April 21, 1925. 1,534,299

W. M. CONNERY

CORRUGATION FORMING DIE FOR METAL PLATES

Original Filed Dec. 21, 1921 2 Sheets-Sheet 1

Fig. 1.

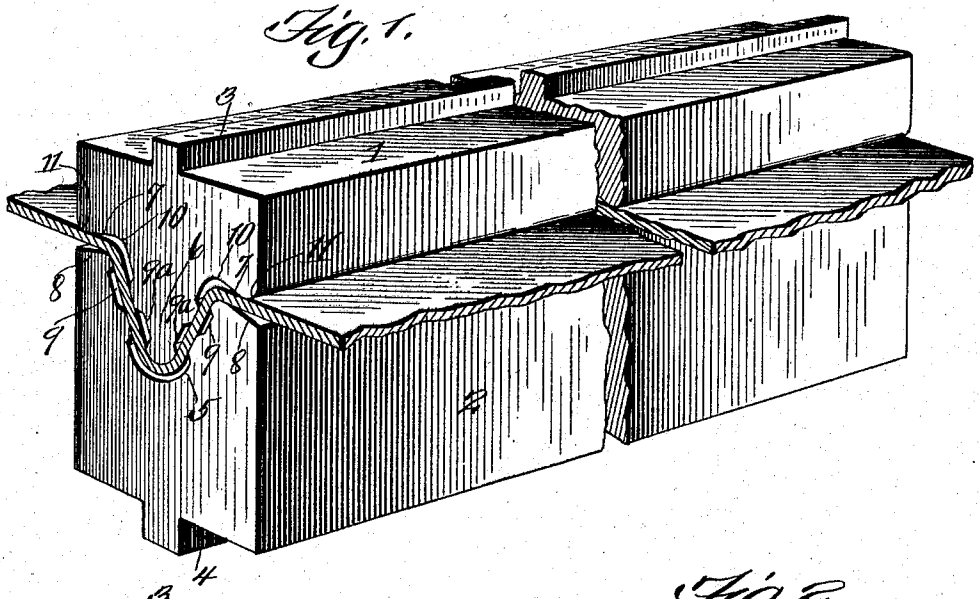


Fig. 2.

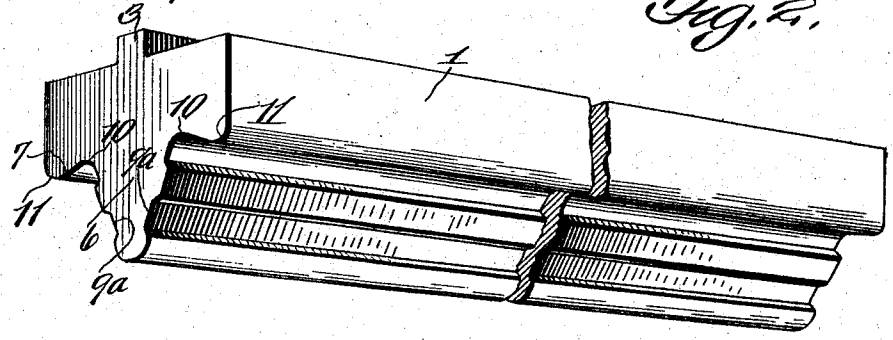
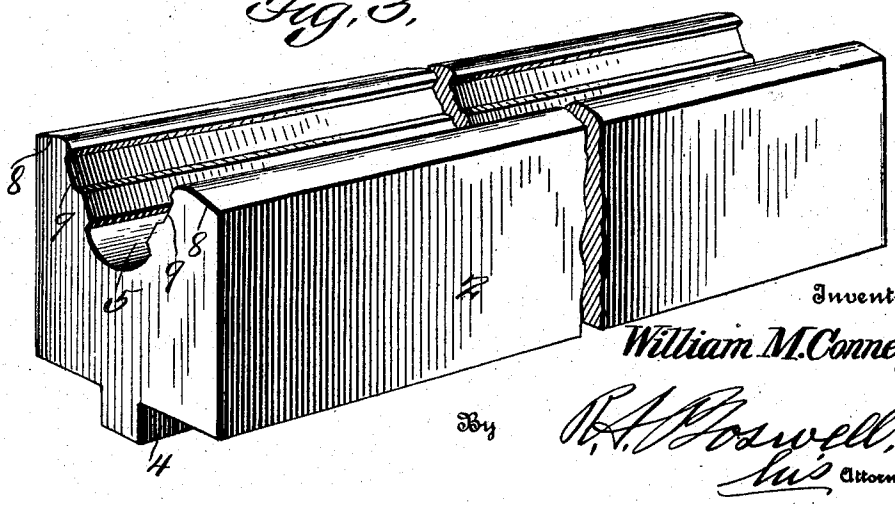


