Patented Feb. 20, 1940

2,190,781

UNITED STATES PATENT OFFICE

2,190,781

ALLOYS RESISTANT TO BURNING AND SCALING

William Guertler, Berlin-Dahlem, Germany, assignor, by mesne assignments, to Chemical Marketing Company Inc., New York, N. Y.

No Drawing. Application January 12, 1939, Serial No. 250,653. In Germany April 29, 1935

4 Claims. (Cl. 75—171)

The present invention refers to alloys with great heat resistance and articles which are made of such alloys.

This application is a continuation-in-part application of my applications Serial No. 69,987 and Serial No. 69,988, both filed upon March 20, 1936.

It has been known that chromium-nickel-alloys containing about 50–90 percent of nickel and 35–10 percent of chromium and which in some cases may contain, in addition, small quantities of other metals such as for instance iron, molybdenum and the like, possess a great resistance to the action of high temperatures and are particularly resistant to burning and scaling at high temperatures. (See Ullmann, Enzyklopädie der Technischen Chemie, II edition, volume 8, 1931, page 1290.)

Alloys of the above-mentioned composition are utilised in consequence of their great resistance to scaling and burning as material for the manufacture of resistances, further of utensils, implements and apparatus which have to resist the action of high temperatures such as for instance from 1000 to 1200° C. and more. They are used especially as resistant material which is electrically heated such as heating wires and the like.

I have found that the resistance of such chromium-nickel-alloys which are by themselves resistant to scaling and burning can be improved greatly in their resistance against the action of high temperatures and the effect of air or oxygen in the air at high temperatures when these alloys, in addition to the ordinary components, contain thorium metal. A considerable improvement of the resistance to scaling and burning of chromium-nickel-alloys of the kind above specified is obtained, as I have found out, by the presence of very small quantities of thorium. These quantities may be 0.5 percent or even less. The upper limit of the thorium content which practically comes into consideration is about 6 percent. To exceed this upper limit of the thorium content is of little use because by the addition of greater quantities of thorium the effect as regards the resistance to scaling and burning is not increased but, on the other hand, the mechanical properties of such alloys may be influenced unfavourably by such higher contents. In general I prefer to keep the thorium content between about 0.5 percent and 2 percent but do not want to be limited especially as regards the lower limit.

For practical purposes such nickel alloys come with advantage into consideration which contain about 10 to 30 percent of chromium, up to about 6 percent of thorium, the remainder being nickel. Whilst chromium-nickel-alloys with a content of about 10 to 30 percent of chromium have a resistance to scaling and burning which corresponds to about 40 times that of nickel alone, alloys which have the same nickel and chromium content and, in addition, a content of thorium in quantities of 0.5 to 2 percent possess a resistance to scaling and burning which is a multiple of the corresponding alloys which are free from thorium.

In carrying out my invention the content of nickel in the alloy may be replaced by other metals of the iron group, i. e., iron, cobalt or both metals. However, the nickel shall only be replaced to such an extent by other metals of the iron group that the resistance of the alloy against scaling is not or only slightly deteriorated and the nickel remains the chief constituent of the alloy. The alloy may be composed, for instance, out of the following constituents: 10 to 30% Cr, about 6% Th, rest nickel plus iron or nickel plus cobalt or nickel plus cobalt plus iron, whereby the quantity of nickel shall exceed the quantity of iron and/or cobalt to a considerable extent. Generally, the content of iron and/or cobalt in those alloys shall not exceed 20%, preferably not 10%.

The alloys may contain in addition other metals such as molybdenum, tungsten, thallium, manganese or the like, regulated respectively, in such a way that the properties of the alloys as regards their resistance to scaling and burning is not or at least not considerably impaired. Such an addition of suitable metals in small quantities which in general do not exceed 5 percent in preference 2 percent of the total alloy has the advantage that the alloys can be influenced as regards their mechanical properties. For example the working of the alloy can be facilitated or their properties in other respects can be improved, for example as regards their core structure.

