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MANUFACTURE OF ZINC ALUMINUM ALLOYS

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Fig. 1.

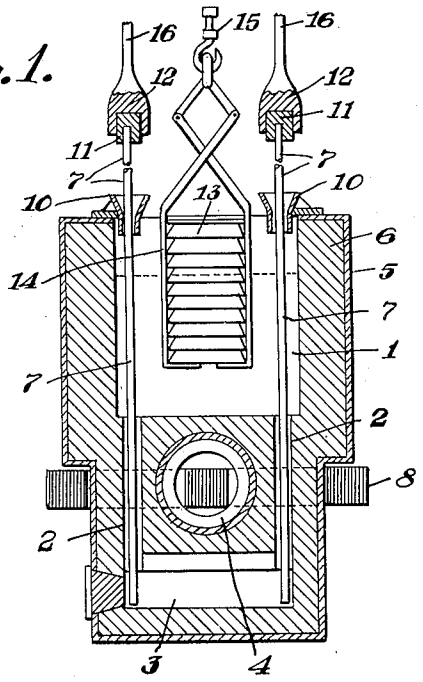
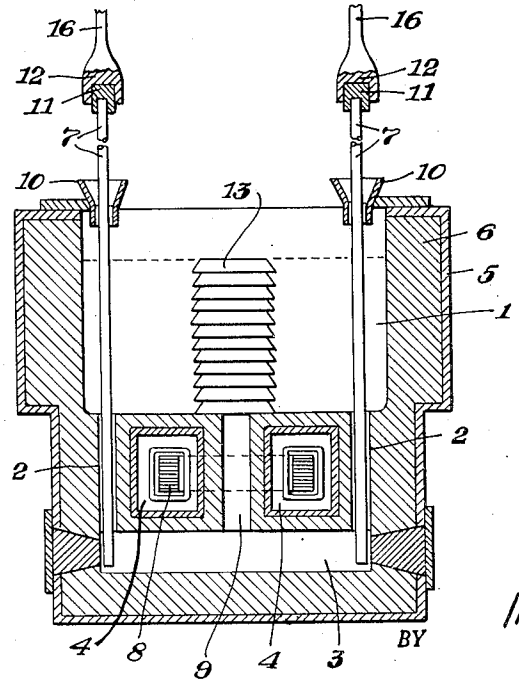


Fig. 2.



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MANUFACTURE OF ZINC ALUMINUM ALLOYS

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3 Claims. (Cl. 75—10)

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This invention relates to methods of alloying light and heavy metals and it relates particularly to the production of alloys consisting predominantly of heavy metals with aluminum, such as zinc aluminum alloys containing additionally minor quantities of copper and magnesium; the invention is specifically applicable to the alloying of heavy metals having a low melting point with light metals having a higher melting point.

The problem of producing alloys of heavy metals with aluminum and particularly zinc aluminum alloys has acquired particular importance in connection with modern die-casting procedures; the alloys which are used for these purposes are frequently zinc alloys having about four percent aluminum; these alloys require a high degree of purity and are made up from high purity components. It is, therefore, necessary to melt them under the adequate conditions prescribed by this invention.

The difficulties involved in the making of this type alloys are not only caused by the different melting point of the metals but by the fact that the aluminum has the very cumbersome tendency to rise in the molten metal bath, to float on the same and to form partly oxidised bodies in the form of layers, shots, flakes and the like.

A frequently used but rather unsatisfactory method of producing alloys of predominantly heavy metals with aluminum consists in adding the same in the molten state.

First of all a rather considerable quantity of the light metal is hereby converted during the admixture and pouring into shots consisting of oxide-covered solid particles, which remain floating on the metal bath and most unwillingly alloy; extensive mechanical stirring must be applied to unite these shots with the metal bath; otherwise a uniform alloy of the desired composition is not obtained.

In accordance with other methods the aluminum is added in the form of ingots; however, the disadvantage of unalloyed remainders consisting of solid pieces is hereby not eliminated. Moreover, with all these methods it has been found necessary to raise the temperature of the zinc alloy considerably and alloying temperatures of up to 1000° F. have been often applied.

