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METHOD OF REMOVING HARD SPOTS FROM ALUMINUM-SILICON ALLOYS

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The invention relates to the production of aluminum-silicon alloys for casting various articles, and also to cast articles made from such alloys. While in its broader aspect the invention is unlimited to aluminum-silicon alloys for any particular purpose, it is especially applicable to these alloys for use in casting pistons for internal combustion engines, and is herein described with particular reference to this use.

The major operations in the manufacture of aluminum base alloy pistons are the casting of the metal into rough piston forms, and subsequent machining to desired shapes and dimensions. The machining operation, which is necessarily separately performed on each piston, must be accurate, rapid, and efficient, for otherwise large scale production at a low cost is impossible. In the machining of pistons made of aluminum base alloys containing substantial amounts of silicon, certain difficulties have been encountered which have seriously impaired the efficiency of the operation and the quality and serviceability of the final product. These difficulties have been caused by what are known as "hard spots", by which are meant minute areas of a hard and refractory nature which occur in these alloys, and which, rather than being cut by machine tools, tend to be pulled out bodily from the metal, thus not only leaving pits in the surface, but also dulling the tools. This is true even when the best machine tools are used. Furthermore, such hard spots as remain in the surface of a piston after it is machined may score the cylinder in which the piston is used.

The object of this invention is to provide a method of producing aluminum-silicon casting alloys which are totally or substantially free from hard spots, and to provide aluminum-silicon pistons cast from such alloys, which pistons, as a result of freedom from hard spots, may be readily and satisfactorily machined, and which when machined are free from pits and from hard areas and projections.

Aluminum-silicon alloys are usually made either by the direct alloying of commercial aluminum and metallic silicon by well known metallurgical methods, or by alloying commercial aluminum with an aluminum-silicon alloy produced by thermal reduction of aluminous and siliceous ores in electric furnaces. These alloys, which generally contain from 30 to 80% of silicon, the balance being aluminum and a small amount of impurities, are herein designated as "concentrated" aluminum-silicon alloys because they contain larger percentages of silicon than aluminum-silicon casting alloys formed from them. In the manufacture of aluminum-silicon casting alloys, concentrated aluminum-silicon alloys are diluted with commercial aluminum to form alloys containing from about 3 to 35% of silicon. These casting alloys, sometimes with the additions of other alloying elements, are considered from many standpoints as the most useful of the aluminum base alloys from which pistons are cast, although they have, as previously stated, the serious characteristic of containing hard spots.

My invention is predicated upon my discovery that an aluminum-silicon casting alloy, free or substantially free from hard spots, may be produced by subjecting a concentrated aluminum-silicon alloy to the action of an electrolytic cell in which aluminum is being produced, the cell being such as that used in the production of aluminum from alumina. In such treatment, the concentrated aluminum-silicon alloy may be diluted to produce an aluminum-silicon casting alloy containing the desired amount of silicon, or less dilution may be effected. In the latter case, the treated aluminum-silicon alloy remains concentrated to such an extent, as far as concerns its silicon content, that it may later be used to alloy with commercial aluminum to form an aluminum-silicon casting alloy.

As is well known, the electrolytic production of aluminum is accomplished in an electrolytic furnace or cell comprising a carbon-lined receptacle containing a lower layer of molten aluminum, which acts as the cathode, and an upper layer of fused cryolite bath covered by a top crust. Within the fused cryolite bath there are suspended carbon electrodes which serve as anodes. In the

operation of the process, alumina is periodically added to the cryolite bath, and by the action of an electric current is electrolytically reduced therein to form metallic aluminum which sinks from the cryolite bath to the cathode layer of molten aluminum. After a certain amount of metal has accumulated, a portion of it is tapped from the furnace or cell.

According to my invention, there is added to such an electrolytic cell, while it is producing aluminum, an amount of concentrated aluminum-silicon alloy which contains the hard spots desired to be removed. This alloy passes through the layer of cryolite bath into the molten aluminum cathode layer where it is melted by the heat of the surrounding metal. This produces in the cell a cathode of aluminum-silicon alloy which is diluted, with respect to silicon, in proportion to the amount of molten aluminum in the cell, as well as in proportion to the amount of concentrated aluminum-silicon alloy added to the bath, and its percentage content of silicon. The action of the cell remains undisturbed until the desired amount of aluminum has been produced by its operation and accumulated in the cathode layer, at which time the cell is tapped in the usual manner to remove a substantial portion of the aluminum-silicon alloy from which hard spots have been removed.

