

March 22, 1960

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2,929,345

METHOD FOR MAKING SHEET METAL V-PULLEYS

Filed Jan. 3, 1950

6 Sheets-Sheet 1

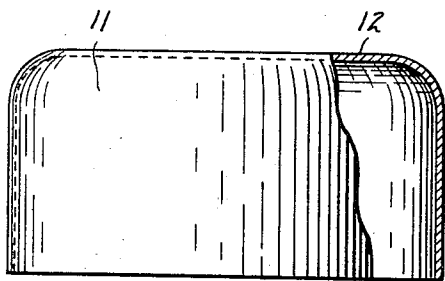


Fig. 1

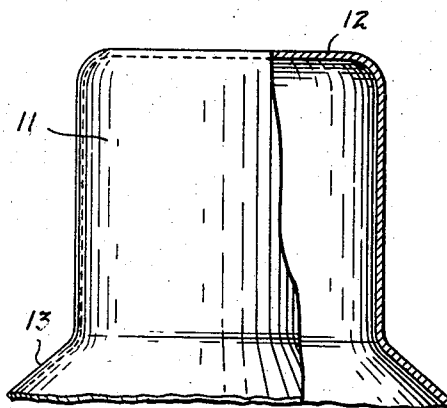


Fig. 2

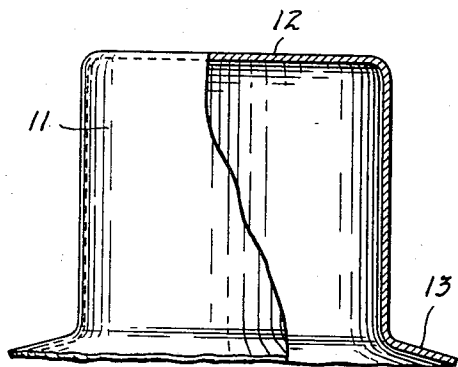


Fig. 3