In order to eliminate this difficulty a preliminary aluminum rich zinc alloy or hardener containing about 40–50 percent aluminum has been made which preliminary alloy was used to produce the aluminum poorer final alloy.

By the use of this method the speed of alloying the different components is increased, but it

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is still necessary to use high alloying temperatures; this requirement eliminates the method for practical reasons, because it is important to melt these alloys at temperatures not exceeding about 850° F. to avoid critical temperatures.

The above analyzed methods of producing alloys of heavy metals and aluminum and particularly zinc aluminum alloys, were conducted in furnaces which are operated without automatic-stirring; they indicate convincingly that a more successful solution of this problem had to be found; they further prove that in order to achieve this end the intensity and speed of mutual penetration of the alloy components must be increased and the alloying time accordingly reduced, which will prevent the aluminum to release not alloyable portions giving rise to the formation of solid layers, shots, flakes and other undesirable by-products.

It could be assumed that the excellent metal melting conditions of an induction furnace might well serve this purpose. Therefore, extensive experiments were conducted with regard to the above described alloying problem in an induction furnace of the submerged resistor type.

The furnace used was of the standard Ajax-Tama-Wyatt type as, for instance, disclosed in U. S. Patents Nos. 2,339,964, 2,342,617, Re. 22,602, 2,368,173, 2,375,049, 2,381,523; a furnace was chosen having a capacity for melting about 1000 lbs. of a zinc aluminum alloy per hour.

The alloy to be produced was of the normal die-casting composition containing four percent aluminum, 0.05 percent magnesium, balance zinc.

The furnace was maintained at a temperature of about 850° F.; after checking the time required for alloying in this manner the necessary amount of zinc was added and particular emphasis was placed on the avoidance of overheating the metal. The furnace was automatically controlled with regard to temperature and for this purpose a Cromel-Alumel thermocouple protected by a silicon carbide tube was used in connection with an automatic potentiometer type controller and recorder.

The experiments were first carried-out by charging molten aluminum containing the required small quantity of magnesium alloyed therewith into the furnace.

The bulk of the metal alloyed comparatively quickly with the zinc at the above stated temperature; however, there was always a certain quantity of aluminum which did not alloy and solid aluminum flakes inevitably appeared on the surface of the molten metal bath.

It was obvious from the above that the previously criticized drawback of an incomplete alloy formation had been removed to a minor extent only and certainly had not been eliminated in spite of the operational advantages of the induction furnace.

Hereupon the aluminum was used in the solid form of 8 lb. pigs.

The result of this procedure was even more disappointing insofar as pieces of the added aluminum metal floated to the surface of the bath; heavy mechanical agitation had to be exercised to melt the same and to force them into an alloy with the zinc. All these experiments were carried out at a temperature not exceeding 850° F., which was automatically controlled in the manner customary for induction furnaces.

The aluminum was then added in the form of an aluminum rich zinc alloy, having about 40 percent aluminum. In conformity with the above described experience the results were less disappointing and it was found that this rich alloy unites faster and better than the aluminum; still, a portion of the metal remained unalloyed and appeared as a thin layer on the bath; it had to be mechanically stirred into the bath to obtain an alloy of the desired composition; moreover, as already stated, the production of a preliminary alloy by a separate step unfavorably influences the economy of the process.

It resulted from the above that in order to successfully solve the problem of producing alloys of low melting heavy metals with smaller quantities of light metals having a higher melting point the following requirements had to be complied with by the operation of the induction furnace:

The light metal must be completely combined with the heavy metal without leaving unalloyed residues adapted to appear as flakes, shots or layers on the surface of the bath,

The final alloy must be thoroughly uniform,

The alloying action must be intensified and the alloying time accordingly reduced,

Additional mechanical agitation must be entirely eliminated,

A substantially uniform and comparatively low alloying temperature must be maintained, which in the case of aluminum zinc alloys should not exceed 850° F.

A fully satisfactory realisation of these various objects was finally attained in the following manner forming the subject matter of this invention.

