United States Patent Office

3,471,343
Patented Oct. 7, 1969

1

3,471,343
PROCESS FOR THE PRODUCTION OF SINTER IRON MATERIALS

Max Koehler, Kastanienallee 2, Witten-Bommern, Germany

No Drawing. Filed May 5, 1966, Ser. No. 547,778
Claims priority, application Italy, May 7, 1965, 10,131/65
Int. Cl. B22f *5/02, 3/24;* C22c *39/54*
U.S. Cl. 148—126 5 Claims

ABSTRACT OF THE DISCLOSURE

Powder metallurgical production of valve seat rings for exhaust valves of vehicle power engines. Adding cobalt ranging from 9.6% to 14.4% and molybdenum ranging from 1.2 to 1.8% to sinter powder metal iron material increases heat resistance stability to over twice previously possible values and permits use of sinter powder metal iron material for exhaust valve seat rings. Admixing of materials, adding cobalt and molybdenum, briquetting, sintering, post-compressing, heating to a temperature above the A_3, quick cooling, and tempering are included in the method steps. Vanadium ranging from 0.05 to 0.2% is also added to the iron powder for enhancing structural strength.

This invention relates to wear resistant materials suitable for the production of sleeve valves and valve seating rings.

In my copending application Serial No. 547,793, titled "Method of Producing Wear Resistant Materials From Sinter Iron," filed May 5, 1966, now abandoned, I have described a method of producing wear resistant material from sinter iron according to which sinter iron, with additions of carbon and lead, is subjected to an additional treatment after briquetting and sintering. This additional treatment may take the form of either hot compression or cold compression at a pressure exceeding the pressure used in briquetting. This treamtent is then followed by a tempering during which the workpiece is heated to a temperature above the Ac 3-point for a short time, and subsequently is quickly cooled and thereafter tempered at temperatures up to 650° C. In the case of cold compression tempering may take place prior to cold compression.

The materials produced in accordance with this method display considerable grain refinement and homogenization of the structure as well as a remarkable increase in strength; the bending capacity for instance is doubled. With respect to abrasion also these materials show an improvement, as abrasion is reduced and the remaining abrasion is more uniform, thus protecting the calibration of the tools.

The present invention relates to a wear resistant material which is suitable for sleeve valves and valve seating rings, said material being produced generally in accordance with my above referred-to method.

It is an object of this invention to provide an improved method of producing sinter iron materials which will bring

2

about a considerable increase in the physical properties of the material.

It is also an object of this invention to provide a method as set forth in the preceding paragraph, which will increase the resistance of the material to wear, corrosion and erosion.

These and other objects and advantages of the invention will appear more clearly from the following specification in connection with the example set forth therein.

According to the present invention, an addition of 0.5 to 5% of nickel is made to the sinter iron which contains approximately 1 to 4% of lead, before it is subjected to the described method. The material produced in this manner is of increased forgeability and is therefore also particularly suited to the rolling, pressing and drawing of pipes. Surprisingly, the material has a coefficient of expansion which is in the range of that of cylinder heads made from light metals, so that the material is particularly suited for valve sleeves and valve seating rings. The strength of the material when compared with a material having no addition of nickel, is increased by 20% and expansion is increased by approximately 100%, i.e. from 2% to 4%.

According to the invention a sintered alloy material is contemplated having the following composition:

	Percent
Carbon	8.8–1.5
Silicon	0.15–0.2
Manganese	0.12–0.18
Phosphorus	0.02–0.03
Tin	0.3–0.4
Copper	0.5–1.0
Lead	1.0–4.0
Nickel	0.5–5
Molybdenum	1.2–1.8
Cobalt	9.6–16.2

remainder iron. The percentages referred to above are percentages by weight.

For certain purposes, such as for instance the production of valve seating rings for the exhaust of power tools, it is necessary that, apart from the mentioned properties of strength, the material should have an increased resistance to heat, i.e., sufficient strength at temperatures up to 600° C. It has now been found quite unexpectedly that a material which has been subjected to the treatment described above has a heat resistance of over 200 Brinell up to 600°° C., if in accordance with a preferred feature of the invention it contains, in addition to 1 to 4% of lead and 0.5 to 5% of nickel, amounts of cobalt and molybdenum in a ratio of from 8:1 prior to treatment, the molybdenum content amounting to 1.2 to 1.8%.

In accordance with a further preferred feature of the invention valve seating rings particularly suitable for motor vehicle exhausts can be produced from a material which, prior to treatment, has the following composition:

	Percent
Graphite	1
Lead	1.5
Nickel	2
Molybdenum	1.5
Cobalt	12

remainder iron, approximately 82%, with the normal small amount of impurities.

Practical experience with valve seating rings made from materials of the above composition has shown that the hardness at the grain limits of the individual structural sections can be increased by an addition of vanadium in amounts of 0.05 to 0.2%, in accordance with a still further preferred feature of the invention, as it has been discovered that during the treatment the vanadium migrates to the grain boundaries where it increases their strength.

Proceeding from the range of vanadium content, the following example, wherein the composition of the material and details of the treatment are given, illustrates the increase in the strength values by the addition of nickel.

EXAMPLE I

To about 91.5% of a sinter iron powder of the following grain size composition:

	Percent
Above 0.2 to 0.3 mm.	20
Between 0.2 to 0.1 mm.	31
Between 0.1 and 0.06 mm.	38
Under 0.06 mm.	21

were added 1% of graphite with an ash content of 15%, 4% of lead powder and 3.5% of nickel powder.

