Dec. 18, 1951 W. J. COOK ET AL 2,578,968

STARTING SHEET FOR ELECTROLYTIC SEPARATION OF NICKEL

Filed Oct. 1, 1948 2 SHEETS—SHEET 1

Fig. 1.

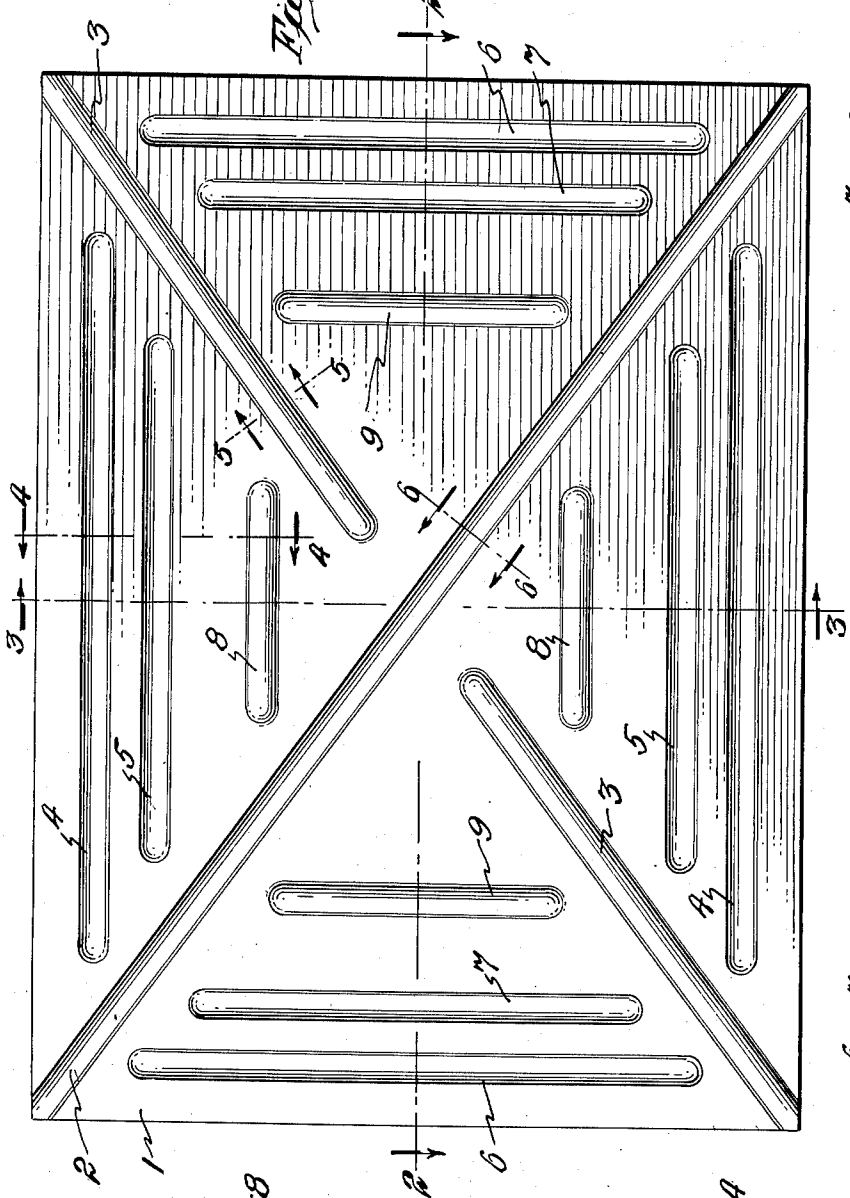

Fig. 2.

Fig. 3.