In conformity therewith aluminum or an aluminum rich, for instance, small amounts of copper and/or magnesium containing alloy, is introduced into the furnace in the form of a rod; these aluminum or aluminum rich alloy rods having a diameter slightly smaller than the diameter of the melting channels of the furnace are directly placed into these channels; the rods are preferably weighted at the upper end to assure their proper location and their gradual passage through the secondary channel in relation to the formation of the desired alloy. A temperature of about 850° F. is maintained in the furnace. Shortly upon the introduction of the aluminum or aluminum alloy rods into the melting channel the amount of zinc, which is necessary to form the desired alloy, is added. The zinc melts and flows into the melting channels.

Due to the direct action of the current and its strong mechanical stirring impetus an intense melting and alloying action results in the restricted space of the secondary channels which

splendidly answers the prestated requirements; the aluminum rich preliminary alloy, which, as previously described, favorably influences the alloying procedure "as such" is here produced in the alloying furnace itself under optimal working conditions and its production as a separate step is avoided. Due to the strong circulating and stirring action of the furnace this aluminum rich alloy is in statu nascendi distributed throughout the hearth and the charge; the aluminum is absorbed in the alloy before it finds time to rise to the surface of the metal bath; in spite of this intense and fast alloying action the low temperature of about 850° F. could be well maintained.

The principle of introducing longitudinally shaped metal bodies into a melting furnace is not novel and for instance disclosed in U. S. Patents Nos. 1,421,886, 1,390,140, 1,521,349; however, the application of this principle to the induction furnace is "per se" unsuccessful. The invention is, however, clearly distinguished over the art by the fact that the aluminum rods are directly located in the secondary melting channels of the submerged resistor type induction furnace, the preliminary aluminum rich alloy being formed in the restricted space thereof.

This alloy is immediately transported by electromagnetic forces and circulated into the hearth and is gradually converted into the alloy of the desired final composition.

The fast transport of the aluminum rich alloy from the secondary channel by electromagnetic motive forces and the thus greatly accelerated formation of the final alloy in the hearth of the furnace eliminates the existence of unalloyed aluminum and prevents the production of solid aluminum by-products; it also eliminates any obstruction to a proper furnace operation which might otherwise arise from the presence of solid aluminum rods in the secondary channels. These straight vertical melting channels of the submerged induction furnaces in which the instant invention is carried-out are therefore particularly adapted for the quick alloying of aluminum or aluminum alloys; a heavy current flows through the melting channels where the aluminum or aluminum alloy rods are temporarily located and a rapid liquefaction results.

The invention will now be described in its application to the production of a zinc alloy containing 4 percent aluminum with reference to a submerged resistor type induction furnace of the type disclosed in U. S. Patent No. 2,339,964 and Reissue Patent No. 22,602.

In the drawings,

Fig. 1 is a vertical sectional elevation of a two channel submerged resistor type induction furnace for the production of zinc aluminum alloys during the introduction of the zinc charge into the hearth,

Fig. 2 is a vertical sectional elevation of a three channel twin coil furnace after deposition of the zinc charge in the bottom of the hearth.

The furnace shown in Fig. 1 contains in the usual manner a hearth 1 and a secondary melting loop situated below the hearth; the loop is composed of two substantially vertical melting channels 2; these channels are at the bottom ends connected by horizontal channel 3.

The furnace is encased in a housing 5 lined with a suitable refractory 6.

A customary transformer assembly is provided which consists of an insulated copper wire coil

4 and an iron core 8 threading the primary winding. The melting channels 2 are circular.

The furnace is shown at the commencement of the alloying operation; the aluminum rods 7 are located in the channels with a small clearance; it has been found that this clearance should not exceed ⅓ of the total cross area of the channel; with circular channels as here used having a diameter of about 2 inches. Aluminum rods having a diameter of about 1½ inches were found to effect the formation of 500 pounds of the final alloy in the surprisingly short time of about 18 minutes. The zinc slabs are suspended by a crane device during their passage onto the hearth.

The rods may be manually inserted into the channels and held in the same by a suitable tool. A holder consisting of an iron rod and sleeve of sufficient weight has been found to fully comply with this requirement. As the rod and collar only expose a small surface to the molten metal and that only during about one-third of the melting cycle the danger of iron contamination is negligible; but, as already stated, mechanically operative devices may be installed for the purpose of inserting and holding the aluminum rods in the melting channels.

