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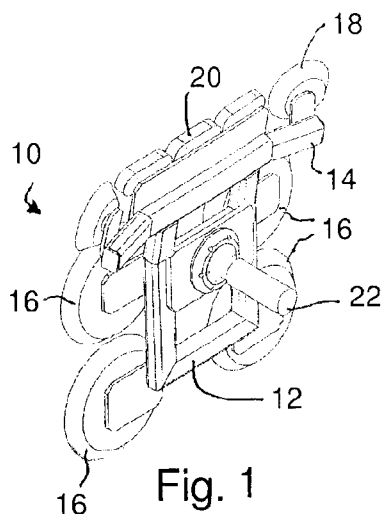


Fig. 1

(57) **Abstract:** An apparatus for stripping a substantially pure electroplated starter sheet from a primary flat plate starter cathode is provided. It comprises a rectangular frame having at least suction cups mounted below the top region thereof, and facing in a direction away from the front of the rectangular frame. A robotic arm is mounted at the rear of the rectangular frame, and is adapted to move the frame forward and rearwardly, and to pivot the frame around horizontal and vertical pivot axes. Upon successive forward movement and pivoting movement of the frame, a substantially pure electroplated starter sheet may be stripped from a primary flat plate starter cathode. Methods for stripping starter sheets from starter cathodes using the apparatus are taught.



METHOD AND APPARATUS FOR STARTER SHEET STRIPPING

Field of the Invention

5 This invention relates to the field of electrorefining, and in particular, the present invention relates to a method and apparatus for stripping substantially pure electroplated starter sheets from primary flat plate starter cathodes. The invention provides a system whereby copper or nickel starter sheets, in particular, may be stripped from a titanium or stainless steel primary flat plate starter cathode.

Background of the Invention

10 The process of electrorefining is well known; - as is its related process known as electrowinning. In both processes, the final refining, whereby substantially pure metal is obtained, is carried out with electrolysis. Either of these processes is particularly useful to obtain substantially pure metals such as copper and nickel in particular, as well as certain other metals such as gold, silver, zinc, chromium, manganese, and aluminium.
15 Indeed, electrolysis is the only production process which is employed to obtain substantially pure aluminium, using the electrowinning process. However, the present invention, while applicable to both electrorefining and electrowinning, is more particularly applicable to electrorefining where substantially flat primary plate starter cathodes are employed, and onto which the metal to be refined is electroplated using
20 an electrolysis process.

In the electrorefining process, dissolvable anodes are employed, and they are produced by casting molten metal into anode moulds. Formed anodes are immersed in the electrolytic cells and suspended therein by "lugs" formed at the upper end of the anode. The electrowinning process uses non-soluble anodes, which are manufactured

from lead or another inert material, and immersed in electrolytic cells which contain an electrolyte having a high concentration of the subject metal dissolved therein. On top of the first sidewall of each cell there is a busbar, and on the top of the second sidewall of each cell there is provided insulation. The anode lugs rest on the busbar and the
5 insulation; and a high electric current in the cell is conducted via the contacts between the busbar and the anode lugs.

A cathode which may be of the same material, or more particularly of another material such as stainless steel or titanium, is also immersed in the cell; and it also has lugs which rest on a second busbar and insulation. During the electrorefining process,
10 metal from the anode dissolves into the electrolyte and is subsequently deposited on the cathode in a more purified state. Similarly, during the electrowinning process, metal from the electrolyte solution is deposited on the cathode in a more purified state. By these processes, the purity of the metal being deposited on the cathode can be raised to 99.9% or higher.

15 It must now be noted that the present invention applies equally to either process, but for purposes of the following discussion and for ease of understanding, only the term electrorefining shall be used hereafter. Of course, it is understood that such term is not exclusive, and that the following discussion of apparatus and method is equally applicable to both processes.

20 There are two major variants in the electrorefining process. The first is known as the starter sheet process, and the second is known as the permanent cathode process. The present invention and following discussion relate only to starter sheet process.

In the starter sheet process, the first step of the refining operation is to produce a primary flat plate starter cathode. Thereafter, a starter sheet of substantially pure
25 electroplated refined metal is deposited onto the primary flat plate starter cathode - most usually onto both sides of the primary flat plate starter cathode. The primary flat plate starter cathode is typically made from titanium, stainless steel, or mixtures and alloys thereof. The deposit of the thin film of refined metal - the substantially pure electroplated starter sheet - onto the surfaces of the primary flat plate starter cathode
30 typically requires one or two days of refining, and is typically less than 5 mm thick. The weight of each substantially pure electroplated starter sheet may be in the range of 5 to 10 kg.

However once the electroplating of the substantially pure electroplated starter sheet has been concluded, it is then mechanically removed from the primary flat plate starter cathode in a process known as "stripping". These sheets which have been stripped from the primary flat plate starter cathode are then further processed into
5 "prepared starter sheet cathodes" which are then reinserted into the electrolytic cell. Then, the plating operation continues with a full plate cathode growing onto the prepared starter sheet cathode. The full plate cathode is typically substantially heavier than the prepared starter sheet cathode, and may take several days to produce.

However, it must be noted that a typical refinery will require the production of
10 several thousand full plate cathodes per day, and consequently requires the production of several thousand prepared starter sheet cathodes per day. Typically, the weight of each prepared starter sheet cathode is in the range of 20 to 40 kg.

For purposes of the following discussion, and for simplicity of explanation, the term "starter cathode" will be understood to mean the primary flat plate starter cathode,
15 which is typically made from titanium, stainless steel, or mixtures and alloys thereof. The term "starter sheet" will be understood to mean the substantially pure electroplated starter sheet which is stripped from the starter cathode, and which is later reinserted back into the electrolytic cell. It will also be understood that the present invention is directed toward an apparatus and method whereby the starter sheets may be stripped
20 from the starter cathodes.

The process of stripping starter sheets from starter cathodes includes three basic operations or steps: pre-separation, separation, and discharge.

"Pre-separation" is the step by which the upper edge of the starter sheet is at least partially separated from the starter cathode.

25 "Separation" is the step by which the majority of the starter sheet is removed or "stripped" from the starter cathode, following pre-separation.

"Discharge" is the step by which the starter sheet is released to the refinery for further processing. Typically, starter sheets are stacked in groups of several hundred sheets for further handling and processing. The discharge step *per se* is beyond the
30 scope of the present invention.

The pre-separation step can be complicated or exacerbated due to the fact that there may be a strong chemical and/or mechanical bond that has been formed between

the starter cathode and the starter sheet which has been electroplated thereon. This is particularly true in the region of the upper edge of the starter sheet - an area which is known as the solution line - and which coincides with the surface of the electrolyte in the refining cell. Generally, it is necessary to break the bond at one or more points
5 along the upper edge of the starter sheet so as to permit the balance or major portion of the starter sheet to be separated or stripped from the starter cathode.

