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MELTING AND CASTING OF METALS

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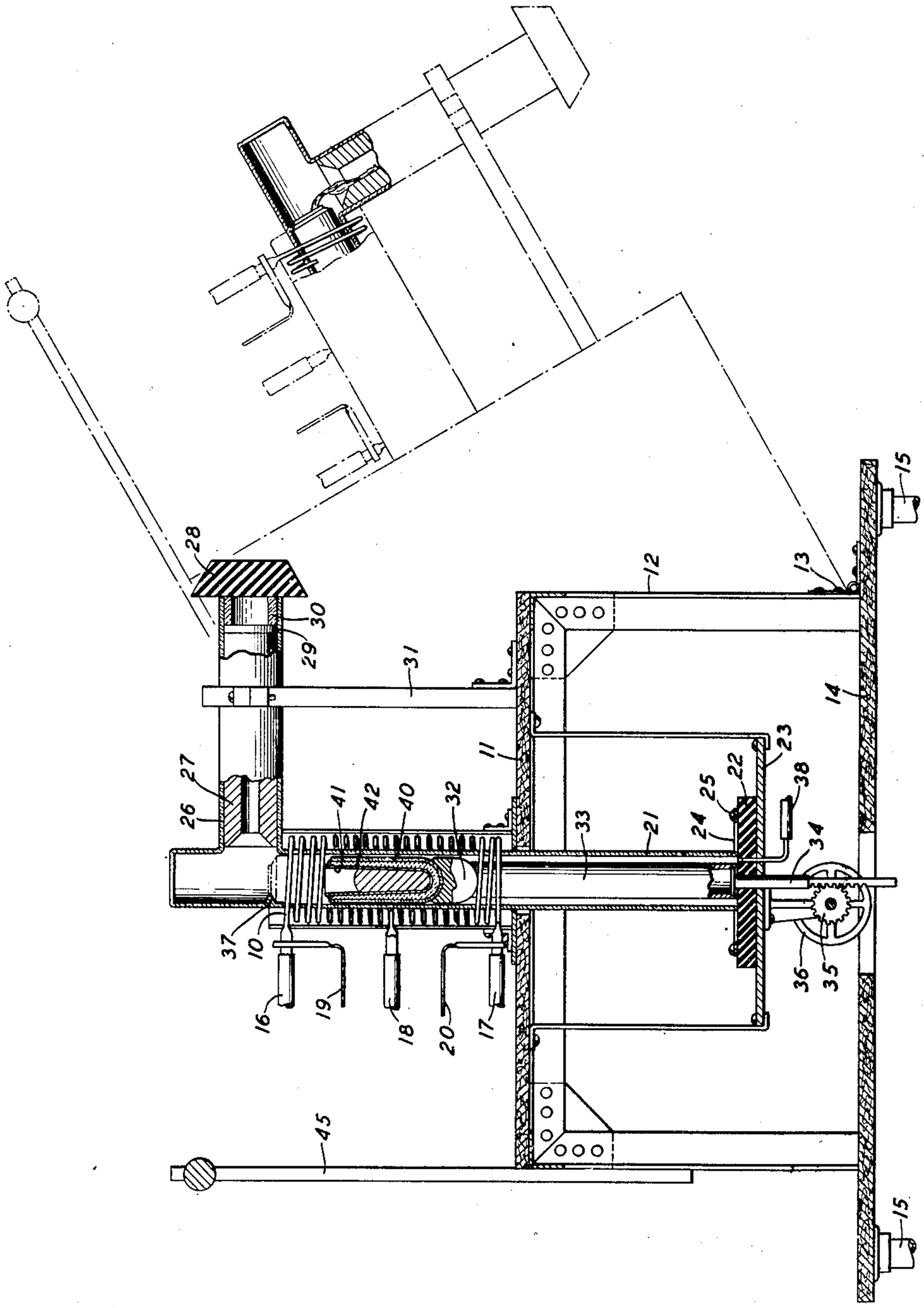

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MELTING AND CASTING OF METALS

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This invention relates to the melting and casting of metals in vacuum and particularly to the method and apparatus for producing ingots of precious metals free from cavities and atmospheric contamination.

