June 2, 1964 TAMIRO HIRAKAWA ETAL 3,135,672

METHOD FOR FEEDING ALUMINA TO ELECTROLYTIC CELL

Filed Jan. 12, 1960

2 Sheets-Sheet 1

Fig. 4

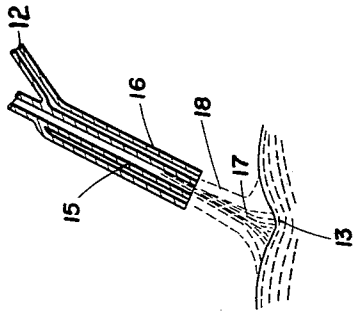
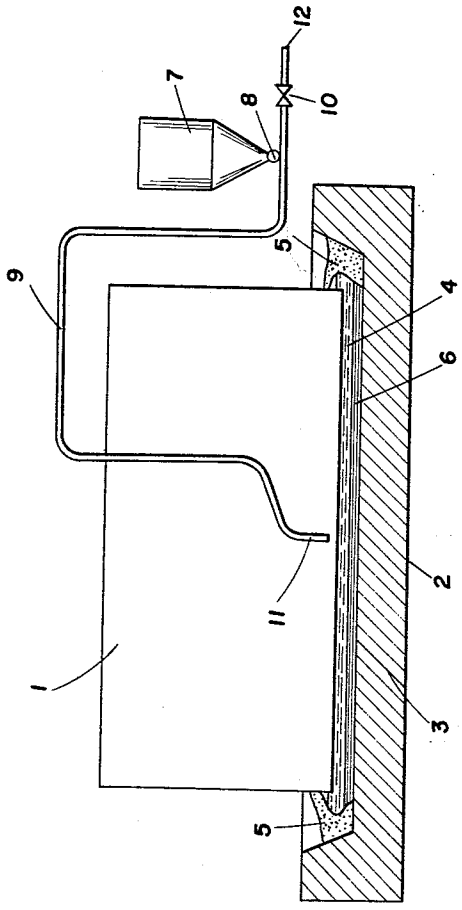


Fig. 1



INVENTOR.
TAMIRO HIRAKAWA, KOSUKE ASANO
SHIGEKI MUKOYAMA, SHUICHIRO HARA
BY
William D. Carothers

June 2, 1964 TAMIRO HIRAKAWA ETAL 3,135,672

METHOD FOR FEEDING ALUMINA TO ELECTROLYTIC CELL

Filed Jan. 12, 1960

2 Sheets-Sheet 2

Fig. 2

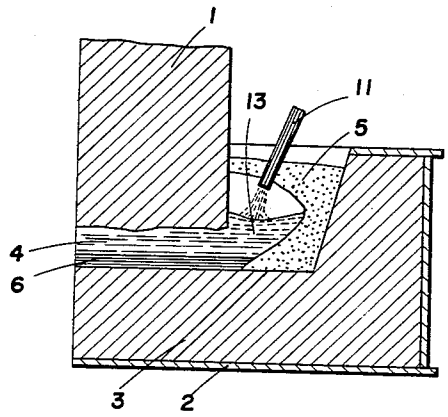
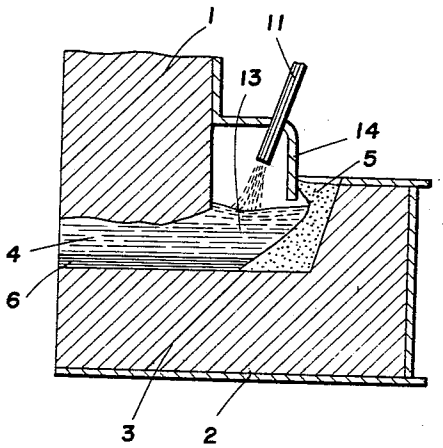


Fig. 3



INVENTOR.
TAMIRO HIRAKAWA, KOSUKE ASANO
SHIGEKI MUKOYAMA, SHUICHIRO HARA
BY
William D. Carter

United States Patent Office 3,135,672 Patented June 2, 1964

3,135,672
METHOD FOR FEEDING ALUMINA TO ELECTROLYTIC CELL

Tamiro Hirakawa, Niigata-shi, Kosuke Asano, Shizuoka-ken, Shigeki Mukoyama, Niigata-shi, and Shuichiro Hara, Shizuoka-ken, Japan, assignors to Nippon Light Metal Co., Ltd., Tokyo, Japan, a company of Japan

Filed Jan. 12, 1960, Ser. No. 1,933
Claims priority, application Japan Jan. 16, 1959
19 Claims. (Cl. 204—67)

This invention relates to a method for feeding alumina to the aluminum electrolytic cell, more particularly, to a method for jetting gas continuously or intermittently to the surface of the molten bath of the aluminum electrolytic cell, alumina being fed to the parts of said surface where no crust is formed.

Generally, aluminum metal is produced by electrolytic reduction of alumina in a bath of fused cryolite or fluoride.

In such process, a comparatively large amount of alumina must be fed to the cell periodically to compensate for alumina consumed gradually as electrolysis progresses.

