July 24, 1923.

1,462,475

C. E. ATKINSON

METHOD OF CRUSHING CORRUGATED METAL

Filed June 4, 1921

4 Sheets-Sheet 1

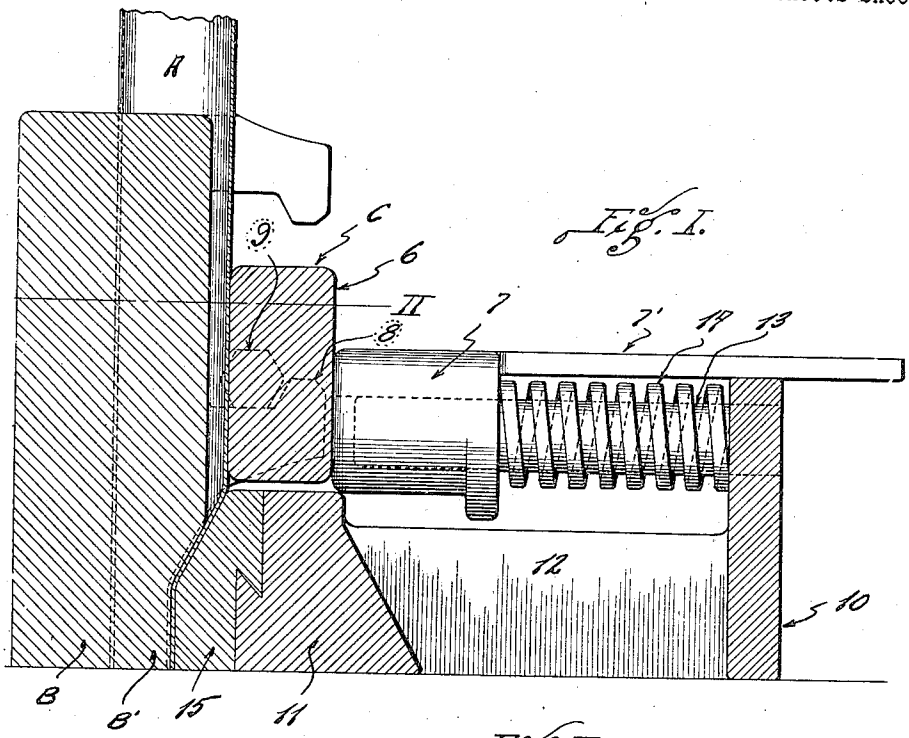

Fig. I.

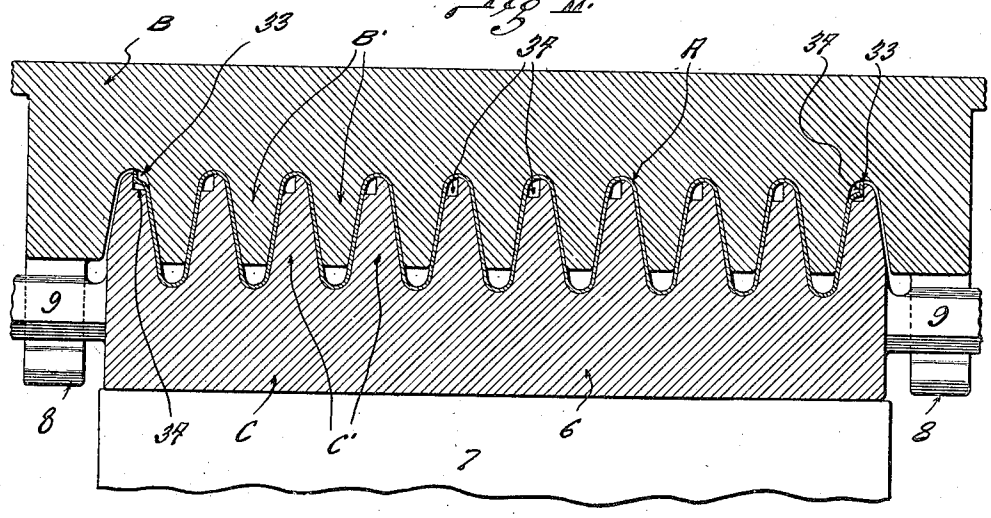

Fig. II.

