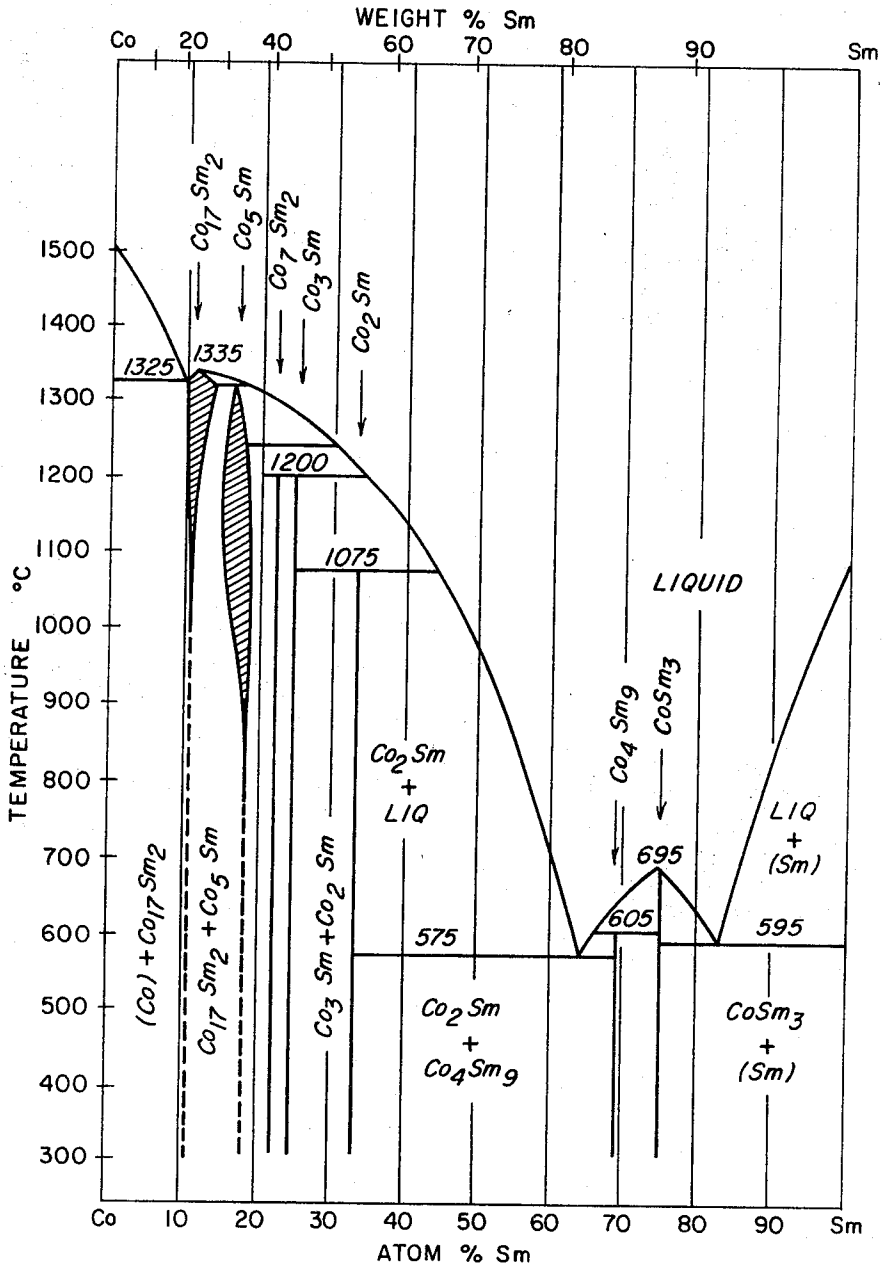
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SINTERED INTERMETALLIC PRODUCT OF COBALT, SAMARIUM AND CERIUM MISCHMETAL AND PERMANENT MAGNETS PRODUCED THEREFROM

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SINTERED INTERMETALLIC PRODUCT OF COBALT, SAMARIUM AND CERIUM MISCHMETAL AND PERMANENT MAGNETS PRODUCED THEREFROM

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ABSTRACT OF THE DISCLOSURE

Novel sintered cobalt-rare earth intermetallic products are used to form permanent magnets having unique properties. The sintered product is comprised of intermetallic compounds of cobalt and rare earth metals composed of samarium and cerium mischmetal. Cobalt is present in an amount of about 61 to 66 percent by weight of the product and the rare earth metals are present in an amount of about 34 to 39 percent by weight of the product with the cerium mischmetal component ranging in amount from about 10 to 90 percent by weight of the rare earth content. Permanent magnets are formed from the sintered product in bulk form or in particulate form.