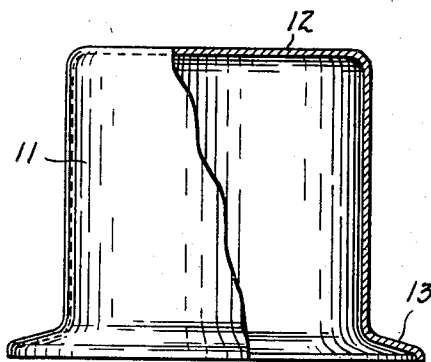


Fig. 4

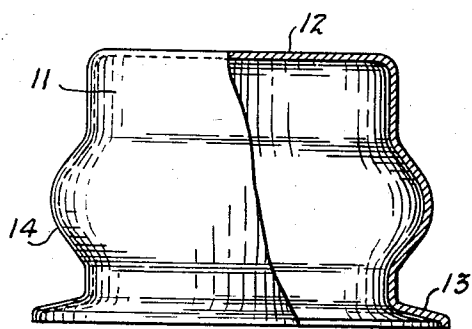


Fig. 5

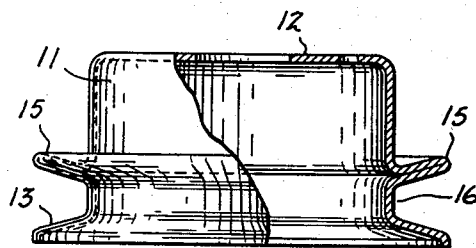


Fig. 6

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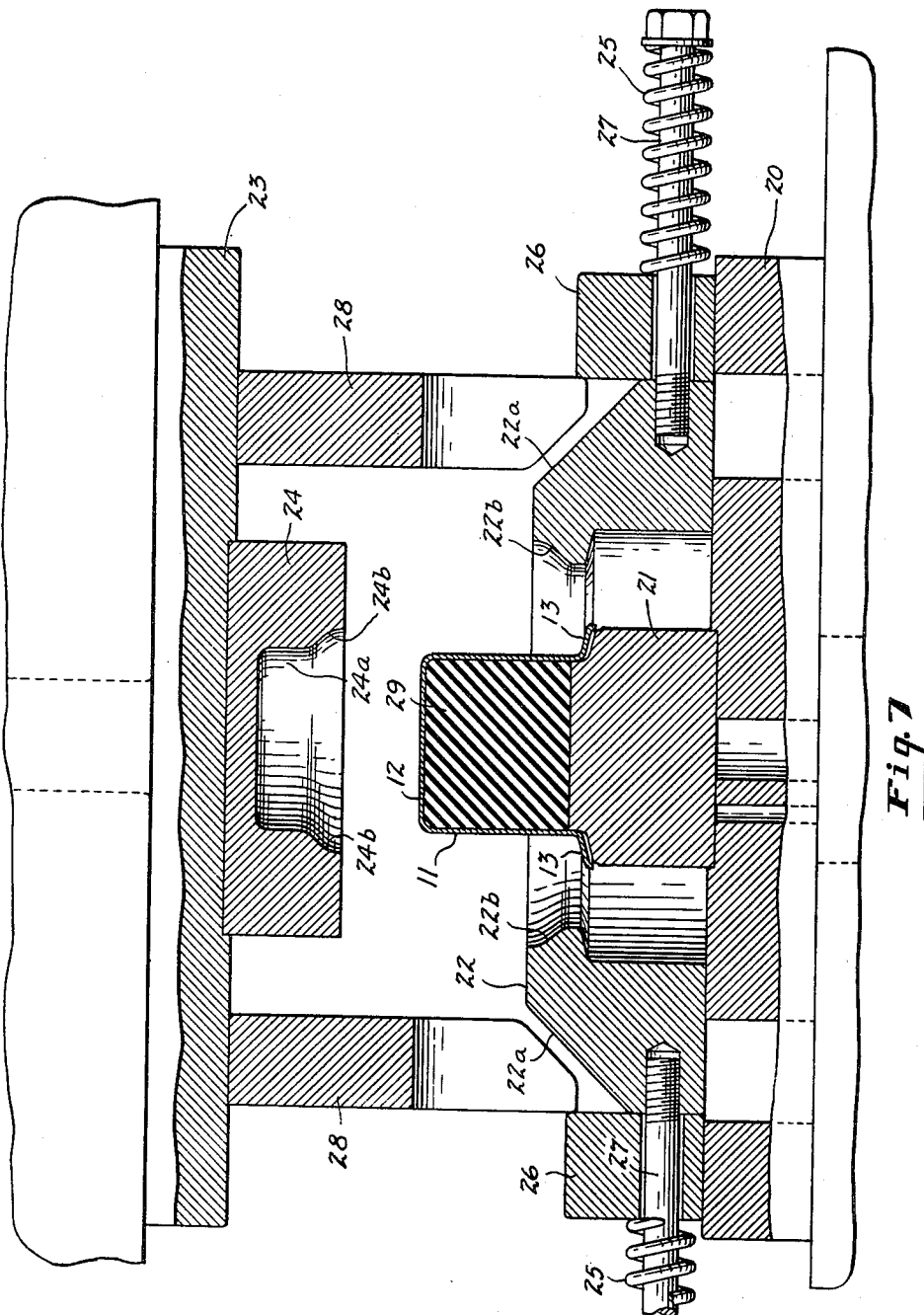


Fig. 7

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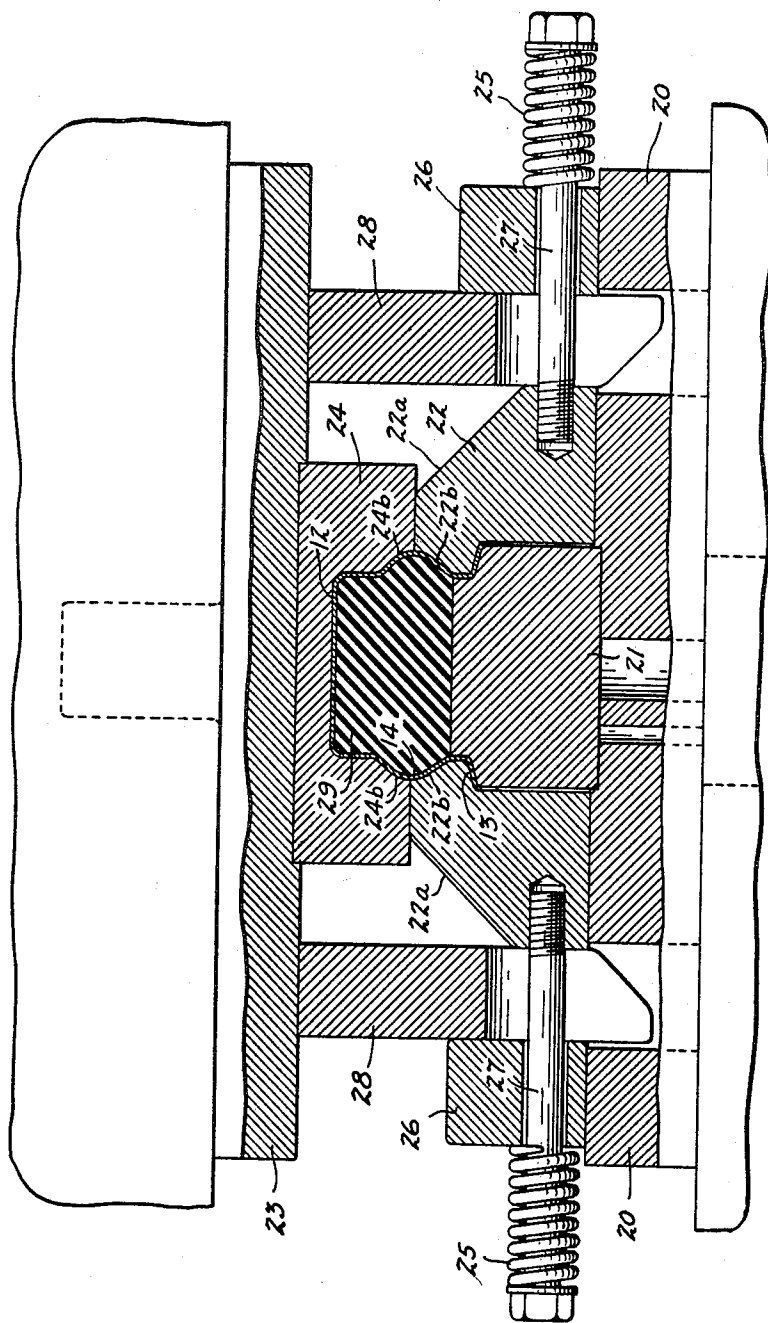