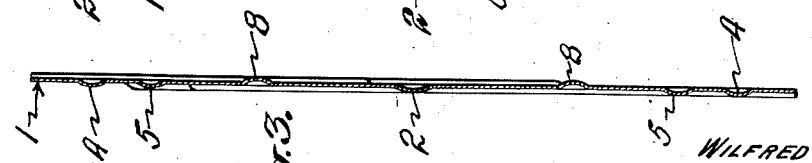

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Fig. 4.

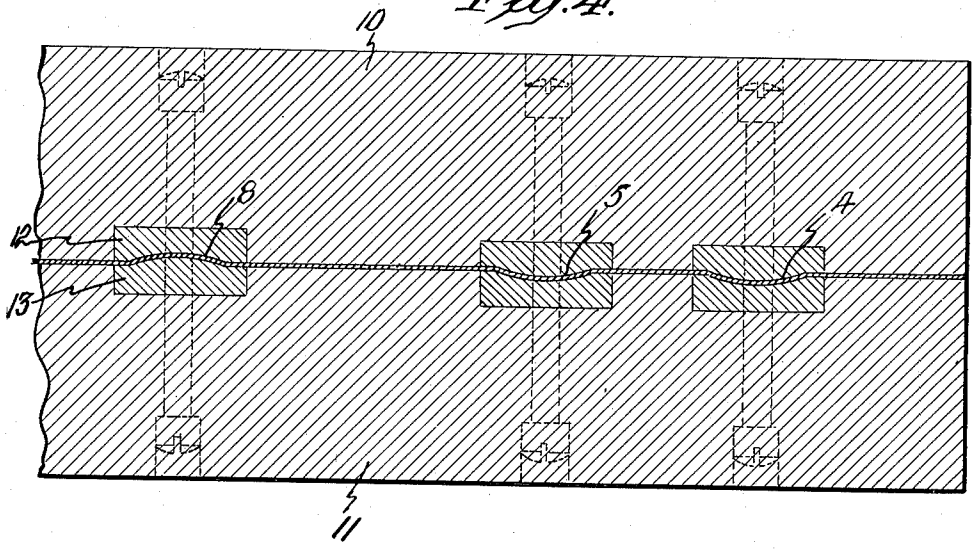


Fig. 5.

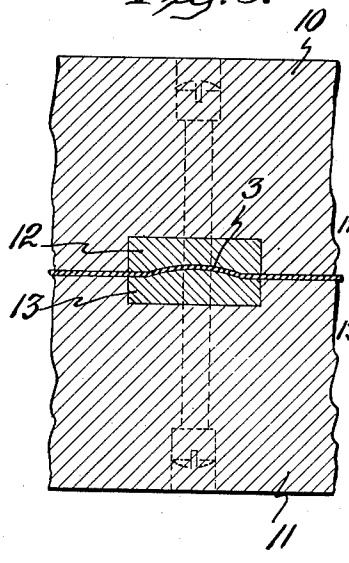


Fig. 6.

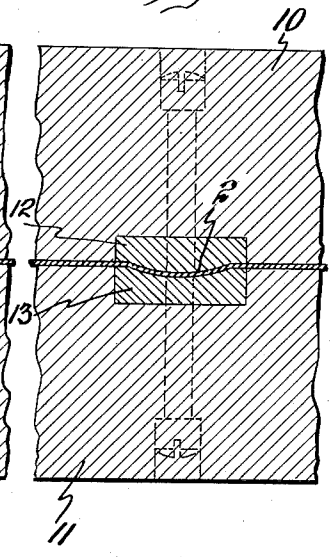
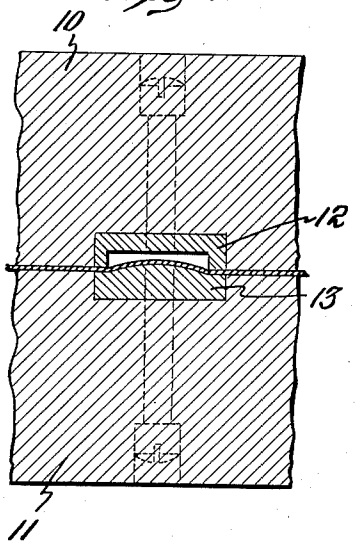


Fig. 7.



