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CONTINUOUS FURNACE FOR THE SEPARATION OF
A METAL ALLOYED WITH OTHER METALS
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Fig. 1

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This invention relates to metallurgical furnaces, more particularly, a furnace for the continuous extraction of individual components from an alloy or mixture containing a plurality of components. The continuous furnace of this invention may be used, for example, in carrying out—in a continuous manner—the process described in my U.S. Patent No. 2,198,673, but is not of course in any way restricted or limited thereto. The said patent relates to the extraction of aluminum from an alloy having as additional components, silicon, iron and other elements.

The metallurgical process to which the continuous furnace of this invention pertains, may be stated in general terms thus: If it is desired to extract a metal or other substance A from an alloy or mixture having one or more components in addition to the metal A, (for example two additional components B and C, the alloy itself being designated ABC), the alloy ABC is first treated with an agent as metal D which alloys with the component A but not, or to a very slight extent, with the other components B and C. The resulting intermediate alloy AD is then separated from the original alloy and subjected to distillation to break it into its component parts, A, the metal component sought to be extracted, and D, the alloying agent which is again used for further extraction. In the patent above referred to, the original alloy ABC is an alloy of aluminum (A), silicon (B) and iron (C), and the alloying agent is zinc (D), the intermediate alloy AD being an alloy of aluminum and zinc.

The continuous furnace of this invention has an extraction chamber in which the raw material or alloy ABC in a crushed, solid state is treated with alloying agent D in a liquid state. The liquid agent D flows in a downward current through the solid particles of raw material ABC and becomes converted into the intermediate alloy AD (likewise in a liquid state) which is received in the lower part of the chamber, together with such portions of D which had not succeeded in alloying itself with A. From the extraction chamber the intermediate alloy AD flows into a distillation or rectification column appropriately heated to cause the vaporization of component D which is required to have a lower boiling point than the metal A. The alloying agent D, in a vapor state, flows upwardly through the rectification column while the metal A, still in a liquid state, flows downwardly into the lower part of the column from which the extracted metal or product A is continuously removed.

The vapor of the agent D is conducted to a condenser at the upper region of the furnace where it is reconverted into its liquid state, and from which the alloying agent D, now in a liquid state, is conducted to the head of the extraction chamber for downward flow therethrough, as already described.

The prime object of this invention is the provision of a furnace capable of carrying out the said metallurgical process in a continuous manner. A like object is the provision of a continuous furnace as briefly described hereinabove. Allied with these objects, it is sought herein to design, locate, and coordinate the various parts of the furnace in a manner to provide for the continuous operation herein of the metallurgical or refining process of the type described. A further object is to provide a continuous furnace for carrying out the aforementioned process in which the reagent (the alloying metal D), is continuously circulated in a closed circuit with substantial or at the most, very little loss of the reagent. A further object of this invention is the provision in a metallurgical furnace of a heating arrangement which will afford continuous operation therein of processes of the character described. A still further object is to provide the said heating arrangement in a manner to reduce heating losses, and to make the most economical benefits of heat gradient.

For the attainment of the above and such other objects as may appear or be pointed out herein, I have shown one embodiment of my invention in the accompanying drawing, wherein:

Fig. 1 is a diagrammatical vertical section through the continuous furnace;

Fig. 2 is a fragmentary plan view of one of the rectification plates;

Fig. 3 is a fragmentary sectional view of a modified condenser provided with a plurality of baffles; and

Fig. 4 is a fragmentary sectional view of a portion of a modification of the furnace showing the auxiliary means inserted in the conduit to the condenser, for removing the last traces of metal from the raw material.