The present invention relates generally to the art of permanent magnets and is more particularly concerned with novel sintered cobalt-samarium-cerium mischmetal intermetallic products having unique characteristics and with permanent magnets formed therefrom.

Permanent magnets, i.e. "hard" magnetic materials such as the cobalt-rare earth intermetallic compounds, are of technological importance because they can maintain a high, constant magnetic flux in the absence of an exciting magnetic field or electrical current to bring about such a field.

Cobalt-rare earth intermetallic compounds exist in a variety of phases. The permanent magnet properties of cobalt-rare earth intermetallic magnetic materials generally can be enhanced by reducing the bulk bodies to powders, but in such finely-divided form these materials are unstable in air and their magnetic properties deteriorate after a short period of time.

One object of the present invention is to provide novel cobalt-rare earth intermetallic magnets which are stable. The cobalt-rare earth intermetallic materials of the present invention are comprised of cobalt, samarium and cerium mischmetal of a specific composition.

Those skilled in the art will gain a further and better understanding of the present invention from the detailed description set forth below, considered in conjunction with the figures accompanying and forming a part of the specification, in which:

The accompanying figure is the cobalt-samarium phase diagram. It is assumed herein that the phase diagram at 300° C., which is the lowest temperature shown in the figure, is substantially the same at room temperatures.

Briefly stated, the sintered product of the present invention is comprised of intermetallic compounds of cobalt and rare earth metals composed of samarium and cerium mischmetal. Cobalt is present in an amount of about 61 to 66 percent by weight of the product and the rare earth metals are present in an amount of about 34 to 39 percent by weight of the product with the cerium mischmetal component ranging in amount from about 10 to 90 percent by weight of the rare earth content. Permanent magnets are formed from the sintered product in bulk or in particulate form.

Cerium mischmetal is an abundant naturally occurring alloy available commercially and generally having a composition comprised of 53 percent cerium, 16 percent neodymium, 5 percent praseodymium, 2 percent gadolinium and 24 percent lanthanum with traces of other rare earth elements present. It is understood that the specific amounts of these components may vary somewhat but generally are within 10 percent of the amount given here for each component.

The sintered product of the present invention may be produced in a variety of different ways but we prefer to use substantially the process disclosed and claimed in copending U.S. patent application Ser. No. 33,347, entitled "Liquid Sintered Cobalt-Rare Earth Intermetallic Product," filed on Apr. 30, 1970 in the name of Mark G. Benz, and assigned to the assignee hereof, and which by reference is made part of the disclosure of the present application. Briefly stated, the process of U.S. patent application Ser. No. 33,347 comprises the steps of forming a particulate mixture of a base cobalt-rare earth alloy and additive cobalt-rare earth alloy. The base alloy is one which at sintering temperature exists as a solid Co_5R intermetallic single phase where R is a rare earth metal. The additive cobalt-rare earth alloy is richer in rare earth metal than the base alloy, and at sintering temperature it is at least partly in liquid form and thus increases the sintering rate. The mixture is compacted to produce a green body which is sintered to the desired density and phase composition. The final sintered product contains a major amount of the Co_5R intermetallic phase and up to about 35 percent by weight of the product of a second solid CoR intermetallic phase which is richer in rare earth content than the Co_5R phase.

The sintered product of our invention is also suitably produced by using substantially the process disclosed and claimed in copending U.S. patent application Ser. No. 33,348 entitled "Sintered Cobalt-Rare Earth Intermetallic Product And Process Using Solid Sintering Additive," filed on Apr. 30, 1970 in the name of Mark G. Benz and assigned to the assignee hereof, and which by reference is made part of a disclosure of the present application.

The procedure for forming sintered products disclosed in U.S. patent application Ser. No. 33,348 is substantially the same as that disclosed in U.S. patent application Ser. No. 33,347 except that an additive CoR alloy which is solid at sintering temperature and which is richer in rare earth metal than the base alloy is used.

