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PROCESS OF TREATING MOLTEN NICKEL AND NICKEL ALLOYS WITH COMPOSITIONS CONTAINING "LITHIUM-ALKALI" ALLOYS AND PRODUCTS RESULTING FROM SUCH TREATMENTS

No Drawing. Application filed December 21, 1931, Serial No. 582,492, and in Canada June 26, 1931.

The present invention relates to a process of treating nickel-bearing metals and alloys in their molten state with an alloy of lithium and a metal of the "alkali" group, including alkali, and/or alkaline earth groups and/or rare earth group and to the improved products resulting from such a process.

Heretofore, a great variety of scavengers and improvers of nickel-bearing metals and alloys have been proposed. Of these scavengers and improvers, the more important were manganese, silicon, magnesium, metallic lithium, metallic calcium, etc. From an industrial point of view manganese, silicon, and magnesium have been the most important, but the art was attempting to obtain better and more satisfactory results than those obtained by the use of these substances. With this object in view, those skilled in the art were attempting to find improved scavengers. Metallic lithium and metallic calcium were proposed, but it was found that these metals had shortcomings and disadvantages when used on an industrial scale. The more serious disadvantages were that the molten metal and alloy undergoing treatment was not cleaned completely, did not possess the desired improved properties and usually was contaminated with impurities or contained blow holes. In other words, when lithium or in fact some other metal of the alkali group or alkaline earth group was added to a molten bath of metal these disadvantages were encountered which in many cases not only counterbalanced any advantages but actually overbalanced any advantages. From a practical point of view, it was found that the use of these metals was not wholly economical and satisfactory on an industrial scale. Various suggestions have been made for remedying the shortcomings and disadvantages noted hereinabove with respect to prior scavengers including metallic lithium and metallic calcium and/or processes of using the same but, as far as is known, no scavenger and/or improver and/or process of using the same has been proposed which is wholly satisfactory and practical when used on an industrial scale.

It is an object of the present invention to provide a process of treating nickel-bearing metals and alloys in their molten state so as to obtain the benefits resulting from lithium treatments without the disadvantage noted hereinabove.

It is a further object of the invention to provide a simple, economical and thoroughly satisfactory process of treating nickel-bearing metals and alloys in their molten state with active lithium-bearing substances so as to improve the characteristics thereof.

It is another object of my invention to provide a process of treating molten metals and molten alloys with an active lithium alloy of a metal of the alkali group or alkaline earth group or rare earth group which is capable of being carried into commercial practice on an industrial scale in the ferrous and the non-ferrous industries, which is also capable of producing greater effects than provided by the same amount of lithium and the like.

Other objects and advantages of the invention will become apparent from the following description.

Broadly stated, my invention contemplates the treatment of molten nickel-bearing metals and alloys with an active lithium alloy of a metal of the alkali group or alkaline earth group or rare earth group in which the lithium is so bonded that the loss thereof through volatilization and the like is materially reduced. At the same time, the lithium alloy can function actively to effect improvements in the properties and qualities of the metallic substance under treatment. I have found that in carrying my invention into practice, that lithium alloys containing members of the alkali or alkaline earth families such, for example, as calcium, barium, strontium, magnesium, lanthanum, cerium, sodium or potassium or relatively stable compositions of lithium and silicon or of mixtures of the foregoing substances can be utilized in the treatment of metals and alloys in their molten state so as to effect improvements in the properties and qualities in the metals or alloys treated.

In order to show the powerful scavenging effect of the present "lithium alkali" alloys

a fairly good grade of scrap nickel, such as used to produce a good nickel castings was melted in an arc furnace of about 1 ton capacity. One portion of this melt was treated with about 0.1% of magnesium while another portion was treated with about 0.03% of the present "lithium-alkali" alloy, for instance lithium-calcium.

Photomicrographs of the magnesium treated nickel show coarse particles of impurities in collected masses whereas microphotographs of the "lithium-alkali" treated nickel disclosed clean metal with only a few fine particles of impurities widely distributed in the metal.

A fairly good grade of scrap monel was melted in an arc furnace, and a few ladles were treated in the usual way with about 0.1% magnesium while other ladles were treated with different compositions of the present lithium alloys containing metals of the alkalis or alkali earths.