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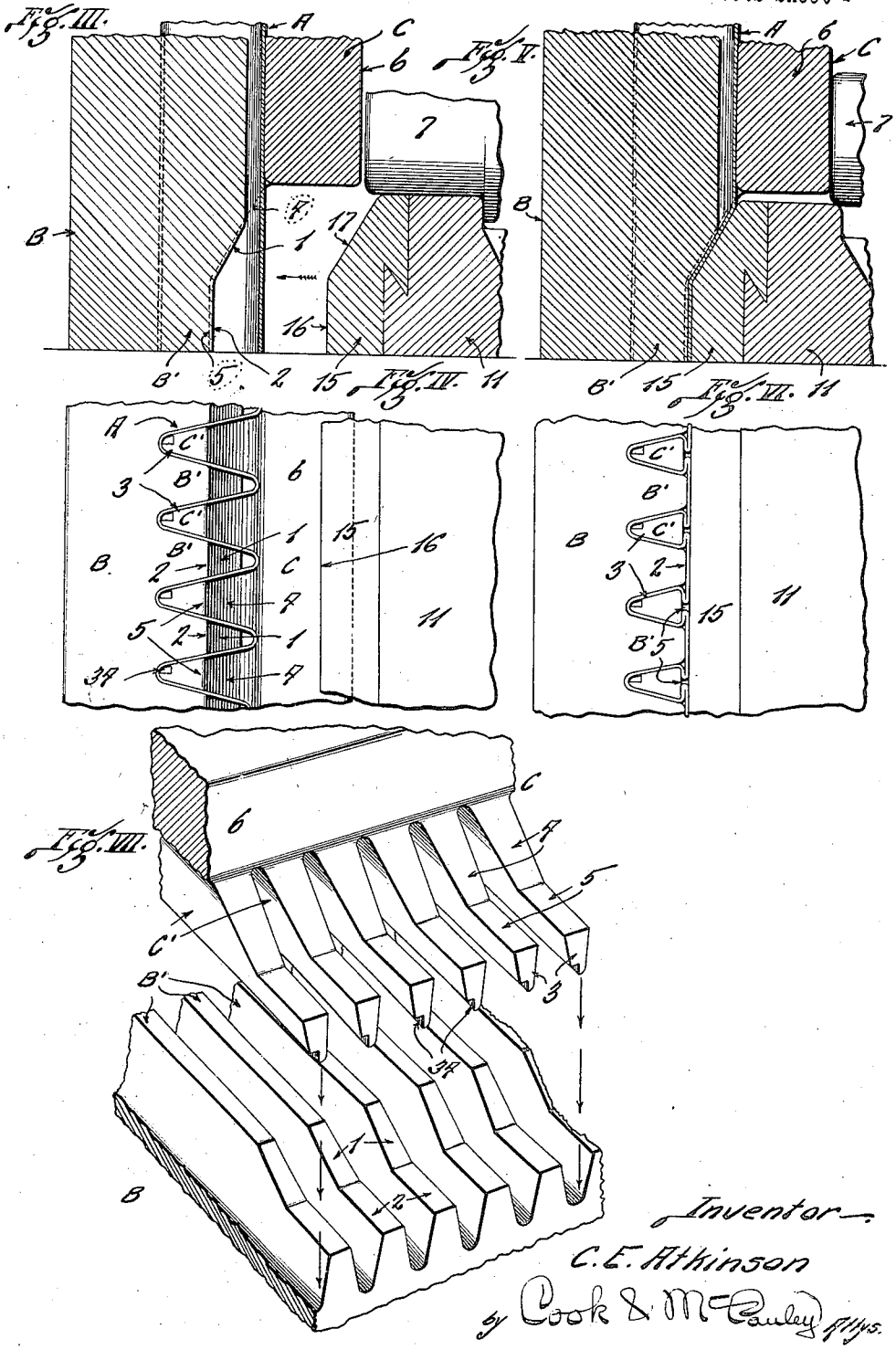
4 Sheets-Sheet 2



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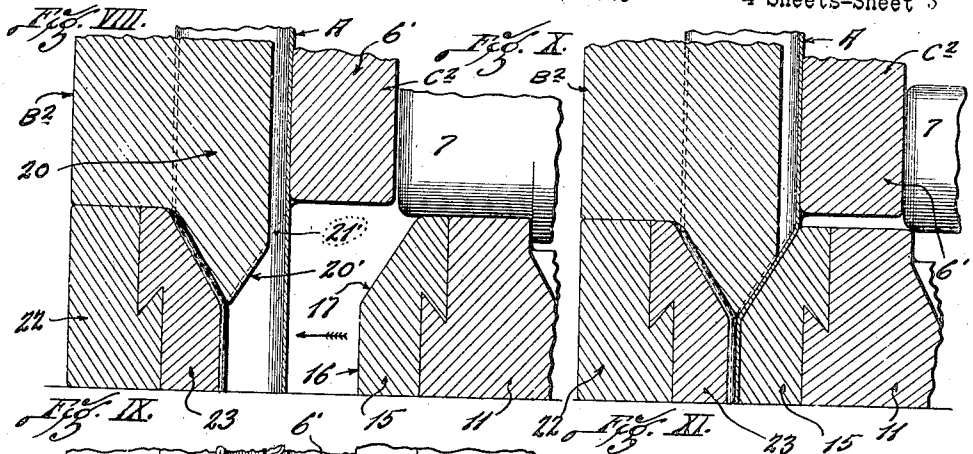

