United States Patent

[11] 3,616,440

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[73] Assignee **Harvey Aluminum (Incorporated) Torrance, Calif.**

[54] **DEVICE FOR SERVICING ALUMINA REDUCTION CELLS**
4 Claims, 14 Drawing Figs.

[52] **U.S. Cl.** **204/245**
[51] **Int. Cl.** **C23d 3/02**
[50] **Field of Search** 204/279, 245, 243, 67; 248/274–285

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Primary Examiner—John H. Mack
Assistant Examiner—Sidney S. Kanter
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ABSTRACT: A vehicle suitable for use in servicing alumina reduction cells, said vehicle having mounted thereon a power operated crust-breaking device and an alumina storage and handling system, the crust-breaking device comprising a head mounted on an extensible arm which is vertically and horizontally actuatable by hydraulic means, sufficient downward force being exerted by the hydraulic means to cause penetration of the head through the electrolyte crust, the alumina content of the cell being replenished by introduction of alumina into the cell from an alumina storage bin on the vehicle.

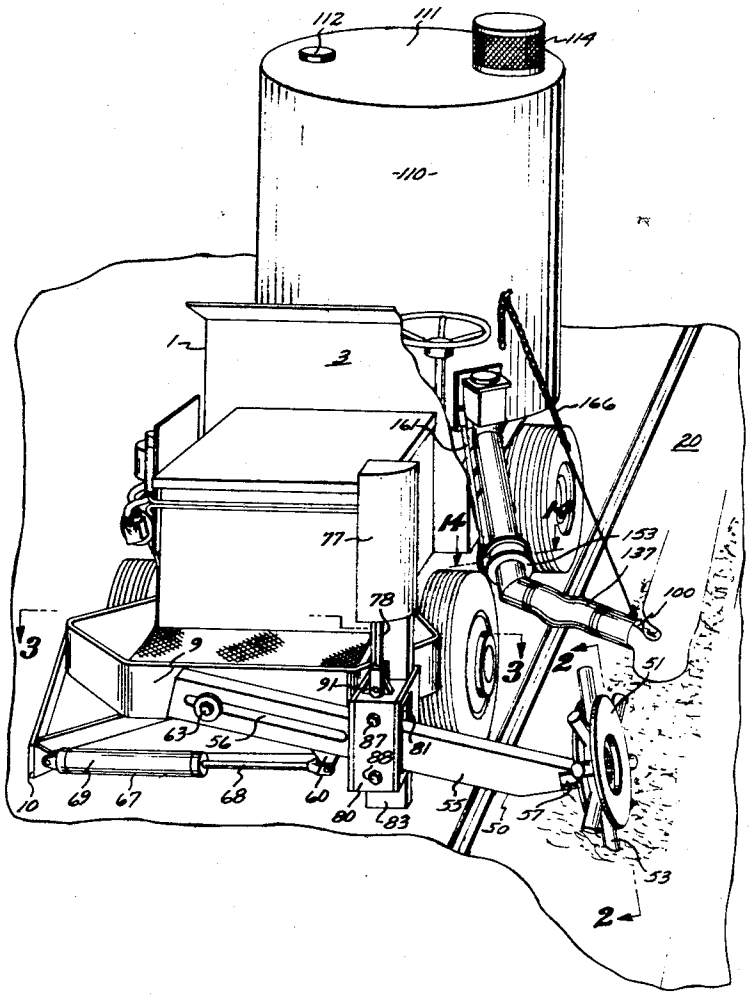


FIG. 1

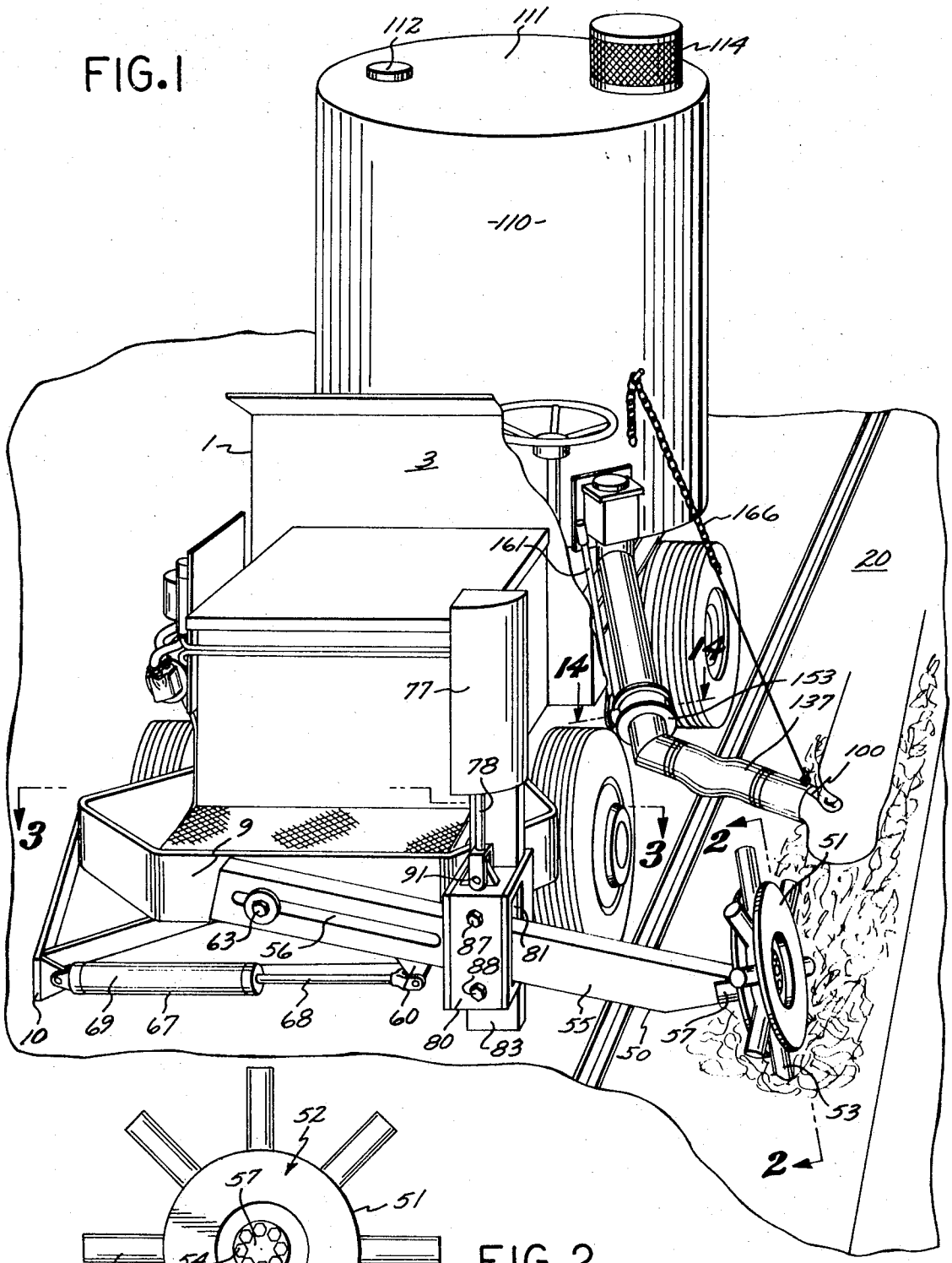


FIG. 2

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FIG. 3

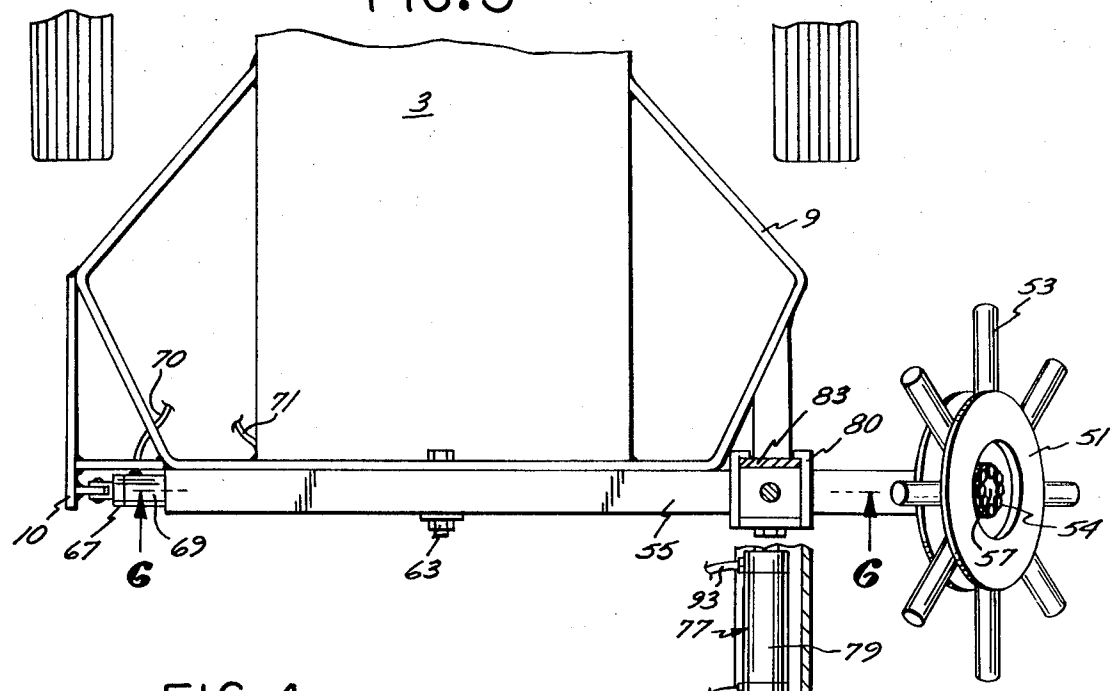


FIG. 4

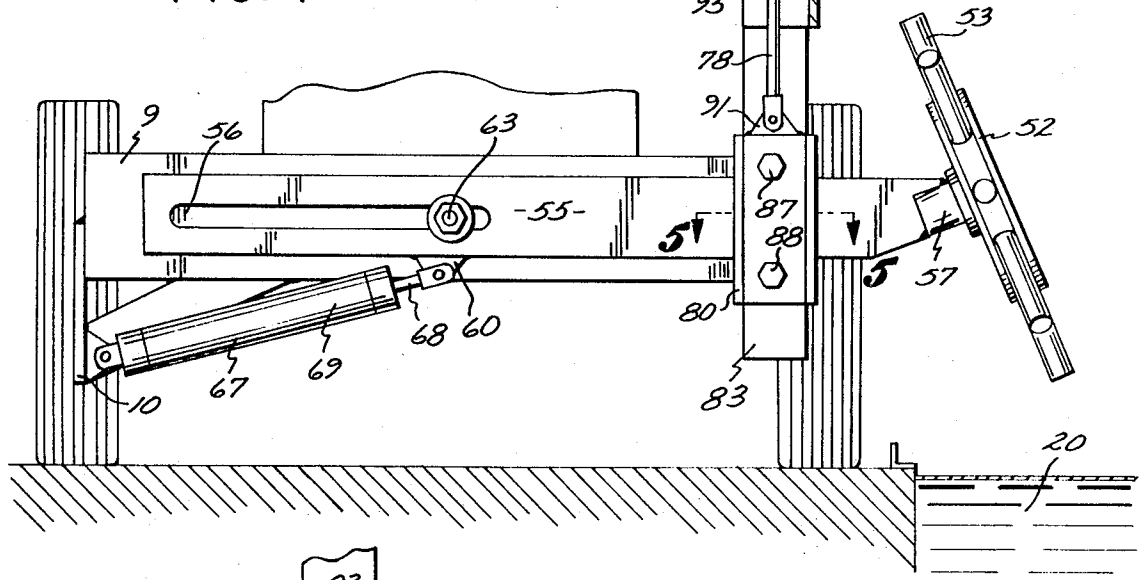
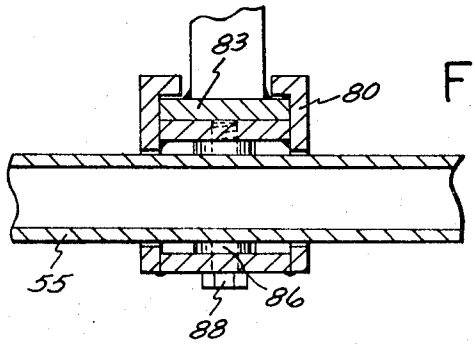


