

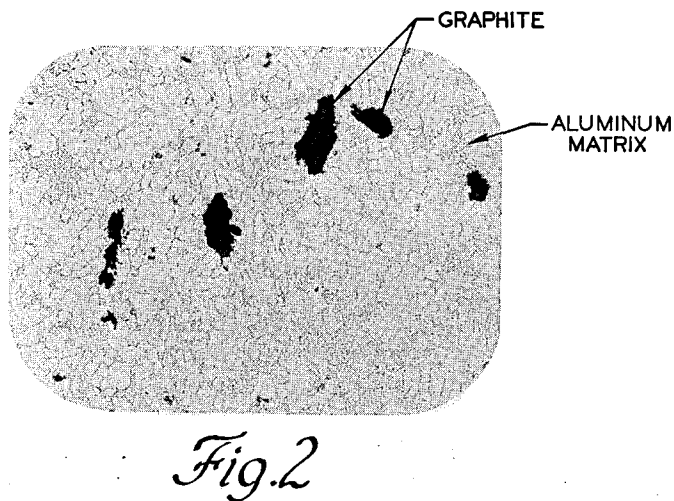
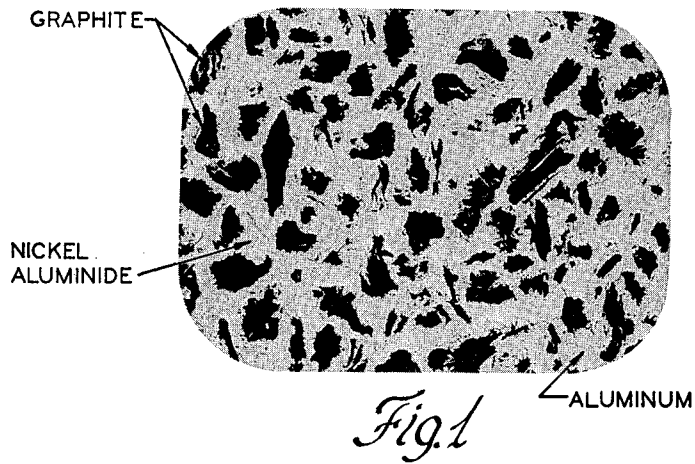
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METHOD OF PRODUCING GRAPHITIC ALUMINUM CASTINGS

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3,758,298

METHOD OF PRODUCING GRAPHITIC ALUMINUM CASTINGS

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5 Claims

ABSTRACT OF THE DISCLOSURE

A method of producing graphitic aluminum castings comprising first reacting nickel coated graphite powder with aluminum at an elevated temperature in a non-oxidizing environment to form on cooling a briquet consisting essentially of graphite particles and a discrete nickel aluminide intermetallic phase in an aluminum matrix and then immersing the briquet in an aluminum melt whereby the briquet melts and the graphite particles become suspended in the molten aluminum. The aluminum melt having a predetermined quantity of graphite dispersed therein is thereafter cast to form a graphitic aluminum casting.

This invention relates to aluminum castings and, more particularly, to a method of producing a graphitic aluminum casting having improved score resistance.

The term "aluminum" as used herein refers to aluminum and to aluminum alloys containing 80% or more aluminum. The term "graphitic aluminum" as used herein refers to aluminum containing from about 1.8% to about 4%, by weight, graphite.

Aluminum is commonly used in such applications as gears, bearings, and automotive pistons because of its light weight and its good thermal conductivity. Aluminum pistons, usually cast in permanent molds from high silicon-aluminum alloys, are used universally in the automotive industry today. One of the problems associated with the use of aluminum parts is that they are subject to scoring wear wherein small particles of aluminum metal are torn loose from the surface of the parts by materials, e.g., steel moving against the aluminum parts. In light duty applications, scoring wear is commonly controlled by heat treating the part to provide increased hardness which tends to prevent both penetration of the aluminum surface and deformation of the metal. In heavy duty applications anodizing or tin plating is used to provide protection.

