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MASTER ALLOY

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This invention relates to improvements in corrosion resistant steels, more particularly to improved master alloys for use as addition agents to steel heats to improve the corrosion resistance of the ultimate steel.

It has been found, as is more particularly described in United States Patent No. 2,156,914, that the addition of silver to the iron-chromium alloys markedly improves such alloys in a number of particulars and especially imparting thereto a greatly increased resistance to pit corrosion. In the commercial production of alloys of this type difficulties are encountered in introducing silver into the melt. If the silver, as such, is attempted to be added in the form of shot or as a relatively massive piece, considerable silver loss ensues by way of oxidation and the like.

According to the present invention these difficulties are avoided and positive advantages attained by preliminarily incorporating silver in a metal or metals which take up silver in solid solution and then utilizing the resulting master alloy as an addition agent to an iron or chromium-iron melt. The major purpose of the invention, therefore, is to attain economies by reducing silver losses and to insure improved operation as well as to facilitate the introduction of silver according to closely controlled analyses.

Silver is insoluble in both iron and chromium but is soluble in varying degrees in nickel and manganese, nickel taking up silver in solid solution to the extent of about 4% and manganese taking it up to about 24%. Nickel and manganese themselves are soluble in iron and chromium.

It is well known that silver has a marked affinity for oxygen; in point of fact the scavaging or oxidizing action of silver is classical in metallurgy. Under the present invention by prefabricating a master alloy of silver and nickel and/or manganese, the normal deoxidizing function of silver is masked or checked and losses by way of oxidation of the silver are thus reduced.

There are other major advantages accruing from the concept of introducing the silver into a melt in the form of a solid solution alloy with a metal which itself forms a component of the ultimate steel. The common solvent effect of nickel and manganese for the silver which is alloyed therewith in solid solution, on the one hand, and for the ferrous base to which these elements are added, on the other, insures the formation of such stainless steels with the silver component uniformly and homogeneously distributed through the ferrous materials in true

solid solution. This insures the rapid dissemination of silver throughout the melt and the operative presence of the silver in the metal crystals as a true component thereof and not as an undissolved or segregated addition. In other words, the introduction in the manner described eliminates segregation during freezing or solidification of the melt. As noted above, by utilizing the concept of a master alloy, the oxidizing tendency of the silver is minimized by presence of nickel and manganese as masking agents. This oxidation-protective function is accentuated by the fact that manganese itself has a definite and positive deoxidizing effect, and when used in relatively large amounts, as compared to silver, serves thus to prevent oxidation of the silver.

The inherent advantages of the present method are particularly susceptible of practical adaptation. Thus utilizing the present concept it is possible to produce a silver-containing stainless steel of a given analysis by addition of a silver-containing master alloy in the casting ladle. This is a very desirable feature and particularly so in the case of relatively small foundries and shops where the silver-containing stainless steel may be made more or less sporadically and not on a continuous or daily production schedule.

This ability to nobilize stainless steel under conditions of predetermined additions of nobilizing agents such as silver, affords peculiar advantage by insuring the proper amounts and distribution of this alloying constituent in the ultimate product. This certitude of factual presence of the predetermined operative qualities of the nobilizing ingredient is made possible by introducing it through the medium of the nickel and/or manganese vehicles in a variety of ways. For example, the nobilizing alloy may be made up of say from 4 to 20% more of silver combined with nickel and/or manganese metals and ferro nickel and/or ferro manganese. The respective proportions of the nickel and manganese may be chosen such that a relatively large quantity of silver can be made available for a melt in a relatively small unit. Thus a nobilizing addition agent comprised of solid solution of 20% of silver in 80% of manganese need be used in only small quantities to produce an ultimate analysis of a stainless steel containing say 0.1% of silver.

The nickel-silver master alloys are particularly well-suited for the purpose of the invention. As is known, nickel constitutes a component of a large number of the stainless steel alloys. Thus additions of argentiferous nickel can be made to a melt so as to produce the proper amount of

silver in the ultimate alloy. The amount of nickel introduced in this manner by way of the master alloy, as will be appreciated, is very small as compared to the quantity of material in the melt, this is to say that, for example, in nobilizing an 18-8 stainless steel melt the amount of nickel added by way of the nickel-silver alloy to insure the presence of a small amount of silver would not materially change the nickel analysis of the product.

It will be appreciated that the utilization of polynary master alloy addition agents presents further advantages. Thus when an alloy of say iron, nickel and silver is utilized, miscibility of the addition agent with the melt is facilitated because of the accentuated common solvent effect of the iron and nickel contained in the master alloy.

It will be appreciated that while for many purposes it is desirable to make up the master alloy of a saturated solid solution of silver in the nickel and/or manganese, it is also within the concept of the invention to add excess silver to the master alloy, i. e. in amounts above the solid solution saturation. In these circumstances the master alloy will contain silver both in the metal crystals and in a dispersed or segregated phase. When such master alloy is added to a melt containing a solvent for the silver, e. g. nickel, the silver is rapidly taken up and dissolved in the nickel and during this period is protected from oxidation by the physical masking effect of the other components of the master alloy.

It will be understood also that while nickel and manganese have been mentioned as particularly effective carrier and protective vehicles for the silver, other similarly functioning metals may be used and particularly so when such other metals beneficially modify the characteristics of the steel. For example, copper additions to certain high chromium melts containing manganese and slight amounts of nickel greatly improved the deep drawing properties of the resulting steel. Silver has a limited solid solubility in copper. It is thus within the scope of the invention to produce master alloys of copper and silver with or without additional metal components such as iron, nickel and manganese for the purpose of producing copper and silver-containing stainless steel.

It will also be appreciated that the master alloy

addition agent may be utilized to carry into the melt other alloying components which beneficially modify the ultimate product. For example, columbium metal, when present in a certain stoichiometrical proportion to the carbon, greatly increases the resistance of stainless steels to intercrystalline corrosion. This metal may be incorporated in the master alloys in amounts so predetermined that the ultimate stainless steel products possess a marked resistance to both intercrystalline and pit corrosion.

The master alloys described herein are preferably cast into pigs or billets of standardized size and of special shape. Such castings may be formed with deeply scored lines at predetermined intervals or spaces so as to present a series of units which may readily be broken off by a hammer blow. The scored units of the pig or billet are so designed as to insure, on the basis of their established silver content, a predetermined amount of silver in each segregation or unit. In other words each section of the scored pig or bar contains a definite weight of silver. In these circumstances a definite ultimate silver analysis in the ultimate steel can be secured by adding the requisite number of sections of the pig to the particular heat. If desired the master alloy pig may be broken up into particles and added as a shot.

I claim:

1. A method of producing chromium-nickel stainless steel characterized by improved resistance to pit corrosion containing homogeneously distributed silver which comprises forming a solid solution master alloy of silver nickel, adding such master alloy to molten stainless steel in an amount sufficient to establish a predetermined percentage of homogeneously distributed silver in the final alloy.

2. A method of producing chromium-nickel stainless steels characterized by improved resistance to pit corrosion containing homogeneously distributed silver which comprises forming a saturated solid solution master alloy of silver and nickel, adding such master alloy to molten stainless steel in an amount sufficient to establish a predetermined percentage and up to substantially .3% of homogeneously distributed silver in the final alloy.

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