

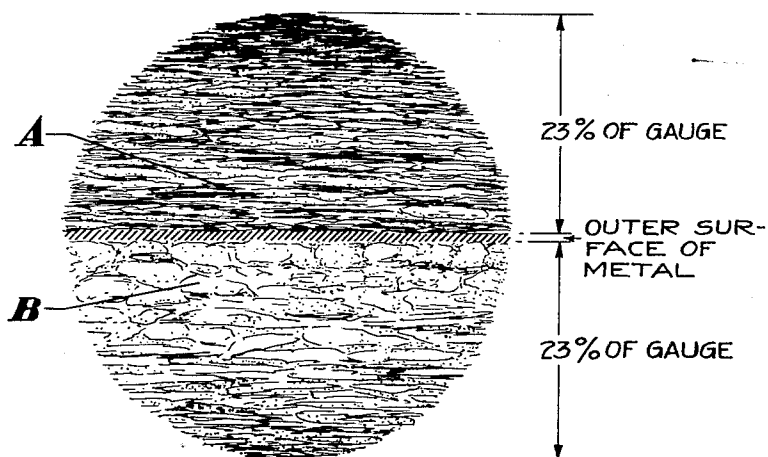
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CHROMIUM-BEARING METAL

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CHROMIUM-BEARING METAL

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6 Claims. (Cl. 148—7)

This invention relates to chromium-bearing metals, and more particularly the heat treatment thereof to render them immune to the corrosive attack of acids and the like.

Stainless and heat-resistant steels may be broadly classified as austenitic (chromium and nickel bearing) and ferritic (chromium-bearing), the physical and chemical properties of each type being well known. The fact that the chromium-bearing steels are more susceptible to corrosive attack than the chromium-nickel steels is also well known but, due to its lower cost, its use is considered wherever possible. For example, the chromium-bearing metals are quite resistant to oxidation up to 1550° F. but cannot resist the corrosive action of certain acids such as sulphuric, hydrochloric and nitric-hydrochloric (aqua regia); whereas the chromium-nickel bearing metals apparently are more satisfactory against corrosive action when in the presence of these above mentioned acids. This corrosive action is also more positive when the acid is diluted, because of greater ionization. Many chemical vessels are made of the cheaper chromium-bearing metals where low strength and use in the lower range of temperature does not warrant the use of the more expensive, stronger and higher heat-resistant chromium-nickel bearing metals.

These chemical vessels made of chromium-bearing metals are often subjected to the action of weak acids; for example, in the manufacture of nitro-cellulose products such as gun cotton, wherein the gun cotton is rinsed with water to free it of all traces of acid, thus giving rise to an acidulous solution which in turn attacks the lining of the metallic vessel. In the case of rinsing out gun cotton with water the resultant solution contains a low concentrate of the nitrating solution such as one-half of one per cent (0.5%) by weight of a mixture of sulphuric (3 parts) nitric (1 part) acids. Chromium-nickel bearing metal would probably eliminate to a marked degree this corrosive action but the use of this more expensive, stronger and greater heat-resistant metal is not warranted over the advantages thus derived.

It is therefore one of the objects of my invention to immunize chromium-bearing metals against the corrosive action of dilute acids and the like.

Another object is to provide a novel method of heat treating chromium-bearing (ferritic) metals so as to render them immune against corrosive action to the extent of immunization ex-

hibited in the chromium-nickel bearing (austenitic) metals.

My method of heat treating is directly related to chromium-bearing metals whose analysis is primarily 16–18% chromium, manganese and silicon, each not in excess of 0.50%, and carbon not in excess of 0.10%, with the remainder substantially iron. More specifically, an approximate analysis of this metal (which is well known and forms no part of the invention except as its heat treatment) is as follows:

	Per cent
Carbon.....	.08
Manganese.....	.35
Phosphorus.....	.01
Sulphur.....	.01
Silicon.....	.35
Nickel.....	.15
Chromium.....	17.00
Iron.....	Remainder

This chromium-bearing metal is hot and/or cold rolled into various forms, such as structural shapes, tubes, sheets, strip, plate, wire, etc., and afterwards immunized by a heat treatment of sufficient degree and duration to render its crystalline structure in a rounded and unstrained condition.