The contrivance shown in the drawings for locating and feeding the aluminum rods 7 into channels 2 and for charging the zinc slabs 13 is constructed, as follows.

In the longitudinal upward direction of the channels two collars 10 are fastened to the furnace casing, which collars guide the aluminum rods 7 into channels 2.

A weight forming top is fastened to the upper end of rods 7 which is composed of cap 11 and a steel rod 16 encasing cap 11 with its lower end portion 12; rod 16 serves to maneuver the aluminum rods 7.

Under the weight exerted by cap 11 and rod 16 the upper portion of the aluminum or aluminum alloy rods pass gradually and in conformity with their liquefaction into channels 2. The weight acting on the aluminum rods 7 may be varied in conformity with the alloying speed and the alloy to be produced. If a heavier weight is used a quicker passage of the aluminum into channels 2 will result. In this manner and by the simple expedient of the adjustment of weight 11, 12, 16 in conjunction with the adjustment of the furnace temperature a very exact control of the alloying procedure is effected.

The zinc slabs 13 are charged by the lowering of the hook 15; as soon as the zinc slabs are deposited on the bottom of the hearth, as shown in Fig. 2, the hook is withdrawn.

The furnace shown in Fig. 2 does not vary essentially from the one just described; the furnace is of the twin coil type and has two inductor coils 4, a horizontal melting channel 3 and three vertical channels 2, 2, 9 connecting channel 3 with the hearth.

As previously stated, the formation of the final alloy is obtained in a surprisingly short time due to the electromagnetic motive forces which are active in the melting channels of the furnace; a thoroughly uniform alloy results with avoidance of unalloyed solid aluminum residues; stirring is not required. Nevertheless, the low temperature of about 850° F. can be maintained without in any way reducing the alloying speed.

I claim:

1. A method for producing zinc aluminum alloys in induction furnaces provided with a hearth, a secondary melting loop located underneath said hearth, said loop consisting of a horizontal bottom channel, straight vertical channels connecting the hearth with said bottom channel and a primary transformer assembly threading said secondary loop, said method comprising charging zinc slabs into the hearth and continuously feeding rods consisting mainly of aluminum into the said vertical channels, switching-on current and melting the aluminum while maintaining in the furnace a temperature substantially not exceeding 850° F., whereupon a flow of molten metal results between the hearth and the said connecting channels, where aluminum rich zinc alloy is formed, which by the circulative action of the furnace is transported into the hearth producing in the same the final alloy.

2. A method for producing zinc aluminum alloys in induction furnaces provided with a hearth, a secondary melting loop located underneath said hearth, said loop consisting of a horizontal bottom channel, straight vertical channels connecting the hearth with said bottom channel and a primary transformer assembly threading said secondary loop said method comprising charging zinc slabs into the hearth and continuously feeding rods consisting mainly of aluminum into the said vertical channels, switching-on current and melting the aluminum while maintaining in the furnace a temperature substantially not exceeding 850° F., whereupon a flow of molten metal results between the hearth and the said connecting channels, where aluminum rich zinc alloy is formed, which by the circulative action of the furnace is transported into the hearth producing in the same the final alloy and effecting the replacement of the alloyed aluminum by the continuous feed of the upper rod portions into the connecting channels.

3. A method for producing zinc aluminum alloys in induction furnaces provided with a hearth, a secondary melting loop located underneath said hearth, said loop consisting of a horizontal bottom channel, straight vertical channels connecting the hearth with said bottom channel and a primary transformed assembly threading said secondary loop said method comprising charging zinc slabs into the hearth and continuously feeding rods consisting mainly of aluminum into the said vertical channels with a clearance of about ⅓ of the cross area, switching-on the current and melting the aluminum while maintaining in the furnace a temperature substantially not exceeding 850° F., whereupon flow of the molten metal results between the hearth and the said connecting channels, where aluminum rich zinc alloy is formed, which by the circulative action of the furnace is transported into the hearth producing in the same the final alloy.

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