Fig. 3.



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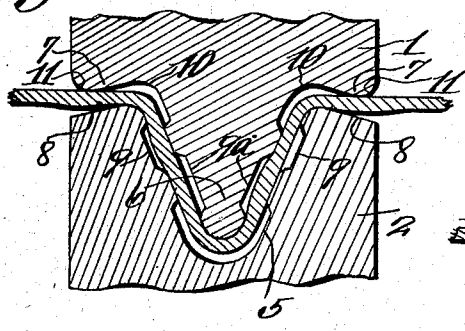
CORRUGATION FORMING DIE FOR METAL PLATES

Original Filed Dec. 21, 1921 2 Sheets-Sheet 2

Fig. 5.



Fig. 4.



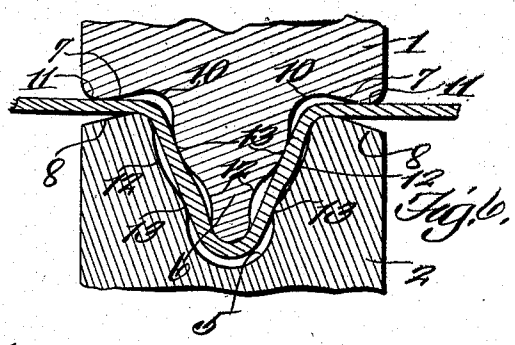


Fig. 6.

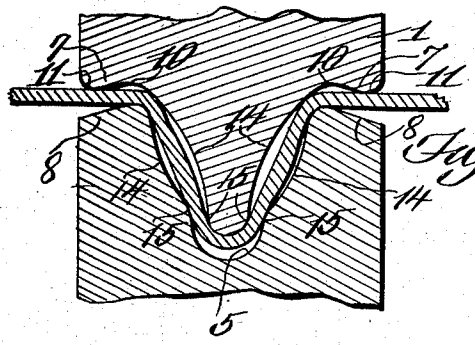


Fig. 7.

Fig. 9.

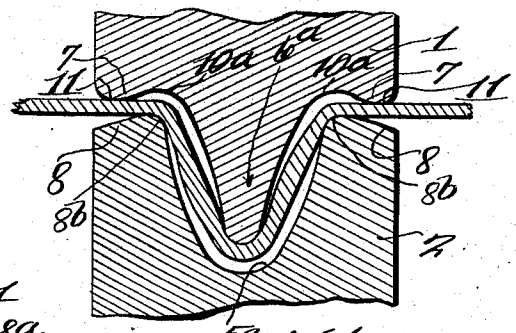
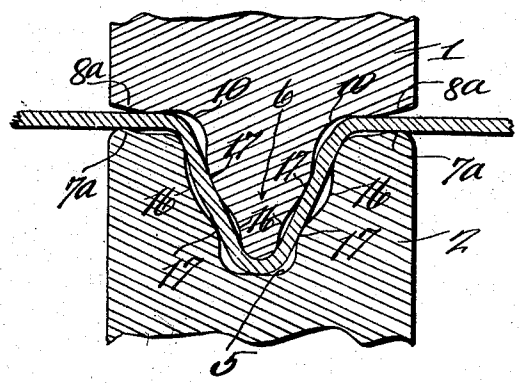


Fig. 8.



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UNITED STATES PATENT OFFICE.

WILLIAM M. CONNERY, OF PHILADELPHIA, PENNSYLVANIA.

CORRUGATION-FORMING DIE FOR METAL PLATES.

Application filed December 21, 1921, Serial No. 523,921. Renewed July 17, 1924.

