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ALLOY FOR PERMANENT MAGNETS

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6 Claims. (Cl. 75—123)

This application forms a continuation in part of my copending application Ser. No. 735,898 filed July 18, 1934 and also of the parent application Ser. No. 697,874, filed November 13, 1933, both pending.

This invention relates to improvements in alloys for permanent magnets and more particularly to an alloy consisting mainly of nickel, titanium, cobalt and iron, and has for its object to provide a permanent magnet which has a very high coercive force and long durability.

Heretofore commonly used magnet steels such as tungsten steel, chrome steel and the like have comparatively small coercive force of only 60 to 70 gausses and if such alloy steels are used as a permanent magnet they lack durability and are especially unsuitable for a magnet of smaller dimension-ratio, that is, having a small ratio of the length and diameter. Moreover, such alloy steels are greatly affected by temperature variations and mechanical shocks and show unstable magnetic properties.

This invention is to obviate the above mentioned defects and to provide an alloy which is well adapted for a permanent magnet of a smaller dimension-ratio, and possesses stable magnetic properties for temperature changes and mechanical shocks and has particularly high coercive force.

The alloy of this invention can be obtained by melting together nickel, titanium, cobalt and iron in the proportion of 3 to 19.9% nickel, 3 to 10% titanium, 0.5 to 60% cobalt and the remainder iron and a small amount of impurities. The preferred composition of the alloy may be of 5 to 19.9% nickel, 5 to 10% titanium, 3 to 35% cobalt and the remainder iron. The molten product may be cast in a suitable mold or sucked up into a tube of refractory material to give a desired shape. The cast products are preferably annealed at a suitable temperature such as 500° to 800° C. to give it stability.

As above described, though the alloy of this invention may be obtained by melting together iron, nickel, cobalt and titanium at a proper proportion, yet it is more convenient in practice to use iron or mild steel, nickel, cobalt and ferro-titanium.

As for example, the following alloy of this invention shows magnetic properties as follows:—

Nickel	16.5%
Titanium	7.4%
Cobalt	9.0%
Iron and impurities	Remainder
Residual magnetic induction (gausses)	6500
Coercive force (gausses)	310

Such magnetic properties are obtained by casting the alloy and afterwards annealing it at about 670° C. for two hours. It will be recognized that the above alloy shows particularly high coercive force.

The alloys of the present invention may also contain manganese, molybdenum, arsenic, vanadium, copper and aluminium in the proportion of less than 6% each for a further increase of the residual magnetic induction and the coercive force.

Accordingly the alloy of this invention is well adapted for the material of permanent magnets in general and more especially of smaller dimension-ratio and it has very stable structure at a temperature below about 700° C. and its magnetic properties are not substantially affected by the change of temperatures and thus it is most suitable for the material of permanent magnets for fine instruments and also for heat resisting permanent magnets.

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

1. A permanent magnet formed of an alloy consisting of 3 to 19.9% nickel, 3 to 10% titanium, .5 to 60% cobalt, molybdenum in an amount less than 6%, and the remainder iron formed by casting the alloy to a desired shape and then annealing it at a temperature of from 500° C. to 800° C, to increase the coercive force thereof to the neighborhood of 250 gausses or more.

2. A permanent magnet of very high coercive force and long durability formed of an alloy containing 3 to 19.9% nickel, 3 to 10% titanium, .5–60% cobalt, molybdenum in an amount less than 6%, and the remainder iron and a small amount of impurities, characterized by a coercive force in the neighborhood of 250 gausses or more.

3. A permanent magnet of very high coercive force and long durability formed of an alloy containing 5 to 19.9% of nickel, 5 to 10% of titanium, 3 to 35% of cobalt, molybdenum in an amount less than 6%, and the remainder iron and a small amount of impurities, characterized by a coercive force in the neighborhood of 250 gausses or more.

4. A permanent magnet having a small ratio of length to diameter formed of an alloy containing as essential ingredients 3 to 19.9% of nickel, 3 to 10% of titanium, 0.5 to 60% of cobalt, molybdenum in an amount less than 6%, and the remainder iron and a small amount of impurities, characterized by a coercive force in the neighborhood of 250 gausses or more, long durability and magnetic stability with respect to temperature changes and mechanical shocks.

5. A permanent magnet having a small ratio of length to diameter formed of an alloy containing as essential ingredients 5 to 19.9% of nickel, 5 to 10% of titanium, 3 to 35% of cobalt, molybdenum in an amount less than 6%, and the remainder iron and a small amount of im-

purities characterized by a coercive force in the neighborhood of 250 gausses or more, long durability and magnetic stability with respect to temperature changes and mechanical shocks.

6. A permanent magnet formed of an alloy containing as essential ingredients about 16.5% of nickel, about 7.4% of titanium and about 9% cobalt, molybdenum in an amount less than 6%, and the remainder iron and a small amount of impurities characterized by a coercive force of about 310 gausses.

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