United States Patent

Schneider

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[54] CRUSHING MACHINE FOR COARSE CRUSHING OF BRITTLE MATERIALS

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[52] **U.S. Cl.**.....**241/69,** 241/84, 241/200, 241/271

[51] **Int. Cl.**.....**B02c 1/14**

[58] **Field of Search**.....241/69, 84, 94, 95, 147, 149, 241/164, 165, 200, 263, 270–273, 283, 264–269, 274; 100/94–99, DIG. 1

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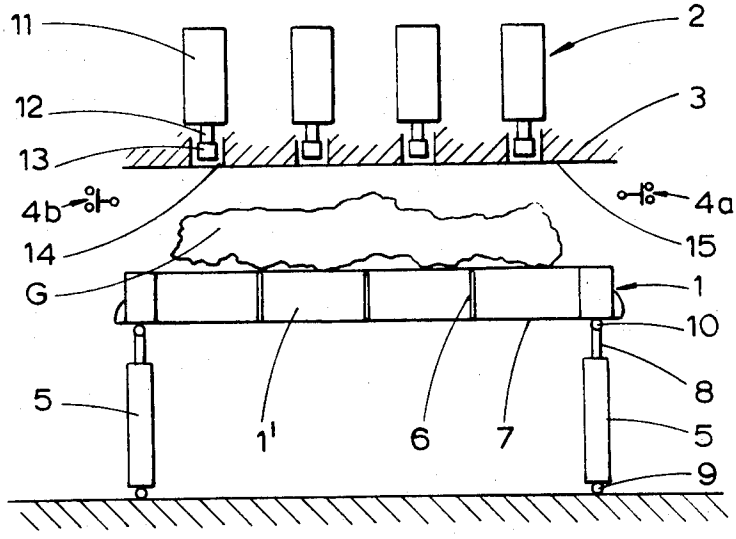
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[57] **ABSTRACT**

A crushing machine for the coarse crushing of brittle materials, such as anode butts in the aluminum electrolysis industry, by utilizing impact energy. The combination of a table or a grate with openings the size of which is dimensioned in accordance with the desired degree of crushing is used. Holding means cooperate with the grate and by relative movement of the holding means and the grate hold the goods to be crushed. One or more striking tools when the goods are held fast, preferably in an intermittent way, exert an impact effect on the goods. The grate and the holding means are pressed together continuously against the goods during the operation of the striking tool.

20 Claims, 6 Drawing Figures



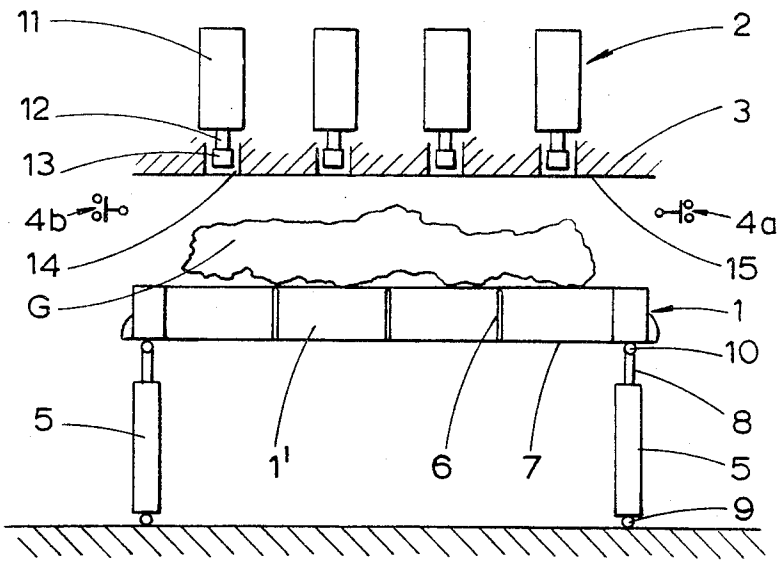


FIG. 1.

