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2,377,664

SHEET METAL SHAPING AND SHEARING

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Fig. 1

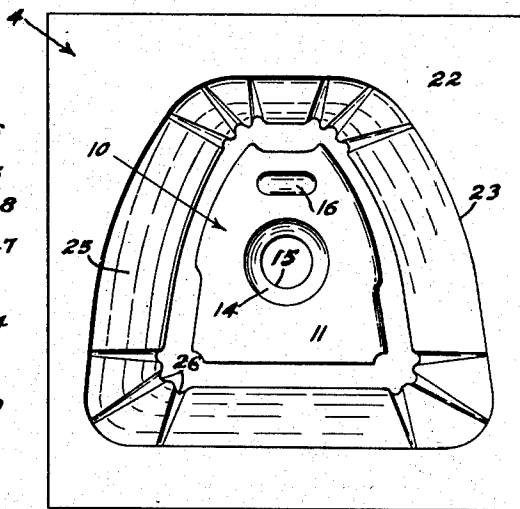
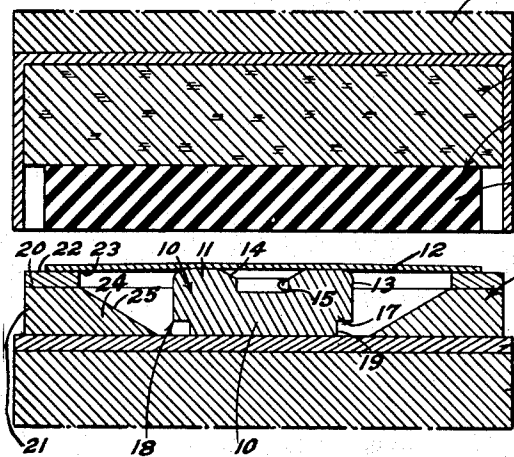


Fig. 2

Fig. 4

Fig. 5

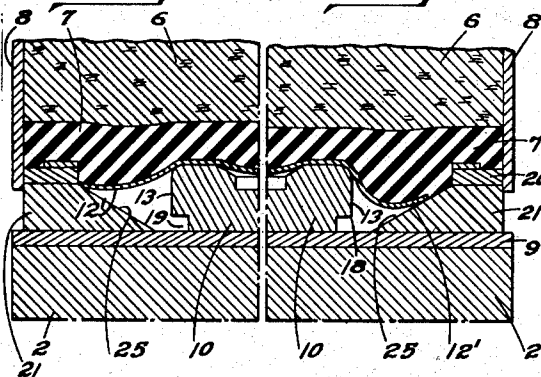


Fig. 3

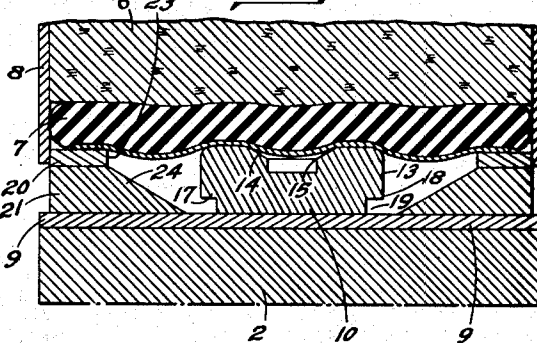


Fig. 6

Fig. 7

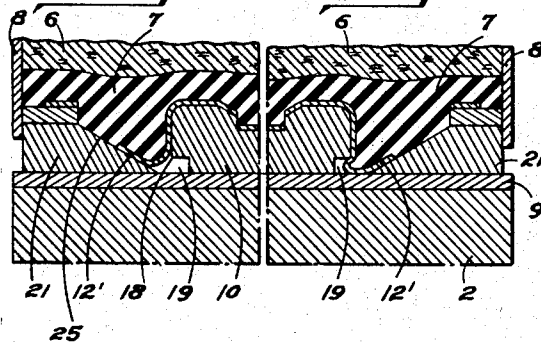
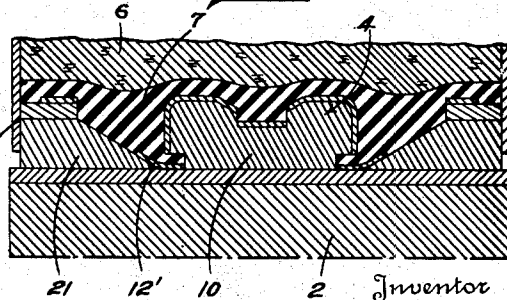


Fig. 8



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SHEET METAL SHAPING AND SHEARING

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This invention relates to sheet metal shaping and/or shearing and, more particularly to a method of shearing sheet metal into blanks of desired size, drawing the blank to desired shape, and shearing the selvage or excess metal from the shaped article.

