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[54] **REFINING OF IMPURE METALS**
9 Claims, 1 Drawing Fig.

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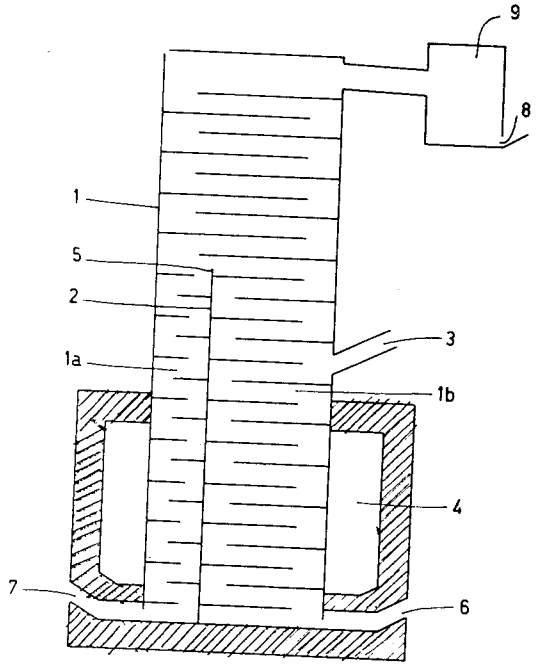
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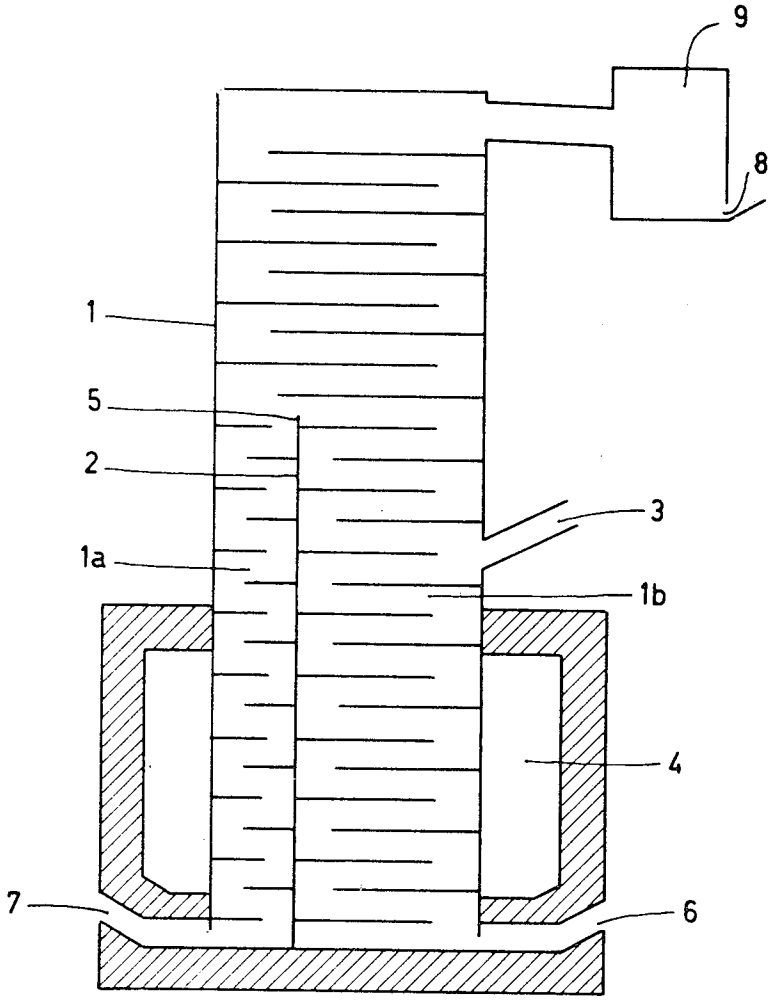
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ABSTRACT: A refining column for refining impure metals which comprises:

a. an upper portion containing trays;
b. a condenser located at the upper portion of the refining column;
c. a lower portion having a vertical partition wall forming two separate parts therein;
d. each of the two separate parts containing trays;
e. both of the two separate parts are located inside a combustion chamber;
f. means for feeding the metal which is to be refined to one of the two separate parts; and
g. the trays in the column and the partition wall being positioned so that reflux from the upper portion flows downward into the other of the two separate parts; and the process for its operation are set forth.