To all whom it may concern:

Be it known that WILLIAM M. CONNERY, a citizen of the United States of America, residing at Philadelphia, in the county of Philadelphia, State of Pennsylvania, has invented new and useful Corrugation-Forming Dies for Metal Plates, of which the following is a specification.

It is well known that corrugated sheet metal and forming machines or dies therefor have heretofore been devised.

However, the corrugated sheet metal is made of relatively thin metal, and furthermore the corrugations are successively formed, and are constructed by forming machines or by means of dies, where the forming faces come together closely, and also where the forming faces have successive projections and depressions. These articles of manufacture are commercially known as corrugated sheet metal plates, and in some cases the walls of the corrugations are fluted, according to the forming faces of the dies. In other words the dies or the forming parts of a machine have their forming faces fluted, so as to construct the walls of the corrugations with flutes or other shapes.

In the present invention there is no claim made for the production of what is commercially known as a corrugated sheet metal, or for dies for forming such sheet metal, whether or not fluted surfaces are used.

On March 16, 1921, William M. Connery, the inventor in the present case filed an application for flues and flue sections, Serial No. 452,755, (which has matured into Letters Patent No. 1,416,334) wherein sheet metal plates provided with corrugations at infrequent intervals are used for constructing a flue or flue section.

It is, therefore, the purpose of the present invention to provide corrugation forming dies for use in connection with metal forming machines, for pressing the corrugation or indentation into a relatively thick plate metal. In fact corrugations or indentures having flat sloping or other shaped sides or walls at infrequent and varying intervals are to be formed in thick plate metal, whereby flues and flue sections or other articles having walls may be stiffened, in such wise as to permit the walls to expand and contract, or to permit the walls to relatively move, due to vibrations.

It is also well known that relatively thick sheet metal, when rolled to form plate metal vary in thickness at various points throughout the area of the metal. These varying thicknesses may occur in the severed portion of the plate metal, or toward the edges, due to the rolls of a rolling mill yielding too much at their ends or their central portions. The metal used for making flues and flue sections, or walls of coal bunkers or like articles averages substantially $\frac{3}{16}$ of an inch in thickness, more or less, and in this case should an attempt be made to corrugate plates of this character by forming machines or dies at present used for constructing successive corrugations, the machines would either break or become jammed. In fact in forming machines for forming dies which may be used for corrugating plates of this character, the machines either break or the parts become jammed, particularly where these relatively thick sheet plate metal vary at different points throughout their area. In other words when the forming faces come together, and contact with the large surfaces, the parts of the machine are put under considerable strain at portions thereof, and in other parts the strain or jamming forces are not present, hence the corrugations are of a deformed character, and will not serve the purpose to the best advantage.

Hence another purpose is to provide forming dies for use on forming machines, wherein the opposed faces of the interengaging projections and indentures are provided with opposing irregular or deformed walls, to compensate for the varying thicknesses at different points throughout the area of the plate, thereby permitting a corrugation to be formed, with sloping walls or other shaped walls, in order that they may uniformly expand and contract, and uniformly reinforce or stiffen a structure.

It is still another purpose to produce the greatest depth of indenture or corrugation without too much drawing of the metal over the opposing edges of the bottom die. By the use of the present invention the plates are indented or corrugated for the purpose

of providing means for stiffening thick steel plates against pressure of any kind. In fact the desire is to provide a strong stiffener and at the same time maintain a uniform section throughout the length of the plate, and one which will uniformly expand and contract.

It is well known that if the sloping or other shaped walls of the corrugation or indenture are fluted, the fluted portions would detract from the value of the corrugation as a stiffener. Furthermore as previously stated the metal used averages substantially $\frac{3}{16}$ of an inch in thickness, which is entirely too stiff or thick to be fluted within the confines of the relatively small indenture, which is designed to be made by the present form of dies or forming machines. In fact the complete indenture or corrugation is the resultant of three separate and distinct bends arrived at by one stroke of the forming machine. The dies in the present case are so proportioned that there is no drawing affect such as is the case in the ordinary commercially known corrugated plate. In forming the corrugation or indenture, the central bend is made at the same time the projection or center die enters the cavity of the other die, whereas the other two bends are made simultaneously, during the last portion of the downward stroke of one of the dies. It has been found impossible with the strongest bending or forming machine to draw a $\frac{3}{16}$ metal plate over and into the female die in a manner similar to the corrugating of relatively thin sheet metal plates, which as before stated are commercially known as corrugated sheets.

