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ALLOY OF NICKEL, TITANIUM, COBALT, IRON, AND ALUMINUM FOR PERMANENT MAGNETS

Kotaro Honda, Sendai, Japan

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8 Claims. (Cl. 75—124)

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

This forms a division from application Ser. No. 735,898, filed July 18, 1934, and also from the parent application Ser. No. 697,874, filed Nov. 13, 1933, both pending.

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, aluminum and iron in the proportion of 3 to 50% nickel, 8.1 to 50% titanium, less than 60% cobalt, .1 to 20% aluminum, and the remainder substantially iron. The preferred composition of the alloy may be of 10.1 to 30% nickel, 8.1 to 40% titanium, less than 50%, cobalt, 2 to 10% aluminum 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 product is 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, titanium and aluminum at a proper proportion, yet it is more convenient in practice to use iron or mild steel, nickel, cobalt, aluminum and ferro-titanium.

As for example, the following two alloys of this invention show magnetic properties as follows:

Nickel	11%	16%
Titanium	10%	11%
Cobalt	20%	28%
Iron	Remainder	Remainder
Residual magnetic induction (gausses)	9000	7500
Coercive force (gausses)	250	830

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

The alloys of the present invention may also contain aluminum in the proportion of less than 20% 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 for 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.

I claim:

1. An alloy containing about 10.1% to 40% nickel, 8.1% to 40% titanium, .01% to 50% cobalt, .1% to 20% aluminum, and at least 20% iron and a small amount of impurities, characterized by a coercive force of about 250 gausses or more.

2. An alloy containing about 3% to 50% nickel, 8.1% to 50% titanium, .1% to 50% cobalt, .1% to 20% aluminum, and at least 20% substantially iron, characterized by a coercive force of about 250 gausses or more.

3. An alloy containing about 11% nickel, 10% titanium, 20% cobalt, .1% to 20% aluminum, and the remainder iron and a small amount of impurities, characterized by a coercive force of about 250 gausses or more.

4. An alloy containing about 16% nickel, 11% titanium, 28% cobalt, .1% to 20% aluminum, and the remainder iron and a small amount of im-

purities, characterized by a coercive force of about 830 gausses or more.

5. A permanent magnet formed of an alloy containing 10.1% to 40% nickel, 8.1% to 40% titanium, 0.01% to 50% cobalt, .1% to 20% aluminum and at least 20% iron and a small amount of impurities.

6. A permanent magnet formed of an alloy containing 3% to 50% nickel, 8.1% to 50% titanium, .1% to 50% cobalt, .1% to 20% aluminum and at least 20% iron and a small amount of impurities.

7. A permanent magnet formed of an alloy containing about 11% nickel, 10% titanium, 20% cobalt, .1% to 20% aluminum, and the remainder iron and a small amount of impurities, characterized by a coercive force of about 250 gausses or more.

8. A permanent magnet formed of an alloy containing about 16% nickel, 11% titanium, 28% cobalt, .1% to 20% aluminum, and the remainder iron and a small amount of impurities, characterized by a coercive force of about 830 gausses or more.

KOTARO HONDA.