Fig. B

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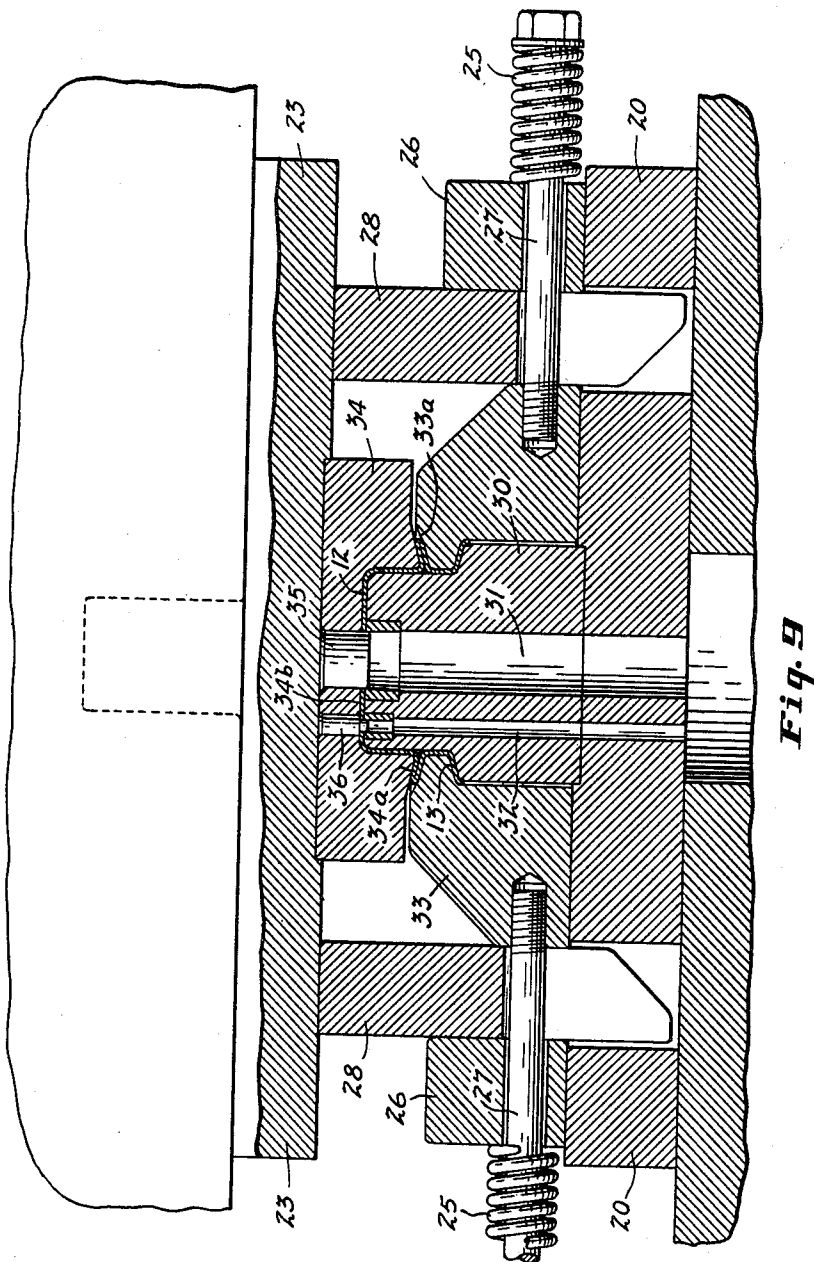
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METHOD FOR MAKING SHEET METAL V-PULLEYS

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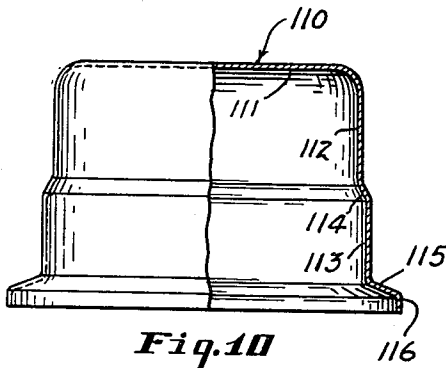


