

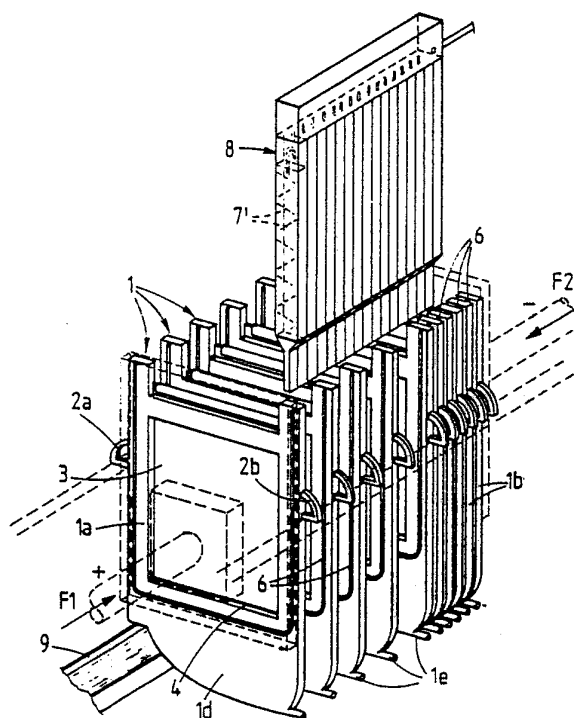


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(54) Title: PROCESS AND APPARATUS FOR THE ELECTRO-DEPOSITION OF COPPER OR OTHER METALS ON BIPOLAR ELECTRODES MADE OF LEAD		

(57) Abstract

An electrolytic process and apparatus for the production of copper cathodes from acid solutions of copper sulphate by a direct electro-deposition of said metal on lead bipolar electrodes arranged "in series" into electrolyzers consisting of lead electrodes (3) juxtaposed to special-frames (1) adapted to define together with said electrodes electrolytic cells, absolutely separated from each other and adapted to prevent any formation of shunt currents. The alternating succession of the frames (1) and electrodes (3) is carried by a support structure and is then compressed at the ends thereof by means of two heads and is hermetically sealed by means of packing means interposed between a frame and the adjacent ones. The process can be also applied to other metals other than the copper.



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PROCESS AND APPARATUS FOR THE ELECTRO-DEPOSITION OF
COPPER OR OTHER METALS ON BIPOLAR ELECTRODES MADE OF
LEAD.

- 5 The invention relates to a process and apparatus for an
electro-deposition of copper or other metals on bipolar
electrodes made of lead.

It is well known in the art that when a solution of
10 copper sulphate, CuSO_4 , is subjected to electrolysis,
the positive ions Cu^{++} perform a migration towards the
negative pole or cathode, where the electrons coming
from the outer circuit will be neutralized, so as to
create a layer or deposit of metallic copper on the
15 electrode.

Of course, said layer of metallic copper is created at
charge of the cupric ions of the electrolytic solution.
Therefore, if a replacement of those ions, which have
been removed with a new supply of new ions would not be
20 provided, said ions will be very soon exhausted and
therefore the process should stop.

The replacement of new Cu^{++} ions in the electrolytic
solution, - which is necessary for the operation of any
plant for the production of the copper by an
25 electrolytic process, - can be obtained either by the
direct solubilization of the metal, i.e. by the use of

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copper anodes, which, under the effect of the passage of the electric current, are caused to pass in the solution, or by a supply of a regenerated solution, i.e. enriched in Cu^{++} ions, in substitution of that one which
5 gets weaker and weaker of said ion content.

As result thereof, the production of the copper cathodes can be carried out according to the following two procedures:

- By the use of soluble electrodes; i.e. by subjecting
10 copper electrodes, as anodes, to an electrolysis process, so that, under the effect of the electric current, copper passes in the solution in an amount equal to that of the copper that deposits on the cathodes;

15 - By the use of insoluble electrodes, as anodes; i.e. by the use of insoluble electrodes (usually lead electrodes); in this case it will be necessary to make up for the loss of cupric ions, which, when they deposit on the cathode at their metal state, are thus removed
20 from the solution, so that it becomes necessary that they have to be replaced by means of an addition of a solution enriched by Cu^{++} ions.

The electrolytic process is usually carried out in tanks which contain: the electrolytic solution of copper
25 sulphate acidified by sulphuric acid; and a plurality of electrodes consisting of an alternating succession of anodes and cathodes dipped into said solution. Said

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tanks are provided with electric connectors for the feeding of electric current to said electrodes.

In its turn, an electrolysis plant, is constituted of a plurality of electrolysis tanks.

5 But, as far as the apparatus is concerned, it is to be pointed out that the process of the present invention will be carried out, instead with the use of electrolysis tanks, with the employ of a structure similar (in its external configuration, but not in its
10 operative function), to a filter press, so that instead of the denomination of "electrolysis tanks", thereafter the more general term "electrolyzers" will be used.

Electrolytic process can also differ from each other, by
15 the manner by which the electric connection of the electrodes is performed, being possible to arrange the electrodes, either "in parallel" or "in series".

Unlike the arrangement "in parallel", usually employed in the process, either with the use of soluble
20 electrodes, or with the use of insoluble electrodes, the arrangement "in series" has been up to the present applied only with the use of soluble electrodes, formed by plates made of copper to be refined, which, - as the current passes therethrough under effect of the electric
25 field -, are charged positively on one side and negatively on the opposite one thereof, so that the material of the electrodes passes in the solution from

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the positive side thereof, i.e. the anodic side, and at the same time on the negative side, i.e. the cathodic side, the electrodes grow in their thickness owing to the electrolytic deposit which is being to be created.

