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CATHODE METAL AND PROCESS OF PRODUCING THE SAME

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Fig. 1

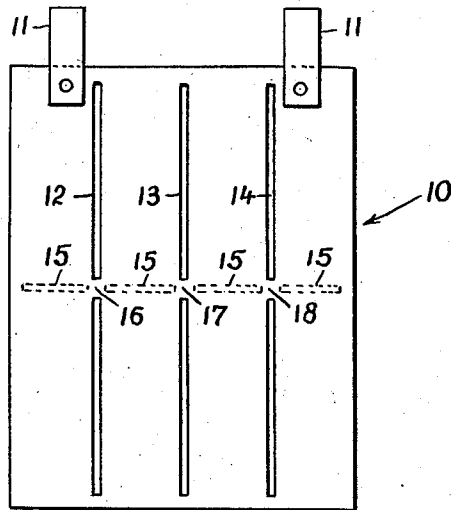


Fig. 2,

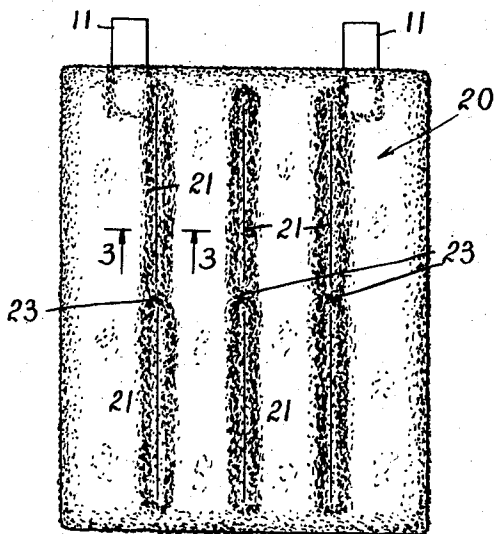
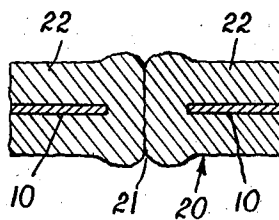


Fig. 3.



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CATHODE METAL AND PROCESS OF
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4 Claims. (Cl. 204—23)

This invention relates to cathodes and cathode starting sheets, and has for its principal objects the provision of an improved cathode which may be broken readily into a plurality of pieces of predetermined size, and of an improved cathode starting sheet for use in the preparation of the cathode of the invention. The invention further contemplates the provision of a method for producing cathodes which may be broken readily into a plurality of pieces of predetermined size.

A considerable quantity of metals recovered or refined by electrolytic means are sold to the trade directly in the form of cathodes as produced in the electrolytic refining or recovering process. The size of such cathodes is determined by the dimensions of the cell and the operating conditions employed at the recovery plant or refinery where they are produced. Size of the cathode, therefore, is not subject to variation, except at considerable trouble and expense. Quite often, however, the cathode produced is too large to be used conveniently by the customer. For example, many concerns manufacturing alloys and purchasing their metal stocks in the form of cathodes do not have the facilities to melt the large cathodes normally produced. To meet the requirements of such concerns, it has heretofore been customary to shear the cathodes at the recovery plant or refinery to the size required by the customer. This shearing operation is a source of considerable expense because of the extra handling of the cathodes which it entails, and it is further objectionable for the reason that transportation, handling and storage of the smaller sheared cathode pieces is more troublesome than in the case of full-size cathodes.

Another procedure which has been followed in the past to produce relatively small cathode pieces is to hang two or more half-size or smaller cathode starting sheets side-by-side, but spaced slightly apart, in the electrolytic cell. The cathodes thus produced are smaller than full-size cathodes in substantially the same proportion that the starting sheets are smaller than a full-size starting sheet. This procedure, however, has generally been considered even more disadvantageous than shearing cathodes, because of the greater difficulty of hanging the smaller cathode starting sheets in the electrolytic cell, and because of the lesser current efficiency which results from following this procedure.

The present invention provides an improved cathode starting sheet which may be hung in an electrolytic cell with substantially no more difficulty than a regular full-size starting sheet, and by the use of which it is possible to produce a full-

size cathode which may be broken quite readily into a plurality of pieces of predetermined relatively small size. The starting sheet of the invention comprises a thin sheet of the metal that is to be deposited thereon. The sheet is formed with at least one slot located so as to define a line along which the cathode is to be breakable.

The cathode of the invention, which may be produced on a starting sheet of the character described, may be broken relatively easily along a line (or lines) of weakness which corresponds in location to the slot (or slots) in the starting sheet. In the finished cathode the line of weakness is defined by particles of electrodeposited metal which approach one another from opposite sides of the line but which are substantially free of any integral bond binding them together across the line of weakness. In consequence the cathode may be broken relatively easily along the line of weakness into a plurality of pieces of a size determined by the location of the line (or lines) of weakness.

In preparing such cathodes in accordance with the method of the invention, a starting sheet is formed with at least one slot defining a line along which the cathode is to be breakable. The thus prepared starting sheet is immersed in the electrolyte and connected as cathode in an electrolytic cell for the deposition of the metal to be deposited. The cell is then set in operation so as to deposit metal on the starting sheet in such manner as to produce ultimately a relatively heavy metal deposit having a line of weakness corresponding in location to the slot formed in the starting sheet.