As applied to the preparation of the new products of the present invention, the process is carried out with a base alloy which is solid at sintering temperature and which at sintering temperature is comprised substantially or completely of Co_5R intermetallic phase where R is samarium, cerium mischmetal or preferably, a mixture of samarium and cerium mischmetal. Generally, the present base alloy is comprised of about 65 to 70 percent by weight cobalt and about 30 to 35 percent by weight rare earth metal or metals. Although the base alloy may vary in composition, it should have a composition which together with the sintering additive, produces the claimed composition of the present sintered product.

The present sintering additive is a cobalt-rare earth metal alloy which is richer in rare earth metal content than the base alloy. Preferably, it is also one that exists at least partly in a liquid form at sintering temperature, but it can be a solid. Representative of the present sintering additives are alloys of cobalt-samarium, cobalt-cerium, cobalt-samarium-cerium, cobalt-samarium-cerium mischmetal, cobalt-cerium mischmetal and cobalt-lanthanum.

The sintering additive alloy may vary in composition and can be determined from the phase diagram for the particular cobalt-rare earth system or it can be determined empirically. When liquid phase sintering is desired, the accompanying figure shows that for the cobalt-samarium system, for example, there are phases which are part-

ly or completely liquid at the temperature ranging from about 950 to 1200° C. Any alloy within the range shown in the accompanying figure which forms at least a partly liquid phase at the particular sintering temperature would be a satisfactory sintering additive. For example, as illustrated in the figure, the Co-Sm additive alloy can vary upward in samarium content from about 46 percent by weight of the additive.

When a sintering additive which is solid at sintering temperature is desired, it also may vary in composition and can be determined from the phase diagram for the particular cobalt-rare earth system or which can be determined empirically. For example, the accompanying figure shows that for the cobalt-samarium system, there is a solid phase containing samarium in an amount greater than about 36 percent by weight at a temperature ranging from 950 to 1200° C. Specifically, from a temperature of 950 to 1075° C., the solid additive alloy for the cobalt-samarium system ranges in samarium content from about 36 to about 55 percent by weight of the additive, and at temperatures ranging from 950 to 1200° C., the solid additive alloy may range in samarium content from about 36 percent to about 45 percent by weight of the additive. Any additive alloy within these ranges would be a satisfactory sintering additive alloy.

If desired, the solid sintering additive can be empirically selected by a number of methods, such as by means of a composition scan at the sintering temperature, i.e. heating samples of various additive alloy compositions to the desired sintering temperature to determine which is solid and which is at least partly liquid at sintering temperatures.

Although suitable sintering additive alloys fall within a general composition range, the preferred ones are comparatively low in rare earth metal content so that undesirable characteristics of the pure rare earth metal in the additive alloy are minimized. Specifically, for example, pure samarium is both pyrophoric and very ductile and consequently difficult to crush and to blend with the base alloy since it has a tendency to separate out and fall to the bottom of the container. However, a sintering additive Co-Sm alloy of samarium content preferably less than 70 percent by weight is substantially non-reactive at room temperature in air, it can be crushed by conventional techniques, and being slightly magnetic, it clings to the base alloy resulting in a substantially thorough stable mixture. The higher the cobalt content of the additive alloy, the stronger are its magnetic properties and the more stable is the particulate mixure it forms with the base alloy.

In preparing the present sintered product, the base and sintering additive cobalt-rare earth alloys can be formed by a number of methods. For example, each can be prepared by arc or induction melting the cobalt and rare earth metal together in the proper amounts under a substantially inert atmosphere such as argon and allowing the melt to solidify. Preferably, the melt is cast into an ingot.

The solid base and additive alloys can be converted to particulate form in a conventional manner. Such conversion can be carried out in air at room temperature since the alloys are substantially non-reactive. For example, each alloy can be crushed by mortar and pestle in air and then pulverized to a finer form by fluid energy in a substantially inert atmosphere.

The particle size of the base and additive cobalt-rare earth alloys used in forming the present mixture may vary. Each can be in as finely divided a form as desired. For most applications, average particle size will range from about 1 micron or less to about 10 microns. Larger sized particles can be used, but as the particle size is increased, the maximum coercive force obtainable is lower because the coercive force generally varies inversely with particle size. In addition, the smaller the particle size, the lower is the sintering temperature which may be used.

