May 7, 1946. W. D. HOLLAND ET AL 2,399,634

HANDLING MOLTEN MAGNESIUM

Filed Dec. 31, 1943

Fig. 1,

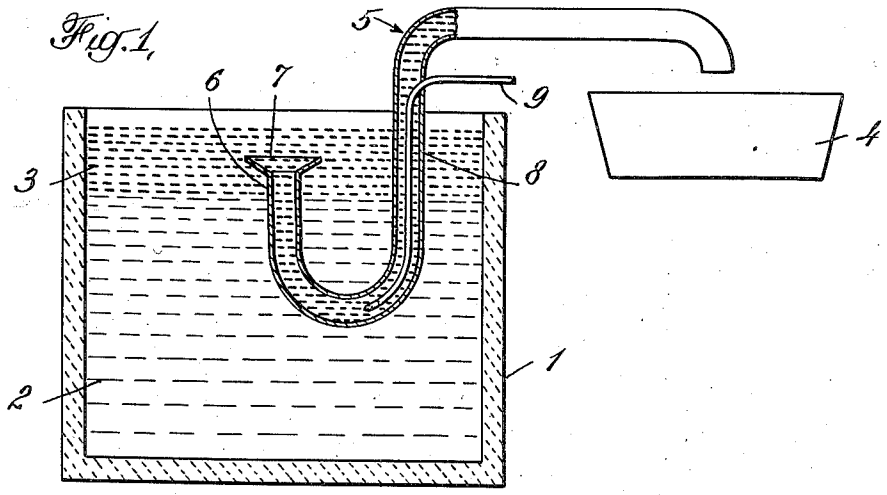


Fig. 2,

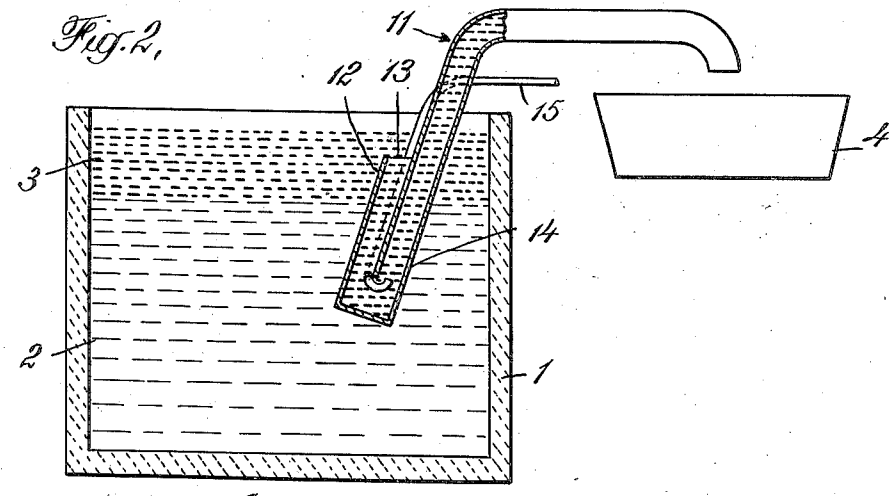
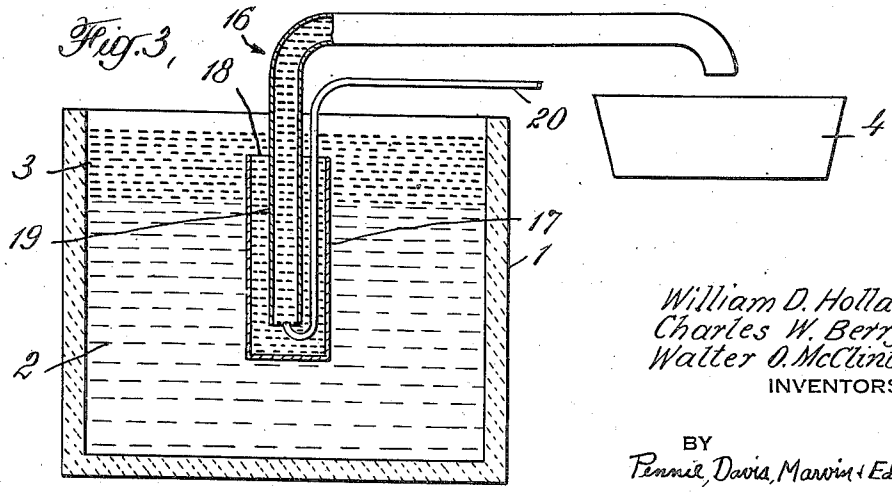


