March 3, 1970
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3,497,928
METHOD OF FABRICATING EXPANDED METAL PRODUCTS, SUCH AS SPEAKER BASKETS
Filed May 31, 1967

FIG. 1

FIG. 1A

FIG. 2

FIG. 3A

FIG. 3

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METHOD OF FABRICATING EXPANDED METAL PRODUCTS, SUCH AS SPEAKER BASKETS
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Filed May 31, 1967, Ser. No. 642,375
Int. Cl. B21d 31/02, 31/04
U.S. Cl. 29—6.1
16 Claims

ABSTRACT OF THE DISCLOSURE
A method for fabricating three-dimensionally expanded metal products having a central hub lying in one plane, a peripheral flange lying in a remote generally parallel plane, and a webbed framework coupling the hub to the flange and lying between the two planes, predominantly normal thereto, and surrounding the hub and flange. The webbed framework comprises a plurality of web portions each having a radial and a circumferential component. The radial components of adjacent web portions are circumferentially offset so as to be out of contact with one another. The web portions are selectively spaced by a plurality of perforations which, during fabrication of the product from a planar blank to a three-dimensional form, radially expand into the normal plane between the hub and flange. Fabrication is accomplished without drawing or stretching of the metal by the application of force normal to the plane of the perforated blank while immobilizing the peripheral flange to thereby induce expansion of the webbed framework by effective radial spreading of the perforations.

This invention relates to expanded sheet metal products of a type having a significantly three-dimensional form and, more particularly, relates to a method for fabricating expanded sheet metal loudspeaker baskets from blanks having the same exterior planar dimensions as the finished product and the method for their fabrication.

The present invention is concerned with improvements in two heretofore separated areas of sheet metal working—that of expanded sheet metal and that of sheet metal loudspeaker baskets.

Until the advent of this invention, the art of making loudspeaker baskets primarily employed the well-known processes of stamping, bending or breaking, and drawing a relatively large sheet metal blank into the desired generally frustum or frusto-conical shaped so-called "basket" used for protecting the diaphragm of the loudspeaker cone. The reference to a "relatively large" sheet metal blank denotes the fact that the surface area of the blank had to be significantly greater than the largest dimension of the speaker basket (the major base of the frustum), so that there was sufficient metal to form the tapered side walls of the basket. As well known, the process of drawing metal causes a relocaive deforming of the metal around a die with stretching of the metal. Thus, as the interior or cup of the speaker basket is being formed, the exterior diameter of the blank is being proportionally reduced because in effect, metal is being pulled into a dish shape by the dies. An overly simple analogy of this size factor can easily be demonstrated by forming an open-mouthed box having a base 12" x 12" and a depth of 12". Such box will require a blank 36" x 36", obviously much greater than the 12" x 12" opening of the box.

According to the present invention, the initial blank and the finished product have the same peripheral size. Thus, if the product is a speaker basket having at its major base a mounting flange of 12" diameter, the blank need be only of the same 12" diameter—an overwhelming saving of material in comparison to the prior art.

Until the advent of this invention, the technique of expanded sheet metal working was limited primarily to a monoplanar field. That is to say, a planar metal blank was extensively perforated in a repeated pattern and forces were applied to opposite ends of the blank, parallel to its plane, to pull the ends away from the center. Normally, the perforating and the pulling were simultaneous and caused an open weave or grill appearance to the finished planar metal product. Since the pulling caused spreading in the areas of the perforation such that the perforations effectively increased in size, the entire planar blank also was rendered larger, but only in the planar direction of the applied force.

Upon completion of this planar grill, there could be further fabrication by breaking to form rectangular conduits, bending to form cylindrical conduits, etc. It is also known to radially expand a piece of tubular metal by slitting it longitudinally.

According to the present invention, the perforations as well as the placement of the perforations are of a nature which permits the perforated planar blank to be subject to force normal to the plane of the blank and thereby enables formation of the metal such that a significantly three-dimensionally formed product results, such as a loudspeaker basket.

