Patented Feb. 4, 1941 2,230,532

UNITED STATES PATENT OFFICE

2,230,532

HEAT TREATMENT OF COPPER-CHROMIUM ALLOY STEELS

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No Drawing. Application June 28, 1937, Serial No. 150,882. In Great Britain July 3, 1936

2 Claims. (Cl. 148—3)

This invention relates to improvements in the treatment of alloy steels containing copper and chromium.

Various alloy steels are known containing copper in proportions of 1% or 2% and it has also been proposed to make alloy steels containing chromium and over 5% of copper. However, such steels containing over 5% of copper have not come into commercial use, as no satisfactory method has been published for the fabrication of a satisfactory range of useful articles therefrom.

It is the object of the present invention to provide an improved process of casting articles from such alloy steels. Further objects of the invention are to provide such alloys characterized by a novel structure and to provide cast articles of such alloys having novel physical properties.

Alloys containing over 5% of copper and over 10% of chromium may be prepared in known manner, and they exhibit stain-resisting properties.

If the alloys are cast in sand in the usual manner, the crystalline structure is undesirable.

I have now discovered that these difficulties can be overcome if certain precautions are observed in casting, though special methods of annealing and heat-treatment (for hardening), are also desirable, and these special methods of treating castings differ profoundly from those applicable to the well known nickel-chromium steels.

I have discovered that slow cooling produces a dendritic structure which is undesirable for castings, but that by suitable rapid cooling it is possible to produce a fine polyhedral structure, which is excellent for castings.

My invention therefore comprises the production of fine polyhedral crystals, and this may be achieved if the castings are cast in chilled moulds or rapidly air-cooled as soon as they can be conveniently removed from the moulds, e. g. after less than 2 to 3 hours in the sand.

The invention further comprises certain methods of annealing and heat treatment as hereafter described in detail. Whereas nickel-chromium steels can either be annealed by quenching or hardened by slow cooling, the properties so obtained are not usually reversible, i. e. a soft material cannot be converted into a hard one after the treatment. According to my invention, annealing is effected at a temperature of say 750°–970° C., and is usually followed by hardening heat-treatment consisting of quenching or air cooling and the hard and soft properties so obtainable are reversible.

Thus the following experiments were made with a casting of an alloy of 15% Cr, 10% Cu and 1% W, annealing at 970° C.

Tempering	200°	500°	600°	700°	750°	800°
Izod value	2	0.5	2	7	16	20
Brinell value	286	340	255	196	163	170

The castings do not work-harden and show other desirable properties.

The lower temperatures of annealing are desirable for ease in pickling, while the higher temperatures are preferred if maximum softness is desired.

The finished article may be further treated by reheating and either quenching in water or air cooling, the quenching temperature varying with the copper chromium content.

For a content of 15% chromium and 10% copper the temperature for maximum hardness is substantially 500° C.

The treatments are set forth above are particularly applicable for chromium-copper alloy steels in which the chromium content is analogous to that of the known nickel chromium steels; the corrosion-resistance increases progressively from 10% to 15% chromium or even 17–19% chromium, for commercial reasons, the upper limit of chromium content is about 20 to 25% though higher percentages may be used.

The minimum coper content is about 5–6% and a preferred lower limit is 7–8%. The preferred range is 8–10%. The copper may be as high as 20%, or even 40–50% but that is an obvious economic upper limit. Large increase in copper raises ductility at the expense of corrosion-resistance. For deep-drawing alloys 15–25% of copper may be present.

The balance of the alloy is principally and almost entirely iron, though small quantities may be present of metals used as additions to steel, and in particular of metals which alloy with copper. The content of any such addition is preferably less than 1–2%. Nickel may be present as an accidental impurity (less than 1%) but it has little or no useful effect, and the nickel content should be less than 2%.

To reduce the size of the polyhedral crystals, especially when the castings cannot be cooled rapidly enough, the alloys may contain molybdenum, tungsten or especially columbium, usually less than 1%. Columbium may be added as a matte of Cb-Ti-Sn.

The carbon content should be low; by sacrific-

ing part of the strain-resistance, a forgeable alloy may be made with up to 0.3% C but the C content is preferably less than 0.12%.

Copper-chromium alloy steels subjected to a treatment as above, and having a chromium content of 15% or less will be found to be air hardening whilst those greater than 15% will not be air hardened.

It is preferable to vary the heat treatment with the percentage of chromium.

Chromium-copper alloy steels treated in the manner of the present invention will be found to have high ductility, a high tensile strength and considerable resistance to corrosion forming "stainless" steels having similar properties to nickel-chromium steel, and of a similar carbon content; that is to say, usually from 0.05 to 0.1% carbon.

I claim as my invention:

1. The process of producing from iron alloys high in copper and chromium easily machinable and stain resisting castings capable of successive softening and hardening heat treatments, which comprises preparing a molten alloy containing chromium 10 to 25 percent, copper 5 to 20 percent, less than 0.3 percent carbon, the balance being substantially all iron, pouring the molten alloy for forming the casting, rapidly cooling the molten mass for producing a fine polyhedral crystalline structure and thereby avoiding the production of dendritic formations; and then annealing the casting at 750 to 970 degrees C. with slow cooling therefrom to provide a soft article.

2. An easily machinable and stain-resisting alloy containing from 5 to 20 percent of copper and from 10 to 25 percent of chromium and less than 0.3 percent carbon, with the balance substantially all iron, in the form of a casting having a structure formed of fine polyhedral crystals which casting has been rapidly cooled from the molten state and then annealed by slow cooling from a temperature of 750 to 970 degrees C. to produce a soft product.

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