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(54) Title: AS SINTERED COINING PROCESS (57) Abstract A process of coining sintered articles of powder metal comprising: blending carbon, ferro manganese, and lubricant with compressible elemental iron powder, pressing the blended mixture to form the articles, high temperature sintering of the articles in a reducing atmosphere and then coining the sintered articles to final shape so as to narrow the tolerance variability of coined articles and substantially eliminate secondary operations.		

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AS SINTERED COINING PROCESS

FIELD OF INVENTION

This invention relates to a process of coining sintered articles to final shape and in particular relates to a process of precision coining sintered articles of powder metal having a composition of between 0.3% to 2.0% manganese, 0.2 to 0.85% carbon with the remainder being iron and unavoidable impurities where the sintered articles are coined to final shape so as to narrow the tolerance variability of the coined articles.

Background to the Invention

Powder metal technology is well known to the persons skilled in the art and generally comprises the formation of metal powders which are compacted and then subjected to an elevated temperature so as to produce a sintered product.

Conventional sintering occurs at a maximum temperature of approximately up to 1,150°C. Historically the upper temperature has been limited to this temperature by sintering equipment availability. Therefore copper and nickel have traditionally been used as alloying additions when sintering has been conducted at conventional temperatures of up to 1,150°C, as their oxides are easily reduced at these temperatures in a generated atmosphere, of relatively high dew point containing CO, CO₂ and H₂. The use of copper and nickel as an alloying material is expensive. Moreover, copper when utilized in combination with carbon as an alloying material and sintered at high temperatures causes dimensional instability and accordingly the use of same in a high temperature sintering process results in a more difficult process to control the dimensional characteristics of the desired product.

Manufacturers of metal powders utilized in powder metal technology produce prealloyed iron powders which are generally more difficult to compact into complex shapes, particularly at higher densities (> 7.0 g/cc). Manganese and chromium can be incorporated into prealloyed powders provided special manufacturing precautions are taken to minimize the oxygen content, for example, by oil atomization.

- 2 -

Notwithstanding this, these powders still have poor compressabilities compared to admixed powders.

Conventional means to increase the strength of powder metal articles use up to 8% nickel, 4% copper and 1.5% molybdenum, in prealloyed, partially prealloyed, or admixed powders. Furthermore double press double sintering can be used for high performance parts as a means of increasing part density. Conventional elements are expensive and relatively ineffective for generating mechanical properties equivalent to wrought steel products, which commonly use the more effective strengthening alloying elements manganese and chromium.

Moreover, conventional technology as disclosed in United States Patent No. 2,402,120 teach pulverizing material such as mill scale to a very fine sized powder, and thereafter reducing the mill scale powder to iron powder without melting it.

Furthermore, United States Patent No. 2,289,569 relates generally to powder metallurgy and more particularly to a low melting point alloy powder and to the usage of the low melting point alloy powders in the formation of sintered articles.

Yet another process is disclosed in United States Patent No. 2,027,763 which relates to a process of making sintered hard metal and consists essentially of steps connected with the process in the production of hard metal. In particular, United States Patent No. 2,027,763 relates to a process of making sintered hard metal which comprises producing a spray of dry, finely powdered mixture of fusible metals and a readily fusible auxiliary metal under high pressure producing a spray of adhesive agent customary for binding hard metals under high stress, and so directing the sprays that the spray of metallic powder and the spray of adhesive liquid will meet on their way to the molds, or within the latter, whereby the mold will become filled with a compact moist mass of metallic powder and finally completing the hard metallic particle thus formed by sintering.

United States Patent No. 4,707,332 teaches a process for manufacturing structural parts

- 3 -

from intermetallic phases capable of sintering by means of special additives which serve at the same time as sintering assists and increase the ductility of the finished structural product.

Moreover, United States Patent No. 4,464,206 relates to a wrought powder metal process for pre-alloyed powder. In particular, United States Patent No. 4,464,206 teaches a process comprising the steps of comminuting substantially non-compactible pre-alloyed metal powders so as to flatten the particles thereof heating the comminuted particles of metal powder at an elevated temperature, with the particles adhering and forming a mass during heating, crushing the mass of metal powder, compacting the crushed mass of metal powder, sintering the metal powder and hot working the metal powder into a wrought product.

Finally, coining is a process well known to those persons skilled in the art. However, a comprehensive method of precision coining of powder metal blanks is lacking. For example, United States Patent No. 2,757,446 teaches a method of forming articles from metal powders which includes hot forging the article to a minimum density of 95% of the theoretical density wherein the entire change of shape of the article takes places in one direction of movement and wherein the minimum internal flow of the particles within the article is at least 5% and finally finishing the forged article.

The processes as described in the prior art above present a relatively less cost effective process to achieve the desired mechanical properties of the sintered product.

It is an object of this invention to provide an improved coining process for producing sintered articles having improved dynamic strength characteristics and an accurate method to control same, while at the same time narrowing the tolerance variability of the coined articles.

It is an aspect of this invention to provide a process of coining sintered articles of powder metal comprising blending carbon, ferro manganese and lubricant with compressible elemental iron powder, pressing said blended mixture to form said

- 4 -

articles, high temperature sintering said articles in a reducing atmosphere and then coining said sintered articles to a final shape.