It has been recently demonstrated, however, that aluminum having graphite contents above 1.8%, by weight, exhibits markedly improved score resistance when run against steel under boundary lubrication conditions. However, since aluminum does not "wet" graphite, a significant problem exists in dispersing graphite particles in an aluminum melt prior to casting of the aluminum. Wetting is a phenomenon involving a solid and liquid in such intimate contact that the adhesive force between the two phases is greater than the cohesive force within the liquid. Thus, a solid that is wetter in a liquid bath will have a thin continuous layer of liquid adhering to it which serves to hold the solid within the liquid. Since graphite is not wetted by aluminum, graphite particles merely dispersed in the aluminum melt will rise to the top of the melt since graphite has a lower specific gravity than aluminum. One solution to the problem of dispersing graphite particles in molten aluminum is to first coat the graphite particles with nickel, which does wet graphite, and then to pneumatically inject the nickel coated graphite into the molten aluminum using a non-oxidizing carrier gas such as nitrogen or argon to produce a suspension of graphite in the molten aluminum. Injection of the nickel coated graphite by the use of a non-oxidizing

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carrier gas is required for if the nickel coated graphite were merely immersed in the molten aluminum, the nickel coating would oxidize in the presence of the atmosphere and the oxygen entrapped in the melt thereby forming a nickel oxide coating on the graphite which prevents aluminum penetration through the coating to the graphite particles. The injection method has the disadvantage of being time consuming and difficult to control. In addition, the force of the gas bubbles rising through the melt tends to force the graphite particles toward the top of the melt resulting in a non-uniform distribution of the graphite particles.

Accordingly, it is the principal object of this invention to provide an improved method of producing graphitic aluminum castings. It is a further object of this invention to provide an improved method of introducing graphite into molten aluminum whereby the graphite particles become suspended and dispersed therein.

These and other objects are accomplished in the preferred embodiment of my invention by first providing nickel coated graphite powder having a size in the range from about 60 to 400 microns and in a predetermined quantity depending on the amount of graphite desired in the aluminum, and then, in accordance with the principal feature of my invention, reacting the nickel coated graphite powder in a non-oxidizing atmosphere with one part and preferably about 2 to 3 parts, by weight, aluminum to 1 part of said powder at a temperature of about 1300° F. At this temperature the aluminum exothermically reacts with the solid nickel coating producing a nickel aluminide compound. As the exothermic reaction is occurring, capillary action draws the molten aluminum completely through the nickel coated graphite thereby forming on cooling to room temperature a briquet consisting essentially of graphite particles and a discrete nickel aluminide intermetallic phase in an aluminum matrix. The briquet is then immersed in an aluminum melt whereby the briquet melts and the graphite particles become suspended in the molten aluminum thereby producing an aluminum melt having a predetermined quantity of graphite dispersed therein.

These and other objects and advantages will become apparent from the following detailed description of my invention reference being had to the accompanying drawings of which:

FIG. 1 is a photomicrograph at 100× magnification showing the microstructure of an aluminum-graphite-nickel aluminide briquet prior to introduction into an aluminum melt, and

FIG. 2 is a photomicrograph at 100× magnification showing the microstructure of a graphitic aluminum casting made in accordance with my improved method.

For purposes of illustrating the practice of my invention, a method of producing an aluminum casting containing about 0.9 wt. percent graphite will be described. However, it will be recognized that castings containing higher quantities of graphite can be made merely by increasing the amount of graphite powder used.

Five pounds of F132, an aluminum-silicon casting alloy typically used for pistons in internal combustion engines, was melted in an induction furnace and held at 1400° F. F132 has a nominal composition of 0.5% silicon, 3.0% copper, and 1.0% magnesium, balance aluminum. 108 grams of nickel coated graphite powder was placed in a graphite crucible with 108 grams of F132 aluminum alloy. Suitable nickel coated graphite powder for use in my invention is available from either the International Nickel Company or Sherritt Gordon Mines Limited in the general size range of 60 to 400 microns. The mixture was heated in a vacuum of 1 to 2 microns at a temperature of approximately 1300° F. Alternatively, the mixture can be heated in any non-oxidizing atmosphere, e.g. a 10