The concentrated aluminum-silicon alloy added to a cell may vary widely in its percentage content of silicon. In the preferred practice of my invention, I have used concentrated aluminum-silicon alloys containing from 50 to 80% of silicon. However, the concentrated alloys,—it being in these that the hard spots are found, may contain much less than 50% of silicon to produce an aluminum-silicon casting alloy containing from 3 to 35% of silicon, which are those commercially used. Ordinarily, the silicon content of the concentrated alloys used in this process is not less than 30%, or more than 90%.

By way of example, if a concentrated aluminum-silicon alloy produced by the electrothermal reduction of aluminous and siliceous ores, and which contains about 75 to 80% of silicon, is added to an electrolytic cell which is in operation producing aluminum, the alloy sinks to the cathode aluminum layer in the cell, and becomes diluted by the aluminum in such a manner as to form an aluminum-silicon cathode layer of such composition that it may be directly used as a casting alloy without further dilution. In the case of an electrolytic cell which produces 200 lbs. of aluminum between tappings, 30 lbs. of a concentrated aluminum-silicon alloy containing 80% silicon and 20% aluminum may be added to the cell during its operation to produce approximately 230 lbs. of an aluminum-silicon casting alloy containing 10% silicon, and free from hard spots. If it is desired to produce an alloy containing 20% silicon, a proportionately larger amount of the concentrated aluminum-silicon alloy is added. If the resulting alloy contains too large a percentage of silicon for use as a casting alloy, it may be diluted to the desired composition by the addition of commercial aluminum without the formation of hard spots, or without otherwise prejudicially affecting its properties. However, if the alloy is deficient in silicon, more silicon should not be added directly to it except in the form of a more highly concentrated aluminum-silicon alloy which has been treated in an electrolytic cell in the manner described.

In the work which I have done on the removal of hard spots from aluminum-silicon casting alloys, I have attempted to determine the nature of the hard spots found in this metal, which, as far as known to me, has not hitherto been determined. I have discovered that the material which forms the hard spots partakes of a non-metallic nature, and is probably a form of crystalline alumina. However, regardless of what its true nature may be, which may still be problematical, the process herein provided effectively, and, for all practical purposes, completely, removes this material from the alloy, so that pistons cast from the alloy exhibit none of the machining difficulties consequent upon the presence of hard spots. The pistons when machined are smooth and free from pits and from hard areas and projections, and accordingly do not score the interiors of cylinders in which they are used.

The resulting aluminum-silicon casting alloys when used for forming pistons, are usually so adjusted as to contain from 3 to 35% of silicon, and occasionally to contain other alloying elements, such as zinc, magnesium, copper, manganese, nickel, and the like. Furthermore, these alloys may be "modified" or treated with amounts of sodium, potassium, calcium, and their salts, as is well known to those skilled in this art. The addition of these alloying elements and modifying or treating agents should take place after the concentrated aluminum-silicon alloy has been passed through an electrolytic cell, although in some cases it has been found to be possible, but not advantageous, to add certain of the alloying elements, such as copper, before treatment in an electrolytic cell.

According to the provisions of the patent statutes, I have explained the principle and mode of operation of my invention, and have given specific examples of how it may be practiced. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

In particular, although I have described my process as being practiced in an electrolytic cell of a certain nature, it will be understood that any electrolytic cell in which aluminum is produced may be used.

I claim as my invention:

1. The method of removing hard spots from a concentrated aluminum-silicon alloy formed by the thermal reduction of aluminous and siliceous ores, comprising subjecting such alloy to the action of an electrolytic cell in which aluminum is being produced.

2. The method of producing a readily machinable aluminum-silicon casting alloy, comprising subjecting a concentrated aluminum-silicon alloy to the action of an electrolytic cell in which aluminum is being produced, and removing from the cell the resulting aluminum-silicon casting alloy diluted with aluminum and substantially free from hard spots.

3. The method of producing a readily machinable aluminum-silicon casting alloy, comprising subjecting a hard-spot including aluminum base alloy containing from 50 to 80% silicon to the action of an electrolytic cell in which aluminum is being produced, and removing from the cell the resulting aluminum base alloy so diluted with aluminum as to contain from 3 to 35% silicon, the resulting alloy being free from hard spots.

4. The method of producing a readily machinable aluminum-silicon piston-casting alloy, comprising subjecting to the action of an electrolytic cell in which aluminum is being produced, a concentrated aluminum-silicon alloy formed by the thermal reduction of aluminous and siliceous ores, and removing from the cell the resulting alloy diluted with aluminum and substantially free from hard spots.

In testimony whereof, I sign my name.

ROBERT S. ARCHER.