In Fig. 1, the region 1 represents the extraction chamber of the continuous furnace of this invention, wherein the metal A is extracted from the raw alloy ABC, by means of the alloying agent D. The crushed solid alloy ABC, contained in perforated cups '1' made of metal, earthenware or other suitable material arranged one above the other in an elevating system of any known type, formed for example by endless
chains actuated by a motor 1' located outside the furnace. The cups containing the raw alloy ABC enter through the lower door 2 of the furnace, and are placed on the elevating system. The alloying metal D in the liquid state enters at the head of the extracting chamber I through distributing orifices 19' in the manner of a shower, and flows downwardly, through the crushed masses of the raw alloy contained in the cups. In its passage through the solid material ABC, the liquid agent D dissolves out or alloys with the metal A of the alloy ABC, without becoming charged with appreciable amounts of the metals B and C. It should be noted that the raw material ABC and the alloying agent D flow in a counter-current manner, so that the alloying agent D, in its most active condition (as it issues from the distributing orifices 19'), encounters (at the topmost cup) the material ABC in its most exhausted condition, and so that the material ABC in its initial condition (in the lowermost cup), encounters the most worn-out agent D (as D flows away from the lower portion of the extraction chamber).

The residual alloy ABC, containing hardly any more metal A and containing perhaps a little metal D, leaves the furnace through the upper door 3.

Underlying the extraction chamber I, more particularly, the lowermost elevator cup thereof, is provided a decanting reservoir II, into which flows the intermediate alloy AD, together with the portion of the alloying agent D, which had not succeeded in contacting the raw material ABC, and solid particles of the alloy ABC, carried along by the liquid current of the alloy AD. These particles will float when they are lighter than the alloy AD, or fail to the bottom of the reservoir in case they are of greater density. They are eliminated, either through the upper plug 4 in the first case, or through the lower outflow hole 5 in the second case.

From the decanting reservoir II the intermediate alloy AD is conducted to a rectification column designated III and IV, where it is broken up into its components, metal A and agent D, as will be shortly described. For this purpose there is provided a conduit 7 connecting the decanting reservoir II at outlet 6', to the rectification chamber (at inlet 8). The outlet is located at a point in the decanting reservoir II removed from both the floor thereof and the surface of the liquid standing therein, so that the outflowing liquid AD will not become contaminated by the floor deposits or the surface cross, respectively. Preferably, the outlet 6' is positioned at a point in the reservoir II as low as possible (but sufficiently removed from the floor, as explained above), so that the minimum of stagnant liquid will be cupped, even below the point of outlet 6. The conduit 7 from the decanting reservoir connects to the rectification column at inlet 8, which is substantially at the level of the surface of the liquid standing in the decanting reservoir II, so that as the intermediate alloy AD from the extraction chamber I streams into reservoir II, equal amounts of AD will overflow into the rectification chamber at 8. In this manner there is provided a flow from the decanting reservoir to the rectification column.

The intermediate alloy AD is separated into its two components (extracted metal A and alloying agent D) in the rectification column by a process of distillation. The rectification column may be considered to consist of two zones, a lower zone III between the inlet 8 and the bottom of the column, and an upper zone IV between the inlet 8 and the top of the column. There are provided in lower zone III a plurality of rectification plates dispositioned in staggered relation. In the distillation of intermediate alloy AD (liquid), the alloying agent D is evaporated, and rises in a vapor state through zone IV to the top of the column from where it is conducted away at outlet 11. The extracted metal A, on the other hand, remains in a liquid state and flows downwardly through zone III of the column, to be collected at the lower portion thereof. This part of the column is directly over the combustion chamber 33 of the furnace.

The liquid alloy AD entering at 8 flows over the fractionating plates 9, so that as the liquid alloy flows towards the botom it is continually in contact with the metallic vapors which are rising from the more heated plates, and is thus washed by it. Even if metal A has a much higher boiling point than metal D, its evaporation is facilitated by the continuous removal of the vapors of metal D from the distillation zone, whereas moreover, the tension of the vapor of metal D is decreased owing to the presence of the liquid metal A. The metal D, as it evaporates, therefore carries with it vapor of metal A. Owing to the staggered plates, the vapor of metal A which has been carried along comes into intimate contact with the liquid alloy AD. An exchange of calories takes place between the vapor of metal A, which is thus condensed, and the liquid metal D, which is thus vaporized.