Of course, it will be understood that the position of the solution line can vary from starter sheet to starter sheet depending on the level of the electrolyte in the cell. This variation can be as much as 40 mm. Needless to say, the effectiveness of fixed
10 mechanical pre-separation techniques and apparatus for separating the upper edge of the starter sheet from the starter cathode may be severely limited.

Once pre-separation has occurred, then the principal step according to the present invention occurs. That is the step of separation. Current processes include a process wherein a suction cups are attached to the starter sheets, to pull the starter
15 sheets from the starter cathode. However, this operation typically is conducted by merely directly pulling the starter sheet off of the starter cathode. As such, in order for separation to proceed, there must have been sufficient pre-separation of the starter sheet from the starter cathode so as to permit the balance of the starter sheet to be released and therefore stripped from the starter cathode, by pulling straight backwards
20 on the suction cups.

The discharge step is also typically carried out using the apparatus of the present invention, because it requires that the starter sheets be removed from the vertically oriented starter cathodes in a controlled fashion, and then placed horizontally either onto a secondary transfer mechanism, or directly onto a stack. It will be
25 understood hereafter that the discharge step is one which is easily carried out using the apparatus of the present invention, employing the necessary robotic and process design, and control and release of vacuum which is utilized for holding and transporting starter sheets once they have been stripped from the starter cathodes.

It thus becomes obvious that there is a specific industrial requirement for the
30 provision of a process or method which might be adapted to existing materials handling robotic machinery; but more particularly, there is a specific industrial requirement for the provision of a method and apparatus whereby the starter sheet pre-separation,

separation, and discharge steps may occur utilizing the same robotic equipment, even while the primary flat plate starter cathode is in motion. Thus, while not mandatory, it is extremely beneficial that the transport of the starter cathodes shall not employ stop motion movement at any stage during the pre-separation, separation, and discharge steps.

Moreover, it is desirable that the method and apparatus provided by the present invention provides a greater degree of reliability in the pre-separation process, irrespective of the position of the upper edge of the starter sheet on the starter cathode. These requirements are, of course, accomplished by the present invention. Still further, the present invention provides that there is a greater degree of reliability in the separation step, even if the pre-separation step has been incomplete or only partially complete.

Obviously, automation or the employment of robotics is most desirable so as to minimize worker involvement in a loud and potentially dangerous environment, and so that human labour handling of large and heavy, sharp-edged cathodes and starter sheets in rapid succession, may be obviated. This is especially so in a typical industrial application of the present invention, where the apparatus of the present invention is intended to provide production rates well in excess of 400 starter sheets per hour, or even higher.

From the above, the aims, objectives, and advantages, of the present invention become more clear, and include among others the following:

First, it is advantageous that the present invention provides a system for more efficient stripping of starter sheets from starter cathodes, and optionally a mechanism for transfer of the starter sheets between processing stations, and during the discharge step.

Also, it is advantageous that there be means for providing starter cathodes in an essentially vertical orientation so that they may be carried through the electrolysis process of electrorefining in their vertical orientation.

The provision of starter sheet pre-separation mechanisms, and the step of pre-separation, assures greater reliability and productivity, especially when the starter cathodes are being transported at a constant speed.

Another advantage of the present invention is that, in certain circumstances,

pre-separation may utilize a two step operation. The first step is to bring separator blades into contact with the starter cathode; and the second step is to bring the separator blades into contact with the upper edge of the starter sheet using a downward motion parallel to or coincident with the plane of the starter cathode where the starter sheet is adhered or bonded thereto. Needless to say, in keeping with the present invention, this two-step pre-separation operation is preferably carried out robotically.

As to the separation step provided by the present invention, it is advantageously carried out using either two steps or three steps, any and all of which assure reliability and successful separation.

In one aspect of the separation step, the full working area of a separator or stripper frame, which carries at least one, more preferably two, but usually four, vacuum suction cups, which is brought into contact with the starter sheet, and then having the robotic arm move so as to provide a rotary prying motion about an essentially horizontal pivot axis, which is thus employed to separate the starter sheet fully away from the starter cathode. In this manner, the starter sheet is effectively "peeled" from the surface of the starter cathode, instead of trying to merely "pull" the starter sheet off of the starter cathode.

A second aspect of separation step involves bringing a single corner of a separator or stripper frame into contact with a corner of the starter sheet, and utilizing a single small vacuum suction cup to separate the starter sheet at that single corner using a prying motion which is about a more vertical pivot axis, followed by contact of the full working area of the stripper frame with the starter sheet and a prying motion about an essentially horizontal axis.

A third aspect of separation step involves bringing the upper edge of a separator or stripper frame into contact with the upper edge of the starter sheet, and utilizing a series of vacuum suction cups to separate the upper edge of the starter sheet along the solution line from the starter cathode using a prying motion about a first, essentially horizontal pivot axis, followed by contact of the full working area of the stripper frame with the starter sheet and a prying motion about a second, essentially horizontal axis.

Of course, the above recital of these operations and steps in keeping with the

present invention, which recital is neither exhaustive nor inclusive, is most expeditiously, economically, and reliably, accomplished using robotic apparatus.

As stated above, the present invention is particularly adapted to the preparation of starter sheets for use in electrorefining of copper or nickel, although other metals are
5 also applicable.

Summary of the Invention

In accordance with one aspect of the present invention, there is provided an apparatus for stripping a substantially pure electroplated starter sheet from a primary flat plate starter cathode, which comprises a rectangular frame having at least one, and
10 preferably at least two first vacuum suction cups mounted below the top region of the rectangular frame in the major body region thereof, and facing in a direction away from the front of the rectangular frame.

In general, there are preferably between 2 and 8, and more preferably, between 3 and 5 first suction cups, and the projected area of each of the first suction cup is
15 preferably round.

A robotic arm is mounted at the rear of the rectangular frame, and adapted to move the frame forward and rearwardly, and to pivot the frame around horizontal and vertical pivot axes. In particular, the arm is moved in a rotational movement so as to cause one corner or edge of the starter sheet to be peeled from the starter cathode,
20 and then effecting rotation and rearward movement of the frame, so as to cause a further peeling action, on the starter sheet.

As such, upon successive forward movement and pivoting movement, an electroplated starter sheet may be stripped (or "peeled") from a primary flat plate starter cathode.

25 Thus, the apparatus of the present invention further preferably comprises a separator blade adapted for vertical movement above and at the top region of the rectangular frame in a plane which is coincident with the interface between the primary flat plate starter cathode and the substantially pure electroplated starter sheet which has been electroplated thereon.

