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METHOD OF CARBONIZING FERROUS METAL

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This invention relates to carbonizing iron and other ferrous metal such as steel and alloys of iron, with a view to increasing the radiation of heat therefrom at elevated temperatures.

5 The carbonization of iron is particularly important in connection with its use for certain parts in thermionic tubes and the like. For the purposes of illustration, the invention will be described more particularly with reference to the preparation of iron sheet for use in radio tubes, but it will be understood that the invention is also applicable to other ferrous metal and other uses.

Considerable difficulty has been encountered in 15 past attempts to carbonize iron, due to uncertainty and non-uniformity of the deposit obtained and the difficulty of securing a firm adherence of the carbon particles to the iron surface. Carbonizing gases which are decomposed at elevated temperatures are usually employed in any of these 20 carbonizing operations. Further difficulty is encountered in view of the case hardening effect which is liable to occur if the temperature gets too high in the carbonizing operation.

25 According to the present invention, uniform deposition of firmly adherent carbon and iron is obtained while avoiding the case hardening effect. This result is achieved by the preliminary treatment of iron which facilitates the formation of carbon on the iron surface and its adherence thereto, while at the same time making it en- 30 tirely feasible to operate at such temperatures that case hardening does not occur to any substantial extent.

35 In principle, the invention involves the treatment of the iron surface with a compound of nickel or other equivalent metal such as cobalt, manganese or the like, or mixtures of such compounds, preferably in the nitrate form and in 40 aqueous solution. This treatment is more effective on an iron surface which has been preliminarily oxidized either from natural exposure or from intentional treatment under oxidizing conditions such as, for example, heating in the open 45 air. The oxidized surface, after passing through an aqueous solution of nickel nitrate, for example, when passed into the carbonizing medium at proper temperatures, receives a very uniform deposit of firmly adherent carbon with substantially 50 no case hardening effect.

To enable others to understand and practice the invention, I shall describe a specific example of the complete process.

It will be understood that the iron treated may 55 be in strip form or in the form of already fabri-

cated parts such as, for example, the plate electrodes of thermionic tubes. The iron is first cleaned of all grease, oil or other foreign material. For this purpose, any of the conventional treatments may be employed, for example, washing in 60 carbon tetrachloride or passing through a hot alkali wash with subsequent rinsing. It is then heated to about 600° C. in the open air to oxidize the surface, this being very readily accomplished in the case of metal strip by drawing the strip 65 through a tube furnace to which air is freely admitted. After oxidation the metal is allowed to cool and is then passed through, for example, an aqueous solution of nickel nitrate of about 3% strength, after which the strip is passed into and 70 through a carbonizing atmosphere, where it is heated to from 650° C. to 700° C. The strength of the nickel nitrate solution or other salt bath may vary considerably, for example, from 20% to saturation. The carbonizing atmosphere may 75 be illuminating gas or any hydrocarbon gas capable of setting free carbon under the conditions recited, but I prefer to employ the compressed hydrocarbon gas known as "Pyrofax" (81.7% carbon and 18.3% hydrogen) and to bubble this 80 through liquid naphtha prior to its introduction into the carbonizing furnace. The furnace may be of the usual carbonizing type, for example, a silica tube heated from an external source, or, if desired, the strip may be heated electrically, either 85 by passing a current through it or by high frequency induction during its passage through the carbonizing atmosphere. The carbonized strip is discharged from the furnace at a sufficiently low temperature to avoid combustion or oxidation, and may be spooled in coils for future use, 90 or fed directly to the machine for fabricating parts.

In the treatment described, it is of particular importance that excessive temperatures be 95 avoided where case hardening is objectionable. The preliminary salt bath, and to some extent the oxidation treatment, appear to facilitate the formation of the firmly adherent carbon deposit at lower temperatures than would ordinarily be 100 obtained without such preliminary treatments. Whether this is due to catalytic or strictly chemical action is not definitely understood, but the action appears to some extent to be catalytic in its nature. The iron, as it enters the furnace, 105 carries a film of salt solution, which appears to have an important effect upon the carbonization even though the total quantity of nickel nitrate or the like per unit area of surface is very small.

The above example has been given merely for 110

the purposes of illustration, and is not to be construed as limiting the invention to the precise conditions or manner of carrying out the respective steps. Oxidation is not strictly necessary, though it is distinctly advantageous in the final result. Instead of aqueous solutions, the nitrates or other salts may be applied in highly comminuted form mixed with water, oil or other liquid to form a paste. A further modification of the procedure may be a preliminary mechanical or chemical treatment of the metal surface prior to oxidation for the roughening or etching of the surface, as for example by scratch brush, sand blast or acid, for the purpose of increasing the surface area with consequent increase in the oxidation effect and in the amount of the nitrate or other salt film carried by the metal as it enters the carbonizing furnace. Such etching or other roughening also tends to further increase the adherence of the carbon deposit.

I claim:—

1. The method of carbonizing ferrous metal, which comprises treating the surface with a nickel nitrate, and exposing the treated surface to a carbonizing medium at carbonizing temperature.

2. The method of carbonizing ferrous metal, which comprises oxidizing the surface, treating the oxidized surface with a nickel nitrate, and exposing the treated surface to a carbonizing medium at carbonizing temperature.

3. The method of carbonizing ferrous metal, which comprises treating the surface with a solution of nickel nitrate, and exposing the treated surface to a carbonizing medium at carbonizing temperature.

4. The method of carbonizing ferrous metal, which comprises oxidizing the surface, treating the oxidized surface with a solution of nickel nitrate, and exposing the treated surface to a carbonizing medium at carbonizing temperature.

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