

UNITED STATES PATENT OFFICE.

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TREATMENT OF METALS.

No Drawing.

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My invention relates to the treatment of metals to prevent harmful deterioration when heated to high temperatures in the presence of oxygen.

5 In my Patent No. 1,365,499 dated January 11, 1921, I have described and claimed a method of treating metals such as iron, nickel, molybdenum and tungsten to prevent corrosion. In accordance with the method
10 of this patent powdered chromium is brought into surface contact with the foundation metal to be protected under non-oxidizing conditions at a suitable temperature to cause the chromium to penetrate the foundation
15 metal and form therewith a surface alloy which serves to protect the interior of the foundation metal. This surface alloy of chromium and the foundation metal is fundamentally a protection against corrosion, although it also resists oxidation at high temperatures to some extent.

I have discovered that if the article to be protected be suitably heated in surface contact with a mixture of powdered chromium
25 and silicon, a surface alloy is formed with the metal of the article which has excellent oxidation resisting properties when heated to high temperatures. Various proportions of silicon may be used. Preferably the powdered chromium and silicon are mixed with
30 a powdered inert, refractory material, such as aluminum oxid or magnesium oxid. I have found that if 10 per cent by weight of powdered silicon be added to the regular chromium mixture of my aforesaid patent consisting of equal parts of powdered chromium and refractory material, either aluminum oxid or magnesium oxid, an excellent heat resisting surface alloy may be formed.
35 The articles to be treated are packed in a receptacle in the chromium silicon treating mixture and then suitably heated, for example, by placing the receptacle with its contents in a hydrogen furnace.

45 The duration of the heat treatment or firing to effect the desired penetration of the chromium and silicon with the foundation metal varies with the temperature used. Temperatures of from 1000° C. to 1500° C. are satisfactory. While a temperature of
50 approximately 1200° C. is required to effect penetration of the powdered chromium alone, when this small amount of powdered silicon is added to the treating mixture good pene-

tration is obtained at approximately 1000° C. Apparently the silicon alloys with the chromium and carries the chromium with it into the foundation metal at this lower temperature. When iron is being treated, a very satisfactory surface alloy is formed
60 by firing for six hours at a temperature of 1350° C. As with the process described in my aforesaid patent, the firing is carried out under non-oxidizing conditions, preferably in the presence of hydrogen.

The surface alloy thus formed gives excellent protection against oxidation at surprisingly high temperatures. A piece of iron after being given the treatment previously described, i. e. fired for six hours at a temperature of 1350° C., was heated at a temperature of 1100° C. in an open furnace for over 200 hours before any signs of breakdown in the protective coating were perceived. Another piece of iron after being
75 given a similar treatment was heated in the open air at a temperature of 900° C. for over 400 hours without showing any appreciable oxidation. This latter piece showed only an exceedingly small increase in weight after being thus heated, which is a further indication of the efficiency of this surface alloy as a protective coating.

If the firing temperature is reduced appreciably, for example, to approximately
85 900° C. but little, if any, further penetration of the chromium silicon mixture takes place, and the surface alloy when subjected to temperatures of 900° C. or less remains fixed. In other words, there is little or no tendency at this or lower temperatures for the chromium and silicon of the surface alloy to gradually diffuse into the interior of the foundation metal and thereby leave the surface unprotected. This is probably one explanation of the extraordinary heat resisting properties obtained by this treatment.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. The method of protecting metals against
100 oxidation at high temperatures which consists in heating the metal at a temperature of from 1000° C. to 1500° C. in a hydrogen atmosphere in contact with a mixture of powdered chromium and silicon.

2. The method of protecting metals against
105 oxidation at high temperatures which consists in heating the metal under non-oxidiz-

ing conditions at a temperature of from 1000° C. to 1500° C. in contact with a mixture of powdered chromium and silicon.

3. The method of providing iron with a heat protecting surface alloy of iron, chromium and silicon which consists in heating the iron in hydrogen in contact with a mixture of powdered chromium, silicon and aluminum oxid at a temperature of from 1000° C. to 1500° C.

4. The method of providing iron with a surface alloy which is resistant to oxidation at high temperatures, which consists in heating the iron in hydrogen in contact with powdered chromium and silicon at a temperature of approximately 1350° C.

In witness whereof, I have hereunto set my hand this 16th day of April, 1925.

FLOYD C. KELLEY.