30 In its usual embodiment, apparatus according to the present invention preferably comprise two opposed rectangular frames and two opposed separator

blades arranged at each side of the primary flat plate starter cathode from which two substantially pure electroplated starter sheets are to be stripped

To assist in establishing the peeling action, in preferred embodiments of the present invention, there is at least a second vacuum suction cup having a round
5 projected area mounted at at least one top corner of the rectangular frame. Preferably, two second suction cups are fitted; one at each of the top corners of the rectangular frame and preferably, the second vacuum suction cups are facing generally in a direction which is angled away from the front of the rectangular frame. The projected front area of the at least one further suction cup is typically smaller than the projected
10 front area of each of the at first suction cups.

Also, in a most preferred embodiments of the present invention, there is at least one third suction cup mounted in the region of the top region of the rectangular frame between the two top corners thereof. This can be one third suction cup, or is preferably, a plurality of third suction cups, with between 2 and 6 suction cups being preferred.
15 Typically, there are at least two third suction cups mounted in the region between the top corners of the rectangular frame, each preferably having a substantially rectangular projected area.

In keeping with one aspect of the present invention, the primary flat plate starter cathode is suspended from an overhead conveyor, and the at least one stripping frame
20 is adapted to move in concert with the respective primary flat plate starter cathode.

While not specifically directed to the following examples, it should be noted that in general, the material of the primary flat plate starter cathode is preferably chosen from the group consisting of stainless steel, titanium, and mixtures and alloys thereof; and the material of the substantially pure electrode starter sheet is preferably chosen
25 from the group consisting of copper and nickel.

The present invention also provides a method for stripping a substantially pure electroplated starter sheet from a primary flat plate starter cathode which comprises the following steps:

(a) Vertically suspending the primary flat plate starter cathode having the
30 substantially pure electroplated starter sheet electroplated on at least a first face thereof;

(b) Moving a separator blade vertically downwardly in a plane which is

coincident with the interface between the primary flat plate starter cathode and the substantially pure electroplated starter sheet which has been electroplated thereon, so as to cause a preliminary separation of the substantially pure electroplated starter sheet from the primary flat plate starter cathode, whereby the chemical bond and/or
5 mechanical bond between the primary flat plate starter cathode and the substantially pure electroplated starter sheet which has been electroplated thereon is broken at at least one point along the upper edge of the substantially pure electroplated starter sheet;

(c) Moving a rectangular frame comprising preferably at least one first suction
10 cup mounted below the top region of the rectangular frame in the major body region thereof, and facing in a direction away from the front of the rectangular frame, into contact with the substantially pure electroplated starter sheet and actuating the first suction cup so as to secure the suction cups to the substantially pure electroplated starter sheet; and

(d) Causing the frame to pivot about a horizontal pivot axis in a manner so as to
15 cause the upper region of the rectangular frame to move outwardly and downwardly with respect to the upper edge of the primary flat plate starter cathode, so as to thereby strip the substantially pure electroplated starter sheet from the primary flat plate starter cathode.

20 In a second variation of the method according to the present invention, step (c) is as follows:

(c1) Moving a rectangular frame comprising preferably at least one first suction
cup mounted below the top region of the rectangular frame in the major body region thereof, and further comprising at least one second suction cup mounted in the top
25 region of the rectangular frame, wherein all of the first and second suction cups are facing generally in a direction away from the front of the rectangular frame, and wherein the projected front area of the at least one second suction cup is smaller than the projected front area of each of the first suction cup, into a region adjacent the substantially pure electroplated starter sheet;

(c2) Pivoting the rectangular frame around both a vertical pivot axis and a
30 horizontal pivot axis so as to bring the at least one second suction cup adjacent a corner of the substantially pure electroplated starter sheet, and actuating the second

suction cup so as to secure the second suction cup to the substantially pure electroplated starter sheet at the corner.

Also, step (d) is as follows:

(d1) Causing the frame to pivot about a vertical pivot axis in a manner so as to
5 bring the first suction cup into contact with the substantially pure electroplated starter sheet, then causing the frame to pivot about a horizontal pivot axis in a manner so as to bring the first suction cup into contact with the substantially pure electroplated starter sheet and actuating the same, and then causing the frame to pivot about a horizontal
10 pivot axis in a manner so as to cause the upper region of the rectangular frame to move outwardly and downwardly with respect to the upper edge of the primary flat plate starter cathode, so as to thereby strip the substantially pure electroplated starter sheet from the primary flat plate starter cathode.

A third variation of the method according to the present invention provides that steps (c) and (d) are as follows:

(c3) Moving a rectangular frame comprising preferably at least one first suction
15 cup mounted below the top region of the rectangular frame in the major body region thereof, and at least one third suction cup mounted in the region of the top region of the rectangular frame between the two top corners thereof, wherein all of the first and third suction cups are facing in a direction away from the front of the rectangular frame, and
20 wherein the projected front area of the at least one third suction cup is smaller than the projected front area of each of the at least one first suction cup, into a region adjacent the substantially pure electroplated starter sheet, and actuating the at least one third suction cup so as to secure the third suction cup to the substantially pure electroplated starter sheet near the upper edge thereof;

(d2) Causing the rectangular frame to pivot around a horizontal pivot axis so as
25 to bring the first suction cup into contact with the substantially pure electroplated starter sheet, and then causing the frame to pivot about horizontal pivot axis in a manner so as to cause the upper region of the rectangular frame to move outwardly and downwardly with respect to the upper edge of the primary flat plate starter cathode, so as to thereby
30 strip the substantially pure electroplated starter sheet from the primary flat plate starter cathode.

It should be noted that any horizontal pivoting of the rectangular frame is

preferably accompanied by an essentially horizontal linear motion of the rectangular frame assembly away from the starter cathode.

Brief Description of the Drawings

Embodiments of this invention will now be described by way of example in association with the accompanying drawings in which:

Figure 1 is an isometric view of a typical rectangular frame used as a stripper frame in keeping with the present invention;

Figure 2 is a schematic view from above showing a conveyor line employing stripper frames in association with starter cathodes having starter sheets electroplated thereon, in keeping with the present invention;

Figure 3 is an elevation view of a stripper frame in association with a starter cathode having a starter sheet electroplated thereon, prior to undertaking a separation operation in keeping with the present invention;

Figure 4 is a side elevation view of a pair of stripper frames, at the conclusion of having stripped starter sheets from a starter cathode, in keeping with a first aspect of the method of the present invention;

Figure 5 is an isometric elevation showing a stripper frame in association with a starter cathode having a starter sheet electroplated thereon, in keeping with a second aspect of the method of the present invention;

Figure 6 is a side elevation view of a pair of stripper frames nearing the conclusion of having stripped starter sheets from a starter cathode, in keeping with a second aspect of the method of the present invention;

Figure 7 is a side elevation of a pair of stripper frames which are about to strip a pair of starter sheets from a starter cathode, in keeping with a third aspect of the method of the present invention; and

Figure 8 is a side elevation view of a pair of stripper frames, at the conclusion of having stripped starter sheets from a starter cathode, in keeping with a third aspect of the method of the present invention.

