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ROBERT J. ANDERSON, OF FAIRMONT, WEST VIRGINIA, ASSIGNOR TO FAIRMONT MANUFACTURING COMPANY, OF FAIRMONT, WEST VIRGINIA, A CORPORATION OF WEST VIRGINIA

PROCESS OF TREATING ALUMINUM WITH HALOGEN GASES

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My invention relates to a process of treating molten metals, including alloys, with halogen gases, and has relation especially to the treatment of aluminum and its alloys to improve their mechanical characteristics.

Molten metals, by which I mean to include alloys, and particularly aluminum and its alloys, may, and usually do, contain dissolved gases and other impurities, such as foreign suspended matter. The dissolved gases present in a metal depend upon the particular metal, the conditions under which the same is melted, the process of manufacture, etc., and, generally speaking, the gases present cannot be controlled effectively, or at all, under the conditions of manufacture. Where dissolved gases are present in metals the effect is to cause porosity in the castings made therefrom, which is, of course, of great moment in foundry practice as it leads to rejection of castings, weakness, breakages, etc. It is found that metals dissolve increasing quantities of gases with increasing temperature of melting, thus departing from Henry's law which applies to other liquids. Also, such metal-gas solutions tend to remain saturated. That is to say, as the temperature is decreased from a higher temperature the molten metal does not give off gas at the same rate at which the gas was taken up, and, on solidifying, there is a tendency for a considerable volume of gas to be evolved, causing blow-holes and porosity.

I have discovered that these gases, and also other deleterious suspended solid impurities, by which term I mean to include solids which become molten or not when the body of metal is melted, may be removed by treatment of the metal with a halogen gas, such, for example, as chlorine, bromine, or fluorine, and that this is particularly true when using such a gas which is only dissolved with difficulty by the metal at a given temperature. It is also desirable to use in this connection, a gas which does not combine to an undesirable extent with the metal itself. However, gases which do combine with the metals may be, and are used in my process with effective results.

The object of my invention is, therefore, to remove such gases and other deleterious matters from metals in the above manner. The theory of the action of the removal thereof is not entirely known but it is believed that the action comprises mainly the removal of the dissolved gases and other deleterious impurities mechanically by agitation due to the introduction of the gas or gaseous materials as above referred to, although there may be, also, some combination brought about with the dissolved gases, or other deleterious impurities, as well. The deleterious solid impurities which are removed in this way are of various kinds, according to the particular kind of metal treated. These comprise the various suspended solid impurities present in the different metals, such as dirt, oxides, nitrides, carbides, etc. In the case of aluminum, for example, and its alloys, I have demonstrated that clean aluminum made by being subjected to my process, has very superior mechanical properties as compared with aluminum which has not been subjected to my process. In fact, in all such metals, not only do solid non-metallic impurities produce zones of weakness around the inclusions as referred to, but such impurities when present even in relatively small percentages, have been found to have a profound influence on the mechanical properties, as well as on the working, rolling and casting qualities of the different metals. Also, the metal so treated is found to have greatly increased strength and to be capable of much greater elongation. In fact, it has been found previously substantially impossible to remove or reduce by any previously known method small percentages of impurities such as can be removed by my process. I have found that even very small percentages of impurities may be practically entirely removed by treatment in my process.

While my invention is capable of embodiment in many different forms, for the purpose of illustration I shall describe only certain forms of my invention hereinafter.

For example, in carrying out my invention I may use any desired halogen gas, such, for instance, as chlorine, bromine or

fluorine. For instance, in treating aluminum I provide a bath of molten aluminum which may have any desired temperature, such as 700° C., or above, and then apply chlorine gas to the metal as by bubbling it through the molten metal until the impurities are substantially entirely removed. This will ordinarily comprise the introduction of nascent chlorine into the metal so that, say 1 cu. ft. of chlorine, referred to standard conditions of temperature and pressure, is introduced per 300 lbs. of aluminum, after which the metal may be poured to form a finished or semi-finished casting. In this treatment the chlorine gas may be applied to the metal in any desired way and in any desired type of apparatus, but, for example, the gas may be injected into the metal with the aid of a perforated pipe which may be located in the metal in such a way that the perforations therein for the discharge of the chlorine are located at the bottom of the molten aluminum. The chlorine combines with the aluminum nitride or carbide, and the dissolved gases, etc., driven out pass out into the atmosphere. The chlorine bubbling upwardly through the liquid has an agitating action which removes the foreign suspended materials due to the resultant upward currents therein. Those impurities which do not combine chemically with the chlorine rise to the surface, forming a scum or dross, which is removed by skimming. In the case of aluminum, the impurities present may be reduced in this way to practically nil.

While I have described my invention above in detail I wish it to be understood that many changes may be made therein without departing from the spirit of the same.

I claim:

1. The process which comprises removing an impurity from aluminum containing aluminum oxide as an impurity by the application of halogen gas thereto so as to combine with the aluminum oxide therein.

2. The process which comprises removing an impurity from aluminum containing aluminum oxide carbide and nitride as impurities by the application of a halogen gas thereto so as to combine with the aluminum oxide, also with aluminum carbide and nitride therein.

3. The process which comprises removing an impurity from aluminum by the application of a halogen gas thereto.

4. The process which comprises removing a gaseous impurity from aluminum carrying the same by the application of a halogen gas thereto.

5. The process which comprises removing a solid impurity while remaining in solid form from aluminum by the application of a halogen gas thereto.

6. The process which comprises removing an impurity from aluminum by the application of chlorine thereto.

7. The process which comprises removing a gaseous impurity from aluminum carrying the same by the application of chlorine thereto.

8. The process which comprises removing a solid impurity while remaining in solid form from aluminum by the application of chlorine thereto.

In testimony that I claim the foregoing, I have hereunto set my hand this 28th day of April, 1928.

ROBERT J. ANDERSON.