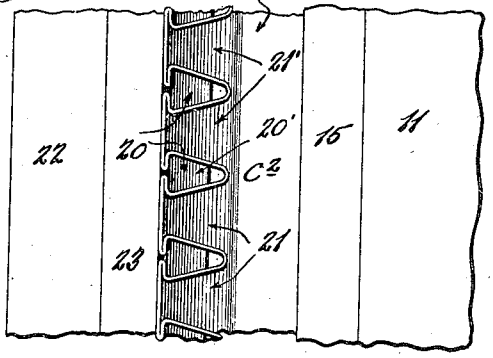

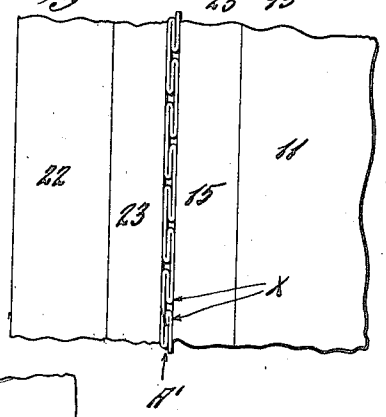

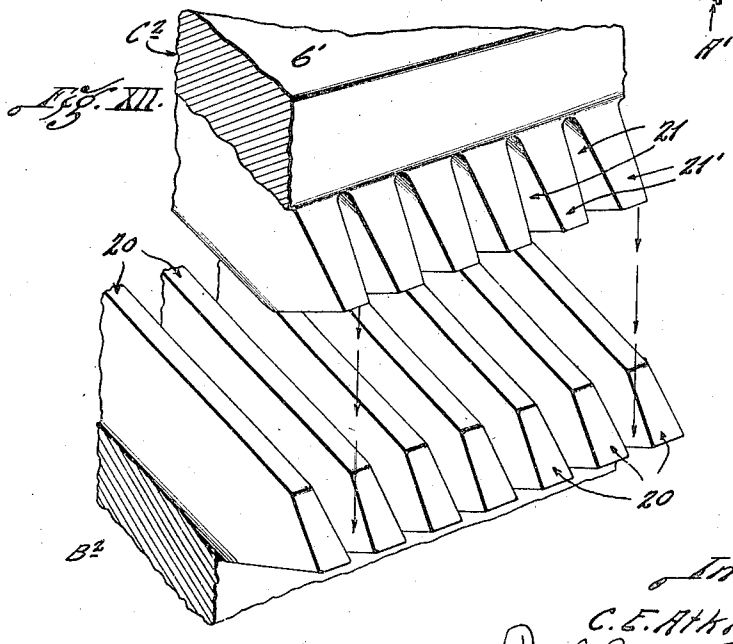

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Fig. XIII.

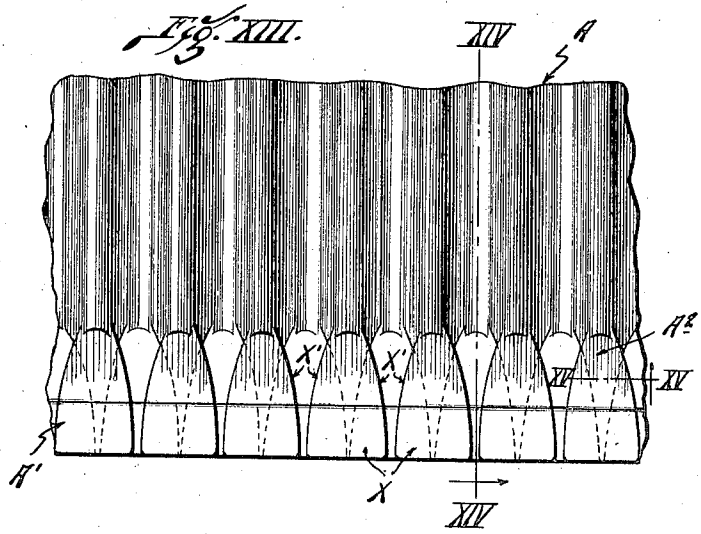


Fig. XIV.

