UNITED STATES PATENT OFFICE.

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APPARATUS FOR HIGH-TEMPERATURE USES.

1,378,941. Specification of Letters Patent. Patented May 24, 1921.

No Drawing. Application filed August 25, 1919, Serial No. 319,755. Renewed October 4, 1920. Serial No. 414,617.

To all whom it may concern:

Be it known that I, FRANK A. FAHRENWALD, a citizen of the United States, residing at Cleveland Heights, in the county of Cuyahoga and State of Ohio, have invented a certain new and useful Improvement in Apparatus for High-Temperature Uses, of which the following is a full, clear, and exact description.

This invention relates to alloys and has for its especial object the provision of an inexpensive and mechanically strong composition of matter which shall withstand repeated exposure to high temperatures without material oxidation, disintegration or change of shape. A great need exists for such an alloy in the manufacture of heat treating boxes; carbonizing boxes; lead-pots; furnace parts, retorts for the distillation of wood, coal oil and oil bearing shales; containers for the production of calcium cyanamid; doors; chains; links and rabble-arms for metallurgical furnaces; and many other metallurgical and chemical relations. Also such alloys in case they have the requisite hardness are of great value for cutting tools and tools for working hot metal. All the foregoing uses are grouped under the expression "apparatus for high temperature uses."

The essential desiderata of such apparatus are cheapness and availability, coupled with reasonably long life. Containers, boxes, and some other articles have been made from certain alloys of nickel and chromium, and serve very effectually the uses to which they are put but their expensiveness is absolutely prohibitive for most purposes, and the same is true of most other compositions heretofore proposed for such uses. The object of my invention is to secure a sufficiently resistant alloy for most practical purposes with the use of inexpensive ingredients and without requiring expensive processes of manufacturing.

Although special substances may be added for special purposes as hereinafter set forth my improved apparatus is ordinarily made from an alloy containing essentially the following ingredients, (the first column showing the preferred species and the second column the permissible variations):

	Per cent.	Per cent.
Iron	80	(75 –85)
Chromium	15	(10 –20)
Silicon	2.5	(2 – 6)
Carbon	1	(.2– 2)
Manganese	.5	(.5– 1)
Aluminum	.5	(.1– 5)
Titanium	.5	(.2– 1)

The iron constitutes the base of the alloy and gives the necessary cheapness. The chromium affords a large amount of resistance to oxidation at high temperatures together with bringing into solution the remaining ingredients and reducing the embrittling tendency of the silicon. The carbon occurs largely as an impurity, although it has the effect of increasing greatly the hardness when cold and reducing the plasticity when hot while assisting in the casting operation by increasing fluidity when molten. The manganese acts as a scavenger particularly of oxygen and sulfur; the titanium acts as a scavenger of oxygen and nitrogen and also increases the resistance of the alloy to oxidation; the aluminum acts to protect against oxidation and also to harden the alloy.

The addition to the above alloy of from about 1% to about 8% of a tungsten-like metal (by which I mean tungsten or molybdenum) greatly increases the resistance of the alloy against warping. It will be understood that I do not restrict myself to the employment of all these ingredients at one time in any one alloy except as pointed out in the claims hereto annexed. The essential substances are the iron, chromium, silicon and carbon although I ordinarily employ at least one and sometimes two or three of the remaining ingredients because of the minor improvement produced by their specific effect above mentioned.

This alloy is almost non-magnetic and hence is peculiarly available in many electrical devices such as electric and induction

furnaces. It is very strong, both hot and cold, and will withstand a temperature of 1000° C. almost indefinitely.

This alloy can be produced by a great many different processes and owing to the permissible elasticity of its composition extreme care need not be used. The nonferrous elements are combined and employed so as to neutralize each other's baneful physical effects while augmenting each other's chemical effects. The alloy is preferably made by adding ferro-chrome to a bath of molten iron in an electric furnace, and also adjusting the amounts of the minor ingredients depending upon the amounts of the same already present as impurities in the iron and ferro-chrome. It can also be made by melting together the pure materials in an electric or other furnace or by reducing the essential elements from the ore as described and claimed in my Patent No. 1,346,187, issued July 13, 1920, which is my preference.

The articles of use are made therefrom by casting directly. If the silicon be reduced the character of the alloy becomes considerably altered. In all cases sulfur and phosphorus ought to be kept below about .05%.

Having thus described my invention what I claim is:—

1. Apparatus for high temperature uses made from an alloy comprising a large preponderance of iron together with about 10% to 20% of chromium and about 2% to 6% of silicon, combined with smaller amounts of carbon and manganese.

2. Apparatus for high temperature uses made from an alloy comprising a large preponderance of iron together with about 10% to 20% of chromium and about 2% to 6% of silicon, combined with smaller amounts of carbon, manganese, aluminum, and titanium.

3. Apparatus for high temperature uses made from an alloy comprising a large preponderance of iron together with about 10% to 20% of chromium and about 2% to 6% of silicon, combined with smaller amounts of at least two of the substances carbon, manganese, aluminum and titanium.

4. Apparatus for high temperature uses made from an alloy comprising a large preponderance of iron together with about 10% to 20% of chromium and about 1% to 8% of a tungsten-like metal, combined with about 2% to 6% of silicon, a small amount of carbon, and fractional percentages of manganese and titanium.

5. Apparatus for high temperature uses consisting substantially of 75% to 85% of iron, 10% to 20% of chromium, 2% to 6% of silicon, .5% to 1% of each of the metals manganese and titanium, and .2% to 2% of carbon.

In testimony whereof, I hereunto affix my signature.

FRANK A. FAHRENWALD.