

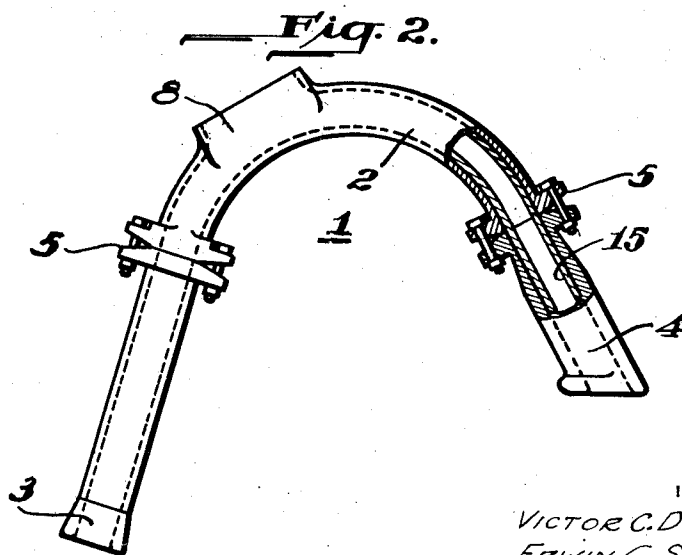
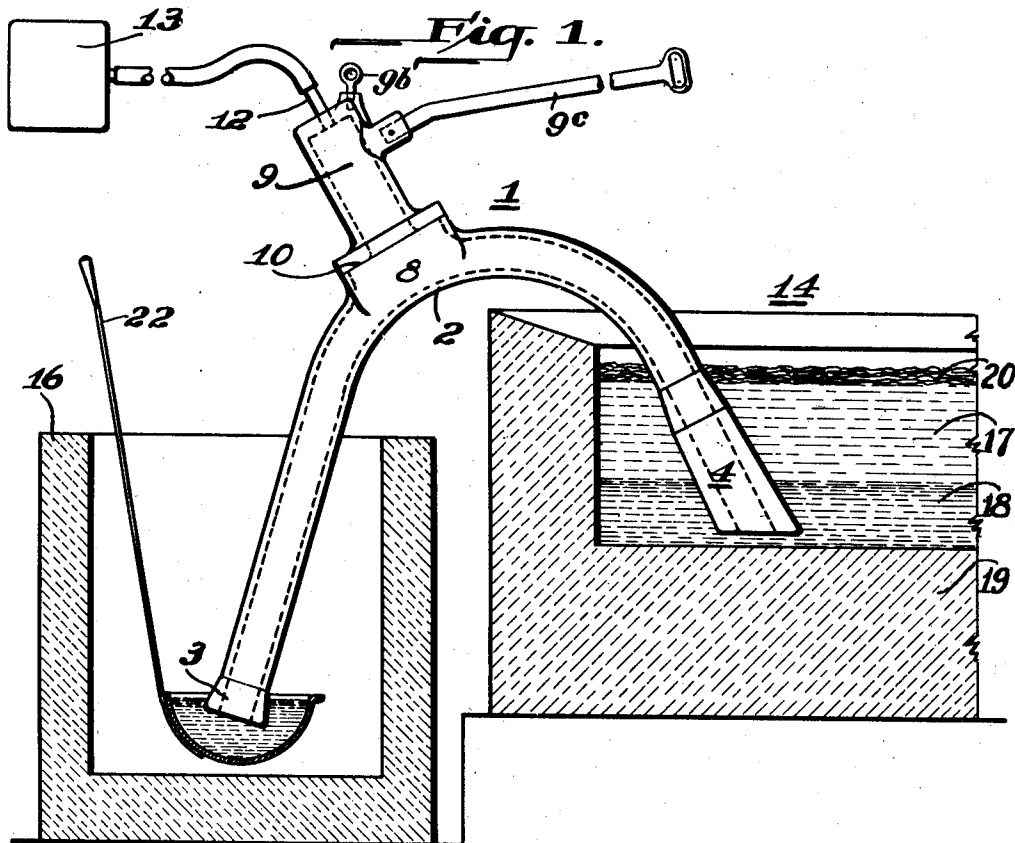
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SIPHONING METAL

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SIPHONING METAL

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This invention relates to the transfer of molten metal from one container to another, such as from a reduction furnace to a pouring crucible, and it particularly relates to the quiet transfer of metal by means of certain improved methods and apparatus.

away of a modified form of part of the apparatus shown in Fig. 1.