Thus, a primary object of this invention is to provide a method for the fabrication of expanded sheet metal products having a three-dimensional form.

A further object of this invention is to teach a cold working process for forming a planar sheet metal blank into a three-dimensional product, the blank being selectively perforated for defining radial and circumferential web components, and the blank being stressed normal to its plane to effectively expand it into the three-dimensional form with a minimum deformation to the webs.

According to a preferred form of this invention, in which a basket is formed for a loudspeaker, a circular or oval sheet metal blank is perforated by a plurality of circumferential slots to define several circumferentially arranged tiers of T-shaped webs. The circumferential cross-bars of the webs in any one tier are of substantially the same size, their stems are radial and abut the ends of the crossbars of two webs in the next adjacent tier, and the crossbars are progressively longer in the tier more remote from the center of the basket blank. The forming of the basket from the planar perforated blank is accomplished by clamping the peripheral edge or flange of the blank, to prevent its movement and deformation, and applying uniform force to the central portion of the blank, normal to the plane of the blank, as by a frustum-shaped die. The applied force causes the perforations surrounding the webs to open generally parallel to the movement of the die and in this manner to enable the expansion of the blank into the desired basket form without straining the stems of the web and only causing the crossbars to be bowed so that the webs take on a generally Y-shaped form.

As it will be discussed hereinafter, other forms of perforations and modified web shapes are usable to obtain baskets as well as additional products of circular, oval and other shapes.

Other objects and advantages of this invention will become more apparent from the following description of preferred and additional embodiments taken in conjunction with the accompanying drawings in which:

FIG. 1 is a top plan view of a blank for a circular loudspeaker basket, in which the perforations are in the form of circumferential slots;
FIG. 1A is a magnified fragmentary portion of the blank shown in FIG. 1;
FIG. 2 is a plan view looking into the basket fabricated from the blank shown in FIG. 1; FIG. 3 is a perspective view of the basket shown in FIG. 2; FIG. 3A is a magnified fragmentary portion of the basket shown in FIG. 3; FIG. 4 is a top plan view of a modified blank for a circular loudspeaker basket, in which the perforations are in the form of circumferential slits; FIG. 5 is a perspective view of a basket fabricated from the blank shown in FIG. 4; FIG. 6 is a top plan view of another blank for a circular basket in which the perforations are in the form of crescents, each of which spirals from the periphery of the blank toward its center; FIG. 7 is a perspective view of a basket fabricated from the blank shown in FIG. 6; FIGS. 8, 9 and 10 are successive top plan views of a blank usable in the fabrication of an oval loudspeaker basket, each figure showing the progressive perforating of the blank; and FIG. 11 is a plan view on an enlarged scale looking into the basket fabricated from the blank shown in FIGS. 8-10.

Referring first to FIG. 1, there is shown a planar, circular sheet metal blank 15 in the final stage of fabrication. This blank has been expanded into a basket shape. The blank has a periphery 17 adjacent to which is a circumferential band 19. In the final form as a loudspeaker basket, as shown in FIG. 2, the band 19 becomes the mounting flange and apertures 21 are provided to become the faster mounting holes for securing the loudspeaker to a chassis, cabinet, or the like. Radially inward of the band 19 are a plurality of circumferential rings of perforations 23, 25, 27 and 29. Each ring is circumferentially offset or rotated with respect to the next, so that a staggered relationship exists between perforations in adjacent rings.

Looking more closely at the rings of perforations, it will be seen that the perforations are slots and all of the perforations in any one particular ring, such as the ring 23, have the same circumferential length and radial width, however, the lengths of the perforations decrease approaching the hub 31. Also, each perforation in a ring is circumferentially spaced from the next by the same amount to define therebetween a portion of webbing 35 which forms the radial component of the framework of the basket. Each two rings of perforations define a web 35 therebetween annular metal tiers or bands 37, 39 and 41, discrete portions of which form the generally circumferential components of the framework of the completed basket. The specific reasons for these interrelationships will become apparent as the description of this preferred embodiment progresses.