In the melting and casting of metals, particularly the so-called precious metals, it is often desirable and in many cases, essential to prevent any atmospheric contamination. This has been accomplished in a number of instances by heating crucibles in which the metals or alloys of metals are to be melted in a vacuum chamber and allowing them to cool while maintained in the vacuum. Such an arrangement, however, is open to the objection that in the case of alloys, segregations may occur due to the slow cooling and in the case of all metals tubular cavities or "pipes" are formed in the interior of the ingots as a result of the manner in which the metal freezes.

It is, therefore, an object of the present invention to provide a method and apparatus for melting and casting ingots free from all atmospheric contamination and substantially free from interior cavities.

This and other objects of the invention are attained by melting the metals or alloys in a crucible maintained in a vacuum chamber such as a quartz tube and causing the flow of the metal into a mold also positioned within the vacuum chamber where the metal or alloy cools at a relatively high speed and in such a way as to prevent the forming of cavities therein.

The invention may be more clearly understood by reference to the accompanying drawing which in full line shows apparatus embodying the features of this invention in position for melting, and in broken line the position of the apparatus at the time of casting.

Referring to this drawing a high frequency inductor coil 10 is mounted on a plate 11 of asbestos wood or similar heat resistant material supported by a suitable framework 12. This framework is hinged at 13 to a second plate 14 of asbestos wood or similar material supported by the stanchions 15—15. The coil 10 which is of a well-known type comprises a plurality of turns of copper tubing and is provided at either end with suitable water outlet connections 16 and 17 while at its mid-point there is provided a water inlet connection 18. Terminals 19 and 20 are provided at the opposite ends of the coil respectively to permit connecting the coil to a suitable source of high frequency current.

Fitting just inside of the coil 10 is the quartz tube 21 which is used as the heating or melting chamber. This tube is open at the bottom and the end is ground off square so as to form a tight joint with the large, soft, rubber stopper 22, which is rigidly secured to the U-shaped supporting bracket 23 by means of plate 24 and screws 25. The tube 21 is provided at its upper portion with an extension tube 26 which is preferably of the same diameter and material as tube 21 and is sealed thereto. This extension tube is adapted to receive the mold 27 in which the molten metal is to be cast. The end of this tube is ground off square in order that an air-tight joint may be made with the rubber stopper 28 which is held in position by atmospheric pressure. In order to prevent excessive heat from being conducted to the stopper 28, a disk 29 of asbestos wood or similar heat resistant material and a tube 30 preferably of quartz are inserted between the mold and the stopper. A support 31 is provided as shown to hold the apparatus rigidly in position during the pouring operation.

The crucible in which the metal is to be melted rests upon a suitable pedestal 32, which in turn is secured to tube 33 preferably of quartz or alundum. The lower end of tube 33 is secured to rod 34 which at its lower end is provided with a rack cooperating with pinion 35 positively driven by a hand wheel 36. The rod 34 is a tight fit in stopper 22 so that the position of the crucible may be changed without destroying the vacuum within the tube. In order to limit the upward travel of the crucible an inwardly extending projection 37 of quartz is provided as shown. To permit exhausting the atmosphere within the heating chamber, tube 38 extends through stopper 22 and is adapt-

ed to be connected to a suitable vacuum pump.

While crucibles consisting of alundum extraction thimbles have been found satisfactory for certain alloys, it has for certain purposes been found desirable to use zirconia crucibles as shown in the drawing. In this type of crucible zirconia powder is tamped dry into an alundum crucible 40 with a tapered platinum crucible acting as a core. A cushion of low ash filter paper is wrapped around the platinum crucible to allow for shrinkage in the firing. The platinum crucible is then brought up to a temperature of approximately 1700° C. in a high frequency furnace, when the layer of zirconia particles next to it will sinter together forming a crucible 41. The outer unsintered portions of the zirconia act as an insulation material 42 while the filter paper burns away and thus allows the platinum crucible to be easily withdrawn.

