

UNITED STATES PATENT OFFICE

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PROCESS FOR TREATMENT OF MOLTEN
STAINLESS STEELHarry Tanczyn, Baltimore, Md., assignor, by
mesne assignments, to Armco Steel Corpora-
tion, a corporation of OhioNo Drawing. Application July 11, 1945,
Serial No. 604,542

7 Claims. (Cl. 22-215)

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This invention is a companion to that of my copending application, Serial No. 604,541, filed July 11, 1945, and entitled Stainless steel process and product and relates to stainless steel, more especially to an art of producing castings of stainless steel and to flux compositions for use against scums of teeming and casting the steel.

One of the objects of my invention is the efficient and economical production of cast stainless steel products, such as ingots, which are substantially free of scum occlusions ordinarily resulting from stainless steel teeming and casting operations.

Another object of my invention is the production of stainless steel castings of the character indicated in a simple, practical and thoroughly reliable manner from any of a wide variety of stainless steels utilizing known and tried casting apparatus.

A further object of my invention is the provision from readily available material or materials of an efficacious addition agent for fluxing stainless steel teeming scums from the steel.

Other objects in part will be obvious and in part will be pointed out hereinafter.

The invention accordingly consists in the combination of elements, composition of ingredients and mixture of materials, in the operational steps, and in the relation of each of the same to one or more of the others as described herein, the scope of the application of which is indicated in the following claims.

As conducive to a clearer understanding of certain features of my invention it may be noted at this point that the stainless steels are defined as low-carbon steels which comprise 10% to 35% chromium, with or without nickel, and with or without supplemental additions of columbium, titanium, aluminum, molybdenum, tungsten, vanadium, cobalt, copper, manganese, silicon, sulphur, and the like, for special purposes, and a remainder which is substantially all iron. The carbon content may range from 0.03% to 0.20%, or more where desired.

In the production of stainless steel castings a serious problem arises which has to do with the prevention or elimination of scums which eventually prove to be hurtful to the cast metal. These scums develop in pouring the steel as to ingot molds and usually are rich in oxides both of iron and chromium or on occasions also include in quantity oxides of special purpose constituents of the steel. Likewise, nitrides of certain elements of the alloy steel usually contribute as a further scum component along with the oxides. At times, the scum assumes a refractory

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or semi-refractory quality which is thick, viscous, frothy, gummy, or even semi-solid and does not readily melt in contact with the molten stainless steel in the mold.

As a matter of usual occurrence these refractory scums are driven into the newly cast stainless steel by the force of the pouring stream or are turned under at the faces of the mold as the metal rises or are otherwise forced to inclusion in the metal during the teeming and casting operations. The scums are sluggish and in part remain entrapped, to the result that the castings after solidification require a considerable amount of surface conditioning such as grinding to remove non-metallics and metal of inferior quality, or at times the castings are rejected due to inferior quality, which in any event is objectionable and creates a need for more efficient stainless steel casting practices. In some cases scum inclusions offer an obstacle to successful forging and rolling as by causing the metal to crack and chip at the edges, or make the metal unsuitable for those uses where high quality or strength is important. The cast stainless steels which contain segregations of scum therefore are susceptible to a host of metallurgical failures. They are not successfully finished as for example to uniform luster and brightness and are unduly subject to corrosion in localized surface areas.

Some of the stainless steels, as when poured in contact with the atmosphere, are more susceptible than others to the formation of deleterious or refractory scums which are especially difficult to prevent or eliminate in the mold. Among these are the high temperature stainless steels in which relatively large amounts of chromium are present, and stainless steels comprising such special purpose constituents as one or more of aluminum, titanium, columbium, or the like, whether the chromium content be relatively large or small.

The fluidification or alleviation of the deleterious scums of teeming and casting stainless steels heretofore has been attempted with various fluxing agents only with quite limited success and with marked ineffectiveness in the instances of high chromium steels and steels including any such elements as titanium, columbium, aluminum, or the like, which produce especially refractory scums.

An object of my invention accordingly is the provision of a simple, direct and practical method of teeming and casting stainless steel, which method is highly efficient in preventing or eliminating deleterious scums of teeming with respect

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to any of a wide variety of stainless steels, even the high temperature stainless steels and those steels including one or more such elements as titanium, columbium, and aluminum.

Referring now more particularly to the practice of my invention I find that by introducing to molten stainless steel alkali metal fluorides of one or more of the three relatively light alkali metals occupying positions in group I of the periodic table, that is, at least one fluoride of the group consisting of lithium fluoride, sodium fluoride and potassium fluoride, those salts exert a powerful action which prevents or eliminates refractory scums of teeming the steel as into a mold. The exact nature of the action itself, which leads to a fluidification of the stainless steel scums, is not clearly understood by me. It appears that the salts in some manner effectively lower the melting point of the refractory scums, however, I do not wish to be bound by any such explanation.

In accordance with my invention I add to the molten stainless steel, as in the production of ingots of the steel, a scum-fluidifying agent comprising in predominating amount or preferably consisting substantially all of one or more of the above noted alkali metal fluorides, for example to a ladle of the steel before lip pouring into a mold, or to the steel in teeming the same to the mold, or at the mold as by sifting the alkali metal salt inside the mold over the rising steel.