Detailed Description of the Preferred Embodiments

The novel features which are believed to be characteristic of the present

invention, as to its structure, organization, use and method of operation, together with further objectives and advantages thereof, will be better understood from the following drawings in which presently preferred embodiments of the invention will now be illustrated by way of example. It is expressly understood, however, that the drawings
5 are for the purpose of illustration and description only, and are not intended as a definition of the limits of the invention.

In the drawings, like reference numerals depict and identify like elements.

Turning now to Figure 1, there is shown an isometric view of a typical frame 10 which is used as a stripper frame in keeping with the present invention.

10 The stripper frame 10 comprises framing elements 12 and 14, which may also function as vacuum manifolds. At the front face of the frame 10 there are mounted a plurality of suction cups 16, 18, 20; and at the rear of the frame 10 there is mounted a robotic arm 22. The suction cups 16 are referred to in the following discussion as first suction cups, and while there are generally four such suction cups mounted at the front
15 face of the frame, it can be understood that there may be as few as one, or two, first suction cups 16.

The suction cups 18 are referred to in the following discussion as second suction cups; and typically there are two second suction cups mounted at the front face of the stripper frame 10 in each top corner thereof. It will be noted that the faces of the
20 second suction cups 18 are not coplanar with the faces of the primary suction cups 16. This is because the second suction cups 18 are positioned so as to begin a separation step of a starter sheet away from a starter cathode in keeping with a second aspect of the method of the invention, as described hereafter.

The suction cups 20 are referred to in the following discussion as third suction
25 cups; and typically there are at least two and usually three third suction cups 20 located in the top region of the stripper frame 10.

It will also be noted that the projected area of the front faces of the first suction cups 16 and the second suction cups 18 are substantially round, whereas the projected area of the front faces of the third suction cups 20 are substantially rectangular.

30 It will be understood that the robotic arm 22 is such that it will move the stripper frame 10 in varying spatial directions. In particular, the stripper frame 10 can be moved forwardly and rearwardly along an axis parallel to the axis of the robotic arm 22 as it is

shown in Figure 1. Moreover, the robotic arm is capable of moving the stripper frame 10 in pivoting actions, about pivot axes which may be horizontal or vertical, or combinations thereof. Such actions will be understood from the discussion hereafter concerning stripping methods in keeping with the present invention.

5 Thus, as will be seen hereafter, successive forward movement and rotational pivoting movement of the stripper frame 10 will result in the stripping (or "peeling") of a substantially pure electroplated starter sheet from a primary flat plate starter cathode.

 As noted above, there are typically three operations or steps which are followed when starter sheets are stripped from starter cathodes. The first of those three steps is
10 pre-separation; and as discussed, this requires breaking the chemical and/or mechanical bond between the starter sheet and the starter cathode, particularly at the upper edge of the starter sheet in the region defined as the solution line. However, as noted, the positioning of the upper edge of the starter sheet with respect to the starter cathode may vary in a vertical direction by as much as 40 mm. Thus, separator blades
15 30 are provided, and they are adapted for vertical movement above and at the top region of the rectangular frame in a plane which is coincident with the interface between the starter cathode and the starter sheet which has been electroplated thereon. That is to say, separator blades 30 can move vertically upwardly and
20 downwardly so as to position themselves at the solution line for any respective starter sheet. Downward motion of the separator blades 30 will result in pre- separation of the starter sheet from starter cathode at least at some points if not entirely along the upper edge of the starter sheet.

 It should also be noted that in the figures of drawings, in all cases where a full stripper frame is shown, there are four first suction cups 16, two second suction cups
25 18, and three third suction cups 20. It has been stated that there are at least two (or even one) first suction cups, one second suction cup, and one third suction cup in the simplest embodiment. However, a most practical embodiment of the stripper frame 10 is as shown because it can be utilized in performing any of the three contemplated variations or aspects of the separation step for stripping starter sheets from starter
30 cathodes in the manners discussed herein.

 Referring to Figure 2, a schematic is shown where a conveyor line 40 is employed, and where opposed sets of stripper frames 10 are shown moving in concert

with a starter cathode 50 which is suspended therefrom. Figures 3 and 5 show further details of the manner in which the primary flat plate starter cathodes 50 are vertically suspended using a ganged trolley 52, hangers 54, and connection arrangements 56. The details of these elements are beyond the scope of the present invention, but should be well known to those skilled in the electrorefining art. The movement of the starter cathodes 50 along the conveyor 40 is from right to left, as indicated by arrow 58.

It will also be understood, of course, that starter sheets 60 have already been electroplated onto at least one face – usually, and as shown, both faces – of each starter electrode 50. Thus, as noted above, it is the purpose of the present invention that the apparatus as shown, and the method to be described hereafter, shall be employed to strip the starter sheets 60 from the starter cathodes 50, in each case.

The method of stripping starter sheets from starter cathodes has been recited above, insofar as it is shown to comprise a number of steps. However, the present invention provides three different aspects to the separation step, otherwise known as the stripping step, by which the starter sheets are stripped from the starter cathode. The first two steps of each of the different aspects of the method in keeping with the present invention remain the same in each case, and are as follows:

(a) Vertically suspending the primary flat plate starter cathode having the substantially pure electroplated starter sheet electroplated on at least a first face thereof.

(b) Moving a separator blade vertically downwardly in a plane which is coincident with the interface between the primary flat plate starter cathode and the substantially pure electroplated starter sheet which has been electroplated thereon, so as to cause a preliminary separation of the substantially pure electroplated starter sheet from the primary flat plate starter cathode, whereby the chemical bond and/or mechanical bond between the primary flat plate starter cathode and the substantially pure electroplated starter sheet which has been electroplated thereon is broken at at least one point along the upper edge of the substantially pure electroplated starter sheet.

The vertical suspension of starter cathodes 50 having starter sheet 60 electroplated thereon is clearly shown in each of Figures 2 through 8.

Also, as can be seen in each of Figures 4, 6, 7, and 8, the separator blades 30

are arranged for upwards and downwards movement as indicated particularly by arrows 32 and 34 in Figure 4. It will be well appreciated that, for the most part, the figures are not to scale; and thus it will be appreciated that the movement of the separator blades 30 downwardly so as to cause pre-separation is in a plane which is substantially coincident with the interface between the primary flat plate starter cathode 50 and substantially pure electroplated starter sheet 60 which has been electroplated thereon.

Now, having regard to Figures 3 and 4, a first aspect of the method in keeping with the present invention is described. First, the remaining two steps of that method are as recited immediately below.