Fig. 10

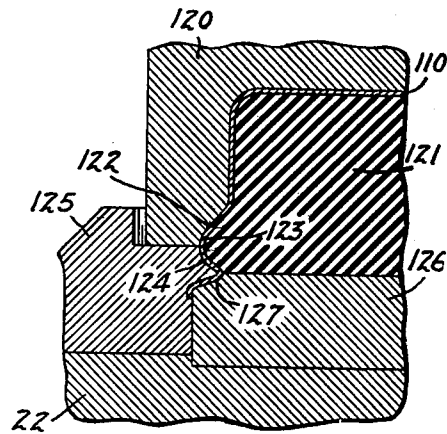


Fig. 11

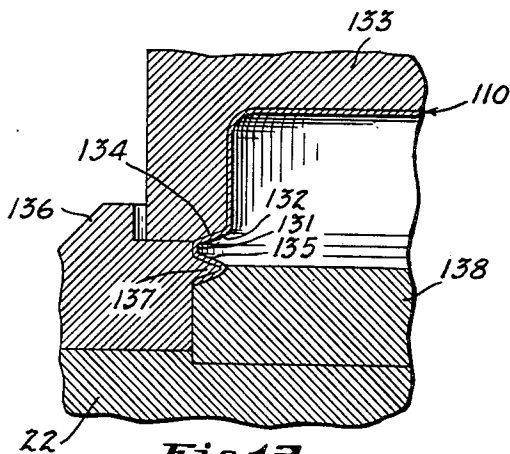


Fig. 12

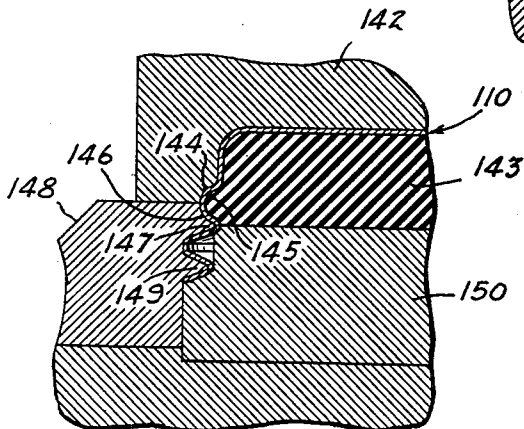


Fig. 14

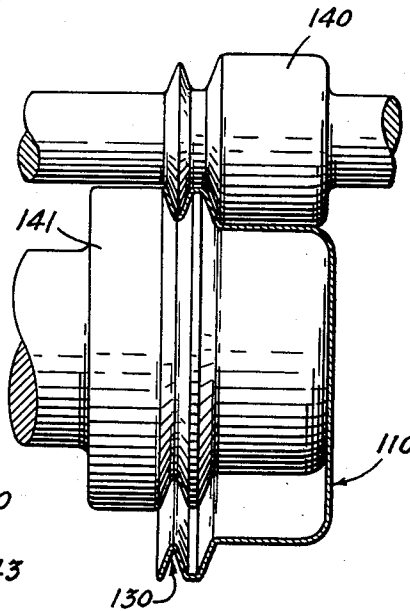


Fig. 13

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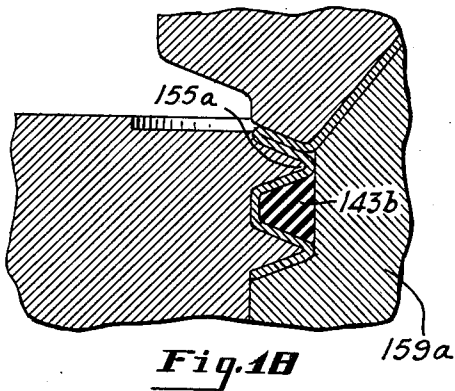
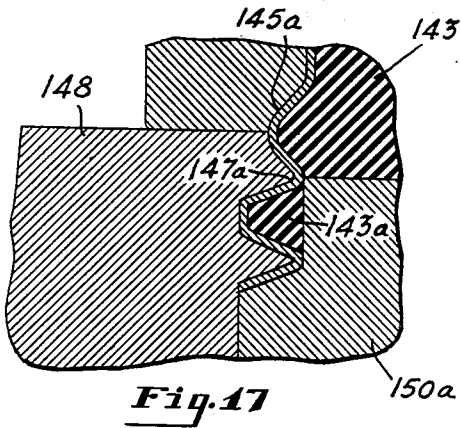
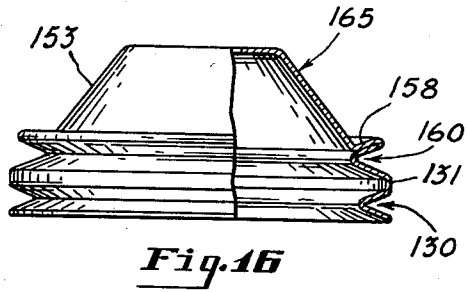
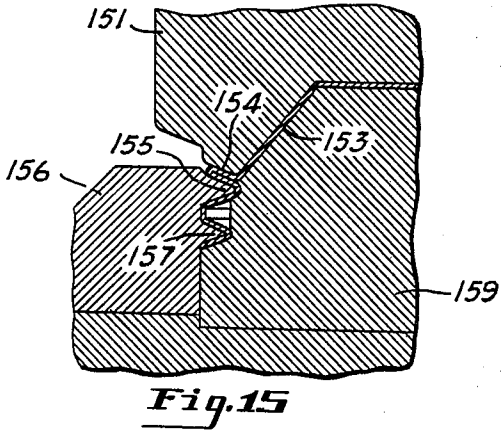
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METHOD FOR MAKING SHEET METAL V-PULLEYS

Filed Jan. 3, 1950

6 Sheets-Sheet 6



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METHOD FOR MAKING SHEET METAL V-PULLEYS

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Application January 3, 1950, Serial No. 136,461

3 Claims. (Cl. 113—51)

This invention relates to V-pulleys of one-piece, stamped sheet metal construction. This application is a continuation-in-part of my copending application for "Method of Making a Pulley" Serial No. 767,670, filed August 9, 1947, now U.S. Patent No. 2,493,053.

