March 24, 1959 H. C. HIRSCH 2,878,553

RIGIDIZED ELECTROLYTICALLY FORMED METAL SHEETS

Filed June 25, 1954

FIG. 1.

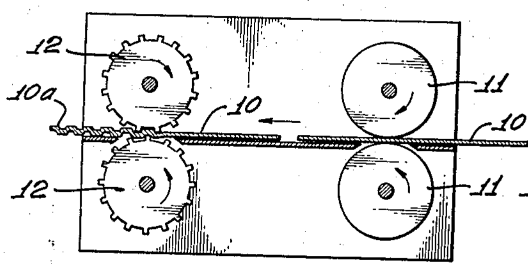

FIG. 2.

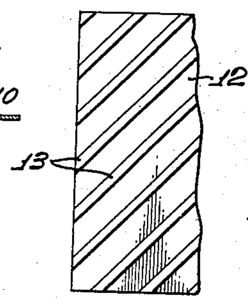

FIG. 3.

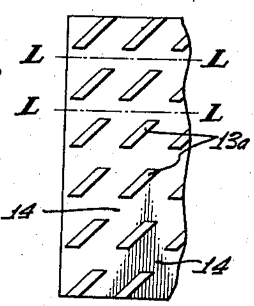

FIG. 4.

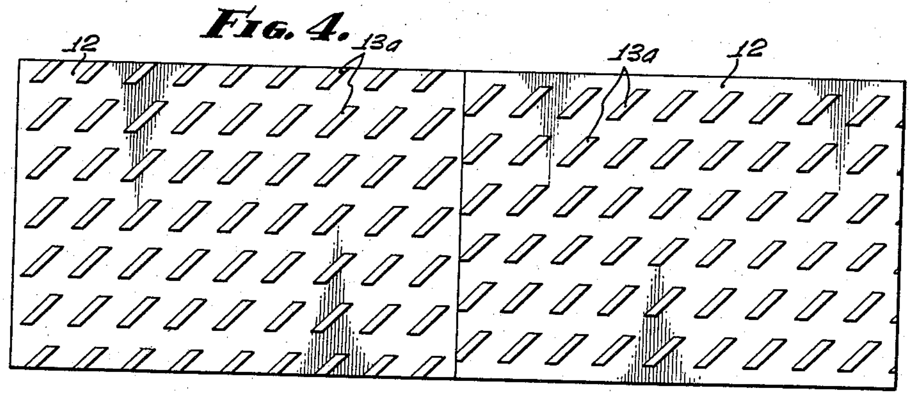

FIG. 5.

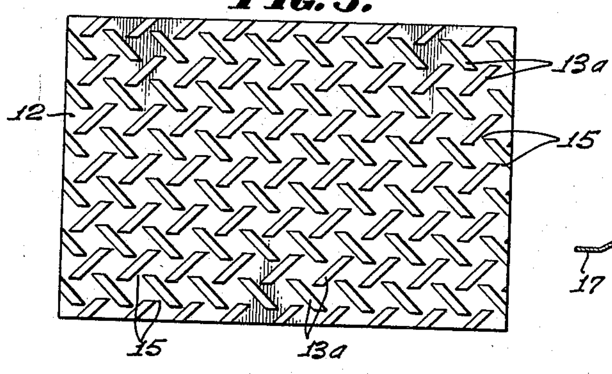

FIG. 7.

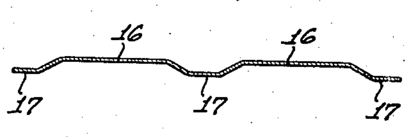

FIG. 6.

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RIGIDIZED ELECTROLYTICALLY FORMED METAL SHEETS

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1 Claim. (Cl. 29—180)

This invention has to do generally with the shape stabilization of electrolytically formed metal sheets, and has particular reference to rigidized so-called "starting" thin metal sheets formed by an initial electrolytic deposition and which according to well-known practices, are used as base or starting sheets for a second stage electrolytic build-up of the sheets to relatively great thickness, e.g. in the range of about 1 to 1½ inches. While applicable to the rigidizing of sheets formed of various electrolytically deposited metals, e.g. copper, the invention has been used with highly satisfactory results as applied to the rigidizing of copper starting sheets, and accordingly will be described hereinafter with reference to that typical adaptation.