millimeter argon atmosphere. At the 1300° F. temperature, the aluminum exothermically reacts with the solid nickel coating producing a nickel aluminide compound. As the exothermic reaction was occurring, capillary action drew the molten aluminum completely through the nickel coated graphite in just several seconds. The reacted mixture was then cooled to room temperature whereby a briquet was formed. Referring now to FIG. 1, the microstructure of the briquet is seen to consist essentially of graphite particles and a discrete nickel aluminide intermetallic phase in an aluminum matrix. Microprobe analysis of the briquet showed the nickel coating to be completely reacted to a nickel aluminide compound. The briquet was then plunged into the aluminum melt until the aluminum in the briquet melted whereby the graphite in the briquet became suspended in the molten aluminum and dispersed therein by the convective forces in the melt. The graphitic aluminum melt was then cast in a permanent mold. FIG. 2 shows the microstructure of the resulting casting to be an aluminum matrix with particles of graphite dispersed therein.

From the foregoing it will be apparent that my improved method provides a much simpler and less expensive method of producing graphitic aluminum castings than heretofore available in the prior art. Although the invention has been described in terms of a specific embodiment, it is to be understood that other forms may be adapted within the scope of the invention.

I claim:

1. A method of producing a graphitic aluminum casting comprising the steps of providing a predetermined amount of nickel coated graphite powder sufficient to produce in said casting a graphite content from about 1.8 to 4.0 wt. percent, said powder having a size from about 60 to 400 microns, reacting one part by weight of said powder in a non-oxidizing environment with about 1 to 3 parts, by weight aluminum at a temperature above the melting point of the aluminum but below the melting point of the nickel coating whereby the molten aluminum infiltrates the powder and reacts with the solid nickel coating forming a nickel aluminide compound thereby forming on cooling a briquet consisting essentially of graphite particles and a discrete nickel aluminide intermetallic phase in an aluminum matrix, and immersing said briquet in an aluminum melt and, thereafter, introducing said melt into a mold to form said casting therein.

2. The method of claim 1 wherein said powder is reacted with about 2 to 3 parts, by weight, aluminum to

1 part of said powder at a temperature of about 1300° F.

3. A method of producing a briquet suitable for immersion in an aluminum melt to produce a dispersion of graphite particles therein comprising the steps of providing a predetermined amount of nickel coated graphite powder sufficient to produce in said melt a graphite content from about 1.8 to 4.0 wt. percent, said powder having a size from about 60 to 400 microns, and reacting one part by weight of said powder in a non-oxidizing atmosphere with about 1 to 3 parts, by weight, aluminum at a temperature above the melting point of aluminum but below the melting point of the nickel coating whereby the molten aluminum infiltrates the powder and reacts with the solid nickel coating forming a nickel aluminide compound thereby forming on cooling said briquet consisting essentially of graphite particles and a discrete nickel aluminide intermetallic phase in an aluminum matrix.

4. The method of claim 3 wherein said powder is reacted with about 2 to 3 parts, by weight, aluminum to 1 part of said powder at a temperature of about 1300° F.

5. A method of producing a graphitic aluminum casting comprising the steps of providing a briquet consisting essentially of graphite particles and a discrete nickel aluminide phase in an aluminum matrix, the graphite content of said briquet being sufficient to produce in said casting a graphite content from about 1.8 to 4.0 wt. percent, said briquet having been formed by reacting one part by weight of nickel coated graphite powder having a size from about 60 to 400 microns with about 1 to 3 parts, by weight, aluminum in a non-oxidizing environment at a temperature above the melting point of the aluminum but below the melting point of the nickel coating, immersing said briquet in an aluminum melt and, thereafter, introducing said melt into a mold to form said casting therein.

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RICHARD O. DEAN, Primary Examiner

U.S. Cl. X.R.

75—68 R, 142; 164—97

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,758,298 Dated September 11, 1973

Inventor(s) Robert E. Eppich

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 48, "ben" should be -- been -- ;

line 68, "penumatically" should be
-- pneumatically -- .

Column 2, line 62, "0.5%" should be -- 9.5% -- .

Signed and sealed this 25th day of December 1973.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

RENE D. TEGTMEYER
Acting Commissioner of Patents