It is well to remember that there are three separate bending processes involved in making each indenture, and it will be noted that all of these bends are caused to be formed upon one stroke of one of the dies.

It is also known that the sloping or other shaped sides of the forming faces of the indenture and projection of the opposed dies approach one another as close as is practicable, and during the approach of these walls the corrugation or indenture is formed in a relatively thick sheet metal plate, with sloping or other shaped walls, which are perfectly straight, and due to the deformed faces of the indenture and projection on the opposing faces of the dies, compensation is made for the varying thicknesses of the sheet metal plates. In fact the varying thicknesses of the plate are allowed to enter the deformities or irregular walls of the indenture and the projection on the dies, in order to prevent jamming or breaking of the forming machine.

The indentures or corrugations to be formed in relatively thick sheet metal plates are to take place of heavy angles or beams that have heretofore been riveted to the plates, and it is also important to note that the indenture or corrugation represents the angle or beam, which permits, as nearly as possible, to oppose the direction of stress and in a line with the direction of stress, in order to not only reinforce the plate, but also to permit the plate to uniformly expand and contract.

The plates which are to be corrugated or provided with indentures of the present character, by the use of the forming dies herein shown, are used in the construction of bins or tanks, or flues or flue sections, conduits or conduit sections, or other ducts, and the various plates for such work may average six feet by ten feet, more or less, with stiffeners or corrugations disposed to extend with the length of the plates.

As previously stated all relatively thick sheet metal plates do not vary alike. The variation in thickness alone is greater than the total thickness of any commercial plates which are corrugated. For this reason it is the purpose of the present invention to provide forming dies, with interengaging projections or indentures with deformed faces, in order to take care of the varying thicknesses of the plates. It is well established that dies and the metal to be formed cannot come together in one solid pack, unless plates are absolutely true and of a uniform thickness throughout their area, which is never the case.

The deformed or fluted dies permit, without altering the adjustment, the forming of the indentures or corrugations in the plates, though varying in thickness, the main purpose of such forming dies is to avoid breaking of the machine or jamming of the parts. Additionally it is the aim to avoid the producing of a fluted product, and this is done by using dies, wherein their interengaging projection or depression have deformed or fluted walls.

The present form of die may be any length whatever, and in some instances it may be found most convenient to use a number of short dies, and in other cases it may be possible to use one long die up to the capacity of the forming machine.

It is most important to note that the deformed walls of the projection and depression provide a suitable clearance, to compensate for the varying thicknesses in the plates, thereby limiting any possibility of jamming the operative parts of the forming machine, and also preventing breaking of the machine.

It is to be understood that the particulars herein given are in no way limitative and that while still keeping within the scope of the invention, any desired modifications of detail and desired proportions may be made in the apparatus according to circumstances.

The invention comprises further features

and combination of parts, as will be hereinafter set forth, shown in the drawings and claimed.

In the drawings:—

Figure 1 is a perspective view of a pair of forming dies, constructed in accordance with the invention;

Figure 2 is a perspective view of the male die;

Figure 3 is a perspective view of the female die;

Figure 4 is a sectional view through a portion of a plate, showing the variations of the thickness thereof;

Figure 5 is a sectional view through the male and female dies, showing the plate which is illustrated in Figure 4 as having been formed with a corrugation or stiffener, and showing how the variations of the thickness thereof are taken by the cavities formed below the general level of the walls of the projection or cavity of the male and female dies;

Figure 6 is a sectional view through the male and female dies, showing a modified construction of projection and cavity, wherein the walls for the depressions are in conformity with each other;

Figure 7 is a sectional view through the male and female dies showing another modified form of projection and cavity;

Figure 8 is a sectional view through the male and female dies showing still another modified form of projection and cavity; and

Figure 9 is a sectional view through the male and female dies showing an additional modified construction of projection and cavity.