The base or starting sheet, later used as a cathode for electro-deposition of copper to the desired thickness, ordinarily consists of a thin sheet about 36 inches square and having a thickness within the range of about 0.025 to 0.050 inch, an average being about 0.030 inch. Ordinarily the thickness of the sheet is not uniform, and will vary progressively say from 0.020 inch at one edge to 0.050 inch at the opposite edge. As used for a cathode base for further deposition of copper, the starting sheets ordinarily are placed in an electrolytic bath in parallel and rather closely spaced relation as by suspending the sheets from an appropriate rack structure. Obviously it is necessary that sheets be prevented from contacting one another, and to obtain highest efficiency in the electrolytic deposition of copper on the starting sheets, it is important that the latter have as uniform spacing as possible throughout their areas.

The invention contemplates rigidizing the starting sheet by deforming the latter in a pattern of corrugations, the principal advantage of which is that the deformation given the sheet renders it substantially uniformly (i.e. in all planar directions) resistant to deflection from an essentially true planar shape. The particular corrugation pattern has the further advantages of allowing ready deformation of the sheet in accordance therewith, and of permitting formation of the corrugations by localized stretching of the metal with its resultant retention of desirable strength, as distinguished from forging deformations which would tend to locally work harden and cause the sheet to bend or curl.

Considering more specifically the particular form of the corrugations, the invention contemplates rigidizing the sheet by deforming it oppositely in a pattern of interrupted and preferably elongated corrugations, one set of which extends in spaced parallel lines or planes, and the other set extending in spaced intersecting lines or planes, all preferably so related that the corrugations of the two sets extend at right angles and the projected line of each corrugation intersects the angularly adjacent corrugation at its longitudinal center. Thus through deformation of the sheet in one direction by the first set of corrugations, and in opposite direction by the second set of corrugations, and through maintenance of uniform

and right angle spacing of the corrugations all in accordance with the later specifically described pattern, the resulting permanent deflections of the sheet convert into a condition of such uniform rigidity as will assure accomplishment of the ultimate object of maintaining the sheets in uniformly spaced relation in being built up to such thickness as may be desired.

All the features and objects of the invention referred to in the foregoing, as well as the details of a typical and illustrative embodiment, will be understood more fully from the following detailed description, in which:

Fig. 1 is a general view illustrating passage of the metal sheet first between the smoothing-out rolls and then between the corrugating and rigidizing rolls;

Figs. 2 and 3 are views illustrating the method of forming the die projections on the corrugating rolls;

Fig. 4 illustrates the relative positions of the die projections on the continguously positioned corrugating rolls;

Fig. 5 is a view illustrative in a single projection area of the interfitting relation of the die projections;

Fig. 6 shows the corrugation pattern in the rigidized sheet; and

Fig. 7 is an enlarged fragmentary section taken on line 7—7 of Fig. 6.

Referring first to the diagrammatic showing of Fig. 1, the thin metal starting sheet **10** as it is taken from the electrolytic deposition stage or bath in which it is formed, may first be passed between a pair of smooth surface cylindrical rolls **11** which flatten and remove all irregularities from the sheet. The latter then may be passed between a pair of corrugating rolls **12** which deform and rigidize the sheet in the condition indicated at **10***a*, all as will later appear. As will be understood without necessity for specific illustration, the rolls **11** and **12** may be driven in the direction of the arrows by any suitable means so that the sheet **10** is advanced.

In reference to the showings in Figs. 2 to 5, here the corrugation forming roll surfaces are represented as developed views in which the roll surfaces are spread in single planes, for the purpose of most clearly explaining the method of forming the die projections and the positional and functional relationship of the formed projections on the two rolls.

