

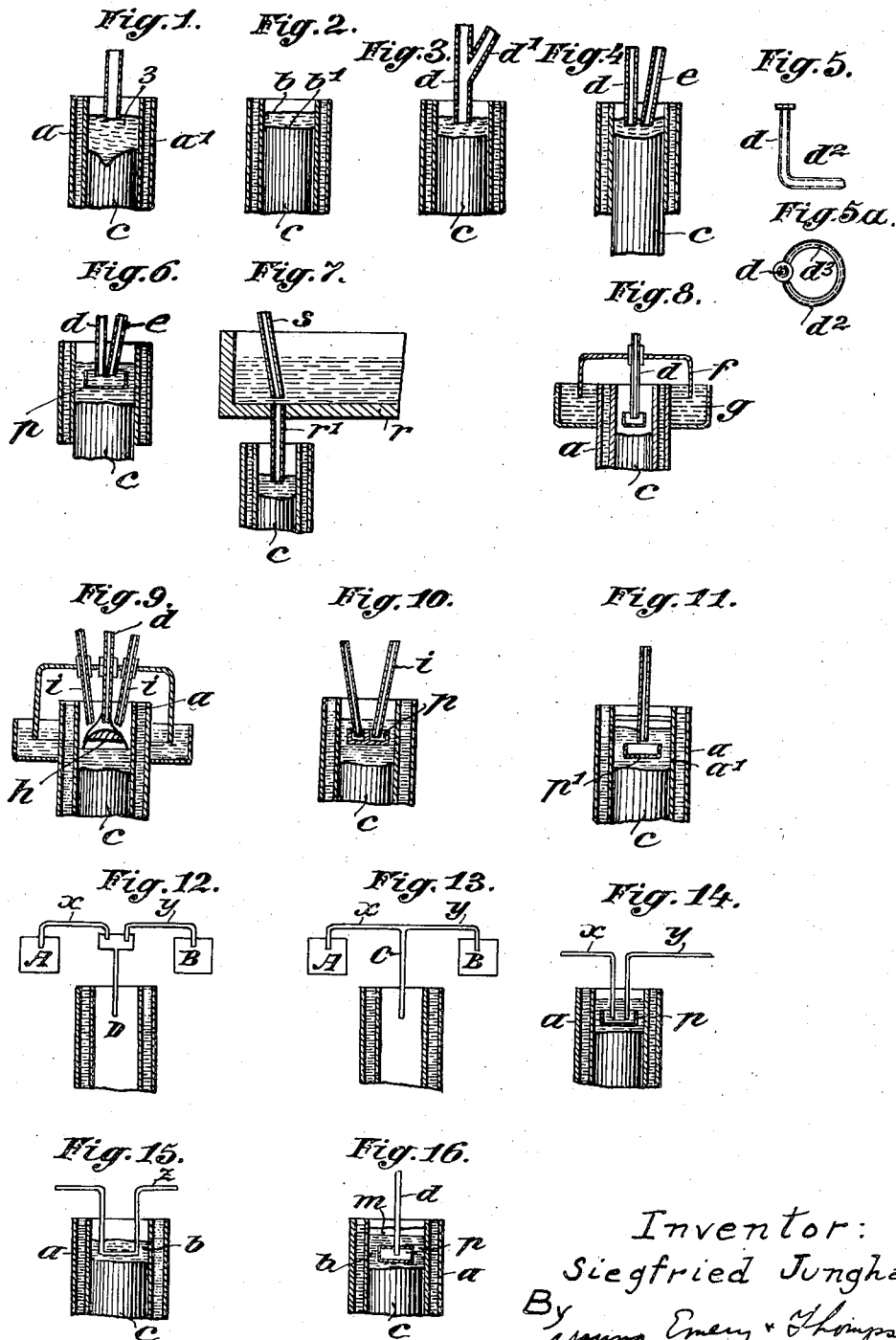
Dec. 15, 1942.