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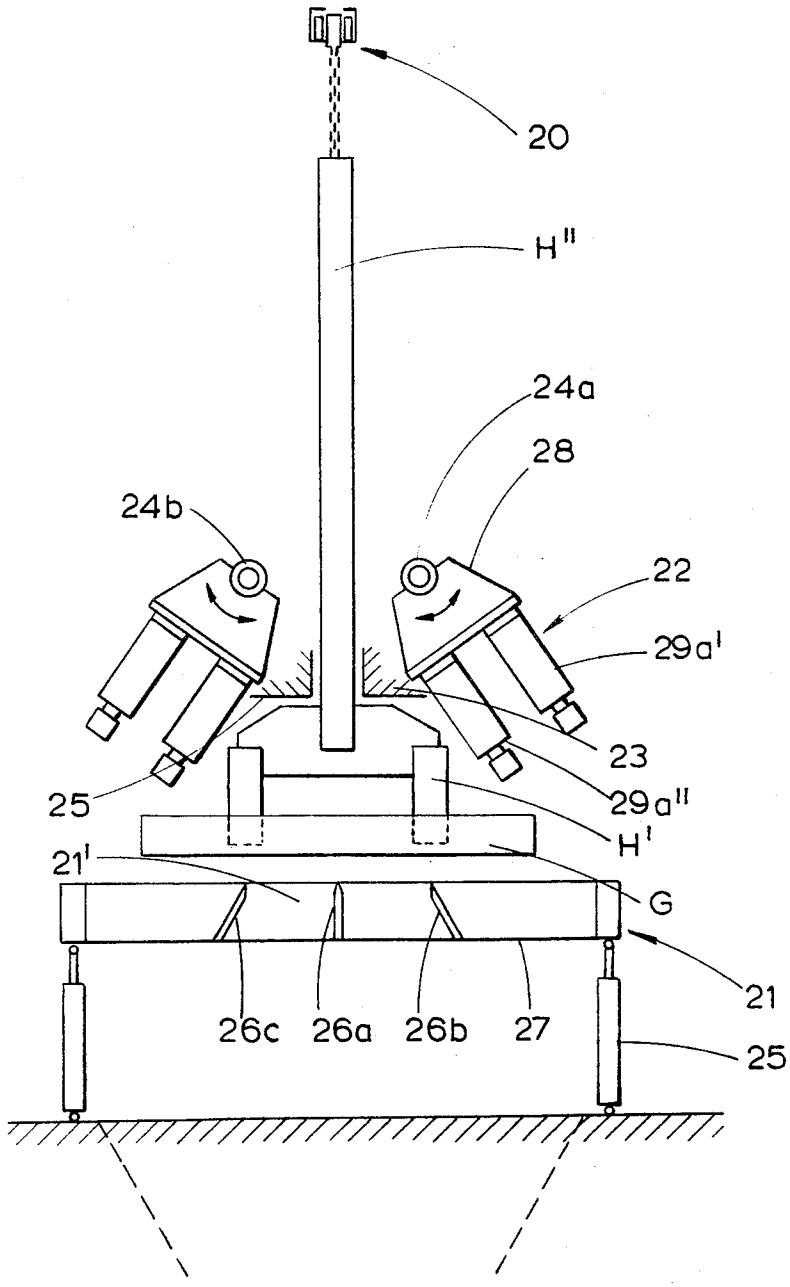


FIG. 2.