The mold 27 may be made of graphite or metal depending upon the nature of the material to be cast. In the casting of platinum, the pouring temperature of which is about 1800° C., satisfactory results have been obtained using molds of nickel although this metal melts at a temperature of 1450° C.

In the operation of this apparatus the crucible with its charge is placed in position on the pedestal 32 and the quartz tube 21 is then placed in position and secured by support 31. Terminals 19 and 20 are connected to a suitable source of high frequency heating current and a heated mold is then introduced into the extension tube 26. A close fitting piece of asbestos wood 29 and refractory spacer 30 are inserted between the mold and the stopper 28. The exhaust pump is then started and the stopper 28 held against the end of the extension tube until the vacuum within the tube is such that atmospheric pressure holds the stopper tightly. When the gauge on the vacuum pump indicates a good vacuum (1/10 to 1/100 millimeter) the metal is quickly melted, and with the current still on, the crucible is raised by means of hand wheel 36 to the pouring position as limited by stopper 37. The whole apparatus is then tilted over by the aid of handle 45 cooperating with hinge 13 and the molten metal is poured into the mold where it solidifies immediately. As soon as the cast metal has cooled sufficiently, the pump is stopped and the apparatus let down to air by means of a stop cock (not shown), thus allowing the stopper 28 to drop off and allowing the mold to be removed by slightly tilting the apparatus. The quartz tube can then be lifted and the crucible removed.

Due to the fact that the entire melting and pouring operations take place while the metal is in vacuum all danger of contamination is removed. Furthermore, due to the rapid cooling of the cast metal segregations which might otherwise occur in certain alloys are prevented as is also the formation of hollow tubular cavities or pipes within the casting. As proof of the fact that ingots cast in this manner are sound and free from cavities, ingots ½″ in diameter and weighing about 500 grams have been repeatedly drawn down to a diameter of .003″ in one continuous length of wire without breakage.

While the apparatus and method of casting in accordance with this invention is of particular importance in the casting of precious metals, it is not limited to such use, since it can also be used to advantage in the casting of copper and other metals on a large scale.

What is claimed is:

1. In apparatus for the casting of metals, a quartz tube adapted to receive a crucible in which the metal to be melted is placed, a substantially right-angled extension on said tube, a mold within said extension, means comprising an inductor coil positioned outside of and closely surrounding said tube for establishing a high frequency field to melt the metal in said crucible, means for positioning said crucible in the most intense part of said field during the melting operation and for raising said crucible to a position adjacent the mold after the metal is melted, means for tilting said quartz tube to cause the transfer of said melted metal to said mold, and means for maintaining a vacuum within said tube and extension during the process of melting, casting and cooling of said metal.

2. In apparatus for the casting of metals, a heating chamber comprising a vertical quartz tube open at the lower end and having a transparent quartz window at the upper end, means for supporting a crucible in said chamber, means for raising and lowering said crucible, a stopper for the lower end of said tube, means extending through said stopper for maintaining a vacuum in the heating chamber, a substantially right-angled extension at the upper end of said quartz tube and sealed thereto, a stopper for the end of said extension, a mold positioned within the extension and means for tilting said tube to cause the transfer of molten metal from the crucible to the mold.

3. The method of casting metals in a mold which consists in placing the metal to be cast in a crucible positioned within a vacuum chamber, heating a mold and placing it in position within said vacuum chamber, maintaining a vacuum in said chamber corresponding to a pressure of not more than .1 millimeter of mercury, establishing a high frequency field about said chamber of sufficient strength to cause the flow of eddy currents which will melt said metal, raising the crucible into a position such that its upper portion is substantially in line with the mold

and tilting said chamber to cause the transfer of the molten metal from the crucible to the mold without destroying the vacuum in said chamber.

In witness whereof, I hereunto subscribe my name this 27th day of October, 1930.

HOWARD T. REEVE.