Fig. 3,



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Patented May 7, 1946

2,399,634

UNITED STATES PATENT OFFICE

2,399,634

HANDLING MOLTEN MAGNESIUM

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Application December 31, 1943, Serial No. 516,380

1 Claim. (Cl. 266—38)

This invention relates generally to the handling of molten magnesium and particularly to the pumping of molten magnesium with associated fused salts and has for its object the provision of certain improvements in the removal of the magnesium which is collected in the cell to a container for the metal. More particularly, the invention aims to provide a method of and means for pumping the magnesium and associated salts from the place collected into the container by means of a submergence gas-lift type of pump.

Heretofore it has been proposed to pump magnesium collected in an electrolytic cell by means of pumps of the entrainment gas-lift type. Such pumps usually employ an upright pipe of small diameter to raise the metal and cause it to flow out of the cell. Pumps of this type require a relatively large volume of gas which is forced into the open bottom of the pipe to blow the metal upward. In view of the relatively large volume of gas required, air cannot be used because of the high affinity magnesium has for oxygen which would result in an excessive loss of metal through oxidation and it is necessary to use an inert gas. The large volume of gas also necessitates preheating the gas to avoid chilling the magnesium.

In accordance with the improvements of the invention, the metal is raised by gravity to a point where it flows out of the cell due to the unbalance created in two connected columns of metal, the lighter column having fine bubbles of gas dispersed therein to decrease its specific gravity. A pump of the submergence gas-lift type used in the invention advantageously comprises a U-shaped or reverse flow duct having an upright duct for the downward flow of metal (inlet duct) and an upright duct for the upward flow of metal (discharge duct), the ducts being connected at the bottom to provide a continuous passage, and means for disseminating gas bubbles in the lower part of the duct through which the metal rises. The pump should preferably be of such size and proportions that it may conveniently be carried from cell to cell. In operation, the pump is at least partly submerged in the floating layer of magnesium and the underlying bath of fused salts, with the upper end of the inlet duct submerged to the interface of the magnesium and fused salt layers in such a manner that salts and magnesium are pumped simultaneously below the upper surface of the magnesium. The column of magnesium and fused salts in the inlet duct is heavier than the column of gas, magnesium and fused salts in the discharge duct and the liquid rises and flows into the container. Only a relatively small quantity of gas is required and, while inert gases, such as flue gas or nitrogen, may be used advantageously, the small volume of gas required enables us to use air at ordinary temperatures without unduly oxidizing or cooling the liquid stream. In using air, permissible only in small quantities, oxidation is largely eliminated by the fluxing action of the fused salts being pumped simultaneously with the metal. The quantity of air required is insufficient to cause a substantial loss of magnesium.

These and other novel features of the invention will be better understood after considering the following description taken in conjunction with the accompanying drawing, in which:

Figs. 1, 2 and 3 are sectional elevational views of three different embodiments of the invention.

The apparatus illustrated in the drawing comprises a vessel 1 containing a bath of molten mixed salts 2, usually including magnesium chloride, an overlying layer of molten magnesium 3 and a container 4, such as an ingot mold or the like, for receiving the magnesium. The vessel 1 may be an electrolytic cell or an extension or other portion thereof such, for example, as a metal collecting well of the cell.

As illustrated in Fig. 1, the submergence gas-lift type pump 5 comprises a U-shaped portion having an inlet duct 6 with an upper open end 7 and a discharge duct 8. The upper open end 7 is flared outwardly to facilitate the entrance of the magnesium or magnesium and fused salts. The upper part of the discharge duct extends laterally a suitable distance to carry the metal away from the vessel and has a spout at the end for directing the magnesium into the container 4. The small pipe 9 for supplying the motivating gas connects at one end to any suitable source of gas, such as air under pressure (not shown), and the other end terminates near the bottom of the U.

The form of apparatus illustrated in Fig. 2 comprises a submergence gas-lift type pump 11 having an inlet duct 12 with an upper open end 13 connected at the bottom to the discharge duct 14 forming a closely connected U. The gas pipe 15 for supplying the motivating gas connects to a suitable source of gas (not shown) and has an open end located at the lower portion of the discharge duct.