In forming the present mixture, the base and sintering

additive alloys are each used in an amount so that the resulting mixture has a cobalt and rare earth metal content substantially corresponding to that of the final desired sintered product. In addition, however, in forming the mixture, the sintering additive should be used in an amount sufficient to promote sintering. This amount depends largely on the specific composition of the additive and can be determined empirically, but generally, the sintering additive alloy should be used in an amount of at least 0.5 percent by weight of the base-additive alloy mixture. Generally, for liquid phase sintering, the larger the rare earth metal component of the sintering additive alloy, the more liquid it is at sintering temperature. Specifically, for liquid phase sintering, a sintering additive composed of 40 percent Co and 60 percent Sm may generally be used in an amount ranging from about 4 to 25 percent by weight of the base-additive alloy mixture wherein the base alloy is comprised of about 65 to 70 percent by weight cobalt and 30 to 35 percent by weight samarium and cerium mischmetal.

In carrying out the process of this invention, the base alloy is admixed with the additive alloy in any suitable manner to produce a substantially thorough particulate mixture. The particulate mixture can then be compressed into a green body of the desired size and density by any of a number of techniques such as hydrostatic pressing or methods employing steel dies. The mixture is compressed in the presence of an aligning magnetizing field to magnetically align the particles along their easy axis, or if desired, the mixture may be compressed after magnetically aligning the particles. The greater the magnetic alignment of the articles, the better are the resulting magnetic properties. Preferably, compression is carried out to produce a green body with as high a density as possible, since the higher its density, the greater the sintering rate. Green bodies having a density of about 40 percent or higher of theoretical are preferred.

The green body is sintered to produce a sintered body of desired density. Preferably, the green body is sintered to produce a sintered body wherein the pores are substantially non-interconnecting. Such non-interconnectivity stabilizes the permanent magnet properties of the product because the interior of the sintered product or magnet is protected against exposure to the ambient atmosphere.

The sintering temperature used in the present process may vary. The minimum sintering temperature must be sufficiently high for sintering to occur in a particular cobalt-rare earth system, i.e. it must be high enough to coalesce the component particles. In the present process, a sintering temperature of about 1000° C. to 1150° C. is suitable with a sintering temperature of 1025° C. to 1075° C. being particularly satisfactory.

Preferably, sintering is carried out so that the pores in the sintered product are substantially non-interconnecting. A sintered body having a density or packing of at least about 87 percent of theoretical is generally one wherein the pores are substantially non-interconnecting. Such non-interconnectivity is determinable by standard metallographic techniques, as for example, by means of transmission electron micrographs of a cross-section of the sintered product. The maximum sintering temperature is preferably one at which significant growth of the component particles or grains does not occur, since too large an increase in grain size deteriorates magnetic properties such as coercive force. The green body is sintered in a substantially inert atmosphere such as argon, and upon completion of the sintering, it is preferably cooled to room temperatures in a substantially inert atmosphere.

The density of the sintered product may vary. The particular density depends largely on the particular permanent magnet properties desired. Preferably, to obtain a product with substantially stable permanent magnet properties, the density of the sintered product should be one wherein the pores are substantially non-interconnecting and this occurs usually at a density or packing of about 87 percent. Gen-

erally, for a number of applications, the density may range from about 80 percent to 100 percent. For example, for low temperature applications, a sintered body having a density ranging down to about 80 percent may be satisfactory. The preferred density of the sintered product is one which is the highest obtainable without producing a growth in grain size which would deteriorate magnetic properties significantly, since the higher the density the better are the magnetic properties. For sintered products of the present invention, a density of at least about 87 percent of theoretical, i.e. of full density, and as high as about 96 percent of theoretical is preferred to produce permanent magnets with suitable magnetic properties which are substantially stable.

Sintering of the green body produces a sintered product which weighs about the same as the green body indicating no loss, or no significant loss, of cobalt and rare earth components. Standard chemical analysis of a sintered product shows that the rare earth and cobalt content is substantially unaffected by the sintering process.

Magnetization of the present sintered products of cobalt, samarium and cerium mischmetal produces novel permanent magnets. Specifically, the magnetic properties of the present permanent magnets are generally significantly better than those provided by prior art permanent magnets such as, for example, cobalt-platinum. One particular advantage of the present invention is that cerium mischmetal is a much more abundant element than samarium, or platinum, thereby making the present permanent magnets available for a wider variety of applications than has been possible heretofore.

The magnetic properties of the present sintered products can be improved by subjecting them to a heat-aging process to produce novel permanent magnets. The heat-aging process is substantially disclosed and claimed in copending U.S. patent application Ser. No. 33,315 (Docket RD-3726) entitled "Heat-Aged Sintered Cobalt-Rare Earth Intermetallic Product And Process," filed Apr. 30, 1970 in the names of Mark G. Benz and Donald L. Martin and assigned to the assignee hereof, and which by reference is made part of a disclosure of the present application.

