METHOD OF DEEP DRAWING RECTANGULAR SHAPES

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The invention relates to the deep drawing of metal parts of generally rectangular, square or multisided design and more particularly to the deep drawing of such items as stainless steel or enameled iron sinks which are generally deep and rectangular in shape with wide mounting flanges extending outwardly in a plane.

This application is a continuation-in-part of application Serial Number 330,570, now abandoned, filed in my name December 13, 1963.

Manufacturers of such flanged and deeply drawn rectangular shapes have long felt the need for a method of deep drawing such items which would save costly materials, reduce the amount of cold worked stresses and distortion in the flange areas and provide a more uniform thinning throughout the corners and sides. In the manufacture of stainless sinks the need has been great, due to the high initial cost of the stainless and the expensive annealing pickling and stress relieving operations, generally required to remove cold worked stresses and distortion after deep drawing.

The importance of this invention will be understood when considering that a great deal of engineering time and money has been spent by various manufacturers of these items, in an effort to reduce or eliminate the mentioned manufacturing costs. Until this invention a satisfactory method had eluded all such efforts.

One object of the invention is to provide a method of deep drawing generally rectangular shapes which provides for substantial material savings.

Another object of the invention is to provide a method of deep drawing flanged rectangular or multisided shapes which provides a more uniform thinning of the material throughout various areas of the corners, sides and bottom.

A further object of the invention is to provide a method of deep drawing rectangular or similar shapes, other than round, which reduces the amount of residual stress and distortion normally remaining in the flange after drawing.

Still another object of the invention is to provide a method of deep drawing such shapes, which reduces or eliminates the need for anneals or stress relief operations.

Another object of the invention is to provide a method which uses a substantially smaller blanket, thereby reducing the strain on the material during drawing and in turn reducing the amount of thinning normally taking place in the corners, near the bottom of the drawn part.

Another important object of the invention is to reduce scrap by providing a method which permits such shapes to be drawn deeper without causing stress fractures.

These and other objects of the invention will appear in the following description and appended claims, reference being made to the accompanying drawings forming a part of this specification wherein,

FIGURE 1 shows a flat rectangular blank of metal before it is drawn.

FIGURE 2 is an enlarged plan view of a deeply drawn rectangular part as produced by this invention, having phantom lines outlining blank sizes and flange shapes before and after drawing, impressed thereon.

FIGURE 3 is a perspective view of a preferred punch shape for a first draw operation, which utilizes an important step of the invention.

FIGURE 4 is a sectional view of the proposed first draw punch taken on line 4—4 of FIGURE 3.

FIGURE 5 is a perspective view of the part 4 shown in FIGURE 2, after the second or stretch operation has been performed but before the flange has been trimmed.

FIGURE 6 is a sectional view of the part 4 taken at line 6—6 of FIGURE 5.

FIGURE 7 is a plan view, similar to FIGURE 2, of a generally rectangularly shaped part having outwardly curved sides.

FIGURE 8 is a perspective view of a proposed first draw punch for the part shown in FIGURE 7.

FIGURE 9 is a perspective view of the part shown in FIGURE 7, after second draw but before the flange is trimmed.

FIGURE 10 is a sectional view taken on line 10—10 of the first draw punch shown in FIGURE 8.

FIGURE 11 is a plan view of the end of the punch shown in FIGURE 8.

Specifically my invention comprehends providing a rectangular blank of smaller size than would normally be required by conventional methods. First drawing the blank over a punch of such end shape and blending radii that the lineal length measured from the base, in the area of the middle of the sides, up over the end of the punch to a determined line on the end of the punch, is substantially less than the lineal length measured in a similar direction or manner, at or near the corners, thereby reducing the lineal length of material required to form over the punch in the side areas. Thereafter further forming the part by placing it over a punch of desired final shape, and while tightly gripping the material in the remaining flange area, to prevent or limit movement therein, stretch the side, corner and bottom areas to desired depth and to conform to the shape of said final punch.

Describing the invention in detail and directing attention to the drawings, wherein, FIGURE 1 shows a flat rectangular blank of metal, of determined suitable dimensions for producing a given drawn rectangular item by the invention covered herein.

