

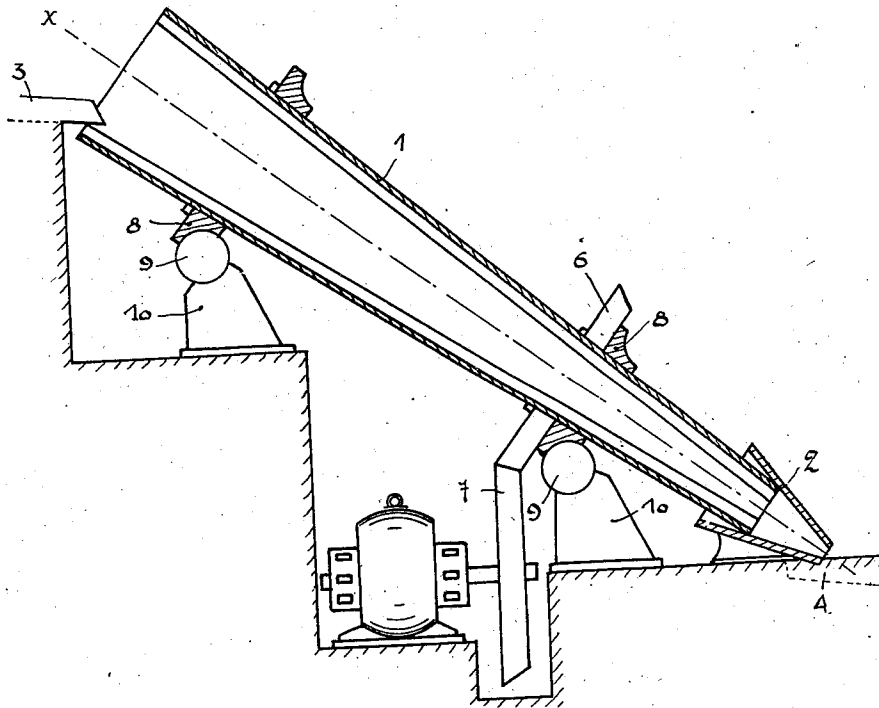
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PROCESS FOR THE PURIFICATION OF MOLTEN METALS

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PROCESS FOR THE PURIFICATION OF
MOLTEN METALS

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2 Claims. (Cl. 75-93)

All metals and alloys prepared in metallurgy by heat treatment contain foreign bodies such as slags and impurities arising from the chemical reactions which produce them (examples, the occluded oxides and gases of steels) or from the gangues of the ores or of the fuel (examples, sulphides, silicates); moreover at their temperatures of solidification they often contain elements in excess or elements with which they are super-saturated (for example the graphite in cast iron).

These impurities are nearly always combinations of metals and metalloids (examples, sulphides, oxides, etc.) of lower density than that of the metal; but they are found most frequently in the metal in a state of emulsion, the fineness of the particles of which prevents them from rising by difference of density to the surface of the viscous mass.

During the melting operation, these metals become more or less stratified in the crucibles or pots from which they subsequently flow with varying compositions.

In metallurgy, it is generally not only necessary for the parts to be homogeneous in order to be sound but in addition the internal crystalline texture of the compounds considerably modifies all the properties.

It is known that the crystals of large dimensions and the compounds in excess which are formed at the beginning of the solidification are sources or means initiating crystallization which increases to an excessive extent the dimensions of the crystals of the same compounds during the course of the subsequent solidification. On the contrary the homogeneous solution in which none of the constituents are in excess crystallizes by spontaneous germination into a very close texture which greatly improves the properties of the metal.

Finally it will be recognized that if a certain minimum quantity of impurities must nevertheless be tolerated, the objectionable effects of these impurities will decrease with an increase of their state of fine division.

The subject of the present invention is a process for the purification of molten metals applicable to all metals or alloys, the metallic constituents of which are of substantially the same density, which are refined by means of heat or intended to undergo heat treatment.

The purifying operation according to the invention comprises the following effects:

1. Homogenization of the metal, general refining of the crystalline structure, or the diffusion in the whole of the mass of the alloy of the addi-

tion elements or compounds which it may be desired to cause to react with the alloy before or during the purification.

2. The separation of included gases, liquids or even solids and of elements or compounds with which the alloy would be super-saturated under the chemical and physical conditions of the operation or in general the separation of all particles of lower density forming that which is usually called the slag and also the separation of the products of chemical reaction, resulting from the additions which may have been made before or during the purification.

