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IMPROVING MAGNESIUM-BASE ALLOYS

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This invention relates to a method of improving the mechanical properties of cast magnesium-base alloys by treatment of the molten metal prior to casting.

A known process for improving the mechanical properties of cast magnesium-base alloys involves heating the molten metal prior to casting for a controlled period at a temperature well above ordinary casting temperatures, usually at above 1600° F. This treatment, which is frequently termed "superheating," effects a grain refinement of the solid metal formed on casting and increases its mechanical properties to a value considerably greater than that of cast metal which has not been "superheated."

While the "superheating" process is effective for its intended purpose, it is in practice limited in application to the treatment of comparatively small melts, since the requirements of time and fuel needed for heating large bodies of molten alloy at high temperatures and the difficulties of accurately controlling considerable changes of temperature in such bodies render the "superheating" of large melts uneconomic. As a result, the optimum properties of cast magnesium-base alloys resulting from "superheating" have for the most part not been attained in large-scale foundry operations and in the pouring of large castings.

In view of these facts it is the principal object of the present invention to provide a method of treating molten magnesium-base alloys prior to casting which produces in the cast metal mechanical properties at least as good as those obtained by "superheating" and which at the same time may be readily and economically applied in the treatment even of very large melts.

The invention depends upon the discovery that gaseous oxides of carbon, when brought into intimate contact with molten magnesium-base alloys maintained at ordinary casting temperatures, refine the metal to an extent such that castings formed from the treated melt exhibit a fine grain structure and improved mechanical properties at least equal to those of castings produced by the known "superheating" method.

In practicing the invention, the magnesium-base alloy to be refined and cast is melted under a protective saline flux and heated to a casting temperature, usually to 1300° to 1600° F., in accordance with conventional practice. A gaseous oxide of carbon is then introduced into or over the body of molten metal, which is agitated to insure intimate contact between the gas and all parts of the melt. Adequate agitation and con-

tact are most conveniently attained simply by bubbling a stream of the gas through the molten metal. Operation in this manner is continued for a time sufficient to produce the desired improvement in grain structure and properties of the metal after casting but insufficient to produce any substantial thickening of the melt by oxidation of the metal, usually for from 5 to 30 minutes. Following the gas treatment, the refined molten alloy is then cast into any desired form in known manner, the resulting article exhibiting a finer grain structure and improved mechanical properties as compared to articles cast from the same alloy without the treatment.

Either carbon monoxide or carbon dioxide may be used as the treating gas in the invention. Carbon monoxide is somewhat rapid in its action, but carbon dioxide is perhaps to be preferred because of its more ready availability and the fact that no health hazard arises if some of it escapes into the foundry atmosphere. The gases are preferably used in a pure or nearly pure state, although they may without serious disadvantages be admixed with air, combustion products, or like gases which are practically inert to magnesium alloys under the conditions of the process. They should, however, be largely free of hydrogen, water vapor, or gaseous hydrocarbons, since these gases may tend to introduce hydrogen into the magnesium alloy and thus to cause porosity in the castings subsequently poured.

The temperature of the magnesium-base alloy during the gas treatment is not critical, but may be maintained at any convenient value in the ordinary casting range, usually at 1300° to 1600° F.; the higher temperatures in the range permit a somewhat shorter treatment time. The rate of addition of the carbon monoxide or carbon dioxide, although not critical, is important, and should preferably be relatively high, addition at the rate of at least 0.004 cubic foot of gas per pound of metal per minute for periods of 5 to 20 minutes producing optimum properties in the cast metal.

In so far as is known, the process of the invention is applicable in improving the physical properties of all magnesium-base alloys. It is particularly advantageous in the case of magnesium-base alloys containing from 3 to 10 percent by weight of aluminum as the major alloying element, with or without lesser proportions of other elements such as manganese, zinc, and silicon.

The following examples will serve to illustrate

the invention, but are not to be construed as limiting its scope:

Example 1

A body of Downmetal E (a magnesium-base alloy containing 5.8 per cent by weight of aluminum and 0.12 per cent manganese, the balance being magnesium) was melted under a protective flux and heated to a temperature of 1500° F. Carbon dioxide was then bubbled through the melt at a rate of 0.005 cubic foot per pound per minute for a period of 5 minutes, after which the treated alloy, still at 1500° F., was poured into sand molds. On examination, the metal thus cast was found to have an average grain size of 0.006 inch, and to exhibit the following mechanical properties: tensile strength, 31,200 pounds per square inch; yield strength, 12,100 pounds per square inch; elongation, in 2 inches, 8.6 per cent.

For the sake of comparison, an otherwise identical casting was poured at 1500° F. from Downmetal E which had not been treated with carbon dioxide. It exhibited an average grain size of 0.009 inch and mechanical properties as follows: tensile strength, 27,600 pounds per square inch; yield strength, 9,500 pounds per square inch; elongation, in 2 inches, 7.4 per cent.

Example 2

A body of Downmetal H (a magnesium-base alloy containing 6.1 per cent aluminum, 3.0 per cent zinc, and 0.11 per cent manganese, balance magnesium) was melted under a protective flux and heated to 1400° F. Carbon monoxide was then bubbled rapidly through the melt for 20 minutes, after which the metal was cast in sand molds. The grain size of the resulting cast metal was 0.003 inch, and the mechanical properties were: tensile strength, 31,000 pounds per square inch; yield strength, 14,200 pounds per square inch; elongation, in 2 inches, 6.6 per cent.

A comparative casting poured at 1400° F. from

the same alloy before the carbon monoxide treatment had a grain size of 0.006 inch and physical properties as follows: tensile strength, 27,600 pounds per square inch; yield strength 10,700 pounds per square inch; elongation, in 2 inches, 5.7 per cent.

The foregoing description is illustrative rather than limitative, the invention being coextensive in scope with the following claims.

10 What is claimed is:

1. In a method of improving the mechanical properties of cast magnesium-base alloys by treatment of the molten metal prior to casting, the step which comprises agitating the molten metal in intimate contact with a gaseous oxide of carbon for a period sufficient to effect the desired improvement in properties but insufficient to produce a substantial thickening of the melt.

2. In a method of improving the mechanical properties of cast magnesium-base alloys by treatment of the molten metal prior to casting, the step which comprises maintaining the molten metal at a casting temperature below about 1600° F. and bubbling a stream of a gaseous oxide of carbon through the melt for a period which is at least about 5 minutes but is insufficient to produce substantial thickening of the melt.

3. A method according to claim 2 wherein the gas employed is carbon monoxide.

4. A method according to claim 2 wherein the gas employed is carbon dioxide.

5. A method according to claim 2 wherein the gas is introduced into the melt at a rate of at least 0.004 cubic foot per pound of metal per minute.

6. A method according to claim 2 wherein the alloy treated is a magnesium-base alloy containing from 3 to 10 per cent by weight of aluminum as the major alloying element.

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