FIGURE 2 shows a plan view of a deeply drawn, flanged rectangular part 4, with the flange trimmed to desired rectangular shape 6. The shape and approximate size of the blank 1 is shown in dotted lines, superimposed on the outside of the trimmed flange 6, of drawn part 4. A dotted line 8 is also superimposed on the FIGURE 2, to indicate the general shape of the outer edge of the blank 1 after drawing and before trimming. For purposes of illustration and clarification a larger rectangular blank 2 is also shown in dotted lines, superimposed on FIGURE 2, to indicate the size blank normally required when using a single punch and conventional draw methods.

In the deep drawing of cup or pan shaped parts, from a flat piece of stock, the blank is normally slideably but firmly held between matching flat surfaces of die and pressure rings, to inhibit wrinkle formation or distortion in the determined outer areas of the blank, while said blank is being forced to gather and stretch over the die punch until it conforms to the shape of said punch. As such standard procedures are generally understood, detailed drawings of draw dies have been omitted.

Those familiar with the deep drawing of rectangular, square or multisided shapes will understand that due to the gathering action taking place at the corners and the forming taking place along the sides, during the draw operation, the shape of the conventional rectangular blank 2, when drawing the deep part 4, on a single punch by conventional methods, changes to form an edge configuration as shown by dotted line 10, having deeply inwardly gathered scallops 12 at the sides, as shown in FIGURE 2.

FIGURE 3 shows a perspective view of a suggested shape of first draw punch employed in this invention. Here it will be noted the shape of the end 24 of the
punch 25 is made up of larger radii 26 in the side areas, which blend into smaller radii 28 near the corners. FIGURE 4, which is a sectional view of the punch taken at line 4—4 in FIGURE 3, clearly shows the larger radii 26 and the smaller radii 28. It will be seen and understood, from this sectional view, that the linear length, measured from one bottom edge 30, at one side of the punch, up to the end of punch 25, in the area of the larger radii 26 and down to the other bottom edge 32, is much shorter than the linear length when measured in a similar direction up over the smaller radii 28, near the corners of the punch 25. It therefore requires less linear length of material to form over the middle of the punch in the areas of the larger radii 26.

In practicing this invention the blank 1 is first drawn over the specially shaped punch 25, shown in FIGURES 3 and 4. It is then desirable to remove residual drawing lubricants from the flange areas of the part. The flange of the part is then firmly held between complementing die members to prevent or limit further inward gathering of the flange material while the part is redrawn and stretched over a punch of desired final shape, wherein the end radii of the punch is generally uniform all around. During this redraw operation the material of the sides and bottom, which was previously drawn to conform to the larger radii 26 of the first draw punch 25, stretches until it conforms to the shape and generally uniform radii of the reshaped punch.

FIGURE 5 shows a perspective view of a part 4 after it has been redrawn and stretched over such punch of desired final shape and uniform radii 36. The flange is shown as it would appear after redraw and before it is trimmed.

FIGURE 6 is a sectional view of the part 4 taken at line 6—6 of FIGURE 5. Dotted phantom lines 44 and 46 indicate the general shape of the part at the sides and corners respectively, as formed on special punch 25, before redrawing and stretching to the final depth and uniform radii 36. Bracketed area 40 of drawn part 4 in FIGURE 6 indicates the approximate depth of the part before it is redrawn and stretched over the final form punch. Bracketed area 42 indicates the additional depth to which the part has been stretched during redrawing of the part.

It will be understood by those familiar with deep drawing of generally rectangular parts that severe stresses and cold worked hardesses are produced in the part during the draw operation. As the metal gathers inward to form the corners 23, of the deeply drawn part 4, these stresses and cold worked hardesses cause the material to become thin in the areas 34, where the radii of the corners blends into the bottom of the deeply drawn part. The larger the blank in relation to a given rectangular part, the greater the stress. Often the corners 20, of the conventional larger blank 2, must be cut off approximately as shown by diagonal lines 14, in FIGURE 5, in order to prevent excessive thinning or fracturing of the material.

It should also be noted and understood that the strains of forming the sides are normally much less than those created by the gathering in at the corners and that little or no thinning takes place in the side areas of the part, or the areas drawn over the radii 26 of punch 25, during the first draw operation.

