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(54) Method and apparatus for cleaning of spent anodes.

(57) A method for cleaning of anode butts from an electrolysis process by means of an oscillating impact tool is disclosed. An apparatus to carry out the method comprises a closed chamber (15), restraining means consisting of a vertically movable grate board (5) and a horizontally operating restraining arm (6) connected to a dolly (4), and an impact tool (7).

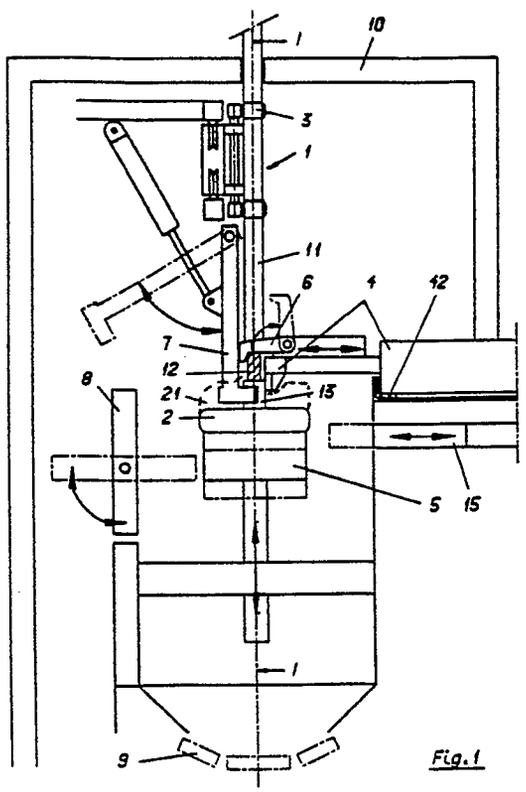

Fig. 1

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METHOD AND APPARATUS FOR CLEANING OF SPENT ANODES

The present invention relates to a method and an apparatus for cleaning of spent anodes and more particularly, the cleaning of prebaked anode butts (residues) from an electrolytic smelting process for aluminium production.

A prebaked anode consists of an already calcined carbon block provided with holes in the top where an aluminium/steel current-providing rod is fastened to the anode by means of cast iron or so-called rodding-mix. The anode rod normally consists of from 2 to 6 vertical cylindrical steel nipples connected together by a top steel cross-bar which in turn is connected to a vertical aluminium rod.

The carbon blocks are consumed during the electrolysis process, and consequently each of the 20-30 anodes in the electrolysis cell has to be replaced when the anode thickness is reduced to approximately 20% of its original height. The top of the anode block is then covered by a thick layer of solidified bath which sticks to the above mentioned nipples and between the carbon block and the steel cross-bar. This bath layer (crust), consisting of a solidified mixture having variable content of cryolite, aluminium fluoride and alumina, can be extremely hard. Both bath material and carbon residues have to be separately recovered for recycling in the electrolysis process.

The conventional method used for breaking down this crust layer is to apply pneumatic chisel machines, quite often manually operated. This is hard work where the chisel is partly used as a crowbar and furthermore, the method involves considerable environmental problems in the form of dust and noise. Consequently, several types of both stationary and mobile cleaning installations and devices have recently been developed in order to mechanize the cleaning of anode butts. These installations/equipment are based on different principles with regard to disintegration and removal of the solidified bath. All the hitherto known mechanized systems are, however, characterized by one or several serious drawbacks. E.g. the use of hydraulic pressure results in a complicated apparatus design where the steel nipples themselves are applied as a dolly during the cleaning operation. Because of the relatively large loads being applied there is a danger for deformation of the anode rod assembly, damaged welded joints between the Al-rod and the cross-bar etc. Milling cutters and chisel machines give a high noise level and dust formation. The light weight mobile cleaning machines, can only remove a warm bath layer from the anode butts immediately after their removal from the electrolysis cells, or possibly a porous bath layer. A common drawback for all known machines is low reliability of service, complicated designs and no possibility for an automatic cleaning operation.