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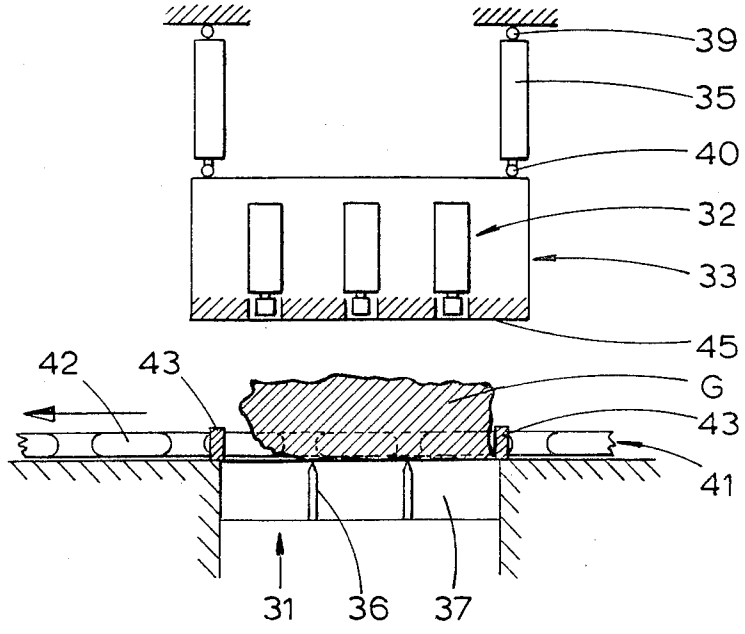


FIG. 3.

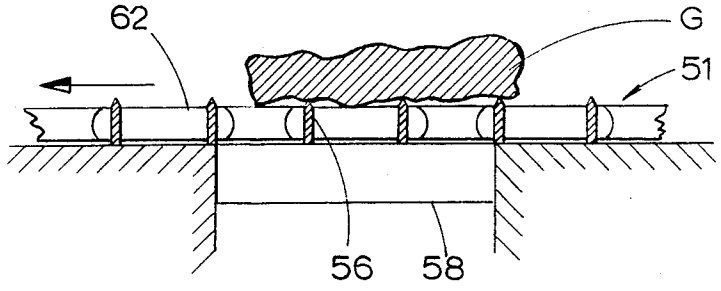


FIG. 5.

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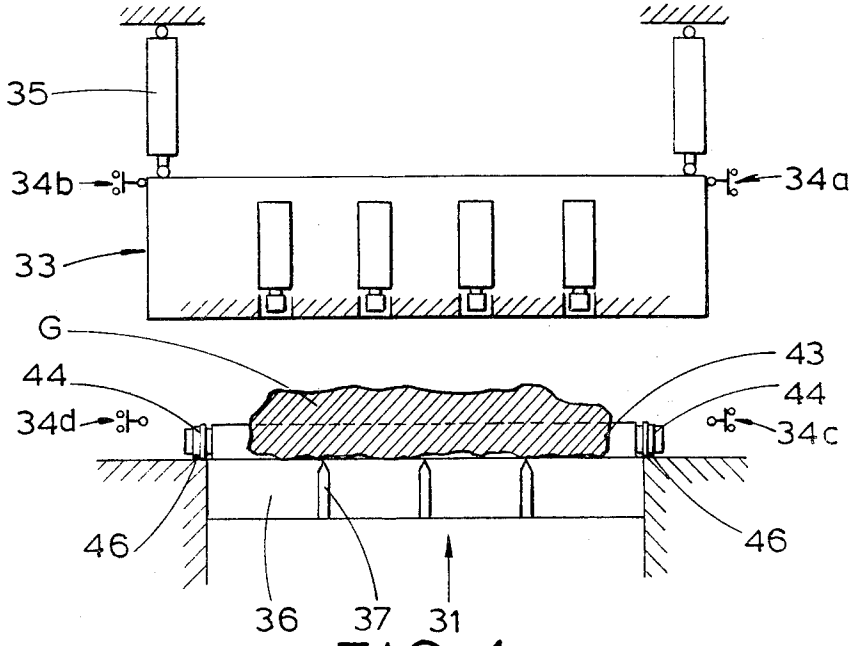


FIG. 4.

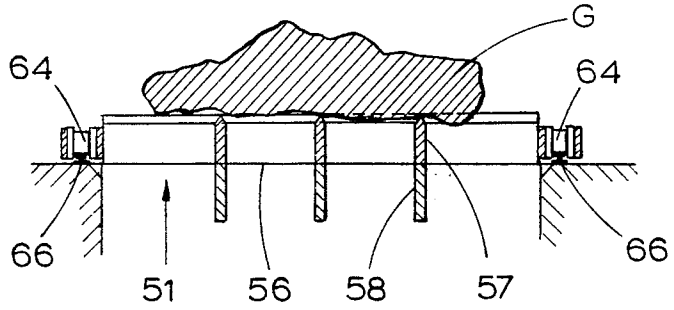


FIG. 6.