The rectification plates 9 are provided on their top surfaces with a plurality of edges 9' which are arranged in staggered relation as clearly seen in Fig. 2. The edges of the plates 9 are provided with overflow notches 9'' as also seen in Fig. 2. The liquid intermediate alloy AD, entering the rectification column at 8, is caused to flow in a zig-zag course downwardly (as viewed in Fig. 1) from plate to plate, and also in a zig-zag course horizontally on each individual plate (as viewed in Fig. 2), the liquid metal flowing in a shower from the overflow notches 9'' of the plate onto the next lower plate.

The devices indicated are in no way limitative. All the devices that are used for fractionating columns can be used for the purpose described. The liquid metal A, completely or almost completely free from metal D, collects in the heated lower part of zone III. It leaves the furnace through an overflow 10 and may be directly cast into ingots.

The almost pure vapors of metal D may undergo a further separation from metal A in zone IV which is above the inlets 8 of both zones III and IV provided with arches 2' which are slightly curved and also arranged in staggered relation; they are provided with ribs on their lower surface and with holes 28. The vortices created in the ascending vapor cause drops of the metal A to be deposited; such deposited drops fall through the holes 28 of the plates, forming a thick stream of liquid, and gives an efficient exchange of calories with the vapor they encounter to extract metal A therefrom. The pure vapor of metal D leave zone IV through outlet 11, flow through the channel 12 and through the inlet 13 enter the condenser 14 which, with the refracting plate 16, form the zone V of the furnace. The condenser is a reservoir containing metal D in the liquid state. In order to facilitate the condensation of the vapors, they are compelled to pass through the liquid metal, and they are washed by
same. The vapor of alloying agent D enters the body of liquid D in the condenser 14, through the submerged inlet 12. The condenser is also connected by submerged overflow 19 to the extraction chamber I, more particularly to the orifices 19' provided at the top of the chamber for the introduction of the liquid alloying agent D. The condenser may be further provided with a plurality of staggered baffle plates 55 and 66, arranged as clearly seen in Fig. 3. Any known type of condenser may be employed instead of the one shown in Figs. 1 and 3. The condenser is capped by a cover 15, provided with a safety valve 31, in which any entrapped vapors are further condensed by cooling.

The reservoir 16 contains metal D, which is used for compensating the losses of said metal that may occur in the extraction process. It is connected to the condenser through an overflow pipe 17.

In summary, the extracting operation is effected as follows:

The raw alloy ABC, loaded in the perforated cups, enters the furnace through the lower door 2. The extraction of the metal A by the alloying metal D takes place in zone I, and the residual alloy containing none or very little of the metal A, leaves the furnace through the upper door 3. The downwardly flowing shower of liquid metal D, encounters the broken solids of the material ABC in the perforated cups of the conveyor, and interacts therewith to form the intermediate alloy AD. It should be noted that the alloy ABC is moved upwardly against the downward flow of the alloying agent, so that the counter-current principle comes into full play. The intermediate alloy AD (a liquid), together with such portions of liquid agent D which had not succeeded in contacting the material ABC, are caught in the reservoir II. There is also carried down and caught in the reservoir II some amounts of solid particles of the alloy ABC, which floats on the surface if lighter than alloy AD, or which sink therein if heavier. Reservoir II is also a decanting reservoir, in that the solid particles are allowed to settle (to be removed at the lower outlet 8), or to float to the surface (to be removed at upper opening 4).

The intermediate alloy AD which is free of particles of alloy ABC flows in a continuous stream from decanting reservoir II into the rectification column, more particularly into zone III. In this zone is effected the separation of the extracted metal A from the alloying metal ABC.