3. The assembling or the coalescence of the elements or compounds of the same nature of this slag and in general of all the light elements already separated as stated in paragraph 2 above.

4. The intensification or completion in general of all the chemical reactions which should normally take place in the alloy under the physical and chemical conditions of the operation and in particular of all the reactions which would result from additions made before or during the purification.

With the object of obtaining the effects enumerated above, the apparatus utilized in the present invention consists of one or more ducts, formed by bodies of revolution, traversed by the metal or alloy to be purified which is in a molten state during the whole of the purifying operation, one or more of these ducts, but not necessarily all of them being given a movement of rotation about their axes such that the metal by centrifugal action is distributed along the periphery of the duct.

The internal longitudinal profile of these ducts may be cylindrical or conical or composed of cone frustra and cylinders or in general they may have the form of any body of revolution.

The speeds of rotation of the sections may be different and some may even rotate in the opposite direction to others.

The inclinations of the axes of the different sections may be different; they are determined in each case by the duration allowed for the metal to travel through the sections, account being taken of their cross sections, longitudinal profiles and speeds of rotation.

That is to say that in each particular case, in order to adapt each section not only to the effect it is desired to obtain but also to the unavoidable fluctuations in delivery, variations in the speed of rotation or in the inclination of the axis of the section considered must be made possible.

It has been found that when a stream of

molten metal, for example cast iron, is poured against the inner surface of the rapidly rotating duct, the metal falling on this solid surface is subjected to a violent shock by reason of the high peripheral speed of the duct in this region and the subsequent vigorous mixing causes a purification of the metal.

In fact, the metal to be purified (for example, cast iron) contains numerous impurities, such as particles of slag, particles of scoria, Al_2O_3 , carbon hyper-eutectic, excess Si, FeO, sulphides, etc. The metal also contains local concentrations and is consequently heterogeneous. Certain of these impurities are emulsified in the metal in the form of liquid particles included in the metal, such as slag, silicates, etc. Other impurities are found either in the form of solid inclusions (Al_2O_3) or in solution in the metal (Si, sulphides, etc.)

It should be noted that the dissolved or solid impurities tend normally to react between themselves and with the emulsified impurities to transform them, in turn, into liquid particles. In this connection, Al_2O_3 reacts with silica (SiO_2) to form a liquid silicate; the silicon reacts with the oxides (FeO) to form silica (SiO_2) forming silicates with the other impurities; the sulphides tend to dissolve in the silicates. These chemical or physical reactions which take place in the midst of the metal are very slow and always incomplete, due to the viscosity of the metal.

When, according to the present invention, the metal to be purified is subjected to a vigorous mixing, the speeds of reaction are increased to a point such that the desired reactions mentioned above are terminated in a very short time, almost instantaneously. The mixing equally leads to the destruction of local concentrations and effects a refining of the grain of the metal.

Due to the inclination of the duct, the metal projected against the solid is continuously removed from the zone of projection, so that the molten metal is always projected on a solid surface and the metal to be treated is always vigorously mixed by means of this rapidly moving solid surface.

Processes are already known in which the molten metal to be treated is flowed into the mass of molten metal previously treated which accumulates and is distributed by centrifugal force on the inner wall of the rapidly rotating casing; but it is easily understood that the mixing of the molten metal falling on the liquid layer of molten metal, is much less vigorous than when the metal to be treated is flowed against a moving solid wall.

The liquid inclusions formed and distributed in the mass of the molten metal during the vigorous mixing are eliminated, according to the present invention, by the reassembly of the small inclusions in order to form voluminous inclusions which can then rise to the surface of the metal. This reassembly of the small liquid inclusions (phenomenon of coalescence) is obtained by submitting the metal to a moderate agitation which effects the bringing together and agglomeration of the fine particles without again effecting their division.

In fact, the metal flowing in the upper part of the tube is subjected to violent shock in falling on the interior wall of the tube and is then rapidly carried along with the rotating tube. After the metal is caused to rotate with the tube, it moves toward the lower part of the apparatus under the effect of gravity. Since the section of the tube progressively diminishes toward its low-

er extremity, the annular layer of metal distributed along the tube progressively thickens. This progressive thickening of the layer of metal creates a moderate agitation in the midst of the same and is highly favorable to the phenomenon of coalescence.

The process according to the present invention is applicable for the purification of cast-iron and other metals or alloys in which solid, liquid or gaseous inclusions are to be eliminated.