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CRUSHING MACHINE FOR COARSE CRUSHING OF BRITTLE MATERIALS

This invention relates to crushing machines for coarse crushing of brittle materials or goods, for instance anode butts in the aluminum electrolysis industry, by employing impact energy. For crushing brittle materials there is usually provided jaw crushers, hammer mills, crushing rolls or similar machines. If the goods which shall be crushed are present in large pieces, such machines are comparatively big, expensive in installation and maintenance as well as power consuming.

The invention is based on the conception that anodes or anode butts in the aluminum electrolysis industry and many other forms of crusher goods, such as slag from iron works, sinter works or metallurgical processes, are often comparatively little resistant to impact energy, whereas for pressing of such goods to pieces very large pressing forces are needed.

The crushing machine according to the present invention makes possible the coarse crushing of large pieces of brittle materials with little power consumption. This is mainly obtained by the combination of a table or a grate with openings the size of which is dimensioned in accordance with the desired degree of crushing, holding means adapted to cooperate with the grate and by relative movement of said holding means and said grate, to hold the goods to be crushed, one or more striking tools which are adapted to when the goods are held fast, preferably in an intermittent way to exert an impact effect on the goods, said grate and said holding means being adapted to be pressed together continuously against the goods during the operation of said striking tool. Crushing machines according to the principle stated here are further much cheaper than the conventional constructions both with respect to installation and maintenance. The initial price is estimated to be between one-fifth and one-tenth of the price of conventional crushing equipment and the power consumption about one-third of that which is common by known crushing machine constructions. Another advantage consists therein that the crushing machine according to the invention has smaller dimensions and thereby also smaller space requirements than equipment of known types.

This invention is primarily directed to utilization in the aluminum electrolysis industry and has particular advantages in this use. In the production of aluminum where for the purpose of supplying current to the electrolyzing furnaces, so-called anode hangers are used, which are attached to a pre-baked anode block by means of cast iron, stamping compound or in other ways, the anode hanger and the remaining part of the anode block must be removed from the electrolyzing furnace at a certain stage in order that steel members in the anode hanger shall not take part in the electrolysis process. It is of great economic importance that the anode butt as well as the anode hangers can be restored so as to be re-used in new anodes. It is then necessary to crush the anode butt simultaneously as the same must be removed from the hanger so that the same can be made ready for re-use in a new anode block. The operation of separating the anode butt from the anode hanger is often carried out manually by crushing the anode piece by piece with a sledge hammer. A more advanced method consists in carrying out this separation mechanically in a known way by pressing with great force one or two pivotable jaws with suitable prongs or ribs against the anode butt while the hanger is located therein. The anode can also as known per se, be pressed away from the hanger without previous crushing of the anode butt.

By employing a crushing machine based on the principles according to the present invention crushing of anode butt and separation thereof from the anode hangers can take place in a much more practical and effective way than with the known methods. Because of the brittleness of the anode butt to applied impact energy the forces being transferred to the anode hanger are small, so that the separation from the hanger and the pre-crushing of the anode can take place in one and the same operation. As this new method requires small static forces, the crushing machine according to the invention can be designed as a comparatively light structure.

The crushing machine according to the invention shall be explained more in detail with reference to the drawings which schematically and simplified show various embodiments of the invention.

FIG. 1 shows in general the fundamental structure of a crushing machine according to the invention.

FIG. 2 shows a crushing machine according to the invention intended for the crushing of anodes in the aluminum electrolysis industry.

FIG. 3 shows in longitudinal section an embodiment with a scraper conveyor for the goods to be crushed.

FIG. 4 shows the embodiment in FIG. 3 in a schematic cross-section.

FIG. 5 shows in longitudinal section an embodiment based on the use of a chain conveyor, and

FIG. 6 shows the embodiment of FIG. 5 in schematic cross-section.

