Apparatus and method for manufacturing copper-base alloy.

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Description

The present invention relates to an apparatus and a method for manufacturing a copper-base alloy having a quite uniform chemical composition.

Prior Art

In manufacturing a copper-base alloy, there has conventionally been employed a batch process, in which solute metals are alloyed with copper in a melting furnace.

The batch process, however, has been disadvantageous in that every time the kinds of copper-base alloys to be manufactured are changed, the inside of the melting furnace has to be washed. As a result, a large quantity of a melt has been required for washing, and it is laborious to carry out such washing. In addition, inasmuch as the intermittent operation deteriorates the rate of operation of the melting furnace, the productivity has been lowered, resulting in a high production cost. Besides, since the solute constituents are difficult to be mixed uniformly with copper, the alloy thus produced has not complied with a desired quality.

US-A-3836360 discloses an apparatus for manufacturing a copper-base alloy which comprises a furnace for heating pure copper which is then released at a controlled rate into a launder. The melted copper flows through a relatively narrow channel formed in the launder to a discharge end. The alloyed metal is continuously discharged from this end into the entrance of a direct chill casting mould. A wire coil comprising a master alloy is fed into the alloy as it flows along the narrow channel of the launder.

GB-A-1181518 discloses a process for producing oxygen-free cast metal by maintaining an inert atmosphere containing carbon monoxide and hydrogen above a molten alloy whilst it is flowing through a furnace system. In the system, a pouring spout of a holding furnace is joined in a gas tight manner to a closed casting head formed as a launder which the holding furnace spout enters at one end and which at the other end has a bottom pouring discharge port which is controlled by a plunger.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a copper alloy manufacturing apparatus which can melt a solute constituent in a molten copper uniformly to continuously produce a copper alloy having a uniform chemical composition with a reduced cost.

Another object is to provide a method of manufacturing a copper alloy by using such an apparatus.

According to a first aspect of the present invention, there is provided an apparatus for manufacturing a copper-base alloy comprising an alloying spout inclined downwardly from one end towards the other end for flowing molten copper therethrough, said alloying spout including an inlet at said one end and an outlet at said other end and having an elongated passageway through which said inlet communicates with said outlet, whereby the molten copper introduced from said inlet can flow downwardly through said passageway to said outlet; characterised in that a tundish is disposed at said other end of said alloying spout for receiving said molten copper-base alloy tapped from said alloying spout; said alloying spout and said tundish are respectively comprised of hermetically sealable casings; and said alloying spout includes first and second spaced-apart feed means provided at relatively upstream and downstream portions of said alloying spout, the upstream feed means being arranged to introduce at least one solid solute constituent having a higher melting point than copper into said passageway, and the downstream feed means being arranged to introduce at least one solid solute constituent having a lower melting point than copper into said passageway, said first and second feed means being arranged to enable said at least two solute constituents to become mixed with said molten copper.

According to a second aspect of the present invention, there is provided a method of manufacturing a copper-base alloy, comprising the steps of providing an alloying spout inclined downwardly from an inlet towards an outlet and having an elongated passageway through which said inlet communicates with said outlet; and continuously introducing molten copper from said inlet into said passageway of said alloying spout and causing the molten copper to flow downwardly through said passageway to said outlet; characterized by continuously introducing at least one solid solute constituent having a higher melting point than copper through a first feed means into an upstream portion of said passageway of said alloying spout and continuously introducing at least one solid solute constituent having a lower melting point than copper through a second feed means into a downstream portion of said passageway, the first and second feed means being arranged to enable the mixing of said at least two solute constituents with said molten copper; imparting a hermetically sealable structure to said alloying spout and providing a hermetically sealable tundish at the outlet of said alloying spout; and tapping the molten copper-base alloy into said tundish from
said alloying spout.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic cross-sectional view showing an apparatus in accordance with the present invention;
Fig. 2 is a schematic transverse cross-sectional view of an alloying spout mounted in the apparatus of Fig. 1;
Fig. 3 is a schematic cross-sectional view showing a part of a modified apparatus in accordance with the present invention; and
Fig. 4 is a schematic cross-sectional view showing a part of another modified apparatus in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

Referring to Figs. 1 and 2, there is illustrated an apparatus for manufacturing a copper-base alloy, which comprises a melting crucible furnace 10 for melting a solid copper material to produce a molten copper. A pouring spout 12, which is inclined downwardly from one end toward the other end and has an inlet 12a at one end and an outlet 12b at the other end, is connected at the one end to the melting furnace 10, and a holding furnace 14 is disposed at the other end of the pouring spout 12 for holding the molten copper tapped from the pouring spout 12 in an oxygen-free state and keeping the temperature of the molten copper at a prescribed level. As shown in Fig. 2, the pouring spout 12 is accommodated in a refractory brick-lined housing 13, and a reducing gas, which consists of a mixture of carbon monoxide gas and nitrogen gas, is contained in the spout 12.