It is another aspect of this invention to provide a process of precision coining a sintered article of powder metal comprising: selecting elemental iron powder; determining the desired properties of said sintered article and selecting; a quantity of carbon; and a quantity of ferro manganese to produce an article having a composition of between 0.3% to 2.0% manganese, 0.2% to 0.85% carbon with the remainder being iron and unavoidable impurities; grinding said ferro manganese to a mean particle size of approximately 8 to 12 microns and substantially all of said ferro manganese having a particle size of less than 25 microns; introducing a lubricant while blending said carbon, and ferro manganese with said elemental iron powder; pressing said mixture to form said article; high temperature sintering said article at a temperature between 1,250° C and 1,350° C in a reducing atmosphere of 90% blended nitrogen and 10% hydrogen so as to produce said sintered article of powdered metal; then coining said sintered article to a final shape so as to narrow the tolerance variability of coined articles and substantially eliminate secondary operations.

It is another aspect of this invention to provide coined as sintered articles having a compacted and sintered mass with composition of between 0.3% to 2.0% manganese, 0.2% to 0.85% carbon, with the remainder being iron and unavoidable impurities, with a narrow dimensional tolerance variability.

Description of Drawings

These and other features and objections of the invention will now be described in relation to the following drawings:

Figure 1 is a drawing of the prior art mixture of iron alloy.

Figure 2 is a drawing of a mixture of elemental iron, and ferro alloy in accordance with the invention described herein.

- 5 -

Figure 3 is a graph showing the distribution of particle size in accordance with the invention herein.

Figure 4 is representative drawing of a jet mill utilized to produce the particle size of the ferro alloy.

Figure 5 is a stress strain graph.

Figure 6 illustrates a coined part such as a clutch backing plate made in accordance with the invention.

Figure 7 is a dimensional stability graph.

Figure 8 graphically illustrates the narrow variability tolerance of the coined parts.

DESCRIPTION OF THE INVENTION

Sintered Powder Metal Method

Figure 1 is a representative view of a mixture of powder metal utilized in the prior art which consists of particles of ferro alloy in powder metal technology.

In particular, copper and nickel may be used as the alloying materials, particularly if the powder metal is subjected to conventional temperature of up to 1150° C during the sintering process.

Moreover, other alloying materials such as manganese, chromium, and molybdenum which were alloyed with iron could be added by means of a master alloy although such elements were tied together in the prior art. For example a common master alloy consists of 22% of manganese, 22% of chromium and 22% of molybdenum, with the balance consisting of iron and carbon. The utilization of the elements in a tied form made it difficult to tailor the mechanical properties of the final sintered product for

- 6 -

specific applications. Also the cost of the master alloy is very high and uneconomic.

By utilizing ferro alloys which consist of ferro manganese, or ferro chromium or ferro molybdenum or ferro vanadium, separately from one another rather than utilizing a ferro alloy which consists of a combination of iron, with manganese, chromium, molybdenum or vanadium tied together a more accurate control on the desired properties of the finished product may be accomplished so as to produce a method having more flexibility than accomplished by the prior art as well as being more cost effective.

Figure 2 is a representative drawing of the invention to be described herein, which consists of iron particles, Fe having a mixture of ferro alloys 2.

The ferro alloy 2 can be selected from the following groups:

<u>Name</u>	<u>Symbol</u>	<u>Approx. % of Alloy Element</u>
ferro manganese	FeMn	78%
ferro chromium	FeCr	65%
ferro molybdenum	FeMo	71%
ferro vanadium	FeVa	75%
ferro silicon	FeSi	75%
ferro boron	FeB	17.5%

The ferro alloys available in the market place may also contain carbon as well as unavoidable impurities which is well known to those people skilled in the art.

Chromium molybdenum and vanadium are added to increase the strength of the finished product particularly when the product is subjected to heat treatment after sintering. Moreover, manganese is added to increase the strength of the finished

- 7 -

product, particularly if one is not heat treating the product after the sintering stage. The reason for this is manganese is a powerful ferrite strengthener (up to 4 times more effective than nickel).

Particularly good results are achieved in the method described herein by grinding the ferro alloys so as to have a D_{50} or mean particle size of 8 to 12 microns and a D_{100} of up to 25 microns where substantially all particles of the ferro alloys are less than 25 microns as shown in Figure 3. For certain application a finer distribution may be desirable. For example a D_{50} of 4 to 8 microns and a D_{100} of 15 microns.

Many of the processes used in the prior art have previously used a D_{50} of 15 microns as illustrated by the dotted lines of Figure 3. It has been found that by finely grinding the of the ferro alloy to a fine particle size in an inert atmosphere as described herein a better balance of mechanical properties may be achieved having improved sintered pore morphology. In other words the porosity is smaller and more rounded and more evenly distributed throughout the mass which enhances strength characteristics of the finished product. In particular, powder metal products are produced which are much tougher than have been achieved heretofore.

The ferro alloy powders may be ground by a variety of means so long as the mean particle size is between 8 and 12 microns. For example, the ferro alloy powders may be ground in a ball mill, or an attritor, provided precautions are taken to prevent oxidation of the ground particles and to control the grinding to obtain the desired particle size distribution.

Particularly good results in controlling the particle size as described herein are achieved by utilizing the jet mill illustrated in Figure 4. In particular, an inert gas such as cyclohexane, nitrogen or argon is introduced into the grinding chamber via nozzles 4 which fluidize and impart high energy to the particles of ferro alloys 6 upward and causes the ferro alloy particles to break up against each other. As the ferro alloy particles grind up against each other and reduce in size they are lifted higher up the chamber by the gas flow and into a classifier wheel 10 which is set at a particular

- 8 -

RPM. The particles of ferro alloy enter the classifier wheel 10 where the ferro alloy particles which are too big are returned into the chamber 8 for further grinding while particles which are small enough namely those particles of ferro alloy having a particle size of less than 25 microns pass through the wheel 10 and collect in the collecting zone 12. The grinding of the ferro alloy material is conducted in an inert gas atmosphere as described above in order to prevent oxidization of the ferro alloy material. Accordingly, the grinding mill shown in Figure 4 is a totally enclosed system. The jet mill which is utilized accurately controls the size of the particles which are ground and produces a distribution of ground particles which are narrowly centralized as shown in Figure 3. The classifier wheel speed is set to obtain a D_{50} of 8 to 10 microns. The speed will vary with different ferro alloys being ground.

