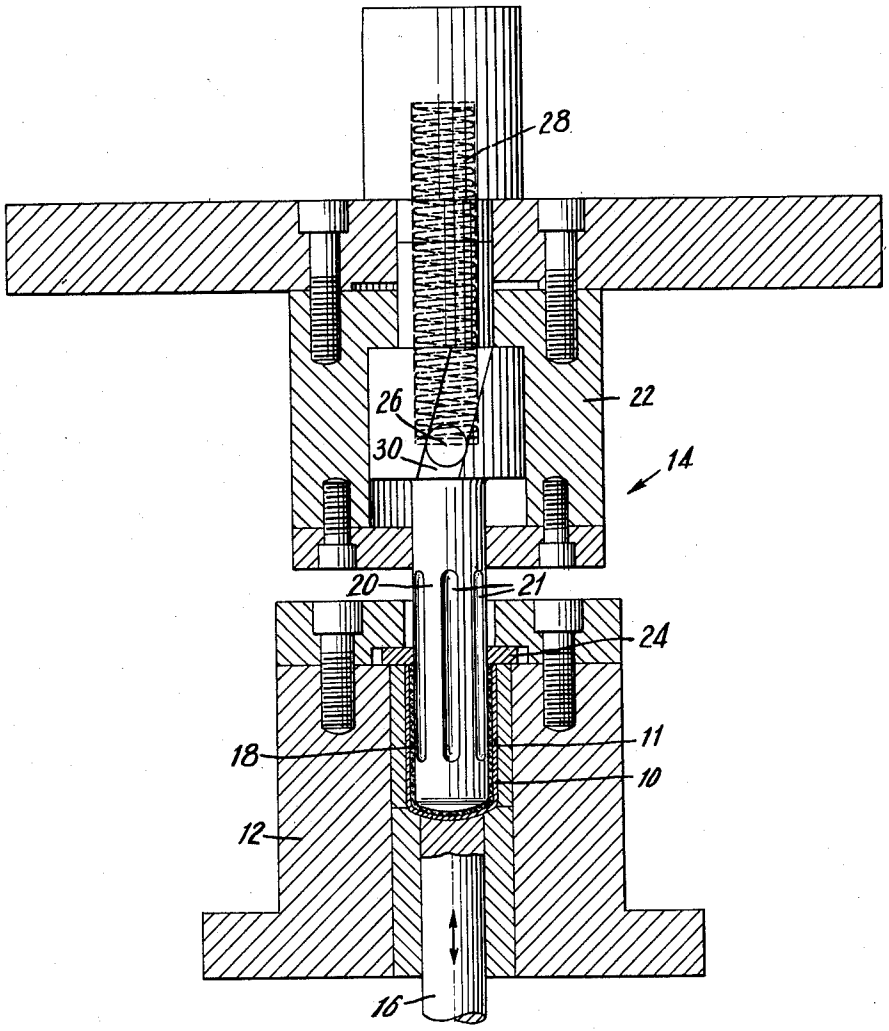
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IMPACT MOLDING OF GALVANIC CELL CATHODES

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IMPACT MOLDING OF GALVANIC CELL CATHODES

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This invention relates to an improved process for molding cathodes for use in electrochemical cells and to apparatus suitable for performing such a process.

In certain type cylindrical galvanic cells such as alkaline-manganese dioxide-zinc cells and Leclanché cells of the type which are referred to as "inside out" cells (U.S. Patent 2,605,299, J. P. Teas, July 29, 1952), a cylinder of mix is provided in juxtaposition with the inside of the cell container. This cylinder serves as the cathode or current collector in the cell reaction and must be compressed tightly to minimize internal resistance.

These type cathodes are currently being produced by one of two methods. The cathodes in alkaline cells are conventionally provided by compression molding of a preform of cathodic mix comprising manganese dioxide and graphite in the cell container, followed by a despruing or removal of the compressed mix in the center of the preform. This method is not completely satisfactory due to the rapid wear which is encountered on the high pressure hydraulic equipment that it used to apply the pressure. In addition, the tools which are employed to perform the de-spruing operation are expensive and wear rapidly on the somewhat abrasive cathodic mix.

The cathode or current collector in the Leclanché cell of the type described is composed of a cylinder of graphite and wax which is in juxtaposition with the inside of a paper spiral wound tube which forms the cell jacket. The common method now in use to form such cathodes consists of injection molding them in large presses which are provided with necessary heating and cooling cycles. It will be appreciated that the time cycle of such equipment is controlled by the fact that the formed cathode must be allowed to cool to a temperature at which it will not distort or sag when it is removed from the press.

The principal object of the invention is to provide a process for forming cylindrical cathodes which avoid the above disadvantages of the prior art.

Another object of the subject invention is to provide a process for forming cylindrical cathodes quickly and efficiently and which may be carried out in simplified equipment.

Broadly stated, the objects of the invention are accomplished by impact molding of a cylindrical cathode mix in place within a cylindrical galvanic cell container utilizing a fluted molding punch as the molding force.

The invention will be more readily understood by reference to the accompanying drawing wherein the single figure is a front elevation partially in section, of a punch press suitable for carrying out the process of the invention, and which shows a fluted punch within a cylindrical cell container in the process of forming a cathode.

