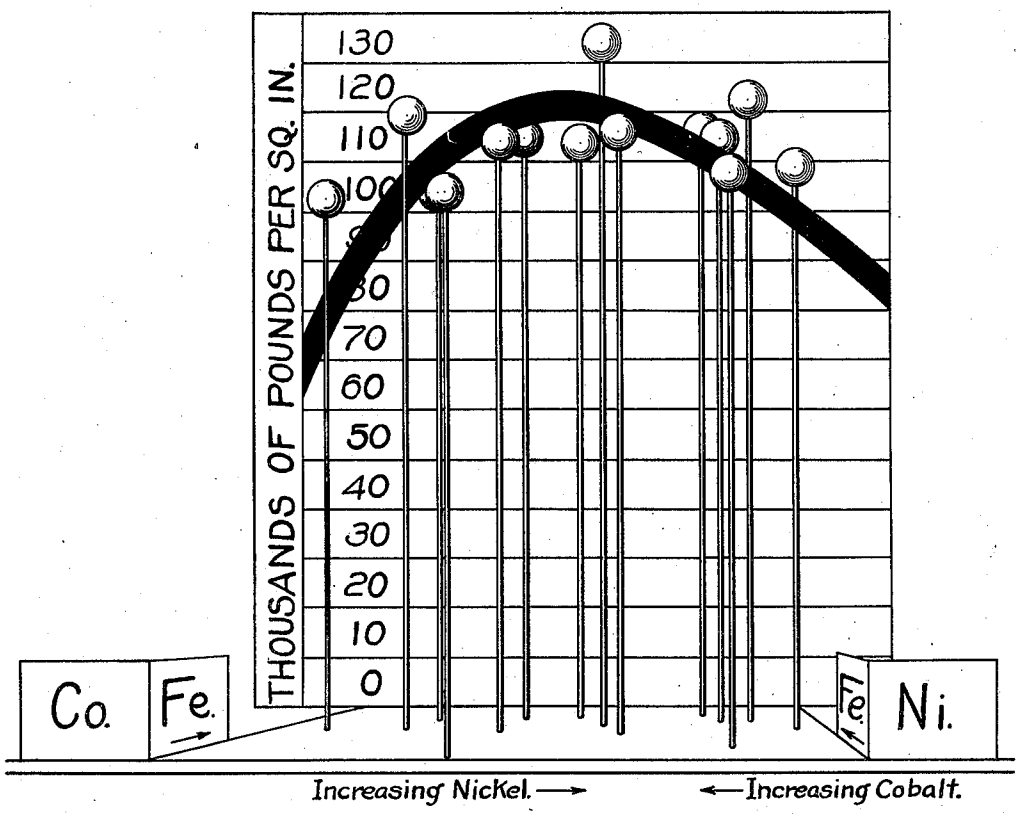
June 21, 1938. E. F. LOWRY 2,121,759

ALLOY

Original Filed Oct. 30, 1929



WITNESSES:

R. J. Fitzgerald

Ann. C. Groome

INVENTOR

Erwin F. Lowry.

BY

Ezra W. Sawyer

ATTORNEY

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ALLOY

Erwin F. Lowry, Forest Hills, Pa., assignor to Westinghouse Electric & Manufacturing Company, a corporation of Pennsylvania

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4 Claims. (Cl. 75—170)

The invention relates generally to improvements in cobalt, nickel alloys and the process of making them, and is a division of my copending application Serial No. 403,664, filed October 30, 1929.

An object of the invention is to provide an alloy possessing the properties of high tensile strength and high proportional (elastic) limit at high temperatures.

Another object of the invention is the provision of an alloy having high ohmic resistance and capacity to resist oxidation at high temperatures.

It is also an object of the invention to provide an alloy which is ductile and which may be readily forged.

Other objects of the invention will in part be obvious and in part appear hereinafter.

The invention accordingly comprises the several steps and the relation and order of one or more of such steps with respect to each of the others, and the product possessing the features, properties, and the relation of constituents, which are exemplified in the following detailed disclosure, and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawing, in which the single figure shows a curve which gives the desired strength of the alloy for different proportions of the ingredients.

The alloy is a cobalt nickel base alloy comprising cobalt and nickel with the addition of some iron and one or more of the following titanium, tungsten, manganese, vanadium or molybdenum. The amounts of the ingredients added will be given in detail hereinafter.

Alloys have been made containing an aggregate of 70% to 95% nickel and cobalt. In these alloys desirable results were obtained with 95 to 5% nickel and from 5% to 95% cobalt, the remainder being iron and one or more of the following titanium, tungsten, manganese, vanadium and molybdenum.