The fluoride of lithium, sodium or potassium, either alone or together with one or more of each other, are highly effective and reliable stainless steel scum combatting materials even in the casting of high temperature stainless steels such as those comprising 20% or more chromium, and stainless steels including at least one such element as titanium, aluminum, columbium or some other element or elements having a tendency to produce a highly refractory non-metallic scum in and on the metal during the casting operations whether the chromium content of the steel be high or low. I find advantage at times in using a proportion of lithium fluoride, which is a very powerful stainless steel scum fluxing agent, in combination with one or more of sodium fluoride and potassium fluoride which are relatively inexpensive yet quite powerful fluxing materials.

Through treating the molten stainless steel with one or more of the light alkali metal fluorides the resulting stainless steel ingots or other cast products which I achieve are of highly desirable quality substantially free of teeming scum inclusions. Likewise, the stainless steel castings have a much superior surface and are remarkably devoid of scabs, cold-shuts, wrinkles, rolls, splash marks, and like defects. The stainless steel ingots which result from my pouring and casting method are satisfactory for reduction as by rolling with a minimum of preliminary conditioning of the surface thereof. The ingots give a high hot working yield with either splitting checking along the forged or rolled edges, ordinarily caused by refractory scum or other surface flaws.

As illustrative of the practice of my invention I provide, in a suitable electro-metallurgical melting furnace, a bath of 18-8 chromium-nickel stainless steel of the 2% titanium grade for casting into ingots. I tap the metal from the furnace into a ladle preparatory to teeming the same into ingot molds. In preparing the molds themselves, I put inside on the bottom of each a

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small quantity, illustratively about 2 to 4 ounces, of a scum-combatting agent consisting substantially all of lithium fluoride and a smaller amount of sodium fluoride, the agent preferably being enclosed in small paper bags or the like. Thereafter, I teem the stainless steel from the ladle into molds and over the alkali metal salts in the same.

The lithium fluoride and sodium fluoride in the ingot molds thoroughly mix with the molten steel during the teeming and casting operations and set up a highly effective fluxing action in preventing and eliminating thick scums in the mold. If desired, additions of fluxing agent are made to the mold as by sprinkling onto the cast metal as the teeming continues or by mixing into the cast molten metal after teeming, to supplement or serve instead of previous additions of the salts to the mold. I let the scum-fluxed ingots solidify and cool, and thereafter strip off the molds. The resulting chromium-nickel-aluminum steel ingots are of good surface quality and are substantially free of scum inclusions such as those including refractory oxides of chromium and aluminum. In the stripped condition, the ingots are ready for storage or sale, or for example are easily made ready for forging or rolling and subsequently are formed into reduction products.

Thus it will be seen that there has been provided in this invention a method and de-scumming agent for the production of cast stainless steel products, and the stainless steel ingots or other cast products themselves, in which the various objects hereinbefore set forth together with many thoroughly practical advantages are successfully achieved. It will be seen that the method includes the use of a powerful descumming agent, is simple, effective and suitable for the production of clean castings from any of a wide variety of stainless steel, and is industrially practicable with known and tried casting apparatus.

As many possible embodiments may be made of my invention and as many changes may be made in the embodiments hereinbefore set forth, it is to be understood that all matter described herein is to be interpreted as illustrative and not as a limitation.

I claim as my invention:

1. In the production in a mold of cast stainless steel products substantially devoid of scabs, cold shuts, wrinkles, rolls and splash marks, the art which includes contacting molten steel during the teeming thereof, and the scum formed by contact of the molten steel with the atmosphere, with a teeming scum flux essentially consisting of at least two of the group consisting of lithium fluoride, sodium fluoride and potassium fluoride.

2. In the production in a mold of cast stainless steel products substantially devoid of scabs, cold shuts, wrinkles, rolls and splash marks, the art which includes adding to a stream of molten steel during the teeming thereof, and the scum formed by contact of the molten steel with the atmosphere, a teeming scum flux essentially consisting of lithium fluoride and at least one of the group consisting of sodium fluoride and potassium fluoride.

3. In the production in an iron metal mold of cast stainless steel products substantially devoid of scabs, cold shuts, wrinkles, rolls and splash marks in which the steel contains one or more of titanium, columbium or aluminum, the art which includes adding to steel during the teeming there-

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of a teeming scum flux essentially consisting of at least one of the group consisting of sodium fluoride and potassium fluoride.

4. In the production in an iron metal mold of stainless steel cast products containing at least 20% chromium and substantially devoid of scabs, cold shuts, wrinkles, rolls and splash marks, the art which includes adding to the mold a teeming scum flux essentially consisting of at least one of the group consisting of sodium fluoride and potassium fluoride.

5. In the production of stainless steel ingots substantially devoid of scabs, cold shuts, wrinkles, rolls and splash marks, the art which includes placing in an ingot mold a teeming scum flux essentially consisting of lithium fluoride and sodium fluoride, and teeming the metal therein.

6. In the production of stainless steel ingots substantially devoid of scabs, cold shuts, wrinkles, rolls and splash marks, the art which includes teeming molten steel into an ingot mold, and during the teeming sprinkling on the surface of the metal rising in the mold a teeming scum flux essentially consisting of lithium fluoride and sodium fluoride.

7. In the production of stainless steel ingots substantially devoid of scabs, cold shuts, wrinkles, rolls and splash marks, the art which includes mixing with metal in an ingot mold a teeming scum flux essentially consisting of lithium fluo-

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ride and at least one of the group consisting of sodium fluoride and potassium fluoride.

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