More specifically, the process of the invention comprises driving a punch into a cell container into which more cathodic mix than is required to form the cathode of the particular cell, has been deposited. The excess cathodic mix is forced out of the cell container by means of a plurality of flutes on the side of the punch. In the preferred embodiment at least three flutes should be provided, and best results have been obtained with six flutes. After the expulsion of the excess cathodic mix, and prior to withdrawal of the punch, the punch is preferably slightly rotated to break the adhesive force between the formed cathode and the punch. This rotation of the punch also smoothes over the inner surface of the molded cathode.

Referring now to the drawing, a cell container **10** is shown in position in a cavity **11** in a base **12** of a punch press **14**. The cell container **10** resides on an ejector member **16** which is used to remove the container **10** from the cavity **11** after the cathode **18** is formed. In the process of the invention, a punch **20** which is provided with a plurality of flutes **21** and which is part of the upper portion **22** of the punch press **14** is driven into a partially precompressed cathodic mix or into a plurality of pellets made from the cathodic mix the punch **20** having a diameter smaller than the inside diameter of the cell container **10**. In order to insure against poor cathode molding due to entrapment of air in the cathode, the density of the mix or pellets should be at least 2.2 grams per cubic centimeters. This action forms the cathode **18** into the desired shape which is controlled by the space defined by the fluted punch **20** and the walls of the punch cavity **11**. As can be seen from the drawing, the excess cathodic mix will be ejected from the cavity **11** by means of the flutes **21** which extend above the cavity **11**. A stripper ring **24** retains the cathode **18** in place while the punch **20** is being withdrawn. In the preferred embodiment a force rotating eccentric cam **26** is provided which will rotate the punch from about 5° to 30°, 15° being preferred, to break the adhesive force between the punch **20** and the cathode **18**, before the punch **20** is withdrawn. The rotation takes place when the upper portion **22** of the punch press **14** starts the upstroke and while the punch **20** is held in the down position by a spring **28** until the slack is taken up in a linkage **30**. This rotation of the punch **20** also irons over the rough places on the inner wall of the cathode **18** along where the excess cathodic mix was ejected by means of the flutes **21**.

As an example of the invention, "G" size alkaline-manganese dioxide-zinc cells were made with cathodes formed by the impact molding process disclosed. A "G" size cell is defined in circular C 466 of the National Bureau of Standards of the United States Department of Commerce. The cells so produced gave 48 cycles to .9 volt on the 1.125 ohm 4 hour discharge, 500 milliamp, 10 hour charge cycle. Cells of the identical size with cathodes produced by the conventional molding technique described, gave only 43 cycles when subjected to the same test.

Leclanché cathodes formed by impact molding also compared favorably with the conventionally prepared Leclanché cathodes when compared on a resistance basis. The cathodes were immersed in mercury and the resistance was read through the cap on bridge. The resistance values of the cathodes of the invention varied from .060 to .110 ohm per linear inch while the range for the injection molded prior art cathodes was from .095 to .126 ohm per linear inch. The lower resistance for the cathodes of the invention is indicative of the high density which is achieved by the process of the invention.

The process and apparatus of the invention has proved successful in the control of the amount of material in the cathode formed by the molding operation. In a trial of 49, ½ "D" size alkaline cells, the amount of cathodic mix added to the cell container was varied between 26 and 34 grams. The weight of the molded cathode after being formed by the fluted punch varied only from 24.33 to 26.04 grams, thus demonstrating that a desired final cathode weight can be obtained even though a substantial variation in the initial amount of cathodic mix is encountered.

I claim:

1. A process for impact molding a cylindrical cathode in place in a galvanic cell container which comprises the steps of dispensing an excess of cathodic mix into the

bottom of said cell container; driving a cylindrical punch, smaller in diameter than the inside diameter of said cell container and provided with a plurality of flutes for expelling said excess of said cathodic mix from said container, into said cathodic mix, removing said excess of said cathodic mix through said flutes while the remainder of said cathodic mix is molded into a cathode between said punch and the inner walls of said cell container, rotating said punch a slight amount prior to withdrawal from said container whereby said excess of said cathodic mix in said flutes is sheared and severed off from said formed cathode; and then removing said punch from said cell container thus forming a finished cathode-container structure.

2. The process of claim 1 wherein said punch is rotated between approximately 5° and 30°.

3. An apparatus suitable for impact molding a cylindrical cathode in place in a cylindrical container containing an excess of cathodic mix therein, which comprises, a punch press, said punch press comprising a movable upper portion having a cylindrical punch provided with a plurality of flutes for expelling said excess of said cathodic mix from said cylindrical container, a stationary lower portion provided with a cavity for receiving said cylindrical container containing said excess of cathodic mix which is in line with said fluted punch, a cam having an oblique slot for controlling the rotation of said fluted punch, resilient means urging said fluted punch downwardly, means for moving said fluted punch in and out of said cavity, said flutes of said punch extending above said cavity when said punch is within said cavity, and a cam pin rigidly attached to said movable upper portion of said press which rides in said oblique slot of said cam, whereby said punch rotates from about 5° to about 30° prior to the initial withdrawal of said punch from said cavity and whereby said excess of said cathodic mix in said flutes is sheared and severed off from said formed cathode-container structure.

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