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PROCESS AND COMPOSITION OF MATTER FOR DEOXIDIZING METALS AND ALLOYS.

No Drawing. Application filed May 11, 1921. Serial No. 468,779.

To all whom it may concern:

Be it known that I, ALADAR PACZ, a citizen of the United States, residing at Cleveland Heights, in the county of Cuyahoga and State of Ohio, have invented a certain new and useful Improvement in Processes and Composition of Matter for Deoxidizing Metals and Alloys, of which the following is a full, clear, and exact description.

This invention relates to the production and refining of metals and alloys and has special reference to the manufacture of steel, though not limited thereto. It is well known that one of the important effects to be guarded against is the presence of oxygen or oxygen compounds in the resultant metal for which reason various deoxidizers are employed, chiefly manganese, silicon, aluminum and titanium, or alloys thereof. Of these the most powerful deoxidizer is aluminum, its effect, as determined by Brinell, being ninety times that of manganese and eighteen times that of silicon, but its use is attended with certain practical difficulties, chief among which is the refractory nature of the alumina produced and the difficulty of removing it from the bath. As a result the particles of alumina remain disseminated throughout the mass with serious impairment of the physical properties.

The main object of my invention is the provision of a method and composition of matter for the treatment of such metals and alloys as shall enable the utilization of the deoxidizing properties of aluminum while avoiding these disadvantages; the provision of a composition of matter containing ingredients additional to the aluminum, which under the conditions of reaction, will combine with the alumina to produce a slag of lower melting point than the metal bath; the provision of a new and improved process for introducing alloying elements in steel and other metal baths; the provision of a process for producing alloy steels by the use of alloying ingredients introduced in other than the metallic state; the provision of a simple process and composition of matter for producing alloy steels and other alloys free from admixture with non-metallic impurities; while further objects and advantages of my invention will become apparent as the description proceeds. This application is in part a continuation of my former application filed March 18, 1920, Serial No. 366,968.

The essence of my invention consists in the admixture with the aluminum of a substance capable of uniting with the resulting alumina to produce an easily fusible slag. According to the simplest form of the invention, powdered aluminum is briquetted with cryolite or with sodium aluminum fluoride artificially produced and introduced into the molten bath. Another mode of producing this result resides in the employment of substances not initially capable of uniting with alumina but which become capable of such action under the conditions of the reaction. For example: I mix thoroughly and compact into briquette form finely divided aluminum, and sodium silico-fluoride, the aluminum being present in excess of that required to replace the silicon. For example, I take two parts of pulverized aluminum to one part of sodium silico-fluoride, briquette the composition with or without the use of a binder, and introduce deep into a molten bath of steel or like metal, afterwards stirring to incorporate thoroughly, or I introduce a briquette of this material into the bottom of the mould and pour the steel thereon, mixing being effected by the flowing. The reaction is as follows: Each 56 parts of the sodium silico-fluoride reacts with 11 parts of aluminum as follows:

$$3Na_2SiF_6+4Al=3Si+6NaF+2Al_2F_6$$

The silicon together with the remainder of the aluminum combines with any oxygen that may be present, either in the combined or dissolved condition, to produce Al_2O_3 and SiO_2. These combine together and with the double fluoride produced by the other part of the reaction to form a slag whose melting point is lower than that of the metal bath. The melting point of this slag can be varied by varying its ingredients, a higher proportion of the double fluoride decreasing it. Also the aluminum need not be added in pure form but may be and in fact preferably is alloyed previously with sufficient silicon to produce an easily disintegrated material. I also may use silico-manganese-aluminum, or numerous other aluminum alloys suitable for each specific purpose. In these cases the additional elements exhibit each its own deoxidizing action and also lower the melting point of the resulting slag.

I do not exclude the condition wherein only sufficient aluminum is employed to re-

act upon the sodium silico-fluoride in which case the resulting silicon, being in the nascent condition, exercises a deoxidizing effect far greater than when in the usual form, and the slag produced has a very low melting point.

As another example of my invention the briquettes may contain 75 parts silicon, 86 parts aluminum, 56 parts $Na_2 Si F_6$. When introduced into a bath of molten iron or steel which contains oxygen in solution, either in the free or combined form, a complicated reaction results whereby the silicon becomes oxidized to silica, a portion of the aluminum becomes oxidized to alumina, and another portion of the aluminum combines with the sodium silico-fluoride to produce silicon and sodium-aluminum-fluoride. The silica and alumina are independently extremely refractory, and even when combined they possess a melting point approximately that of a very pure clay, namely about 1800° C., but the sodium-aluminum-fluoride has a melting point of only about 600° C. and in addition exercises a vigorous dissolving action upon these other substances with the production of a slag-like substance which melts below the temperature of the bath and is therefore very easily eliminated.

I do not restrict myself in all cases to the use of a double fluoride or silicon, inasmuch as by using the double fluorides of other metals I can introduce the same into the bath in metallic form, either for scavenging purposes or alloying purposes. For example, if it be desired to introduce uranium into steel, a step ordinarily attended with the greatest difficulty, I merely substitute for sodium silico-fluoride a double fluoride of uranium together with at least enough aluminum to displace the same, generally with such excess of aluminum as is necessary to deoxidize the bath.