As applied to the preparation of the new permanent magnets of the present invention, the heat-aging process comprises heating the present sintered products at a temperature within 400° C. below its sintering temperature for a period of time ranging up to 24 hours in a substantially inert atmosphere such as, for example, argon. The particular aging temperature and aging period is determinable empirically depending on the resulting improvement in magnetic properties produced. Specifically, such heat-aging of the present products usually increases their resistance to demagnetization as reflected by at least about 15 percent increase in the H_k value of the resulting magnet. Generally, significant increases in the H_k factor are produced wherein the H_k factor is initially relatively low.

The permanent magnets of the present invention are substantially stable in air and have a wide variety of uses. For example, they are useful in telephone, electric clocks, radios, television, and phonographs. They are also useful in portable appliances, such as electric toothbrushes and electric knives, and to operate automobile accessories. In industrial equipment, the present permanent magnets can be used in such diverse applications as meters and instruments, magnetic separators, computers and microwave devices.

If desired, the sintered bulk product of the present invention can be crushed to a desired particle size preferably a powder, which is particularly suitable for alignment and matrix bonding to give a stable permanent magnet. The matrix material may vary widely and may be plastic, rubber or metal such as, for example, lead, tin, zinc, copper or aluminum. The powder-containing matrix can be cast, pressed or extruded to form the desired permanent magnet.

All parts and percentages used herein are by weight unless otherwise noted.

The invention is further illustrated by the following examples in which, unless otherwise noted, the conditions and procedure were as follows:

The letters MM herein denote cerium mischmetal.

The base alloy and sintering additive compositions as well as the compositions of the green bodies were determined on a nominal weight basis.

The cerium mischmetal used is sold under the trademark of CerAlloy 100× and has the following composition: 53 percent cerium, 16 percent neodymium, 5 percent praseodymium, 2 percent gadolinium and 24 percent lanthanum with traces of other rare earth elements.

Alignment is the ratio of the magnetization at zero field to that at 100K oe. That is, $A=B_r/4\pi M_{100}$.

Particle size was determined by means of a Fisher Sub-Sieve Sizer.

The sintering furnace was an electrically heated ceramic tube.

All sintering was carried out in an inert atmosphere of purified argon and upon completion of the sintering, the sintered product was cooled in the same purified argon atmosphere.

Percent packing was determined from the measured density of the sample divided by the full density of the alloy under consideration. The full alloy densities used are as follows:

Alloy	Gm./cm.^{3}
Co_5Sm	8.6
$Co_5MM_{0.5}Sm_{0.5}$	8.4

B_5 is the saturation induction.

B_r is the residual or remanent induction, i.e. the flux when the applied magnetic field is reduced to zero.

The intrinsic coercive force H_{ci} is the field strength at which the magnetization (B—H) or $4\pi M$ is zero.

Normal coercive force H_c is the field strength at which the induction B becomes zero.

The maximum energy product $(BH)_{max}$ represents the maximum product of the magnetic field H and the induction B determined on the demagnetization curve.

The term H_k helps characterize the squareness of the $4\pi M$ demagnetization curve. Specifically, H_k is the demagnetizing field required to drop the magnetization 10 percent below the remanence B_r. That is, $4\pi M_k=.9B_r$, and H_k is the corresponding field strength. H_k is a useful parameter for evaluating demagnetization resistance.

EXAMPLE

In the runs of the following table, each alloy melt was made under purified argon by induction melting and cast into an ingot. The ingot was then crushed in air by means of mortar and pestle or in a jaw crusher in nitrogen and then ground in nitrogen by fluid energy milling into a powder of 6 to 8 microns average particle size. The sintering additive alloy was admixed with the base alloy by tumbling to form a substantially thorough mixture which was stable since the additive was substantially non-reactive in air and was slightly magnetic.

The green body of each run was formed by packing the mixture into a rubber tube having a working space of ⅜ inch in diameter and 1¾ inch long. The tube was placed in an axial magnetic field of 60,000 to 100,000 oersteds to align the particles along the easy axis. After aligning, the tube was evacuated and the sample was hydrostatically pressed under 200,000 p.s.i. The pressed samples, i.e. green bodies, had a packing density of about 80 percent. The green bodies were cylindrical in form and had a diameter ranging from about ¼ up to about ⅜ inch and a length ranging from about ¾ to 1½ inches. Generally, the green bodies were machined to make a right cylinder of proper dimensions for testing purposes. The green bodies were sintered as indicated in the following table.