This invention relates to stamped sheet metal one-piece multiple-V as well as to single V-pulleys. Not only does such stamped sheet metal construction reduce the ultimate cost of such pulleys, but pulleys made according to this invention are stronger, more durable, and more accurately sized and balanced than prior art sheet metal pulleys made from sheet metal of equal gauge. Single pulleys made according to this invention thus permit the use of metal which is several gauges lighter than that heretofore specified for pulleys of equal strength.

As far as is known, the prior art never produced one-piece multiple-V sheet metal pulleys. Either machined cast multiple V-pulleys were employed or two or more single-V sheet metal pulleys were joined together. Neither prior art construction has proved to be both satisfactory and economical. The cast and machined pulleys have been expensive and the strength and concentricity of the joined sheet metal pulleys was poor.

The greater strength of sheet metal pulleys made according to my invention results from the fact that uniform gauge is maintained throughout the folds of the metal pulley, whereas the prior art methods, principally spinning, caused a stretching and thinning of the metal of the pulley, particularly at the roots of the V's in the pulleys. In fact, the stretching and drawing of the metal in prior art pulleys created such lines of weakness that minimum thicknesses were characteristically specified at these points and it was impractical to produce a pulley having a single sharp V-fold at the root of the pulley grooves. Such sharp V-folds may be provided in pulleys made according to my invention (see Figs. 10 to 18) without thinning.

Another factor contributing to the strength of my pulley is that the metal therein is not subject to over-working during the forming of the pulley. In my pulley, the sheet metal is worked only to the extent necessary to shape the cups from which the pulleys are formed and to fold the metal to form the V-grooves. In the prior art, similar appearing single-V pulleys could be formed by spinning, but in so spinning the pulleys, the metal was so drawn and stretched that it was subject to cracks and fracture, particularly in the thinned areas.

Arcuate sizing, balance, and concentricity are obtained due to the fact that the grooves are substantially coined in the finishing operations. Due to the smoothness and concentricity obtainable, belt wear and possible fatiguing of the metal in the pulley (due to shifting loads resulting from eccentricity) is minimized.

Other objects and advantages will be apparent from the following detailed description of the method in which particular reference will be made to the accompanying drawings and in which

Figures 1 to 6, inclusive, show the successive stages

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in this process of stamping a single-V pulley from a sheet metal blank, each view being partially in elevation and partially in vertical cross-section,

Figure 7 is a vertical cross-section of the stamping dies just before the stamping operation for forming the inner pulley flange as shown in Figure 5,

Figure 8 is a vertical cross-sectional view of the dies similar to Figure 7 but showing the dies immediately after the stamping operation has been carried out,

Figure 9 is a vertical cross-section of the dies immediately after carrying out the final stamping operation for the single-V pulley,

Figures 10 to 15 are fragmentary cross-sections of the stamping dies or the timing rolls showing successive steps in forming a double-V pulley having an inner V-groove of slightly lesser diameter than the outer V-grooves,

Figure 16 is an elevation, partly broken away, showing the double-V pulley formed by the steps of Figures 10 to 15, and

Figures 17 and 18 are enlarged fragmentary views showing the steps employed in forming a double-V pulley having V-grooves of equal diameter.

With reference to Figures 1 to 6, inclusive, a piece of sheet metal is first stamped to form a cylindrical cup-shaped blank 11, having a base or web 12 as shown in Figure 1. The blank 11 is then stamped and drawn to form the outwardly flared flange 13, as shown in Figure 2. This operation also reduces the diameter of the blank and increases its length or depth. The depth of the blank at this stage, i.e. the distance from the web 12 to the flange 13, determines to a large extent, though not exclusively, the final location of the web with respect to the groove of the finished pulley. The next operation, as shown in Figure 3, consists in spreading the flange 13 to correspond with the outer flange of the finished pulley. The blank 11 is then stamped as shown in Figure 4 to trim the edge of the flange 13 and to provide a flanged edge. This completes the stamping operation for forming the outer flange of the pulley and the blank 11, at this stage will be termed a preformed cylindrical cup-shaped blank.

Figure 5 shows an annular bulge 14 which is formed around the cylindrical wall of the blank 11 and which is ultimately formed into the inner flange 15 of the pulley, as shown in Figure 6.

The operation for forming the bulge 14 is carried out by applying pressure to the base 12 of the blank 11, and at the same time by applying outward radial pressure against the cylindrical wall of the blank 11 at the point where the bulge 14 is to be formed. The manner of carrying out this operation will be more fully described hereinafter.

Figure 6 shows the finished pulley in which the bulge 14 has been crimped together to form the flange 15, the flanges 13 and 15 forming the pulley groove 16. To accomplish this, pressure is applied on opposite sides of the crown of the bulge 14 to fold the metal flat upon itself in the manner shown.