The mechanical properties of a produced powder metal product may be accurately controlled by:

- (a) selecting elemental iron powder;
- (b) determining the desired properties of the sintered article and selecting:
 - (i) a quantity of carbon; and
 - (ii) the ferro alloy(s) from the group of ferro manganese, ferro chromium, ferro molybdenum, and ferro vanadium and selecting the quantity of same;
- (c) grinding separately the ferro alloy(s) to a mean particle size of approximately 8 to 12 microns, which grinding may take place in a jet mill as described herein;
- (d) introducing a lubricant while blending the carbon and ferro alloy(s) with the elemental iron powder;
- (e) pressing the mixture to form the article; and

- 9 -

- (f) subjecting the article to a high temperature sintering at a temperature of between 1,250°C and 1,350°C in a reducing atmosphere of, for example 90% nitrogen and 10% hydrogen.

The lubricant is added in a manner well known to those persons skilled in the art so as to assist in the binding of the powder as well as assisting in the ejecting of the product after pressing. The article is formed by pressing the mixture into shape by utilizing the appropriate pressure of, for example, 25 to 50 tonnes per square inch.

The invention disclosed herein utilizes high temperature sintering of 1,250°C to 1,350°C and a reducing atmosphere of, for example nitrogen and hydrogen in a 90/10% ratio, or in vacuum. Moreover, the reducing atmosphere in combination with the high sintering temperature reduces or cleans off the surface oxides allowing the particles to form good bonds and the compacted article to develop the appropriate strength. A higher temperature is utilized in order to create the low dew point necessary to reduce the oxides of manganese and chromium which are difficult to reduce. The conventional practice of sintering at 1150°C does not create a sintering regime with the right combination of low enough dew point and high enough temperature to reduce the oxides of chromium, manganese, vanadium and silicon.

Secondary operations such as machining or the like may be introduced after the sintering stage. Moreover, heat treating stages may be introduced after the sintering stage.

Advantages have been realized by utilizing the invention as described herein. For example, manganese, chromium and molybdenum ferro alloys are utilized to strengthen the iron which in combination or singly are less expensive than the copper and nickel alloys which have heretofore been used in the prior art. Moreover, manganese appears to be four times more effective in strengthening iron than nickel as 1% of manganese is approximately equivalent to 4% nickel, and accordingly a cost advantage has been realized.

- 10 -

Furthermore sintered steels with molybdenum, chromium, manganese and vanadium are dimensionally more stable during sintering at high temperatures described herein than are iron-copper-carbon steels (ie. conventional powder metal (P/M) steels). Process control is therefore easier and more cost effective than with conventional P/M alloys.

Furthermore, the microstructure of the finished product are improved as they exhibit:

- (a) well rounded pores;
- (b) a homogenous structure;
- (c) structure having a much smaller grain size; and
- (d) a product that is more similar to wrought and cast steels in composition than conventional powder metal steels.

The process described herein allows one to control or tailor the materials which are desired for a particular application.

- (1) sinter hardening grades
- (2) gas quenched grades
- (3) as sintered grades
- (4) high strength grades
- (5) high ductility grades

The following chart provides examples of the five grades referred to above as well as the range of compositions that may be utilized in accordance with the procedure outlined herein.

<u>Alloy Type</u>	<u>Composition</u>	<u>Typical Mechanical Properties</u>	
		<u>Ultimate Tensile Strength</u>	<u>Impact</u>
		<u>UTS (ksi)</u>	<u>ft/lb</u>
As Sintered	Mn: 0.3 - 2.5% C: 0.2 - 0.85%	90	25

- 11 -

Sinter Hardening	Mn: 1.0 - 2.0% C: 0.5 - 0.85% Mo: 0 - 1.0%	120	15
Gas Quenched	Mn: 0.5 - 2.0% Mo: 0.5 - 1.5% C: 0 - 0.8% Cr: 0 - 1.0%	150	15
High Strength	Mn: 0.5 - 2.0% Cr: 0.5 - 2.0% Mo: 0 - 1.0% C: 0.1 - 0.6%	200	8
High Ductility	Cr: 0.5 - 2.0% Mo: 0 - 1.0% C: 0.1 - 0.6%	80	15

Particularly good results were achieved with the as sintered grade with 1.5% Mn and 0.8%C; UTS of 90ksi and impact strength of 20 ft lbs. Other combinations of alloying are possible to produce articles with specifically tailored balance of properties such as high toughness and ware resistance.

Moreover good results were achieved with:

- (a) sinter hardening grade with 1.5% Mn, 0.5% Mo, and 0.85% C;
- (b) gas quenching grade
 - (i) with 1.5% Mn, 0.5% Mo, and 0.5% C
 - (ii) with 0.5% Cr, 1.0% Mn, and 0.5% C
- (c) high strength grade
 - (i) with 1.0% Mn, 0.5% C, 0.5% Cr, 0.5% Mo
 - (ii) with 1.5% Cr, 0.6% C, 1.0% Mn,

Rollable Grade

Moreover, the method described herein may be utilized to produce a sixth grade identified as a rollable grade having the following composition:

- 12 -

Rollable Grade	Cr: 0.5 - 2.0%	80	15
	Mo: 0 - 1.0%		
	C: 0.1 - 0.6%		
	Mn: 0 to 0.6%		

Coining

It has been found that the method of producing the as sintered grade as described above is particularly useful when used in combination with a coining operation so as to produce precision coining as sintered parts which substantially eliminate the secondary operations such as grinding, cutting or the like.