9
8
1
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1a
1b
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7
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REFINING OF IMPURE METALS

This invention relates to a process for the refining of impure metals containing simultaneously various impurities having a higher boiling point than that of the basic metal, and impurities having a lower boiling point than that of the basic metal.

The invention applies more particularly to the refining of zinc obtained by a thermal method.

It is known to refine zinc thermally produced and containing impurities such as Cd, Pb, Fe, Cu, Sn, in a plurality of refining columns containing trays made of silicon carbide.

Each of said columns is provided with a feed device for liquid metal, such a feed device being situated approximately at midheight of the column; an outlet is provided at the lower end of the column for the non volatilized metal, while at the upper end an outlet is provided for the escape of metal vapors. The lower part of the column is situated in an oven which supplies the heat required for the heating of the column.

A known arrangement of that type comprises two columns fed with liquid raw zinc (called "lead columns") at the lower part of which zinc flows out which has collected metals such as Fe, Pb, Cu, Sn, etc. the boiling point of which is higher than that of the zinc; at the upper part of said lead columns, zinc and cadmium vapors are collected, and these vapors are condensed in condensers.

The arrangement comprises also a column (called "cadmium column") the arrangement of which is identical with that of the lead columns. The cadmium column is fed with liquid metal (Zn-Cd mixture) leaving the condensers of the lead columns. Zinc of "special high grade" quality is collected at the bottom of the cadmium column, while the top of the column is connected with a condenser in which a Zinc-Cadmium alloy is obtained containing from 10 to 30 percent of Cd.

Such an arrangement has many drawbacks, namely: from the thermal point of view it is unsatisfactory since a metal is condensed which comes from the lead columns, and part of that metal is again vaporized in the cadmium column;

- the rate of vaporizing in the two lead columns is generally such that the amount of metal which arrives at the Cd column is lower than that which such a column is capable to treat for removing the cadmium; the column therefore is not always used at 100 percent of its capacity;
- the length of life of the refining columns is far from constant; it follows that very often during the working of the columns, one of the columns is under repairs (such repairs being always of long duration); this entails a low efficiency of the Cd column when for example one of the lead columns is under repairs. When the Cd column is under repairs it is necessary to store the zinc and to remelt it, or to transfer it to another column arrangement with all the drawbacks which this may entail.
- a proper working of the cadmium column from the point of view of Cd removal may be rendered difficult owing to lack of regularity in the output of zinc coming from the condensers of the lead columns, for instance when a partial or total obstruction occurs at an outlet orifice or at a channel serving for the flow of liquid zinc.

The present invention avoids the above-mentioned drawbacks. The invention has for its object to realize the feed of a cadmium column with vapors of zinc and cadmium coming from several lead columns, and allows of adjusting, to a certain extent, the quality of fine zinc produced as to its lead contents, permitting for instance to produce at will by means of one column either "zinc 99.95," or "zinc 99.995."

It is to be understood that the present invention, described for the refining of raw zinc, is not limited to that particular application. The invention applies to the refining of any metal simultaneously containing metallic impurities, of which some have a boiling point higher than that of the said metal, and some have a boiling point lower than that of the said metal.

The present invention consists in a refining column fed with liquid metal, and more particularly with liquid zinc containing impurities such as Cd, Pb, Fe, Cu, Sn, comprising trays, preferably made of silicon carbide, and which is connected at its upper part with a condenser for collecting a Zn-Cd alloy, such a column being characterized in that its upper part consists of trays superposed so as to form a conduit through which metal vapors flow in an upward direction and liquid metal flows in a downward direction, while the remaining lower part of the column (hereinafter called "the mixed portion of the column") consists of two parts which are separated by a tight sealing partition wall, each of the two parts comprising superposed trays forming by their arrangement a passage serving as well for the upward flow of metal vapors as for the downward flow of liquid metal, both parts working in the manner of two distinct refining columns, and the said two parts of the mixed portion of the column are placed, advantageously in part only, inside a combustion chamber which supplies the heat required for heating the column.