(c) Moving a rectangular frame comprising at least one first suction cup mounted below the top region of the rectangular frame in the major body region thereof, and facing in a direction away from the front of the rectangular frame, into contact with the substantially pure electroplated starter sheet and actuating the first suction cups so as to secure the suction cups to the substantially pure electroplated starter sheet; and

(d) Causing the frame to pivot in a rotational fashion about a horizontal pivot axis in a manner so as to cause the upper region of the rectangular frame to move outwardly and downwardly with respect to the upper edge of the primary flat plate starter cathode, so as to thereby strip the substantially pure electroplated starter sheet from the primary flat plate starter cathode.

Figure 3 shows a front elevation of a stripper frame in association with a starter cathode 50 which has had a starter sheet 60 electroplated thereon. According to the first aspect of the present invention, as defined immediately above, the starter frame 10 having the first suction cups 16 is moved into contact with the substantially pure electroplated starter sheet 60, and the vacuum for each of the first suction cups 16 is actuated so as to secure the stripper frame structure 10 to the starter sheet 60. Then, each of the stripper frames 10, as shown, is caused to pivot in a rotational fashion about a horizontal axis so that the upper region of the stripper frame 10 moves first outwardly and then downwardly with respect to the upper edge of the starter cathode, as shown in Figure 4. As such, starter sheet 60 is "peeled" or stripped from starter cathode 50, in a manner where the upper edge is first removed from starter cathode 50.

In a second variation of the method according to the present invention, step (c) is as follows:

(c1) Moving a rectangular frame comprising at least two first suction cups mounted below the top region of the rectangular frame in the major body region thereof, and further comprising at least one second suction cup mounted in the top region of the rectangular frame, wherein all of the first and second suction cups are facing generally in a direction away from the front of the rectangular frame, and wherein the projected front area of the at least one second suction cup is smaller than the projected front area of each of the at least two first suction cups, into a region adjacent the substantially pure electroplated starter sheet;

(c2) Pivoting the rectangular frame around both a vertical pivot axis and a horizontal pivot axis so as to bring the at least one second suction cup adjacent a corner of the substantially pure electroplated starter sheet, and actuating the second suction cup so as to secure the second suction cup to the substantially pure electroplated starter sheet at the corner.

This second variation is shown particularly in Figures 5 and 6. In those figures, a second suction cup 18 (in this case, located at the upper left corner of the stripper frame 10, as shown) is brought into contact with a corner of the starter sheet 60, as shown at 62. This requires first that the operating second suction cup 18 is moved into place by pivoting the stripper frame 10 about a vertical axis in the first instance, and pivoting it as well about a horizontal axis so that only the operating second suction cup 18 is in contact with the starter sheet 60. When the vacuum is activated in the operating second suction cup 18, then the stripper frame 10 may be pivoted about an essentially horizontal axis so as to cause the starter sheet 62 to break away from the starter cathode 50 at the corner 62. This step may be carried out for limited period of time, at least sufficient that stripping of the starter sheet 60 away from the starter cathode 50 has begun, at least at the corner 62 and somewhat beyond.

Then, step (d) is carried out, as follows:

(d1) Causing the frame to pivot about a more vertical pivot axis in a manner so as to bring the first suction cups into contact with the substantially pure electroplated starter sheet, then causing the frame to pivot about a vertical pivot axis in a manner so as to bring the first suction cups into contact with the substantially pure electroplated

starter sheet and actuating the same, and then causing the frame to pivot about a horizontal pivot axis in a manner so as to cause the upper region of the rectangular frame to move outwardly and downwardly with respect to the upper edge of the primary flat plate starter cathode, so as to thereby strip or peel the substantially pure electroplated starter sheet from the primary flat plate starter cathode, in a manner that begins first at corner 62.

In other words, as can be seen particularly from Figure 6, the first suction cups 16 are brought into contact with the starter sheet 60 by appropriate manipulation of the stripper frame 10 about a vertical pivot axis. Thereafter, each stripper frame 10 is caused to pivot about a horizontal axis so as to strip the entire starter sheet 60 away from the starter cathode 50.

A third variation of the method according to the present invention provides that steps (c) and (d) are as follows:

(c3) Moving a rectangular frame comprising at least two first suction cups mounted below the top region of the rectangular frame in the major body region thereof, and at least one third suction cup mounted in the region of the top region of the rectangular frame between the two top corners thereof, wherein all of the first and third suction cups are facing in a direction away from the front of the rectangular frame, and wherein the projected front area of the at least one third suction cup is smaller than the projected front area of each of the at least two first suction cups, into a region adjacent the substantially pure electroplated starter sheet, and actuating the at least one third suction cup so as to secure the third suction cup to the substantially pure electroplated starter sheet near the upper edge thereof;

(d2) Causing the rectangular frame to pivot around a horizontal pivot axis so as to bring the first suction cups into contact with the substantially pure electroplated starter sheet, and then causing the frame to pivot in a rotational fashion about a horizontal pivot axis in a manner so as to cause the upper region of the rectangular frame to move outwardly and downwardly with respect to the upper edge of said primary flat plate starter cathode, so as to thereby strip the substantially pure electroplated starter sheet from the primary flat plate starter cathode.

Here, Figures 7 and 8 illustrate the operation of the third variation of the method in keeping with the present invention. The third suction cups 20 are brought into contact

with the starter cathode near the upper edge thereof by appropriately tilting the stripper frames 10 about a horizontal pivot axis. Upon actuation of the third suction cups 20, and pivoting the stripper frames 10 about a horizontal axis so as to move the third suction cups 20 outwardly and downwardly with respect to the upper edge of the starter cathode 50, following the usual pre-separation step, the starter sheet 60 will begin to break away from the starter cathode 50. There may be some bending of the starter cathode 60, as shown in each of Figures 7 and 8, but either the malleability and/or the elastic memory properties of the starter sheets 60 will cause them to assume planarity, as required for subsequent processing.

This process is similar to that described in Figures 3 and 4, but third suction cups 20 provided increased efficiency in peeling starter sheet 60 from starter cathode 50.

In any aspect of the methods of the present invention, it will be understood that the time which may be allotted for any particular step to take place at any particular station may vary. However, production rates of 800 starter sheets per hour are possible to be achieved using the apparatus and methods of the present invention. In any event, most refining operators typically require a production rate of at least 400 starter sheets per hour, and some may demand production rates of at least 1000 starter sheets per hour. Such requirements are possible by utilizing the present invention.

It is clear from the above discussion that execution of the processes or steps required for production of starter sheets may be automated to a significant degree when the present invention is employed; and all of the necessary steps may be taken automatically in the appropriate sequence.

Needless to say, virtually all aspects of the operation and control of the apparatus and method in keeping with the present invention, and as taught above, may be under the control of a programmable logic controller. That means that when the apparatus and methods of the present invention are employed, the need for human intervention is obviated. Thus, safety of the operation is self-evident.

The present discussion has provided a teaching with appropriate examples, which are in no way either exhaustive or exclusive, but merely exemplary, of an invention whereby substantially pure electroplated starter sheets may be stripped from primary flat plate starter cathodes, thereby satisfying all of the aims and objectives of

the present invention as set forth above.