As shown in Figure 6, the web 12 of the finished pulley is spaced from the plane of the peripheral groove 16. If desired the web 12 of the pulley may lie in the same plane as the groove 16 or within the general plane of the inner flange 15 or in any other desired plane depending upon the use for which the pulley is designed. The pulley shown in Figure 6 is especially designed for use as a fan-belt pulley in automobiles.

With reference to Figure 7 a stamping press is shown which includes a die holder 20 and a form punch 21 removably secured thereto in any conventional manner. The form punch 21 is shaped to receive the flange 13 of the blank 11 after it has been preformed as seen in Figure 4. A pair of semi-circular slide form blocks 22, which

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constitute a split ring assembly, are slidably mounted on the holder 20. A portion of the blocks are shaped to complement the form punch 21 so that the blank 11 will be gripped around the flange 13 during the stamping operation. A vertically movable punch holder 23 is located above the die holder 20 and its associated parts. A form ring 24 is removably secured to the punch holder 23 in any conventional manner. Blocks 22 normally take their open or retracted position, as shown in Figure 7, by the action of springs 25. The springs 25 cooperate with cam heel blocks 26 and the heads of bolts 27 which are secured to the slide form blocks 22 in the manner shown. When the punch holder 23 is lowered, the form blocks 22 are drawn together by cams 28 to the position shown in Figure 8. During this operation the cams 28 strike the tapered or conical surface 22a of the slide form blocks 22 and force them into the closed position, thus gripping blank 11 about the flange 13. The cam heel blocks 26 act as bearing surfaces for the cams 28 when they are lowered. The form ring 24 is recessed at 24a to receive the top of blank 11.

The slide form blocks 22 are each provided with annular recesses 22b for shaping the lower half of the bulge 14 while the form ring 24 is provided with a similar annular recess 24b which serves as a mold for the upper half of the bulge 14.

The form punch 21 which engages the lower portion of blank 11 is provided with a block of rubber 29 as shown in Figure 7, which acts as an expander as hereinafter described. This rubber block 29 is made of dense rubber of so-called "bumper stock," or its equivalent, which has a toughness and resiliency corresponding to the commonly known vulcanized tire-tread stock. The diameter of the rubber block 29 is substantially the same as the internal diameter of the blank 11 so that the blank can be easily placed thereon. However, the height of the rubber block 29 is such that when the blank 11 is in place as shown in Figure 7, the flange 13 thereof will be spaced slightly from the corresponding surface of the form punch 21 for purposes described hereinafter.

Figure 8 shows the position of the elements at the conclusion of the operation for forming the bulge 14, as shown in Figure 5.

In starting this operation, the stamping device appears as shown in Figure 7. When the punch holder 23 is lowered the cams 28 draw the slide form blocks 22 together. Thus, the inner edge of the blocks 22 will strike the upper surface of the flange 13 and by a camming action, will draw the blank 11 downward till it is seated on the form punch 21, thus compressing the rubber block so it will be engaged snugly at all points against the inner surface of the blank 11. At the same time, the form ring 24 descends and fits over the blank 11 and exerts pressure upon the base 12 of the blank tending to crush the cylindrical walls. However, the rubber block 29 prevents the walls from bending inwardly due to the initial compression of the block as well as the further compression by the form ring 24. The rubber block 29 will bulge and thus force the walls of the blank outwardly and into the mold provided by recesses 22b and 24b. When the form ring 24 and slide form blocks 22 have been brought completely together as shown in Figure 8, the recesses 22b and 24b define the outer limits of the bulge 14. The rubber block 29 pushes the walls of the blank 11 outwardly as they are being crushed, thus shaping the blank as shown in Figure 5. It is to be particularly noted that the bulge 14 is not formed only by the radial pressure exerted on the cylindrical walls by the rubber block 29 but also by the pressure exerted by the form ring 24 on the base 12 as it descends and tends to crush the blank 11. The principal function of the rubber block 29 is to "trigger" the walls of the blank 11 as they are crushed by the form ring 24 and thus start their outward bending. However, the rubber block 29 continues to exert some pressure on the walls all through this operation so that

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the metal is pressed firmly into the recesses 22b and 24b, thus forming a smooth, uniform bulge in the walls.

After the bulge 14 has been formed, the next step is to crimp the bulge so as to form the inner flange 15, as shown in Figure 6. This is accomplished by stamping the bulged blank 11 in the manner shown in Figure 9. In this view many of the elements are the same as those shown in Figures 7 and 8 and serve the same purpose. However, those elements which stamp or press the blank 11 are different. A form punch 30 is mounted on the die holder 20 and is shaped to support the blank 11 around the outer flange 13. The form punch 30 is provided with an axial hole 31 which is adapted to receive a punch as described further hereinafter. Another hole 32 is provided in the form punch 30 spaced from the axial hole 31, for purposes described below. The slide form blocks 33, which are operated and controlled in the same manner as in Figures 7 and 8, are shaped to cooperate with the form punch 30 so as to grip the flange 13 of the blank when the press is actuated. However, the blocks 33 are provided with an inwardly sloping conical surface 33a around the center to receive and crimp the lower half of bulge 14.

