# United States Patent [19]

**Hatlevoll et al.**

[11] **3,819,144**

[45] **June 25, 1974**


[54] **CRUST BREAKING MACHINE**


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[22] Filed: **Oct. 16, 1972**

[21] Appl. No.: **297,709**

[52] **U.S. Cl.** ..... **299/37,** 173/22, 173/43

[51] **Int. Cl.** ..... **E21c 29/24**

[58] **Field of Search** ..... 299/37, 38, 70; 173/22, 173/23, 28, 43, 42; 404/133



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[57] **ABSTRACT**

Crust breaking machine for breaking the crust on the electrolytic bath in electrolytic cells, in particular in enclosed cells, for producing metal such as aluminum. The machine comprises a self-propelled carriage provided with a cantilever arm which can be elevated and lowered and carries a hammer tool at its free end. The hammer tool is adapted to be swung about an axis which is substantially parallel to or coincident with the axis of the cantilever arm.


**6 Claims, 2 Drawing Figures**

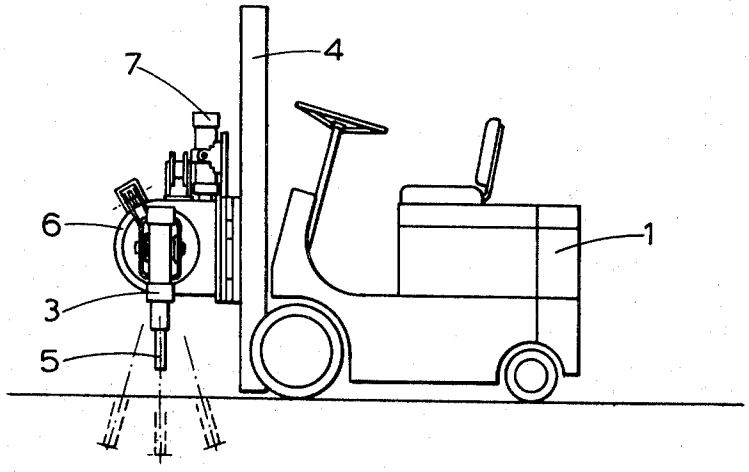
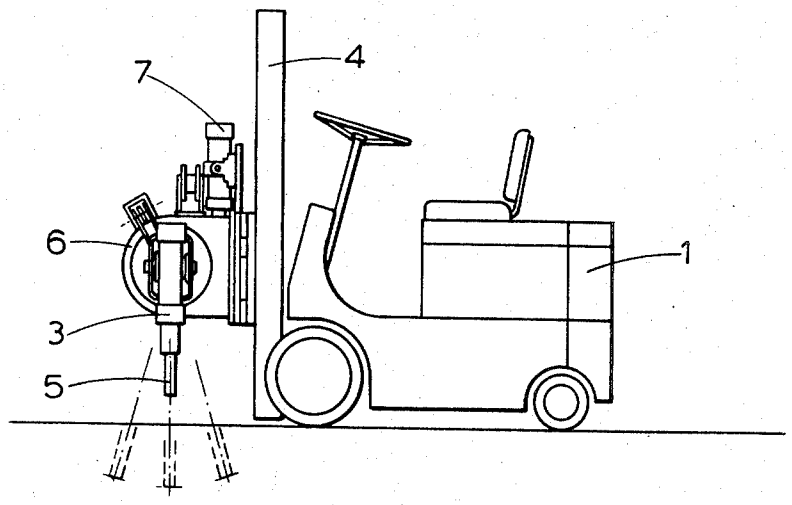


Fig. 1.