An alloying spout 16, which is inclined downwardly from one end toward the other end, is connected at the one end to the holding furnace 14 for causing the molten copper tapped from the holding furnace 14 to flow downwardly therethrough. The alloying spout 16 is comprised of a hermetically sealable casing having an inlet 16a at one end and an outlet 16b at the other end and an elongated passageway 16c through which the inlet 16a communicates with the outlet 16b, and an inert gas or a reducing gas is filled in the passageway 16c. As is the case with the pouring spout 12, the alloying spout 16 is accommodated in a refractory brick-lined housing 13. A pouring basin or tundish 18, which is also comprised of a hermetically sealable casing, is disposed at the other end of the alloying spout 16 for receiving the molten metal tapped from the alloying spout 16, and graphite powder is contained in the tundish to cover the surface of the molten metal for sealing purposes. First and second feeders 20 and 22 are respectively connected to the alloying spout 16 for introducing solid solute constituents into the passageway 16c of the alloying spout 16, the first feeder 20 being connected to an upstream portion of the spout 16 adjacent to the one end thereof while the second feeder 22 is connected to a downstream portion of the spout 16 adjacent to the other end thereof. The passageway 16c of the alloying spout 16 should be long enough to melt the solute constituents to mix them with the molten copper during the passage of the molten copper through the passageway 16c.

The solute constituents to be alloyed with copper are different depending upon the kinds of the copper alloys to be produced. As such solute constituents, many elements such as chromium (Cr), zirconium (Zr), titanium (Ti), silicon (Si), nickel (Ni), iron (Fe), magnesium (Mg), tin (Sn), tellurium (Te), arsenic (As), phosphorus (P), aluminium (Al), zinc (Zn), beryllium (Be), W (tungsten) and the like may be alloyed with copper. With respect to an element having a higher melting point as compared with copper, such as Cr, Zr, Ti, Si, Ni and Fe, a solid material of a high purity should preferably be used. Such pure solid material may be in the form of granules, grains, wires, pieces, powders or the like.

The outer shell of the tundish 18 has an opening in the bottom, in which is fitted a nozzle 18a with a stopper 24. By raising and lowering the stopper 24, the quantity of the molten copper alloy to be tapped from the tundish 18 can be controlled. A mould 26 is disposed under the tundish 18 for continuously casting the molten alloy tapped from the nozzle 18a of the tundish 18 to produce a cast copper alloy. A sealing shell 28 is mounted between the tundish 18 and the mould 26 for hermetically sealing the inside of the mould and the tundish, and an inert gas is supplied thereinto.

The operation of the copper alloy manufacturing apparatus will now be described.

First, the melting furnace 10 is charged with the solid copper, and the copper is melted. Specifically, in this melting furnace 10, pieces of charcoal are added to prevent the molten copper from being exposed to the air, so that low oxygen molten copper, which contains an oxygen content of not greater than 50 ppm, is produced in it. When the molten copper in the melting furnace 10 exceeds a prescribed level, it overflows into the pouring spout 12 and passes therethrough to the holding furnace 14. In the pouring spout 12, the
low oxygen molten copper is reduced by the reducing gas contained therein to an oxygen free molten copper, an oxygen content of which is not greater than 10 ppm.