A process of shearing and shaping sheet metal heretofore used in the industry has involved the steps of placing a sheet of metal over a die, and forcibly applying pressure to the sheet by means of a confined, fluidlike, flowable rubber pad to cause it to assume a shape as near as possible to the contour of the die. If the sheet were to be sheared, portions on opposite sides of the shearing edge of the die were immovably held in place while pressure was applied through the pad to set up tensile forces in the sheet adjacent the shearing edge thus causing it to shear adjacent such edge.

This process was disadvantageous for if the sheet were immovably held in place at spaced portions the application of pressure to draw or shape the sheet resulted in tearing or cracking of the sheet in the portion to be shaped. Consequently, common practice in the industry consisted in securely holding the central portion of the sheet against the die while leaving the peripheral portion unrestrained and free to be drawn or shaped over the forming surface. Unfortunately, such practice results in the peripheral portion of the sheet being shaped to desired contour prior to the complete shaping of central portions of the sheet due, probably, to the fact that less force is required to shape the peripheral portion of the sheet than is necessary to shape or draw the central portions of the sheet over the corners or angles of the die. Accordingly, excess or surplus metal created during the drawing operation is forced inwardly toward the center of the sheet rather than outwardly toward its periphery and causes wrinkles, gathers or folds in the shaped portion of the sheet. This disadvantage is particularly noticeable when the die possesses curved and rounded contours. These disadvantages were known to the industry but the solution presented was to continue the formation of defective shapes and to attempt to pound out such wrinkles manually; this, of course, is very expensive and does not solve the problem since in many cases pounding by hand does not eradicate the wrinkles and does result in deformation or distortion of the shaped article.

The chief object of my invention is to provide an improved process of metal shaping in which the disadvantages discussed above are eliminated.

An object of my invention is to provide an economical and ready method of shaping a metal sheet to the precise contour of a forming surface without developing wrinkles, folds or gathers in the shaped article. A further object is to provide a speedy and accurate process of shaping sheet metal to desired contour by means of a pressure pad. A still further object is to provide a method of shaping and shearing sheet metal in which the central portion of the sheet is effectively clamped to a die while the peripheral portion of the sheet is yieldingly secured by a slip-grip action. A still further object is to provide an improved die for sheet metal shaping and/or shearing.

This invention relates to a process of shaping and/or shearing sheet metal to desired contour by means of a suitable die and a pressure pad capable of transmitting applied forces to the sheet to deform it about the forming surface of the die. The process consists essentially in disposing a metal sheet over a die, applying pressure to a pressure pad disposed above the sheet to securely clamp the sheet against flat surfaces of the die and continuing the application of pressure to the pad to set up tensile forces in the unsupported portion of the sheet to cause it to shear adjacent a shearing edge of the die and thus form a blank of desired contour. Immediately after the shearing operation, the peripheral portion of the blank is seized and held by a slip-grip action against a secondary clamping surface; the central portion of the blank, of course, is still securely clamped by the pressure pad against a flat surface of the die. Continued application of pressure by means of the pad against the unsupported portion of the sheet shapes it over the forming surface of the die. Since the peripheral portion of the blank is yieldingly held, it is free to slide automatically along the secondary clamping surface as required for the shaping operation which results in the excess or surplus metal created in the drawing operation being urged outwardly into the peripheral portion of the sheet. Thus the desired article is shaped accurately over the forming surface without folds or wrinkles. Continued application of pressure to the pressure pad sets up tensile forces in the unsupported portion of the blank and causes it to shear adjacent a secondary shearing edge disposed in the lower portion of the forming surface thus separating the selvage or excess metal from the finished shape.

This invention also relates to a die for use in shaping and shearing a metal sheet which comprises a shaping element having a clamping surface and a forming surface extending in a direc-

tion substantially normal to the direction of the clamping surface, a shearing edge disposed in the lower portion of the forming surface adapted to shear the sheet to predetermined size after it has been shaped over said element, and a member spaced from said element forming a downwardly extending secondary clamping surface against which the peripheral portion of the metal sheet may be held with a slip-grip action. If desired, a second member is provided spaced from said element and having a clamping surface provided with a shearing edge to shear the metal sheet into a blank of desired contour which is then shaped over the forming surface. Preferably, flutes are provided in the secondary clamping surface to accommodate surplus metal drawn in the shaping operation.