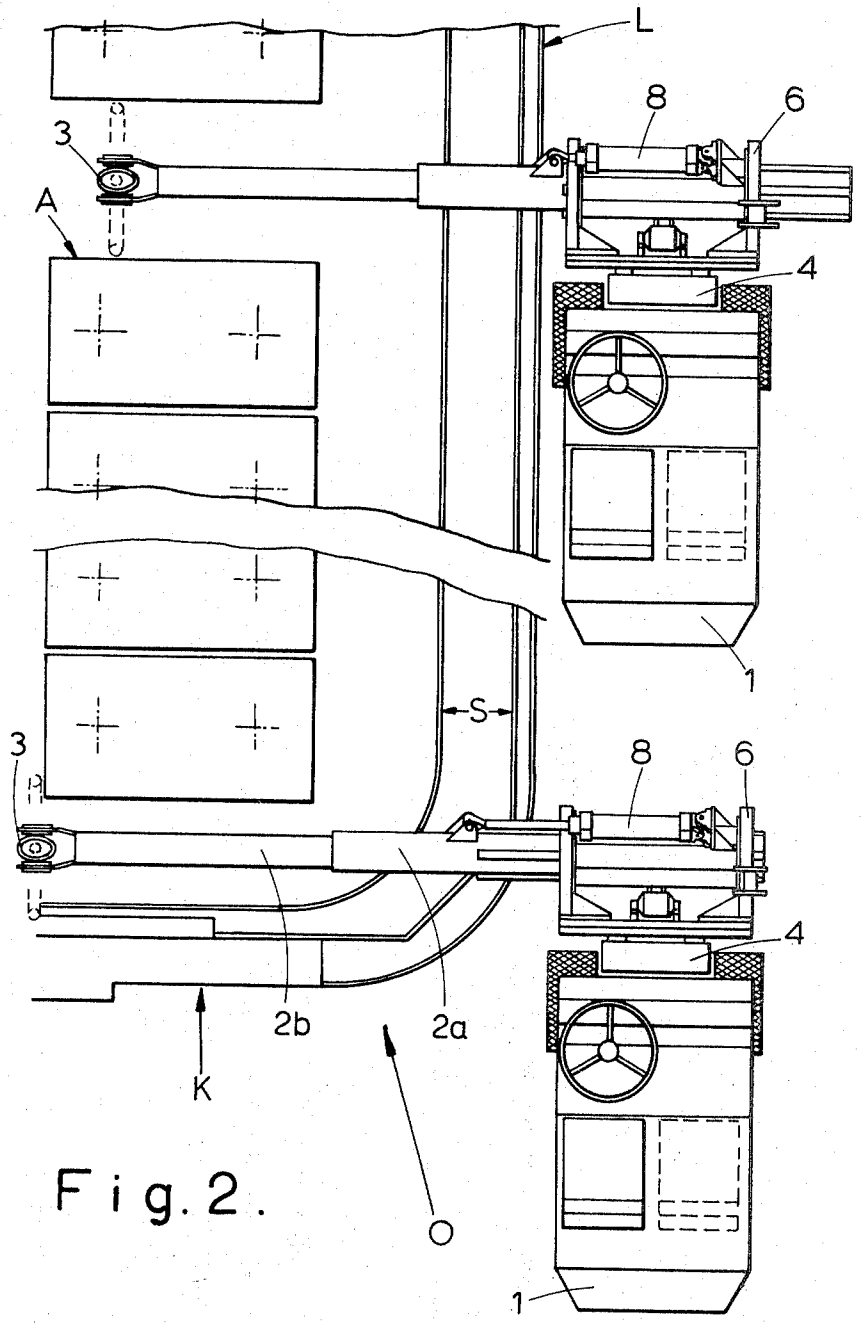



Fig. 2.

# CRUST BREAKING MACHINE

In the production of metal by electrolysis in a melt bath, for example the production of aluminum by electrolysis of $Al_2O_3$ dissolved in molten cryolite, a crust is formed on the surface of the electrolytic bath. This crust must be broken and pushed down into the molten electrolyte where it is melted or dissolved.

This work was previously made by means of hand tools, but is now usually accomplished by means of crust breaking machines. Such a crust breaking machine usually consists of a truck or carriage which can be moved along the electrolytic cell or furnace, or possibly a row of such cells or furnaces, on which carriage there is mounted a movable cantilever carrying at its free end a pneumatic tap bar or a hammer which is the crust breaking tool proper. By moving the carriage and the cantilever the tool can be applied on the surface of the crust which by a number of quick strokes effected by the tool, is broken into small pieces which can melt or dissolve in the electrolytic bath.