It is therefore an object of the present invention to provide an apparatus and a method for cleaning of anode butts which overcome the above drawbacks, the apparatus having a simple and sturdy construction, high efficiency and where the cleaning operation can be conducted automatically.

Another object of the invention is to provide an apparatus and a method satisfying the strict environmental requirements with regard to the dust and noise level in workshops.

These objects are achieved according to the invention by providing a stationary apparatus completely encapsulated and based on application of an impact tool which under pendulous movement disintegrates and removes the solidified bath layer on the anode butts.

These and other characteristic features of the invention will be more apparent from the following description, patent claims and accompanying drawings, Figs. 1-3, where

Fig. 1 shows schematically and in a cross-section, a preferred embodiment of an apparatus for cleaning of anode butts,

Fig. 2 shows the apparatus in a cross-sectional longitudinal view taken along line I-I in Fig. 1, and

Fig. 3 illustrates schematically a rotating device applied to provide a profiled notch in the bath material adjacent to the anode cross-bar.

The disclosed cleaning machine is situated in a closed chamber 10 built of sound-insulating material and provided with a powerful vent-hood (not shown on the Figures), so that the machine is noise- and dust-insulated from the surroundings. A spent anode 2 having a solidified bath layer 21 on the top, as shown in Fig. 1, is fastened and ready for the cleaning operation.

The anode rod assembly 1, comprising an aluminium rod 11, attached to carriers in an overhead conveyor is fed into the cleaning chamber. The aluminium rod 11 is connected to a steel cross-bar 12, provided with welded nipples 13, embedded by solidified bath 21, on the top of the anode butt 2. A clamping device 3, grasps the aluminium rod and provides transport and alignment of the anode assembly through the machine in the cleaning chamber.

The cleaning machine itself comprises an impact tool 7, a dolly 4 provided with an aligning arm 6 and a vertically movable grate board 5 providing support for the anode during the cleaning operation. The impact tool 7 is illustrated on the Figure

as a pendulous hammer, e.g. pneumatically powered hammer.

The lower part of the chamber is intentionally narrowed into a hopper and terminated by transport means, e.g. a conveyor 9 for removal of bath lumps from the disintegrated bath layer 21. A specially designed accessory device for removal of possible broken anode pieces from the grate board 5 consists of a tipping board and a pusher 15. Their function and mode of operation will be described in more detail in connection with a detailed description of the method for cleaning of the anode butts.

Fig. 2 shows the machine in a longitudinal cross-section taken along the line I-I in Fig. 1 and illustrates in more details a preferred embodiment of the grate board and the pendulous hammer 7. The hammers are shown as two separate oscillating hammers which aim their impact outside of the three steel nipples 13 connected to the cross-bar 12 being in its turn attached to the rod 11, and at the solidified bath surrounding the nipples between the cross-bar and the anode butt. It should be noted that the impact surfaces 71 of the hammers have a butt configuration without any acute or oblong parties so that the impact energy of the hammers is fully utilized.

The vertically movable board 5 is intentionally designed as a grate or gitter. Some of the gitter parts are furthermore intentionally provided as longitudinally extending ribs 53 protruding in the vertical direction so that during the downward movement of the board these ribs will co-operate with a stationary grate and break any possible larger lumps of the disintegrated bath layer.

The cleaning of the spent anodes from the solidified bath by means of the above disclosed apparatus is executed in the following manner: Anode butts 2 are fastened through their aluminium rods 11 to a transport means, e.g. suspended rails which convey the anodes into the closed chamber 10. Clamping device 3 grasps the aluminium rod and pulls the anode passing a rotating tool, e.g. a milling cutter, which removes possible bath depositions from the cross-bar 12 on its dolly side.

