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SPIRO KYROPOULOS, OF GOTTINGEN, GERMANY.

PROCESS OF COATING IRON AND IRON ALLOYS WITH CHROMIUM.

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My invention relates to an improved process of coating iron or iron alloys with chromium.

I am aware that a process for coating metals has already been suggested consisting in a heating process to which the coated object, for example an aluminium-plated copper sheet, is exposed for the purpose of increasing the density and adherence of the coating. In a publication of this well known process is mentioned the possibility of treating iron and steel by coating them with those metals which are already used in the manufacture of high grade alloy steels such as tungsten, nickel, molybdenum, chromium etc.

It is also a well known fact that iron forms mixed crystals (solid solutions) with chromium; iron-chromium alloys have been manufactured for a long time and it was to be expected that the possibility mentioned above could be realized.

However experiments of the inventor have shown that satisfactory chromium coatings of iron and steel were not to be obtained by the well known method. The coatings obtained were more or less brittle and did not adhere well to the core.

Extensive experimental researches of the inventor have shown that the carbon content of the iron or iron alloys of manufacture were the reason of the failure. This fact was most clearly demonstrated by applying the process to high-carbon steels. On electroplating them with chromium and heating them to a suitable temperature, extremely brittle coatings are obtained which very often crack immediately on removing the chromium-plated objects from the heat or separate as brittle films, leaving an irregular surface on the core. Experiments of the inventor have shown that this hitherto unknown disturbing effect of carbon is due to the presence of cementite or another mixed chromium-iron-carbide formed at high temperatures, which prevents the diffusion of chromium into the core.

Using the aforesaid results of experiment, the inventor solved the problem of coating iron and iron alloys with chromium by artificially producing at least a superficial zone free or nearly free of carbon in or on the iron body to be coated. This may be done in different ways, for example by providing the carbon steel with a layer of pure or low carbon iron before plating it with chromium,

thus making possible the diffusion of chromium into the surface on heating, which results in a uniform ductile and adherent coating of high chromium steel, the chromium content of which may raise up to pure chromium on the surface.

The process is not limited to chromium coating of iron with a low or medium carbon content; experiments show that even in its application to low carbon steels or alloy-steels an intermediary layer of metal free from carbon yields considerably improved chromium coatings.

The discovery of the injurious influence of carbon further showed the conditions under which it is possible to obtain directly a satisfactory coating of chromium on iron and its alloys.

A satisfactory coating of chromium on iron and its alloys is to be obtained only when the iron core is free of carbon or its carbon content is so low as not to prevent chromium from entering the superficial zone of the core by diffusion during the tempering process. It has been shown by the inventor that as a rule iron and its alloys with other metals with a carbon content less than 0.1% may readily be chromium-plated and tempered without any intermediary layer.

The process according to this invention may be carried out according to the following detailed specifications:

The steel which is to be chrome-plated is first electroplated or otherwise coated with a layer of iron free of carbon or of iron with a very low carbon-content, then coated with chromium, preferably by electroplating, then heated to a convenient high temperature (1000-1300° Cels.) in vacuo or in an inert gas (hydrogen, nitrogen etc.) so as to avoid oxidation and to cause the chromium to diffuse into the core within a reasonable time and to the depth desired, thus becoming an integral part with the core. Objects treated in that way are resistant to most corrosives, take a high lustre by polishing and have all the desired mechanical properties. For instance they may be bent without losing these properties and without damaging the anticorrosive surface.

Another possible method consists in electroplating or otherwise coating the steel with iron or some other metal (for instance nickel), suitably treating the coated body in order to decrease the percentage of carbon

in it and forming mixed crystals with iron and chromium, then coating it with chromium (preferably electroplating) and then heating it as specified above. There may also be inserted a tempering process between these coating operations.

One may also proceed as follows: Coat the steel with chromium first, then coat with iron, then temper, or alternately coat the iron coated steel with chromium and iron and then temper. In this way also a very resistant and adherent coating is obtained, which becomes thicker in a comparatively shorter time, the chromium having a chance to diffuse in two directions. The procedure which is to be followed depends on the anticorrosive and mechanical properties and the thickness desired for the special purpose (for instance valves, cylinders, spokes, shafts for automobiles, parts resistant to chemical action). If in any of these latter processes the iron coating applied last should not yet have been sufficiently mixed with the last chromium coating during the last tempering process and thus not have wholly formed the resistive mixed crystals, the surplus iron on the surface may be readily removed by the action of acids without any injury to the high chromium alloy below.

All ways of carrying out such processes which involve alternating coatings with the production of a metal layer (for instance iron) free or nearly free of carbon and chromium and alternating, repeated tempering, are to be regarded as consistent with the spirit of this invention. Probably the advantage of one or the other of these methods consists in that the velocity of diffusion of iron into chromium seems to be much higher than the reverse. If the chromium coated iron bodies are to be used for apparatus, in which they are exposed to high temperatures, for instance as parts of a gas turbine driven by explosive mixtures, it is not necessary to artificially temper the bodies previously because in such cases a natural tempering will happen automatically.

It will be readily understood that I do not limit myself to the exact details of the

procedure described above as examples and that these may be easily modified in many ways by experts within the range of my claims without departing from the spirit of my invention or sacrificing any of its advantages.

What I claim as my invention and desire to secure by patent is:

1. The process of coating iron containing bodies with chromium comprising producing a superficial zone of iron with a small percentage of carbon on the body to be coated, coating the body with chromium and tempering the coated body.

2. The process of coating bodies with chromium comprising producing a superficial iron zone with at most 0.1% of carbon on the body to be coated, coating the body with chromium and tempering the coated body.

3. The process of coating bodies of iron or iron alloys with chromium comprising producing on the body to be coated a superficial iron zone with a small percentage of carbon, electrolytically depositing a chromium coating on the body and tempering the coated body.

4. The process of coating bodies of iron or iron alloys with chromium comprising producing on the body to be coated a superficial iron zone with at most 0.1% of carbon, electrolytically depositing a chromium coating on the body and tempering the coated body.

5. The process of coating bodies of iron or iron alloys with chromium, comprising coating the body with iron free of carbon, on the surface so obtained producing a chromium coating and tempering the coated body.

6. The process of coating bodies of iron or iron alloys with chromium comprising coating the body with a metal substantially free of carbon, on the surface so obtained producing a chromium coating, producing another coating of a metal substantially free of carbon on the chromium surface and tempering the coated body.

In testimony whereof I affix my signature.

SPIRO KYROPOULOS, PH. D.