The crushing machine according to the invention as shown schematically in elevation on FIG. 1, comprises a table or a grate 1 formed of longitudinal plate-like grate elements 7 and transverse plate-like grate elements 6. These grate elements are arranged in a mutually intersecting pattern and form preferably square through openings 1' the dimensions of which are chosen according to the desired degree of crushing. The grate 1 is supported by a number of lifting cylinders 5 which can elevate or lower the grate 1 as will be explained below. Above the grate 1 there is mounted a holding member 3 which is here considered to be stationary. The holding member has a substantially horizontal downwardly facing operative surface 15 which can be formed of various types of structural elements, for instance strong rods. The goods G which shall be crushed, are brought onto the grate 1 and by elevating the same by means of the lifting cylinders 5 the goods are clamped between the grate and the surface 15.

Outside or through openings 14 in the holding member 3 there are provided a number of striking tools 2, for instance of pneumatic type, with a cylinder 11, piston rod 12 and striking element 13 at the lower end of the piston rod. The striking tool 2 can be attached to the holding member 3.

By means of the hydraulic or pneumatic lifting cylinders 5 the grate 1 with the goods G can be raised so that the goods will engage the surface 15. The lifting cylinders 5 are connected to the floor and each is connected to the grate 1 through its piston rod 8 by means of universal joints 9 and 10, respectively, so that the grate 1 depending upon the shape of the goods G, can adjust itself somewhat inclined with respect to the horizontal plane in order that the best possible clamping of the goods against the surface 15 of the holding member is secured. The lifting cylinders 5 are further adapted to press continuously upwardly so as to re-adjust the grate 1 towards the holding member as the goods are broken to pieces by means of the striking tools 2.

The striking tools 2 can with advantage be located in such a way that they operate vertically right down towards the upper edge of the intersecting grate elements 6 and 7, and possibly towards the intersecting points between these elements. Further, it is usually considered an advantage to shape the upper edge of the grate elements 6 and 7 with a somewhat pointed or sharp edge portion which contributes to an easier breaking up of the goods into smaller pieces. When it comes to the way in which the striking tools function, this can be varied in many ways. It is preferred to let these striking tools work intermittently, i.e. with operating intervals of a certain duration and pauses in between. The striking tools or striking hammers can either operate with intense single strokes or with stroke sequences with quickly repeating hammering. All tools can operate simultaneously or only one tool can be in operation at a time so that all tools operate in sequence during a striking cycle. By concentrating in the latter way the available power on one striking tool at a time, the striking force can be increased in each point of the goods to be treated at a given available driving power for the striking tools. As the charged goods are crushed and fall through the grate the same is further elevated towards the holding member and when the

goods are essentially crushed to the desired degree, end switches 4*a* and 4*b* which are actuated by the grate 1 will provide for termination of the crushing process and the grate returns to its original position so as to receive a new charge of goods or material to be crushed.

If the grate does not reach its upper position after a predetermined number of striking cycles the grate can be adapted to be temporarily lowered so that the goods are freed from the holding member and can assume new positions on the grate, or possibly fall through the openings therein, whereafter the grate is again lifted so as to clamp the goods and for performing new striking cycles. It will also in many instances be practical to vibrate the grate in the pauses between operating intervals or striking cycles so as to further amplify the effect concerned.

FIG. 2 shows the presently preferred embodiment of the crushing machine according to the invention for use in crushing anode butts in the aluminum electrolysis industry. The goods G to be crushed are here in the form of an anode butt in which there is attached a so-called anode hanger consisting of a hanger yoke H′ and the hanger proper H″. The machine is here designed for fully automatic and unmanned operation and the anode butts with anode hangers are conveyed to the crushing machine by means of a travelling crane 20 in which the anode hanger H″ is suspended. The construction of the grate 21 with lifting cylinders 25 is here substantially as shown in FIG. 1, but the grate elements 26*b* and 26*c* are here shown inclined so that the corresponding openings 21′ in the grate will have a cross-section which increases in a downward direction from the upper surface of the grate 21. Such a design makes it easier for the crushed pieces of the goods to fall freely through the grate.