Subsequently, the oxygen-free molten copper is tapped into the holding furnace 14 and kept at a prescribed temperature. Then, the molten copper overflows into the alloying spout 16 and passes through the passageway 16c thereof to flow into the tundish 18. During the passage of the copper through the alloying spout 16, first solid solute constituents, which have high melting points compared with copper and are difficult to be melted, are added through the first feeder 20 into the passageway 16c of the alloying spout 16, and second solute constituents, which have low melting points compared with copper, are added through the second feeder 22 into the passageway 16c of the spout 16. In this step, inasmuch as the molten copper is flowing through the passageway 16c at a sufficient flow rate, the solute constituents introduced into the passageway 16c are mixed with the molten copper uniformly and melted quickly, and thus a molten copper-base alloy of the uniform chemical composition is produced. In addition, although the first solute constituents have high melting points and are difficult to be melted, they are added in the alloying spout 16 at its upstream portion, and therefore they can be sufficiently alloyed with the copper during the passage through the elongated passageway 18c. With respect to the second solute constituents having low melting points, they are added in the spout 16 at its downstream portion, but are easily mixed with and alloyed with the copper. Some solute constituents having higher solubilities may be added in the tundish 18. Further, the solute constituents may preferably be preheated to temperatures near to their melting points before they are added.

The molten copper alloy thus produced is tapped from the alloying spout 16 into the tundish 18, and teemed from the tundish 18 into the mould 26 through the nozzle 18a, so that a cast product 30 of copper alloy is manufactured.

Although in the foregoing, the solute constituents are alloyed with the oxygen free copper in the alloying spout 16, they may be alloyed with low oxygen copper or deoxidized copper. However, if the solute constituent to be added is an active or reactive element such as Cr, Ti, Zr, Si, Mg, Ca, Al and the like, which has a great affinity for oxygen, such element combines with oxygen to thereby lower the yield of the alloy. In such a case, the low oxygen copper may be preferably used.

Fig. 3 shows a modified apparatus in accordance with the present invention which differs from the apparatus of Figs. 1 and 2 only in that there is provided a heating furnace 32 between the alloying spout 16 and the tundish 18 for heating the molten alloy tapped from the spout 16. The heating furnace 32 is a high frequency induction furnace, to which is attached a bubbling apparatus 34 for blowing an inert gas such as argon into the molten alloy to stir it up. An alloy produced by the apparatus of this embodiment contains a high content of solute elements.

Fig. 4 shows another modified apparatus in accordance with the present invention which differs from the apparatus of Figs. 1 and 2 only in that heating means 36 is attached to the alloying spout 16 for heating the molten copper and the solute elements passing through the passageway 16c.

Further, although in the above embodiments, two feeders are connected to the alloying spout 16, only one feeder may be enough if only a few solute constituents are to be added, or the solubilities of the solute constituents are almost equivalent to each other. In addition, each of the spouts 12 and 16 may be a spout of a U-shaped cross section housed in a hermetically sealable refractory brick-lined housing.

As described above, in the apparatus in accordance with the present invention, the solute constituents are continuously added in the molten copper which is flowing at a sufficient flow rate. Accordingly, the solute constituents added are stirred by the flow of the molten copper and mixed therewith uniformly and melted quickly, and thus the copper-base alloy of a uniform chemical composition is produced continuously.

In addition, by changing the quantity of the solute constituents to be added in the alloying spout, the quantity of the alloy to be produced is changed, and besides different kinds of alloys can easily be manufactured. Further, since the alloying is carried out in the alloying spout, there is no need to wash the inside of the melting furnace when changing the kinds of alloys to be manufactured, thus increasing the operating rate of the apparatus substantially.

The invention will now be illustrated by way of the following EXAMPLES.

EXAMPLE 1

Cr-Cu alloys of a desired Cr content ranging from 0.25 to 0.40 % by weight were manufactured using the apparatus of Figs. 1 and 2. For comparison purposes, Cr-Cu alloys of the same desired Cr content were produced by the conventional batch process. The data on Cr contents and the like for such alloys are shown in TABLE 1.

As seen from TABLE 1, the alloys obtained by the apparatus in accordance with the present invention
exhibits generally uniform Cr contents and complies with the desired specification. On the other hand, Cr contents of the alloys obtained by the conventional batch process vary widely, and besides there is an alloy which does not meet the specification.

**TABLE 1**

<table>
<thead>
<tr>
<th></th>
<th>Cr-Cu alloys obtained by the apparatus of the invention</th>
<th>Cr-Cu alloys obtained by the conventional apparatus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling number</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Average Cr content (wt %)</td>
<td>0.345</td>
<td>0.324</td>
</tr>
<tr>
<td>Maximum Cr content (wt %)</td>
<td>0.390</td>
<td>0.490</td>
</tr>
<tr>
<td>Minimum Cr content (wt %)</td>
<td>0.320</td>
<td>0.260</td>
</tr>
<tr>
<td>Range</td>
<td>0.070</td>
<td>0.230</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>0.029</td>
<td>0.070</td>
</tr>
</tbody>
</table>

**EXAMPLE 2**

Zr-Cu alloys of a desired Zr content ranging from 0.07 to 0.13 % by weight were manufactured by using the apparatus of Figs. 1 and 2, and by the conventional batch process for comparison purposes. The data on Zr contents and the like for such alloys are shown in TABLE 2.