5 On the contrary, it is believed that industrial processes for an electrolytic removal of the copper from a solution thereof by the use of insoluble electrodes arranged "in series" have never been provided up to the date.

10

The present invention relates to an electrolytic process based on the last aforementioned method, i.e. which concerns the electrolysis of solutions of copper sulphate acidified by sulphuric acid (which from now on
15 will be called simply "electrolyte") by the use of bipolar lead electrodes arranged "in series", taking advantage of the characteristic of the so arranged electrodes, i.e. their characteristic of acting on one of their sides as anodes and on the opposite side as
20 cathodes, so as to obtain directly the formation of copper cathodes on the face of the electrodes acting as cathode i.e. the face having a negative polarity that will be called from now on "cathodic side" of the electrodes, while the opposite face having positive
25 polarity will be called "anodic side".

The choice of the lead for the electrodes is due to the fact that such a material, besides of having the quality

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of being insoluble in the electrolyte, and having also a sufficient electric conductivity as well as a resistance to the anodic oxidation, is further more sufficiently adapted, owing to its ductility, to permit the removal
5 of the copper cathodes which have been produced on the electrodes, as well as to be able to be then again well flattened in order to allow their further re-use.

A standard lead plate of the market having a thickness of 1 mm has been found to be adapted for this purpose
10 without needing any further treatment.

Owing to the simplicity of this process and on account of the reduction to the minimum of the electric connections that is the characteristic of an arrangement "in series", said process has been found to be very
15 advantageous as compared with other known electrolytic processes. However for the industrial realization thereof, the following conditions have to be satisfied:

I - The copper cathodes, which in the course of the electrolysis are going to be formed on the lead
20 electrodes, cannot found a suitable support on the electrodes, which are clearly unadapted for such a purpose, but, on the contrary, they have to find a reliable support on a special support frame. Furthermore the electrode surface on which after all the productive
25 capacity of the plant depends in a measure directly proportional, must be sufficiently large so as to be adapted for an industrial use.

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II - The operations which have to be carried out in order to put said electrodes in their operative condition at the beginning of the electrolysis cycle and in order to permit their removal from said operative
5 position at the end of each cycle, have to be of a very easy performance.

III - To the electrolyte of each cell ("cell" will be here named each single elementary electrolytic system, that in the presence of electrolyte each electrode will
10 form either with the immediately preceding electrode or with the immediately successive one) any contact of the electrolyte must be prevented with those circulating in the other cells. On the contrary, the electric current, instead of passing through the electrodes (which, on
15 account of the layer of dioxide that is formed on the anodic side thereof under the electrolysis effect, offers a high electric resistance) would pass nearly wholly through the electrolyte (thus creating the so called shunt currents) and as a result thereof, except
20 on the first electrode having negative polarity no other deposit of metal would be obtained.

IV - At last, in each of the cells, in which the electrolyzer can be considered subdivided by the electrodes, a nearly continuous circulation of the
25 electrolyte has to be assured, so as to obtain a supply of new electrolyte enriched in Cu^{++} ions in substitution of those which are going to be removed.

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Suitable device to perform such conditions are modular composable element frames by means of which an electrolyzer with lead electrodes can be assembled, which permits to carry out the process object of the

5 present invention.

Such an electrolyzer is thus constituted of a structure similar to that of a filter press, namely which consists of a plurality of said modular elements or frames, arranged in an alternating succession with said lead
10 electrodes. Said structure is hermetically closed at its ends by means of heads. Furthermore it is hermetically closed between a frame and the adjacent ones by means of suitable packing. Therefore it can have a configuration of a tank subdivided by the electrodes in so many cells
15 as the frames are.

Said frames must be made of an electrically insulating material which must be corrosion-resisting, such, for instance, the PVC or other plastic material having similar characteristic.

20 Each element has a structure like to a hollow frame so as to permit circulation of the electrolyte, as will be better illustrated thereafter. Its lower portion is convex and gradually sloping down in order to permit to obtain the whole emptying of the hollow frame through a
25 discharge means provided at the lowermost part thereof.

The process, the electrolyzer, the electrodes and the

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modular elements or frames of the present invention will be now described in a more detailed manner, with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic view of the electrodes of a
5 conventional electrolysis apparatus, which are arranged "in parallel";

Figure 2 shows diagrammatically the electrodes of a conventional electrolysis apparatus, which are arranged "in series";

10 Figure 3 shows diagrammatically an arrangement "in series" of the electrodes; on this figure some of the paths of the shunt currents are indicated, which could be created, if they are not prevented by suitable means;

Figure 4 shows the front view of a modular element
15 according to the present invention;

Figure 5 is the longitudinal sectional view taken on line A-A of Figure 4;

Figure 6 is a detail, in an enlarged scale, of the sectional view of Figure 5;

20 Figure 7 shows the cross section taken on line B-B of Figure 4;

Figure 8 shows an axial view on line C-C of Figure 5, where the arrows indicate the travel of the electrolyte;

Figure 9 shows a series of modular elements assembled to
25 each other in their operative position, some of which being shown in their side view and some in a cross sectional view;

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Figure 10 shows a perspective view of a series of elements during their assembling step.

As can be seen in Figure 4, each modular composable element, i.e. the frame 1 in question, - which has, as aforesaid, a frame structure - , comprises two vertical members 1a and 1b, connected to one another at their upper ends by a transverse member 1c and at their lower ends by a base member, convex in its lowermost part.