Referring to the drawing, in which like reference numerals are used to designate like parts, a siphon, generally designated by the numeral 1, is shown which comprises a body, preferably tubular in form, with its center portion 2 substantially U-shaped. This siphon is preferably made of heat-resisting cast iron. The discharge end 3 and the intake end 4 of the siphon are, in the preferred embodiment of our invention, provided with thickened walls to increase their heat capacity and prolong their life, and to produce other results which will hereinafter appear. The siphon ends 3 and 4 may be formed integrally with the center portion 2 as shown in Fig. 1. Frequently, however, it is preferable to have the siphon ends detachable from the center portion in order that they may be readily cleaned or replaced, and in such case a siphon of the form shown in Fig. 2, having suitable flange joints 5 or connections of other suitable form provided between the center portion of the siphon body and one or both of the end sections thereof, may be used.

In transferring molten metals from one container to another in an open stream, difficulty is always encountered in keeping the metal free from oxidation. This is particularly true in the case of easily oxidizable metals, such as aluminum, which oxidizes quite rapidly at temperatures above its melting point. In the production and preparation of such metals a series of transfers is usually involved, and the turbulence resulting from the discharge of an open stream of metal leads to the inclusion of considerable quantities of dross or oxidation product therein at each transfer. Furthermore, mechanical difficulties of an equally troublesome nature are frequently encountered in the open transfer of molten metals, and especially in the removal of molten aluminum from reduction pots, which in the past have generally been discharged by tapping a side of the pot. The tapping operation requires a large amount of labor, leads to frequent accidents, and sometimes does not produce the results desired because the tapping pin goes astray and pierces the wall of the container above the hearth.

The principal object of this invention is to overcome the difficulties previously encountered in the transfer of molten metals and especially in the transfer of molten aluminum. A further object of the invention is to provide an apparatus for transferring molten metal quietly and without contamination or oxidation. A specific object of the invention is to provide an improved method of removing aluminum from electrolytic reduction pots.

A further object of the invention is to provide a siphon coated internally with a protective layer of congealed refractory material and adapted for use in the quiet transfer of metal. A further object is to provide a siphon which will withstand continued use at elevated temperatures and which is so designed that the cleaning and replacement of parts may be readily effected when desired. Further objects will appear upon reference to the following description and the accompanying drawing, in which:

Fig. 1 is a diagrammatic view partly in elevation and partly in vertical section of one form of siphoning apparatus adapted to the objects of the present invention; and

Fig. 2 is an elevational view with parts broken

away of a modified form of part of the apparatus shown in Fig. 1. In intermediate the ends of the siphon body and preferably forming a part of the center portion 2 thereof, at or near its highest point, a base or mounting 8 is provided on which a member enclosing a surge chamber 9 is secured by the joint 10. The cross sectional area of the surge chamber is preferably considerably larger than the cross sectional area of the tubular passage through the siphon body, with which it is preferably in constant communication. The upper end of the surge chamber is provided with a pipe 12 or other suitable outlet connected by means of a flexible tube or the like with an exhaustor, suction pump, or other suitable means 13 adapted to withdraw air or other gas from the surge chamber and siphon body and produce a partial vacuum therein. A ring or hook 9b may be secured to the surge chamber in any suitable manner, if desired, for attachment to a crane or other means for raising or lowering the siphon, and a handle 9c may be connected to the surge chamber or some other part of the siphon to assist in bringing it to the desired position.

While the invention herein described is broadly applicable to the transfer of molten metals generally, especially advantageous and desirable results are obtained when the invention is applied to the transfer of easily oxidizable metals and particularly aluminum, and more particularly when applied to the transfer of molten alu-

minum from electrolytic reduction pots. The invention will therefore be described, by way of example, with reference to the last-named application.