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2,305,477

PROCESS FOR THE TREATMENT OF MATERIALS AS METALS OR METAL ALLOYS

Filed March 26, 1937



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UNITED STATES PATENT OFFICE

2,305,477

PROCESS FOR THE TREATMENT OF MATERIALS AS METALS OR METAL ALLOYS

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Application March 26, 1937, Serial No. 133,280
In Germany July 30, 1936

2 Claims. (Cl. 22—200.1)

This invention relates to the treatment of materials such as metals and metal-alloys, and especially to the treatment of the materials in a hot or molten state directly before solidification by means of cooling down.

It is an object of the invention to treat only a small amount of the molten material as casting proceeds instead of treating the whole mass. The preparation or treatment of great volumes of material may be attained in this connection by treating the small volumes in a continuous manner. Consequently, notwithstanding the treatment of small volumes, the final result will be great amounts of treated materials because in view of the continuous process a great production may be attained.

One of the most important conditions for the creation of small volumes of molten materials in a container or a mould into which the molten material is introduced consists in causing the material to solidify as close as possible to the level of the molten material. This solidifying may be produced by cooling or similar removal of heat directly at the level of the molten material. In connection with this feature the feeding-speed of the molten material must be adjusted with respect to the speed of cooling down in order to control the height and consequently the volume of the molten material within the container or the mould. For example, it is preferable that the volume of the molten metal in the mould should be less than one twentieth of the volume of molten metal flowing into the mould in one minute.

With the recently created new processes of continuous casting, such as described in my prior application Ser. No. 748,046 filed October 12, 1934, it is possible to operate with a small volume of molten material, because in the vicinity of the level of the molten material a good removal of heat will take place, so that the pipe or funnel of molten metal within the casting will be limited to a small depth and does not greatly extend into the solidified part of the casting.

A further object of the invention is to provide a new method of attaining a liquid volume as small as possible. In open molds as used for continuous casting of continuous rods a constant and relatively small mass of the molten material will be maintained, and in this small mass various controlled actions may be produced. The main actions are the following:

(A) Purifying and separating of metals.

(B) Production of alloys of metals and/or metal-alloys or of metals and metal-alloys and

gases or other fluids or materials. Embedding into or reinforcing of materials.

(C) Production of protecting layers of liquid or solid materials on molten materials.

All these and further objects and features of the invention will be explained and described more clearly in connection with the accompanying drawing showing diagrammatically different forms which can be used for an intermittent or a continuous production.

Fig. 1 is a vertical section through a mold and shows diagrammatically the form of the usual liquid head of a casting as attained with the known processes.

Fig. 2 illustrates in the same manner as Fig. 1 the shape of the head used in connection with the invention.

Figs. 3, 4 and 6 to 16 inclusive are similar sectional views showing different means for introducing the materials into the molds, which different means will be described in detail hereinafter.

Figs. 5 and 5A are a front elevation and a top plan view respectively of one form of nozzle used for pouring molten metal into the mold.

According to Fig. 1, *a* designates the upper end of an open mould, provided with a water jacket *a1* for cooling purposes. This mould contains the solidified part *c* and the liquid head *b* of the casting. The liquid funnel extends to a relatively great depth into the solidified part *c*, and consequently the liquid head represents a relatively great mass which cannot be used for the purposes of the invention.

In Fig. 2 is shown a relatively small liquid head *b* above the solidified part *c* of the casting, the solidified level *b1* being relatively flat or plain and lying very close below the liquid level. In this manner a constant and relatively small mass of liquid metal will be maintained to be acted upon by the various actions and treatments hereinafter described, to remove undesired metallic admixtures or gases or the like if any. In view of the fact that the molten material is introduced constantly in accordance with the speed of solidification, the purifying means may be introduced always in a constant quantity as well, and may easily be distributed and intimately mixed with the whole liquid mass of material. Consequently any reactions may be produced in a short time and in a constant manner, which when produced in the melting furnace or crucible—that is to say in connection with great quantities—would necessitate a long time without warranting good and complete results, if they

would be possible at all in practice. As examples of possible treatments may be named the following: Removing of undesired metallic admixtures by introducing steam, or the deoxidation of copper by the introduction of suitable gases.