Fig. 3 illustrates schematically the rotating device 18 comprising several parallel arranged and vertically adapted rotating discs to provide a profiled groove along the cross-bar 12 and the nipples 13 in the bath layer 21 so that the dolly 4 can be aligned close to the nipples under the disintegration step of the operation. At the impact tool 7 a restraining arm 6 grasps the cross-bar 12 on the hanger 1 and simultaneously the grate board 5 lifts the anode against the restraining arm which clamps the cross-bar against the dolly 4. In this manner a proper fixation of the anode butt, both vertically and horizontally, is achieved. Simultaneously, by such releasing of the transport carrier and the aluminium rod for the load, the conducted cleaning operation is very lenient with regard to these parts. The dolly is dimensioned with regard to the applied impact force of the impact tool (the hammers) and is shielded from vibration by means of inserted blocks 42. The two shown pneumatic hammers 7 are sequence controlled and each hammer has its individual steering with regard to the number of strokes against the solidified bath 21 between the cross-bar 12 and the anode 2. Because of the butt shape of the impact surfaces of the hammers the impact energy of the oscillating hammers is exploited maximally. Tests conducted with the hammers having an acute or an oblong shape failed to achieve an efficient cleaning of the anodes in spite of the high hammer weight and a countless number of conducted blows. The bath layer 21 is disintegrated and thrown outside of the anode and the grate board 5, being collected in the hopper shaped lower part of the chamber 10 and conveyed out of the chamber, e.g. by means of a conveyor 9.

After terminated disintegration operation, the restraining arm 6 is released from the cross-bar, the grate board 5 goes down and simultaneously larger bath lumps being retained on the stationary grate 55 are crushed under the movement of the board. The anode is released from the fastening means 3 and is conveyed further inwardly into the chamber or to a next chamber for a possible additional post-cleaning step by means of conventional means like sand blasting, rotating brushes etc. When the anode is removed from the hammer station the tilting board 8 is turned to a horizontal position. The grate board is elevated to a level corresponding to the surface of the tilting board and a pusher 15 transfers possible broken carbon pieces from the anode on the tilting board. The pusher, the grate board and the tilting board are retracted to their start positions, the carbon rests fall down on a conveyor or a hopper (not shown on the Figures) and the machine is automatically reset to receive the next anode. The apparatus hereby automatically ensures an efficient separation of bath residues from the carbon residues which currently represents a problem for the hitherto known cleaning installations and machines.

Claims

1. Method for cleaning of anode butts from an electrolysis process for an attached solidified bath material,
characterized in that
the anode butt is locked in a closed chamber by means of a vertically movable board (5) and an

aligning arm (6) which clamps the anode cross-bar (12) in the horizontal direction against a dolly (4), and where the anode is subsequently exposed to several reiterated impacts from one or more oscillating impact devices (7) aimed at the solidified bath material on the anode.

2. Method according to claim 1,
characterized in that
the oscillating impact device (7) are pendulous hammers with butt impact surfaces.

3. Apparatus for cleaning of anode butts from an electrolysis process for an attached solidified bath material comprising a closed noise- and dust-insulated chamber (10), clamping device (3) for transport and positioning of the anode in the chamber, restraining means and a device for disintegration of the bath material,
characterized in that
the restraining means comprise a vertically movable board (5), a horizontally aligning arm (6) and a dolly (4), and where the disintegration device is an oscillating impact device (7).

4. Apparatus according to claim 3,
characterized in that
the oscillating impact device (7) comprises one or more pendulous hammers having butt impact surfaces.

5. Apparatus according to claim 3 or 4,
characterized in that
the vertically movable board (5) is designed as a grate board provided with downwardly protruding ribs (53) which co-operate with a stationary grate (55) located below the board, and where a tilting board (8) and a pusher (15) are provided on the respective sides of the grate board.

