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PROCESS OF REFINING METALS AND ALLOYS.

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This invention relates to improvements in metals and alloys in respect to their density, tensile strength, homogeneity, and casting qualities and has for its object the provision of a simple and inexpensive method of treatment whereby certain defects heretofore observed can be overcome. It is well known for example that silver can be cast only with great difficulty, and it has long been appreciated that the basis of difficulty resides in the great avidity of metallic silver for oxygen which it dissolves by occlusion and without chemical combination. At the instant of solidification this oxygen is liberated producing bubbles in the interior of the casting or ingot and horns or protuberances, for which reason the casting of silver has never been successfully accomplished and great difficulty experienced in its refining inasmuch as a solidification from the molten condition is necessarily encountered at some stage of the operation.

Similar difficulty is experienced in the casting of copper, especially in the pure state such as is required in wire for electrical conductors. When perfectly pure copper is melted in contact with air a considerable amount of oxygen is absorbed, largely in the combined state, (although the particular nature of its appearance is immaterial) but with the result that at the moment of casting it appears in the form of bubbles disseminated throughout the ingot.

In order to overcome this porous condition it is necessary to employ a deoxidizing agent, and for this purpose aluminum, silicon, phosphorous, boron or like oxidizable substances have heretofore been employed. Aluminum and silicon however, cannot be employed with copper which is to be used for electric conductors because of their marked effect upon the conductivity as well as certain well known operative disadvantages, the other substances mentioned are highly expensive, and in addition the phosphorous is extremely poisonous.

Likewise many copper alloys such as the bronzes exhibit a porous condition unless great case is used in casting, and to overcome this tendency, deoxidizing agents are often used which have a deleterious effect upon the alloy. For the same reason it is impossible to secure good castings of pure nickel or of other metals of the nickel group, such as steel, or of alloys of the same with other metals, such as Monel metal, which is an alloy of nickel and copper.

It has long been known that the use of a deoxidizer would obviate some of these disadvantages, but no deoxidizer has heretofore been known that would not impart new disadvantages to compensate for those which it overcame. Thus the softness and chemical resistivity of silver may easily be impaired, or the electrical conductivity of copper, or the homogeneity of steel. My invention relates to the use of a refining and deoxidizing agent which shall produce the beneficial results in view without any injurious effects whatever.

My invention consists of stirring into the molten bath of any one of these metals an alkali compound such as sodium fluoride, of a nature to become dissociated under the conditions of the operation with the liberation of alkali metal and gas. The alkali metal combines with the non-metallic impurities in the bath and the alkali salts thus produced combine with solid and liquid inclusions to produce a very fusible and limpid slag. This alkali compound may be used, either alone or in combination with any of the deoxidizing agents heretofore employed. Generally I prefer to employ it alone, although its use in conjunction with the other substances decreases the amount of refining agent required, and assists in the elimination of the injurious reaction products of such other substances, so that its use in this manner is permissible where cost is an important factor.

For example, by stirring into a bath of molten silver or copper about 2% more or less of sodium fluoride, I am able to secure a casting entirely free from bubbles or blowholes and of a density far superior to that obtained by other modes and of an electric conductivity very close to the theoretical. An ingot so produced can be rolled into sheets and rods or drawn into wire far more easily than without such treatment, and castings of finished articles can be made successfully.

Likewise in the casting of alloys of copper such as those with silver or nickel, or in the casting of nickel or other nickel alloys, a similar stirring into the bath of say 2% of sodium fluoride will produce results superior to that of any other deoxidizing agent. In all these cases I find it desirable to use not less than about 1½% of sodium fluoride, but the amount can be increased any desired degree since the only effect of an excess is to produce a flux, so that I do not limit myself to the proportion mentioned.

I do not confine myself to the use of so-

dium fluoride since other fluorides such as that of potassium can be employed but with less pronounced results. I do not confine myself to the use of sodium fluoride since any non-metallic refining agent having the attribute of becoming dissociated under the conditions of the reaction producing an alkali metal and a freely evolved gas can be employed. To decrease the amount required I may use this material either in admixture with or subsequently to any of the known deoxidizing substances, for example titanium, manganese, silicon or aluminum. When so employed the refining agent not only performs to some degree its own advantageous effect directly upon the metal but also by combining with the oxidation products of the other reagents to produce substances of a lower melting point which are thus easily eliminated from the metal. In such case I employ a much reduced quantity and find beneficial results even with so small an amount of the alkali salt as .25%.

I may also add to the molten bath in company with the refining agent various alloying metals which I wish to combine therewith, particularly such metals as are benefited by treatment with a deoxidizing agent, in which case I find that the purification produced by the presence of this material assists greatly in the production of a homogeneous alloy. As an example I may introduce tungsten, titanium, silicon, aluminum, manganese, or the like, mixed with sodium fluoride with the result that the product produced is much denser and more homogeneous than is otherwise procurable and more free from nonmetallic impurities.

At the moment of stirring sodium fluoride into the molten bath a vigorous ebullition occurs accompanied by a yellow flame of sodium and the evolution of choking, acrid fumes. The action with potassium fluoride is less vigorous and the flame is violet colored and less pronounced. Under the conditions of the reaction the sodium fluoride is dissociated, the sodium combining with the oxygen dissolved, absorbed, or combined with the metal while freeing the fluorine in gaseous form; and inasmuch as the use of such a non-metallic refining agent having these attributes is thought to be entirely new I have claimed the same broadly as well as narrowly, to the end of asserting and securing the broadest patent protection to which I am entitled.

Having thus described my invention, what I claim is:

1. The process of refining a metallic composition containing silver characterized by stirring an alkali fluoride therein while in the molten condition.

2. The process of producing a homogeneous casting of a metallic condition containing silver which contains the step of incorporating therein a decomposable substance containing fluorine and sodium.

3. The process of producing a homogeneous casting of a metallic composition containing silver, which contains the step of stirring into the molten metal immediately prior to casting an amount of alkali fluoride equivalent to at least about 1½% of the weight of the metal.

4. The process of producing a homogeneous casting of an alloy of silver and copper, which contains the step of stirring into the molten metal immediately prior to casting an amount of alkali fluoride equivalent to at least about 1½% of the weight of the metal.

5. The process of refining a metallic composition which does not contain both aluminum and silicon characterized by incorporating therein a carbon-free alkali compound capable of becoming dissociated under the conditions of the operation with the production of an elemental alkali metal and a gaseous substance.

6. The process of refining a metallic composition which does not contain both aluminum and silicon, characterized by incorporating therein a decomposable substance containing fluorine and an alkali metal.

In testimony whereof, I hereunto affix my signature.

ALADAR PACZ.