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SIZING OF FINE PARTICLE FERROMAGNETIC MATERIALS

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ABSTRACT OF THE DISCLOSURE

Fine particle ferromagnetic materials have a tendency to form clusters or clumps of strongly adherent aggregates which prevent effective screening or sieving. It has been found that if the screening or sieving is done in the presence of either a constant polarity magnetic field or a magnetic field the polarity of which is cyclically reversed or alternated, that this problem is eliminated or substantially so.

The invention described herein was made in the course of or under a contract with the Department of Defense.

BACKGROUND OF THE INVENTION

The present invention relates generally to the art of making magnets and is more particularly concerned with processing powders of magnetic alloys for use in the manufacture of such magnets.

It is generally recognized that the permanent magnet properties of bulk magnetic materials having large crystalline anisotropies can be enhanced by reducing them to powder form. It is also known that such powders can be aligned in a bonding medium by an applied magnetic field to produce a composite permanent magnet body having superior properties in the alignment direction. In general, the smaller particles of a given powdered magnetic material have better permanent magnet properties, such as coercive force, than do larger particles of the same material. However, certain magnetic materials such as the alloys having the composition Co_5R where R is a metal selected from the group of yttrium, thorium and the lanthanide series of the rare earths or combinations of these elements, excessive grinding can cause a decline in magnetic propertes such as coercive force in the smaller particle size ranges. Futhermore, the strongly magnetic small particles tend to become strongly agglomerated into aggregates or clumps which are much larger than the individual particles, making effective sizing by conventional screening or sieving operations difficult if not impossible, even with agitation of the particles and agglomerated particles on the sizing screen.

It would be desirable to provide a method for improving the yield of small particles from the screening of such materials, and this is a principal object of this invention. Other and specifically different objects of the invention will become apparent to those skilled in the art from the following detailed disclosure.

Briefly stated, and in accordance with one aspect of the invention, it has been found that the screen sizing of fine particle magnetic materials may be markedly improved by the application of a relatively small but effective magnetic field across the surface of a screen bearing such particulate material, particularly if the particles are simultaneously mechanically agitated.

More specifically, and as an example of the invention, a quantity of Co_5Sm, a very brittle material as are the other Co_5R intermetallic compounds, was ground to a powder in a mortar and pestle. The powder was then brushed through a 100 mesh sizing screen. The −100 mesh material was then brushed with a nylon brush on a

170 mesh sizing screen for two minutes, yielding 138.7 milligrams of −100, +170 mesh material. At the end of the two minute brushing period, substantially no more material was passing through the screen. Upon microscopic examination of the material retained upon the screen, it was observed that a substantial portion thereof was composed of agglomerated clumps of small particles strongly adhered together. A strong permanent magnet was then placed near the exit side of the screen, producing a magnetic field about the −100, +170 mesh material retained on the screen and the material was brushed for a few minutes until no further material passed through the screen. After this treatment, the material retained by the 170 mesh screen was weighed and found to be 40.5 milligrams. The magnetic coercive force of these materials is known to increase with decreasing particle size. The coercive force of the −100, +170 mesh material after brushing without the magnetic field was determined to be 2370 oersteds and after brushing in the magnetic field was 540 oersteds. The magnetic sieving was continued with 250 and 325 mesh screens and the results are summarized in the following table.

Weight of original brushed +170 mesh material was 138.7 mg. This material had a coercive force (H_c) of 2370 oersteds.

Sieve	Microns	Weight (mg.)	Hc, oersteds
+170	+88	40.5	540
−170 +250	−88 +61	30.5	900
−250 +325	−61 +43	14.7	1,735
−325	−43	46.8	7,500
Loss		6.2	
		138.7	

A similar quantity of powdered Co_5Sm was placed on a 325 mesh sieve and brushed with a nylon brush for a period of time until there was substantially no more material passing through the screen. The amount of −325 mesh material was found to be 3.2 milligrams. This material was returned to the top of the screen and mixed with the +325 mesh material retained thereon. The material was subjected to a 60 cycle alternating current magnetic field from a solenoid placed beneath the screen and the material brushed as before while under the influence of the alternating magnetic field. The amount of the material passing the screen under these conditions was 19.4 milligrams. This −325 mesh fraction was returned to the top of the screen and the separation was repeated without the magnetic field in an attempt to duplicate the original result. This time the amount of −325 mesh powder was 3.5 milligrams, an amount in reasonable agreement with the first separation without the field.

From all the foregoing, it will be apparent that the sizing of small particles of permanent magnet materials of the type disclosed is greatly facilitated by the application of a magnetic field during the screening operation. Furthermore, the invention enables the selective sizing of particular particle size ranges. For example, if it be desired to produce particle sizes in the range of −250 +325 mesh, such a size range is more effectively achieved by means of the subject invention. Yet further, the invention is applicable to other fine particle ferromagnetic materials which may or may not be considered as "hard" magnetic materials. Additionally, by combining the grinding operations with alternate sieving operations the application of a magnetic field as taught by this invention permits the ready removal of the smaller particles as they are produced and minimizes undesirable excessive grinding which, as previously pointed out, may cause a decline in magnetic properties in some materials. While certain specific embodiments of the invention have been disclosed

as examples, it is not intended to limit the invention except as set forth in the appended claims.

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

1. A method for producing sized fine particles of ferromagnetic material comprising the steps of grinding a quantity of said ferromagnetic material into fine discrete particles, placing said particles on the surface of a sizing screen, exposing said particles to a magnetic field and simultaneously agitating said particles.

2. The method recited in claim 1 wherein said magnetic field is of a constant polarity.

3. The method recited in claim 1 wherein said magnetic field is cyclically reversed.

4. The method recited in claim 1 wherein the particles which fail to pass said sizing screen are reground and rescreened under the influence of the magnetic field and agitation as aforesaid.

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