The accompanying drawing illustrates a preferred embodiment of my invention, in which

Figure 1 is a sectional view illustrating a simple form of apparatus by which my invention may be practiced;

Figure 2 is a plan view of the die of my invention; and

Figures 3-8 inclusive are fragmentary sectional views illustrating various stages in the process of forming the shaped metal article.

Referring to the drawing, there is shown in Figure 1 two cooperating elements 2 and 3 which are adapted to be moved relatively together and apart under pressure. Member 2 may be considered a support or table and member 3 may be considered a head which moves toward the table. Disposed on the support 2 is a die designated generally at 4 which in the ordinary course of use is merely laid on such support although it will be understood it may be formed integral with support 2 if desired. The preferred construction of the die 4 is illustrated in Figure 2, hereinafter described.

Secured to the lower portion of the head member 3 is a yieldable pressure pad 5. The pad 5 may be formed of rubber, rubber composition, cork, cork composition, or similar materials which possess resilient, flexible and/or compressible characteristics. Preferably pad 5 consists of a compressible and yieldable cork composition backing 6 of predetermined area and a resilient rubber facing 7 of less surface area than backing 6 disposed over the die 4 and forming a wear resistant surface for the die engaging portion of the pad. It will be noted the cork pad 6 is confined within a box or container 8 which may be bolted to the head member 3 in order to avoid side rupture of the cork. The container 8 may be formed of wood or metal of desired thickness. Preferably, the rubber facing 7 is unconfined and may or may not be secured to the backing 6.

The die 4 is illustrated primarily in Figures 1 and 2 and comprises a base 9 to which is bolted the shearing and forming members. Disposed centrally of the die is an element 10 having a flat surface 11 against which a metal sheet 12 may be clamped by the pad 5 and a forming surface 13 extending in a direction substantially normal to the direction of surface 11. The juncture between the surfaces 11 and 13 is slightly rounded to avoid shearing of the metal sheet at such point during the shaping operation. A downwardly and inwardly extending surface 14 is provided in flat surface 11 and terminates in a shearing edge 15 so as to provide a circular opening surrounded by a downwardly extending flange centrally of the formed article; a rectangular indentation 16 is also provided in the fore-

part of surface 11 and is adapted to form a corresponding indentation in the shaped article. A shoulder 17 is provided in the lower portion of forming surface 13 and terminates in an outwardly extending secondary shearing edge 18 for a purpose hereinafter described. A recess 19 is disposed in the lower portion of element 10 below the shoulder 17.

A member 20 spaced from the element 10 is disposed on a block 21 secured to the base 9. The flat surface 22 of member 20 forms a clamping surface similarly to surface 11 of element 10 and terminates in an inwardly extending shearing edge 23 which projects in a direction opposed to the direction of shearing edge 18. Surface 22 is disposed in substantially the same plane as surface 11 so that a metal sheet disposed between the die and the pressure pad is securely clamped or held in position peripherally and centrally.

Block 21 is provided with an inwardly inclined portion 24 which forms a secondary clamping surface 25 as hereinafter explained. The surface 25 is disposed in a plane below the plane of clamping surfaces 11 and 22 and is disposed between such surfaces. Flutes 26 are placed in surface 25 and are adapted to accommodate excess or surplus metal created during the drawing operation. Preferably, the surface 25 inclines inwardly and downwardly so as to direct forces applied to the pad 5 inwardly below the shoulder 18 into recess 19 as hereinafter explained.

I will now describe my process by reference to Figures 3-8 inclusive. Sheet 12 of metal such as aluminum or aluminum alloy is disposed over die 4. The head 3 is moved downwardly toward the table 2 forcing pad 5 against the die and securely clamping sheet 12 against the flat surfaces 11 and 22. As downward movement of the head continues, the forces transmitted to the sheet 12 by the pad 5 increase and force the unsupported portion of the sheet into the cavities in the die (see Figure 3) thus setting up or creating tensile forces in the unsupported portion of the sheet. The sheet 12 being securely clamped against the surfaces 11 and 22, the tensile forces set up in the sheet cause the sheet to shear adjacent the shearing edge 23 thus forming a metal blank of suitable contour.

Immediately, the sheet 12 is sheared, the peripheral portion 12' of the blank is forced downwardly and held against the secondary clamping surface 25 by a slip-grip action; in other words, the peripheral portion 12' of the blank is yieldably clamped against the downwardly extending surface 25 as shown in Figure 4. Holding the peripheral portion 12' by means of slip-grip action is an essential feature of my invention and so doing permits the portion 12' of the blank to slide automatically along the clamping surface 25 as required for the shaping and drawing operation, thus ensuring that the central portion of the blank is drawn to desired shape prior to shaping the peripheral portion and ensures that wrinkles, folds or gathers created in drawing of the desired shape are forced outwardly into the peripheral portion of the blank.