Referring to the drawings, 1 designates the male die, which may be attached in any suitable manner to a moving member of a forming machine and 2 denotes the female die, which may be attached to the bed of the forming machine. In fact the male and female dies peferably have ribs 3 and 4, whereby the dies may be connected to the forming machine, in order to prevent lateral movements of the dies.

The female die 2 may be any suitable length, and it is to be understood that several short dies used in alignment may be provided. The female die is provided with a longitudinally arranged depression 5, which may be any suitable shape in cross section, preferably of a V-contour. The male die is provided with a longitudinally depending projection 6, which may also be any suitable shape, preferably correspondingly to the shape of the depression of the female die. It will be noted that the projection and the depression are formed a substantial distance between the opposite sides of the die, so as to provide substantial edges or supports 7 and 8 between the projection or depression and the opposite sides of the die.

As shown in Figures 1 to 3 inclusive the opposed walls of the projection and the depression are provided with what may be termed as fluted surfaces, comprising alternately arranged depressions 9 and 9a. These depressions may be any suitable shape in cross section, either as shown in Figures 1 to 5 or as shown in Figures 6, 7, 8 and 9. In fact the depressions extend longitudinally of the walls of the projection 6 and the depression of the female die, and are disposed to break joints. These alternate depressions arranged in break joint fashion are for the purpose of receiving or compensating for the varying thicknesses in the sheet metal plates, which are pressed between the dies. In fact the alternate depressions may be termed as deformities, or in some instances may be called flutes. The supporting edges 7 and 8 between the projection 6 and the depression of the female die may vary in contour. In fact the supports 8 of the female die, as shown in Figures 1 to 3 inclusive and Figure 5 may converge inwardly and upwardly, while the supports 7 of the male die may converge inwardly and upwardly. Where the supports 7 converge inwardly and upwardly, they merge into the surfaces 10 which are curved in cross section. In fact these surfaces 10 also act as depressions, to compensate for the vaying thicknesses of the plates, which are designed to be pressed between the dies. The supporting edges 7 of the male die merge into rounded corners 11 adjacent the side faces of the male die.

In Figures 6, 7, 8 and 9 there is disclosed various modified forms of dies, wherein the opposed surfaces or walls or projections are modified in form, so as to provide differently arranged depressions, to compensate for the varying thicknesses of the plates. In Figure 6 the deformities or the alternate depressions and projections 12 and 13 are less abrupt, whereas in Figure 7 the depressions 14 and the projections 15 are opposed, and more gradual, whereas the depressions and projections 16 and 17 are in conformity to each other, and are less abrupt and more broken. It will be noted that the deformities or alternate depressions of the opposing surfaces of the projection and depression of the dies may vary. In fact they may not be limited to any particular shape, preferably designed for the purpose of compensating for the varying thicknesses in the plates to be pressed between the dies.

In Figure 8 the projection 6a of the male die is constructed so that only its apex engages with the plate to be formed with a corrugation, while the side walls of the projection are formed below a general level, so as not to contact with the plate to be formed with a corrugation, and constructed to merge

into the curved surfaces 10^a. The cavity 5^a in Figure 8 is not engaged by the plate to be formed with a corrugation. However the plate is drawn over the curved corners 8^b, and furthermore when forming the plate with a corrugation by means of the dies in Figure 8, the male die moves to a position shown in Figure 8, so that the portion of the plate on opposite sides of the corrugation will not become distorted out of alignment, and so that the apex of the corrugation will not contact with the bottom of the cavity 5^a.

In Figure 9 the edges or supports 7^a and 8^a are simply reversed to the edges or supports 7 and 8 in the other figures. It will be noted that the adjacent faces of the male and female dies, that is to say upon opposite sides of the dies, as at 8 and 11 are so formed as to permit the plate metal to creep from opposite sides of the die, as the male die enters the female die. Furthermore the two dies do not come together any closer than sufficient to permit the plate metal to engage between the dies. In other words the male die is limited in its movement to a certain position. However the inclined faces 8, as well as the parts 8^a in Figure 9, together with the portions or parts 11, and 7^a in Figure 9 act to hold or dispose the metal on opposite sides of the corrugation in direct alignment, and on a horizontal plane, and will also maintain the metal horizontally. When the corrugation begins to form due to the male die bearing upon the metal and acting to force it into the female die, the metal begins to bend over the opposite corners of the depression or indentation of the female die, and obviously the metal will creep from opposite sides of the die, whereas the dies heretofore used the metal is only free to creep from one side only. The terms general level, general plane or shape define those parts of the corrugation forming means, which contact with the metal, in other words those parts of the corrugation forming means, prior to constructing the depressions, which are below the general plane of the corrugation forming means.