FIG. 5



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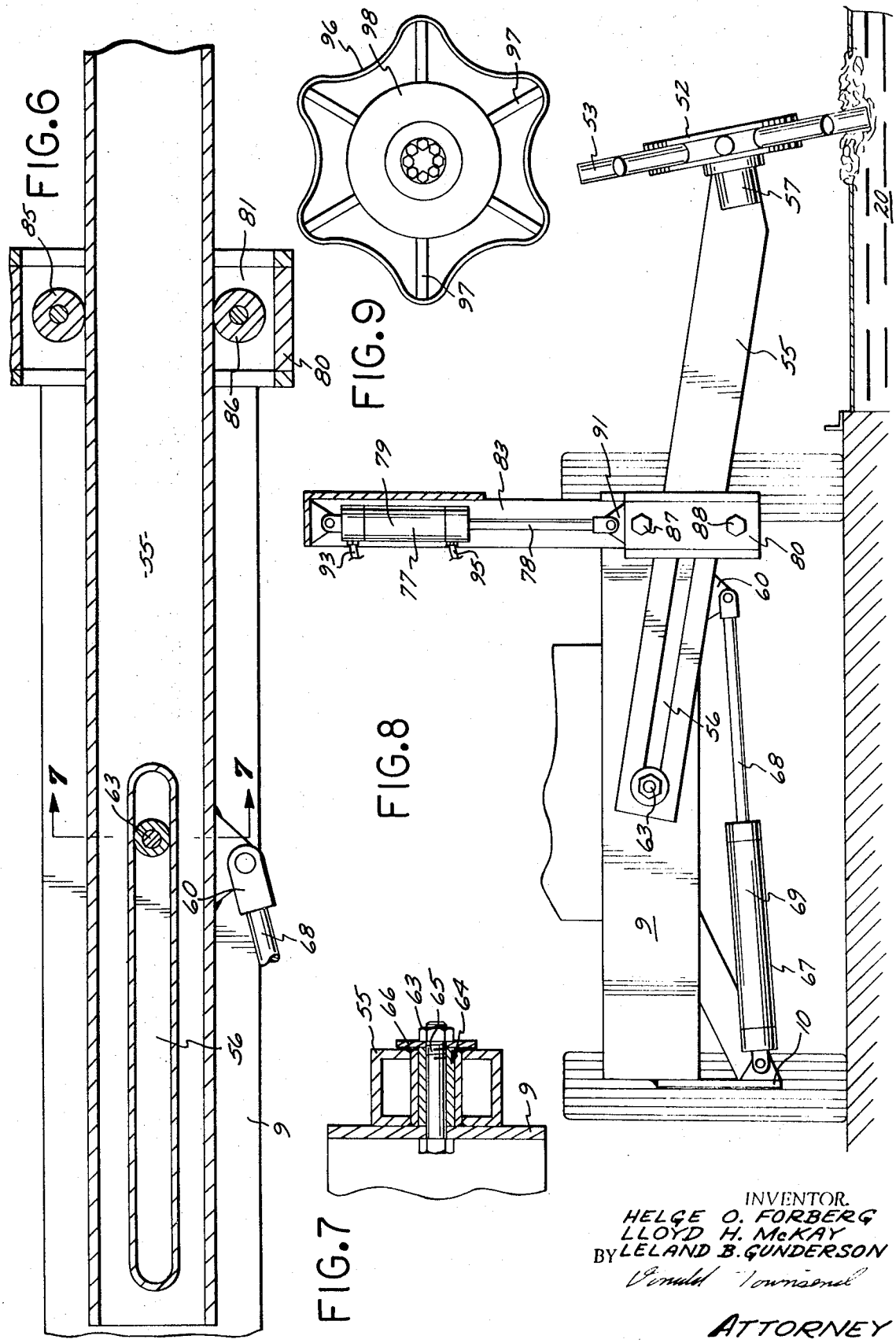

FIG.6
FIG.9
FIG.8
FIG.7
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FIG.10