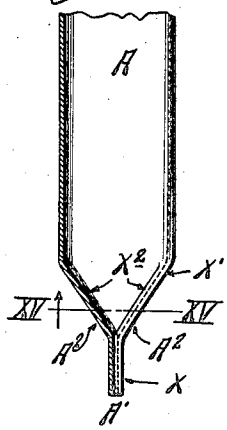


Fig. XV.

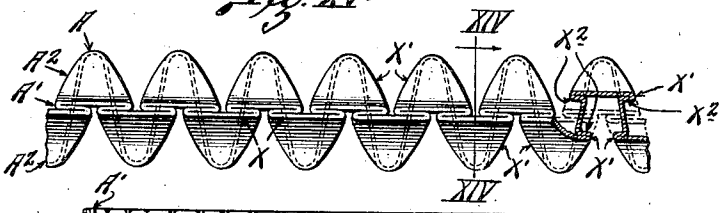
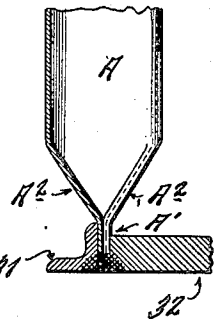


Fig. XVII.



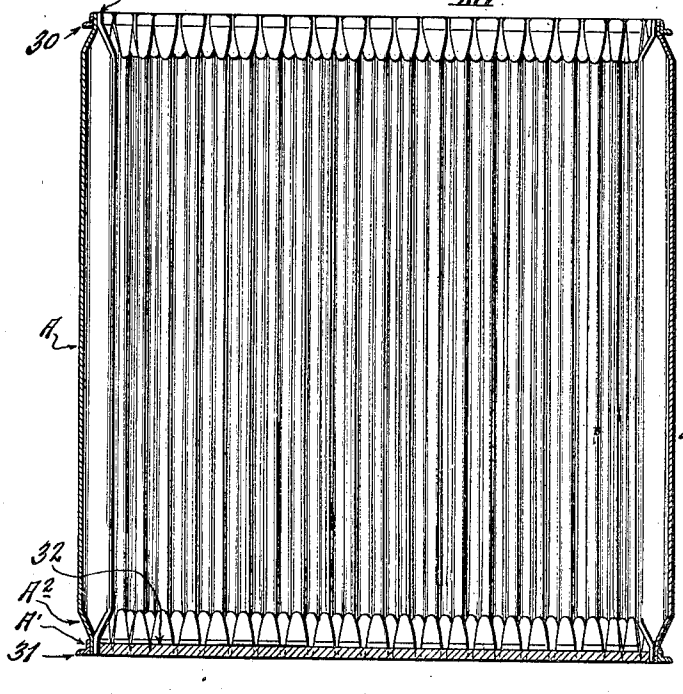


Fig. XVI.

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UNITED STATES PATENT OFFICE.

CHARLES E. ATKINSON, OF PINE LAWN, MISSOURI, ASSIGNOR TO E. E. SOUTHER IRON COMPANY, OF WELLSTON P. O., ST. LOUIS COUNTY, MISSOURI, A CORPORATION OF MISSOURI.

METHOD OF CRUSHING CORRUGATED METAL.

Application filed June 4, 1921. Serial No. 475,048.

To all whom it may concern:

Be it known that I, CHARLES E. ATKINSON, a citizen of the United States of America, and a resident of Pine Lawn, in the county of St. Louis and State of Missouri, have invented certain new and useful Improvements in Methods of Crushing Corrugated Metal, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

This invention relates to improvements in methods of crushing corrugated sheet material, and more particularly to a method of crushing and flattening the corrugations at a marginal portion of a corrugated metal sheet. An object of the invention is to provide a method whereby marginal portions of corrugated metal sheets can be crushed and at the same time accurately folded to provide substantially flat and smooth surfaces at the crushed margins.

Briefly stated, the method I have described as an illustration of one form of the invention consists in flattening the marginal portion of a corrugated sheet, and at the same time forming inclines merging into said marginal portion and also into uncrushed portions of the corrugations. During the crushing operation, the corrugations are folded in a peculiar manner, as will be hereafter described, so as to form predetermined folds in the metal, and these folds are flattened to provide substantially smooth flat faces at the crushed margin.