In the following table, the magnetic properties of the sintered products were determined after magnetization at room temperature in a field of 100,000 oersteds.

In Runs 4 and 7, sintered products were heat-aged as indicated. In Run 12, a sintered product was additionally sintered and heat-aged as indicated. In Runs 8 and 14, the sintered products were also heat-aged. All heat-aging was carried out in a substantially inert atmosphere of argon. After magnetization at room temperature in a field of 100,000 oersteds, the magnetic properties of the heat-aged sintered products were determined.

Run No.	Base alloy, Percent Co	Base alloy, Percent Sm	Base alloy, Percent MM	Base alloy, Weight, (percent)	Sintering additive, Percent Co	Sintering additive, Percent Sm	Sintering additive, Weight, (percent)	Green body, Percent Co	Green body, Percent Sm	Green body, Percent MM	Green body, MM percent of Sm-MM	Green body, Alignment	Sintering treatment, Time (min.)	Sintering treatment, Temp. (° C.)	Sintered product, packing (percent)	Magnetic properties of sintered product after magnetization: B_s gauss	B_r gauss	H_c oers.	H_k oers.	H_{ci} oers.	$(BH)_{max.}$ (10^6 gauss, oers.)
1	68	0	32	77.9	40.8	59.2	22.1	62	13.1	24.9	66	.89	30	1,100	79	8,070	6,980	550	400	600	2.4
2	68	0	32	45.5	40	[2] 30	17.8	62.9	5.3	[3] 14.6	39	.89	30	1,050	94	7,830	6,550	4,000	3,400	4,400	10.6
	[1] 67.7	[1] 32.3	-------	[1] 36.7		[1] 30				[1] 17.2											
3	64.5	19.5	16.0	93.8	39.9	60.1	6.2	62.9	22.1	15.0	40	.96	60	1,070	96	8,700	7,900	6,200	5,100	9,400	15.2
4	Sintered product of Run No. 3 heat-aged at 950° C. for 15 hrs.											.95			96	8,700	7,950	6,500	5,800	>14,000	15.8
5	68	0	32	81.6	40.8	59.2	18.4	63	10.9	26.1	71	.90	30	1,000	88	8,520	6,700	6,200	7,500	11,700	10.9
6	64.5	19.5	16.0	95.9	39.9	60.1	4.1	63.4	21.3	15.3	42	.96	60	1,070	95	8,700	7,900	6,700	5,800	12,500	15.2
7	Sintered product of Run No. 6 heat-aged at 950° C. for 15 hrs.											.94			96	8,730	7,900	7,200	7,500	>15,000	15.5
8	64.5	19.5	16.0	95.9	39.9	60.1	4.1	63.4	21.3	15.3	42	.96	[4] 60	[4] 1,075	97	9,600	9,000	7,600	6,600	15,200	20.0
9	64.5	19.5	16.0	97.9	39.9	60.1	2.1	63.9	20.4	15.7	43	.94	60	1,070	91	8,600	7,300	6,900	4,800	>14,000	12.6
10	68	0	32	85.3	40.8	59.2	14.7	64	8.7	27.3	76	.85	30	1,000	87	8,990	7,000	6,200	6,500	9,600	11.4
11	66.5	9.5	24.0	92.5	40	60	7.5	64.5	13.3	22.2	63	.95	30	1,025	86	9,480	7,680	5,850	4,600	8,500	13.6
12	Sintered product of Run No. 11 sintered at 1050°C. for 30 minutes and then heat-aged at 900° C. for 20 hours											.95			91	9,680	8,440	5,400	4,000	6,300	16.6
13	66	17	17	94.1	39.9	60.1	5.9	64.5	19.5	16.0	45	.93	60	1,070	88	9,050	7,500	4,200	2,300	6,800	10.0
14	66	17	17	94.1	39.9	60.1	5.9	64.5	19.5	16.0	45	.94	[4] 60	[4] 1,075	92	9,500	8,100	4,200	3,200	5,200	14.0
15	68	32	0	81.6	40.8	59.1	18.4	63	37	0	0	.96	30	1,125	94	9,330	8,450	7,500	7,200	19,500	17.6

[1] Ce. [2] Sm. [3] MM. [4] And heat-aged for 15 hours at 900° C.