10 The transverse member 1c, in its cross section shown in Figure 5, is shaped as a U and has a very narrow base and one of their sides of the U-structure higher than the other one.

The portion of the higher side extending beyond the shorter one, is designed to serve to fix the electrode 3 to the frame 1 by means of a thin bar, which has the shape of an inverted U.

The base 1d is provided, at the lowermost end thereof 1d' with a discharge means 1e for obtaining the complete emptying of the cell at the end of the electrolysis cycle.

The vertical member 1a in its inner cavity houses a flow breaker 7, the configuration and function of which will be illustrated thereafter.

25 The vertical members 1a, 1b, the transverse member 1c and the base member 1d are hollow and are made intercommunicating between themselves so as to permit

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the electrolyte circulation, as will be better explained thereafter.

The upper part of the transverse member 1c is open and said opening has the purpose to permit the free

5 discharge of the oxygen developping on the anodic side of the electrodes (in an amount equivalent to the copper depositing thereon), as well as to permit possible inspections which, with the use of adapted implements, can reach the inner space of the cell.

10 The lower part of the transverse member 1c, i.e. the base portion thereof, in the front part of this latter (with regard to the space designed to house the copper cathode) is provided with slits 1c'; also the element 4 is provided with slits 4', said element 4 having a U

15 cross section and being inserted in the upper part of the base member 1d. Said slits are necessary in order to allow that the electrolyte can come out of the base member 1d into the cell (i.e. in the space interposed between the electrodes) and then come out therefrom

20 together with the oxygen developping on the anode, thence entering in the transverse member 1c. On the outer sides of the vertical members 1a, 1b there are two shoulders 2a, 2b respectively for the support of the frame in its work condition on guiding support means.

25 The configuration of the lead electrodes 3 has a mutual relation with those of the frames 1. The area which is enclosed in the quadrilateral "abcd" (Figure 4) is

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called "cathodic surface" and corresponds to the inner outline of the frames 1, while the surface of the electrodes 3 corresponds to that of the cathodic surface, but increased of a peripheral border portion of 8-10 cm near the upper side a-d and of about 5-6 cm near the other three sides. The presence of said border portions is necessary in order to permit to securely fix the electrodes 3 between a frame and the adjacent one according to the following manner.

- 10 A part of the upper border portion of each electrode, i.e. the upper band of said border portion, will be securely connected to the upper part of the higher side of the transverse member 1c by means of the thin bar 5 having a cross section like to an inverted U, the
- 15 function of which is that of permitting to clamp together said parts of the electrode and of the transverse member. In fact as the electrode has been so securely connected to the transverse member 1c, said electrode remains automatically fixed to this latter and
- 20 that takes place since a small protrusion is provided near the edge of the electrode; this protrusion acts in contrast with the higher edge of the structure, so preventing that the electrode can be moved away therefrom and slide downwards.
- 25 After having mounted the frames 1 together with the respective electrodes 3 in succession one after the other on the guiding support means (not shown), the

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border portions of all the four edges of the electrodes will remain automatically entrapped between a frame and the adjacent one, when, after having mounted the heads (not shown), the whole structure of said electrolyzer
5 will be pressed, by a suitable device, between these latter according to the direction indicated by the arrows F1 and F2 in Figure 10 (just as it takes place in a filter-press). In fact also the upper border portion of the electrodes (the part which is inserted in the bar
10 5 excepted), will remain clamped between a frame and the adjacent ones, and more precisely between the back side of the transverse member, to which the electrode is locked by the bar 5, and the front side of the front transverse member of the frame. The aforementioned
15 difference in height of the two parallel vertical sides of the transverse member has been provided exactly for the necessity of leaving sufficient space for receiving said bar 5.

This locking system of the electrodes 3 enables the use,
20 without any difficulty, of the lead electrodes in the form of plates of a thickness of 1 mm and having a cathode surface of at least 70 dm² (such a surface area being industrially convenient).

The poor initial mechanical resistance of the lead
25 sheets which constitute the electrodes will be progressively increased by the copper layer (diagrammatically represented in Figure 9), said layer

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having a more and more increasing thickness without any risk that tensions between the two metals can be created.

Of course, the configuration of the copper cathodes will
5 correspond to the outline of the inner space abcd of the frames 1, within which said cathodes will be formed. As the electrolysis goes on, the thickness of said cathodes will more and more increase, as well as their weight, which for its most part will be supported by the lower
10 member of the frame and more in particular on a special lip provided on the element 4 of the transverse member 1d, which is open in the remaining upper part thereof. The copper cathodes can be considered adapted to be sold, after having reached a thickness of 6-7 mm.
15 Therefore only at this time the electrolyzer will be emptied of the electrolyte and thus disassembled while the lead electrodes and the copper cathodes, which remain still connected together, are at first separated from the frames.
20 Afterwards the copper cathodes will be, in turn, separated from the lead electrodes. This last operation does not offer any difficulty, since to such a purpose it is only necessary to coat the cathodic face of the electrodes, before the beginning of the electrolysis,
25 with a thin layer of oil or grease, so as it is commonly carried out in the process "in parallel" with the use of "mother plates", in order to remove the cathodic sheets.

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As the copper cathodes have been removed, the lead electrodes have to be only flattened again so as to be again adapted to be used in the next electrolysis cycle and so on, from a cycle to the next one.

- 5 Therefore the first two conditions, on which is based the task relating to the present invention, are thus satisfied.