The extracted metal A in the liquid state, flows downwardly and leaves the furnace through the overflow pipe 18, the alloying metal D, in the vapor state, rises to the top of the column, and flows through the pipe 12 into the zone V, where it is condensed to its liquid state. The extracting metal D flows through the furnace in a closed circuit, and its losses which are comparatively small, are replaced from the store of this metal contained in the reservoir 16.

The arrangement of the heating system is governed by the necessity of producing different temperatures in different parts of the furnace. The heating may be effected by means of hearths, gas-pits, burners, or electrically.

The heating system is shown diagrammatically in Fig. 1, by way of a non-diminitive example, is a producer-gas heating system. Combustion takes place in chamber 30 of the lower part of zone III where inlets 31 are located for the heated air. The combustion gases are conducted through conduits 32. The temperature of the hot gases gradually decreases all along the two circuits just traced, corresponding to the decreasing temperature which is to preserve the various zones passed through. The burnt gases finally issue through the exhaust 33, which is located in the coolest portion of the furnace. Air for combustion enters the combustion chamber 30 at air inlets 39, from preheated air flues 36a and 36c, which surround the rectification column or rather the hot gas duct 32l. That is, the hot gas duct is between the rectification column and the preheated air flues, which are thus furthest removed from the column. The preheated air flues 36a on the right of the column, connect with flues 36b positioned to the left of the hot gas duct 32l, which surrounds the extraction chamber I. Here also the hot gas duct 32R is between the preheated air flues 36b and the chamber I. The flues 36l connect with a fresh air inlet 34. The preheated air flues 36c on the left of the rectification column, are positioned on the outside left wall of the furnace, and connect with a horizontal flue 36a at the top of the furnace, which leads to a second fresh air inlet 35. It will be observed that the hot gas duct 32H lies between the condenser V and the preheated air flues 36d, which are nearest the roof of the furnace. The combustion air entering at comparatively cool points of the furnace, namely, points 34 and 35, is gradually preheated as it is conducted to the combustion chamber 30. The distribution of the temperature in the various zones of the furnace is of capital importance. The temperature reaches its maximum, for example about 1,000 to 1,500° C., in the lower part of zone III and its minimum, for example about 300 to 500° C., in zone II. It is between these two zones, which are adjacent each other, that there is the greatest difference of temperature of the furnace. However, there is no danger of zone II being undesirably heated by conductivity from zone III, because of the fact that the metal circulates from zone II toward zone III.

In zone III, which is the hottest part of the furnace, there should be a temperature which is considerably higher than the boiling point of metal D. For example, where zinc is used as the alloying agent D, zone III is required to be maintained at as least 90° C. Furthermore, the quantity of heat supplied should be sufficient to completely evaporate the extracting metal D, and the temperature of the upper part IV should be lower than that of the lower part III. Actually, as the intermediate alloy AD flows downwards in zone III, it becomes enriched in metal A which has a substantially higher boiling point than that of D. The boiling point of the alloy therefore rises, and the vapor tension of metal D, the percentage of which decreases, would gradually decrease if the temperature were not gradually increased.

In zone IV, the prevailing temperature should be near the boiling point of alloying metal D. This is to cause the condensation of portions of vapor of metal A which may have been carried along by D. Also, in this zone the temperature is not everywhere the same, but as in zone III, gradually decreases, and near the cutlet 12 of the pipe 12, the temperature of the furnace is scarcely higher than the boiling point of metal D. In zone V, the temperature should be below the boiling point of alloying metal D, but remains constant throughout the entire zone; it is...
chosen in accordance with the desired conditions of extraction. It is at this temperature that the metal D flows into the extracting chamber I. Extraction in the cups 1', is therefore effected under the best temperature conditions, thereby facilitating the extraction of the last traces of metal A from the alloy ABC.