Although the bath is melted at the high temperature of nearly 1000° C., the surface of it is covered with a thick hard crust of frozen cryolite.

Therefore, it has hitherto been practised to break down the surface crust with a tool beforehand, and such operation together with the feeding operation of alumina have been done by toilsome man power or machine power.

These operations cause a temperature drop due to a wide opening of the bath exposed to the atmosphere and to the sudden addition of large amounts of alumina to the cell at a time.

Furthermore, as the concentration of alumina in the electrolyte varies continuously between maximum and minimum, from the period when the alumina is fed to the cell to the period when the alumina is reintroduced, the operating condition is apt to be changed and frequently the "anodic effect" occurs when alumina concentration drops below a certain critical limit, thereby making the consumption of electric power and fluoride considerable.

So it is desirable to feed alumina continuously and constantly to the cell without breaking down the surface crust of the bath, in accord with the gradual consumption of alumina when electrolysis progresses.

An attempt was made in the past to break down a small part of the crust and expose a molten surface of the bath, whereby alumina may be fed continuously therethrough.

However, this method is unsatisfactory. On the bath surfaces where alumina is fed, a thin skin is formed by a temperature drop soon after breaking down the crust and this causes the piling of alumina at the said surface of the bath, and in such state alumina feeding operation will become impossible because the said skin will gradually form a hard crust.

Therefore, for feeding alumina continuously into the cell, it is necessary to prevent the formation of skin by some means or other or to break off the skin before it forms a hard crust.

This invention is devised to solve the above mentioned difficulties by jetting gas to the alumina feeding surfaces of the bath. According to this invention alumina can be fed continuously or with an extremely short interval for example at every several minutes interval while, in the hitherto practiced method, alumina can be fed only with an interval of several hours.

The main object of this invention is to eliminate a toil of crust breaking work and alumina charging work which are the most toilsome works in the ordinary cell operations.

Another object of this invention is to stabilize the operating condition of the cell by constantly supplying alumina

whereby the concentration of alumina in the bath is made constant and proper.

Still another object of this invention is to reduce consumption of electric power and fluoride to avoid anodic effect which occurs when the concentration of alumina in the bath drops below a certain critical limit.

When gas is jetted onto the surface of the molten bath from a nozzle, a fine vibration or rippling occurs on the surface of the bath by its pressure, and such vibration or rippling aids to prevent the formation of skin on the bath surface.

Thus, alumina can be fed continuously and constantly into the bath without any obstacle, and alumina can easily be dissolved and dispersed into the bath.

Generally, air is a suitable gas to be used in this invention.

By jetting air onto the bath surface nearby the anodic carbon, a part of CO gas which is formed by the oxidation of anodic carbon is burned out and the temperature of the bath there around rises up slightly.

The formation of skin on the bath surface can be avoided by this elevation of temperature.

A combustible gas, for instance CO gas which is formed in the cell, or a combustible gas mixed with a proper amount of air also can be used instead of air only. A natural gas or an artificial gas or a butane or some other form of gas with air can also be used.

By using such combustible gas or mixed gas, the frozen skin on bath surface is more completely avoided due to higher temperature on the surface of the bath.

The invention is hereunder explained with reference to the accompanying drawings, for the purpose of exemplification without limiting the invention or the claims thereto, in which:

FIG. 1 shows a front view of the device of this invention which is used in the aluminum electrolytic cell having soderbuerg electrode.

FIG. 2 shows an enlarged side view of the jet pipe of FIG. 1.

FIG. 3 shows an enlarged side view of around the jet pipe of another example of this invention which is used in the aluminum electrolytic cell having gas collector ring.

FIG. 4 shows a vertical sectional view of the jet nozzle in still another example of this invention.

In FIG. 1, **1** is an anode of aluminum electrolytic cell, **2** is a vessel of the cell lined with carbon **3**. **4** is a molten electrolytic bath, of which the surface and the inner side of the vessel form a frozen cryolite bath crust **5**. **6** is molten aluminum which is deposited at the bottom of the vessel by electrolysis. **7** is alumina banker, the bottom of which is shaped as conical, and a feeder **8** is set up at the lower part of **7** for supplying alumina constantly into the guide pipe **9** which guides alumina into the cell by means of jet flow.

One end of the guide pipe **9** forms a jet nozzel **11** which leads alumina to the surface of the bath nearby the anode. **10** is a control valve which is set up at the other end of the guide pipe **9** and the amount of outflow of alumina is controlled by it.

Now, when feeding alumina into the guide pipe **9** by the feeder **8** from the alumina banker **7** which is filled with alumina, and blowing gas, such as air, from the end **12** of the guide pipe **9** at a suitable velocity by controlling the control valve **10**, alumina is blown off through in the guide pipe **9** in the state of dispersing and floating in the air and blown out on the surface **13** of the bath from the jet nozzle **11**.

As the jet nozzle is directed to the surface of the bath **13** as shown in FIG. 2, alumina which is blown out to the surface of bath from the jet nozzle **11** with the air stream, is dissolved and dispersed into the bath.