As far as the third condition is concerned, it will be evident that the special manner, according to which the
10 electrodes 3 are maintained in their operative position (i.e. with their border portions securely retained between the frames 1), prevents that the electrolyte of each cell can come into contact with those of the other cells; therefore no shunt currents can be created
15 through said paths.

The water-repellent effect of the surface of the frames made of plastic material (which usually present such a characteristic) as well as the thin greasy layer coating the electrodes are "per se" sufficient in order to
20 prevent infiltrations of the electrolyte into possible interstices so that the use of packing means is not even necessary in order to obtain a sufficient separation of the electrolyte.

On the contrary, it is necessary the provision of
25 packing means 6 (Figures 4 to 10) mount in a peripheral position along the outline of the electrodes, in order to ensure a hermetic seal of the electrolyzer. It is

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furtherly convenable that said packing element 6 extends with a flat flange underneath the edge portions of the electrodes, so that, in such a manner, said packing means 6, can be more easily applied to the frames 1 and
5 also because, owing to this extended configuration, this packing means, besides acting as a shock absorber, i.e. as a "cushion", interposed between an electrode and a frame, can also ensure a more efficient locking of the electrodes (between a frame and the adjacent one), thus
10 preventing that said electrodes can slide along the rigid and smooth surface of the frame. In order to not make the accompanying drawings too complicate, the flat portions of the packing means 6 have been shown only in Figures 6 and 9.

15 The other paths along which possible derivative or shunt currents could be transmitted, i.e. the conduits through which the electrolyte flows in and out any single cell, are, on the contrary forbidden by the use of suitable devices 7' and 7 respectively, i.e. by the use of the
20 already mentioned electrolyte flow breaker.

During the passage of the electrolyte said devices create repeated breakages of the liquid flow which cause thus interruptions of the electric conductivity.

Said devices consist in the combination of a small
25 deposit tank adapted to be emptied under a siphon effect, and of an underlying conduit including superposed sloping wall elements; the siphon serves to

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break the liquid flow during the storage phase of the electrolyte into the deposit tank, while such a conduit has the function to maintain the flow breakage during the phase in which the electrolyte comes out of said
5 deposit tank and that because the electrolyte volume at each cycle is not sufficient to fill up the whole conduit.

The liquid flow breakers are provided at the input and the output of each cell and therefore there are two of
10 said breakers associated with each cell.

The last condition is also equally satisfied. The circulation of the electrolyte through each cell is permitted by the inner conduit systems of the frames 1.
The supply of the electrolyte to the inlet orifice E of
15 each frame (Figure 8) takes place through a distributor 8 which has the function of distributing the electrolyte (having now again original concentration) in equal amount into each cell, said electrolyte, before reaching each inlet orifice E, is caused to pass through an
20 electrolyte flow breaker 7' (Figure 8), to which reference has been already made. The arrows in Figure 8 show how the electrolyte circulates in a cell.

After being entered the inlet orifice E the electrolyte travels along the vertical conduit provided in the
25 vertical member 1b, from which said electrolyte goes down into the inner cavity of the base member 1d of the frame 1 and therefrom, according to the principle of the

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communicating vessels, it re-ascends into the interspace between one electrode and the adjacent one, passing through the slits 4a of the element 4 mounted in the upper part of the member 1d and then it will enter,
5 again in the hollow structure 1c passing through the slits 1c', provided in the lower portion of the transverse member 1c. Then the electrolyte comes out therefrom through the orifice 1c" and falls down in the electrolyte flow breaker 7, through which it reaches the
10 outlet orifice U, from which the electrolyte falls down, at last, into the manifold 9.

For the purpose of completing the description, it is to be pointed out that the components of the electrolyzer are maintained in their operative condition by means of
15 a support framework on which the frames are suspended and on which therefore the whole weight of the electrolyzer discharges, and as well as by means of a compression device which serves to press together the juxtaposed frames and electrodes one against to the
20 other between the two press head.

These latter structures and devices are conventional and substantially similar to those provided in a filter press, so that it is not necessary that they have to be described in a more detailed manner.

25 Of course, the end electrodes, i.e. the first and the last ones, are applied directly on the heads which by means of suitable connecting means are connected to the

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electric current feeding circuit.

Still for the purpose of completing the description, it is necessary to still say what follows.

It has been assumed that the frames have a thickness of
5 about 2 cm and that their thickness corresponds to the initial distance of the electrodes from each other. Of course, as the electrolysis process goes on, said distance will decrease of an amount equal to the thickness of the copper layer, which deposits on the
10 cathodic side of the electrodes, so that near the end of the electrolytic cycle said distance will become lesser than 1 cm. Evidently, if the thickness of the frames will be increased, a greater distance between the electrodes will be obtained with the advantage of a
15 higher reliability against possible short circuits between an electrode and the adjacent ones, but with the disadvantage of a higher electric resistance of the cells and therefore a higher electric power consumption per product unit. The other dimensions of the frames
20 depend upon the area of the cathodic surface which will be provided. With the provision of a cathodic surface of about 70 dm², the inner outline of the frames will be a rectangular space abcd with a base of about 80 cm and of a height on 90 cm and accordingly also all the other
25 dimensions will be determined, which will be proportionally calculated in concordance with the preceding ones.

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The electrolyte circulation except the little discontinuity of fluid flow (due to the presence of the flow breakers 7 and 7') is obtained in a continuous manner by means of a pump which receives the

5 electrolyte, coming out of the electrolyzers and which will be previously let enter a reactor which provides to re-establish the original cations' concentration. Afterwards the electrolyte returns to the electrolyzer so as to complete the cycle.