Pressure against the blank is continued by the pad 5; in Figure 5, I have shown a further stage of the drawing operation illustrating the blank beginning to receive the contour of surface 13 and showing that the peripheral portion 12' has slid automatically a slight distance along surface 25 as required for such preliminary shaping. I do not know definitely the manner in which

such steps occur but I believe pressure builds up at the unsupported portion of the sheet until it has increased to an amount in excess of the holding pressure at the peripheral portion of the sheet. This necessarily is an amount less than the tensile strength of the sheet to obviate cracks or tears in the blank. When pressure at the unsupported portion of the sheet is greater than the holding pressure at the peripheral portion of the sheet, the peripheral portion 12' slides downwardly along surface 25 until the holding pressure at the peripheral portion of the sheet is again equal to or greater than the pressure at the unsupported portion of the blank. I believe this procedure continues until the unsupported portion of the blank conforms to the shaping surface 13 and is supported thereby.

During this process, I believe the direction of pressure applied to the unsupported portion of the sheet gradually changes as the sheet conforms to the forming surface 13 until at the bottom of the die the direction of forming pressure is substantially normal to the direction of clamping pressure. This is aided, of course, by the downwardly extending secondary clamping surface.

In Figure 6, it will be noted the blank conforms to surface 13 and is supported thereby. It should be noted that at this stage the peripheral portion 12' of the blank has slid automatically almost to the bottom of surface 25. Excess metal caused by drawing has been forced outwardly to the peripheral portion and has taken the contour of the flutes 26. While the blank at this stage has been shaped to desired contour it is desirable that the selvage or excess portion of the sheet be sheared from the formed article. Accordingly, for this purpose, the shoulder 17 provided with the secondary shearing edge 18 is formed in the lower portion of surface 13. As pressure continues and increases, it is localized at the bottom of the die adjacent the recess 19. This is aided, of course, by the configuration of surface 25 which directs the pressure toward such recess. The continued application of pressure sets up or creates tensile forces in the unsupported portion of the blank and forces the sheet into the recess (see Figure 7). Since the blank is securely clamped against the bottom of the die and the forming surface 13, the tensile forces so set up in the unsupported portion cause the blank to shear adjacent the secondary shearing edge 18 thus shearing the shaped article to desired size. In Figure 8, I have illustrated the shaped article at the end of the operation and prior to the release of pressure. It will be noted the desired article has been shaped and cut to desired size about the element 11 and that scrap or surplus metal has been severed therefrom as above described. Pressure is released and the formed article and the selvage or waste metal pieces are removed from the die, a second metal sheet disposed thereover, and the process repeated.

It will be understood the desired indentation, flange and opening in the central portion of the sheet are formed at the same time as the sheet is shaped about the surface 13. That is, application of pressure transmitted by pad 5 forms the desired indentation in the surface of the article and forces it downwardly to take the contour of flange 14. Continued application of pressure shears the central portion of the sheet adjacent shearing edge 15 and forms an opening of desired contour in the sheet surrounded by a downwardly extending flange.

While I have described the above stages or steps of operation as occurring sequentially it will be understood that shaping and/or shearing occurs as a continuous operation and that such steps follow one another so closely as to occur, for all practical purposes, substantially simultaneously.

My invention provides an improved process of metal shaping which permits more accurate and satisfactory metal shaping than heretofore obtainable. Surplus metal created by drawing the ductile metal is forced outwardly into the selvage and is not permitted to form wrinkles, folds or gathers in the shaped article. The provision of slip-grip holding action at the peripheral portion of the blank being shaped prevents cracks or tears in the blank and ensures more accurate conformation of the blank to the contour of the forming surface, thus doing away with the expensive and laborious manual labor heretofore required to shape the article to precise contour.

While I have illustrated and described a preferred embodiment of my invention, it will be understood my invention is not limited thereto but may be otherwise embodied within the scope of the following claims:

I claim:

1. In the method of shearing and shaping a metal sheet, the steps which comprise clamping portions of the sheet against spaced flat surfaces of a die disposed in substantially the same plane, applying pressure to the unsupported portion of the sheet to set up tensile forces therein causing it to shear adjacent a shearing edge of the die, yieldably clamping a peripheral portion of the sheared sheet against an inclined secondary clamping surface disposed in a plane below the plane of said flat die surfaces, applying pressure to the unsupported portion of the sheet to cause it to conform to the contour of the die while permitting downward slippage along the inclined surface of the yieldable clamped peripheral portion occasioned by such pressure, and applying pressure to the sheet in a direction normal to the direction of clamping pressure applied against the flat surfaces of the die to set up tensile forces therein adjacent a shearing edge disposed in the lower portion of the die to shear the selvage from the shaped portion of the sheet.