Of course, it will be understood that alternatives, modifications, and variations thereof, may be suggested to those in the art, without falling outside the scope of the appended claims.

5 Use of the word "comprise" and variations of the word such as "comprising" and "comprises" in the present specification and claims, is not intended to exclude other additives, components, integers, or steps. Moreover, it is evident that the invention disclosed herein may be practiced by those skilled in the art in the absence of any element which is not specifically disclosed herein.

10 Moreover, the word "substantial" and variations of the word such as "substantially" and "generally", when used with an adjective or adverb, are intended to enhance the scope of the particular characteristic. For example, substantially pure is intended to mean pure or nearly pure and/or exhibiting characteristics associated with purity – such as being in the range of 99.9% pure, or higher, with respect to metals.
15 Also, facing generally in a direction is intended to mean more or less facing in a given direction, but not necessarily exactly in that direction.

The present invention has been discussed, and prior art known to the inventor has been addressed as to conventional processes; but no admission is made that any of the prior art discussed herein is citable against the present application.

What is claimed is:

1. An apparatus for stripping a substantially pure electroplated starter sheet from a primary flat plate starter cathode, comprising:
 - a rectangular frame having at least one first suction cup mounted below the top region of said rectangular frame in the major body region thereof, and facing in a direction away from the front of said rectangular frame; and
 - a robotic arm mounted at the rear of said rectangular frame, and adapted to move said frame forward and rearwardly, and to pivot said frame around horizontal and vertical pivot axes;
- 10 whereby upon successive forward movement and pivoting movement an electroplated starter sheet may be stripped from a primary flat plate starter cathode.
2. The apparatus of claim 1, further comprising a separator blade adapted for vertical movement above and at the top region of said rectangular frame in a plane which is coincident with the interface between said primary flat plate starter cathode and said substantially pure electroplated starter sheet which has been electroplated thereon.
- 15 3. The apparatus of claim 2, further comprising at least one further suction cup mounted in the top region of said rectangular frame at a corner thereof, wherein all of said suction cups are facing generally in a direction away from the front of said rectangular frame; and
- 20 wherein the projected front area of said at least one further suction cup is smaller than the projected front area of each of said at least one first suction cup.
4. The apparatus of claim 3, comprising two opposed rectangular frames and two opposed separator blades arranged at each side of the primary flat plate starter cathode from which two substantially pure electroplated starter sheets are to be stripped.
- 25

5. The apparatus according to any of claims 1 to 4, wherein there are four first suction cups, and the projected area of each of said first suction cups is round.
6. The apparatus of claim 3, wherein there are four first suction cups, and the projected area of each of said first suction cups is round.
- 5 7. The apparatus of claim 6, wherein said further suction cup is at least one second suction cup having a round projected area, mounted at at least one top corner of said rectangular frame.
8. The apparatus according to any of claims 1 to 5, wherein there is at least one third suction cup mounted in the region of said top region of said rectangular frame
10 between the two top corners thereof.
9. The apparatus of claim 6, wherein there is at least one third suction cup mounted in the region of said top region of said rectangular frame between the two top corners thereof.
10. The apparatus of any of claims 1 to 6, wherein said primary flat plate starter
15 cathode is suspended from an overhead conveyor, and said at least one stripping frame is adapted to move in concert with the respective primary flat plate starter cathode.
11. The apparatus of claim 9, wherein said primary flat plate starter cathode is suspended from an overhead conveyor, and said at least one stripping frame is
20 adapted to move in concert with the respective primary flat plate starter cathode.
12. The apparatus of claim 9, wherein there are at least two third suction cups mounted in the region between the top corners of said rectangular frame, each having a substantially rectangular projected area.

13. The apparatus of claim 1, wherein the material of said primary flat plate starter cathode is chosen from the group consisting of stainless steel, titanium, and mixtures and alloys thereof; and wherein the material of said substantially pure electrode starter sheet is chosen from the group consisting of copper and nickel.

5 14. A method of stripping a substantially pure electroplated starter sheet from a primary flat plate starter cathode, comprising the steps of:

(a) vertically suspending said primary flat plate starter cathode having said substantially pure electroplated starter sheet electroplated on at least a first face thereof;

10 (b) moving a separator blade vertically downwardly in a plane which is coincident with the interface between said primary flat plate starter cathode and said substantially pure electroplated starter sheet which has been electroplated thereon, so as to cause a preliminary separation of said substantially pure electroplated starter sheet from said primary flat plate starter cathode, whereby the chemical bond and
15 mechanical bond between said primary flat plate starter cathode and said substantially pure electroplated starter sheet which has been electroplated thereon is broken at at least one point along the upper edge of said substantially pure electroplated starter sheet;

(c) moving a rectangular frame comprising at least one first suction cup
20 mounted below the top region of said rectangular frame in the major body region thereof, and facing in a direction away from the front of said rectangular frame, into contact with said substantially pure electroplated starter sheet and actuating said first suction cup so as to secure said suction cups to said substantially pure electroplated starter sheet; and

25 (d) causing said frame to pivot about a horizontal pivot axis in a manner so as to cause the upper region of said rectangular frame to move outwardly and downwardly with respect to the upper edge of said primary flat plate starter cathode, so as to thereby strip said substantially pure electroplated starter sheet from said primary flat plate starter cathode.

15. The method of claim 14, wherein step (c) is as follows:

(c1) moving a rectangular frame comprising at least one first suction cup mounted below the top region of said rectangular frame in the major body region thereof, and further comprising at least one second suction cup mounted in the top
5 region of said rectangular frame at a corner thereof, wherein all of said first and second suction cups are facing generally in a direction away from the front of said rectangular frame, and wherein the projected front area of said at least one second suction cup is smaller than the projected front area of each of said at least one first suction cup, into a region adjacent said substantially pure electroplated starter sheet;

10 (c2) pivoting said rectangular frame around both a vertical pivot axis and a horizontal pivot axis so as to bring said at least one second suction cup adjacent a corner of said substantially pure electroplated starter sheet, and actuating said second suction cup so as to secure said second suction cup to said substantially pure electroplated starter sheet at said corner; and

15 wherein step (d) is as follows:

(d1) causing said frame to pivot about a vertical pivot axis in a manner so as to bring said first suction cup into contact with said substantially pure electroplated starter sheet, then causing said frame to pivot about a vertical pivot axis in a manner so as to bring said first suction cup into contact with said substantially pure electroplated starter
20 sheet and actuating the same, and then causing said frame to pivot about a horizontal pivot axis in a manner so as to cause the upper region of said rectangular frame to move outwardly and downwardly with respect to the upper edge of said primary flat plate starter cathode, so as to thereby strip said substantially pure electroplated starter sheet from said primary flat plate starter cathode.