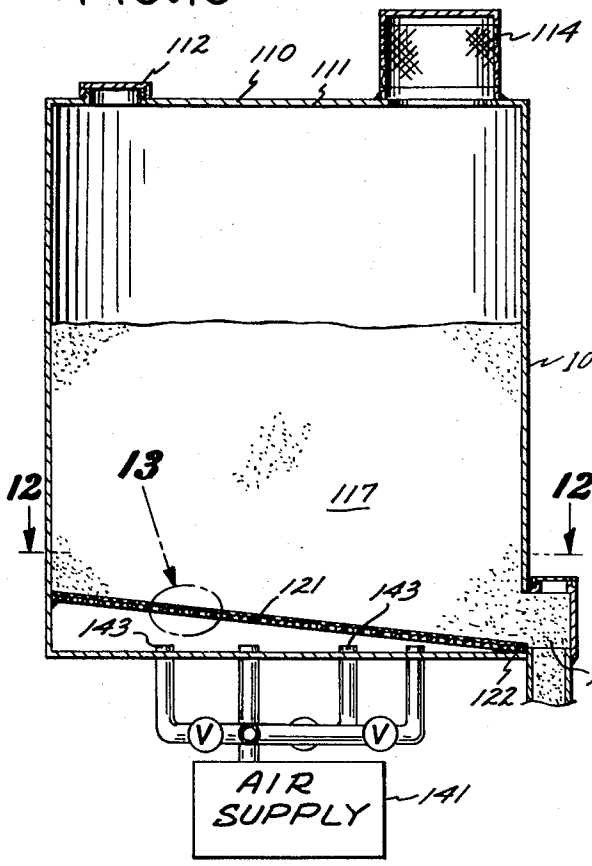


FIG.11

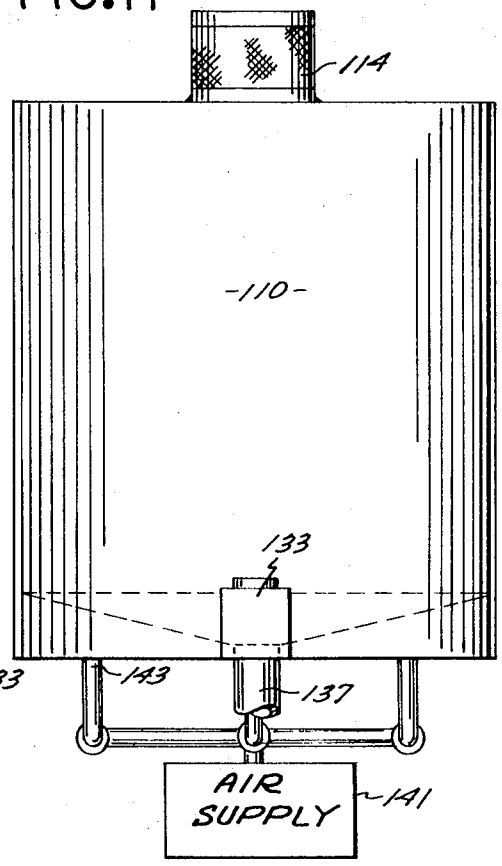
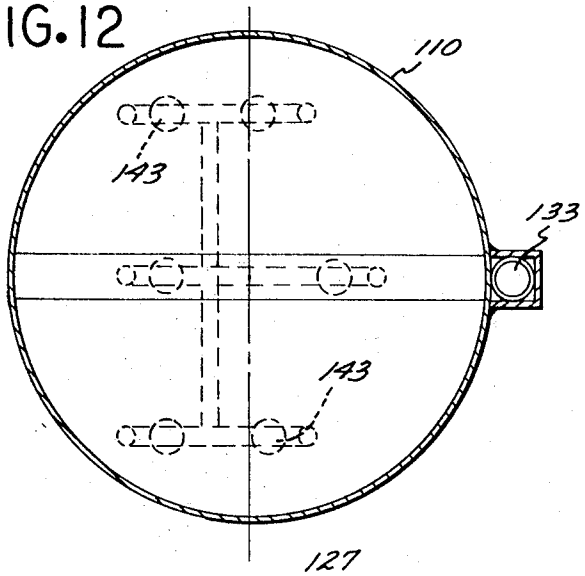


FIG.12



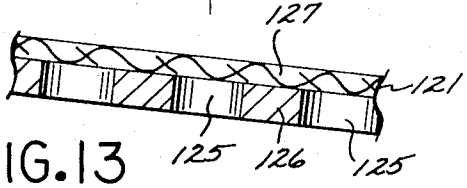


FIG.13

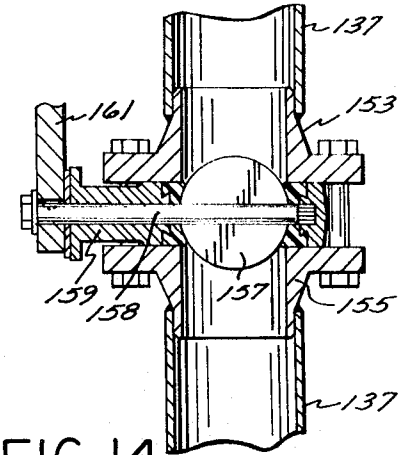


FIG.14

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DEVICE FOR SERVICING ALUMINA REDUCTION CELLS

In the conventional electrolytic reduction of alumina, high convective heat losses from the surface of the molten electrolyte results in the formation of a relatively thick crust completely covering the surface of the cell. To replenish consumed alumina in such continuously operated cells, it has heretofore been necessary to periodically rupture this crust with jackhammers in order to introduce alumina directly into the molten electrolyte. To minimize disturbances in the heat balance of the cell, the alumina is usually charged onto the hot surface of the crust about an hour before it is broken to facilitate preheating of the alumina.