As seen from TABLE 2, the alloys obtained by the apparatus in accordance with the present invention exhibits a generally uniform Zr content and complies with the desired specification. On the other hand, Zr contents of the alloys obtained by the conventional batch process vary widely, and besides there is an alloy which does not meet requirements. Further, although Zr is reactive and is liable to oxidation, Zr contents of the alloys obtained by the apparatus of the invention are relatively higher as compared with the alloys obtained by the conventional process.
### TABLE 2

<table>
<thead>
<tr>
<th></th>
<th>Zr-Cu alloys obtained by the apparatus of the invention</th>
<th>Zr-Cu alloys obtained by the conventional apparatus</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sampling number</strong></td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td><strong>Average Zr content (wt %)</strong></td>
<td>0.098</td>
<td>0.058</td>
</tr>
<tr>
<td><strong>Maximum Zr content (wt %)</strong></td>
<td>0.107</td>
<td>0.105</td>
</tr>
<tr>
<td><strong>Minimum Zr content (wt %)</strong></td>
<td>0.095</td>
<td>0.018</td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>0.012</td>
<td>0.087</td>
</tr>
<tr>
<td><strong>Standard deviation</strong></td>
<td>0.005</td>
<td>0.034</td>
</tr>
</tbody>
</table>

**EXAMPLE 3**

Mg-Cu alloys of a desired Mg content ranging from 0.02 to 0.08 % by weight were manufactured by using the apparatus of Figs. 1 and 2, and by the conventional batch process for comparison purposes. The data on Mg contents and the like for such alloys are shown in TABLE 3.

As seen from TABLE 3, the alloys obtained by the apparatus in accordance with the present invention exhibit a generally uniform Mg content and comply with the desired specification. On the other hand, Mg contents of the alloys obtained by the conventional batch process vary widely, and besides there is an alloy which does not meet requirements. Further, as is the case with EXAMPLE 2, although Mg is reactive and is liable to oxidation, Mg contents of the alloys obtained by the apparatus of the invention are relatively higher as compared with the alloys obtained by the conventional process.
### TABLE 3

<table>
<thead>
<tr>
<th>Sampling number</th>
<th>Mg–Cu alloys obtained by the apparatus of the invention</th>
<th>Mg–Cu alloys obtained by the conventional apparatus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Average Mg content (wt %)</td>
<td>0.055</td>
<td>0.030</td>
</tr>
<tr>
<td>Maximum Mg content (wt %)</td>
<td>0.058</td>
<td>0.050</td>
</tr>
<tr>
<td>Minimum Mg content (wt %)</td>
<td>0.052</td>
<td>0.008</td>
</tr>
<tr>
<td>Range</td>
<td>0.006</td>
<td>0.042</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>0.002</td>
<td>0.019</td>
</tr>
</tbody>
</table>

#### EXAMPLE 4

Cr-Cu alloys of a desired Cr content ranging from 0.75 to 0.90 % by weight were manufactured using the apparatus of Fig. 3 which includes the heating furnace 32. For comparison purposes, Cr-Cu alloys of the same desired Cr content were produced by the conventional batch process. The data on Cr contents and the like for such alloys are shown in TABLE 4.

As seen from TABLE 4, the alloys produced by the apparatus in accordance with the present invention exhibits a generally uniform Cr content and complies with the desired specification. On the other hand, Cr contents of the alloys obtained by the conventional batch process vary widely, and besides there are alloys which do not meet requirements.
TABLE 4

<table>
<thead>
<tr>
<th>Sampling number</th>
<th>Cr-Cu alloys obtained by the apparatus of the invention</th>
<th>Cr-Cu alloys obtained by the conventional apparatus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Cr content (wt %)</td>
<td>0.831</td>
<td>0.781</td>
</tr>
<tr>
<td>Maximum Cr content (wt %)</td>
<td>0.857</td>
<td>0.920</td>
</tr>
<tr>
<td>Minimum Cr content (wt %)</td>
<td>0.817</td>
<td>0.615</td>
</tr>
<tr>
<td>Range</td>
<td>0.040</td>
<td>0.305</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>0.019</td>
<td>0.084</td>
</tr>
</tbody>
</table>