Each of the essentially cylindrical rolls **12** initially is formed with an helical rib **13** cut or cast integrally with the roll metal at preferably a 45° helix angle. Thus in form, the rib may be similar to an essentially square helical thread on the roll surface. This rib is cut at uniformly spaced intervals circularly of the roll, either by a cutter moved longitudinally of the roll or by a lathe cutting operation in which the tool cuts the rib transversely of the roll axis. In Fig. 3 the rib is indicated as having been cut at circularly spaced intervals as by means of a standard hobbing cutter moved straight longitudinally of the roll surface along the lines L—L to sever the rib into helically alined die-forming projections **13***a* uniformly spaced apart at **14**. The hobbing cutter may be so shaped as to leave a slight radius at the bases of the projections **13***a*. At this point it may be mentioned that in the broad contemplation of the invention, the helical rib **13** may be otherwise interrupted and with some variances from the form illustrated, in the shape configurations of the projections and spaces between them, but in general the preferred method of forming the projections **13***a* will be essentially similar to the described method involving longitudinal advancement of the hobbing cutter to intercept the rib. As a result of this operation, the rib segments or projections **13***a* have the form of right angle-obtuse angle parallelograms.

Merely as illustrative of a practicable dimensioning of the die projections and their spacing which have proven satisfactory for the rigidizing of copper starting sheets having an average thickness of around 0.030 inch, each projection **13*a*** may have a width (normal to its edges) of about ⅛ inch, a length (measured on the angle) of about ¾ inch, and a depth of about 0.125 inch. The pitch of the teeth or projections, cut at a 45° helix angle, may be about 0.530 inch, which approximates ¾ inch pitch on the angle or longitudinally of the roll, and the space adjacent longitudinally alined projections (measured normal to their parallel ends) may be about ¼ inch.

Fig. 4 illustrates the relative positioning of the projections **13*a*** on the two rows **12** in a developed representation of their positions appearing in Fig. 1. It will be noted that the projections on one roll are off-set uniformly and symmetrically relative to the projections on the other roll, so that if super-imposed according to the directions of relative rotation of the rolls, the projections assume the interfitting relationship appearing in Fig. 5. Thus as the projections come together upon rotation of the rolls **12**, they form a developed pattern in which the two sets of projections extend relatively at right angles, the helical center line of each set intersecting the projections of the other set at their longitudinal centers. The clearances are such as to leave spaces at **15** between the projections, which are sufficiently great as to avoid forging or work hardening deformations of the metal sheet, and instead deform the latter by bending and stretching the metal without impairment of its strength properties.

Fig. 6 illustrates the corrugation pattern into which the sheet **10*a*** is deformed after passage between the rolls **12**. One set **16** of the corrugations result from deformation of the metal outwardly from its base or body plane, and the other set **17** of the corrugations, extending in spaced relation and at right angles, result from corresponding opposite displacement of the sheet metal from its body plane. By reason of the symmetry of the corrugation pattern and uniform deflections of the metal oppositely and at right angles in accordance with that pattern, the sheet is given such rigidity as will assure maintenance of successively racked or suspended sheets in a subsequent electro deposit build-up stage in the uniformly spaced

parallel relation essential to achieving maximum efficiency in the plate build-up. Finally it may be observed that not only is the sheet rigidized, but it becomes so dimensionally stabilized without appreciable or consequential variation of its overall sheet or area dimension, a feature of importance by reason of the desirability for overall dimensional correspondence between the starting and built-up sheet.

I claim:

A rigidized electrolytically deposited metal sheet deformed from an initial planar shape by one set of interrupted and elongated corrugations projecting outwardly from one side of the plane of the sheet and extending in alignment and in uniformly spaced relation with outward elongated extremities of the corrugations being in first parallel lines, and by a second and corresponding set of interrupted corrugations projecting outwardly from the opposite side of the plane of the sheet with the outward elongated extremities of the second set of corrugations extending in second parallel lines crossing over and equally perpendicularly offset from the first parallel lines at the interruptions between said second set corrugations, said sheet being unbrokenly continuous throughout the area occupied by said corrugations, the total numbers of corrugations in said first and second sets at opposite sides of said sheet being substantially equal, all of said corrugations having the same shape and size, and each corrugation having the shape of an obtuse angle-acute angle elongated parallelogram projecting outwardly from the plane of said sheet.

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