A form ring 34 is secured to the punch holder 23 and is provided with an outwardly extending conical surface 34a adapted to cooperate with the surface 33a to receive and crimp the upper half of the bulge 14 to form the inner flange 15. The form ring 34 is also provided with a centrally located depression 34b to receive the base or web 12 of the blank 11. A punch 35 and one or more punches 36 are provided in the depression 34b to cooperate with holes 31 and 32, respectively, for punching holes in the base 12 of the blanks. The central hole which is cut out by the punch 35 enables the finished pulley to be mounted on a shaft or other rotatable element and the smaller hole cut out by the punch 36 is for receiving one or more locking bolts or pins.

In operation, the blank 11 which has been stamped to provide the bulge 14 as shown in Figure 5 is placed upon the form punch 30 and the punch holder is lowered. The slide form blocks 33 are contracted by means of the cams 28 so as to grip the flange 13 of the blank 11. At the same time the form ring 34 engages the web 12 of the blank in the depression 34b as well as the bulge 14 on the conical surface 34a and crushes the bulge against the conical surface 33a of the blocks 33. By this operation the bulge 14 is transformed into the inner flange 15, as shown in Figure 6. Near the end of the downward travel of the punch holder 23, the punches 35 and 36 will punch the holes as referred to above, thus completing the pulley.

In this final operation, in which the bulge 14 is folded along a median annular fold line, the groove 16 of the pulley is accurately sized and substantially coined about the inner annular groove-sizing ridge of the form block 33. By maintaining a high finish on this ridge, a smooth finish is obtained in the groove 16 and accurate concentricity of the groove 16 is obtained due to the punching of the shaft and locking bolt holes by the punches 35 and 36 simultaneously with the sizing of the groove 16. It is also to be noted that the equal gauge of metal shown throughout the pulley may actually be obtained. In fact, instead of thinning the metal by drawing, the formation of the groove 16 is obtained by bulging or folding the metal under a crushing load, thereby tending to upset the metal rather than drawing it.

To form a double-V pulley, such as may be used on an automobile crank-shaft to provide a separate drive for the generator and water pump or pumps, it is usually preferable to provide the inner groove with a slightly smaller diameter than the outer groove in order to provide support for the root of the inner groove, as will be explained in connection with Figures 10 to 15 of the drawings. Similarly, if more than two grooves are desired, it is preferable that the diameter of the

grooves decrease progressively toward the web of the pulley.

To form a double-V pulley, a shouldered cup 110 is stamped by conventional methods to provide a starting blank corresponding to the single groove pulley at the stage shown in Figure 4. As shown in Figure 10, the cup or blank 110 is comprised of a base or web 111 and an upper wall 112 joined to a lower wall 113 by a sloping shoulder 114. The lower wall 113 terminates in a sloping flange 115 which constitutes the outer flange of the pulley to be formed; the flange 115 is, in turn, preferably provided with a depending stiffening flange or bead 116. The diameter of the wall 112 is preferably substantially the diameter of the root of the inner V-groove and the diameter of the lower wall 114 is preferably the diameter of the root of the outer V-groove. The length of the wall 114 and the shoulder 113 is, therefore, the length of the inner flange of the outer groove and the outer flange of the inner groove plus the length of the web which may be desired between the grooves. The blank 110 is preferably formed so that the gauge of the metal in the walls and shoulder is substantially uniform; the gauge of the flange 115 may be equal to that of the walls and shoulders but is preferably rolled so that it is approximately ten percent heavier. By so providing a heavier gauge for the flange 115, a stiffer and stronger outer pulley flange is provided.

The stamping press, die holders, and camming mechanism for forming the multiple-V pulley are substantially identical with that shown in Figures 7 to 9 and, accordingly, Figures 11, 12, 14, 15, 17 and 18 simply show the particular slide form blocks and rings employed.

As indicated in Figure 11, the blank 110 is first bulged by crushing the blank in a form ring 120 against a rubber punch block 121 similar to the block 29. As indicated, the form ring 120 is provided with a recess 122 to receive the upper part of the bulge 123 formed from the shoulder 113 and lower wall 114 of the blank 110. The lower part of the bulge 123 is received in a recess 124 in the form block 125, which also engages and confines the flange 115 and bead 116 before and during the bulging operation against the form punch 126.

During this first bulging operation, the bead 116 serves the function of stiffening the flange 115 and preventing its warping during bulging, thereby easing the load on the inner ridge 127 of the form block 125. In many instances it is advantageous to allow the bead 116 to remain on the blank 110 and the finished pulley, but in this particular instance, the bead 116 is trimmed away (in trimming dies not shown) before the collapsing operation shown in Fig. 12.

The first bulge 123 is next collapsed to form the approximate outer groove 130 of the pulley, the groove-connecting web 131 and the outer flange 132 of the inner groove. As indicated in Figure 12, the apparatus for so collapsing the bulge 123 comprises simply a form ring 133 having a lower annular beveled inner edge 134 which engages the upper portion of the bulge 123 to form the flange 132 as the inner flange 135 of the outer groove 130 and the connecting web 131 are formed against the stepped ridge 137 of the form block 136. During this collapsing operation, the flange 115 is confined between the ridge 137 and the form punch 138. As indicated, a rubber punch block is not necessary during this collapsing operation.