The introduction of the materials in accordance with the invention may be made in different ways:

The material producing the reaction may be mixed with the metal before its entering into the mold. To this end the material producing the reaction, contained in a suitable receptacle, will be introduced by means of a tube *d'* (Fig. 3) into the tube *d* guiding the molten material into the mould. The reaction material is discharged into the tube *d* at a certain point above the mould. Preferably the pressure in the receptacle, not shown, for the reaction-material is to be held constantly at the same value, which can be a higher or lower one than the pressure within the container of the molten metal. With this arrangement the metal before leaving the tube *d* will be brought together with the treating material, and will be thoroughly mixed together during their further travel within the tube. After leaving the tube *d* the gases or vapors freed by the reaction may escape.

A modified method is illustrated in Fig. 4. The reaction material will be introduced into the molten metal entering through the tube *d* by means of a second tube *e* arranged independently of the tube *d*. The tubes *d* and *e* discharge below the level of the liquid head. The end of the tube *d* may be formed with a single opening as illustrated in Fig. 4, or it may be shaped as illustrated in Figs. 5 and 5a, showing a side elevation and a plan view, respectively; from which it may be seen, that the lower end of the tube *d* is bent at right angles and formed into a loop *d2* provided with a number of openings *d3* through which the molten metal may be discharged. The tube *e* for the reaction material may have its discharge opening within the circle *d2*, so that both materials are discharged in close proximity and below the level of the liquid head.

If gaseous materials are used for treating purposes it is important to produce a fine distribution which may be attained by the use of different pressures of the molten metal and of the gases.

If it is desirable that the stream of molten metal discharging from the tube *d* shall be influenced by the treating material before the molten metal has been distributed over the whole section of the mold the process illustrated in Fig. 6 may be used.

Below the mouths of the tubes *d* and *e*, as described in connection with Fig. 4, a cup *p* may be arranged thus bringing and maintaining closely together the molten metal and the treating material before their distribution into the mould. By this means the molten metal is intimately mixed with the treating material. This mixing is aided by the fact that the molten metal as well as the treating means may produce heavy streamings and whirlings in the cup thereby causing a good mixing. After the reaction has taken place the purified or otherwise influenced molten metal may enter the mould and may uniformly be distributed over the mould section.

The arrangement of this cup, especially within the liquid head below the liquid level has also an important value. This cup prevents the molten metal when leaving the tube *d* from violently streaming down against the solidifying part of the casting. The metal stream will be

caught by the cup and forced to move in an upward direction, so that, even if the molten metal moves with a relatively great speed, as is necessary for a good mixing with the treating material, the molten metal is prevented from producing a great funnel within the solidifying part, as it is illustrated in Fig. 1. Instead according to the invention, a small liquid head without any deep funnel should be produced.

Sometimes in known processes and arrangements the molten metal is introduced at first into an intermediate receptacle before entering the mold. In connection with these arrangements it is possible to produce a purification within this intermediate receptacle by introducing the reaction means, as shown in Fig. 7, into the receptacle *r* by material of a tube *s* discharging in close proximity of the opening or tube *r1* guiding the molten metal from the receptacle *r* into the mould *a*.

In all these cases the escaping gases or metal steams may be recovered if they are of any value.

As already stated, the main purpose of the cup *p* is to receive the stream of molten metal in order to produce a calm distribution within the liquid head. A further purpose is to produce a thorough mixing of the molten metal with additional materials if such are used. The arrangement of the cup below the liquid level further serves to protect the newly introduced metal against the contact with the surrounding air. On the other hand the cup may also be arranged as shown in Fig. 8 above the liquid level if the air is prevented from entering the space between the mouth of the metal feeding tube, the cup and the liquid level. For this purpose the upper end of the mould *a* is provided at its outer circumference with a cup-like container *g* filled with oil or another suitable liquid. The tube *d* entering the mould *a* is provided with an inverted cup *f* the lower edge of which projects into the oil within the container *f*. By this means an air-tight closing may be attained.