Looking next at FIG. 1A, which is a greatly magnified portion of FIG. 1, but in reality approaches true size of a 12" speaker, there is shown portions of the rings of perforations and the flange 19. Perforations 43 and 45 of the ring 23 and a perforation 47 in the ring 25 define therebetween a T-shaped web portion 49, having its circumferential crossbar in the annular band 37 and its radial stem 35 extending between the perforations 43 and 45 toward the flange 19. To emphasize the outline of the web portion 49 and adjacent similarly shaped web portions 51, 53, and 55, each is contrastingly shaded and bordered by short dashed lines. Reduced to its simplest form, the web portions 49 through 55 and their repeated counterparts lying intermediate the hub 31 and the flange 19 form a web matrix generally similar to that of a spider's web, except for the significant difference that the radial components of the web are not continuously aligned, but are alternately offset so that the radial portions and intercoupled via the circumferential components. This aspect is notably apparent in FIG. 1A, which shows the radial stem 35 of web portion 49 offset from the radial stems 35 of web portions 51 and 53 in the next adjacent circumferential annular band; yet, aligned with the radial stem 35 of the web portion 55 lying in the next further remote annular band.

FIGS. 2, 3, and 3A illustrate the basket formed from the blank of FIGS. 1 and 1A. Of considerable significance is the fact that, as illustrated, the periphery 17 of the blank and the periphery 17 of the finished basket are the same size. In like manner, the flange 19 remains unaltered in dimensions during fabrication. Likewise, each of the numerous T-shaped web portions 49, 51, etc., are unchanged in dimension by the expansion step of the fabrication process, even though their crossbars have been bent from their prior slightly curved form, concentric with the port 33, to a portion of a V-shape, which causes each web portion to resemble a Y. Their radial stems 35 remain unaltered in size and shape, as well as circumferential and radial orientation. However, the web portions 49, 51, etc., are displaced into the plane normal to that of the blank, i.e., the Z plane of projection. In this manner, the completely fabricated basket to be placed in a form of a frustum, the web portions lie parallel to the sloping or tapered sides of the basket. If the finished product were generally spherical between its hub 31 and flange 19, the web portions 49, 51, etc., would lie along and define the arc of the profile of the product, formed of a plurality of chords defining the curved profile of the product.

FIGS. 1A and 3A illustrate the same portions of metal, before and after expansion, for emphasizing the web and perforation relationships provided by the inventive format and fabrication as to be developed in this embodiment of a specific product, in the form of a T-shaped web portion. For example, if the perforation 43 were a slit while the perforation 45 remained a slot, there could not be sufficient spreading of the perforation 43; hence, strain and stretch of the left side of the web portion 49 and of the stem of the web portion 51 would develop, possibly to the extent of fracture of the web portions. Likewise, non-uniformity of web portions would result in uneven distribution of the applied force of expansion and result in an imperfect and possibly defective product.

The exact profile of the expanded sheet metal product depends both upon the shape and location of the web portions, as is the case for the 12" speaker, as well as upon the shape of the web portions in the expanded process, where the preferred embodiment of FIG. 3, as well as the later to be described embodiments of FIGS. 5 and 7, a frusto-conical die is employed. In the oval embodiment shown in FIG. 11, an oval die is used. Those skilled in the art will appreciate that other die configurations are applicable to the teachings of the invention and that correspond
ing minor modifications of the web portions may be required, while at the same time retaining the basic criteria of each web portion; that is to say, each web portion is to contain a radial component and a circumferential component, the radial components of two adjacent tiers of web portions are to be concentric, and the webs are not changed in their dimensions while being translated from the plane of the blank into the plane normal thereto.