A corrugated metal sheet having flat margins can be conveniently used for the side walls of a container, it being a comparatively simple matter to secure the top and bottom walls at the flat margins. Prior to this invention, transformer casings and other receptacles have been provided with corrugated side walls which are exposed to the atmosphere for the purpose of cooling the contents of the receptacles. In the manufacture of such casings, or receptacles, it has been very difficult to firmly and accurately secure the bottom walls to the corrugated side walls. According to the usual practice, transformer casings are made by first forming the corrugated side walls and then inserting the corrugated lower margins of these walls into a mold where the bottom wall is formed by pouring molten metal into mold, so as to integrally connect the bottom wall to the corrugated side walls. Obviously, this old method is both difficult and expensive, especially in the manufacture of very large transformer casings, and it results in the production of casings having very heavy cast metal bottoms.

After the corrugated margins have been crushed and flattened in accordance with the present invention, they can be very easily welded to a simple sheet metal bottom, so as to integrally connect the flat margins to the bottom.

Fig. I is a vertical section illustrating an apparatus adapted for use in crushing and flattening a marginal portion of a corrugated sheet.

Fig. II is a horizontal section on the line II in Fig. I.

Fig. III is a vertical section of portions of the apparatus shown in Fig. I, illustrating the parts in the positions they occupy immediately before the first crushing operation.

Fig. IV is a fragmentary bottom view of the parts shown in Fig. III.

Fig. V is a view similar to Fig. III showing the parts in the positions they occupy when the first crushing operation has been completed.

Fig. VI is a fragmentary bottom view of the parts shown in Fig. V.

Fig. VII is a fragmentary perspective view of the two corrugated dies between which the corrugated sheet is clamped for the first crushing operation.

Fig. VIII is a vertical section similar to Fig. III, showing the dies between which the corrugated sheet is clamped for the second crushing operation, the parts being shown in the positions they occupy immediately before the second crushing operation.

Fig. IX is a fragmentary bottom view of the parts shown in Fig. VIII.

Fig. X is a view of the parts shown in Fig. VIII, illustrating them in the positions they occupy after the second crushing operation has been completed.

Fig. XI is a fragmentary bottom view of the parts shown in Fig. X.

Fig. XII is a fragmentary perspective view of the dies between which the corrugated sheet is clamped for the second crushing operation.

Fig. XIII is a view of a portion of a

corrugated sheet having one of its margins crushed and flattened in accordance with this invention.

Figure XIV is a vertical section on the line XIV—XIV in Figs. XIII and XV.

Fig. XV is a bottom view of the sheet shown in Fig. XIII, the portion of the sheet at the right hand side of the view being in section on the line XV—XV in Figs. XIII and XIV.

Fig. XVI is a vertical section on a small scale showing a casing, or receptacle, having corrugated side walls with their upper and lower margins crushed and flattened in accordance with this invention.

Fig. XVII is an enlarged fragmentary section showing the manner in which the bottom wall of the receptacle may be welded to the lower margin of a corrugated side wall.

Before describing the method of crushing the corrugations, I will refer to Figs. XIII, XIV and XV which show a corrugated sheet having one of its margins crushed and flattened in accordance with this invention. A designates a corrugated metal sheet having a flat margin A′ and inclined faces A^2 extending from said flat margin and merging into uncrushed portions of the corrugations. Oppositely disposed three-ply flat folds X are formed at the flat lower end of each corrugation. Inclined two-ply folds X′ extend from said three-ply flat folds X and merge into uncrushed portions of the corrugations. The outer plies of each three-ply fold X are extended in diverging lines so as to form part of the inclined folds X′ which merge into uncrushed portions of the corrugations.

The manner in which the outer plies of the flat three-ply folds X are extended to diverge to the whole corrugations at opposite side of the sheets will be readily understood by referring to Figs. XIII, XIV and XV, but a careful study of the drawings and description may be necessary to understand how the interposed ply of each flat three-ply fold is divided so as to form part of the inclined two-ply folds. The interposed ply of each flat three-ply fold X lies between and parallel with the flat outer plies, but this interposed ply must also merge into the uncrushed portions of the corrugations. Fig. XV shows that each interposed ply at the flat margin lies transversely to the corrugations which appear in dotted lines crossing the middle of the interposed ply. To form the inclined two-ply folds at X′, each of said interposed plies has diverging extensions X^2 (Figs. XIV and XV) leading from the flat margin and merging into corrugations at opposite sides of the sheet. To understand this by referring to Figs. XIV and XV, assume that one-half of each interposed ply is extended to form part of an inclined fold X′, while the other half of the same interposed ply is extended to form part of an inclined fold X′ at the opposite side of the sheet.