EXAMPLE 5

Granules of a pure Cr metal, each of which had a high melting point and had a purity of not less than 99.7 % by weight and a granular size of 0.1 mm to 1.5 mm, were alloyed with copper using the apparatus of Figs. 1 and 2, and a copper alloy which had a uniform chemical composition containing a Cr content of 1.1 % by weight was successfully obtained. Similarly, smashed pieces of Ti each having a purity of not less than 99.6 % by weight and a size of 3.0 mm to 5.0 mm, pieces of Zr each having a purity of not less than 99.0 % by weight and a size of 1.0 mm × 5.0 mm × 10.0 mm, smashed pieces of Si each having a purity of not less than 99.9 % by weight and a size of 3.0 mm × 5.0 mm, spherical pieces of Ni each having a purity of not less than 99.8 % by weight and a size of 8 mm, and pieces of Fe each having a purity of not less than 99.9 % by weight and a size of 1 mm × 2 mm to 5 mm were alloyed with copper, respectively, and copper alloys which contain Ti content of 2.5 % by weight, Zr content of 0.2 % by weight, Si content of 1.7 % by weight, Ni content of 2.5 % by weight, and Fe content of 2.3 % by weight, respectively, were obtained.

EXAMPLE 6

A Cu-Cr-Ti-Si-Ni-Sn alloy was produced by the apparatus of Figs. 1 and 2. In this case, by adding the alloying elements in the order of Cu-Cr-Ti-Si-Ni-Sn, an alloy having Cr content of 0.3 % was obtained.

Claims

1. An apparatus for manufacturing a copper-base alloy comprising
   an alloying spout (16) inclined downwardly from one end towards the other end for flowing molten copper therethrough, said alloying spout (16) including an inlet (16a) at said one end and an outlet (16b) at said other end and having an elongated passageway (16c) through which said inlet (16a) communicates with said outlet (16b), whereby the molten copper introduced from said inlet (16a) can flow downwardly through said passageway (16c) to said outlet (16b); characterized in that
a tundish (18) is disposed at said other end of said alloying spout (16) for receiving said molten copper-base alloy tapped from said alloying spout (16);
said alloying spout (16) and said tundish (18) are respectively comprised of hermetically sealable casings; and
said alloying spout (16) includes first and second spaced-apart feed means (20, 22) provided at relatively upstream and downstream portions of said alloying spout (16), the upstream feed means (20) being arranged to introduce at least one solid solute constituent having a higher melting point than copper into said passageway (16c), and the downstream feed means (22) being arranged to introduce at least one solid solute constituent having a lower melting point than copper into said passageway (16c), said first and second feed means (20, 22) being arranged to enable said at least two solute constituents to become mixed with said molten copper.

2. An apparatus according to claim 1, further comprising a heat furnace (32) interposed between said alloying spout (16) and said tundish (18) for heating the molten copper-base alloy tapped from said alloying spout (16).

3. An apparatus according to claim 2, wherein said heating furnace (32) is an induction furnace.

4. An apparatus according to any preceding claim, further comprising a melting furnace (10) for melting solid copper to produce the molten copper, a pouring spout (12) for causing the molten copper produced in said melting furnace (10) to flow therethrough, a holding furnace (14) interposed between said pouring spout (12) and said alloying spout (16) for receiving said molten copper therein and for keeping the molten copper at a prescribed temperature, and a mould (26) disposed adjacent to said tundish (18) for casting said molten copper-base alloy to produce a cast product of the copper-base alloy.

5. An apparatus according to any preceding claim, wherein said alloying spout (16) includes heating means (36) attached thereto for heating the molten copper passing through said passageway (16c).