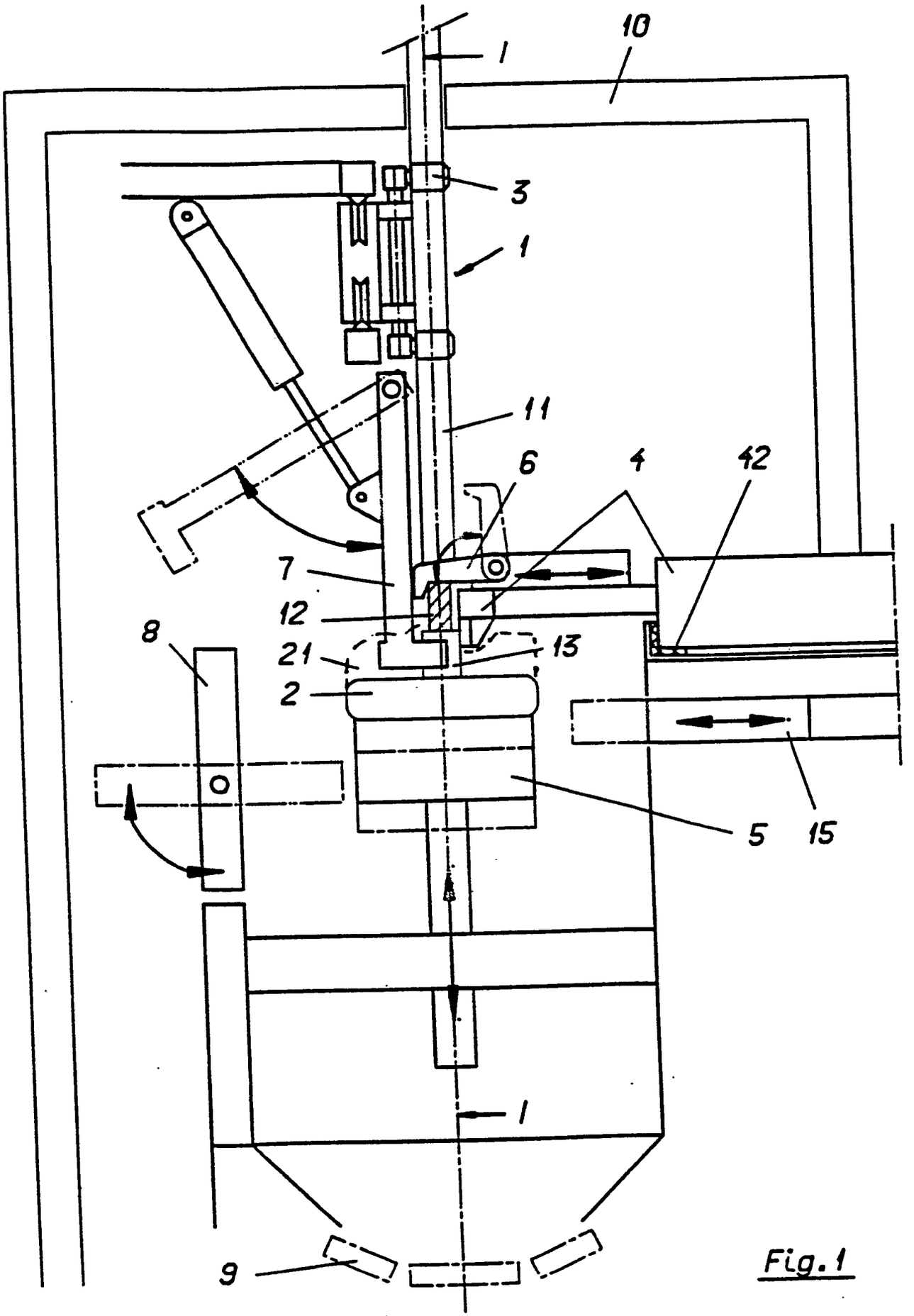