25 16. The method of claim 14, wherein step (c) is as follows:

(c3) moving a rectangular frame comprising at least one first suction cup mounted below the top region of said rectangular frame in the major body region thereof, and at least one third suction cup mounted in the region of said top region of said rectangular frame between the two top corners thereof, wherein all of said first and
30 third suction cups are facing in a direction away from the front of said rectangular frame, and wherein the projected front area of said at least one third suction cup is

smaller than the projected front area of each of said at least two first suction cup, into a region adjacent said substantially pure electroplated starter sheet, and actuating said at least one third suction cup so as to secure said third suction cup to said substantially pure electroplated starter sheet near the upper edge thereof;

5 and wherein step (d) is as follows:

 (d2) causing said rectangular frame to pivot around a horizontal pivot axis so as to bring said first suction cup into contact with said substantially pure electroplated starter sheet, and then causing said frame to pivot about a horizontal pivot axis in a manner so as to cause the upper region of said rectangular frame to move outwardly
10 and downwardly with respect to the upper edge of said primary flat plate starter cathode, so as to thereby strip said substantially pure electroplated starter sheet from said primary flat plate starter cathode.

17. The method of claim 14, wherein the material of said primary flat plate starter cathode is chosen from the group consisting of stainless steel, titanium, and mixtures
15 and alloys thereof; and wherein the material of said substantially pure electrode starter sheet is chosen from the group consisting of copper and nickel.