5 We have found that in using a siphon of the type herein described, it is highly advantageous, and in many cases necessary, to the quiet transfer of metal without contamination thereof to provide the metal-contacting portions of the
10 siphon assembly with a layer 15 of congealed refractory material of such composition that it will not in itself cause contamination of the molten metal. This refractory material should also have a melting point higher than the temperature of
15 the metal to be transferred. A salt of the metal being transferred, or a mixture of salts, is generally suitable for this purpose. In the case of the transfer of aluminum, the molten bath which is used in the electrolytic reduction pots in which
20 aluminum is produced is the preferred protective material, as it has no injurious effect on the metal, is readily separated therefrom, and is often available at places where molten aluminum is to be transferred. This bath usually consists of
25 natural or artificial cryolite, which is essentially a mixture of fluorides of sodium and aluminum, with or without the addition of smaller quantities of other ingredients, such as aluminum oxide, dissolved therein.

30 The application of a congealed coating 15 of refractory material to the metal-handling surfaces of the siphon assembly may be accomplished in several ways, the most practical of which is to draw molten refractory material
35 through the siphon passage and there congeal it to form a smooth and even coating. For instance, when molten aluminum is to be transferred from a reduction pot to a crucible or other receiver, the coating may be applied in a manner which is
40 best understood by further reference to the drawing, in which a conventional cell 14 for the electrolytic reduction of aluminum is shown, with a crucible 16 positioned adjacent thereto for receiving the molten metal. In the operation of the
45 cell or reduction pot 14 in known manner, alumina dissolved in the molten bath 17 is electrolytically reduced to form molten aluminum, which sinks to the bottom of the pot and forms a layer 18 adjacent the bottom lining 19, while a crust 20 is
50 usually formed on the surface of the bath. The siphon 1 is preferably preheated at least sufficiently to remove surface moisture, and its metal-receiving end or intake end 4 is inserted through the crust 20 and into the molten bath of cryolite
55 17. The discharge end 3 of the siphon is then closed to exclude air, as by means of a fusible plug or cover or, as is generally more convenient, by surrounding the discharge end of the siphon with a seal of the molten bath, which may be held
60 in the ladle 22. By means of the mechanism 13 suction is applied to the siphon, creating a partial vacuum therein and causing the molten bath to rise through the siphon and completely fill the passage thereof as well as the lower part of the surge chamber 9. If during this process the walls
65 of the siphon are at a temperature somewhat below the melting point of the bath, the bath in contact with the walls of the siphon and the surge chamber will congeal and form a protective coating thereon.

70 The siphon is now ready for use, with or without draining the uncongealed bath therefrom, and its intake end 4 is lowered through the molten bath 17 into the molten layer of aluminum 18 which it is desired to transfer to the crucible 16.

Suction is preferably applied continuously by the exhaustor 13, at least until the flow of molten aluminum through the siphon is established, and usually throughout its transfer, but the suction
80 may be released to allow the bath to drain from the siphon before starting the flow of aluminum if desired. The ladle 22, when used, is usually kept in the position shown in Fig. 1 until the layer of molten aluminum in the receiving vessel
85 16 is deep enough to cover the discharge end 3 of the siphon, and it is then withdrawn. If the suction is released to allow the siphon to drain before starting the flow of aluminum, however, the ladle 22 may be emptied of bath, filled with
90 molten aluminum, and returned to the position shown, where it is preferably held until the level of the metal in the crucible 16 is above the discharge end 3 of the siphon. The ladle has a
95 two-fold function, whether it is initially filled with bath or with molten metal, as it seals the end of the siphon and excludes air therefrom when the suction is first applied, and then diffuses the metal discharged from the siphon, reducing the turbulence of its flow into the receiver and preventing spattering. When molten
100 metal is present in the receiver 16 in such quantity that it covers the end 3 of the siphon, so that discharge from the siphon takes place beneath its surface, the presence of the ladle is unnecessary.

105 During the transfer of the molten aluminum, the intake end 4 of the siphon is positioned substantially at the bottom of the cell 14, and its edge may be provided with short legs or analogous projections to facilitate entrance of the
110 molten metal into the siphon passage, but irregularities in the surface of the lining 19 usually make this unnecessary. The partial vacuum created in the siphon must initially be sufficient to overcome the static head of the molten material
115 in the intake portion of the siphon, and it is preferable to maintain throughout the transfer of metal a vacuum sufficient to hold molten material in the entrance to the surge chamber. When so
120 operated, a siphon equipped with a surge chamber of suitable size and having its metal-contacting surfaces coated with congealed refractory material which is unreactive with the metal transferred, as described hereinabove, will effect
125 a quiet transfer of metal from one container to another with a minimum of contamination and with a rapidity and economy which are highly desirable in commercial operation.