In another embodiment, the method of producing the gas quenched grade as described above is also particularly useful when used in combination with said coining operation so as to produce precision coining gas quenched particles which substantially eliminate the secondary operations such as grinding, cutting or the like. In particular it has been found that articles which have a gas quenched composition described herein with relatively small sections do not require molybdenum while heavier parts require the molybdenum.

In particular, it has been found that parts such as clutch backing plates illustrated as 30 in Figure 6, or geo rotors (not shown) may be consistently, accurately manufactured within narrow tolerance variabilities by coining the sintered product.

In particular, the process of precision coining of a sintered article of powder metal consists of the steps of:

1. selecting the elemental iron powder;
 2. determining the desired properties of the sintered articles and selecting:
 - (a) a quantity of carbon, and;
 - (b) a quantity of ferro manganese;
- to produce an article having a composition of between 0.3% to 2.5%

- 13 -

manganese, 0.2% to 0.85% carbon with the remainder being iron and unavoidable impurities;

3. grinding the ferro alloy to a mean particle size of approximately 8 to 12 microns and substantially all of the ferro alloy having a particle size of less than 25 microns;
4. introducing a lubricant while blending the carbon and ferro alloy with the elemental iron powder; and
5. pressing the mixture to form the article;
6. high temperature sintering the article at a temperature between 1,250°C 1,350°C in a reducing atmosphere of for example 90% blended nitrogen and 10% hydrogen so as produce the sintered article of powdered metal; and
7. then coining the sintered article to a final shape so as to narrow the tolerance variability of coined articles and substantially eliminate secondary operations.

Another embodiment of the invention comprises:

1. selecting the elemental iron powder;
2. determining the desired properties of the gas quenched grade articles and selecting:
 - (a) a quantity of carbon, and
 - (b) a quantity of ferro alloys from the group of ferro manganese, ferro molybdenum and ferro chromiumso as to produce a sintered blank resulting in a mass having between 0.5 to 2.0% manganese, 0.5% to 1.5% molybdenum, between 0 to 1.0% chromium, and between 0 to 0.8% carbon;
3. grinding the ferro alloy to a mean particle size of approximately 8 to 12 microns and substantially all of the ferro alloy having a particle size of less than 25 microns;
4. introducing a lubricant while blending the carbon and ferro alloy with the elemental iron powder; and

- 14 -

5. pressing the mixture to form the article;
6. high temperature sintering the article at a temperature between 1,250°C 1,350°C in a reducing atmosphere of for example 90% blended nitrogen and 10% hydrogen so as produce the sintered article of powdered metal; and
7. then coining the sintered article to a final shape so as to narrow the tolerance variability of coined articles and substantially eliminate secondary operations.

In particular, Figure 5 illustrates the stress strain diagram of coining sintered articles having the prior art composition of FeCuC as well as the lower graph which illustrates the stress strain relationship of an article produced in accordance with the method described herein having a composition of between 0.3% to 2.5% manganese, 0.2% to 0.85% carbon, with the remainder being iron and unavoidable impurities. The stress strain diagram of the composition described herein illustrates the plastic zone 32 which allows the sintered blank to move upon coining to its final shape. The as sintered size change variability is less than in conventional PM materials, on coining this variability is further reduced.

More particularly, Figure 7 illustrates two dimensions which have an acceptable tolerance level of between 140.00 to 139.70 as well as a second part having an acceptable tolerance of between 1.51.20 and 1.51.00. The upper portion of the graph in Figure 7 illustrates that a coined article made from a prior art composition of FeCuC (0.1% to 3% Cu and 0.5% to 0.8% Carbon) has dimensional variability between 139.820 and 139.940 which peaks approximately between said levels. The tolerance variability of the parts produced with a composition of Fe 0.3 to 2.5% Mn and 0.2 to 0.85% C is more acceptable since the tolerance variability ranges from 139.840 to 139.880 peaking at 139.860, and since the tolerance variation lies in the middle of the acceptable tolerance range. In other words if the CPK as illustrated in Figure 8 lies in the middle of the acceptable tolerance range a and b, such tolerance variability is desirable particularly since the variation peaks in the middle which takes up approximately one-third of the tolerance.

- 15 -

More particularly, it has been found that the CPK of the coined as sintered article having a composition of Fe 0.3 to 2.5% Mn and 0.2 to 0.85% C has the desirable CPK of greater than or equal to 1.33. If the CPK shifts from this position, it is less desirable. In other words, the CPK illustrated in Figure 7 relating to a composition of Fe 0.3 to 2.5% Mn and 0.2 to 0.85% C is more desirable than the CPK illustrated in the composition of Fe 0.1% to 3% Cu and 0.5% to 0.8% C. (Although the tolerance variability is still acceptable, it does not lie toward the middle range of the acceptable tolerance level).

It has been found that after producing the sintered article in accordance with the as sintered article in accordance with the as sintered grade method as described above, one can expect a CPK of 5. However, upon coining of a part made in accordance with the as sintered grade, one can expect to obtain a CPK of greater than or equal to 1.33 which is highly desirable as the coined sintered powder metal parts will be more uniform in dimensional size thus substantially eliminating secondary operations such as grinding or the like.

CP relates to the "Process Capability Index" and is defined as

$$CP = \frac{\text{Total Tolerance}}{\text{Process Variation}}$$

The higher the CP the less variation there is in a process. In other words CP measures the tightness of the spread in the dimensions produced by the process against the acceptable tolerance. The bigger the spread the lower the CP.

The CPK is the combined measure of variation in process and relationship of process average to specification limit (ie. upper and lower limit).