Since the smaller blank 1 can be used with the special first draw punch 25, the normal thinning in the critical corner areas 34 is reduced. When the part produced on special draw punch 25 is reformed and stretched over the blank, the punch to the desired shape and generally uniform radii 36, as shown in FIGURES 5 and 6 the material in the sides and general area of the larger blending radii 44 stretches and thins out. Since the smaller blank 1, made possible by this invention, causes less strain and less thinning at the critical corner areas and since the stretching of the areas of the larger radii 44 during the redraw operation causes these side areas to thin out somewhat, the resulting part has a generally more uniform thickness throughout the areas of the bottom after stretching over the first draw punch 25, made on the special punch 25, can be relatively shallow in depth. The added depth and amount of stretch which can be obtained in the redraw operation is largely determined by the elongation limits and physical properties of the material being drawn.

Referring again to FIGURE 2, it will be noted the edge configuration 10, of the larger blank 2, drawn by conventional methods, and edge configuration 8, of the smaller blank 1, drawn by use of special punch 25 and methods outlined in this invention, both follow the same general line in the scalloped areas 12, at the sides. Both blanks remain large enough in the scalloped areas 12, after drawing, to obtain the final desired flange trim size 6.

As special punch 25, in FIGURES 3 and 4, uses less linear of material and the smaller blank 1, the overall depth of inward scallop outlined by edge configuration 8 is much less, when practicing the stepped method outlined in this invention, than the depth of inward scallop formed at the sides, as outlined by edge configuration 10, when conventional methods and the larger blank 2 are used. It will be understood that since the depth of scallop is less the amount of residual stress and distortion in the flange, after drawing, is less. This generally reduces or eliminates the need for anneals or stress relief operations.

In FIGURE 2 it will be noted that the amount of trim scrap remaining in the corner areas 18, outlined by dotted line 8, when the smaller blank 1 is drawn by use of the special punch and stepped methods of this invention, is less than the trim scrap remaining in corresponding corner areas 16, outlined by dotted line 10, normal when conventional methods and larger blank 2 are used.

FIGURE 7 shows a generally rectangularly shaped part 50 having curved sides 52 and with outer flange 54 trimmed to a determined size, as shown at 53. The curved sides give the rectangle a more oval shape. Here again the part can be produced, by methods outlined in this invention, from a blank 48 which is smaller than a blank 49, normally required with conventional methods. The amount of the corner trim scrap of the flange 54 is reduced and the strain which normally causes critical thinning in areas 56, where the corner bends into the bottom, is also reduced, due to the smaller blank 48.

FIGURE 8 shows a proposed punch 55 for the first draw operation in producing part 50, which has curved sides as shown in FIGURE 7. After the blank is first drawn over the specially shaped punch 55, to determined depth, the flange 54 of the part so formed is firmly held to limit further inward gathering therein, and the body of the part is stretched to determined final depth over a punch of generally uniform end configuration.

The finished drawn part 50 is shown in perspective in FIGURE 9, as it would appear after the second draw or stretch operation and before the excess flange at the corners is trimmed.

Section view FIGURE 10, taken at line 10—10 of FIGURE 8, and end plan view FIGURE 11 of the same punch, are provided to help describe a practical method of measuring the linear lengths down over the end and sides of the first draw punch 55 to the base 66, of this special punch configuration. This measuring method consists of starting from a reference line 60 spaced inward, on the end, a uniform distance from the wall 62 of the punch. This reference line 60, in this case, is
spaced in from the wall 62 of the punch 55, a distance equal to the radii of the corner 58.

It will be noted that when measuring down over the ends of the punch 55, from the reference line 60, to the base 66, in the area where the larger radii 64 is shown, the lineal length would be less than when measuring in a similar manner from the reference line 60 down over the punch 55 to the base 66 in the area of the corners 58.

The principle of the shorter line in the area of the sides, of punch 55, is the same here as explained in relation to the straight sided rectangular punch shown in FIGURE 3. The only difference being in the method of measuring. In both cases the special punch should be properly designed to take advantage of given elongation limits and physical characteristics of the material to be drawn.