Photomicrographs of a specimen treated with magnesium in the usual way showed that the metal is fairly clean but the impurities have not segregated entirely. In addition, there are still some gases left as shown in the photomicrographs of the unetched specimen. Furthermore, the metal is rather weak, due to the accumulated impurities at the grain boundaries.

A portion was treated with 0.04% of a lithium-alkali-earth alloy. A photomicrograph of an unetched specimen shows a clean metal where the small impurities left in the metal have accumulated, no gases are shown. The photomicrograph of the etched specimen shows a clean and strong metal.

Some of the physical data obtained in a series of tests may explain the superiority of the present process.

Scrap monel was melted and cast as customary, one part being treated as usual with magnesium and the other parts according to the present method:

	Tensile # sq/in.	Elongation
		Per cent
Treated with Mg	37-39000	6-11
Present treatment	58-65000	18-25

A comparison of the data of magnesium treated with Monel metal and the "lithium-alkali" treated with Monel metal gave the following results:

Per cent increase over the Mg treated monel

Elastic limit	Ultimate T. S.	Ductility of elongation
60-110 per cent	50-55 per cent	150-210 per cent.

It is well known, that the production of workable castings from monel scrap is very difficult, (if not impossible) because the scrap metal contains so many impurities distributed throughout the structure in such large amounts as to prohibit the production of metal with satisfactory working quantities. It is to be observed that the improvement shown on scrap material, bringing it up to virgin metal qualities, is far more striking than the improvement obtainable on the virgin metal itself. Furthermore, this progress and improvement is not only of great interest scientifically and technically, but even more economically and industrially.

In every case there was a better fluidity of the molten material than of the magnesium treated ones. The corrosion resistance was quite remarkably increased, as found in etching the specimen under the same conditions and as confirmed by corrosion tests.

The following examples are given for illustrative purposes and for a better understanding of carrying my invention into practice.

Example No. 1

In the treatment of nickel or nickel alloys, for instance the molten metal is contained in a furnace or suitable crucible such as a graphite crucible or in a bull ladle or in an ingot mold. To the molten mass I add in any appropriate manner, an active lithium alloy, for example, an alloy of lithium and calcium in an amount sufficient to effect improvements in the properties of the nickel or nickel alloys. In practice, I have found that up to about 2 parts of an alloy of lithium and calcium having about a 50% lithium content are capable of effectively treating about 100 parts of molten nickel or nickel alloys.

The addition of the active lithium alloy to the molten metal is preferably effected by plunging the selected amount of active lithium alloy into the molten material in a crucible by any appropriate means such as an inverted cup with side openings or ports or the like. By adding the active lithium alloy to the molten metal in the aforesaid manner, I am able to effect a thorough distribution of the lithium alloy throughout the molten mass and to effect the proper treatment of said metal to improve the properties and qualities thereof.

When nickel or nickel alloys thereof are treated with one of my active lithium-bearing alloys, the molten mass has a better fluidity and consequently, can be cast very much better than heretofore and gives better and denser castings. In addition, the physical properties of the nickel or nickel alloy treated and the finished product is relatively or practically free from blow holes, oxygen, sulphur and the like.

Example No. 2

When nickel or nickel alloys are used for

the production of castings, I add to about 100 parts of molten nickel or nickel alloy prior to casting enough of a lithium alloy such as lithium-calcium alloy or a mixture of lithium alloys having such a composition as to give a lithium content up to about 1%. The lithium alloy is preferably added in the form of a solid briquette, block, lump or the like which is introduced into the body and preferably the lower portion of the molten mass of nickel or nickel alloy by means of an inverted cup or other appropriate instrumentality. The lithium alloy thus added, improves the crystal structure of the nickel; combines with gases, such as hydrogen oxygen and nitrogen, and also with such detrimental substances as sulphur and phosphorus; increases the fluidity of the molten nickel and produces denser and sounder casting than produced heretofore. In practice, I prefer in some instances to add the lithium alloy in a mass which is surrounded by or coated with nickel silicide. By adding the lithium alloy in this manner, the procedure is facilitated. If it is desired, a lithium-calcium alloy can be silicided and then the silicided lithium alloy used for the treatment of the molten metal or alloy.

In some instances, I prefer to employ an alloy of lithium with the metal or alloy to be treated. For example, if nickel is to be treated, I use an active lithium alloy containing nickel. The lithium alloys should preferably be silicided or reacted with silicon prior to use.