6. A method of manufacturing a copper-base alloy, comprising the steps of:
   (a) providing an alloying spout (16) inclined downwardly from an inlet (16a) towards an outlet (16b) and having an elongated passageway (16c) through which said inlet (16a) communicates with said outlet (16b); and
   (b) continuously introducing molten copper from said inlet (16a) into said passageway (16c) of said alloying spout (16) and causing the molten copper to flow downwardly through said passageway (16c) to said outlet (16b);
   characterized by continuously introducing at least one solid solute constituent having a higher melting point than copper through a first feed means (20) into an upstream portion of said passageway (16c) of said alloying spout (16) and continuously introducing at least one solid solute constituent having a lower melting point than copper through a second feed means (22) into a downstream portion of said passageway (16c), the first and second feed means (20, 22) being arranged to enable the mixing of said at least two solute constituents with said molten copper;
   imparting a hermetically sealable structure to said alloying spout (16) and providing a hermetically sealable tundish (18) at the outlet (16b) of said alloying spout (16); and
   tapping the molten copper-base alloy into said tundish (18) from said alloying spout (16).

7. A method according to claim 6, wherein said molten copper is an oxygen free copper.

8. A method according to claim 6, wherein said molten copper is low oxygen copper.

9. A method according to claim 6, wherein said molten copper and said solute constituents are mixed in a non-oxidizing atmosphere.

10. A method according to claim 9, in which said non-oxidizing atmosphere is an inert gas atmosphere.

11. A method according to claim 10, in which said non-oxidizing atmosphere is a reducing gas atmosphere.

12. A method according to claim 6, wherein at least one of said solid solute constituents is a reactive
Revendications

1. Appareil pour fabriquer un alliage à base de cuivre, comprenant :
   un canal (16) de formation d'alliage incliné vers le bas depuis une première de ses extrémités en
direction de sa seconde extrémité pour l'écoulement du cuivre fondu à travers ce canal, le canal (16)
de formation d'alliage comprenant une entrée (16a) à ladite première extrémité et une sortie (16b) à
ladite seconde extrémité et comportant un passage allongé (16c) à travers lequel l'entrée (16a)
communique avec la sortie (16b), grâce à quoi le cuivre fondu introduit à partir de l'entrée (16a) peut
s'écouler vers le bas à travers le passage (16c) jusqu'à la sortie (16b),
 caractérisé en ce que :
   un panier (18) de coulée est disposé à ladite seconde extrémité du canal (16) de formation
d'alliage pour recevoir l'alliage à base de cuivre fondu souillé du canal (16) de formation d'alliage ;
   le canal (16) de formation d'alliage et le panier (18) sont constitués respectivement par des
enveloppes pouvant être fermées de façon hermétique ; et
   le canal (16) de formation d'alliage comprend des premier et second moyens d'amenée (20, 22)
espacés l'un de l'autre et disposés l'un par rapport à l'autre dans des parties d'amont et d'aval du
canal (16) de formation d'alliage, les moyens d'amenée (20) d'amont étant agencés pour introduire
dans le passage (16c) au moins un constituant soluté de solution solide ayant un point de fusion plus
élevé que celui du cuivre, et le moyen d'amenée (22) d'aval étant agencé pour introduire dans le
passage (16c) au moins un constituant soluté de solution solide ayant un point de fusion inférieur à
ceux du cuivre, les premiers et second moyens d'amenée (20, 22) étant agencés pour permettre aux
constituants solutés au nombre d'au moins deux de se mélanger avec le cuivre fondu.

2. Appareil selon la revendication 1, comprenant en outre un four de réchauffage (32) interposé entre
le canal (16) de formation d'alliage et le panier de coulée (18) pour réchauffer l'alliage à base de cuivre
fondu souillé du canal (16) de formation d'alliage.

3. Appareil selon la revendication 2, dans lequel le four de réchauffage (32) est un four à induction.

4. Appareil selon l'une quelconque des revendications précédentes, comprenant en outre un four de
fusion (10) pour fondre le cuivre solide de manière à produire le cuivre fondu, un canal de coulée (12)
pour que le cuivre fondu produit dans le four de fusion (10) s'écoule à travers ce canal, un four de
maintien (14) interposé entre le canal de coulée (12) et le canal (16) de formation d'alliage pour
recevoir le cuivre fondu et pour maintenir le cuivre fondu à une température prescrite, et un moule (26)
disposé en un point adjacent au panier (18) pour mouler l'alliage à base de cuivre fondu de manière à
produire un produit moulé en alliage à base de cuivre.

5. Appareil selon l'une quelconque des revendications précédentes, dans lequel le canal (16) de formation
d'alliage comprend un moyen de réchauffage (36) qui lui est associé pour réchauffer le cuivre fondu
traversant ce passage (16c).