During the operation of electrolytic cells, for instance in the aluminum melting industry, it is necessary to break the crust on the electrolytic bath both alongside and at the ends of each cell. The breaking of the crust along the sides of the cell does not represent any big problem with the designs of crust breaking machines hitherto known, but breaking of the crust at the cell ends has always involved more problems because of the narrow space available there. This problem has become larger since enclosed electrolytic cells have come into use. None of the previously known crust breaking machines can be used for this operation in a satisfactory way, and it is therefore an object of the present invention to provide a crust breaking machine which is particularly capable of carrying out crust breaking at the cell ends in an effective and economical way, in replacement of the mainly manual operation which hitherto still has been common at these locations in the cell.

A specific difficulty in breaking the crust at the cell ends consists therein that the passage or opening available for introducing a crust breaking tool, is smaller than the area or more specifically the width of the crust to be broken.

An advantageous solution of the above problems is obtained with a crust breaking machine according to the present invention. More specifically, therefore, this invention relates to a crust breaking machine for breaking the crust on the electrolytic bath in electrolytic cells, in particular enclosed cells, for producing metal such as aluminum, the machine comprising a self-propelled carriage provided with a cantilever arm which can be elevated and lowered and carries a hammer tool at its free end. What is new and specific in the machine according to this invention primarily consists therein that the hammer tool is adapted to be swung about an axis which is substantially parallel to or coincident with the axis of the cantilever arm. According to a preferred embodiment of this invention the cantilever arm is telescopic.

In the following description the invention shall be explained with reference to an exemplary embodiment shown in the drawings in which:

FIG. **1** shows an embodiment of the crust breaking machine according to the invention in elevation, and



FIG. **2** shows the machine of FIG. **1** in two different positions seen from above during work at an electrolytic cell.

The crust breaking machine shown in the drawing is built up on an ordinary fork truck **1** comprising a conventional lifting mast **4** at its front end. By means of particular mounting arrangements a telescopic cantilever arm **2** is mounted on the lifting mast of the fork truck. This cantilever arm **2** can consist of two parts **2***a* and **2***b* so as to make possible the extension of the end of the cantilever arm to a sufficient length for use with the types of electrolytic cells of interest. At the free end of the cantilever arm **2** there is mounted a hammer tool **3** which is preferably pneumatically driven, but which can also be based on other forms of power.

By means of conventional arrangements in connection with the lifting mast of fork trucks, the cantilever arm **2** can be arranged for elevation or lowering by translative displacement in a vertical or substantially vertical plane. In this way the hammer tool **3** with its impact member **5**, for example a tap bar or the like, can be brought down into engagement with the crust surface to be broken. Another way of effecting this movement can be to mount the cantilever arm pivotally about a horizontal axis normal to the axis of the cantilever arm. Even though it is preferred to mount the cantilever arm substantially perpendicularly to the normal driving direction of the carriage, taking into account among other things the operator's general view of the working area, the cantilever can also be mounted at other angles, including one generally corresponding to the driving or longitudinal direction of the carriage.

It is of substantial importance in connection with this invention that it is possible to swing the hammer tool about an axis which is generally parallel to or coincident with the axis of the cantilever arm. In the embodiment shown in the drawing this feature has been obtained in that the cantilever arm **2** as a whole is mounted for rotation in a bracket **6** and is actuated by means of a hydraulic cylinder **7**. In this way the hammer tool **3** can be essentially fixed at the free or outer end of the outer part **2***b* of the cantilever arm **2**. As indicated with dotted lines in FIG. **1**, the hammer tool thereby can be brought to work a breaking area of considerable width without requiring a correspondingly wide passage or opening for moving the hammer tool **3** or the cantilever arm **2** to the working location concerned.

At the lower portion of FIG. **2** it is shown how the crust breaking machine according to the invention can operate in the very narrow end portion of an electrolytic cell **0** the end or short side of which is designated K and the long side of which is designated L. The anodes are indicated with reference letter A, and S designates the area of the electrolytic bath on which the crust is formed, and which the tool of the crust breaking machine must be able to work.