10 Nothing has to be said, on the contrary, about the composition of the electrolyte, and about the current density value to be used in the process because the arrangement "in series" of the electrodes do not influence the chemic-physical reactions of the

15 electrolytic process, so that the selection of said parameters have to be performed according to the same criteria of the other known processes.

On the contrary, as far as the difference of potential is concerned, it is necessary to remind that, on account
20 of the higher electric resistance offered by the lead electrodes and due to the dioxide layer which will be formed on their anodic side, the required voltage for each cell, in the case of currents varying from 100 to 200 Amperes, varies between 1,85 and 2,05 volts and, of
25 course, since a connection "in series" is considered, the potential difference in the electrolyzer must be equal to the sum of the potential differences of the

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single cells which compose this latter.

It will be advisable that the electrolyzers according to the present invention have to be provided with suitable devices which allow that all the possible electrolyte losses are to be collected and returned into the operative cycle, losses which could be due to packing means which do not offer a hermetical seal so that they do not cause undue problems. It is also necessary that collectors or other devices adapted to permit an easy emptying and filling of the electrolyzers with the electrolyte are provided.

It is also provided the application of the present process to metals, other than the copper, metals which permit an electrolytic separation thereof from acid solutions of their sulphates and where lead electrodes can be used as in the case of the copper. More in general the present process will be applied whenever it will be possible to use electrodes which are insoluble in the solution to be subjected to an electrolysis process and which permit the cathodes removal in order to their new use, or which would have a so-limited cost that they could be used for a sole cycle (i.e. one-use electrodes).

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CLAIMS

- 1 - An electrolytic process for the production of copper cathodes from aqueous solutions of copper sulphate, CuSO_4 , which are acidified by sulphuric acid, by means of a direct electro-deposition of said metal on the cathodic side of bipolar insoluble lead electrodes (3) arranged "in series", characterized by the fact that said electrodes are maintained in their operative position by means of modular composable frames (1) which have to be corrosion-resisting and which are electrically non-conductive, by means of which an electrolyzer is obtained which is formed by an alternating juxtaposition of electrodes and frames in a more or less high number and which is supported by a support framework and which is compressed and closed at its end by two heads and is hermetically closed, so far as the electrolyte is concerned, owing to the presence of packing means (6) inserted between a frame and the adjacent ones, said frame succession being adapted to support the lead electrodes (3) having a large surface, on account of the fact that the electrodes, which are previously overhung to the transverse member (1c) of each frame by means of a thin bar (5), remain entrapped by means of all their four edges between a frame and the adjacent one.
- 2 - An electrolytic process according to claim 1,

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characterized by the fact that the weight of the copper cathodes to be produced is supported directly by said frames (1) by means of a lip provided at the upper part of the base transverse member (1d) of each frame, and by
5 the fact that flat portions of the packing means (6) remain securely held between a frame and the adjacent electrode, said flat portions serving to securely fix the electrodes (3) in their operative position.

3 - An electrolytic process according to the preceding
10 claims, characterized by the fact that the said frames are made of a plastic material and have a hollow structure which forms inner intercommunicating conduits provided with slits (4a, 1c') arranged in the upper portion of the base transverse member (1d) as well as in
15 the lower portion of the upper transverse member (1c) respectively, adapted to permit a continuous circulation of the electrolyte in each of the cells which compose the electrolyzer and which are separated by the electrodes, said circulation being obtained owing to the
20 difference of level between the input and the output orifices respectively of the cells, circulation which is also promoted by the vertical ascent caused in the cells of oxygen developing at the anodes thereof.

4 - An electrolytic process according to the preceding
25 claims, characterized by the fact that any shunt current is prevented in the electrolyzer, since the electrolyte of each cell is separated from those of the other cells,

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either owing to a sufficient locking of the border portions of the electrodes between a frame and the adjacent one, or under the effect of repeated breakages of the electrolyte flow, circulating in the

5 conduits, which is created by special devices (7, 7') which are named flow breakers, with which each cell is provided either in the inlet conduit after the distributor (8), and in the outlet conduit in the inside of the member (1a) of each frame.

10 5 - An electrolyte flow breaker (7, 7') according to claim 4, which is constituted of a small deposit-tank which can be emptied by a siphon effect and which provides to supply the electrolyte in an underlying conduit comprising a plurality of sloping wall elements
15 and having such a length so as not to be filled entirely by the liquid amount coming out from the deposit tank at each cycle, so that between the entrance section and the exit section of said device at least an interruption of the electrolyte flow is created.

20 6 - A composable modular frame for carrying out the electrolysis process according to the preceding claims, characterized by the fact that said frame comprises a lower (1d) member having a convex lower portion (1d') provided with a discharge means (1e), two vertical
25 members (1a, 1b), the upper member (1c) and the lower member (1d) being hollow and being put in communication.

7 - A composable modular frame according to claim 6,

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characterized by the fact that the vertical members (1a, 1b) have outwardly extending shoulders (2a, 2b) for the support of the frame (1) in its operative position, the lower portion of the upper transverse member (1c) being
5 provided with slits (1c'), while other slits (4a) are provided in an element (4) having a cross section of a U-like shape, which is inserted in the upper part of the base transverse member (1d) along the whole length thereof, the back portion of the transverse member (1c)
10 being higher than the front part thereof, so as to permit that the electrode is securely connected to said back portion without occupying the border zone of the electrodes designed to be entrapped therein .

8 - The production of cathodes of metals other than the
15 copper by means of the process according to the preceding claims by the use of lead electrodes or not, but which have however to be insoluble in the used electrolytic solutions.