It is well understood by those skilled in the art that well-annealed metals like those under consideration may bear a structural appearance like section A of Figure 1; but this structure appears as striated or elongated grains and, while satisfactory for drawing or forming purposes, it cannot be tolerated for the purposes of my method. The granular shape of the chromium-bearing metal should be as indicated in section B of Figure 1, and without it my method will not provide the degree of immunization desired. It is possible to heat-treat this chromium-bearing metal so as to render the grains of the central portion of the metal still in an elongated or striated condition, but in any event the outer surface (when later exposed to corrosive action) must be of rounded crystalline structure approaching equi-axial dimensions and be devoid of any strained areas resulting from the strains set up in its hot and/or cold working. I have found that heating this particular metal to a temperature of about 1450° F. and holding it at that temperature for about two hours will provide at least the outer surfaces of the metal with a rounded, unstrained crystalline structure similar to that illustrated in section B of Figure 1. A temperature of this order is, of course, above

the lower critical point of this type of metal and within its annealing range. As is well known to those skilled in the art, a temperature which is below the lower critical point of the metal will not produce the change in crystalline structure to the desired unstrained substantially rounded grains. This heat-treatment can be carried out in any desired manner; for instance, by heat-treating sheets in a conventional closed annealing box.

After this unstrained rounded structure has been attained in the metal particularly adjacent its outer surfaces, the metal is pickled, or cleaned, by dipping the same in an acid solution comprising nitric and hydrofluoric acids.

The next and final step of my method is to pacify the outer surface of the chromium-bearing metal (with its unstrained, rounded crystalline structure) by applying to the same an oxide film of such thickness as to render it invisible to the eye and without affecting the pickled surface, or changing the outer grain structure produced by the step of annealing above desired. This is accomplished by heating the metal to a temperature of between 400 to 500° F. in the presence of any suitable oxidizing medium. For example, the material may be passed between electric resistors in the presence of air or, if so desired, immersed in an oxidizing solution such as a permanganate heated to the above temperature. This treatment is more or less the equivalent of a drawing operation.

It should be noted that the obtaining of the unstrained, rounded outer structure by the first heating step will not immunize the metal against corrosion if it is not followed by the second heating or pacifying step. Likewise, I have found that this pacifying step is worthless if the first annealing step produces a striated grain structure as shown in Section A of Figure 1. The success of my method therefore resides in both steps.

While I have shown and described several specific embodiments of my invention, it will be understood that I do not wish to be limited exactly thereto, since various modifications may be made without departing from the scope of my invention, as defined by the following claims.

I claim:

1. The method of immunizing stainless steel of the ferritic type against the corrosive attack of acids and the like, which includes the steps of heating the said stainless steel to a temperature which is above its lower critical temperature, whereby the grain growth of the said steel is changed, the temperature and period of time of the said heat treatment being so co-related as to provide the outer surfaces of the said stainless steel with an unstrained and unstriated substantially rounded grain structure which is visible under microscopic examination, cooling the said heat treated stainless steel to substantially room temperature without changing the said unstrained and unstriated substantially rounded grain structure to a temperature which will permit the removal of oxide scale, and thereafter exposing the said heat treated and cooled stainless steel with its surfaces cleaned to an oxidizing medium while the said stainless steel is heated to a temperature which is materially above normal atmospheric temperature but below its lower critical point, the temperature and the period of time of said last named heat treatment being so co-related as to provide the surfaces of the said

stainless steel with an invisible corrosion-resistant oxide film.

2. The method of immunizing stainless steel of the ferritic type containing approximately 17 per cent chromium and the remainder iron against the corrosive attack of acids and the like which includes the steps of heating the said stainless steel to a temperature which is above its lower critical temperature, whereby the grain growth of the said steel is changed, the temperature and period of time of the said heat treatment being so co-related as to provide the outer surfaces of the said stainless steel with an unstrained and unstriated substantially rounded grain structure which is visible under microscopic examination, cooling the said heat treated stainless steel to substantially room temperature without changing the said unstrained and unstriated substantially rounded grain structure to a temperature which will permit the removal of oxide scale, and thereafter exposing the said heat treated and cooled stainless steel with its surfaces cleaned to an oxidizing medium while the said stainless steel is heated to a temperature which is materially above normal atmospheric temperature but below its lower critical point, the temperature and the period of time of said last named heat treatment being so co-related as to provide the surfaces of the said stainless steel with an invisible corrosion-resistant oxide film.