Each inclined two-ply fold X′ is thus formed partly by an inclined extension leading from one of the flat outer plies and partly by an extension X^2 leading from one-half of an interposed flat ply. The side edges of each inclined fold X′ (Figs. XIII and XV) converge from a flat three-ply fold X and merge into an uncrushed portion of a corrugation.

Before describing the details of the crushing elements herein shown, I will state that the peculiar folds may be formed by two successive crushing operations, and I will briefly point out the results of these operations. In Figs. III and IV the uncrushed corrugated sheet A is illustrated as it appears when placed in the apparatus. Figs. I, V and VI illustrate the results of the first crushing operation whereby the ends of the corrugations at one side of the sheet are crushed. After one side has been crushed in this manner, the sheet is placed in the dies shown by Figs. VIII to XII inclusive, and the other side is crushed as shown by Figs. X and XI. The sheet is then removed from the dies, and it is in the condition shown by Figs. XIII, XIV and XV.

Referring now to Figs. I to VII inclusive, B designates a back die and C designates a front die, said dies having ribs B′ and C′ respectively conforming approximately to the corrugations of the metal sheet A. This sheet is clamped between the dies as shown most clearly in Fig. II. The lower margins of the ribs B′ on the back die B are cut away (Figs. III and VII) to provide inclined faces 1 and flat faces 2 leading from said inclined faces. The ribs C′ of the front die C are extended at the lower portion of the die to form fingers 3 (Figs. IV and VII) and each finger 3 has an inclined face 4 and a flat face 5. Fig. VII shows the dies separated from each other and it will be apparent that the front die C may be moved as indicated by arrows in Fig. VII, so as to interlock with the back die B as shown by Figs. II and IV.

The ribs C′ and the rib extensions 3 of the front die C are formed integral with an abutment 6 adapted to be engaged by a thrust member 7 for the purpose of securely clamping the corrugated sheet A between the front die C and the stationary back die B.

As shown by Figs. I and II, supporting arms 8 extend from the back die B, and the front die C is provided with fingers 9 adapted to rest upon said arms.

When the front and back dies are assembled to clamp the corrugated sheet between them (Figs. III and IV), the flat faces 2 of

the ribs on the back die B lie approximately flush with the flat faces 5 of the front die, so as to provide a substantially continuous and approximately flat face at the lower margins of the dies. The inclined faces 1 and 4 are likewise approximately flush with each other. However, the faces 1 and 2 are not precisely flush with the faces 4 and 5. These faces are slightly offset as shown by Figs. III, IV and VI.

When the corrugated metal sheet A is clamped between the dies, it is securely held, but the corrugations at one side are exposed at the lower margins of the dies, as shown in Figs. III and IV.

I will now describe the movable carriage which cooperates with the dies to crush and flatten the exposed corrugations at the lower margin of the corrugated sheet. This movable carriage is provided with a frame (Fig. I) including a front member 10, a back member 11, and suitable connecting ribs 12 formed integral with said front and back members. A rod 13 (Fig. I) extending from the back member 10 is loosely fitted to the thrust member 7, the latter being provided with a flat extension 7'. A compression spring 14 is interposed between the thrust member 7 and the front member 10. 15 designates a bending bar interlocked with the back member 11 of the movable carriage and having a flat face 16 (Figs. III and IV) located opposite to and parallel with the flat faces 2 and 5 on the dies. This bending bar 15 is also provided with an inclined face 17 located opposite to and parallel with the inclined faces 1 and 4 on the dies.

The operation of the parts so far described may be described as follows: After the dies have been assembled with the corrugated sheet between them (Figs. III and IV) the movable carriage including the bending bar 15 and yielding thrust member 7, is moved to the left from the position shown by Figs. III and IV to the position shown by Figs. I, V and VI. At the beginning of this operation, the yielding thrust member 7 engages the abutment 6 of the front die C so as to securely clamp the corrugated sheet between the correspondingly corrugated dies, the back die B being stationary. The bending bar 15 then engages the tips of the corrugations at one side of the sheet, and as this bending bar continues to move toward the stationary dies the exposed portions of the corrugations are gradually folded and flattened between the faces 16 and 17 of the bending bar and the correspondingly formed faces of the dies.