This procedure for metering alumina into the electrolyte is, however, inaccurate and unreliable because the extent to which the crust is disrupted spilling alumina into electrolyte cannot be regulated closely by using jackhammers or the like. In some cases, for example, only a small fraction of the needed alumina drops from the crust into the molten electrolyte, the bulk of the alumina charged remaining undissolved on the surface of the unbroken crust. When this occurs, the concentration of alumina in the cells can drop below the critical 2percent level and into a semistarved condition before the next scheduled alumina addition. During such a semistarved condition, a so-called "anode effect" occurs in which aluminum production is sharply reduced while the power requirements of the cell increase up to tenfold. Also, a considerable period of time elapses even after a prompt alumina addition before steady state operation of the cell can again be achieved. Attempts have been made to mechanize the crust-breaking operation by mounting several pneumatic jackhammers or the like on a vehicle. The problem associated with the accurate metering of alumina by control of crust disruption has not, however, been solved by this approach. As discussed above, the use of localized vibratory stresses causes erratic and uncontrolled disruption of the crust resulting in an uneven and uncontrolled addition of alumina to the electrolyte. It has also been found that the vibrations caused by such jackhammers, especially in relatively small cells, not only disrupts the magnetic circulatory flow of molten electrolyte, but also causes splashing of aluminum onto the anode, all of which result in reductions in cell efficiency.

It is therefore a principal object of the invention to provide an improved apparatus for replenishing consumed alumina in alumina reduction cells.

Another object is to provide in the crust-breaking operation an improved device therefor which effects more uniform disruption of the crust and accurate metering of alumina into the molten electrolyte.

Still another object is to provide an improved crust-breaking device which can be used without seriously impairing cell operation.

Yet another object is to provide an improved apparatus for rupturing the crust and supplying alumina to the cell.

These and other objects and advantages of the invention will become apparent upon reference to the following description, drawings, and claims appended hereto.

According to the present invention, consumed alumina in the cells can be periodically replenished by utilizing a vehicle having mounted thereon both a crust-breaking device and an alumina storage and handling system. The alumina is stored in a vessel having a slanted, perforated floor upon which the particulate alumina rests, and a fluidizing means supplies a stream of gas to the vessel below the floor thereof, resultant fluidized alumina being conveyed from the vessel to the cell through an extensible discharge line connected near the bottom of the vessel.

The crust-breaking device employed herein comprises a crust-breaking head mounted on an extensible support means and a hydraulic means connecting therewith which is adapted to move the head laterally outwardly from the vehicle and downwardly with sufficient force to press the head through solidified electrolyte crust in the cell. While maintaining the crust-breaking head adjacent the surface of the molten electrolyte and at the surface of the crust, the vehicle together with the crust-breaking head is moved forward resulting in the controlled rupture of additional crust. By utilizing the crust-breaking device of the present invention, it has been found that rupture of the crust can be more closely regulated with more accurate metering of alumina resting on the crust.

As additional crust is ruptured by the crust-breaking head, any desired amount of alumina can be introduced directly into the molten electrolyte through the discharge line from the alumina storage vessel. When alumina from the storage vessel is introduced directly into molten electrolyte, it is preferred to employ a heated gas as the fluidizing medium in order to preheat the alumina being added. If desired, alumina may be charged onto the crust surface before its scheduled introduction into molten electrolyte thereby to effect preheating of the alumina.

Utilizing the vehicle and crust-breaking device of the present invention, more accurate control of alumina addition can be effected even when alumina is prematurely charged onto the crust and allowed to preheat thereon. In this case, it was unexpectedly found that the more uniform disruption of crust achieved by using the crust-breaking device of the present invention results in more accurate metering of alumina into molten electrolyte. The use of the present nonvibratory crust-breaking device was also found to minimize disturbances in the magnetic circulatory flow of electrolyte and alumina addition to the electrolyte can be successfully carried out without seriously impairing cell operation.