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STARTING SHEET FOR ELECTROLYTIC SEPARATION OF NICKEL

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1 Claim. (Cl. 204—281)

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The present invention relates to the art of producing electrolytic nickel, and, more particularly, to the production of starting sheets used as cathodes in the conventional process of nickel electrorefining.

In conventional practice, starting sheets have been produced by the plating of a thin sheet of substantially pure nickel on a mother plate of stainless steel or other suitably inert metal, such as a nickel-chromium alloy, stripping the starting sheet therefrom, and then manually straightening the stripped starting sheet prior to its use as the cathode in the electrolytic refining process. As thus produced, the starting sheets are in the form of plain blanks or flat sheets which, by reason of their size, relative thinness and lack of rigidity result in troublesome and expensive operational difficulties. The inherent tendency of the cathode sheets is to warp or curl after a relatively short period in the refining bath making it necessary to remove the sheets from the bath and to restraighten them before continuing the growth of the cathodes. Such warping of the cathode sheets if allowed to progress would result in short circuiting between the cathodes and anodes causing current losses, diaphragm failures and interruption to the process.

The initial straightening of the starting sheets as manually performed is objectional under industrial conditions because careless operators either do not properly straighten the sheets or, as commonly experienced, dirty the face of the sheets leading to undesirable surface effects on the face of the finished cathode known as "honeycombing" and/or "berrying." The manual straightening is moreover costly and labor-consuming. The further requirement of restraightening encounters still greater objections and difficulties incident to the nature of the operation. This necessitates removal of the cathode sheets from the bath with the coincidental dispersion of electrolyte causing occupational hazards and interference to good electrical contacts.

While efforts have heretofore been made to remedy the objections and difficulties, they have shown no substantial degree of success in the electrolytic refining of nickel largely by reason of the peculiar properties of this specific metal. For example, the high modulus of elasticity of the metal renders is extremely difficult to straighten mechanically. In addition, the inherent tendency to form "berries" at local high spots frequently leads to cathode-anode short circuits with the resulting loss of current. The attempted solutions of the problem presented have included varied formation of the starting sheets to obtain stiffening effect including corrugating of the sheets which, however, have heretofore proven ineffective and unsatisfactory for the purpose in its application to practical nickel refining. In this connection it has been found that in the corrugating of the sheets over extended areas of parallel corrugation warping of the sheets occurs particularly during electrolytic separation with resulting short circuiting, particularly due to the local area warping or deflection of the metal.

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In accordance with the present invention, the objections and disadvantages incident to the warping of the starting sheets have to a large degree been eliminated by the provision of novel starting sheets with special structural arrangements to provide stiffening deformations of the metal in a special pattern, designed to reinforce or stiffen the metal against bending or warping in all directions, and of a character permissible of successful use in practical electrolytic nickel refining. Important features which materially contribute to the successful use in the specific process comprises an improved starting sheet having stiffening deformations wherein the major surface areas of the starting sheets are plane or flat surfaces and wherein the deformations of the metal provide elongated channels or ribs of shallow cross-sectional form and in an arrangement of the ribs providing maximum stiffening effect with a minimum deformation of the metal or sheets.

It is an object of the invention to provide stiffening of the starting sheets in such manner as to maintain a straight sheet during the electrolytic separation and to provide the channel-rib formation by reversely offsetting the sheet material to balance or neutralize the warping tendencies incident to nickel deposition in the process of electro-refining.

A further object of the invention is to produce an improved starting sheet inherently stiffened in its structural formation, wherein the major portion of its surface area will constitute a plane or flattened surface, wherein the stiffening ribs are made by offsetting the metal and wherein the rib formations are of relatively shallow cross-sectional contour suitable to economic commercial production of the novel nickel starting sheets.