In the apparatus illustrated in Fig. 3, the submergence gas-lift type pump 16 comprises an inlet duct 17 having an annular upper open end 18 and a closed bottom. The discharge duct 19 is considerably smaller in diameter than the inlet

duct and is mounted concentrically therein with its open lower end a short distance above the closed bottom of the inlet duct 17. The gas pipe 20 for supplying motivating gas connects at one end to a suitable source of gas under pressure (not shown) and runs through the annular space between ducts 17 and 19 to the bottom of duct 19 where it turns upward inside duct 19 in the form of a U for directing the gas upwardly into the discharge duct 19.

In the various modifications of pumps illustrated in the drawing, the gas pipes may be provided with small holes or nozzles for discharging the gas in fine bubbles into the lower portion of the column of material in the discharge duct. We may also use a fine screen in the lower portion of the discharge duct to aid in disseminating the fine bubbles of gas throughout the rising column of magnesium and fuel salts. While a U type pump is referred to, the inlet and exit ducts may be connected in a V type shape in place of the usual cursive form of U or may depart slightly from the common plane and still fall within the scope of the invention. The various forms of submergence gas-lift pumps illustrated are so proportioned and arranged that they may easily be carried by hand from one cell to another. The gas pipe may be connected by pressure hose to an air header by any of the common couplings for rapid connection. The gas pipe may be carried on the outside of the discharge duct, as shown in Figs. 2 and 3, or partly on the inside as shown in Fig. 1. The various elements comprising the pump may be formed of any suitable material, such as iron or iron alloys, and the discharge duct may be covered with a heat insulating material, such as asbestos rope, or the like, wrapped thereover. Such insulation is especially advantageous when the magnesium pumped out of the container is at a temperature only slightly above its melting point.

The vertical height of the discharge duct, or more accurately, the distance the magnesium may be elevated above its level in the vessel 1, will be governed by the vertical height of the inlet duct, by the pressure head of the liquid at the point where the gas is discharged, and by the lifting effect of the motivating gas.

In carrying out a method of the invention, the procedure depends upon the melting characteristics of the layer of magnesium with reference to the liquid salt bath. In the instance where the liquid salt bath has a lower melting temperature than the magnesium, the operating procedure is as follows: The submergence gas-lift type pump is inserted into the salt bath with the upper opening of the inlet duct below the layer of magnesium. The air under a suitable pressure is discharged through the gas pipe and the fused salt is pumped through the discharge duct, thereby heating the duct to a suitable temperature to begin pumping the magnesium. The pump is then elevated until the upper opening of the inlet duct is immersed in the layer of molten magnesium preferably to the interface between the magnesium and the fused salts. The molten magnesium with fused salts immediately starts flowing through the pump and out of the discharge duct into the container 4. When the metal is removed to the desired extent, the pump is lifted from the vessel 1 and removed to another vessel. Alternatively the apparatus may be merely raised from the liquid in the vessel or left in the vessel. When the pump is lifted from the vessel, the fluid remaining in the pump is removed either by pouring it out or by blowing it out with gas.

When the salt bath has a higher melting temperature than the magnesium, or when it is desired to keep the salt bath entirely separate from the magnesium, the pump is preferably inserted in the bath to a depth where the opening of the inlet duct is immersed in the layer of magnesium. In this instance, it is unnecessary to preheat the pump by first pumping a small volume of the fused salt therethrough. By passing the motivating gas through the gas pipe, the magnesium flows directly through the pump and is discharged into the container 4.

We claim:

The method of pumping magnesium collected in a layer over a molten salt bath which comprises providing first two connected upright columns of fused salts, one column in which the fused salts flow downward, and the other in which the fused salts flow upward and are discharged, blowing air into the column of salt in which the material flows upward to cause the mixture of salt and air to flow upward by gravity action, continuing such pumping of fused salts until the pump is heated to approximately the melting point of the magnesium metal, elevating the pump until the downward flowing column of salt contacts the upper layer of molten magnesium, continuing the pumping operation wherein the molten magnesium replaces essentially all of the fused salts in the two upright columns, maintaining the two connected upright columns of magnesium and fused salts, one column in which the magnesium and fused salts flow downward from the layer of magnesium, and the other in which the magnesium and fused salts flow upward and are discharged, continually blowing air into the column of metal and fused salts in which the magnesium and fused salts flow upward, to cause the mixture of magnesium, fused salts, and air to flow upward by gravity action, and limiting the amount of air, to prevent excessive reaction with the metal.

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