When several transfers of metal are to be made in quick succession with the same siphon,
130 which is frequently the case, it is not necessary to coat the siphon as a separate step before each transfer. Enough bath is congealed on the siphon while lowering it into position, or during the transfer of the metal, or after the transfer when a small amount of bath is usually drawn
135 over to be sure that the metal is completely recovered, to keep the protective layer intact after a thorough initial coating has been applied. Small amounts of bath delivered by the siphon
140 into the crucible or other receiver 16 are not troublesome, as this material rises to the surface of the metal and is readily skimmed off or otherwise removed in known manner.

145 Considerable advantage is gained by designing the siphon with removable tips, such as the sections 3 and 4 shown in Fig. 2, because, after long use, the tips may require replacement, or the layer of congealed bath or other refractory material may build up, or other stoppages may oc-

cur, so that the siphon has to be cleaned. This is readily accomplished after removal of the surge chamber and the detachable ends, which gives easy access to all parts of the siphon for cleaning, replacement or repairs. The surge chamber mounting provides a large and conveniently located opening through which any temporary stoppage of the siphon tube may be relieved.

During the operation of the siphon or siphon pump, it is necessary to operate the vacuum pump 13 continuously to obtain the best results. We have found in practice that maintenance of a vacuum of about 3 inches of mercury throughout the transfer of the aluminum is generally satisfactory, although apparently not critical. With the surge chamber opening from the siphon passage at substantially its highest point and maintained at a suitable vacuum, gas is continuously withdrawn from the molten metal during its transfer and escapes without interruption of the metal flow. The metal is thus at least partially de-gassed during its transfer, and its quality is improved as compared with metal transferred by the gravity method of tapping. One function of the surge chamber is to prevent plugging of the pipe 12, the vacuum hose connected thereto, and the pump 13. The coating of congealed bath or other refractory material on the metal-contacting surfaces of the siphon protects the molten metal from contamination and also protects the siphon from attack by the metal and from deterioration due to the high temperature of the metal.

While our invention has been described with special reference to a preferred embodiment and application thereof, it will be obvious to those skilled in the art that certain changes or modifications can be made therein, in addition to those described by way of example hereinabove, without departing from the spirit of our invention.

We claim as our invention:

1. The process of siphoning molten metal, which comprises drawing through a siphon molten material having a higher melting point than the metal, cooling said material by contact with the siphon to form a protective coating on the inner surface thereof, and drawing the molten metal through the siphon.

2. The process of siphoning molten metal, which comprises drawing through a siphon a mixture of molten salts having a higher melting point than the metal and substantially unreactive therewith, cooling said mixture by contact with the siphon to form a protective coating on the inner surface thereof, and drawing the molten metal through the siphon.

3. The process of providing siphons for the transfer of molten metal with linings of refractory material, which comprises drawing through a siphon molten material having a higher melting point than the metal to be transferred and refractory thereto, and cooling said material by contact with the siphon to form a protective coating on the inner surface thereof.

4. The process of transferring molten metal from a vessel wherein it is contained to a receiver, which comprises sealing one end of a siphon to exclude air, inserting the other end of the siphon in molten material having a higher melting point than the metal to be transferred and applying a suction to the siphon to draw said molten material therethrough, the siphon being at a temperature such that at least a portion of the molten material therein is congealed to form a protective coating on the interior of

the siphon, and then inserting the intake end of the siphon into the molten metal and applying suction to draw the molten metal through the siphon into the receiver.

5. The process of transferring molten metal from a vessel wherein it is contained to a receiver, which comprises inserting the discharge end of a siphon into said receiver and temporarily closing said discharge end, lowering the intake end of the siphon into a body of molten material having a higher melting point than the metal to be transferred and applying a suction to the siphon to draw said molten material there-through, the siphon being at a temperature such that at least a portion of the molten material is congealed thereby to form a protective coating thereon, and then lowering the intake end of the siphon into the molten metal while applying suction to induce a flow of said metal through the protectively-coated siphon into said receiver.

6. The process of transferring molten aluminum which comprises drawing through a siphon a fused salt bath having a higher melting point than aluminum and substantially unreactive therewith, cooling at least a portion of said bath by contact with the siphon to form a protective coating on the inner surface thereof, and drawing the molten aluminum through the protectively-coated siphon.