The invention is also characterized in that:

- the metal to be refined is fed in a liquid state to one of the two parts forming the mixed portion of the column, while the metal refluxing from the upper part of the column (that is the part of the column which is not subdivided) is fed to the second part of the mixed portion of the column;
- the heating surfaces provided by the two parts forming the mixed portion of the column are dimensioned according to the amount of heat which they need in order to realize a suitable volatilization, the one of the fresh metal fed in, the other of the metal refluxing from the upper part (undivided) of the column;
- means are preferably provided in order that trays belonging to the mixed portion of the column and which are situated above the level of the device feeding the liquid zinc to be refined to the column, shall be either capable of losing heat to the atmosphere by radiation or by forced convexion or they will be heat insulated, so as to adjust the lead content of the refined metal collected at the bottom of that part of the mixed portion of the column which receives the metal refluxing from the upper part of the undivided part of the column;
- preferably, the number of trays forming that part of the mixed portion of the column which is situated above the level of the device feeding the liquid zinc to be refined, is chosen according to the highest degree of purity with regard to lead content, which is required for the refined zinc collected at the bottom of the part of the mixed portion of the column which receives the metal refluxing from the upper part of the undivided portion of the column.

Other characteristic features of the invention will appear from the description given hereinafter with reference to the accompanying drawing which shows diagrammatically and by way of example only, one mode of carrying the invention into effect.

Referring to the drawing, the head or top part of the column **1** contains trays arranged in a conventional manner. The mixed portion of the column is formed by the lower part of the column and consists of two parts **1***a* and **1***b*, separated by a tight-sealing partition wall **2**. The mixed portion of the column is fed with liquid raw zinc by means of a pipe **3** which enters the part **1***b* at a point above the combustion chamber **4**.

The vapors of the metals volatilized in **1***b* flow in an upward direction, and a substantial fraction of these vapors reaches the upper part of the column, which is undivided and is provided with trays arranged in a conventional manner, while the remaining fraction of vapors, that is the fraction which has been subjected to a condensation in the part of the mixed portion of the column which is situated above the combustion chamber **4**, refluxes to the part of the mixed portion of the column situated inside the combustion chamber.

At the upper part of the column there is also a partial condensation of the vapors of zinc and cadmium; the corresponding condensate flows also down towards the combustion chamber; however, owing to the upper edge **5** of the partition wall **2** (which edge does not ensure a tight sealing between the two parts of the mixed portion of the column as in the case for

the trays placed at a lower level), the condensate flows into the part 1*a* of the mixed portion of the column. It is subjected then to a partial reevaporation in that part of the zone 1*a* which is situated inside the heating chamber.

At the top of the column a small fraction only of zinc vapor arrives, accompanied by almost the entirety of the Cd contained in the charge, forming an alloy Zn-Cd, generally containing 10–30 percent Cd, which is condensed and is collected at an outlet 8 at the lower part of the condenser 9.

The raw zinc which has not been volatilized and has substantially collected all the metals of a higher boiling point (Fe, Cu, Sn, Pb), flows through the orifice 6 provided at the bottom of the portion 1*b* of the divided column, while the greater fraction of the zinc volatilized in the part 1*b*, which fraction is condensed at the upper part of the undivided column and flows in a downward direction through the trays shown on the left hand in the drawing, is collected at 7 at the bottom of the part 1*a* of the mixed portion of the column, after being subjected in the zone of the combustion chamber to a second partial volatilization to remove any Cd which it may still contain.

The metal flowing at 7 is thus "high grade" zinc or "special high grade" zinc (S.H.G. zinc).

According to the quality of the metal to be produced, (the grades to be obtained being characterized by their lead content), the part of the mixed portion of the column situated between the feed pipe 3 and the upper edge 5 will either be allowed to lose heat to the atmosphere by radiation, by forced convexion or in another manner, or will be heat insulated.

In order to produce S.H.G. zinc (that is a zinc which is very poor in lead), said part of the mixed portion of the column is not heat insulated or is only very little heat insulated; protecting screens which can be directed in a given direction, allow the heat to be radiated, or may allow an inlet of air or other fluid which, by forced convexion, is able to drive the heat away, in an adjustable manner.