It will be understood that the various movements of the cantilever arm **2** can be provided for by means of hydraulic components as indicated in the drawings, in which it is seen among other things that a hydraulic cylinder **8** is adapted to extend or retract the telescopic unit **2***a*/**2***b*. This movement mechanism results in a machine requiring less space and which is easier to drive in narrow locations, as the telescopic unit with the hammer tool in the inoperative position is substantially centered in front of the fork truck so that the unit only

projects slightly to each side of the fork truck. The telescopic unit 2*a*/2*b* contains a hydraulic cylinder for extending the cantilever arm 2*b*, which represents the main movement of the hammer tool in the horizontal plane. The cylinder **8** is rotated together with the remaining cantilever structure in the bracket **6** when during operation swinging movements of the hammer tool **3** with the impact member **5** shall be effected.

To contribute in the attainment of dynamic loads during crust breaking the free end of the cantilever arm and/or the hammer tool proper can be constructed with a comparatively heavy weight, whereby the loads on the cantilever arm **2** itself and the hydraulic components included therein, as well as the bracket **6** and parts of the fork truck **1**, are reduced to a large extent.

The machine can also serve other functions than crust breaking operations as such, for instance in connection with the exchange of anode blocks, such as cleaning along anode blocks and cleaning of openings for clumps in the bath and anode butts. This application of the machine is illustrated in the upper portion of FIG. **2**. Here the tool **3** has been inserted into the comparatively narrow space between two anode blocks during replacement of an anode block, and as a consequence of the reduced space requirement of the machine during operation, cleaning can be effected before a new anode block is inserted in the interspace.

The crust breaking assembly proper can possibly be designed for easy mounting and dismounting on a common fork truck, whereby the same can also be used for operations conventional for such fork trucks.

The possibilities mentioned here result in a machine being very flexible, versatile and economical with respect to labour, and it can of course be used for breaking the crust on the electrolytic bath in the various cell types found, since for all such operations it requires less space than any previously known machine for such applications. These advantages add to the essential and primary advantage of this new crust breaking machine for breaking the crust at the cell ends, in particular on enclosed electrolytic cells.

What is claimed is:

**1.** Crust breaking machine for breaking the crust on the electrolytic bath in electrolytic cells, in particular in enclosed cells, for producing metal such as aluminum, said machine comprising:

a self-propelled carriage;

an extendable cantilever arm mounted on said carriage to extend laterally thereof;

means for elevating and lowering said cantilever arm;

a hammer tool mounted in a substantially fixed position at the free end of said cantilever arm and substantially normally thereto;

said cantilever arm being mounted for limited rotation about its own longitudinal axis; and

means for selectively rotating said cantilever arm about said longitudinal axis.

**2.** A machine as claimed in claim **1**, wherein said cantilever arm is telescopic.

**3.** A machine as claimed in claim **1**, wherein said cantilever arm is pivotally mounted about a horizontal axis perpendicular to the axis of said cantilever arm.

**4.** A machine as claimed in claim **1**, further comprising means on said free end of said cantilever arm and said hammer tool for making the same comparatively heavy so as to attain dynamic loads during crust breaking.

**5.** A machine as claimed in claim **1**, wherein said means for rotating said cantilever arm comprises a fluid operated mechanism.

**6.** A machine as claimed in claim **1**, wherein said means for elevating and lowering said cantilever arm includes means for maintaining the lateral orientation of said cantilever arm.

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UNITED STATES PATENT AND TRADEMARK OFFICE

# CERTIFICATE OF CORRECTION

PATENT NO. : 3,819,144

DATED : June 25, 1974

INVENTOR(S) : Jens Bugge HATLEVOLL, Per JORDAL and Georg Sigurd SIVERTSEN

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

Page 1, in the address of the Assignee, change "Oslo, Sweden" to -- Oslo, Norway --.

Page 1, insert the following Foreign Application Priority Data: -- October 14, 1971 Norway.....3792/71 --.

Signed and Sealed this

*Twenty-fourth* Day of *January 1978*

[SEAL]

*Attest:*

RUTH C. MASON
*Attesting Officer*

LUTRELLE F. PARKER
*Acting Commissioner of Patents and Trademarks*

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