Another important object of the invention, involving the elimination of the detrimental features of the prior art, is to provide a starting sheet of perfected structure which shall be inher-

ently stiffened against warping in a manner to preserve its original flat plane during the entire period of electrodeposition in the practical nickel refining operation.

It is within the contemplation of the invention to effect important savings in operational costs which are likewise accompanied by advantages such as the maintenance of clean contacts, resulting in uniformity of voltage with high ampere efficiency.

The invention likewise contemplates an improved method of producing the starting sheets of the character described wherein the initially stripped sheets are first roller-straightened and subsequently die-pressed to form, thereby insuring uniform production of inherently stiffened starting sheets which will maintain their straightened condition throughout the practical refining process.

Moreover, the invention provides a process for the production of an inherently rigid starting sheet involving associated steps in an electrolytic nickel refining operation.

Other desirable features and advantages of the present invention will be more fully understood by reference to the accompanying drawings in which:

Fig. 1 illustrates a plan view of a rectangular starting sheet embodying the features of the present invention;

Fig. 2 is a vertical and longitudinal sectional view thereof taken on line 2—2 of Fig. 1;

Fig. 3 is a transverse sectional view thereof taken on line 3—3 of Fig. 1;

Fig. 4 depicts a sectional view illustrating a portion of the die structure employed in the production of the starting sheets and illustrating in section a portion of the starting sheet corresponding to a section taken on line 4—4 of Fig. 1;

Fig. 5 is a similar sectional view of a portion of the mating dies employed in the offsetting of the metal of the starting sheets wherein the starting sheet portion illustrated in section is that portion as indicated by the sectional line 5—5 of Fig. 1;

Fig. 6 shows a corresponding view illustrating the production of the portion of the sheet corresponding to the sectional line 6—6 of Fig. 1, and

Fig. 7 is a similar view of a die formation of modified structure.

In the embodiment of the invention illustrated in the drawings, the several features are incorporated in a cathode starting sheet formed as a rectangular blank or sheet of nickel. The rectangular blank or sheet of nickel in its initial stage is produced as a plane sheet by the electrodeposition of substantially pure nickel upon a blank of stainless steel and by stripping of the deposited sheet nickel from the blank. The sheets as thus produced may, if desired be roller leveled or initially straightened and are then, in accordance with the invention, die-pressed for localized deformation or offsetting of portions of the sheet nickel to provide stiffening or reinforcing ribs or channels in an arrangement such as to stiffen the starting sheet against bending in all directions. The arrangement is such that the number and dimensions of the deformations are such that the major surface area of the starting sheet is a plane or flat surface and the stiffening deformations are such that the sheet is of unchanged thickness throughout. The deformations as shown in the drawings are in their cross-sectional contour of shallow depth and relatively large radius and curvature thereby to provide

on one side of the sheet a shallow curve or curved channel and at the opposite side of the sheet an arching or rib formation of substantially corresponding radius. These rib-channel stiffening deformations by reason of their shallow depth are of a form adapted for their economic production by die-pressing of the relatively high modulus of elasticity metal. Moreover, by reason of the shallow depth of the deformations with relation to their width the stiffening effect is provided with avoidance of high spots or ribs of a nature tending to build up or "berry" during electrodeposition in such manner as to interfere with the refining process.

In Fig. 1 of the drawing there is illustrated a preferred spacing and arrangement of the stiffening deformations formed by die-press offsetting of the metal. This spacing and arrangement in a rectangular sheet 1, comprises diagonally stiffened means, such as deformations 2 and 3. Between said diagonal deformations is a plurality of ribs or deformations 4 and 5 which are parallel to the longitudinal edges of the sheet. A plurality of transverse ribs or deformations 6 and 7 are arranged perpendicular thereto and parallel to the shorter edges of the sheet. The said ribs and deformations are formed by offsetting them to one side of the sheet. Associated with the longitudinal ribs is a pair of similar reinforcing "rib-channels" or deformations 8 which are offset to the opposite side of the sheet and which are arranged within an intermediate area thereof and parallel to an associated longitudinal edge. Similarly, reinforcing rib-channels or deformations 9 are arranged within an intermediate area of the sheet and parallel to the transverse or shorter edge thereof. These reinforcing rib-channels or deformations are designed to neutralize warping tendencies as may occur at certain periods of the building up of the cathode during electrodeposition.