The conversion of the blank 15 of FIG. 1 into the basket 18 of FIGS. 2 and 3 is accomplished by the two-step operation of first immobilizing the band 19 so that it cannot move or be stretched in any direction or plane, and secondly, applying a stressing force, normal to the plane of the blank, to the hub 31 and the adjacent web portions 49, 51, etc., so that the slotted perforations 43, 45, etc., are urged to open radially, and thus have a significant component in the Z plane, and the circumferential crossbars of the web portions are bent to also provide a radial component lying partly in the Z plane.

The first step can be accomplished simply by the circumferential clamping of the band 19 relative to the upper face of the female half of the frusto-conical die. The second step can be effected by the slow, generally uniform, forward motion of the male half of the frusto-conical die into the female portion, i.e., normal to the plane of the blank 15. The relative rate of motion of the die portions and the force applied thereby, as by a hydraulic press, is to be limited so that the metal, especially that of the web portions, is not drawn or stretched and certainly not fractured. All that is to be achieved by this fabrication is the expansion of the blank into the normal plane by the opening or expanding of the perforations, 43, 45, etc., from the planar orientation illustrated in FIG. 1A, to the three-dimensional form shown in FIG. 3A and the accompanying changing from exclusively circumferential to partially radial of the crossbar sections of the web portions 49, 51, etc. Of course, these two steps can be accomplished simultaneously.

Although not specifically noted hereinabove, this method of fabrication is specifically directed to cold working procedures. Despite the fact that web portions are bent and translated geometrically, there is no deformation in the sense of drawing or stretching or plasticizing of the metal. Of course, the numerous metallurgical parameters of a particular blank are to be considered in optimizing the accomplishments of this process. As long as coarse grained metals are avoided, grain direction is of little consequence.

The first introduction of the blank 15 of FIG. 1 noted that the blank was in final form. This was to emphasize two related and significant aspects of this invention. Of considerable importance is the fact that the perforating is completed prior to the application of any forming stress or force to the planar blank 15. Not only does the separation of these two steps, in combination with the already discussed unique relationships of the web portions, produce an unstretched, unstrained symmetric product, but it greatly simplifies the fabrication and fabricating equipment, which heretofore was forced to intermix or simultaneously apply both the perforating and expanding steps to arrive at a desired result. Additionally, expanding only after perforating eliminates either accidental or inherent drawing of the metal; a feature undesired in this invention, since it could cause the peripheral dimensions of the blank and the product to differ as well as increase warpage.

The second aspect relates to the fact that it has been found desirable to perforate the blank with slots in successive stages, rather than by a single stamping. The progression of the perforating is to be discussed hereinafter with reference to FIGS. 8, 9 and 10, in which the concentric rings of slotted perforations in the oval blank therein illustrated are sequentially shown. Since the numerous slotted perforations in the blank of FIG. 1 have specific circumferential and radial relationships for defining the web portions in each of the bands 37, 39 and 41, relatively strict tolerance of the perforating or punching members must be maintained. If a single perforating step were required, the single, unitary die block used for perforating as noted above would have to be replaced by closely spaced slot cutting faces or punching members; hence, there would result considerable strain on the punching members of the die block because their close proximity to one another would cause their supporting portions to be of relatively small cross section. Not only would a die block required to stamp a complete blank by very expensive, but if it had to be frequently replaced due to strain produced fractures, its use would prove uneconomical. This adverse condition can be attenuated by the use of a few die blocks, each having their punching members relatively remote from one another for stamping adjacent perforations in a few successive steps. Even though more die blocks would be required initially, they would be simpler and stronger; hence more economical in the long run, even in view of the added costs of the extra few stamping steps.

An alternate approach to successive punching steps in the preparation of a blank having slotted perforations is provided by the embodiment of FIG. 4, in which a blank 75 is perforated with a plurality of concentric rings of slits 77, 79, 81 and 83, which lie between a hub portion 85 and a peripheral band 87. As in the embodiment of FIG. 1, the perforations define a plurality of annular bands of webbing 37, 39 and 41, each band having a plurality of T-shaped web portions. Also, as in the embodiment of FIG. 1, the web portions have circumferential and radial sections abutting one another so that in adjacent tiers, the web stem portions are offset from one another and lie adjacent the mid sections of the abutting perforations. The notable change in this FIG. 4 embodiment is the fact that the perforations are merely slits or cuts in the metal blank and not slots from which metal has been removed in the perforating procedure. This change in the perforations enables fewer and further spaced apart cutting edges in the perforating die and thereby reduces the incidence of die fracture. Hence, all the slit-like perforations can be made in the blank 75 in a single perforating step.