Actual experience has shown that the exposed portions of the corrugations will be bent from the condition shown by Figs. III and IV to the condition shown by Figs. V and VI, but it may be difficult to understand just why the neat and regular folds are positively formed during the crushing operation. At the beginning of the operation, the uncrushed corrugated sheet is firmly held between the dies as shown by Figs. II, III and IV, and by referring to Fig. IV it will be seen that the corrugations will readily bend at the junction of the flat faces 2 and 5. Considering only one of the exposed corrugations, note that the exposed portion is approximately V-shaped and that its tip, or apex, is rounded. The flat face of the crushing bar 15 engages this rounded tip and moves toward the flat faces 2 and 5. As a result, there is a tendency to flatten the rounded tip and at the same time bend the corrugated sheet metal at the junctions of the flat faces 2 and 5. While the bending bar 15 is moving toward these flat faces, the sheet metal webs diverging from the tip of a corrugation are bent away from each other at the junctions of the flat faces 2 and 5. At the same time, the portions of the diverging webs near the rounded tip are gradually flattened until the bending bar 15 reaches the position shown by Figs. V and VI. The exposed end portion of each corrugation is thus crushed and flattened to provide two oppositely disposed folds on a flat face 5, and these folds are extended along one of the inclined faces 4 so as to merge into an uncrushed portion of the corrugation.

After the corrugated sheet has been acted upon in this manner, the dies are separated to release the sheet from the back die B, and the front die C is moved longitudinally of the corrugations so as to withdraw its ribbed extensions 3 from the folded lower marking of the corrugated sheet.

Thereafter, the partly crushed sheet is applied to the dies shown in Figs. VIII to XII inclusive, and a second crushing operation is performed to place the sheet in the condition shown by Figs. XIII, XIV and XV.

Before describing the second crushing operation, I will describe the second set of dies which are shown most clearly by Figs VIII, IX and XII.

B^2 designates a stationary back die having ribs 20, and C^2 designates a front die having ribs 21 adapted to interlock with the ribs 20 so as to clamp the corrugated sheet between these dies. The lower ends of the ribs 20 and 21 are V-shaped to provide the inclined faces 20' and 21'. When these dies are interlocked with each other, the inclines 20' are almost flush with the inclines 21', but these inclined faces are slightly offset as shown by Fig. VIII. The front die C^2 is provided with an abutment 6' to which the ribs 21 are integrally connected.

To provide a backing for the folded metal that has been crushed by the first operation, a stationary bar 22 is located beneath the

stationary back die B^2, and an abutment bar 23 is interlocked with this bar 22, as shown in Fig. VIII.

In assembling the dies shown by Figs. VIII to XII, the ribs 20 of the back die B^2 are applied to one side of the partly crushed corrugated sheet, and said die is moved downwardly relative to the sheet, so as to engage the V-shaped lower ends of ribs 20 with the previously formed inclined folds, as shown in Fig. VIII. The front die C^2 is applied to the other side of the corrugated sheet so as to clamp the sheet between the ribs of the dies. The abutment bar 23 engages the outer faces of the folds previously formed in the sheet (Fig. VIII), and these outer faces conform to the adjacent faces of the abutment bar 23, the inclined folds being clamped between the inclined face of the abutment bar and the corresponding inclines at the lower ends of the dies.

When the parts have been assembled in this manner (Figs. VIII and IX), the corrugated sheet is securely held, and its uncrushed lower marginal portion is exposed in front of the flat folds at the lower margin of the sheet. At a slightly higher elevation, an uncrushed portion of the sheet is exposed in front of the inclined faces 20′ and 21′ at the lower margins of the dies. The flat face 16 of bending bar 15 is opposite to and parallel with the crushed portions of the corrugations, while the inclined face 17 of said bending bar lies opposite to and parallel with the inclined abutment faces 20′ and 21′.

To crush and flatten the exposed lower marginal portions of the corrugations, the carriage including the yielding thrust member 7 and bending bar 15, is moved to the left from the position shown by Figs. VIII and IX. The yielding thrust member 7 engages the abutment 6′ while the bending bar 15 moves to the left until it occupies the position shown by Figs. X and XI. During this operation, the exposed lower marginal portion of the corrugated sheet is folded and flattened between the flat face 16 of the bending bar and the previously formed flat folds in the corrugations. At the same time, the inclined face 17 of the bending bar moves toward the stationary inclines 20′ and 21′, so as to form inclined folds above the flat lower margin. The bending bar finally reaches the position shown by Figs. X and XI, and this completes the second crushing operation. The crushed portion of the sheet then appear as shown by Figs. X, XI, XIII, XIV and XV.

Actual practice, in the manufacture of transformer casings, has shown that my method of folding and flattening the margins of corrugated sheets is entirely feasible and that the peculiar folds herein shown can be easily and quickly formed with a high degree of accuracy and at a very low cost.

Although I have described two successive crushing operations and illustrated the minute details of the folds produced by these operations, it is to be understood that the scope of the invention is to be determined by the claims hereunto appended, and not by the specific description of the particular method herein set forth.