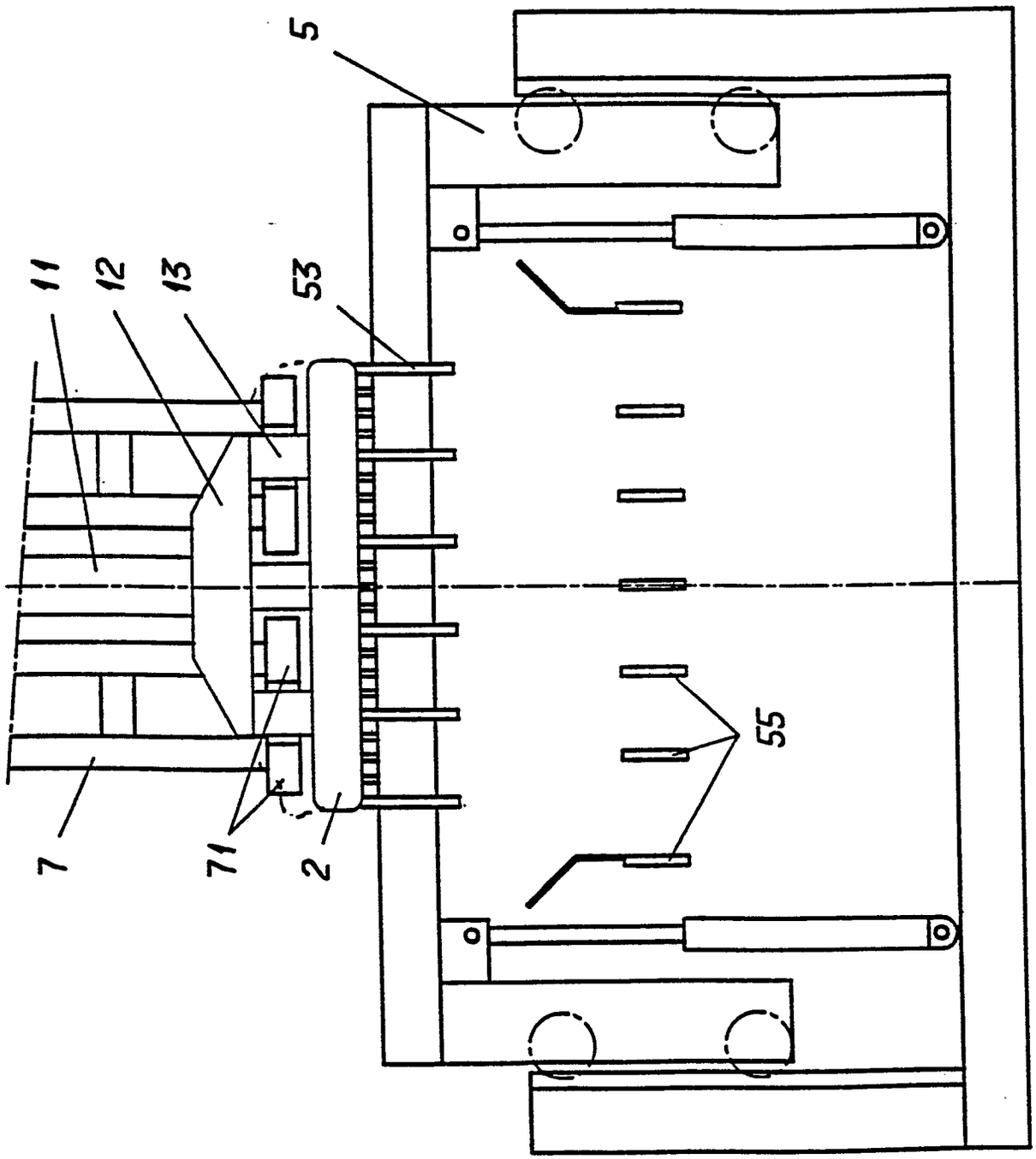