Wires, made from an alloy of 78% Ni, 20% Cr and 2% manganese have shown a durability of 20 hours under the influence of temperatures of about 1150° C. Wires made from the same alloy with a content of about 0.1% Th had a longevity of 65 hours, with a content of about 0.48% Th a durability of 114 hours, and with a content of 2.75% Th one of 132 hours.

It has been found that thorium containing alloys of this kind which contain thorium, that thorium being practically free from carbides, silicides, aluminides, nitrides and oxides, have

an increased and sometimes an extraordinarily increased resistance to the oxygen of the air at high temperatures and in consequence of this advantage are particularly suitable for use as the material from which to make electrically heated resistances and the like.

For the preparation of the alloys according to my invention it has therefore been found useful to utilise thorium metal which is substantially free from carbides, silicides, aluminides, nitrides, oxides, and such like impurities.

The new alloys are preferably made by melting together the constituents of the alloy in the absence of oxygen for example in vacuo using a considerable excess of thorium, for example, an excess of 50 percent of the content of thorium desired in the final alloy.

The above described alloys particularly such as contain about 10–30 percent of chromium, up to 6 percent of thorium, rest nickel and which, as the case may be, might contain in addition small quantities of other metals which do not influence the resistance to scaling and burning deleteriously but which may improve the mechanical properties of the alloy are particularly suitable for the utilisation as material for making electrically heated resistances, apparatus and implements and parts thereof which are subjected to heat. Comparative experiments in which resistances made of alloys containing about 20% chromium and 2 to 5% thorium, the remainder nickel, have been compared with chromium-nickel-alloys of corresponding composition but which are free from thorium have proved that the wires containing thorium used as electrical resistances could be charged about 100° C. higher and that their life when charged to the same high temperatures lasted about 5 times longer than wires made of alloys free from thorium.

At all events nickel shall form the main constituent of the alloy. The content of chromium may vary within wide ranges. The ranges may be 10 or 15 or 20 or 25 or 30% Cr. In all cases a considerable increase of the resistance of the alloys at high temperatures and in the presence of oxygen (air) will be effected by the addition of thorium. As the price of thorium is comparatively high and considerable increases of the effect may be reached already with small or even very small additions it is advantageous to keep the thorium content below 2%, for instance, between 0.05% and 2%. Even contents of thorium which are less than 0.05% have yet a remarkable effect in the alloy as to the increase of resistance against scaling.

In the claims the recitation "the remainder substantially all nickel" designates nickel or nickel and small quantities of other metals, said other metals being present in an amount insufficient to reduce the resistance of the alloy to burning and scaling to any considerable extent.

What I claim is:

1. An alloyed material which is resistant to burning and scaling in the presence of oxygen at temperatures above 1000° C. consisting of 10% to 30% of chromium, thorium in an amount sufficient to increase the resistance of the alloy to burning and scaling in the presence of oxygen, said amount being up to and including 6% of the alloy, and the remainder substantially all nickel.

2. An alloyed material which is resistant to burning and scaling in the presence of oxygen at temperatures above 1000° C. consisting of 10% to 30% of chromium, thorium in an amount sufficient to increase the resistance of the alloy to burning and scaling in the presence of oxygen, said amount being up to and including 2% of the alloy, and the remainder substantially all nickel.

3. An alloyed material which is resistant to burning and scaling in the presence of oxygen at temperatures above 1000° C. consisting of 10% to 30% chromium, .05% to 2% of thorium and the remainder substantially all nickel.

4. An electric resistance element composed of an alloyed material which is resistant to burning and scaling in the presence of oxygen at temperatures above 1000° C. consisting of 10% to 30% of chromium, thorium in an amount sufficient to increase the resistance of the alloy to burning and scaling in the presence of oxygen, said amount being up to and including 6% of the alloy, and the remainder substantially all nickel.

WILLIAM GUERTLER.