As an illustration of an article involving the use of a corrugated sheet having flat margins, in Figs. XVI and XVII I have shown a transformer housing having corrugated side walls with flat top and bottom margins formed in accordance with this invention. A closure-receiving bar 30 is welded to the flat outer face of the upper margin and a similar bar 31 is welded to the flat outer face of the lower margin. 32 designates a plain flat sheet of metal surrounded by the corrugated side walls and welded to the flat lower margins. The bar 31 and sheet metal bottom 32 are preferably flush with the extreme lower edge of the flat margin.

The welding operation can be readily performed by the use of an ordinary welding torch, so as to integrally connect the flattened portions of the corrugations to the bottom 32 and at the same time effectively seal the folds at these flattened margins, thereby preventing leakage of fluid through the flattened portions of the corrugations.

In the preferred form of the invention, the corrugated sheet to be crushed (Fig. II) is formed with side flanges 33, and the flange at either side of the sheet may be welded to a similar flange on another corrugated sheet, so as to form a continuous corrugated sheet made of a number of sections welded together at the flanges 33. The die C shown in Fig. II is provided with recesses 34 at the extremities of its ribs C′ adapted to receive the flanges 33. Each rib C′ may be recessed so that sheets of various widths may be clamped between the dies.

I claim:

1. The method of crushing corrugated metal sheets which comprises crushing and flattening a marginal portion of the corrugated metal so as to form two oppositely disposed flat marginal folds at the end of each crushed corrugation, at the same time forming tapering folds converging from the respective marginal folds and merging into uncrushed portions of the corrugations.

2. The method of crushing corrugated metal sheets which comprises crushing and flattening a marginal portion of the corrugated metal so as to form two oppositely disposed flat marginal folds at the end of each crushed corrugation, at the same time forming in each of said corrugations a pair of oppositely disposed inclined folds con-

verging from the oppositely disposed marginal folds in the same corrugation and merging into uncrushed portions of the corrugation.

3. The method of crushing margins of corrugated metal sheets which comprises folding the corrugations at both sides of the marginal portions of a corrugated metal sheet and flattening the marginal folds to provide substantially flat surfaces at opposite sides of said marginal portion, and forming inclined folds extending from said marginal folds and merging into uncrushed portions of the corrugations.

4. The method of crushing margins of corrugated metal sheets which comprises folding the corrugations at both sides of the marginal portion of a corrugated metal sheet and flattening the marginal folds to provide substantially flat surfaces at opposite sides of said marginal portion, thereby forming oppositely disposed three-ply flat folds at the end of each of said corrugations, and forming inclined two-ply folds extending from said three-ply folds and merging into uncrushed portions of said corrugations.

5. The method of flattening marginal portions of corrugated metal sheets which comprises flattening the corrugations at one side of a marginal portion of a corrugated metal sheet, at the same time forming inclined folds extending from said marginal portion and merging into uncrushed portions of the corrugations, and thereafter flattening the corrugations at the other side of the same marginal portion and at the same time forming inclined folds extending from the flattened portions of the last mentioned corrugations and merging into uncrushed portions of the same corrugations.

6. The method of flattening marginal portions of corrugated metal sheets which comprises crushing and flattening the corrugations at one side of a marginal portion of a corrugated metal sheet, so as to form two oppositely disposed flat marginal folds at the end of each crushed corrugation, at the same time forming tapering folds converging from the respective marginal folds and merging into uncrushed portions of the corrugations, and thereafter crushing and flattening the corrugations at the other side of the same marginal portion so as to form two oppositely disposed flat marginal folds at the end of each of the last mentioned corrugations, and at the same time forming tapering folds converging from the flattened portions of the last mentioned corrugations and merging into uncrushed portions of the same corrugations.

7. The method of crushing margins of corrugated metal sheets which comprises clamping a corrugated metal sheet between dies having corrugations and inclined faces, exposing a corrugated marginal portion of the sheet adjacent to said dies, crushing the exposed corrugations on said inclined faces so as to form corresponding inclines on the crushed corrugations, and at the same time crushing and flattening marginal portions of the corrugations adjacent said inclines.

8. The method of flattening margins of corrugated metal sheets which comprises clamping a corrugated metal sheet between dies having corrugations and flat faces and inclined faces extending from said flat faces, exposing a marginal portion of the corrugated metal sheet at said faces, folding and flattening the corrugations on said flat faces, and at the same time forming inclined folds in the exposed corrugations and flattening said inclined folds on said inclined faces.

In testimony that I claim the foregoing I hereunto affix my signature.

CHARLES E. ATKINSON.