7. The process of transferring molten aluminum, which comprises drawing through a siphon a fused salt bath consisting essentially of a mixture of sodium and aluminum fluorides having a higher melting point than aluminum, cooling at least a portion of said bath by contact with the siphon to form a protective coating on the inner surface thereof, and drawing the molten aluminum through the protectively-coated siphon.

8. The process of transferring molten aluminum into a receptacle therefor from an electrolytic reduction pot containing a layer of said molten aluminum and a superposed layer of molten electrolytic bath, which comprises inserting the discharge end of a siphon into said receptacle and sealing said discharge end with molten material from a reduction pot to exclude air, and lowering the intake end of the siphon through the layer of molten electrolytic bath into the molten metal in said reduction pot while applying suction to the siphon, thereby drawing molten bath through the siphon where it is congealed by the siphon to form a protective coating thereon and then drawing molten aluminum through the protectively-coated siphon into the receptacle.

9. In a process of transferring molten metal into a receptacle therefor, the combination of steps comprising coating the inner surface of a siphon with a congealed layer of material having a higher melting point than the metal and drawing the molten metal through the coated siphon while continuously applying suction thereto.

10. In a process of transferring molten aluminum into a receptacle therefor, the combination of steps comprising coating the inner surface of a siphon with a congealed layer of salts having a higher melting point than aluminum and substantially unreactive therewith, and drawing molten aluminum through the coated siphon into said receptacle while continuously applying suction to the siphon.

11. In a process of transferring molten aluminum into a receptacle therefor, the combination of

steps comprising coating the inner surface of a siphon with a congealed layer of salts consisting essentially of sodium and aluminum fluorides and drawing molten aluminum through the coated siphon into said receptacle while continuously applying suction to the siphon.

12. In a process of transferring molten aluminum from an electrolytic reduction pot which comprises drawing the aluminum through a siphon at least partially coated with a congealed layer of the electrolytic bath, the step comprising closing the discharge end of the siphon with molten material withdrawn from the reduction pot while applying suction to induce a flow of molten material through the siphon.

13. A siphon for transferring molten metal comprising a substantially U-shaped tube coated on its inner surface with a congealed layer of material having a higher melting point than the metal to be transferred and operatively connected intermediate its ends with means adapted to apply a suction to the tube.

14. A siphon for transferring molten metal comprising a substantially U-shaped tube coated on its inner surface with a congealed layer of material having a higher melting point than the metal to be transferred and provided intermediate its ends with a surge chamber of materially greater cross-sectional area than the tube, said chamber being connected with means adapted to create a partial vacuum in the tube.

15. A siphon for transferring molten metal, comprising a hollow substantially U-shaped member with a tubular passage therethrough, the walls of said passage being thickened near the ends of said member, and said member being provided intermediate its ends with a surge chamber of greater cross-sectional area than the said tubular passage and connected therewith, said chamber being also connected with means adapted to apply a suction to the passage to draw molten metal therethrough.

16. A siphon for transferring molten metal, comprising a curved member with a passage therethrough, said member consisting of at least one detachable end portion having increased wall thickness throughout at least a part of its length, and a center portion detachably connected to said end portion, said center portion being also detachably connected with a member enclosing a surge chamber of greater cross-sectional area than the said passage and communicating therewith, and said surge chamber being operatively connected with means for producing a partial vacuum therein.

17. In a siphon for transferring molten metal, a surge chamber communicating with a passage through the siphon, said chamber being of materially greater cross-sectional area than the passage, and being readily detachable therefrom.

18. A siphon for transferring molten aluminum from electrolytic reduction pots to receptacles therefor, comprising a substantially U-shaped tube coated on its inner surface with a congealed layer composed principally of a mixture of sodium and aluminum fluorides having a higher melting point than the aluminum, and operatively connected intermediate its ends with means adapted to create a partial vacuum in the tube.

19. A siphon for transferring molten aluminum from electrolytic reduction pots to receptacles therefor, comprising a substantially U-shaped tube coated on its inner surface with a congealed layer composed principally of a mixture of sodium and aluminum fluorides having a higher melting point than the aluminum and provided intermediate its ends with a surge chamber of materially greater cross-sectional area than the tube, said chamber being connected with means adapted to create a partial vacuum therein to draw molten aluminum through the siphon.

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