By way of example of one embodiment of the apparatus according to the invention, the accompanying drawing illustrates the diagrammatic elevation of a duct formed by a body of revolution in the shape of a cone rotated about its axis X X'.

In the accompanying drawing, 1 is the centrifugal cone shaped purifier provided with bands or rails 2 upon which it turns. These bands or rails 2 are carried upon bearings 3 supported by frames 4 or supports 5. The purifier 1 also comprises a driving crown or pinion 6 engaging with another toothed wheel 7 keyed upon the shaft of an electric motor 8 or other suitable source of power.

3 is the channel through which the molten metal is fed to the purifier. A fixed funnel 2 collects the metal at outlet from the purifier 1 and pours it into the discharging channel 4.

In the example illustrated, one single purifier 1 has been shown but it can be imagined that the discharge channel 4 may in its turn become the feeding channel for another purifier which is identical or different in form or inclination.

The apparatus or pieces of apparatus will be placed directly at the outlet of the blast furnace or at the outlet of a melting furnace, or the like.

The introduction of a continuous or intermittent current of molten metal in one or more sections of ducts having a given movement of rotation causes the molten metal to be given a sudden rapid movement of rotation in a different direction from that in which it previously moved. This sudden change of direction has the effect of producing an energetic mixing of the metal with a view to obtaining the following effects:—

(a) The homogenization of the elements forming the usable or slag-free part of the alloy, which elements have similar densities;

(b) The diffusion and homogeneous distribution in the usable or slag-free part of the metal of any addition compounds that may be present;

(c) The completion of all the chemical reactions which normally have to occur in the metal in view of the chemical and physical conditions of the operation or the reactions which would result from any additions which may have been made;

(d) A general refining of the crystalline structure of the solidified metal.

The radius, the speed of rotation and the duration of travel are chosen to suit the metal treated with a view to obtaining:—

(a) The expulsion of the occluded gases and of any foreign bodies the alloy contains;

(b) The separation into concentric layers pressed against the inner face of the rotating apparatus of the particles of various density and of the excess of elements or compounds with which the alloy would be before the treatment super-saturated under the physical and chemical conditions of the operation.

The speed of the travel and thickness of the layer may be varied from one point to the other of the duct and are determined with a view:

(a) To complete the effects of separation enumerated above;

(b) To obtain the grouping or coalescence of the particles of the same nature or of similar nature of the slag and of all the light elements already separated from the dense part.

The inclination of the axes of the purifiers and their diameters or sections of passage, and their speeds of rotation are suited to the nature of the material or alloy treated and to the delivery available in order to obtain variable conditions of speed and thickness in the liquid vein during its flow.

In this connection, if it is desired to increase the speed of rotation, it is important to increase the inclination of the duct and to reduce its taper.

The effects described above do not necessarily succeed each other in time and space; some of them may occur simultaneously. Further, they need not necessarily be carried out in the order set forth and finally they may be subdivided and obtained on some occasions in a plurality of successive pieces of apparatus with or without interruption of the operation between two pieces of apparatus and at other times in a single suitably designed section.

The best internal profile for the duct is that of a paraboloid of revolution.

The various effects set forth above may, if desired, be assisted in an auxiliary manner for example by the addition of chemical substances before or during the passage through one or more pieces of apparatus, for example, by means of desulphurants such as carbonate of soda, or deoxidizing agents such as aluminium, or simple fluxes such as burnt foundry sand, or else by a

physical or thermal treatment such as mixing or superheating with the object of obtaining the bodies to be separated or refined in a form which is most suitable for their separation, coalescence or refining.

The enumeration of the effects resulting from the centrifuging and the flow through these pieces of apparatus under the conditions of duration and thickness already described is not limiting and consequently may extend to other objects such for example as the modifications in the metallographic nature of the metal.

The present application is a division of application, Serial No. 695,190, filed October 25, 1933.

What I claim is:—

1. A process for the purification of metals and alloys, comprising projecting a stream of molten metal against a solid surface moving at high speed in front of the metal stream and in a direction different from that of the stream in order to cause an energetic mixing in the metal, causing the molten metal to be continuously removed from the place of the solid surface where the molten metal is projected, and then causing the molten metal to flow through a path of decreasing breadth in order to cause a gradual deepening in the flow of metal and thereby causing the coalescence of the impurities included in the molten metal.

2. A process for the purification of molten metals and alloys, comprising projecting a stream of molten metal against the upper part of an inclined conduit rapidly rotating about its axis and having an interior cross-section gradually decreasing from its upper part towards its lower part.

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