As shown, in FIG. 4, each slit is somewhat longer than the corresponding slot of FIG. 1. Such is necessary so that a significant amount of radial opening of the slits is effected by the application of the Z plane force. Small circular punches 89 may be used at the ends of the slits to increase the amount of its radial expansion or spreading and to decrease a tendency for the metal to rip at those points.

As shown in FIG. 5, the bands of webbing 37, 39 and 41 are not stretched radially or peripherally, even though their circumferential sections now also contain a radial component. Again, as previously emphasized with respect to the embodiment of FIGS. 1-3, the peripheral dimension of the band 87 of the completed product of FIG. 5 is the same as that of its blank 75. Also, the same two either concurrent or successive steps of forming the three-dimensional product are employed—clamping the peripheral band and applying force in the plane normal to that of the blank.

A third embodiment of the subject invention is shown in FIGS. 6 and 7. Although there may at first appear to be a significant departure from the previously described embodiments, the generic basis will be recognized from the common factors next to be pointed out. In FIG. 6, a blank 95 has a peripheral band 97 and a central hub 99 surrounding a port 101. Radially and circumferentially joining the hub 99 to the peripheral band 97 are a plurality of similar web portions 103 to 113. Each web portion has radial and circumferential components which are blended into a spiral form. Nevertheless, these components are distinctive in that the radial component is dominant.
close to the hub 99 and the circumferential predominates adjacent the band 97. In lieu of the T-shaped web portions of the bands in FIGS. 1 and 4, the web portions 103–113 have been modified by the removal of one-half of the crossbar so that they generally resemble an inverted L. Quite obviously, the radial component of each web portion is circumferentially offset from that of the adjacent web portions.

Circular perforations 115–125 are employed in defining the web portions 103–113. As in the FIG. 4 embodiment, it is helpful if circular punches or perforations, are placed at the ends of each crescent perforation to enhance the extent of its opening and to retard a tendency for the metal to rip at those points. Circular perforations 127 and 129 in the ends of the crescent perforation 119 are for this purpose. Because of the size, shape and spacing of the perforations and webs of this embodiment, the blank 95 can be stamped in one step.

The three-dimensional forming steps of securing the periphery 97 of the pre-perforated blank while forcing and expanding the remainder of the blank normal to the plane of the blank is readily accomplished with the addition of one factor, that of allowing for the twisting of the hub 99 and adjacent web sections as the male part of the die expands the blank 95. Because of the inward, clockwise spiraling of the webs and perforations, as illustrated in FIG. 6, there is a significant and desirable tendency for the radial components of the web portions to dominate over the circumferential components adjacent the hub 99 and for there to be a resultant radial straightening of the web portions as the plane of the hub 99 is forced farther from the plane of the peripheral band 97 (upward from the plane of the drawing). This straightening action is brought about by the hub to pivot counter-clockwise. To reduce frictional reaction of the blank and the female portion of the die, that die portion can be made in two coaxial parts—an immobile outer surface, to which the band 97 is secured, and a pivotal inner part which turns with the hub 99 as it twists counter-clockwise.

It is again emphasized that the placement and shapes of the web portions are such that there is neither drawing or stretching of the blank during forming into the three-dimensional shape shown in FIG. 7. Likewise, the fabrication of the blank does not change, expand or shrink the diameter or periphery of the band 97, it is the same in FIGS. 6 and 7.