In zone I (extraction chamber), the temperature gradually decreases, but from the top towards the bottom. In the region of the lowest cup, the prevailing temperature will be slightly higher than the melting temperature of the intermediate alloy AD, depending upon the percentages of extracted metal A and extracting metal D. Zone II (decanting reservoir), should be maintained at the same temperature as prevails in the lower portion of zone I (extraction chamber).

The cup containing the alloy ABC which is not yet sufficienty impoverished in metal A, and which leaves the furnace of Fig. 1 through the upper part 3, may be conveyed into a small auxiliary chamber 20 provided in the path of the vapors D, as shown diagrammatically in Fig. 4. Before entering the condenser, the metallic vapors D will be in contact with the metal A of the alloy ABC. The alloy thus formed flows in the liquid state through the pipe 13 into the condensing tank 14.

While I have illustrated and described the preferred forms of construction for carrying into effect, this is capable of variation and modification, without departing from the spirit of the invention. I therefore do not wish to be limited to the precise details of construction set forth, but desire to avail myself of such variations and modifications as come within the scope of the appended claims.

I claim:

1. In apparatus of the type which employs an alloying agent D for extracting a component metal A from a raw alloy or mixture ABC by forming an intermediate alloy AD with the said extracted metal, the combination of an extraction chamber, means for introducing the alloying agent D in its liquid state into the top of the chamber in the form of flowing streams, means for presenting broken solids of the raw alloy ABC to the said downwardly flowing streams of alloying agent, means for charging the said presenting means with fresh amounts of the raw alloy, means for removing therefrom the exhausted raw alloy, and a reservoir underlying the said extraction chamber for receiving the flow of the intermediate alloy AD formed by the alloying of the agent D with the component A of the raw material ABC together with the remaining part of the alloying agent which had not succeeded in reacting with the raw material.

2. In apparatus of the type which employs an alloying agent D for extracting a component metal A from a raw alloy or mixture ABC by forming an intermediate alloy AD with the said extracted metal, the combination of an extraction chamber, means for introducing the alloying agent D in its liquid state into the top of the chamber in the form of flowing streams and means for presenting broken solids of the raw alloy ABC to the said downwardly flowing streams of alloying agent, and a reservoir underlying the said extraction chamber for receiving the flow of the intermediate alloy AD formed by the alloying of the agent D with the component A of the raw material ABC together with the remaining part of the alloying agent which had not succeeded in reacting with the raw material.

3. In apparatus of the type which employs an alloying agent D for extracting a component metal A from a raw alloy or mixture ABC by forming an intermediate alloy AD with the said extracted metal, the combination of an extraction chamber provided with means for introducing the alloying agent D in its liquid state into the top of the chamber in the form of flowing streams and means for presenting broken solids of the raw alloy ABC to the said downwardly flowing streams of alloying agent, and a decanting reservoir underlying the said extraction chamber into which the flow of the intermediate alloy AD formed by the alloying of the agent D with the component A of the raw material ABC together with the remaining part of the alloying agent which had not succeeded in reacting with the raw material is received together with particles of the solid raw material carried downward with the liquid stream, and means for removing the said solid particles from the liquid in the said decanting reservoir.

4. The combination of claim 3 wherein the last mentioned means comprises an aperture in the wall of the said reservoir at the surface of the liquid therein for removing floating particles and an aperture at the foot of the reservoir for removing settled particles.

5. In apparatus of the type which employs an alloying agent D for extracting a component metal A from a raw alloy or mixture ABC by forming an intermediate alloy AD with the said extracted metal, the combination of an extraction chamber provided with means for introducing the alloying agent D in its liquid state into the chamber in the form of flowing streams and means for conveying broken solids of the raw alloy ABC through the chamber, and a reservoir underlying the said extraction chamber for receiving the flow of the intermediate alloy AD formed by the alloying of the agent D with the component A of the raw material ABC together with the remaining part of the alloying agent which had not succeeded in reacting with the raw material, a rectification column for separating the said intermediate alloy AD into its components, a conduit connecting the said rectification column with the said reservoir, the said rectification column including a receptacle at the bottom of the column for collecting liquid flow of extracted metal A and an outlet at the top of the column.
for escape of vapor of the alloying metal D, a condenser for liquefying the said vapor, a conduit for conducting the said vapor from the said column outlet to the said condenser and a conduit for conducting the liquid agent D from the said condenser to the said agent introducing means of the extraction chamber.