Run Nos. 1 through 14 illustrate the present product and permanent magnet as prepared by liquid phase sintering. Specifically, in Run Nos. 4 and 7, sintered products were heat-aged as indicated and showed significant increases in their H_k values as well as intrinsic force H_{ci} which results in their having a significant increase in resistance to demagnetization.

Although the table shows that the permanent magnet properties of the present magnets in a number of instances may be somewhat lower than those of Run No. 15 where only samarium was used, the present invention provides a number of advantages. Cerium mischmetal is a much more abundant material than samarium which makes it more practical to use. In addition, the permanent magnet properties of the present magnets makes them available for a much wider variety of applications than has been possible heretofore.

Copending U.S. patent application Ser. No. 33,224 entitled "Sintered Cobalt-Rare Earth Intermetallic Product," filed on April 30, 1970, in the name of Mark G. Benz and assigned to the assignee hereof is, by reference, made part of the disclosure of the present application. In U.S. patent application Ser. No. 33,224, there is disclosed a process which, brefly stated, comprises forming a particulate alloy of cobalt and rare earth metal content substantially the same as that desired in the sintered product, compressing the particulate alloy into compacts and sintering them to the desired density. The sintered product is comprised of a major amount of Co_5R intermetallic phase and up to about 35 percent by weight of the product of a second CoR phase which is richer in rare earth metal content than the Co_5R phase, where R is a rare earth metal. These sintered products are then magnetized to form novel permanent magnets.

In copending U.S. patent application Ser. No. 66,171 entitled "Sintered Cobalt-Rare Earth Intermetallic Product And Permanent Magnets Produced Therefrom" filed of even date herewith in the name of Donald L. Martin and assigned to the assignee hereof, there is disclosed novel sintered products comprised of intermetallic compounds of samarium and praseodymium and permanent magnets produced therefrom.

In copending U.S. patent application Serial No. 66,173 entitled "Sintered Cobalt-Rare Earth Intermetallic Product Including Samarium And Lanthanum And Permanent Magnets Produced Therefrom" filed of even date herewith in the name of Donald L. Martin and assigned to the assignee hereof, there is disclosed novel sintered products comprised of intermetallic compounds of cobalt and rare earth metals composed of samarium and lanthanum and permanent magnets produced therefrom.

In copending U.S. Patent Application Ser. No. 66,172 entitled "Sintered Cobalt-Rare Earth Intermetallic Product Including Samarium And Cerium And Permanent Magnets Produced Therefrom" filed of even date herewith in the name of Donald L. Martin and assigned to the assignee hereof, there is disclosed novel sintered product comprised of intermetallic compounds of cobalt and rare earth metals composed of samarium and cerium and permanent magnets produced therefrom.

All of the above cited patent applications are, by reference, made part of the disclosure of the present application.

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

1. A permanent magnet having substantially stable permanent magnet properties and having as the active magnetic component a sintered product of compacted particulate cobalt-rare earth intermetallic material, said sintered product having pores which are substantially non-interconnecting, a packing of at least 87 percent and a composition consisting essentially of cobalt in an amount of 61 to 66 percent by weight of said sintered product and the rare earth metals of samarium and cerium mischmetal in an amount of 34 to 39 percent by weight of said sintered product with the cerium mischmetal component ranging in amount from about 10 to 90 percent by weight of the total rare earth metals content.

2. A permanent magnet according to claim 1 wherein said cerium mischmetal is present in an amount ranging from about 39 to 76 percent by weight of the total rare earth metals content.

3. A permanent magnet having substantially stable permanent magnet properties having as the active magnetic component particles of a sintered product of compacted particulate cobalt-rare earth intermetallic material, said particles of said sintered product being bonded to a matrix material, said sintered product having pores which are substantially non-interconnecting, a packing of at least 87 percent and a composition consisting essentially of cobalt in an amount of 61 to 66 percent by weight of said sintered product and the rare earth metals of samarium and cerium mischmetal in an amount of 34 to 39 percent by weight of said sintered product with said cerium mischmetal ranging in amount from about 10 to 90 percent by weight of the total rare earth metals content.

4. A permanent magnet according to claim 3 wherein said matrix material is a metal.

5. A permanent magnet according to claim 3 wherein said matrix material is a plastic.

6. A permanent magnet according to claim 3 wherein said matrix material is a rubber.

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