The final embodiment of the invention is illustrated in FIGS. 8–11. By “final” it is not intended to imply that there are not other possible species. Quite to the contrary, all that is meant is that the teachings of the four herein provided embodiments should enable those skilled in the art to form products of variously desired shapes and uses without need for skill beyond that of the artisan, in view of the herein presented disclosure.

FIGS. 8–11, as earlier noted, relate to an oval configuration basket, FIGS. 8–10 showing progressive steps in the stamping of a blank 135. Inasmuch as the oval periphery 137 tends to create an illusion with respect to the disposition of the webs and perforations, specific note should be made to the fact that each of the eleven rings of slotted perforations is concentric about the hub 139, notwithstanding the fact that some of the outermost rings have slots only near the remote ends of the oval, such as the slots 141 and 143 in FIGS. 8 and 11. Also, some of the slots, such as those shown 147 in FIGS. 9 and 11, have been shortened so as not to run into the oval flange 137. Similarly, the two generally rectangular, large apertures 149 and 151 shown in FIGS. 10 and 11 are employed for specific use in assembly of a loudspeaker and are not responsive to the needs of the basic invention. However, because of the placement of the apertures 149 and 151, slots, such as 153, 155, and 157 in FIGS. 10 and 11 had to be foreshortened. Accordingly, as shown in FIG. 11, they cannot contribute as much to the expansion of the blank as do longer slots in the same concentric ring, such as the slot 159 which is in the same ring as the slot 153.

A comparison of the slots provided in each successive stamping illustrated in FIGS. 8–10, points up the fact that the slots created in each step of the perforating are radially and circumferentially displaced from one another to as great an extent as possible so that relatively stronger punch die members can be employed for each perforating step. In lieu of the slotted perforations illustrated in FIGS. 8–11, slits can be used, as in the embodiment of FIG. 4.

The same two-step forming procedure is utilized as earlier described with reference to the preferred embodiment in FIG. 1. Of course, herein the coaxing portions of the die are of oval or ellipsoidal configuration in all three planes of concern. Once again, the blank has been subjected to cold forming of its T-shaped webs, and portions thereof without drawing and stretching of either their radial or circumferential components.

Since in the blank the radial and circumferential segments of all of the web portions have respectively the same uniform width, they retain this uniformity during the three-dimensional forming as well as in the final product. Accordingly, wider appearing framework segments, as at 161 and 163 in the product of FIG. 11, should not be considered web portions which have been stretched. The segments in fact parts of the oval peripheral flange 137 at positions that the oval peripheral configuration prevents the completion of one of the concentric tiers of web portions, as seen also in FIG. 10. A similar relationship is seen in FIGS. 6 and 7 at the junction of the webs 103 to 113 and the flange 97.

As repeatedly emphasized, the primary achievement of this invention is the formation of three-dimensional products having a peripheral size the same as that of their planar blanks to effect a considerable savings of cost of materials. Relating the savings to the embodiment of FIGS. 8–11, if the final product were a typical 8" x 12" speaker basket, a blank 8.625" x 12.250" having a 105.65 sq. in. planar surface, would be employed. (The slightly larger than 8" x 12" dimensions are to enable the forming of non-expanded rims around the flange and hub, not subject to illustration.) However, if conventional drawing were employed, the blank's dimensions would have to be 15.250" x 14.19" and contain 170.24 sq. in. planar surface—almost 70% larger than the blank needed for the process of this invention. This equates to a savings of close to 40% of the metal used in the prior art procedures.

Not only is there a savings of about 40% of the cost of the metal blanks, but additionally, there is an equal reduction in total weight of the sheet metal blanks as well as the finished product. Inasmuch as product cost depend considerably upon shipping costs to and from the manufacturer as well as within the plant handling, all of which are directly related to weight, the significant weight reduction may prove to be equally as important as the savings of material for each unit of production.

It is believed that the above presented embodiments and disclosed methods for their fabrication have been presented in sufficient detail for those skilled in the art to be able to practice the teachings of this invention not only to the extent of being able to duplicate the illustrated structural embodiments and also fabricate other related species, but to appreciate the underlying and generally inventive sheet metal forming method and products derivable therefrom.