6. Procédé de fabrication d'un alliage à base de cuivre comprenant les étapes consistant :
   (a) à mettre en place un canal (16) de formation d'alliage incliné vers le bas depuis une entrée (16a)
en direction d'une sortie (16b) et comportant un passage allongé (16c) par l'intermédiaire duquel
l'entrée (16a) communique avec la sortie (16b) ; et
   (b) à introduire de façon continue le cuivre fondu dans le passage (16c) du canal (16) de formation
d'alliage à partir de l'entrée (16a) et à faire s'écouler le cuivre fondu vers le bas à travers le passage
(16c) jusqu'à la sortie (16b) ;
 caractérisé par le fait que :
   l'on introduit de façon continue ou par l'intermédiaire d'un premier moyen d'amenée (20) dans une
partie d'amont du passage (16c) du canal (16) de formation d'alliage au moins un constituant soluté de
solution solide et on introduit de façon continue par l'intermédiaire d'un second moyen d'amenée (22)
dans une partie d'aval du passage (16c) au moins un constituant soluté de solution solide ayant un
point de fusion inférieur à celui du cuivre, les premier et second moyens d'amenée (20, 22) étant
agencés pour permettre le mélange des constituants solutés au nombre d'au moins deux avec le cuivre
fondu ;
7. Procédé selon la revendication 6, dans lequel le cuivre fondu est un cuivre exempt d'oxygène.

8. Procédé selon la revendication 6, dans lequel le cuivre fondu est un cuivre à faible teneur en oxygène.

9. Procédé selon la revendication 6, dans lequel le cuivre fondu et les constituants solutés sont mélangés dans une atmosphère non-oxydante.

10. Procédé selon la revendication 9, dans lequel l'atmosphère non-oxydante est une atmosphère formée par un gaz inerte.

11. Procédé selon la revendication 10, dans lequel l'atmosphère non-oxydante est une atmosphère formée par un gaz réducteur.

12. Procédé selon la revendication 6, dans lequel au moins un des constituants solutés de solution solide est un élément réactif qui est susceptible d'être oxydé.

**Patentansprüche**

1. Vorrichtung zur Herstellung einer Kupferlegierung enthaltend eine Ausflußröhre zum Legieren (16), die von einem zum anderen Ende abwärts geneigt ist, um geschmolzenes Kupfer hindurchfließen zu lassen, wobei diese Ausflußröhre zum Legieren (16) an einem Ende eine Zulauföffnung (16a), an dem anderen Ende eine Ausflußöffnung (16b) und eine verlängerte Durchflußbahn (16c) aufweist, durch welche die Zulauföffnung (16a) mit der Ausflußöffnung (16b) verbunden ist und wobei das zugeführte geschmolzene Kupfer von dieser Zulauföffnung (16a) durch diese Durchflußbahn (16c) zu dieser Ausflußöffnung (16b) abwärts fließen kann; dadurch gekennzeichnet, daß eine Gießwanne (18) an dem anderen Ende der Ausflußröhre zum Legieren (16) angebracht ist, um die geschmolzene Kupferlegierung, die von der Ausflußröhre zum Legieren (16) abgestochen wird, aufzunehmen, daß diese Ausflußröhre zum Legieren (16) und diese Gießwanne (18) jeweils mit hermetisch verschließbaren Gehäusen umfaßt sind, und daß die Ausflußröhre zum Legieren (16) eine erste und zweite voneinander räumlich getrennte Beschildungsvorrichtung (20, 22) enthält, die an dem oberen und unteren durchströmten Teil der Ausflußröhre zum Legieren (16) angebracht sind, wobei die obere Beschildungsvorrichtung (20) so angeordnet ist, daß zumindest eine feste, in geschmolzenem Kupfer lösliche Komponente mit einem höheren Schmelzpunkt als Kupfer in die Durchflußbahn (16c) eingebracht wird, und die untere Beschildungsvorrichtung (22) so angeordnet ist, daß zumindest eine feste, in geschmolzenem Kupfer lösliche Komponente mit einem niedrigeren Schmelzpunkt als Kupfer in die Durchflußbahn (16c) eingebracht wird, und diese erste und zweite Beschildungsvorrichtung (20, 22) so angeordnet sind, daß zumindest zwei feste, lösliche Komponenten mit dem geschmolzenen Kupfer gemischt werden können.