The invention is illustrated further in several typically preferred embodiments in the accompanying drawings in which:

FIG. 1 is a perspective view partially broken away of the vehicle of the present invention, showing the manner in which the crust on the cell is ruptured and alumina charged into the molten electrolyte;

FIG. 2 is a side elevational view taken along line 2—2 of FIG. 1, illustrating the operation of the crust-breaking head;

FIG. 3 is a plan view taken along line 3—3 of FIG. 1, showing the support means mounting the crust-breaking head on the vehicle;

FIG. 4 is a front elevational view in partial section of the vehicle of FIG. 1, illustrating the position of the crust-breaking head poised in an inoperative position above the cell;

FIG. 5 is an enlarged sectional view taken along line 5—5 of FIG. 4, illustrating the coupling between the arm holding the crust-breaking head and the first hydraulic means used in effecting vertical movement of the arm;

FIG. 6 is an enlarged sectional view of the arm taken along line 6—6 of FIG. 3;

FIG. 7 is an enlarged sectional view of the arm taken along line 7—7 of FIG. 6;

FIG. 8 is a front elevational view in partial section of the vehicle with the arm extended and the head resting on the crust;

FIG. 9 is a side elevational view of a preferred head used on the crust-breaking device;

FIG. 10 is a cross-sectional view of the alumina storage vessel, illustrating the perforated floor of the vessel and air supply used in fluidizing the alumina;

FIG. 11 is a side elevational view of the alumina storage vessel;

FIG. 12 is a cross-sectional view of the alumina storage vessel taken along line II—II of FIG. 9, showing in dashed lines the location of the air discharge ports;

FIG. 13 is an enlarged cross-sectional view of the floor area 12 of FIG. 9;

FIG. 14 is a cross-sectional view taken along line 13—13 of FIG. 1, showing the valve in the alumina discharge line.

Referring now to the drawings, the vehicle of the present invention for servicing alumina reduction cells is indicated generally at 1, FIG. 1 and comprises a motor-operated vehicle 3, having mounted thereon a power-operated crust-breaking device 50 together with an alumina storage and handling

system 100. The vehicle 3 can be propelled by either an electric motor or by an internal-combustion engine, it being preferred to employ a motor having sufficient power to propel the vehicle and also operate the crust-breaking device 50 and alumina storage and handling system 100.

The crust-breaking device 50, which is preferably mounted on the front end of vehicle 3, comprises a crust-breaking head 51 mounted on arm 55 which is vertically and horizontally actuatable by a first and second hydraulic means 77, 67, respectively. The crust-breaking head 51 has a generally cylindrical body 52 which can be rotatably mounted by means of bolts 54 on axle 57 which extends from the end of arm 55. A plurality of projections or spikes 53 extending from the periphery of body 52 facilitate rupture of crust 20, the head being rotated as the vehicle moves forward with the end of spikes 53 first coming into contact with the crust and breaking it as the body 52 rotates. Pin 63 which is fixedly attached to frame 9 of vehicle 3 extends through the elongated slot or aperture 56 in arm 55, the lateral travel of the arm corresponding to the length of the slot 56.

Pivotally connected intermediate support member 10 projecting from frame 9 and arm 55 is hydraulic means 67, the end of the piston rod 68 extending from hydraulic cylinder 69 being pivotally connected to bracket 60 on arm 55. As hydraulic fluid is introduced into cylinder 69 through line 70 (FIG. 3), the arm 55 shown in a fully retracted position in FIG. 4 moves outwardly from the vehicle and into an operatively extended position as depicted in FIGS. 1 and 8.

Cooperating with hydraulic means 67 to operatively position arm 55 is another hydraulic means 77 with a collar 80 having a slot 81 therein through which arm 55 extends, the collar 80 being slideably mounted on vertical track 83. To facilitate the lateral movement of crust-breaking head 51, the arm 55 rides on and between a pair of spaced rotatable rolls 85, 86 (see FIGS. 5 and 6) mounted in slot 81, each of the rolls 85, 86 being connected to the collar 80 by bolts 87, 88, respectively. The arm 55 also rides on stationary pin 63 which comprises an outer sleeve 64 mounted on nut-and-bolt assembly 65 which has a relatively large retaining washer 66 thereon (FIG. 7).