The higher the CPK the more capable a process is to specification. In other words CPK measures the tightness of the spread as well as the position of the spread within the acceptable tolerance. A high CPK translates to parts having a narrow tolerance

- 16 -

spread positioned in the middle of the acceptable tolerance. The CPK can be changed by changing the tooling or process.

Sintered powder metal parts such as clutch backing plates, geo rotors or the like normally require grinding which increases the cost of same and increases the tolerance variability of successively manufactured parts. By utilizing the process as described herein one is able to tighten down the tolerances of coined as sintered powder metal parts thereby facilitating the design of more efficient pumps for example due to the tightening of the tolerance levels.

The as sintered powder metal parts produced in accordance with the invention described herein make it possible for sintered material to flow to final dimensional size as the coining takes place in the plastic zone 32 described above.

Although the preferred embodiment as well as the operation and use have been specifically described in relation to the drawings, it should be understood that variations in the preferred embodiment could be achieved by a person skilled in the trade without departing from the spirit of the invention as claimed herein.

- 17 -

CLAIMS

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A process of coining sintered articles of powder metal comprising blending carbon, ferro manganese and lubricant with compressible elemental iron powder, pressing said blended mixture to form said articles, high temperature sintering said articles in a reducing atmosphere and then coining said sintered articles to a final shape.
2. A process as claimed in claim 1 wherein said ferro alloy has a mean particle size of approximately 8 to 12 microns and substantially all of said ferro manganese has a particle size of less than 25 microns.
3. A process as claimed in claim 1 wherein said article has a composition of between 0.3% to 2.5% manganese, between 0.2% to 0.85% carbon, with the remainder being iron and unavoidable impurities.
4. A process as claimed in claim 1 wherein said sintering is undertaken under a vacuum.
5. A process as claimed in claim 3 wherein said reducing atmosphere comprises a blended nitrogen-hydrogen atmosphere, or dissociated ammonia.
6. A process as claimed in claim 5 wherein said article has a composition of between 0.3% to 2.0% manganese, 0.2% to 0.85% carbon with the remainder being iron and unavoidable impurities.
7. A process as claimed in claim 6 wherein said high temperature sintering is conducted at a temperature between 1,250°C and 1,350°C.

- 18 -

8. A process as claimed in claim 7 wherein said ferro alloy is ground in an atmosphere of inert gas.

9. A process of precision coining a sintered article of powder metal comprising:

- (a) selecting elemental iron powder;
- (b) determining the desired properties of said sintered article and selecting;
 - (i) a quantity of carbon; and
 - (ii) a quantity of ferro manganese to produce an article having a composition of between 0.3% to 2.0% manganese, 0.2% to 0.85% carbon with the remainder being iron and unavoidable impurities;
- (c) grinding separately said ferro manganese to a mean particle size of approximately 8 to 12 microns and substantially all of said ferro manganese having a particle size of less than 25 microns;
- (d) introducing a lubricant while blending said carbon, and ferro manganese with said elemental iron powder;
- (e) pressing said mixture to form said article;
- (f) high temperature sintering said article at a temperature between 1,250°C and 1,350°C in a reducing atmosphere of 90% blended nitrogen and 10% hydrogen so as to produce said sintered article of powdered metal;
- (g) then coining said sintered article to a final shape so as to narrow the tolerance variability of coined articles and substantially eliminate secondary operations.

- 19 -

10. A process as claimed in claim 9 wherein said ferro manganese is ground such that the mean particle size is between 8 to 12 microns and the particle size of substantially all of said ferro manganese is less than 25 microns.

11. In a process as claimed in claim 10 wherein said tolerance variability has a CPK of greater than or equal to 1.33.

12. In a process as claimed in claim 11 wherein said sintered article presents a sintered blank which moves to its final shape upon coining.

13. In coined as sintered articles having a compacted and sintered mass with composition of between 0.3% to 2.0% manganese, 0.2% to 0.85% carbon, with the remainder being iron and unavoidable impurities, with a narrow tolerance variability of a CPK greater than or equal to 1.33.

14. In an article as claimed in claim 13 wherein said article comprises a clutch backing plate.

15. In an article as claimed in claim 13 wherein said article comprises a geo rotor.

16. A process of coining gas quenched articles of powder metal comprising blending carbon, ferro manganese, ferro molybdenum, ferro chromium and lubricant with compressible elemental iron powder, pressing said blended mixture to form said articles, high temperature sintering said articles in a reducing atmosphere and then coining said gas quenched articles to a final form.

17. A process as claimed in claim 1 wherein said article has a composition of between 0.5% to 2.0% manganese, between 0.5% to 1.5% molybdenum, 0 to 1.0% chromium and between 0 to 0.8% carbon.

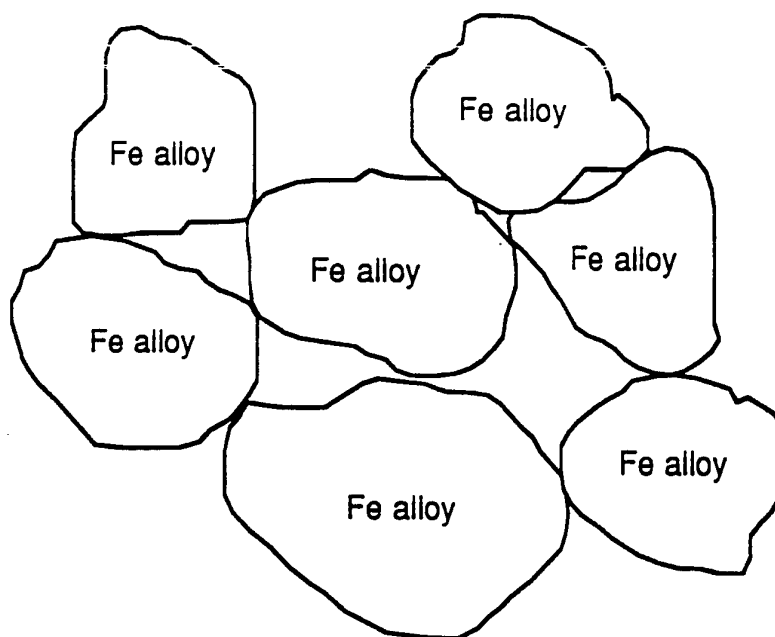


Figure 1.