A very good mixing of the base-material (metal) with the additional material may be attained with the construction according to Fig. 9 even if the mouth of the pipe *d* lies above the liquid level. The tube *d* is provided with a funnel-like lower end and below this mouth a guiding head *h* is arranged. The tubes *i* feeding the additional material (gases or the like) open above the funnel-like end of the tube *d* within the mould *a*. The air-tight closing of this arrangement is the same as that described in connection with Fig. 8. In this construction the base material and the additional material when leaving the corresponding tubes *d* and *i* encounter the head *h* and are completely mixed together.

The cup *p* referred to above may have different shapes according to the different materials to be treated. In the construction of Fig. 10 it is provided with a separating wall *k*. Furthermore it may be provided with perforations *p1* (Fig. 11), thus catching the material leaving the tubes but making it possible for some of the materials to flow directly through said perforations in a downward direction into the mould, however with a diminished speed compared with the speed with which the materials leave the tubes. The remaining quantity is obliged to flow at first upwardly to the upper edge of the cup before it can enter the mould.

It is also possible, as stated above, to produce alloys from their elements in the mould itself,

or it will be possible to add to alloys or metals gases, other metals or other materials, which up to present could not be brought together because a mixing in the molten state could not be attained for certain reasons. According to the process of this invention this can be done with the means already described in the following way:

It may be assumed that a brass-alloy is to be produced from its elements within the mould. Then, in the furnace A (Fig. 12) may be contained the copper in molten state whilst the furnace B contains the molten zinc. The furnaces A and B are provided with tubes *x* and *y* respectively leading to the common feeding tube C, the mouth of which is arranged within the mould D. The sections of the tubes *x* and *y* are so proportioned, that with equal pressures applied to the furnaces A and B the quantities of the materials passing through the tubes *x* and *y* correspond to the desired proportion of the alloy. If, therefore, the furnaces are set under this pressure the elements will flow according to the named proportion into the tube C, where they are mixed together so that they enter the mould as the desired alloy. On the other hand, the sections of the tubes *x* and *y* may be equal whilst the pressures applied to the furnaces A and B are different. The pressures are to be adjusted so as to cause flow of metal through tubes *x* and *y* at such rates as to produce the desired alloy.

The construction according to Fig. 13 serves the same purpose. However, instead of a special mixing tube C the tubes *x* and *y* from the furnaces A and B are connected to a single tube C1.

This process enables every base element to be held in a molten state in its special furnace and to be treated with special protecting means, which are the best suitable for them. Furthermore, every element may be held at its best conditions with respect to its melting point. Higher temperatures are not necessary as every alloy has a lower melting point than the highest melting point of the elements. In view of the fact that the treating and feeding of the elements may be protected against the air, and further in view of the fact that always only the special melting point is to be maintained, superheating and evaporation caused thereby may never occur. The mixing of the elements will always be very thorough and intimate, and the mixing cannot be changed when the materials enter the mould, because in view of the small liquid head within the mould the materials will be solidified in a very short time without any deep liquid funnel as produced with the usual processes. Consequently it will be possible as well to alloy metals the specific weights of which are very much different. As an example the alloy of Al and Pb may be named, an alloy which up to present can not be produced with known processes in a satisfactory manner. The lead, in view of its high specific weight, always settled toward the lower part of the casting, so that this part of the casting contained a much higher percentage of lead than the upper part.

It is possible as well to produce alloys of metals which differ much in their melting points. For this purpose it is suitable to use the following process, which, however, can be used as well in connection with the examples named above:

As shown in Fig. 14 the tubes *x* and *y* feeding the metals open into a cup *p* similar to the cup described in connection with Figs. 6, 8, 10 and 11. This cup *p* is arranged within the mould *a* and within the liquid head *b*. In the cup *p* the

metals entering by the tubes *x* and *y* are intimately mixed one with the other, and the alloy thus created will be distributed uniformly over the whole section of the mould, whereupon it solidifies in a short time.