The mixed powder was subjected to briquetting at a pressure of 3.5 tons/cm.², whereupon it was sintered at a temperature of 1100° C. in a neutral furnace atmosphere for three hours. Analysis of the unworked pieces revealed the following composition:

	Percent
C	0.62
Si	0.17
Mn	0.16
P	0.028
Sn	0.32
Cu	0.62
Pb	3.52
Ni	2.38

remainder Fe. The percentages referred to above are percentages by weight.

After briquetting and sintering, these unworked pieces with nickel addition had a pore content of approximately 20%, Brinell hardness was 26 to 27 kg./mm.² and was approximately 20% higher than unworked pieces without Ni-addition.

The unworked pieces were then subjected to a cold compression at a pressure of 12 tons/cm.², brought to a temperature of 830° C. for 15 minutes and then quickly cooled and tempered for 30 minutes at 580° C., whereupon the Brinell strength of the material was approximately 250 kg./mm.² at normal temperature (20° C.) and lower than 100 kg./mm.² at a temperature of 600° C. The specific gravity had risen from 6.7 to 7.3. The bending limit was 46.3 kg./mm.².

It is, of course, to be understood that the present invention is, by no means, limited to the above example, but also comprises any modifications within the scope of the appended claims.

EXAMPLE II

To about 78.0% of a sinter iron powder of the following grain size composition:

	Percent
Above 0.2 to 0.3 mm.	20
Between 0.2 to 0.1 mm.	31
Between 0.1 and 0.06 mm.	38
Under 0.06 mm.	21

were added 1% of graphite with an ash content of 15%, 4% of lead powder, 3.5% of nickel powder, 1.5% of molybdenum powder and 12% of cobalt powder.

The mixed powder was subjected to briquetting at a pressure of 3.5 tons/cm.², whereupon it was sintered at a temperature of 1100° C. in a neutral furnace atmosphere

for three hours. Analysis of the unworked pieces revealed the following composition:

	Percent
C	0.62
Si	0.17
Mn	0.16
P	0.028
Sn	0.32
Cu	0.62
Pb	3.52
Ni	2.38
Mo	1.3
Co	11.4

remainder Fe. The percentages referred to above are percentages by weight.

After briquetting and sintering, these unworked pieces with nickel, molybdenum and cobalt addition had a pore contents of approximately 20%, Brinell hardness was 35 to 40 kg./mm.² and was approximately 20% higher than unworked pieces without Ni-addition.

The sintered pieces were cooled, subjected to a cold compression at a pressure of 12 tons/cm.² and heated for a time period of 15 minutes to a temperature above the Ac 3-point; after quickly cooling they were finally tempered at temperatures of 580° C. for 30 minutes. The Brinell strength of the material was about 320 kg./mm.² at normal temperature (20° C.) and about 205 kg./mm.² at a temperature of 600° C.

The sinter iron materials are generally briquetted at a pressure of from 3 to 5 tons/cm.². The briquette is typically sintered at a temperature of from 1050° C. to 1150° C. for a time period of approximately from 2 to 4 hours. The sintered briquette is subsequently compressed at pressures from 10 to 15 tons/cm.². The final tempering step is conducted at temperatures of from 550° to 650° C. for a time period of from 20 to 40 minutes.

What I claim is:

1. A method of producing sinter powder metal iron materials, especially for sleeve valves and valve seating rings, which includes the steps of: to the total of iron powder to be processed admixing of from 0.8 to 1.5% of graphite, of from 1 to 4% of lead, and of from 0.5 to 5% of nickel, adding cobalt and molybdenum thereto in mixture ranging from 9.6 to 14.4% of cobalt and from 1.2 to 1.8% of molybdenum for increasing heat resistant stability of the sinter materials up to substantially 600° C., briquetting the thus obtained mixture at a pressure of from 3 to 5 tons/cm.², sintering the briquetted material at a temperature of from 1,050° C. to 1,150° C. for a time period of approximately 2 to 4 hours, subsequently compressing the thus obtained substance at a pressure of from 10 to 15 tons/cm.², quickly cooling the thus compressed substance, and finally tempering the resulting substance at temperatures of 550° C. to 650° C. for a time period of from 20 to 40 minutes.

2. A method according to claim **1**, which includes the step of: following the said compressing step and preceding the said quick cooling, heating the substance for a time period of from 10 to 20 minutes to a temperature above the Ac 3-point.

3. A method according to claim **1**, in which to approximately a total of 83% of iron powder are admixed 1.0% of graphite, 1.5% of lead, 2% of nickel, 1.5% of molybdenum and 12% of cobalt aside from nominal impurities.

4. A method according to claim **1**, in which to the iron powder there is also added from 0.05 to 0.2% of vanadium for enhancing structure strength.

5. A sintered heat treated alloy material composed of from 0.8 to 1.5% of C, from 0.15 to 0.2% of Si, from 0.12 to 0.18% of Mn, from 0.02 to 0.03% of P, from 0.3 to 0.4% of Sn, from 0.5 to 1.0% of Cu, from 1.0 to 4.0% of Pb, from 0.5 to 5% of Ni, from 1.2 to 1.8% Mo, from 9.6 to 16.2% Co and the remainder Fe.

(References on following page)

References Cited

UNITED STATES PATENTS

2,315,565	4/1943	Waltenberg.	
2,741,827	4/1956	Koehler	29—182
2,759,810	8/1956	Koehler.	
2,816,052	12/1957	Hoff et al.	148—12
2,842,471	7/1958	Koehler	148—12
2,882,190	4/1959	Thomson et al.	148—12
3,093,519	6/1963	Decker et al.	

OTHER REFERENCES

Kahles, J. F., "Formation and Transformation Studies of Iron, Carbon Powder Alloys," ASM, 1946, reprint, p. 1.

CHARLES N. LOVELL, Primary Examiner

U.S. Cl. X.R.

29—182, 182.5; 75—123, 125, 201; 148—12, 31