After approximate formation in the collapsing dies of Figure 12, the outer groove 130, connecting web 131 and flange 132 are accurately sized and finished in the finishing rolls 140 and 141 shown in Figure 13.

After accurate sizing and finishing of the groove 130 and flange 132, the blank 110 is again bulged in a form ring 142 against a rubber punch block 143, the form ring 142 having a recess 144 to receive the upper portion of the bulge 145. The lower portion of the bulge 145 is

received in a recess 146 which constitutes the upper surface of the upper ridge 147 of the form block 148, the lower surface of the ridge 147 engaging the sized flange 132. The block 148 is provided with a lower ridge 149 which fits the groove 130 and confines the flange 115 against the form punch 150 during this second bulging operation. It is to be noted that the form punch 150 extends upwardly to engage the inside of the flange 132 at the root of the inner V-groove. By so engaging the root of the inner groove, the form punch 150 holds the flange 132 to size and also supports the point of the upper ridge 147.

After the second bulging operation, the bulge 145 may be collapsed and roll-finished (as was the bulge 123) to form the inner groove 160. For strength and rigidity, however, it is preferable to fold the bulge 145 on its median line in a collapsing and finishing die comprised of a form ring 151 having a conical recess to shape the remainder of the wall 112 to provide the conical shoulder 153 desired for this particular pulley. The form ring 151 is provided with a seat 154 which engages the upper portion of the bulge 145 and folds the bulge against the upper ridge 155 of the form block 156. The form block is provided with a lower ridge 157 which fits the lower groove 130 and confines it against the form punch 157. It is to be noted that the form punch 157 extends upwardly to engage the root of the inner groove 160 and the edge of the ridge 155. The reentrantly folded inner flange 158 of the groove 160 provides stiffness and rigidity. This final folding operation accurately sizes and finishes the groove 160. Suitable punches are preferably carried by the ring and holes are provided in the punch 157 to provide suitable shaft and locking bolt holes in the web of the completed pulley 165 shown in Figure 16.

Although the support of the form punches available when the inner groove of the pulley is of a lesser diameter than the outer groove makes such multi-V pulleys desirable, it is possible to produce a pulley having equal groove diameter, as shown in Figures 17 and 18. In this modified construction, the outer groove is formed in the outlined manner, but in the second bulging operation shown in Figure 17, the modified form punch 150a extends up to the root of the groove to hold the size of the root and support is provided for the modified ridge 147a by means of an auxiliary rubber ring 143a. In collapsing the bulge 145a so formed, as shown in Figure 18, an auxiliary rubber ring 143b is employed to support the ridge 155a while the form punch 157a extends past the root of the groove to hold the groove to size.

It should be apparent from the foregoing that a repetition of the operations set forth above is to be employed for producing more than two V-grooves, except that the folding operations shown in Figures 15 and 17 are reserved for the innermost groove. The grooves formed in the pulleys shown in Figures 10 to 17 come to an apex and provide a sharp V, being intended for the relatively recently developed small V-section belts. It should be obvious that the more conventional V-grooves, as shown in the pulley of Figure 6, may be formed in multiple-V pulleys and, also, that the webs between the grooves may be greater or lesser than that shown in the pulley of Figure 15. The bottom of the cup or blank 110 may be variously fabricated to provide a web for the pulley. Accordingly, therefore, this invention is not limited to the specific embodiments disclosed, either in whole or in part, but may be modified by those skilled in the art without departing from the scope of the invention as defined in the following claims.

What is claimed is:

1. The method of making a multiple groove V-belt pulley from sheet metal characterized by a plurality of axially spaced concentric grooves in which the diameters of the grooves do not increase from the outermost groove to the innermost groove, comprising the steps of form-

ing from a blank of said metal a seamless flanged cup, the flange on said cup constituting the outer flange of the outer groove of the pulley, simultaneously transmitting an axial compressive force along said cup wall and applying an outward transaxial force to an annular portion of said cup wall to form an annular bulge in the wall of said cup above said flange, said forces being applied while confining said flange, collapsing and sizing said bulge to form the inner flange of the outer groove of said pulley, the outer flange of the adjacent groove, and the web connecting said second and third mentioned flanges, while confining said first flange, and repeating said steps of bulging the wall of said cup above the most recently formed outer flange and collapsing said bulge to form an inner flange for said most recently formed outer flange while confining said outer flange until the desired number of pulley grooves is formed.

2. The method of making a multiple groove V-belt pulley from sheet metal characterized by a plurality of axially spaced concentric grooves in which the diameters of the grooves progressively decrease from the outermost groove to the innermost groove comprising the steps of the method of claim 1 and including the step of rigidly supporting the root of the most recently formed outer flange while the cup wall is being subjected to an axial compressive force to bulge the cup wall above said most recently formed outer flange and while said bulge is being collapsed to form an inner flange for said outer flange.

3. The method of making a multiple groove V-belt

pulley from sheet metal as defined in claim 1 including the step of folding the bulge for the final innermost groove about a median fold line by subjecting the opposing sides of said bulge to opposing compressive forces until a double-wall inner flange is formed.

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