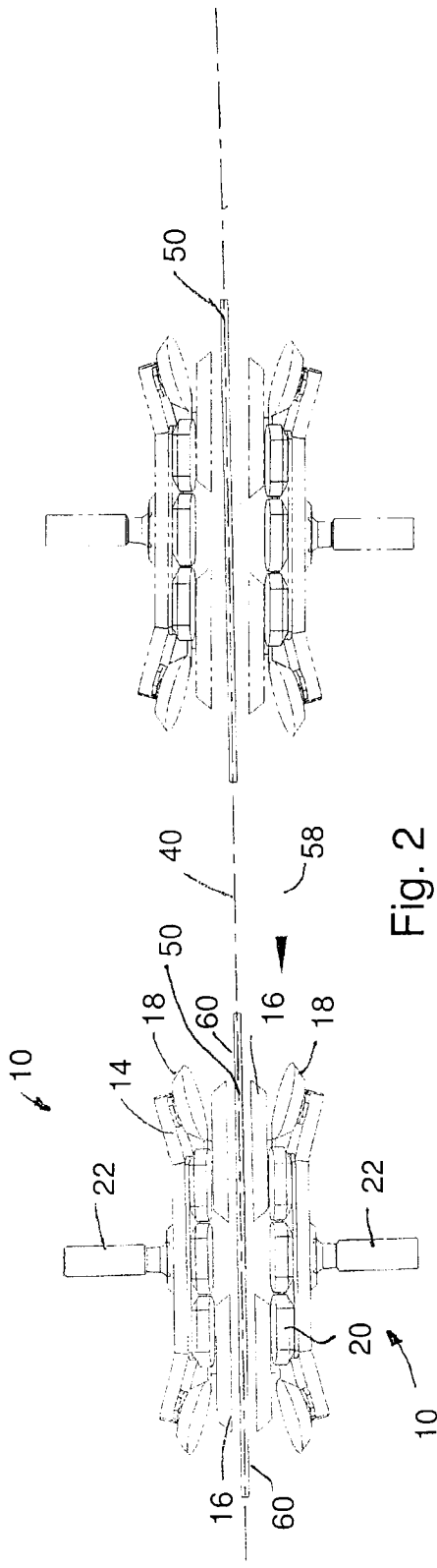


Fig. 2

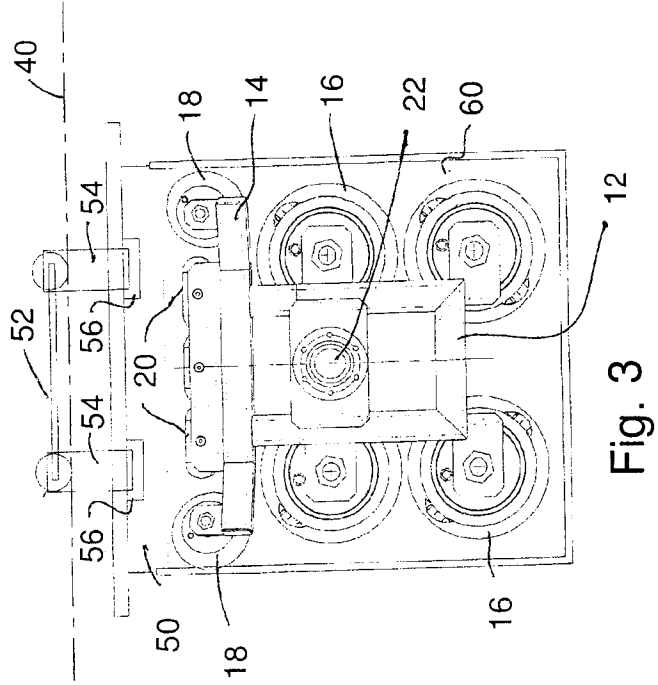


Fig. 3

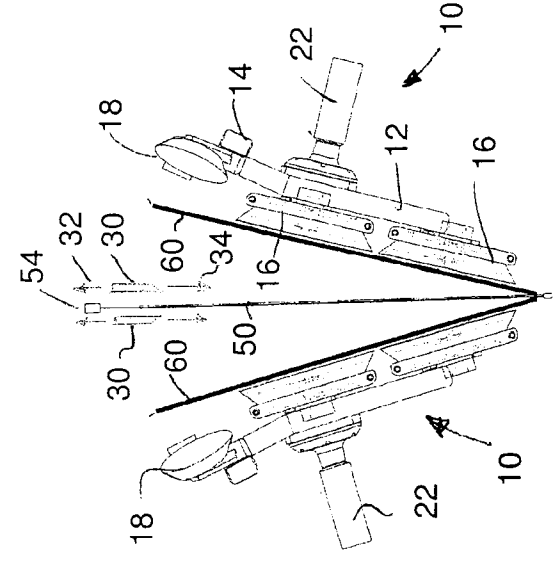


Fig. 4

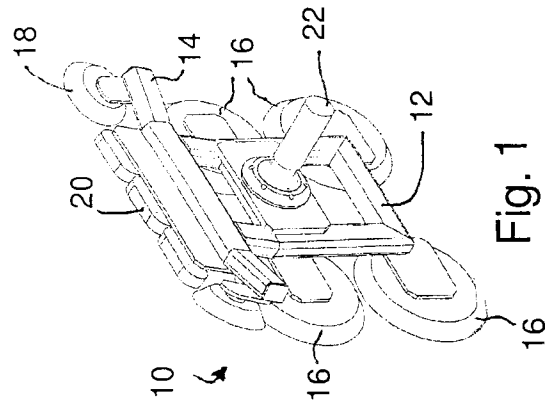


Fig. 1

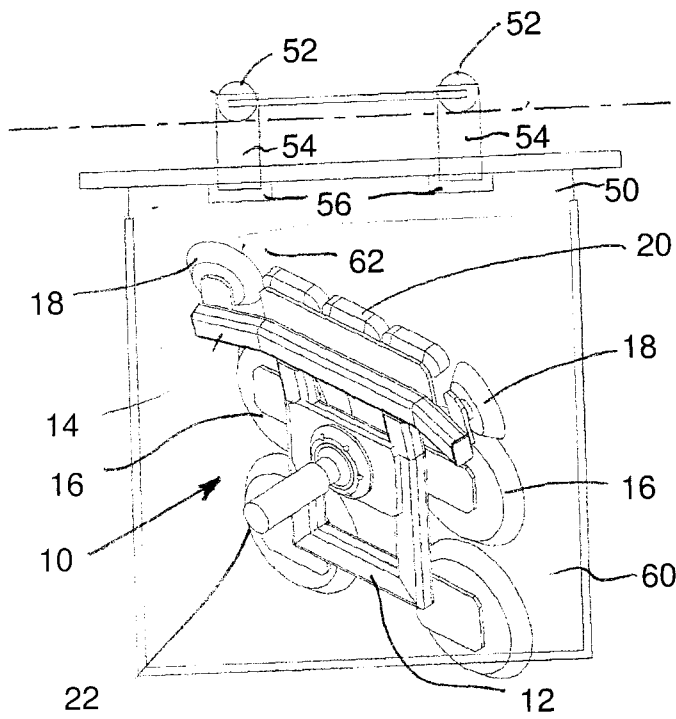


Fig. 5

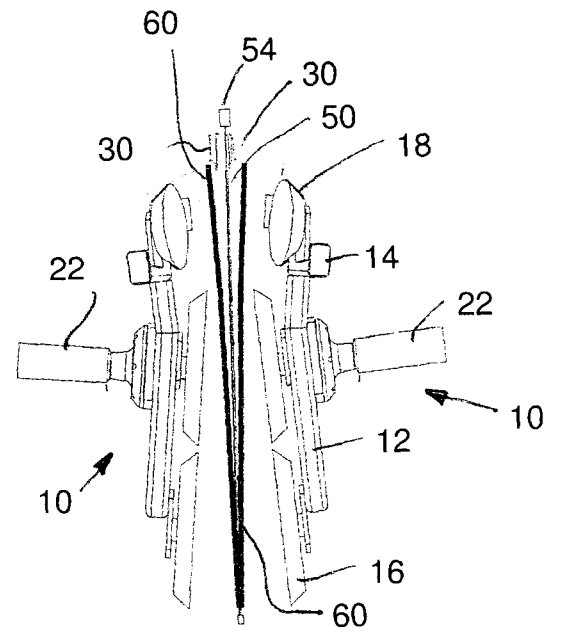


Fig. 6

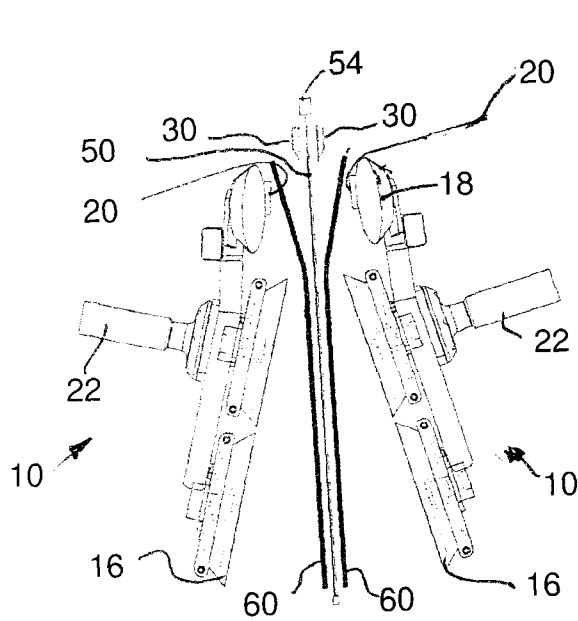


Fig. 7

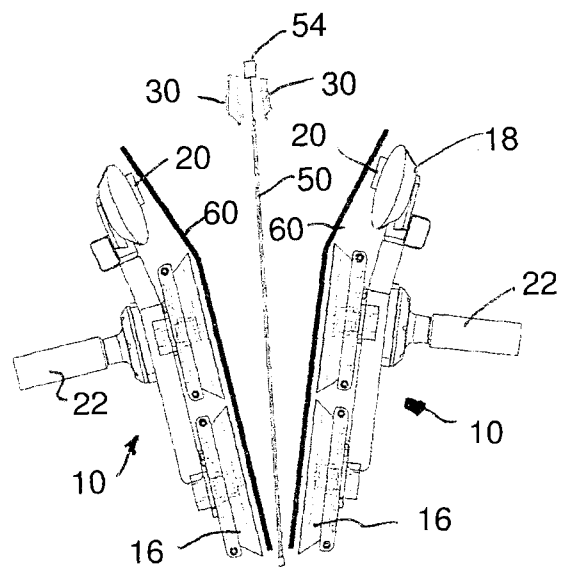


Fig. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2013/000677

A. CLASSIFICATION OF SUBJECT MATTER IPC: C25D 5/48 (2006.01) , B23P 19/00 (2006.01) According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC: C25D, C25C, B23P Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used) EPOQUE (EPODOC & FULLTEXT); STN (CAplus); TotalPatent; Google; Canadian Patent Database		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,417,953; VIELLEFONT ET AL.; 29 November 1983 (29-11-1983) Abstract; Columns 1,2,5,6; Figs 8,9,12	14
A	US 3,807,020; VAN RAEVELS ET AL.; 30 April 1974 (30-04-1974) whole document	
A	US 2012/0037319 A1; RUDDLE ET AL.; 16 February 2012 (16-02-2012) whole document	
A	WO 2010/116038 A1; ANDREN ET AL.; 14 October 2010 (14-10-2010) whole document	
A	JP 2001081591 A; TAKEDA ET AL.; 27 March 2001 (27-03-2001) whole document	
A	US 3,636,677; MCNAMARA ET AL.; 25 January 1972 (25-01-1972) whole document	
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent 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 when the document is taken alone "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	
Date of the actual completion of the international search 31 October 2013 (31-10-2013)	Date of mailing of the international search report 01 November 2013 (01-11-2013)	
Name and mailing address of the ISA/CA Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001-819-953-2476	Authorized officer David Chamberlain (819) 934-3594	

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2013/000677

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US3636677A	25 January 1972 (25-01-1972)	None	