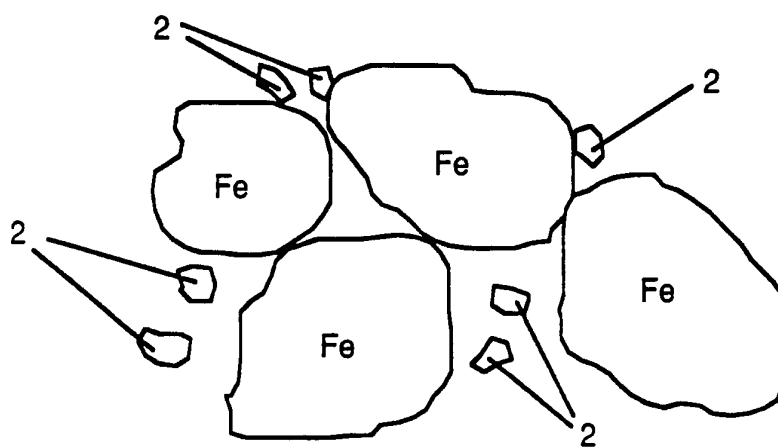


Figure 2.

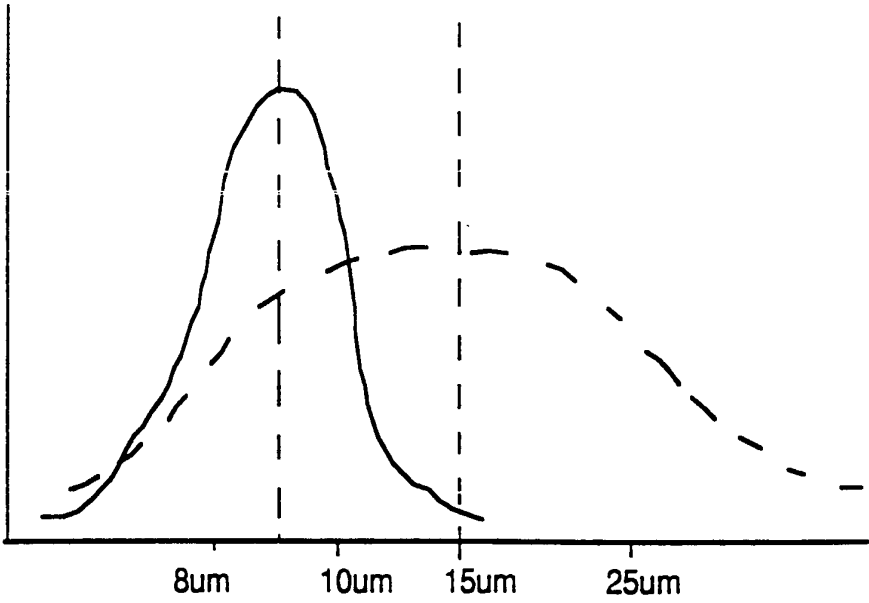


Figure 3

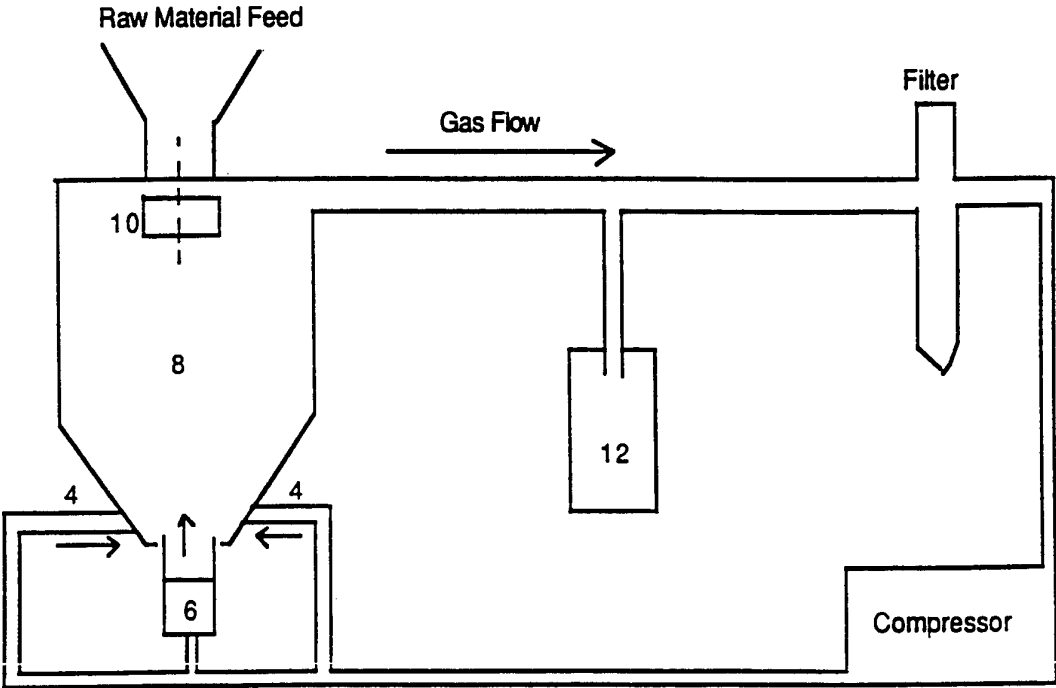


Figure 4

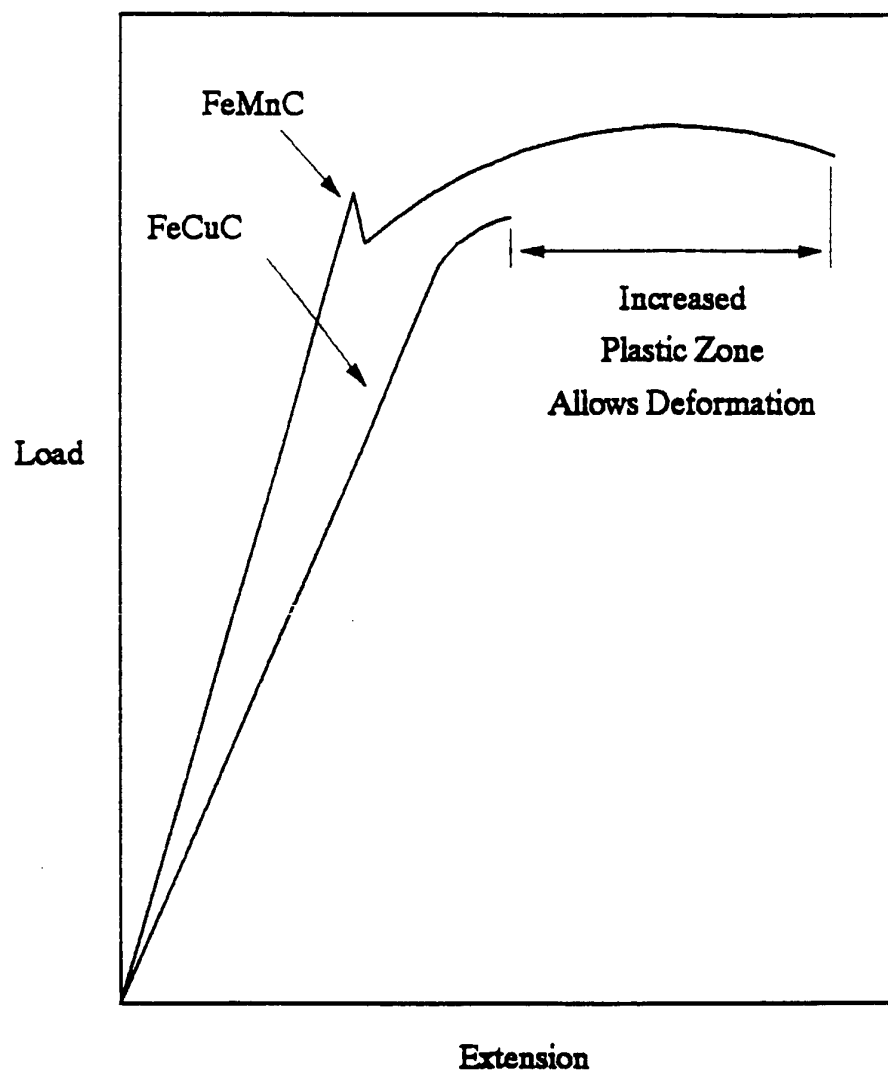


Figure 5

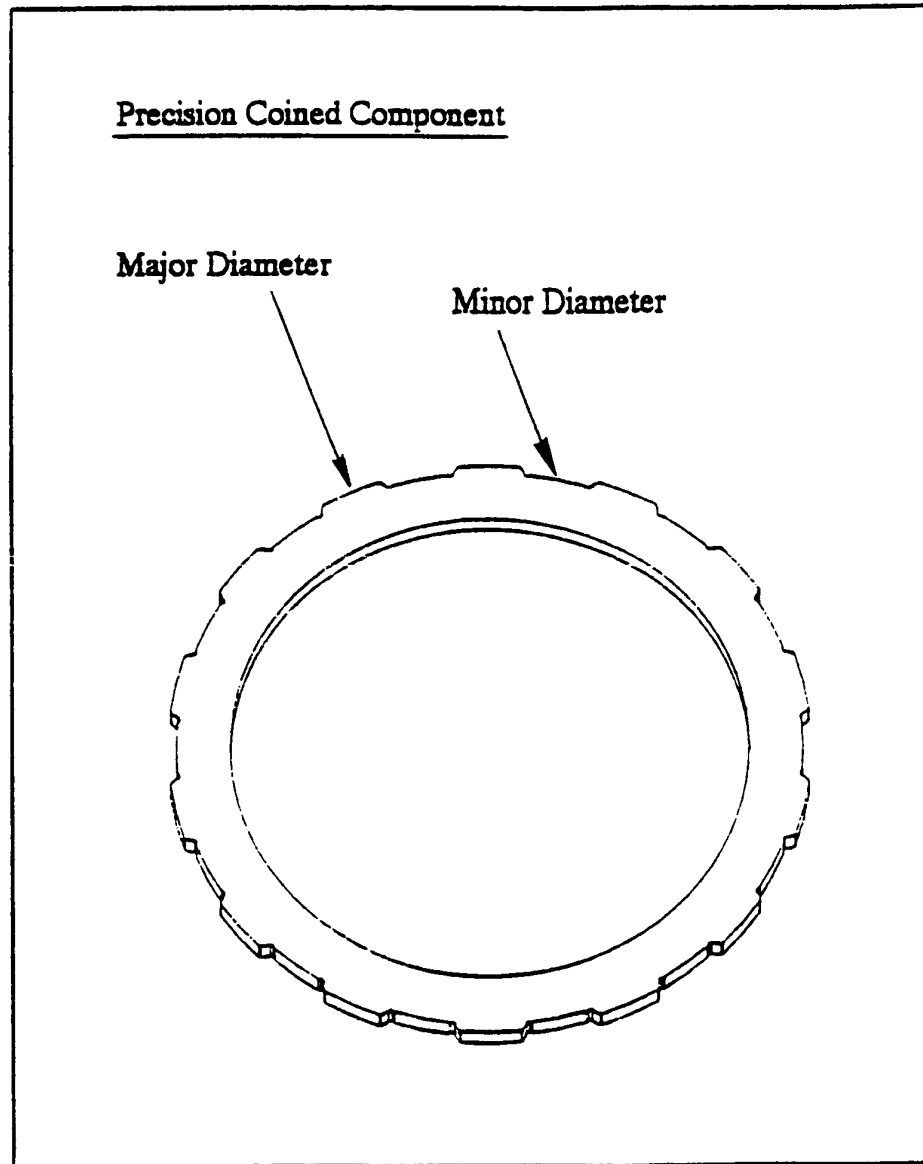


Figure 6

		Typical Dimensional Distributions	
		FeCuC	FeMnC
Minor ø Print 140.00 Tol. 139.70	139.700	.	.
	139.720	.	.
	139.740	.	.
	139.760	.	.
	139.780	.	.
	139.800	.	.
	139.820	+	.
	139.840	+++	+
	139.860	+++	+++++
	139.880	+++	+
	139.900	+++++	.
	139.920	+++	.
	139.940	++	.
	139.960	.	.
	139.980	.	.
	140.000	.	.
Major ø Print 151.20 Tol. 151.00	151.000	.	.
	151.020	.	.
	151.040	.	.
	151.060	.	.
	151.080	++	.
	151.100	+++	+++++
	151.120	++	++
	151.140	+++++	.
	151.160	++	.
	151.180	.	.
	151.200	.	.

Figure 7

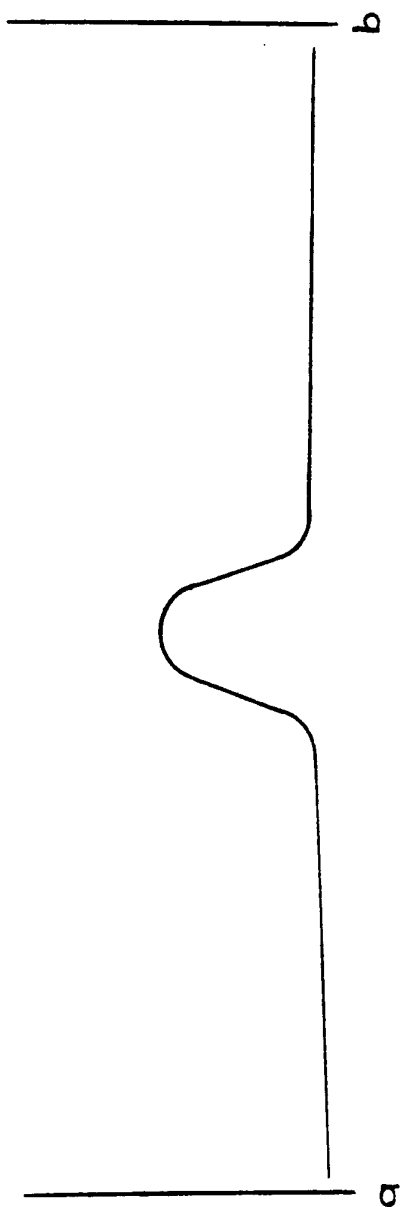


FIG. 8

INTERNATIONAL SEARCH REPORT

PCT/CA 92/00555

International Application No