The invention having been set forth, what is claimed is:—

1. A pair of corrugation forming dies having their adjacent cooperative faces provided with interengaging corrugation forming means, the corrugation forming means of one of the dies being cut away to receive the varying thicknesses of plate metal during the formation of a corrugation therein.

2. A pair of corrugation forming dies provided with male and female corrugation forming means, the corrugation forming means of each die having means formed below the general level of the surface of said forming means to receive the varying thicknesses in plate metal during the formation of a corrugation.

3. A pair of corrugation forming dies provided with male and female corrugation forming means, the corrugation forming means of each die provided with depressions and protuberances, the depressions adapted to receive the varying thicknesses in plate metal during the formation of a corrugation, one of said dies having means bearing against portions of the plate metal upon opposite sides of the corrugation to hold the opposite portions of the plate in horizontal alignment during the formation of the corrugation.

4. A pair of dies, the adjacent faces thereof provided with male and female corrugation forming means, said corrugation forming means having excessive plate metal receiving means extending longitudinally of the forming means, said excessive plate metal receiving means being constructed below the general contour of the forming means and arranged in staggered relation, for the reception of the varying thicknesses in plate metal in which the corrugation is to be formed.

5. A pair of dies, the adjacent faces thereof provided with male and female corrugation forming means, said corrugation forming means having excessive metal receiving means extending longitudinally of the forming means, said excessive metal receiving means being constructed below the general plane of the forming means and arranged in staggered relation, for the reception of the varying thicknesses in a sheet metal plate in which the corrugation is to be formed, the ends of the staggered excessive metal receiving means overlying each other to insure the reception of the excessive metal of a plate varying in thickness throughout its area.

6. A pair of dies, the adjacent faces thereof provided with male and female corrugation forming means, said corrugation forming means having excessive metal receiving means extending longitudinally of the forming means, said excessive metal receiving means being constructed below the general plane of the forming means and arranged in staggered relation, for the reception of the varying thicknesses in a sheet metal plate in which the corrugation is to be formed, the ends of the staggered excessive metal receiving means overlying each other to insure the reception of the excessive metal of a plate varying in thickness throughout its area, one of said dies having means bearing upon opposite sides of the corrugation, to hold said opposite portions of the plate in positions perpendicular to the side faces of the die during the formation of the corrugation.

7. In a pair of dies, the opposing cooperative faces of said dies having male and female corrugation forming means, the opposed surfaces of said corrugation forming

means having alternate opposed depressions and protuberances extending longitudinally of said corrugation forming means, and constructed below the general plane of said forming means, to permit of the reception of the varying thicknesses in a sheet metal plate in which the corrugation is to be formed.

8. In a pair of dies, the opposite cooperative faces of said dies having male and female corrugation forming means, the opposed surfaces of said corrugation forming means having alternate opposed depressions and protuberances extending longitudinally of said corrugation forming means, and constructed below the general plane of said forming means, to permit of the reception of the varying thicknesses in a sheet metal plate in which the corrugation is to be formed, one of said dies having means bearing upon opposite sides of the corrugation, to hold said portions in positions perpendicular to the side faces of the die during the formation of the corrugation.

9. A pair of dies, the cooperative adjacent faces thereof having male and female corrugation forming means, the surfaces of said forming means having excessive metal receiving depressions and protuberances extending longitudinally of said faces, said protuberances being staggered, whereby the depressions are alternately opposed with their ends overlying, to insure the reception of the metal in said depressions.

10. A pair of dies, one having a cavity extending longitudinally of its forming face, over the opposite edges of which plate metal bends during the forcing of the plate metal into said cavity, the other die having a projection extending longitudinally of its forming face and provided with means to bear upon the plate metal at a point substantially between the points where the plate bends over the opposite sides of the cavity, thereby forcing the plate into the cavity to form a corrugation.

