

UNITED STATES PATENT OFFICE

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TREATMENT OF ALLOYS

No Drawing.

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The invention relates to methods of improving the internal structure and mechanical properties of easily oxidizable metals, such as aluminum and magnesium, or the alloys of easily oxidizable metals.

It is known to the art that the easily oxidizable metals, when molten, have a tendency to absorb gases and hold them either in mechanical suspension or in solution, principally the latter. This absorption is particularly troublesome in connection with the melting of aluminum and magnesium. These gases may come from various sources, usually from the furnace atmosphere during melting of the metal and in maintaining its heat until pouring, but possibly also from the atmosphere or other source. It is known that hydrogen may penetrate even the pots in which the metal is being heated. In addition to hydrogen, certain other gases such as nitrogen, carbon monoxide, carbon dioxide, methane, etc. have been noted by investigators in studies of the gases absorbed by molten alloys of the light metals.

The greater part of such absorbed gas may be held in solution in the molten metal and as the metal cools it becomes super-saturated with respect to the gas. When a casting is poured, escaping gases are frequently observed to disturb the surface of the molten metal in the gate but this never affords a complete method of escape for all the gases in the metal and sometimes a casting solidifies while still retaining a large and injurious quantity of entrapped gas. Occasionally, if a casting be fractured, the cavities formed by gas bubbles in the metal are visible to the naked eye, frequently the porosity from this source appears under the microscope, and, in many cases, there may be an appreciable amount of diffuse metallic unsoundness which, though submicroscopic, may be, under some circumstances, reflected either in reduced mechanical properties or unexpected failure of the article in service. In addition to being injurious in a casting, entrapped or dissolved gases are very undesirable in ingots which are subsequently to be worked by rolling, forging, or other mechanical de-

This invention is directed to a method of producing soundness in easily oxidizable metals and is particularly efficacious in producing internal soundness in articles fabricated from aluminum and magnesium and alloys of these metals. The invention resides in the discovery that if helium gas be passed through the molten metal before pouring into ingots or castings, the subsequent articles are greatly improved, and the gas content is considerably diminished.

A secondary benefit arising from the treatment of the metal with helium resides in the fact that dross or oxide films suspended in the molten metal are caused to rise to the surface of the molten metal from whence they may be skimmed before pouring. Previously, such a method of removing dross skins has met with little success since any gases used reacted injuriously with the molten metal or dissolved, with the undesirable results mentioned hereinabove.

Additional advantages resulting from the use of helium in the treatment of molten metal are that it is chemically inactive with respect to the metal, that it will not ignite or explode on escaping from the surface of the metal, and, as I have discovered, it does not appear to dissolve in the metal but will carry out the other gases which are dissolved therein, with the effect that the resulting casting or ingot is considerably sounder than one not similarly treated.

The amount of improvement which can be effected is dependent upon the previous condition of the molten metal. If extensive precautions have been taken to keep the molten metal free from gases or from dross or other suspended matter, the beneficial effect will not be so noticeable as if the metal has been prepared and melted under ordinary commercial conditions. It is economically advantageous to eliminate tedious and expensive preliminary precautions and to subject the metal to the simple and relatively short treatment hereinafter described.

With aluminum base alloys which are particularly prone to dissolve gases, the principal function of the treatment seems to con-

sist in the removal of the gas. Magnesium base alloys do not so readily dissolve gases but are particularly susceptible to oxidation or reaction with the atmosphere and other gases, causing numerous dross and oxide inclusions in the molten metal; these mechanical inclusions are carried to the surface by the helium which does not react with the molten magnesium but has a protective effect so long as it maintains its contact with the surface of the metal.

Although I have found the treatment with helium advantageous with a number of different alloys of the easily oxidizable metals, I have found it of particular usefulness in that type of alloy which contains substantial quantities of magnesium in an aluminum base. Alloys of this class have just recently come into commercial use by reason of new developments in their casting and fabricating technique and I have found their desirable properties to be markedly enhanced by treatment with helium.

As an instance of the improvement produced by the practice of the invention, a heat of an alloy of 10 per cent magnesium, balance aluminum, was prepared, and, after pouring a number of test specimens for the purpose of comparison, the balance of the molten metal was given several treatments with helium gas. In Table I, A indicates the average physical properties of a number of specimens of the alloy from the melt which was not treated with helium; B indicates the average properties of a number of specimens of the alloy from a portion of the melt through which helium gas had been bubbled for one minute; C indicates the average properties of a number of specimens of the alloy from a portion of the melt through which helium gas had been bubbled for two minutes; and D indicates the average properties of a number of specimens of the alloy from the portion of the melt through which helium had been bubbled for five minutes. After casting in sand, the specimens were heat treated for twenty hours at 800° Fahrenheit and quenched.

Table I

	Time of treatment with helium gas in minutes	Yield stress lbs. per sq. in.	Tensile strength lbs. per sq. in.	Per cent elongation in 2 inches
A-----	0	24,800	38,000	8.5
B-----	1	25,100	39,000	9.0
C-----	2	25,500	40,000	9.2
D-----	5	27,500	43,000	10.0

The results given in Table I indicate clearly the improvement in yield stress, tensile strength, and elongation as additional amounts of helium are passed through the molten metal. There is an increasing and

marked beneficial effect. This beneficial effect does not continue to increase in direct ratio to the amount of helium supplied, since the dissolved gases and mechanical inclusions are rapidly removed and the molten metal is soon in the optimum condition for pouring. After a period readily determined by experiment, further treatment has no appreciable effect.

Table II contains results showing the effect of helium treatment on the physical properties of an aluminum base alloy containing about 4 per cent copper. This metal was known to be badly gassed and the treatment with helium was intended to restore, if possible, its original properties. In the table, A indicates the result of tests on untreated metal and B indicates the result of tests on metal after a three-minute treatment with helium gas.

Table II

	Time of treatment with helium gas in minutes	Yield stress lbs. per sq. in.	Tensile strength lbs. per sq. in.	Per cent elongation in 2 inches
A-----	0	13,890	23,960	5.1
B-----	3	14,760	26,570	6.3

Any method or apparatus for fluxing molten metal with gas can be used. I have found it convenient to use a tank of helium gas (which is obtainable commercially) by connecting the tank through a flexible hose to a section of heat resistant tubing which can be dipped into the molten metal. The molten metal may be conveniently stirred, using the tube as a stirring rod, while the gas bubbles through the molten metal. A short time, usually less than six or seven minutes, is sufficient for small heats in the neighborhood of one or two hundred pounds of metal, but, in dealing with larger heats, it is well to extend the time until experiment shows that all potential improvement has been effected.

In this specification and in the appended claims, the term "aluminum" defines both the metallic aluminum and aluminum base alloys in which the aluminum content is more than 50 per cent while the term "magnesium" defines not only magnesium but magnesium alloys in which the magnesium content is more than about 50 per cent.

I claim:

1. The method of improving easily oxidizable metals, comprising treating the molten metal by passing therethrough helium gas.
2. The method of treating easily oxidizable metals to remove therefrom dissolved gases and mechanical inclusions, comprising melting the metal and fluxing the molten metal with helium.
3. The method of improving the internal

structure and mechanical properties of aluminum, comprising fluxing molten aluminum with helium gas.

4. The method of improving the internal structure and mechanical properties of magnesium, comprising fluxing the molten magnesium with helium gas.

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