While the proportions of the ingredients specified hereinbefore have been found satisfactory, a very desirable alloy has been made with the cobalt in excess of the nickel. A suitable range is nickel from slightly below 40% to 10% and cobalt 40% to 85% plus iron and one or more of the following titanium, tungsten, manganese, vanadium or molybdenum. An example of a suitable mixture which has been prepared is as follows:

	Per cent
Cobalt	69.2
Nickel	13.2
Iron	14.4
Titanium	2.5
Aluminum, manganese, silicon	.7

In making the alloy the cobalt and nickel are first melted together in some suitable furnace in a reducing or inert atmosphere. An electric furnace has been found to be satisfactory for melting the ingredients of the alloy. After the cobalt and nickel have been melted the iron and additional ingredients are added. In adding the iron, care should be exercised to prevent oxygen in an appreciable volume from entering the furnace.

In preparing the alloy it is good practice to add a small amount of a deoxidizer such as aluminum or magnesium to remove contained oxygen. The deoxidizer may be introduced in any suitable manner such for example as by applying it to a silica rod and plunging it into the molten metals.

On the completion of these operations the molten alloy may be cast in permanent molds. In order to prevent oxidation of the alloy, the molds may be coated with a heavy oil.

It has been found good practice to pour the alloy rapidly into the molds after the temperature has been somewhat lowered from that to which it has been heated to obtain good alloying. This method of introducing the metal into the molds gives a smooth surface to the ingots which is highly desirable.

The ingot thus prepared may be forged into bars of any predetermined size depending on the purposes for which the alloy is to be utilized. Generally, in the primary forging operation the ingot should be heated but the temperature should not exceed 1100° C. In some instances, to meet predetermined conditions in forging operations, the temperature may be raised a little higher, for example to 1150° C.

In order to make wires from the ingot it may be forged into bars of square cross section of ½" dimension. These bars may be readily rolled at a temperature of from 700° C. to 800° C. into bars having a cross-sectional area of ¼" x ¼". These bars may be subsequently cold rolled and swaged with frequent annealing at temperatures of 800° C. to 900° C. into wires having some predetermined diameter. The annealing should be carried out in a reducing or an inert

atmosphere such as hydrogen or nitrogen to prevent the formation of an oxide coating on the surface which would become embedded in the alloy during the rolling operations.

After a wire of say 50 mils diameter has been made, it may be drawn down to any other required diameter by drawing it through diamond dies. If it is drawn through a number of dies, it may be necessary to anneal the wire during the drawing procedure. Wires made from this alloy have a high ohmic resistance which adapts them for the making of filaments for thermionic tubes and the like.

In view of the strength which this alloy evidences at high temperatures, it may be used for many purposes in thermionic devices. It lends itself very well to the manufacture of thermionic tubes which are provided with a filament having an oxide coat. This alloy will receive the oxide coat and has the strength that is desired at high temperatures.

Another important advantage of this type of alloy for the making of filaments for thermionic tubes is that when subjected to heating temperatures in the neighborhood of 1000° C. they have, when subjected to stresses, stood an elongation amounting to as much as 10% to 12% of their length before breaking. This makes unnecessary elaborate compensating devices to provide for changes in size of the filament. The following table gives the physical characteristics of a representative alloy containing 58.6% cobalt, 20.6% nickel, 17.4% iron and 2.5% titanium and balance aluminum, manganese and silicon.

	Temperatures	
	24° C.	600° C.
Proportional limit (lbs. per square inch)	70000	42500
Yield point lbs. sq. inch (plastic strain)	103000	78000
Ultimate tensile strength (lbs. per square inch)	149500	119000
Per cent elongation in 2"	21.5	9.6
Per cent reduction of area	49.3	13.6

While I have described my invention in considerable detail and given numerous illustrations, it is to be understood that the preferred embodiments described in detail should be construed as illustrative and not in a limiting sense, since numerous modifications may be made without departing from the spirit and scope of my invention, and it is desired that the claims be not interpreted in a limiting sense.

I claim as my invention:

1. A cobalt-nickel base alloy consisting of 40% to 85% cobalt and 40% to 10% nickel aggregating from 80% to 95% of the alloy and 20% to 5% iron and titanium, the titanium ranging from about 1% to 10% of the alloy, the alloy having high tensile strength at high temperatures.

2. A cobalt-nickel alloy consisting of approximately 58.6% cobalt, 20.6% nickel, 17.4% iron and 2.5% titanium plus .9% impurities.

3. A cobalt-nickel base alloy consisting of cobalt and nickel in the aggregate amount of 80% to 95% by weight of the alloy, the cobalt ranging from 45% to 85% by weight and from 20% to 5% by weight iron and one of the following, titanium, manganese or vanadium, the metal selected from the group being from 1% to 10% of the alloy.

4. A cobalt-nickel base alloy consisting of cobalt and nickel in the aggregate amount of 80% to 90% of the alloy, the cobalt ranging from 40% to 75% and the nickel 15% to 40% and the balance being 20% to 5% iron and one or more of titanium, manganese, vanadium, the metal or metals other than iron ranging from about 5% to 1% of the whole alloy.

ERWIN F. LOWRY.