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int.Cl. 5 C22C33/02		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
Int.Cl. 5	C22C	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹		
Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	EP,A,0 097 737 (KERNFORSCHUNGSZENTRUM KARLSRUHE GMBH) 11 January 1984 see page 3, line 15 - page 4, line 15; claims 1,2,5; examples 3,4 ---	1-17
X	FR,A,2 253 101 (HÖGÄNÄS) 27 June 1975 see claims 1,4,6,8; example 1 ---	1-17
X	DATABASE WPI Section Ch, Week 8040, Derwent Publications Ltd., London, GB; Class M22, AN 80-70285C & JP,A,55 107 756 (KAGAKU GIJUTSU-CHO) 20 August 1980 see abstract --- -/--	1,16
¹⁰ Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "A" document member of the same patent family		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search 27 JULY 1993		Date of Mailing of this International Search Report 28.08.93
International Searching Authority EUROPEAN PATENT OFFICE		Signature of Authorized Officer SCHRUEERS H.J.

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	FR,A,2 084 728 (THE BIRMINGHAM SMALL ARMS CO) 17 December 1971 see page 4, line 27 - line 34; claims 1,6,8,12,14	1-17
A	WO,A,8 808 459 (D.LLOYD) 3 November 1988 see claims 1,7,9,10,13,16; example 1	1-17

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.**

CA 9200555
SA 68144

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

27/07/93

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FR-A-2253101	27-06-75	SE-B- 378260 AT-B- 344763 CA-A- 1036389 DE-A,B,C 2455850 GB-A- 1491726 JP-C- 1221688 JP-A- 50113402 JP-B- 54029171 SE-A- 7316117 US-A- 3899319	25-08-75 10-08-78 15-08-78 05-06-75 16-11-77 26-07-84 05-09-75 21-09-79 30-05-75 12-08-75
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