On the contrary, when the lead content of the zinc to be produced is comprised between that of a S.H.G. and that of a raw zinc, that part of the mixed column is more or less efficiently heat-insulated. In this way, the amount of metal condensed in that part of 1*b* situated above the feed pipe 3, is strictly limited, and this will produce an increase:

a. of the amount of zinc vapors which reaches the upper zone and therefore of the amount of zinc flowing afterwards towards the outlet orifice 7;

b. of the amount of lead carried over by these vapors, and which, owing to its higher boiling point, is the first to condense when the metal vapors are cooled.

It should be noted that various modifications may be made in the mode of carrying the invention into effect, without departing from its scope. For instance, the tight-sealing partition may be two-walled in such a manner that the two parts 1*a* and 1*b* of the mixed portion of the column form two adjacent elements without contact between them.

The number of trays in the two parts of the mixed portion of the column may be different from one another.

What we claim is:

1. A refining apparatus for the refining of impure metals which comprises:

a. an upper column portion containing a plurality of trays that are superposed above one another in such a way as to form a conduit through which metal vapors can flow in an upward direction while liquid metal can flow in a downward direction;

b. a condenser located adjacent the top of said upper portion of said refining column for collecting impurities with a boiling point lower than that of the metal which is to be refined;

c. a lower column portion having a vertical partition wall which divides said lower column portion into two separate vertical tray chambers, the upper portion of each vertical tray chamber being in open communication with the bottom end of said upper column portion;

d. each of said two separate tray chambers containing trays superposed above one another so as to form a conduit through which metal vapors can flow in an upward direction while liquid metal can flow in a downward direction;

e. said partition wall being positioned so that both of said two separate tray chambers operate as two distinct refining columns;

f. both of two said tray chambers being located within a combustion chamber which supplies the heat required for heating the column;

g. both of said two separate tray chambers containing outlet means adjacent their lower ends for removing metal therefrom;

h. inlet means for feeding the liquid metal which is to be refined into the first of said two tray chambers; and

i. the trays in said upper column portion being arranged so that reflux from said upper column portion flows downwardly into the second of said two tray chambers.

2. The apparatus of claim 1 wherein the trays of the first of said two tray chambers which are situated above the means for feeding the metal which is to be refined are provided with heat-insulating means.

3. The apparatus of claim 1 wherein said trays are made of silicon carbide.

4. The apparatus of claim 1 wherein said partition wall is two-walled so that the two separate tray chambers of the lower column portion are not in abutting contact with each other.

5. The apparatus of claim 1 wherein the trays of that portion of the first tray chamber that are situated above the feed inlet means are capable of losing heat to the atmosphere by either radiation or by forced convexion.

6. In a process for the refining of impure metal containing both impurities having a boiling point higher than that of the metal which is to be refined and impurities having a boiling point lower than that of the metal which is to be refined which comprises:

a. feeding a liquid stream of impure metal within a first distillation zone;

b. heating said liquid stream in order to cause metal vapors to flow out of the upper portion of the first distillation zone into the lower portion of a second distillation zone, and to cause impurities with a boiling point higher than that of the metal which is to be refined to flow downwards as a liquid to the bottom of said first distillation zone;

c. collecting the impurities with a boiling point higher than that of the metal which is to be refined at the bottom of said first distillation zone;

d. condensing a portion of the metal vapors that rise upwardly through said second distillation zone;

e. causing the condensate from the second distillation zone to flow downwards into the top of a third distillation zone;

f. heating said condensate that passes downwardly through said third distillation zone so as to cause metal vapors of impurities with a boiling point lower than that of the metal which is to be refined to flow upwards towards the upper portion of the third distillation zone; and

g. collecting refined metal in the bottom of said third distillation zone.

7. The process of claim 6 wherein the impure metal which is to be refined is impure zinc.

8. The process of claim 6 wherein the impure metal which is to be refined is raw zinc obtained by the thermal reduction of an ore selected from the group consisting of oxidized zinc ores and sulfide ores which have been subjected to a preliminary oxidizing roasting.

9. The process of claim 8 wherein said impurities with a boiling point lower than that of the metal which is to be refined comprise cadmium, and said impurities with a boiling point higher than that of the metal which is to be refined comprise lead.

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