The support or holding member 23 with its downwardly facing surface 25 is here adapted to engage the hanger yoke H′ when the anode butt or goods G are pressed upwardly by the grate 21.

The striking tools 22 are here mounted in a number of two or more on a common bracket 28 which is pivotable about an axle 24*a* and 24*b*, respectively. This arrangement is necessary to enable the automatic transfer of the anode butt G with the hanger structure H′, H″ by means of the travelling crane 20. When an anode butt has been brought into position and the striking tools 22 swung down into a vertical position, the anode butt is clamped by means of the grate 21 and the goods can be treated as explained above. The striking tools of which two have been designated 29*a*′ and 29*a*″, respectively on the bracket 28, start to strike a pre-determined number of strokes against the anode butt. As the same is crushed and broken pieces are pressed through the grate openings, the grate is moved upwardly towards the end switches (not shown). On actuation of these end switches it is indicated that the anode has been sufficiently crushed, so that the cycle can be terminated thereby that the grate is lowered and the striking tools are swung out sideways again so as to permit the removal of the hanger structure which has now been freed from the remaining anode block, and can be transported away and a new hanger with an anode butt supplied from the opposite side.

In FIGS. 3 and 4 there is shown another form of automatic charging of the goods G to be crushed. Here there is provided a stationary grate 31 with grate elements 36 and 37. Above the stationary grate there is provided a scraper conveyor 41 adapted to move along the grate and on supporting surfaces being flush therewith on both sides. The scraper conveyor can be constituted by links 42 with transverse elements 43 being adapted to entrain the goods. The spacing between subsequent transverse element 43 must be equal to or greater than the length of the grate 31. Thus, it is a prerequisite that a section of the scraper conveyor 41 between subsequent transverse element 43 does not include elements which prevent the above explained function of the crushing machine according to the invention.

In contrast to the above explained embodiments the embodiment of FIGS. 3 and 4 has as mentioned a stationary grate 31 and accordingly the holding member 33 must be movable with respect to the grate. Therefore the holding member is supported by lifting cylinders 35 with universal joints 39 and 40 so as to make possible a certain inclination of the holding member 33 depending upon the shape of the goods G. The striking tools are here designated with reference numeral 32 and the operative surface of the holding member has the number 45.

The conveyor can be provided with rolls 44 on each side, being adapted to run on rails 46 or the like at the marginal portion of the surrounding foundation.

Further in FIG. 4 there are shown end switches 34*a* and 34*b* for the upper position of the holding member and end switches 34*c* and 34*b* for the lower position of the holding member.

FIGS. 5 and 6 illustrate a further embodiment of the crushing machine according to the invention in which the grate itself is formed by a chain conveyor. The holding member and the support thereof can be exactly as shown in FIGS. 3 and 4.

The conveyor 51 in FIGS. 5 and 6 can consist of transverse grate elements 56 and longitudinal grate elements 57 being constructed as conveyor links 62. In the longitudinal direction of the conveyor there can, beneath each longitudinal grate element 57, be provided supports 58 which span the open area in which the crushing takes place. In similarity to the embodiment of FIGS. 3 and 4, the embodiment of FIGS. 5 and 6 can be provided with rolls 64 adapted to run on rails 66 or the like along the marginal portion of the supporting surfaces.

It will be obvious that the operation of the conveyors in FIGS. 3–6 must be stepwise, since the conveyor must be at rest as long as the treatment of a piece of goods takes place. The drive of the conveyors thus must be controlled in accordance with the control of the movement upwardly and downwardly of the holding member and with the function of the striking tools.