Around the surface of bath directly attacked by jet flow

is vibrated finely by the jet pressure and the temperature thereabout is raised up by burning of a part of CO gas which is produced by the anodic carbon by the electrolytic reaction.

Therefore, alumina can easily be fed continuously and constantly into the bath without forming a thin skin on the surface of the bath and the fed alumina is easily dissolved and dispersed into the bath due to the vibration of the bath.

In the example shown in FIG. 3, the jet nozzle is inserted into a gas collector or sealed **14** which, although not shown, is stationary relative to the anode **1**.

In the example shown in FIG. 4, the jet nozzle is formed by the two coaxial tubes of which the inner nozzle is used for alumina supplying pipe. Alumina **17** is supplied from the inner nozzle **15** and the jet stream **18** is blown out from the outer nozzle **16** surrounding the inner nozzle **15** so as to form an air curtain and to make rippling on the surface of the bath. The said air curtain has the effect of preventing alumina from being scattered away from the bath surface.

In the method of FIG. 4, it is not necessary to mix alumina with air beforehand, only alumina can be supplied from the inner nozzle **15** directly by any mechanical means, and it is not always necessary to blow gas continuously to the surface of the bath.

Namely, gas can intermittently be blown to the extent that frozen skin will not be formed, and by doing so alumina can be fed onto the bath continuously.

Although the invention is described above with reference to alumina, the same method can be applied generally to powdered substances which are to be supplied to molten substances apt to form frozen skin on the surface thereof.

We claim:

1. The method of feeding alumina to an aluminum electrolytic cell containing molten aluminum covered by a molten electrolytic bath engaged by an electrode which consists of the steps of supplying a forceful jet of gas under pressure to the cell, producing a ripple on the liquid surface of the molten electrolytic bath by impringing the forceful jet of gas directly on a limited area of the liquid surface of the molten electrolytic bath adjacent the aforementioned electrode, the rippling of the molten liquid surface preventing crustation of cryolite, and supplying alumina directly to the rippled molten surface to feed it into the molten bath.

2. The method of claim 1 characterized in that the step of supplying the forceful jet of gas under pressure to the liquid surface of the molten bath to ripple the same is applied intermittently.

3. The method of claim 1 characterized in that the step of supplying the forceful jet of gas under pressure to the liquid surface of the molten bath to ripple the same is applied continuously.

4. The method of claim 1 characterized in that the gas supplied is a combustible gas.

5. The method of claim 1 characterized in that the gas supplied is a combustible gas and air.

6. The method of claim 1 characterized in that the gas supplied is air.

7. The method of claim 1 characterized in that the steps of supplying the forceful jet of gas and the alumina to the molten surface of the bath is by supplying the alumina in a jet surrounded by the forceful jet of gas under pressure to the liquid surface of the molten bath to ripple the same.

8. The method of claim 1 characterized by the step of premixing the gas and alumina, and feeding them under pressure directly to the rippling molten surface.

9. The method of claim 1 which also includes the step of enclosing the space around the electrode to enchamber the gas supplied to the molten surface.

10. An electric aluminum melting furnace comprising a kettle providing a chamber lined with material capable of carrying electric current and to contain liquid aluminum covered with a molten electrolytic bath, an anode arranged to be lowered into said chamber to complete the circuit in said molten electrolytic bath to maintain the molten condition, and a nozzle supported to discharge a forceful jet of gas directly on the liquid surface of the molten electrolytic bath between the anode and the chamber lining wall to ripple the molten electrolytic surface and keep it free of crustation to permit the charging of alumina to the bath.

11. The furnace of claim 10 characterized in that said nozzle also supplies the alumina to the molten electrolytic bath.

12. The furnace structure of claim 11 characterized in that said nozzle has an inner tube for the discharge of alumina and an outer tube for the discharge of gas surrounding the discharge of alumina.

13. The furnace structure of claim 10 characterized by an annular canopy slidably engaging said anode and spreading to spaced relation with said kettle lining, a support to hold said canopy while said electrode is consumed by said molten bath, and said nozzle extending through said canopy.

14. The method of feeding alumina to an aluminum electrolytic cell containing molten aluminum covered by a molten electrolytic bath engaged by an electrode which consists of the steps of vibrating the surface of the molten electrolytic bath by impinging a jet of gas under pressure to the molten liquid surface to keep it clear of crustation, and feeding alumina to the vibrating molten surface.

15. The method of claim 14 characterized in that the step of vibrating the molten surface by jet pressure impingement is intermittently blown to prevent a skin from forming on the surface.

16. The method of claim 14 characterized in that the step of feeding the alumina is commensurate with and in the jet pressure.

17. The method of claim 14 characterizd in that the step of feeding the alumina is independent of the jet pressure.

18. The method of claim 17 characterized in that the independent feeding of the jet pressure and the alumina is coaxially with the alumina feed surrounded by the jet pressure.

19. The method of claim 17 characterized in that the independent feeding of the jet pressure and the alumina is through coaxial jets.

References Cited in the file of this patent

UNITED STATES PATENTS

2,631,972	Luzzatto	Mar. 17, 1953
2,713,024	Mantovanello	July 12, 1955
3,006,825	Sem	Oct. 31, 1961