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UNITED STATES PATENT OFFICE.

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ALLOY.

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My invention relates to alloys and has for its object the provision of an alloy which is heat resisting or capable of withstanding high temperatures without excessive oxidation.

More specifically my invention relates to alloys which may be cast to form various articles required to withstand high temperatures, such as annealing boxes, furnace structures, etc., and also to electric resistance heating alloys.

I have found that an alloy having an iron base and containing from 25 to 40 percent of nickel, 7 to 9 percent of aluminum, and 7 to 15 percent of chromium forms a very satisfactory material for castings required to withstand high temperatures. About 1 percent each of a suitable purifying and grain refining material, such as titanium, manganese, or both, may and preferably is added for the purpose of improving the physical characteristics of the alloy, although this is not absolutely necessary. The alloy may not and preferably will not contain the percentage of purifying and grain refining material added to the mixture since all or a large portion of it may go off with the slag. Preferably, I use 30 percent of nickel, 8 percent of aluminum, and 10 percent of chromium, the remainder consisting substantially of iron.

An alloy made up of the various metals in the percentage ranges given is extremely tough and is very readily cast. It may be machined and hence is particularly suitable for castings requiring machining. The alloy may also be forged, rolled or drawn into wire. Its drawing properties are improved by the addition of the manganese, and preferably a small amount of the manganese should remain in the alloy. It has a resistance of approximately 850 ohms per mil. foot and a low temperature coefficient of resistance so that it is particularly adapted for use as an electrical resistance heating element. The alloy shows very little oxidation when run for long periods at temperatures above 1000 degrees C.

The metal forming the base of the alloy may be ordinary low carbon steel or even commercial iron. A steel containing .02 percent or less of carbon, .04 percent or less of sulphur, .03 percent or less of phosphorus, and .15 percent of silicon is satisfactory for my purpose.

In making the alloy it is preferable to use an electric furnace since it lends itself more readily to the controlling of the alloy. The furnace should preferably have a basic lining since if an acid lining were used a certain amount of silicon in the lining would be reduced by the aluminum and enter into the alloy. Even a small percentage of silicon in the alloy would be objectionable. When the aluminum is not added in the furnace but is added in the ladle the basic lining becomes less important.

The iron and nickel and chromium are melted in the furnace and then tapped on to the aluminum which has been preheated to a molten condition in the ladle. The titanium and manganese are also added in the furnace. Care should be taken to have the iron nickel chromium mixture thoroughly deoxidized before adding it to the aluminum. It is preferable to have the carbon as low as possible and in case the material used runs a little higher than approximately .01 percent of carbon, the carbon should be reduced in the furnace before making the alloy. This applies also to the elements phosphorus and sulphur. None of the furnace slag should be allowed to come into contact with the alloy after the aluminum has been added. The molten aluminum and also the alloy after the addition of the aluminum should be kept covered with a special slag of cryolite or a cryolite lime mixture to protect it from oxidation. Cryolite is used because of its solubility for aluminum oxide. Care should be taken to have the metal in the furnace just hot enough to pour cleanly from the ladle. The cooler it is when cast the better the grain obtained.

When casting the alloy every precaution should be taken to prevent oxidation. This may be done by filling the molds beforehand with a non-oxidizing gas, such as nitrogen or carbon dioxide, or by dusting the molds lightly but thoroughly with cryolite to dissolve the oxide film formed between the ladle and the mold. This prevents the formation of cold shuts and subsequent cracks due to them. The cryolite method is preferred to the gas method.

While I have described a specific embodi-

ment of my invention in accordance with the provisions of the patent statutes, it should be understood that I do not limit my invention thereto, since various modifications thereof will suggest themselves to those skilled in the art without departing from the spirit of my invention, the scope of which is set forth in the annexed claims.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. A heat resisting alloy containing from 40 to 60% iron, 25% or more of nickel and smaller amounts but at least 7% each of aluminum and chromium.

2. A heat resisting alloy having an iron base and containing from 25 to 40% of nickel, from 7 to 9% of aluminum and from 7 to 15% of chromium.

3. A heat resisting alloy containing 50% or more of iron, 25% or more of nickel and 7% or more each of aluminum and chromium.

4. A heat resisting alloy having an iron base and containing approximately 30% of nickel, 8% of aluminum and 10% of chromium.

5. A heat resisting alloy having an iron base and containing, approximately 30% of nickel, 8% of aluminum, 10% chromium, and 1% of titanium.

6. A heat resisting alloy having an iron base and containing, approximately 30% of nickel, 8% of aluminum, 10% of chromium, 1% of titanium, and 1% of manganese.

In witness whereof, I have hereunto set my hand this 6th day of June, 1923.

WILLIAM E. RUDER.