It will be seen, therefore, that the invention as described and shown provides a method of deep drawing rectangular parts which reduces the blank size, thereby reducing material costs. It also reduces the residual stresses and flange distortion which, in turn, reduces or eliminates the need for intermediate anneals or stress relief operations. The smaller blank also reduces the amount of strain, thereby reducing the amount of thinning taking place in critical corner areas and reduces the danger of fractures. It also reduces the amount of trim scrap and provides a method of obtaining a more uniform amount of thinning throughout the corners, sides and bottom of the part.

It will be understood that although only one generally preferred shape of special first draw punch is shown for a straight sided rectangular part and only one is shown for a rectangular part having outwardly curved sides, various combinations of slopes and blending radii can be provided on the end of the punch which would similarly require less lineal length over the end in the area of the sides. Or, if desired, the corner areas could also be made to extend out beyond the center area of the end of the punch.

The invention as shown is by way of illustration and not limitation and may be subject to various modifications without departing from the spirit thereof or the scope of the appended claims.

I claim:

1. In a method of deep drawing rectangular parts the steps of providing a generally rectangular blank of determined dimension, first drawing the blank punch having an end configuration of such shape and blending radii that the lineal length measured over the middle of the end of the punch in the area of the sides is less than the lineal length measured over the end of the punch, in the same direction, near the corners; said first drawing being done to determine depth and remaining outer flange width; thereafter, while tightly gripping the remaining outer flange to limit further inward movement of the material therein, reform the part so drawn by stretching to desired final shape and depth over a second punch of determined generally uniform end configuration.

2. A method of manufacturing flanged rectangularly shaped parts comprising providing a generally rectangular blank of determined dimension, first drawing the blank over a rectangular punch having an end configuration of blending slopes and radii so formed that the lineal length measured from the middle of one side over the center of the end of the punch to the middle of the opposite side is less than the lineal length when measured in a similar manner and direction over the end of the punch near the corners; said first draw operation being done to determined generally shallower depth than desired in the finished part and with determined flange extending outwardly therefrom; annealing the part so formed and thereafter, while tightly gripping the outwardly extending flange to limit further inward movement therein, reform the part by progressively stretching it over a second punch having a determined generally uniform radii around the end.

3. A method of manufacturing flanged rectangularly shaped parts comprising providing a generally rectangular blank of determined dimension, slidably but firmly gripping the outer areas of the blank between complementing die surfaces to inhibit wrinkle formation therein while drawing the blank over a rectangular punch of such end shape and blending radii that the lineal length when measured over the middle of the end of the punch in the area of the sides is less than the lineal length measured over the end of the punch, in the same direction, near the corners; said drawing of the blank being done to determined depth and desired outer flange width; thereafter, while tightly gripping said outer flange, to limit further inward movement of the material therein, reform the part so drawn by stretching same to desired shape and depth over a second punch of determined generally uniform end radii.

4. A method of manufacturing generally rectangularly shaped receptacles such as pans and sinks, comprising providing a flat generally rectangular blank of determined dimension, slidably but firmly gripping the outer areas of the blank between complementing die surfaces to inhibit wrinkle formation therein while forming the blank over a rectangularly shaped first draw punch of such determined end configuration that the lineal length measured axially over the surface from the base of the punch, in the middle of the sides, to a determined line located on the end of the punch a uniform distance in from the sides of said punch, is less than the lineal length when measured in the same manner near the corners of said punch; said forming of the blank over said first draw punch being done to determined depth and desired outer flange width; thereafter, while tightly gripping the flange to limit further inward gathering of the material therein, reform the part by stretching said part tightly over a second punch having a determined generally uniform end configuration.

5. In a method of deep drawing generally rectangular parts the steps of providing a flat rectangular blank of determined dimensions, slidably but firmly gripping the outer areas of the blank between complementing die surfaces to inhibit wrinkle formation therein, while forming the blank over a first draw punch of such determined end shape and blending radii that the lineal length, when measured generally axially, from a line located on the end of the punch a determined uniform distance from the walls of the punch, down over the surface of the punch to the base, in the areas near the corners, is greater than the lineal length when measured from said line in a similar manner in the area of the sides of the punch; said first draw being done to determined depth and remaining outer flange width; thereafter, while tightly gripping the remaining outer flange to limit further inward gathering of the material therein, reform the part so drawn by stretching to desired final shape and depth over a second punch having a generally uniform end configuration.

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