Fixedly attached to the upper end of vertical track 83 is hydraulic means 77, the piston rod 78 thereon extending from hydraulic cylinder 79 being connected to bracket 91 on an upper surface of collar 80. By introducing hydraulic fluid under pressure through line 93, piston rod 78 permits collar 80 to slide downwardly on track 83 while lowering arm 55 from its position shown in FIG. 4 to the operative position in FIGS. 1 and 8.

After the electrolyte crust has been broken, hydraulic fluid is passed through lines 71 and 95 into hydraulic cylinders 69 and 79 is supplied by a single pump connected to the vehicle motor. In addition to the crust-breaking head in FIG. 2, other types of crust-breaking heads can also be employed such as those having an irregular peripheral surface or projections extending from their periphery. Another crust-breaking head for use herein, for example, comprises an outer steel rim 96 connected to and supported by a plurality of spokes 97 extending from disc 98 (see FIG. 9).

The alumina supply means indicated generally at 100 comprises a storage vessel 110 with a top 111 having thereon an alumina loading port 112 and an air filter 114. The stored alumina 117 rests on a false floor or grating 121 which is advantageously positioned at an angle of about 10° from the horizontal, the lowermost side 122 of grating 121 being immediately adjacent discharge port 133 (FIGS. 10 and 11).

To facilitate the discharge of alumina 117 from vessel 110, an air supply means 141 having a plurality of discharge lines 143 passes a stream of air through a plurality of holes 125 in rigid floor member 126 and then through the pores of canvas cover 127 which rests thereon (FIGS. 12 and 13). The upwardly flowing air fluidizes the alumina particles 117 causing them to more easily flow by gravity into discharge part 133 and out to the cell through discharge 137, the bulk of the fluidizing air laden with alumina fines being passed through screen filter 114 and then discharged to the atmosphere.

The flow of alumina through line 137 can be regulated by a butterfly-type valve 153 (FIG. 14) having a body 155, a circular gate 157 mounted on stem 158 to revolve within the body, a packing gland 159 and a handle 161 to manually turn stem 158.

To supply alumina to a cell, discharge line 137 is swung into place and positioned a proper distance above the cell with the aid of support chain and wire 166, the alumina is fluidized by means of air supply 141, and valve 153 is adjusted to effect the discharge of the desired amount of alumina.

In operation, the alumina can be introduced into the cell either before or during the crust-breaking step. During an anode effect or where the alumina content of the electrolyte is low, the alumina is advantageously introduced directly into the electrolyte as the crust thereon is broken. In this latter case, heated air is advantageously used as the fluidizing medium to preheat the alumina introduced into the cell.

From the foregoing description, one skilled in the art can easily ascertain the essential characteristics of this invention, and without departing from the spirit and scope thereof, can make various changes and modifications of the invention to adapt it to various usages and conditions. Consequently, such changes and modifications are properly, equitable, and intended to be, within the full range of equivalency of the following claims:

What we claim is:

1. In the combination of a self-propelled truck having thereon a crust-breaking device for rupturing solidified electrolyte in alumina reduction cells, and an alumina storage and handling means to supply alumina to molten electrolyte in the cell comprising a storage vessel having a perforated floor upon which particulate alumina rests, the improvement comprising a crust-breaking head mounted on one end of an arm which is pivotally connected near its other end to the truck, said arm having a collar slideable thereon which is connected to a first hydraulic means on the truck whereby to effect vertical movement of the crust-breaking head, and a second hydraulic means connected between the truck and arm, said arm having a transversely extending elongated slot to facilitate movement of the pivot point thereby permitting horizontal movement of said arm, the alumina storage and handling means comprising an extensible discharge line connected near the bottom thereof, said discharge line being positioned to discharge alumina adjacent the curst-breaking head, fluidizing means to pass a stream of gas through stored alumina, whereby to assist in removal of alumina through the discharge line.

2. The vehicle as defined by claim 1, wherein the crust-breaking head is circular in cross section.

3. The vehicle as defined by claim 1, wherein a plurality of projections extend from the periphery of the crust-breaking head.

4. The vehicle as defined by claim 1, wherein the crust-breaking head is rotatably mounted on the arm.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,616,440 Dated October 26, 1971

Inventor(s) HELGE O. FORBERG et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 3, line 52, after "79" insert -- respectively, to retract the crust-breaking arm 55 lateral inwardly and upwardly. Advantageously, the hydraulic fluid used in cylinders 69, 79 --

Col. 4, line 55, "curst" should be -- crust --.

Signed and sealed this 13th day of March 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

M PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334