The invention may be employed with success in the preparation of breakable cathodes of any metal which is recovered or refined electrolytically by deposition on to a starting sheet of that metal. For example, the method of the invention may be used with advantage in electrolytic processes for the refining or recovery of such metals as nickel, lead, tin, etc. As a specific example, however, the invention is described below in connection with the production of copper cathodes, using a cathode starting sheet of substantially pure copper. In the following description reference is made to the accompanying drawing, in which

Fig. 1 is a plan of a starting sheet made in accordance with the invention;

Fig. 2 is a plan of a cathode according to the invention; and

Fig. 3 is a cross section taken substantially along the line 3—3 of Fig. 2.

The starting sheet of the invention (Fig. 1) is composed of a thin sheet 10 of the metal to be deposited thereon—copper in the case of the present example. The overall dimensions of the sheet 10 are substantially the same as would be those of a conventional starting sheet employed in producing ordinary cathodes in the particular electrolytic cell in which it is intended to be used. Copper (or other metal) loops 11 are secured to the top edge portions of the starting sheet 10 for the purpose of hanging the starting sheet on a copper or other metal rod to support the starting sheet in the cell and to make electrical connection thereto.

The starting sheet 10 is formed with a plurality of slots 12, 13, and 14. These slots are located so as to define the lines along which the cathode is to be breakable. In Fig. 1 three slots 12, 13, and 14 are shown in such locations that a cathode deposited thereon may be broken longitudinally into four segments each approximately one-quarter the width of the full-size cathode. If desired, additional slots, such as the slots 15 shown in dotted lines, extending horizontally of the starting sheet 10 may be provided. It is understood, of course, that any desired number, arrangement, and location of the slots may be employed, depending upon the number, size, and shape of the pieces into which the cathode is to be breakable.

The width of the slots 12, 13, and 14 need not be great, but to some extent their width is governed by the thickness of the cathode to be formed on the starting sheet. Generally, wider slots are desirable in the production of thick cathodes than would be necessary in the production of relatively thin cathodes. In the case of a copper cathode starting sheet to be employed in the production of a cathode about $\frac{1}{2}$ an inch thick, the starting sheet is only about $\frac{1}{4}$ of an inch thick, and the slots advantageously are made about $\frac{1}{2}$ an inch wide.

As shown in the drawing, each of the slots 12, 13, and 14 terminates short of the top and bottom edges of the starting sheet, and each is interrupted at a point about midway between the edges of the sheet by webs of metal 16, 17, and 18, respectively. In consequence of the metal webs 16, 17, and 18 and the unslotted top and bottom edges of the starting sheet 10, the several segments of the sheet defined by the slots 12, 13, and 14 are sufficiently united to enable the sheet to be handled and inserted into an electrolytic cell substantially without difficulty.

The starting sheet described above may be prepared in any of a number of ways. For example, copper starting sheets made in the usual manner by electrodeposition on a starting sheet blank and then stripped therefrom may be provided with slots by stamping or otherwise cutting the slots in the blank. The same procedure may, of course, be employed in the preparation of starting sheets of other metals than copper.

In some cases the starting sheet blank (on which the starting sheet is electrolytically deposited) may itself be provided with slots corresponding with the slots which it is desired to have in the starting sheet itself. Copper (or other metal) may then be deposited upon the starting sheet blank in the usual manner. No copper, of course, will deposit where the slots occur in the starting sheet blank, and when the starting sheet is stripped from the blank, it will be provided with slots corresponding to the slots in the blank. Some difficulty may be encountered in preparing slotted starting sheets by this method, for the

copper deposited on the blank during formation of the starting sheet will extend around the edges of the slots in the blank and tend to bind the starting sheet to the blank. In consequence it may be difficult to strip the starting sheets from the blank without tearing them. To a considerable extent this difficulty may be overcome if the starting sheet blank is provided with appropriately located slots, and these slots are then filled with an insulating material, such as an insert of rubber, asphaltic material or other suitable insulating material. With a properly prepared blank of this sort, the copper or other metal deposited thereon to form the starting sheet will be unable to deposit around the edges of the slots, and stripping will, therefore, be facilitated.

A copper (or other metal) starting sheet of the character described, prepared in any appropriate manner, is immersed in the electrolyte of an electrolytic cell for the electrodeposition of copper (or other metal). The starting sheet is connected as a cathode in the cell, and deposition of copper thereon is commenced. The deposited copper gradually builds up, increasing the thickness of the cathode. Some copper of course deposits at and around the edges of the slots formed in the starting sheet. In consequence, the slots are gradually closed by deposited copper as the electrolytic operation proceeds. Ultimately the slots will become quite completely closed, if deposition is continued for a sufficient length of time. It is advisable to discontinue further deposition of copper when this stage has been reached, for otherwise enough copper may be deposited along the line of the slot to increase considerably the difficulty with which the cathode may be broken. Generally speaking, the deposition of copper should be continued only for about so long as is required to build up a copper cathode deposit which substantially completely closes the slots, but is not so thick that the copper (or other metal) has completely bridged and formed an integral bond across the slots. Conversely, the starting sheets should be prepared with slots of such width that a copper cathode of the thickness desired will have been formed about the time the slots are completely closed, but before an integral bond of copper has bridged the slots.