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FIG. 1

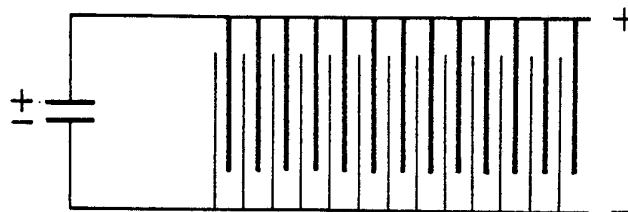


FIG. 2

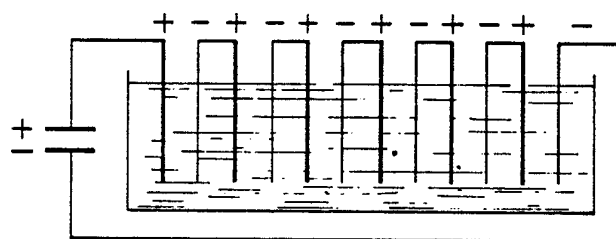


FIG. 3

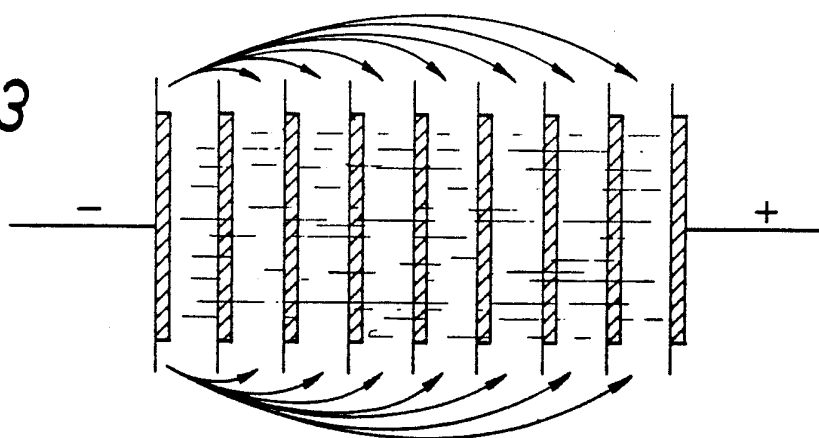


FIG. 4

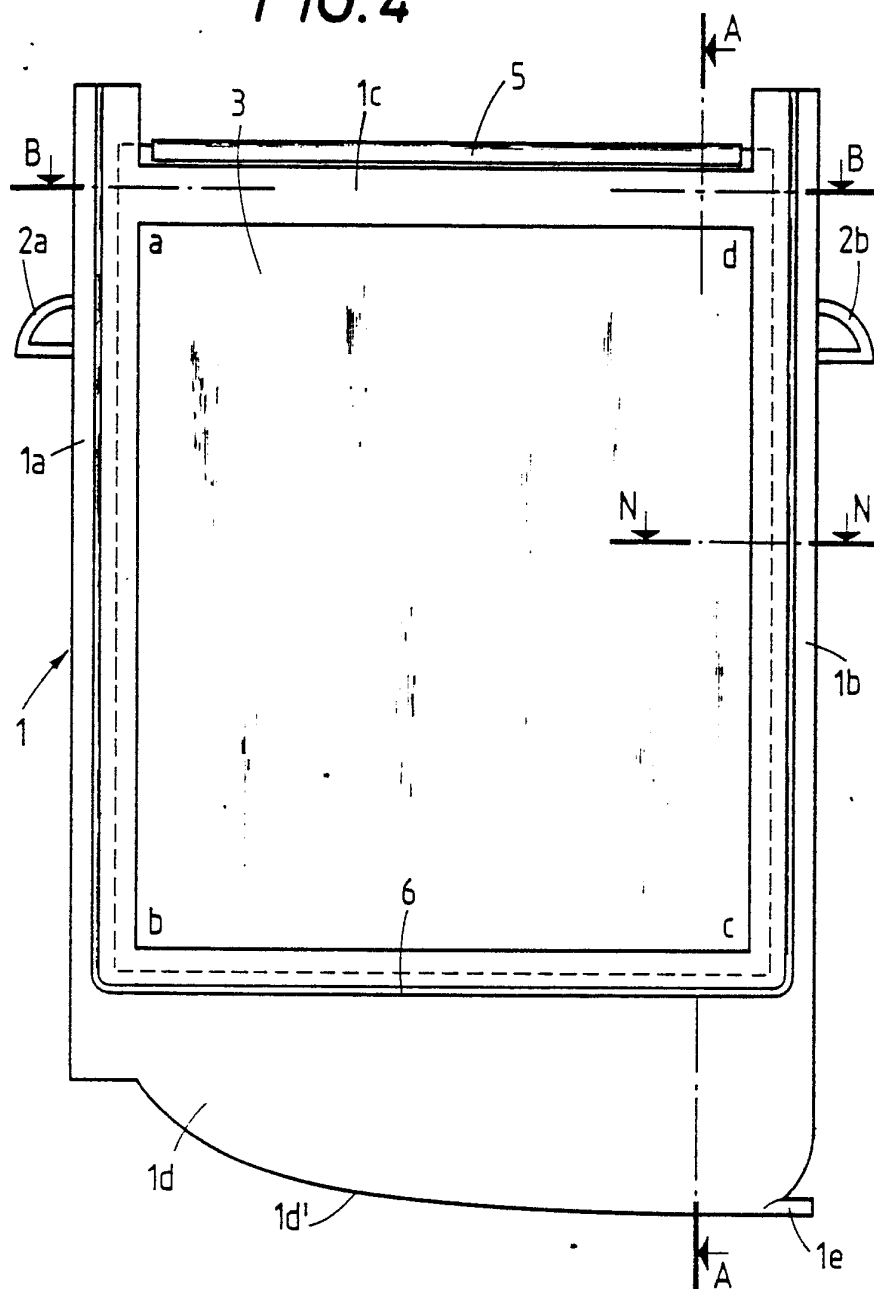


FIG.5

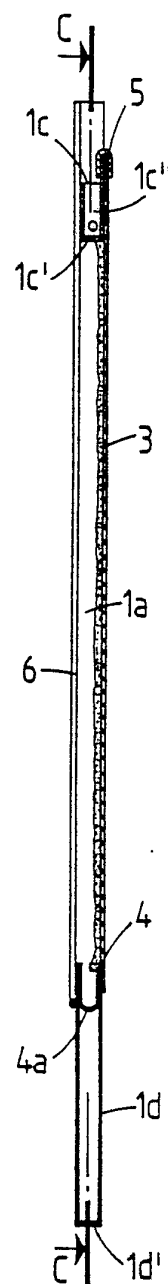


FIG. 7

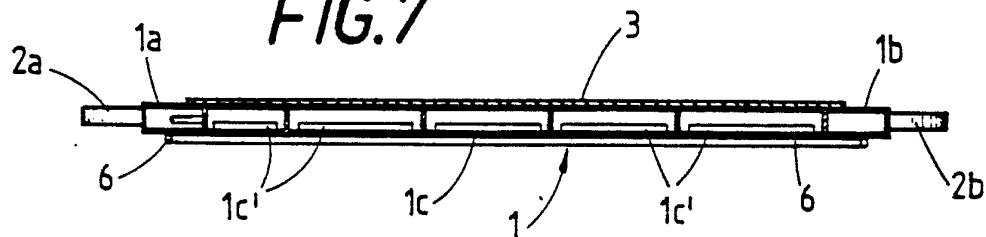


FIG. 8

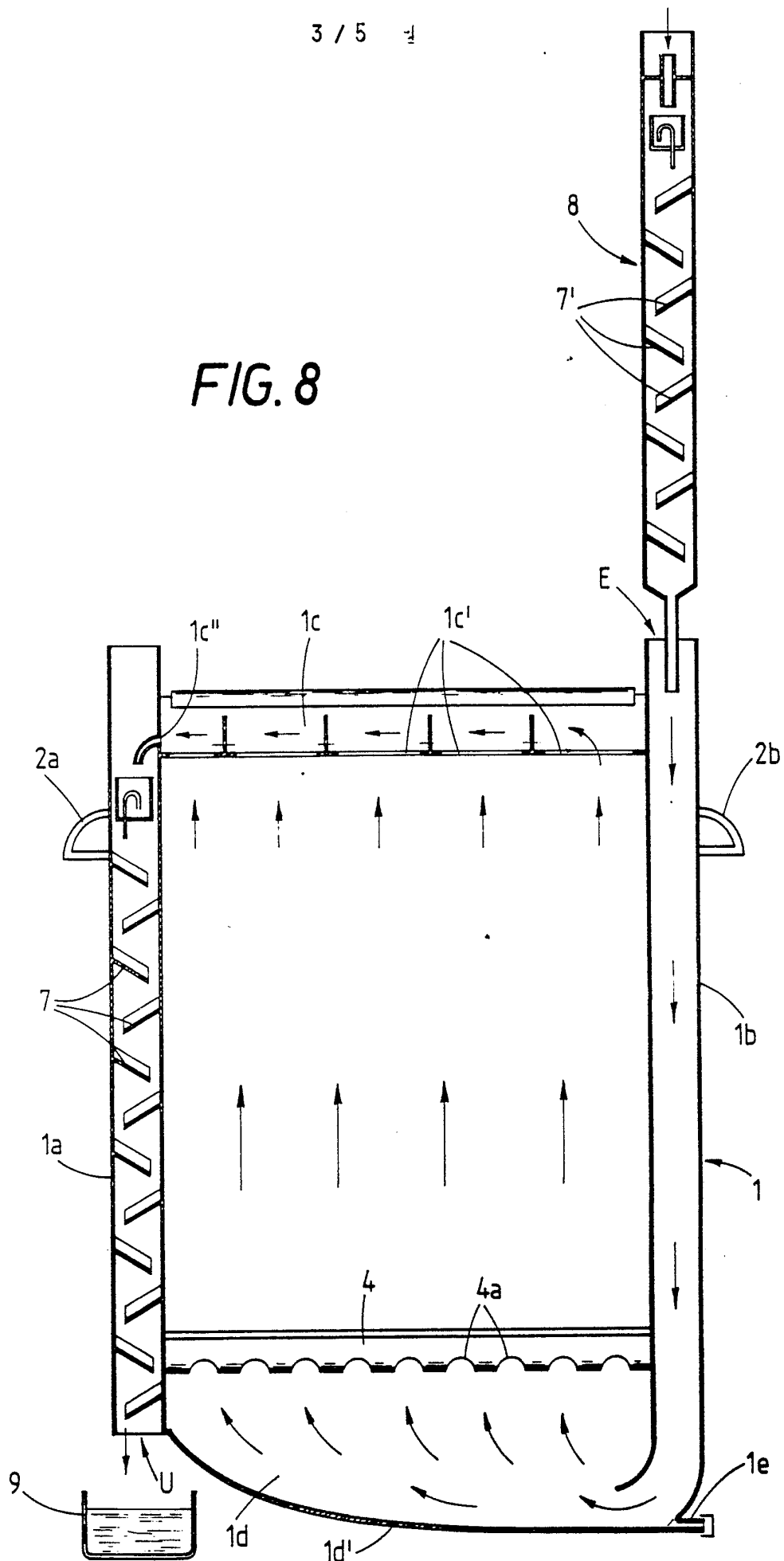
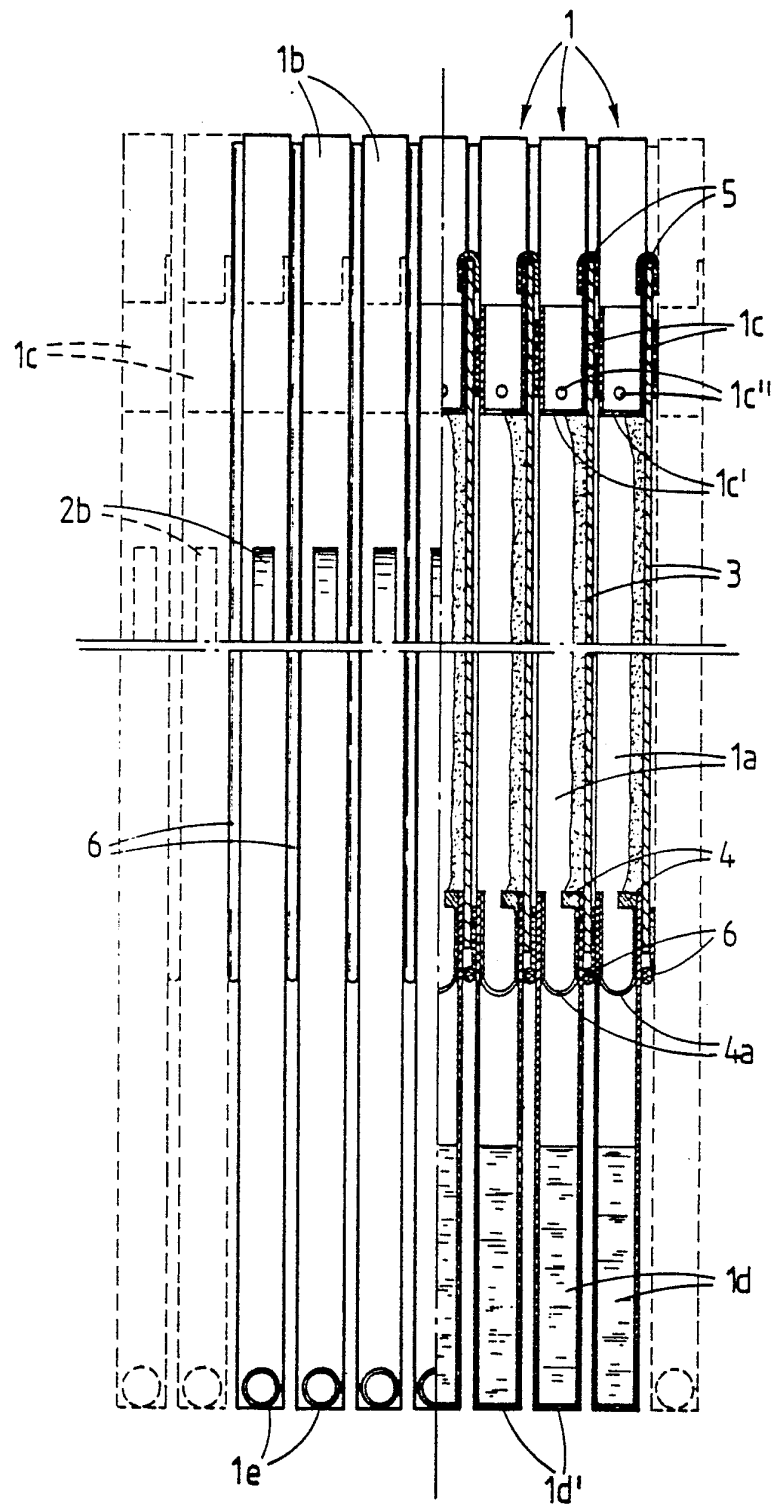


FIG. 9



INTERNATIONAL SEARCH REPORT

International Application No

PCT/IT 87/00052

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) *		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC ⁴ : C 25 C 7/00; C 25 C 1/12		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
IPC ⁴	C 25 C 7 C 25 C 1	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁶		
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹		
Category ⁸	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
A	US, A, 1738372 (R. EDGEWORTH-JOHNSTONE) 3 December 1929 see page 3, lines 50-75 --	1
A	FR, A, 2528075 (J.V. KUNSTSTOFFWERK) 9 December 1983 --	
A	US, A, 4033839 (W.W. HARVEY) 5 July 1977 -----	
* Special categories of cited documents: ¹⁰ "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search		Date of Mailing of this International Search Report
7th September 1987		- 6 OCT 1987
International Searching Authority		Signature of Authorized Officer
EUROPEAN PATENT OFFICE		L. ROSSI

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/IT 87/00052 (SA 17437)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 16/09/87 .

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 1738372		None	
FR-A- 2528075	09/12/83	DE-A,C 3221371	15/12/83
		JP-A- 58217687	17/12/83
		SE-A- 8303103	06/12/83
		AU-A- 1536783	08/12/83
		US-A- 4455209	19/06/84
		AU-B- 544729	13/06/85
		CA-A- 1204410	13/05/86
US-A- 4033839	05/07/77	US-A- 3979275	07/09/76

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