Fig. 1

Fig.2



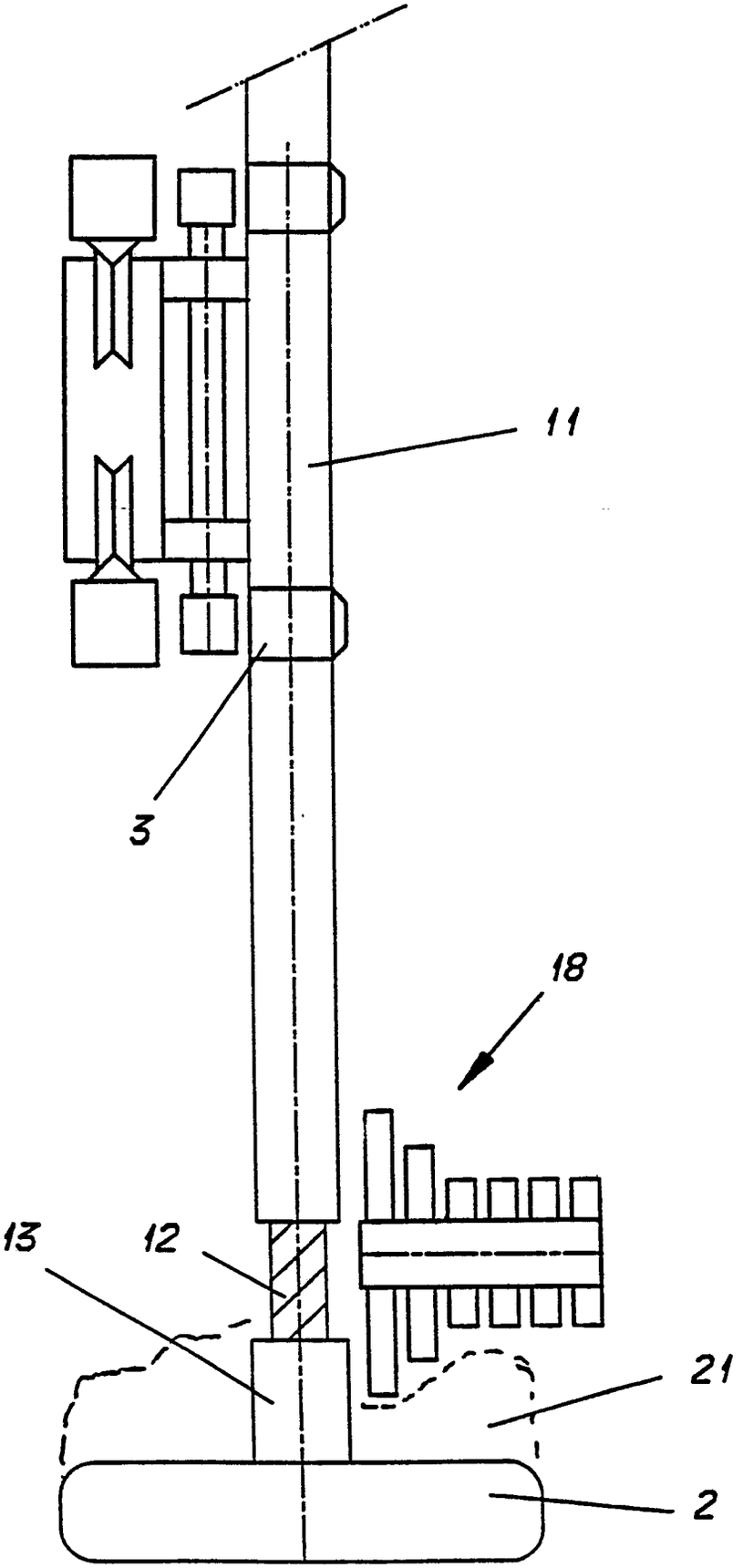


Fig.3

European Patent Office

EUROPEAN SEARCH REPORT

Application number

DOCUMENTS CONSIDERED TO BE RELEVANT

EP 89102083.6

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	US - A - 4 418 435 (ARNOLD) * Abstract; fig. 5,9 * --	1-4	C 25 C 3/12 C 25 C 7/02
A	EP - A2 - 0 076 441 (NORSK HYDRO) * Abstract; fig. 1 * --	1,3,5	
A	DE - A1 - 3 032 525 (HAMBURGER ALUMINIUM) * Claims 1,3 * --	1,3,5	
A	DE - A1 - 3 510 523 (ALMEQ NORWAY) * Abstract; fig. 3 * ----	1,3,5	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

C 25 C
B 08 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	27-04-1989	LUX

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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