Certainly, other arrangements will be possible as well. Thus, every tube may open at a distinct place within the liquid head, and only one of these tubes may be provided with a cup *p*. This will depend always from the kind and nature of the elements, the desired alloy and similar factors. By this means it may be possible to produce within a single casting different mixing proportions or different alloys.

If two metals of different specific weights or of great differences in the solidifying temperature should incline to separate quickly a special cooling device may be provided which according to Fig. 15 may consist of a tube *z* entering the liquid head *b* beside the tubes *x* and *y* which are not shown in this Fig. 15. The tube *z* leads a cooling means as water or the like in a constant flow, so that the heat from the liquid head *b* may be dissipated not only at its outer side by means of the cooling jacket *a1* of the mould but also at the inner side by means of the cooling tube *z*.

In the same way as described heretofore in connection with two metals it is also possible to mix a metal and an alloy or a metal or metal alloy with gases or other materials producing any desired effect.

In view of the fact that according to the invention there exists always a small liquid head, at the level of this head any object or material can be introduced which has a higher melting point than that of the base-material or which is not attacked by the heat of the base material, because it is possible to work without the influence of the air. The following examples are named:

(a) In a similar manner as in the production of reinforced concrete, iron-wire or a framework of iron may be embedded in a continuous way into an alloy of light-metals. The alloy of light-metals will be reinforced on this way.

(b) To get different colours, for instance in connection with a white alloy of light-metals, copper-wire, brass-wire or nickel-wire may be introduced so that after the further treatment the incorporated material may appear at the outer surface or within the section, and after pickling or colouring nice designs may be produced.

(c) Furthermore it is possible in view of the absence of the oxygen to incorporate wood or other combustible materials such as fibrous material, leather or the like.

Instead of solid materials such as gases other materials may be introduced into and incorporated in the liquid head as well. Finely divided materials in the form of powder or grains such as metals with a high melting point, graphite, may be introduced and afterwards form a completely uniform distribution within the final product. In this way it is possible to produce alloys the continuous and uniform production of which was not possible up to the present time. Furthermore it is possible to produce great profiled bars from light metals in lengths, which could never have been produced.

The invention may be used also in connection with the production of combinations or alloys of hard materials with high melting points such as nitrides, carbides and the like, which sometimes

are desired to be embedded into metals or other materials.

In some cases the closing or protecting against the contact with the atmospheric air is made by a covering sheet of protecting materials on the upper level of the liquid head *b*. In connection with this arrangement the invention prevents the entering material from creating a suction-action in view of the fact, that the metal entering the cup receives a movement in an upward direction by which a whirling of the metal in the liquid head *b* will be caused, but none in the downward direction, which could produce the suction named above.

What I claim is:

1. A process for the continuous casting of metal rods which comprises pouring molten metal continuously into one end of a chilled mold, withdrawing solidified rod continuously from the other end, adjusting the rate of withdrawal and the rate of pouring with respect to the rate of cooling to cause the liquid casting head to be maintained at a depth not greater than the diameter of the mold and continuously mixing said

molten metal with a reaction medium, said molten metal and reaction medium being discharged simultaneously into an impervious cup disposed below the level of the molten metal in the mold whereby the direction of flow is reversed and directed upwardly.

2. A process for the continuous casting of metal rods which comprises pouring molten metal continuously into one end of a chilled mold, withdrawing solidified rod continuously from the other end, adjusting the rate of withdrawal and the rate of pouring with respect to the rate of cooling to cause the liquid casting head to be maintained at a depth not greater than the diameter of the mold and maintaining a layer of protective material on the surface of the molten metal in the mold, said molten metal being discharged into an impervious cup disposed below the level of said protective material, and adapted to reverse the direction of flow to cause the inflowing metal to flow upwardly toward the surface of the fluid metal.

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