Of the many possible modifications and variants which can be thought of in connection with the above discussed embodiments, the following shall be mentioned: The elements which form the surface of the grate, must not necessarily lie in the same plane. In certain cases it can be an advantage that some points or edges project higher up than others so that a more uneven support is the result. Correspondingly, the operative surfaces at the underside of the holding member can deviate from a plane shape, and can possibly consist of a number of separate supports which are individually brought into engagement with a portion of the goods. The supporting function can here for instance be exerted more or less pointwise instead of being distributed over larger areas. As mentioned, the striking tools can operate either simultaneously or in sequence according to a predetermined cycle when two or more striking tools are used. It will be understood, however, that the employment of only one single striking tool can also be an advantage in certain cases, alternatively with the possibility of moving the striking tool to different positions so as to work the goods in several places sequentially.

I claim:

1. Crushing machine for the coarse crushing of brittle materials, such as anode butts in the aluminum electrolysis industry, by utilizing impact energy comprising the combination of a grate having openings dimensioned in accordance with the desired degree of crushing, holding means cooperating with said grate, means for relatively moving said holding means and said grate to hold the goods to be crushed, at least one striking tool when said goods are held fast exerting an impact effect on said goods and means for pressing said grate and said holding means together continuously against said goods during the operation of said striking tool.

2. Crushing machine according to claim 1 wherein said grate is substantially horizontal and said holding means is located above said grate.

3. Crushing machine for the coarse crushing of brittle materials, such as anode butts in the aluminum electrolysis in-

dustry, by utilizing impact energy, comprising the combination of a grate having openings dimensioned in accordance with the desired degree of crushing, holding means cooperating with said grate, means for relatively moving said holding means and said grate to hold the goods to be crushed, at least one striking tool when said goods are held fast exerting an impact effect on said goods, and means for pressing said grate and said holding means together continuously against said goods during the operation of said striking tool, said grate being generally horizontal and said holding means being located above said grate, and said striking tool being adapted to work the goods from that side on which said holding means engages the same and on portions of the goods accessible past said holding means.

4. Crushing machine according to claim 3 wherein a plurality of striking tools are provided and means operate one of said striking tools at a time in sequence according to a determined cycle.

5. Crushing machine according to claim 3 wherein a plurality of striking tools are provided and means operate all said striking tools substantially simultaneously.

6. Crushing machine according to claim 2 wherein said holding means is stationary and said grate is movable relative thereto.

7. Crushing machine according to claim 2 wherein said striking tool works the goods from that side on which said holding means engages the same end on portions of the goods accessible past said holding means, said holding means being stationary and the grate being movable with respect thereto.

8. Crushing machine according to claim 7 wherein means are provided for said grate to assume inclined positions with respect to said holding means depending upon the shape of the goods.

9. Crushing machine according to claim 7, wherein there is provided an end switch for said grate whereby the movements thereof towards said holding means and the striking action is stopped when a predetermined minimum spacing between said grate and said holding means is attained.

10. Crushing machine according to claim 3 wherein there is provided a scraper conveyor to move said goods onto said grate and said holding means is movable vertically.

11. Crushing machine according to claim 3, wherein said grate is a chain conveyor and said holding means is movable vertically.

12. Crushing machine according to claim 10 wherein said holding means assumes inclined positions with respect to said grate.

13. Crushing machine according to claim 11 wherein said holding means assumes inclined positions with respect to said grate.

14. Crushing machine according to claim 10 wherein an end switch is provided for said holding means so that the movement thereof towards said grate and the striking action is stopped when a predetermined minimum distance between said holding means and said grate is attained.

15. Crushing machine according to claim 11 wherein an end switch is provided for said holding means so that the movement thereof towards said grate and the striking action is stopped when a predetermined minimum distance between said holding means and said grate is attained.

16. Crushing machine according to claim 1 wherein a plurality of striking tools are provided and means operate one of said striking tools at a time in sequence according to a determined cycle.

17. Crushing machine according to claim 1 wherein a plurality of striking tools are provided and means operate all said striking tools substantially simultaneously.

18. Crushing machine according to claim 1 wherein said holding means is stationary and said grate is movable relative thereto.

19. Crushing machine according to claim 1 wherein said grate is vibrated in the pauses between the operating intervals of said striking tool.

20. Crushing machine according to claim 1 wherein said grate and said holding means are removed from each other in pauses between the operating intervals of said striking tool.

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