What is desired to be secured by Letters Patent of the United States is:

1. A method for fabricating a significantly three-dimensional product from a planar sheet metal blank, the peripheral dimensions of the blank and the product being substantially equal, and the fabricating being accomplished in the absence of straining, stretching or drawing of the metal, comprising the steps of:

(a) selectively perforating and removing material from
the blank defining thereby a plurality of web portions, each web portion having a generally radial and a generally circumferential component, said perforating being completed while the blank is in its planar form,
(b) immobilizing the periphery of the blank, and
(c) applying a stressing force to the surface of the blank in the direction normal to the plane of the blank and thereby expanding the portion of the blank within its periphery out from said plane, such expanding being accomplished by enlarging said perforations radially, as related to their original disposition in the blank.
2. A method as defined in claim 1 in which the step of selectively perforating comprises:
introducing into the blank a plurality of rings of perforations, each concentric about a central hub of said blank, each said ring having numerous adjacent perforations spaced equally from one another and defining thereby said radial web components.
3. A method as defined in claim 2 in which said perforating is accompanied by arranging each of the rings such that each perforation in each ring is circumferentially offset from the nearest perforations in the next adjacent ring, thereby separating the radial web components.
4. A method as defined in claim 3 in which said perforating is accompanied by arranging each of the rings such that perforations in alternating rings are circumferentially aligned.
5. A method as defined in claim 4 in which said stressing is accompanied by moving the web portions at a relatively slow and uniform rate into said normal direction and thereby modifying the circumferential web components such that they also contain a radial disposition.
6. A method as defined in claim 5 in which said immobilizing is accomplished by securing the periphery of the blank to a portion of a die and the moving of the web portions is accomplished by forming the blank between mating parts of the die.
7. A method as defined in claim 1 in which the step of selectively perforating comprises removing a plurality of slotted metal segments lying concentric about the center of the blank.
8. A method as defined in claim 7 in which said perforating is accomplished by removing the metal segments in successive stages in each of which remotely located slotted segments are removed.
9. A method as defined in claim 7 in which said immobilizing is accomplished by securing the periphery of the blank across the major base of a frusto-conical die such that the periphery of the blank lies circumferentially external of the die cavity.
10. A method as defined in claim 9 in which said stressing is accompanied by moving the web portions into the die cavity and modifying their circumferential components to include radial directiveness.
11. A method as defined in claim 1 in which the step of selectively perforating comprises slitting the blank into a plurality of concentric discontinuous rings and removing small generally circular bits of the blank lying at the ends of each slit, each ring being circumferentially offset from the next by a distance approximately equal to one-half the length of an individual slit.
12. A method as defined in claim 11 in which said slitting is accomplished in a single action.
13. A method as defined in claim 10 in which the step of perforating comprises stamping a plurality of crescent configured segments, each spirally disposed between the periphery of the blank and a hub portion thereof.
14. A method as defined in claim 13 in which said perforating is accompanied by the step of removing generally circular segments of the blank lying at the ends of each crescent segment.
15. A method as defined in claim 13 in which said immobilizing is accomplished by securing the periphery of the blank to a planar peripheral surface of a die having a cup-shaped interior and therein a plane generally parallel to and remote from said planar surface for receiving the hub portion of the blank.
16. A method as defined in claim 15 comprising the further step of inhibiting circumferential rotation of the planar peripheral surface of the die while at the same time enabling such rotation of its interior during stressing of the blank, so as to accommodate for twisting of the web and hub portions of the blank.

References Cited

UNITED STATES PATENTS
1,736,317 11/1929 Lewis et al. .......... 29—6.1
2,588,859 3/1952 Lombard .............. 29—6.1

FOREIGN PATENTS
302,880 12/1928 Great Britain.

JOHN F. CAMPBELL, Primary Examiner
R. J. CRAIG, Assistant Examiner
U.S. Cl. X.R.
29—6.2