7. In apparatus of the type which employs an alloying agent D for extracting a component metal A from a raw alloy or mixture ABC by forming an intermediate alloy AD with the said extracted metal, the combination of an extraction chamber provided with means for introducing the alloying agent D in its liquid state into the chamber in the form of a flowing stream and means for presenting broken solids of the raw alloy ABC to the said downwardly flowing stream of alloying agent, a rectification column connected to the said chamber to receive the flow of the intermediate alloy AD formed by the alloying of the agent D with the component A of the raw material to form an inlet into the vessel at a point substantially level with the surface of the liquid in the said reservoir whereby the said liquid flows continuously into the said distillation vessel.

10. In apparatus of the type which employs an alloying agent D for extracting a component metal A from a raw alloy or mixture ABC by forming an intermediate alloy AD with the said extracted metal, the combination of an extraction chamber provided with means for introducing the alloying agent D in its liquid state into the top of the chamber in the form of flowing streams and means for presenting broken solids of the raw alloy ABC to the said downwardly flowing streams of alloying agent, a reservoir underlying the said extraction chamber for receiving the flow of the intermediate alloy AD formed by the alloying of the agent D with the component A of the raw material ABC together with the remaining part of the alloying agent which had not succeeded in reacting with the raw material, a distillation vessel for separating the said alloying agent D in vapor form from the said extracted metal A in liquid form by distillation of the said intermediate alloy AD, and a condenser for liquefying the said alloying agent vapor.

11. In apparatus of the type which employs an alloying agent D for extracting a component metal A from a raw alloy or mixture ABC by forming an intermediate alloy AD with the said extracted metal, the combination of an extraction chamber with means for introducing the alloying agent D in its liquid state into the top of the chamber in the form of flowing streams and means for presenting broken solids of the raw alloy ABC to the said downwardly flowing streams of alloying agent, a reservoir underlying the said extraction chamber for receiving the flow of the intermediate alloy AD formed by the alloying of the agent D with the component A of the raw material ABC together with the remaining part of the alloying agent which had not succeeded in reacting with the raw material, a distillation vessel for separating the said alloying agent D in vapor form from the said extracted metal A in liquid form by distillation of the said intermediate alloy AD.

12. In apparatus of the type which employs an alloying agent D for extracting a component metal A from a raw alloy or mixture ABC by forming an intermediate alloy AD with the said extracted metal, the combination of an extraction chamber provided with means for introducing the alloying agent D in its liquid state into the chamber in the form of a flowing stream and means for presenting broken solids of the raw alloy ABC to the said downwardly flowing streams of alloying agent, a reservoir underlying the said extraction chamber for receiving the flow of the intermediate alloy AD formed by the alloying of the agent D with the component A of the raw material ABC together with the remaining part of the alloying agent which had not succeeded in reacting with the raw material, a distillation vessel connected to the said chamber to receive the flow of the intermediate alloy AD formed by the alloying of the agent D with the component A of the raw material ABC together with the remaining part of the alloying agent which had not succeeded in reacting with the raw material, the said distillation vessel being adapted to separate the said intermediate alloy AD into its components.
an alloying agent D for extracting a component metal A from a raw alloy or mixture ABC by forming an intermediate alloy AD with the said extracted metal, the combination of an extraction chamber provided with means for introducing the alloying agent D in its liquid state into the top of the chamber in the form of flowing streams and means for presenting broken solids of the raw alloy ABC to the said downwardly flowing streams of alloying agent, a reservoir underlying the said extraction chamber for receiving the flow of the intermediate alloy AD formed by the alloying of the agent D with the component A of the raw material ABC together with the remaining part of the alloying agent which had not succeeded in reacting with the raw material, and a rectification column for separating the said intermediate alloy AD into its components, including a receptacle at the bottom for collecting liquid flow of extracted metal A and an outlet at the top of the column for escape of vapors of the alloying agent D.