I may also add the alloying ingredient in metallic form, for example metallic tungsten, molybdenum, chromium, etc. mixed into the briquette, since a thorough deoxidation at the instant of adding these metals is very important to the production of a homogeneous alloy.

I do not restrict myself to the treatment of steels or of iron group metals since other metals and alloys can be deoxidized in this way, such as nichrome, Monel metal and stellite. Also in its broadest aspect my invention is not restricted to the use of aluminum but may be extended to the treatment of steel with other oxidizable substances like silicon and titanium whose oxides are comparatively infusible and the subsequent removal of these oxides by means of combination with a more fusible substance, especially one which contains sodium and fluorine. For example my broadest claims contemplate the use of sodium fluoride, equally with silico-fluoride, although for purposes of economy and large scale production I prefer the less expensive substance.

I have already suggested the possibility of using instead of pure aluminum an alloy of the same with some other substance such as silicon. The term "aluminum powder" as used in my claims is intended to cover either the pure aluminum or such an alloy.

Having thus described my invention what I claim is:

1. The process of deoxidizing steel which contains the step of adding metallic aluminum thereto mixed with non-metallic substance adapted to combine with a portion of the same with the production of slag-like substances which melt below the melting point of the steel and dissolves aluminum and silica.

2. The process of refining iron group metals which contains the step of incorporating into a molten bath of the same a metallic deoxidizing agent whose oxide is comparatively infusible mixed with a non-metallic compound containing sodium and fluorine and adapted under the conditions of the reaction to produce a different compound of sodium which will combine with such infusible oxide to produce a substance which is more fusible than iron.

3. The process of deoxidizing steel which contains the step of adding to a molten bath of the same is a metallic deoxidizing agent whose oxide is comparatively infusible, in company with sodium silico-fluoride and a substance adapted to react therewith under the temperature conditions of the process with the generation of a secondary substance adapted in turn to combine with such infusible oxide to produce a substance which is more fusible than the bath.

4. In the process of deoxidizing steel by the use of aluminum, the step of adding to the molten bath, in conjunction with the aluminum, a compound containing sodium and fluorine under circumstances leading to the production of a different sodium compound which will combine with alumina.

5. The process of treating steel which contains the steps of mixing intimately together approximately five parts of sodium silico-fluoride with one part of powdered aluminum and a quantity of one or more metallic deoxidizers such as silicon, titanium or more aluminum, briquetting such mixture, and introducing such briquettes below the surface of the molten steel.

6. The process of deoxidizing steel which contains the steps of mixing powdered sodium silico-fluoride with at least about one fifth of its weight of aluminum powder, briquetting the mixture, and introducing such briquettes below the surface of the molten steel.

7. The process of producing alloy steel

which contains the steps of mixing a powdered double fluoride of sodium and another metal desired to be alloyed with the steel and an amount of aluminum powder at least sufficient to replace such other metal, briquetting the mixture, and introducing such briquettes beneath the surface of the molten steel.

8. Composition of matter for use in the production of steel consisting essentially of the double fluoride of an alkali metal and a non-alkali metal mixed with at least enough aluminum powder to replace the non-alkali metal, such mixture compacted into briquette form.

9. Composition of matter for deoxidizing steel consisting essentially of sodium silico-fluoride mixed with at least about one fifth of its weight of powdered aluminum and compacted into briquettes.

10. Composition of matter for deoxidizing steel consisting essentially of sodium silico-fluoride mixed with a powdered metal or alloy containing at least about one fifth its weight of metallic aluminum, the mixture being compacted into briquettes.

11. The process of refining metals and alloys which contains the step of incorporating in a molten bath of the same a double fluoride, one of whose constituents is an alkali metal, intimately mixed with aluminum powder.

12. The process of refining metals and alloys which contains the step of incorporating in a molten bath of the same an intimate mixture of aluminum powder and a double fluoride of which sodium is a constituent part.

13. The process of refining metals and alloys which contains the step of incorporating in a molten bath of the same an intimate mixture of aluminum powder and sodium silico-fluoride.

14. The process of producing complex alloys which contains the step of introducing into a molten bath of one of the component metals an intimate mixture of another component metal in powdered form with finely divided aluminum and the double fluoride with sodium of yet another component metal, the aluminum being present in such quantity as will replace such last named metal from its combination.

15. Composition of matter for the purpose described consisting essentially of the double fluoride of an alkali metal and a non-alkali metal mixed with an amount of aluminum powder approximately equivalent atomically to such non-alkali metal, and an additional quantity of metal which is to be incorporated.

16. Composition of matter for the purpose described consisting essentially of sodium silico-fluoride mixed with a quantity of aluminum powder substantially equivalent to the silicon component thereof, and an additional quantity of high melting point metal in a powdered condition.

In testimony whereof I hereunto affix my signature.

ALADAR PACZ.