A cathode 20 thus prepared (Fig. 2) is provided with lines of weakness 21 which are visibly defined by electrodeposited copper crystals extending from the main body of the cathode on each side of the line toward the body of the cathode across the line. There is, however, substantially no integral bond binding these crystals together across the line. This structure is illustrated diagrammatically in Fig. 3, showing a cross section through a cathode taken across a line of weakness 21. The main body of copper 22, deposited on the starting sheet 10 on each side of the line of weakness is built up to such thickness as to have substantially completely closed the slot in the starting sheet, but the adjacent crystals of copper on each side of the line of weakness 21 have not been united by an integral bond, and consequently the line 21 is a line of weakness along which the cathode may be broken quite readily.

It will be noted that the lines of weakness 21 (Fig. 2) terminate short of the edges of the cathode and are interrupted at a point approximately midway between the edges of the cathode by sections 23 of integrally bonded metal. These sections 23, and the integrally bonded metal along the edges of the cathode, correspond in location to the location on the starting sheet of the metal

webs 16, 17, and 18 and the integral edge portions of the starting sheet. The provisions of integrally bonded metal at these points unites with sufficient strength the segments into which the cathode may be broken, so that the cathode may be handled without accidental breakage.

The new cathode may be broken readily by hand or by mechanical breaking apparatus along the lines of weakness 21, but, of course, cannot be broken readily elsewhere. Thus, the cathode illustrated in Fig. 2 may be broken into as many as four pieces each as long as the original cathode but only one-quarter as wide. Although the cathode shown in Fig. 2 is provided only with lines of weakness running longitudinally of the cathode, it is, of course, understood that lines of weakness running horizontally may be provided in addition, or may be provided to the exclusion of the longitudinal lines of weakness, depending upon the manner in which the starting sheet has been slotted.

The slotted starting sheet described above may be handled substantially as easily as the conventional solid starting sheet. It has been found, furthermore, that slotted starting sheets of the character described do not materially affect the current efficiency of the cell in which they are used.

The new cathode may be shipped directly, without breaking, to the customer, who may break it with comparative ease into as many segments as desired, up to the maximum number permitted by the number of lines of weakness provided. Increased costs for shipping, handling, and storing small cathode segments are thereby avoided. If desired, however, the cathode may be broken into segments of the desired size at the plant at which it is produced. In either case, the disadvantages and the expense attending shearing cathodes to desired size, or producing half-size or smaller cathodes directly, as has heretofore been customary, is avoided.

I claim:

1. The method of producing a metallic cathode which may be broken relatively easily into a plurality of pieces of predetermined size which comprises preparing a cathode starting sheet having therein at least one slot of substantial width perforating the sheet and defining a line along which the cathode is to be breakable, said slot terminating short of the edge of the sheet, immersing said starting sheet as a cathode in the electrolyte of an electrolytic cell for the deposition of the metal, and depositing metal on the immersed surfaces of the starting sheet filling the slot and producing a relatively heavy cathode having at least one line

of weakness where the deposited metal fills the slot of the starting sheet.

2. The method of producing a copper cathode which may be broken relatively easily into a plurality of pieces of predetermined size which comprises preparing a starting sheet having therein at least one slot of substantial width perforating the sheet and defining a line along which the cathode is to be breakable, said slot terminating short of the edge of the sheet, immersing said starting sheet as a cathode in the electrolyte of a cell for the electrodeposition of copper, and causing a deposit of metallic copper to be formed on the immersed surfaces of said starting sheet in such manner that the deposited copper fills the slot but does not bond firmly across the slot, whereby the cathode produced has the starting sheet embedded in deposited copper and has at least one line of weakness where the deposited copper fills the slot of the starting sheet.

3. A substantially flat metal cathode comprising a starting sheet perforated by at least one slot of substantial width terminating short of the edge thereof, and a layer of electrodeposited metal on both sides of said sheet, said cathode having at least one line of weakness along the line of said slot and along which the cathode may be broken relatively easily into a plurality of pieces, said line of weakness further being defined by particles of electrodeposited metal which approach one another from opposite sides of the line but which are substantially free of any integral bond binding them together across the line, and said line of weakness terminating short of the edges of the cathode and being interrupted at a point between the edges by a section of integrally bonded metal, whereby the pieces into which the cathode may be broken are sufficiently strongly united to permit handling of the whole cathode without accidental breakage.

4. A substantially flat copper cathode comprising a starting sheet perforated by at least one slot of substantial width terminating short of the edge thereof, and a layer of electrodeposited metal on both sides of said sheet, said cathode having at least one line of weakness along the line of said slot and along which the cathode may be broken relatively easily into a plurality of pieces, said line of weakness further being defined by electrodeposited copper crystals extending from the main body of the cathode on each side of the line toward the body of the cathode across the line, said crystals being substantially free of any integral copper bond binding them together across the line.

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