Patented Sept. 9, 1947

2,427,018

UNITED STATES PATENT OFFICE

2,427,018

PERMANENT MAGNET MATERIALS

Ethan A. Nesbitt, Chatham, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

No Drawing. Application January 15, 1944, Serial No. 518,409

4 Claims. (Cl. 175—21)

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This invention relates to permanent magnets and especially permanent magnets comprising a small range of the alloy of iron and molybdenum in which 1 to 4 per cent of vanadium is included.

It has been found that alloys of iron and molybdenum containing around 75 to 86 parts iron and 13 to 24 parts molybdenum may have their permanent magnet properties substantially increased by inclusion in the alloy composition of 1 to 4 per cent vanadium. With a given heat treatment applied to such compositions not containing vanadium and to those containing vanadium, it has been found that the residual induction of the composition is somewhat increased and the coercive force increased by a somewhat greater percentage with the result that the maximum energy product which is related to the product of residual induction and coercive force is increased from 40 to 75 per cent, a result which is unexpected and not predictable upon the basis of prior knowledge. Maximum energy product is defined as the product of B and H at the most efficient operating point of a permanent magnet and is herein expressed as multiplied by 10^{-6} to give a more convenient figure in accordance with a practice commonly employed.

Compositions in accordance with the invention may be prepared by alloying together 75 to 86 parts iron, 1 to 4 parts vanadium and sufficient molybdenum to make up 100 parts or, in general, from 13 to 24 parts of molybdenum, depending upon the amount of iron and the amount of vanadium included. After alloying such compositions they may be heat treated to 1300° C. for 1 hour or more, then quenched in oil, raised to a temperature of around 675° C. and maintained thereat for approximately an hour and cooled at any desired rate. As a result of this treatment, the desired permanent magnet properties are manifested and suitably shaped specimens adapted for use as permanent magnets may be magnetized and used in any usual manner for any purpose for which permanent magnets are employed. Typical compositions are 21 parts molybdenum, 78, 77, 76 and 75 parts respectively, of iron, and 1, 2, 3 or 4 parts respectively, of vanadium.

In a specific instance a composition containing 79 parts iron and 21 parts molybdenum when heat treated in the manner described possessed a residual induction after saturation of 6350, a coercive force of 188 and a maximum energy product of .45.

When 2 per cent vanadium was used to replace 2 per cent of the iron, residual induction was 8200, the coercive force 240 and the maximum energy product .8. When 4 parts vanidium were added to a similar composition of iron and molybdenum and given a similar heat treatment,

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the residual induction was 7200, the coercive force 240 and the maximum energy product .6.

The indications are that whereas both the residual induction and the coercive force are increased by the presence of vanadium in the compositions within the ranges of the proportions indicated perhaps both of them do not always reach a maximum at the same proportions of constituents. In the case of alloys composed of 79 parts of iron and 21 parts of molybdenum compared with alloys in which 1, 2, 3 and 4 parts respectively of iron are replaced by vanadium, for example, it was found that the residual induction reached a maximum at 2 per cent vanadium, whereas the coercive force was higher at 3 per cent vanadium than at 2 per cent vanadium. These values were higher at both 2 and 3 per cent vanadium than they were at 1 percent vanadium or 4 per cent vanadium and were both substantially higher than they were when no vanadium at all was included in the composition.

What is claimed is:

1. A permanent magnet comprising a magnetized body composed of an alloy of 75 to 86 per cent iron and the balance molybdenum and vanadium of which the molybdenum consists of 13 to 24 per cent of the total and the vanadium consists of 1 to 4 per cent of the total.

2. A permanent magnet consisting of a strongly magnetized body consisting of an alloy of within 1 per cent of 77 per cent iron, within 1 per cent of 21 percent molybdenum and within 1 per cent of 2 per cent vanadium.

3. A permanent magnet consisting of a strongly magnetized body consisting of an alloy of within 1 per cent of 75 per cent iron, within 1 per cent of 21 per cent molybdenum and within 1 per cent of 4 per cent vanadium.

4. A permanent magnet consisting of a strongly magnetized body consisting of an alloy of 75 to 78 parts iron, 20 to 22 parts molybdenum and 1 to 4 parts vanadium.

ETHAN A. NESBITT.

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