3. The method of immunizing stainless steel of the ferritic type against the corrosive attack of acids and the like, which includes the steps of heating the said stainless steel to a temperature of approximately 1400 degrees F., whereby the grain growth of the said steel is changed, the period of time of the said heat treatment being so co-related with the temperature thereof as to provide the outer surfaces of the said stainless steel with an unstrained and unstriated substantially rounded grain structure which is visible under microscopic examination, cooling the said heat treated stainless steel to substantially room temperature without changing the said unstrained and unstriated substantially rounded grain structure to a temperature which will permit the removal of oxide scale, and thereafter exposing the said heat treated and cooled stainless steel with its surfaces cleaned to an oxidizing medium while the said stainless steel is heated to a temperature which is materially above normal atmospheric temperature but below its lower critical point, the temperature and the period of time of said last named heat treatment being so co-related as to provide the surfaces of the said stainless steel with an invisible corrosion-resistant oxide film.

4. The method of immunizing stainless steel of the ferritic type against the corrosive attack of acids and the like, which includes the steps of heating the said stainless steel to a temperature which is above its lower critical temperature, whereby the grain growth of the said steel is changed, the temperature and period of time of the said heat treatment being so co-related as to provide the outer surfaces of the said stainless steel with an unstrained and unstriated substantially rounded grain structure which is visible under microscopic examination, cooling the said heat treated stainless steel to substantially room temperature without changing the said unstrained and unstriated substantially rounded grain structure to a temperature which will permit the removal of oxide scale, and thereafter exposing the said heat treated and cooled stain-

less steel with its surfaces cleaned to an oxidizing medium while the said stainless steel is heated to a temperature which is not in excess of approximately 500 degrees F., the period of time of said last named heat treatment being so co-related with the temperature thereof as to provide the surfaces of the said stainless steel with an invisible corrosion-resistant oxide film.

5. The method of immunizing stainless steel of the ferritic type against the corrosive attack of acids and the like, which includes the steps of heating the said stainless steel to a temperature of approximately 1400 degrees F., whereby the grain growth of the said steel is changed, the period of time of the said heat treatment being so co-related with the temperature thereof as to provide the outer surfaces of the said stainless steel with an unstrained and unstriated substantially rounded grain structure which is visible under microscopic examination, cooling the said heat treated stainless steel to substantially room temperature without changing the said unstrained and unstriated substantially rounded grain structure to a temperature which will permit the removal of oxide scale, and thereafter exposing the said heat treated and cooled stainless steel with its surfaces cleaned to an oxidizing medium while the said stainless steel is heated to a temperature which is not in excess of approximately 500 degrees F., the period of time of said last named heat treatment being so co-

related with the temperature thereof as to provide the surfaces of the said stainless steel with an invisible corrosion-resistant oxide film.

6. The method of immunizing stainless steel of the ferritic type against the corrosive attack of acids and the like, which includes the steps of heating the said stainless steel to a temperature of approximately 1400 degrees F., whereby the grain growth of the said steel is changed, the period of time of the said heat treatment being so co-related with the temperature thereof as to provide the outer surfaces of the said stainless steel with an unstrained and unstriated substantially rounded grain structure which is visible under microscopic examination, cooling the said heat treated stainless steel to substantially room temperature without changing the said unstrained and unstriated substantially rounded grain structure to a temperature which will permit the removal of oxide scale, and thereafter exposing the said heat treated and cooled stainless steel with its surfaces cleaned to an oxidizing medium while the said stainless steel is heated to a temperature which is between approximately 400 degrees F. and approximately 500 degrees F., the period of time of said last named heat treatment being so co-related with the temperature thereof as to provide the surfaces of the said stainless steel with an invisible corrosion-resistant oxide film.

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