2. In the method of shearing and shaping a metal sheet, the steps which comprise clamping portions of the sheet against spaced flat surfaces of a die disposed in substantially the same plane, applying pressure to the unsupported portion of the sheet to set up tensile forces therein causing it to shear adjacent a shearing edge of the die, yieldably clamping a peripheral portion of the sheared sheet against a downwardly extending, inclined secondary clamping surface disposed in a plane below the plane of said flat die surfaces, applying pressure to the unsupported portion of the sheet to cause it to conform to the contour of the die while permitting downward slippage of the yieldably clamped peripheral portion occasioned by such pressure, and applying pressure to the sheet in a direction normal to the direction of clamping pressure applied against the flat surfaces of the die to set up tensile forces therein adjacent a secondary shearing edge disposed in the lower portion of the die and extending in a direction opposite to the direction of the first shearing edge to shear the selvage from the shaped portion of the sheet.

3. A die for use in shaping and shearing a metal sheet comprising a shaping element having a clamping surface, a forming surface extending in

a direction substantially normal to the direction of the clamping surface, and a shearing edge disposed in the lower portion of the forming surface, a member spaced from said element having a clamping surface terminating in a shearing edge extending in a direction opposite the direction of said first-mentioned shearing edge, and a block having a secondary, downwardly extending, inclined clamping surface disposed between said element and said member and in a plane below the plane of the clamping surface of said member, said downwardly extending clamping surface having flutes therein adapted to receive excess metal during the shaping operation.

4. In the method of shearing and shaping a metal sheet the steps which comprise forcing a pressure pad against a metal sheet disposed over a forming surface to securely clamp the sheet thereagainst, holding with a slip-grip action a peripheral portion of the sheet against an inclined downwardly extending clamping surface, applying pressure by means of said pad to the unsupported portion of the sheet in a direction at an angle to the direction of clamping pressure, and continuing the pressure while gradually changing the direction thereof to cause the unsupported portion of the sheet to conform to the contour of the forming surface, the peripheral portion of the sheet automatically and substantially continuously sliding downwardly over said downwardly extending clamping surface during the shaping operation as required for such shaping, and applying pressure to the sheet in a direction normal to the direction of clamping pressure to set up tensile forces therein adjacent a shearing edge disposed in the lower portion of the forming surface to shear the selvage from the shaped portion of the sheet.

5. In the method of shearing and shaping a metal sheet the steps which comprise forcing a pressure pad against a metal sheet disposed over a die to securely clamp the sheet against spaced surfaces of the die, continuing the application of compressive forces to the pad to set up tensile forces in the unsupported portion of the sheet thus causing it to shear adjacent a shearing edge of the die, immediately yieldably clamping the peripheral portion of the sheet against a downwardly extending, inclined clamping surface dis-

posed in a plane below said spaced surfaces of the die, applying pressure by means of said pad to the unsupported portion of the sheet in a direction at an angle to the direction of clamping pressure, and continuing the pressure while gradually changing the direction thereof to cause the unsupported portion of the sheet to conform to the contour of the die, the yieldably clamped peripheral portion of the sheet automatically and substantially continuously sliding downwardly over said downwardly extending clamping surface during the shaping operation as required for such shaping and applying pressure to the sheet in a direction normal to the direction of clamping pressure to set up tensile forces therein adjacent a shearing edge disposed in the lower portion of the die to shear the selvage from the shaped portion of the sheet.

6. A die for use in shaping and shearing a metal sheet comprising a shaping element having a clamping surface and a forming surface extending in a direction at an angle to the direction of the clamping surface, said forming surface having a shearing edge disposed in its lower portion adapted to shear the sheet to predetermined size after it has been shaped over said element, and a block having a secondary, downwardly extending, inclined clamping surface spaced from said element and in a plane below the plane of the clamping surface of said element, said downwardly extending clamping surface having flutes therein adapted to receive excess metal during the shaping operation.

7. A die for use in shaping and shearing a metal sheet comprising a shaping element having a clamping surface, a forming surface extending in a direction at an angle to the direction of the clamping surface, and a shearing edge disposed in the lower portion of the forming surface, a member spaced from said element having a clamping surface terminating in a shearing edge extending in a direction opposite the direction of said first-mentioned shearing edge, and a block having a secondary, downwardly extending, inclined clamping surface disposed between said element and said member and in a plane below the plane of the clamping surface of said member.

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