The amount of lithium alloy added to the molten metallic mass depends upon a number of variables as one skilled in the art will readily understand. For example, the percentage of lithium in the lithium alloy will determine in part how much of the substance is to be used. Then again, the amount of impurities and gases in the molten metal or alloy and the improvement to be given to the metal or alloy will also have to be taken into account in determining the amount of lithium-bearing substance to be used.

It will be observed that the present invention provides a process which can be utilized on an industrial scale to produce successful and satisfactory results which are acceptable to those skilled in the art.

It will be further observed that the present invention provides a method for the production of improved metals and alloys which not only can be carried out on a laboratory scale but which also can be carried out on an industrial scale.

It will also be noted that the present invention provides a process by the use of which the disadvantages inherent in the sole use of lithium alone or other member of the alkali group or the alkaline earth group alone are avoided and unexpected advantages are obtained from the use of lithium alloys of metals of the alkali group or the alkaline earth group. The lithium in alkali alloys contemplated by my invention is exceedingly active and has an activity which could not be predicted from the prior use of lithium alone or of other metals of the alkali or alkaline earth groups alone.

Although I have herein described specific illustrative examples of my invention which included specific substances, percentages and the like, it is to be observed that the invention is not to be limited thereto but the scope and spirit thereof is to be determined by the appended claims. For instance, when in the specification and claims I use the term "lithium-alkali alloy" it is intended to mean lithium alloy of a metal of the alkali group or alkaline earth group or rare earth group. Similarly when the term "alkali" is used, it is intended to refer to alkali group, alkaline earth group or rare earth group.

The present application is a continuation in part of my co-pending application, Serial No. 467,625, filed July 12, 1930, entitled "Processes of treating molten metals and alloys with compositions containing lithium and products resulting from such treatment."

What is claimed is:

1. The process of treating nickel and/or nickel alloys thereof in their molten state to improve the properties thereof, which comprises treating said nickel and/or nickel alloys thereof while in a molten state with a "lithium-alkali" alloy.

2. The process set forth in claim 1 in which the "lithium-alkali" alloy contains lithium and calcium.

3. The process set forth in claim 1 in which up to about 2 parts of the "lithium-alkali" alloy is used to about 100 parts of nickel and/or nickel alloys thereof.

4. The process of treating nickel and/or nickel alloys thereof in their molten state to improve the properties thereof which comprises dipping a solid body of an active "lithium-alkali" alloy into a molten mass of nickel and/or nickel alloys thereof to be treated and stirring the thus treated molten mass to effect a thorough distribution of said "lithium-alkali" alloy.

5. The process of treating nickel and/or nickel alloys thereof in their molten state to improve the properties thereof which comprises adding a briquette containing an active "lithium-alkali" alloy to the lower portion of a molten mass of nickel and/or nickel alloys thereof to be treated and causing a thorough mixing of said lithium alloy in said molten nickel and/or nickel alloys thereof.

6. The process of treating nickel and/or nickel alloys thereof in their molten state to improve the properties thereof which comprises adding a lithium-calcium alloy to a molten mass of nickel and/or nickel alloys

thereof to be treated and stirring said molten mass to effect a treatment of the various parts of said mass with said lithium-calcium alloy.

7. The process of treating nickel and/or nickel alloys thereof in their molten state to improve the properties thereof which comprises dipping a block of lithium-calcium alloy into the lower portion of a molten mass of the nickel and/or nickel alloys to be treated and effecting a distribution of said lithium-calcium alloy substantially throughout said mass.

8. The process of treating nickel and/or nickel alloys thereof in their molten state to improve the properties thereof which comprises adding a lithium alloy containing an "alkali" metal to a molten mass of metal or alloy to be treated and stirring said molten mass to effect a treatment of the various parts of said mass with said lithium alloy containing an "alkali" metal.

9. The process set forth in claim 8 in which the lithium alloy is coated with lithium.

10. The improved nickel and/or nickel alloy which comprises a nickel and/or nickel alloy resulting from the treatment thereof in a molten state with a "lithium-alkali" alloy.

11. The improved nickel and/or nickel alloys thereof as set forth in claim 10 in which the active lithium alloy is a lithium calcium alloy.

12. An article of manufacture comprising an improved nickel and/or nickel alloy thereof containing residual "lithium-alkali" alloy.

13. An article of manufacture set forth in claim 12 in which the "lithium-alkali" alloy comprises lithium and calcium.

In testimony whereof I have hereunto set my hand.

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