2. Vorrichtung gemäß Anspruch 1, die zusätzlich einen Glühofen (32), der zwischen der Ausflußröhre zum Legieren (16) und der Gießwanne (18) angebracht ist, um die geschmolzene Kupferlegierung zu erhitzten, die von der Ausflußröhre zum Legieren (16) abgestochen wird, enthält.

3. Vorrichtung gemäß Anspruch 2, in der der Glühofen (32) ein Induktionsofen ist.

4. Vorrichtung gemäß einem der vorhergehenden Ansprüche, die zusätzlich einen Schmelzofen (10) zum Schmelzen von festem Kupfer zur Überführung in geschmolzenes Kupfer, eine Ausflußröhre (12), um das in dem Schmelzofen (10) geschmolzene Kupfer hindurchfließen zu lassen, einen Warmhaltofen (14), der zwischen der Ausflußröhre (12) und der Ausflußröhre zum Legieren (16) angebracht ist, um das geschmolzene Kupfer aufzunehmen und auf der erforderlichen Temperatur zu halten, und eine
Gußform (28), die anschließend an die Gießwanne (18) angebracht ist, um die geschmolzene Kupferlegierung zu gießen und ein Gußprodukt der Kupferlegierung herzustellen, enthält.

5. Vorrichtung gemäß einem der vorhergehenden Ansprüche, in der die Ausflußdüse zum Legieren (16) daran angebrachte Heizelemente (36) enthält, um das die Durchflußbahn (16c) passierende geschmolzene Kupfer zu erhitzten.

6. Verfahren zur Herstellung einer Kupferlegierung, folgende Verfahrensschritte umfassend:
   (a) Anbringen einer Ausflußdüse zum Legieren (16), die von einer Zulauföffnung (16a) zu einer Ausflußöffnung (16b) geneigt ist und eine verlängerte Durchflußbahn (16c) aufweist, durch welche die Zulauföffnung (16a) mit der Ausflußöffnung (16b) in Verbindung steht, und
   (b) kontinuierliches Einführen von geschmolzenem Kupfer aus der Zulauföffnung (16a) in die Durchflußbahn (16c) der Ausflußdüse zum Legieren (16) und Hineinfließen des geschmolzenen Kupfers durch diese Durchflußbahn (16c) zu der Ausflußöffnung (16b),
dadurch gekennzeichnet, daß zumindest eine feste lösliche Komponente mit einem höheren Schmelzpunkt als Kupfer durch eine erste Beschickungsvorrichtung (20) in einen oberen Teil der durchströmten Durchflußbahn (16c) der Ausflußdüse zum Legieren (16) kontinuierlich eingeführt wird und zumindest eine feste lösliche Komponente mit einem niedrigeren Schmelzpunkt als Kupfer durch eine zweite Beschickungsvorrichtung (22) in einen unteren Teil der durchströmten Durchflußbahn (16c) kontinuierlich eingeführt wird, wobei die erste und die zweite Beschickungsvorrichtung (20, 22) so angeordnet sind, daß sie die Mischung der genannten mindestens zwei löslichen Komponenten mit dem geschmolzenen Kupfer ermöglichen,
   daß eine hermetisch verschließbare Konstruktion an die Ausflußdüse zum Legieren (16) und eine hermetisch verschließbare Gießwanne (18) an die Ausflußöffnung (16b) der Ausflußdüse zum Legieren (16) angebracht werden,
   und daß die geschmolzene Kupferlegierung in die Gießwanne (18) aus der Ausflußdüse zum Legieren (16) abgestochen wird.

7. Verfahren gemäß Anspruch 6, in dem das geschmolzene Kupfer sauerstofffreies Kupfer ist.

8. Verfahren gemäß Anspruch 6, in dem das geschmolzene Kupfer ein solches mit niedrigem Sauerstoffgehalt ist.


10. Verfahren gemäß Anspruch 9, in dem die nicht oxidierende Atmosphäre aus einem inerten Gas besteht.

11. Verfahren gemäß Anspruch 10, in dem die nicht oxidierende Atmosphäre aus einem reduzierenden Gas besteht.

12. Verfahren gemäß Anspruch 6, worin zumindest eine der festen löslichen Komponenten ein reaktionsfähiges Element ist, das zu Oxidation neigt.