffuse into the metallic body of the article and produce a hardened layer contain-

ing phases the composition of which is a direct function of temperature, quenching the cemented articles and treating them finally at a temperature ranging from 200° to 350° C.

3. A process of obtaining local effects of increased hardness and magnetic permeability upon the surface of articles made of metals and alloys melting between 750° and 1550° C. and containing from one to ten percentum of manganese, which comprises applying to them a localized plating with antimony followed by a controlled heat treatment between 400° and 620° C. to thereby produce a hardened layer containing phases the composition of which is a direct function of temperature and finishing by quenching from this range and reheating to 200-350° C.

4. The process of hardening the surface of metals and alloys having a melting point within the range of 750° C. to 1550° C., which comprises

electroplating said metals with antimony, heating the electroplated articles to a temperature of 400° C. to 620° C. to thereby produce a hardened layer consisting of antimony and said metals or alloys and containing phases the composition of which is a direct function of temperature, quenching the coated articles, and reheating to 200° C. to 350° C.

5. The process of heat treating articles made of workable metals and alloys whose melting point is located between 750° C. and 1550° C. and containing 1 to 10% manganese which comprises coating said articles with a layer of antimony, heating the coated articles at a temperature between 400° C. and 620° C. to thereby form a ternary compound of antimony and manganese with the base metal, quenching said articles and reheating to 200° C. to 350° C.

MICHAEL GEORGE CORSON.