The starting sheets may have any appropriate size, say about 29" x 39", with the curved or arched deformations having a limited or restricted depth and width of say about $\frac{1}{16}$" and about 1" respectively. The ratio of width to depth of the deformation has been found to be somewhat critical and is preferably of the order of 16 to 1. Novel starting sheets embodying these deformations have under comparative test with the customarily employed plain or straight starting sheets, shown marked superiority in the resulting product without restraightening even though these conventional straight sheets were lifted and re-straightened within twenty-four hours.

The spacing arrangement of the deformations used by the invention provides for the major surface area of the sheets to be plain flat surfaces and further provides a marginal flat surface of sufficient area to permit the attachment of the usual terminal straps employed for suspending the sheets in the tanks. The flat marginal portions are, accordingly, of a character to insure good electrical contact with the straps which are customarily secured by spot welds. The starting sheets may normally have a thickness of about 0.040 inch.

In Figs. 4 to 6 a suitable arrangement is illustrated for die-pressing the starting sheets to incorporate therein the stiffening deformations or ribs in accordance with the present invention. Upper and lower mating dies 10 and 11 are employed and provided with die inserts 12 and 13 having their active or forming surfaces conform-

ing to the configuration to be produced. In practice it has been found beneficial, at times preliminary to the die-pressing of the deformations, to subject the stripped sheets to a roller straightening operation after which the sheets are die-pressed with a simultaneous trimming or shearing of the sheets to proper size. The roller straightening is found to be advantageous particularly with sheets having low ductility which in view of the springiness of the metal does not readily straighten under the press. The roll straightening is desirably performed with a single pass but may necessitate repeated passes with a turning of the sheet end for end or lengthwise rolling in reverse directions.

In Fig. 7 a modified die structure is shown wherein the upper die insert is formed as a clearance die and wherein the offsetting is effected entirely by the lower cooperating die insert.

The preparation of the starting sheets of the unique structural form results in substantial operational and maintenance economies, particularly as related to the elimination of the requirement for re-straightening of the sheets during the process and the detrimental conditions incident thereto.

While a preferred formation of the novel starting sheets and an improved method of production suited for nickel refining is described and shown, it will be understood that variations and modifications thereof may be resorted to without departing from the scope of the invention as defined in the appended claim. For instance, while the present improvements are designed particularly for meeting the more severe conditions imposed in nickel refining, it will be understood that certain features thereof may be advantageously employed in the electrolytic separation of other metals which may offer less in difficulties such as to provide for the economic formation of stiffened starting sheets. Also, the roll straightening operation, as hereinbefore described, may be modified by first straightening of the sheet through a roll pass and then repeating with a rotation of the sheet through a 90° angle instead of the 180° angle as hereinbefore referred to.

We claim:

As an article of manufacture, a rectangular nickel cathode starting sheet for electrolytic refining of nickel having its major area constituted of plane surfaces disposed in a common plane and having elongated stiffening deformations formed by shallow offsetting of the metal with an arched cross-sectional contour, wherein the deformations have a ratio of width to depth of about sixteen to one, said deformations including multiple spaced deformations at each side of the central axis of the sheet and extending parallel to the side edges of the sheet and spaced from the edges thereof by plane surface marginal areas and centered deformations extending diagonally of the sheet and including a continuous deformation coextensive therewith, and certain of the deformations being offset to the opposite side of the sheet from other of the deformations.

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