11. A pair of dies, one having a cavity extending longitudinally of its forming face, over the opposite edges of which plate metal bends during the forcing of the plate metal into said cavity, the other die having a projection extending longitudinally of its forming face and provided with means to bear upon the plate metal at a point substantially between the points where the plate metal bends over the opposite sides of the cavity, thereby forcing the plate metal into the cavity to form a corrugation, one of said dies having means to bear upon opposite sides of the corrugation to be formed, to hold the opposite sides of the plate metal in positions perpendicular to the side faces of the die during the formation of the corrugation.

12. A pair of dies, one having a cavity extending longitudinally of its forming face, over the opposite edges of which plate metal bends during the forcing of the plate metal into said cavity, the other die having a projection extending longitudinally of its forming face and provided with means to bear upon the plate metal at a point substantially between the points where the plate metal bends over the opposite sides of the cavity, thereby forcing the plate metal into the cavity to form a corrugation, the construction and arrangement of the opposing surfaces of said cavity and projection being such as to permit of the reception of the varying thicknesses at different points throughout the area of the plate metal.

13. A pair of dies, one having a cavity, extending longitudinally of its forming face, over the opposite edges of which plate metal bends during the forcing of the plate metal into said cavity, the other die having a projection extending longitudinally of its forming face and provided with means to bear upon the plate metal at a point substantially between the points where the plate metal bends over the opposite sides of the cavity, thereby forcing the plate metal into the cavity to form a corrugation, the construction and arrangement of the opposing surfaces of said cavity and projection being such as to permit of the reception of the varying thicknesses at different points throughout the area of the plate metal, one of said dies having means to bear upon opposite sides of the corrugation to be formed to hold the opposite portions of the plate metal in positions perpendicular to the side faces of the die during the formation of the corrugation.

14. A method for forming corrugation in a relatively thick plate metal, consisting in pressing a corrugation in the plate metal, in compensating for varying thicknesses at different points throughout the area of the plate metal, in maintaining portions of the plate metal on opposite sides of the deformed corrugation perpendicular to the sides of a corrugation forming die.

15. A pair of dies, the cooperative adjacent faces thereof having male and female corrugation forming means, the surfaces of said forming means having excessive metal receiving depressions and protuberances extending longitudinally of said surfaces, to permit of the reception of the varying inequalities in the plate metal.

16. As an article of manufacture, a pair of dies, the adjacent faces thereof having male and female corrugation forming means, said adjacent faces upon opposite sides of said corrugation forming means being such as to permit the plate metal to creep from either of the sides of the dies.

17. As an article of manufacture, a pair of dies, the adjacent faces thereof having

male and female corrugation forming means, said adjacent faces upon opposite sides of said corrugation forming means being such as to permit the plate metal to creep from the sides of the dies, and also to insure maintaining the plate metal on both sides of the dies horizontally and in alignment.

18. A pair of dies, the cooperative adjacent faces of which having male and female corrugation forming means, the surfaces of said forming means having means constructed below the general level of the surfaces for the reception of the inequalities in the plate metal when one die is limited in its movement toward the other die.

19. A pair of dies, the cooperative adjacent faces of which having male and female corrugation forming means, the surfaces of said forming means having means constructed below the general level of the surfaces for the reception of the inequalities in the plate metal, the adjacent faces of the dies beyond the opposite remote portions of the forming means being such as to permit the plate metal to creep from both sides of the dies as the corrugation is formed.

20. A method for forming a corrugation in relatively thick plate metal, which is capable of feeding from opposite directions toward the corrugations, which first consists in pressing a corrugation in the plate metal, maintaining the plate metal beyond and upon opposite sides of the corrugation in aligning planes perpendicular to the sides of a corrugation forming means, in compensating for the varying inequalities at different points throughout the area of the plate metal.

In witness whereof, in the presence of two witnesses, the inventor's signature is hereunto affixed.

WILLIAM M. CONNERY.

Witnesses:

EDGAR C. ANCOTT,

ALBERT W. STEWART.