14. In apparatus of the type which employs an alloying agent D for extracting a component metal A from a raw alloy or mixture ABC by forming an intermediate alloy AD with the said extracted metal, the combination of a main extraction chamber provided with means for introducing the alloying agent D in its liquid state into the top of the chamber in the form of flowing streams and means for presenting broken solids of the raw alloy ABC to the said downwardly flowing streams of alloying agent, a reservoir underlying the said extraction chamber for receiving the flow of the intermediate alloy AD formed by the alloying of the agent D with the component A of the raw material ABC together with the remaining part of the alloying agent which had not succeeded in reacting with the raw material, a rectification column for separating the said extracted metal A in liquid form from the said alloying agent D in vapor formed by distillation of the said intermediate alloy AD, a condenser for liquefying the said alloying agent vapor, and an auxiliary extraction chamber between the said condenser and rectification column for subjecting the exhausted raw alloy taken from the main extraction chamber, to the said vapors of the alloying agent.

15. In apparatus of the type which employs an alloying agent D for extracting a component metal A from a raw alloy or mixture ABC by forming an intermediate alloy AD with the said extracted metal, the combination of an extraction chamber provided with means for introducing the alloying agent D in its liquid state into the top of the chamber in the form of flowing streams and means for presenting broken solids of the raw alloy ABC to the said downwardly flowing streams of alloying agent, a reservoir underlying the said extraction chamber for receiving the flow of the intermediate alloy AD formed by the alloying of the agent D with the component A of the raw material ABC together with the remaining part of the alloying agent which had not succeeded in reacting with the raw material, a rectification column for separating the said intermediate alloy AD into its components, including a receptacle at the bottom of the column for collecting liquid flow of extracted metal A and an outlet at the top of the column for escape of vapors of the alloying agent D, a condenser between the said vapor outlet of the rectification column and the said alloying agent introducing means of the extraction chamber for liquefying the said vapor, along a heating system including a furnace underlying the said extracted metal receptacle and a hot gases duct passing the rectification column, condenser, extraction chamber and reservoir in succession, adapted to maintain the rectification column at a temperature above the evaporation point of the alloying metal D, to maintain the condenser at a temperature below the said evaporation point, and to maintain the extraction chamber and reservoir at a point above the solidification point of the intermediate alloy AD.

16. In apparatus of the type which employs an alloying agent D for extracting a component metal A from a raw alloy or mixture ABC by forming an intermediate alloy AD with the said extracted metal, the combination of an extraction chamber provided with means for introducing the alloying agent D in its liquid state into the top of the chamber in the form of flowing streams and means for presenting broken solids of the raw alloy ABC to the said downwardly flowing streams of alloying agent, a reservoir underlying the said extraction chamber for receiving the flow of the intermediate alloy AD formed by the alloying of the agent D with the component A of the raw material ABC together with the remaining part of the alloying agent which had not succeeded in reacting with the raw material, a rectification column for separating the said intermediate alloy AD into its components, a conduit connecting the said rectification column with the said reservoir, the said rectification column including a receptacle at the bottom of the column for collecting liquid flow of extracted metal A and an outlet at the top of the column for escape of vapor of the alloying metal D, a condenser for liquefying the said vapor, a conduit for conducting the said vapor from the said column outlet to the said condenser, a conduit for conducting the liquid agent D from the said condenser to the said agent introducing means of the extraction chamber, and means for maintaining a continuous circulation of the said alloying agent through the apparatus.

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