Feb. 13, 1968 D. L. PREVITE 3,368,376

METHOD AND APPARATUS FOR MAKING PULLEYS

Filed Nov. 26, 1965 2 Sheets-Sheet 1

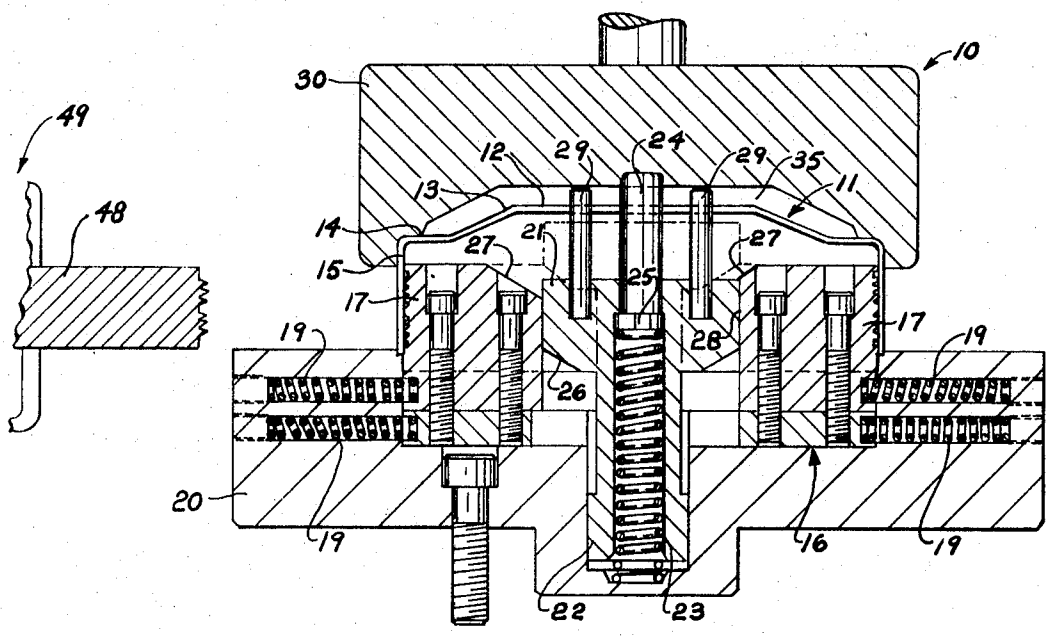

FIG. 1

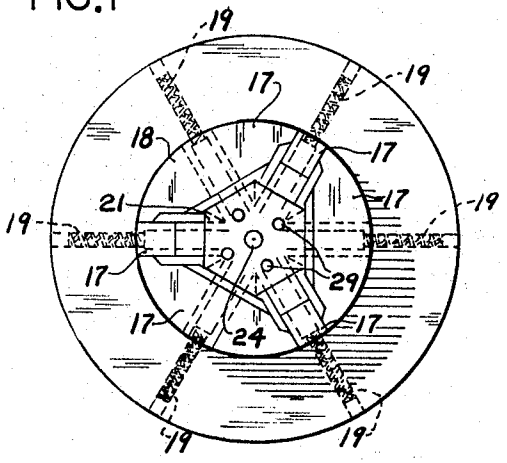

FIG. 2

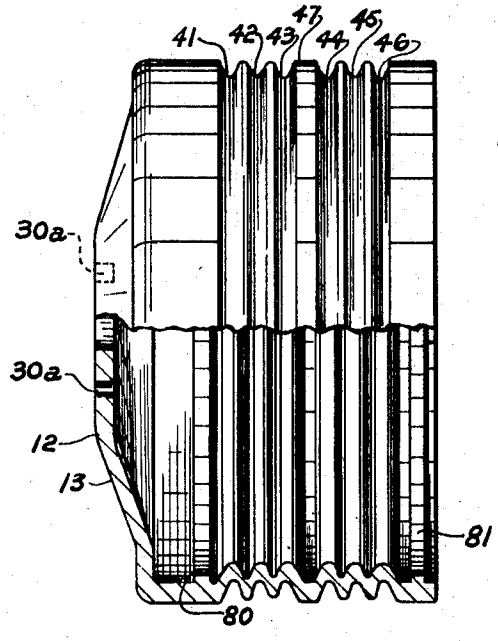

FIG. 3

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METHOD AND APPARATUS FOR MAKING PULLEYS

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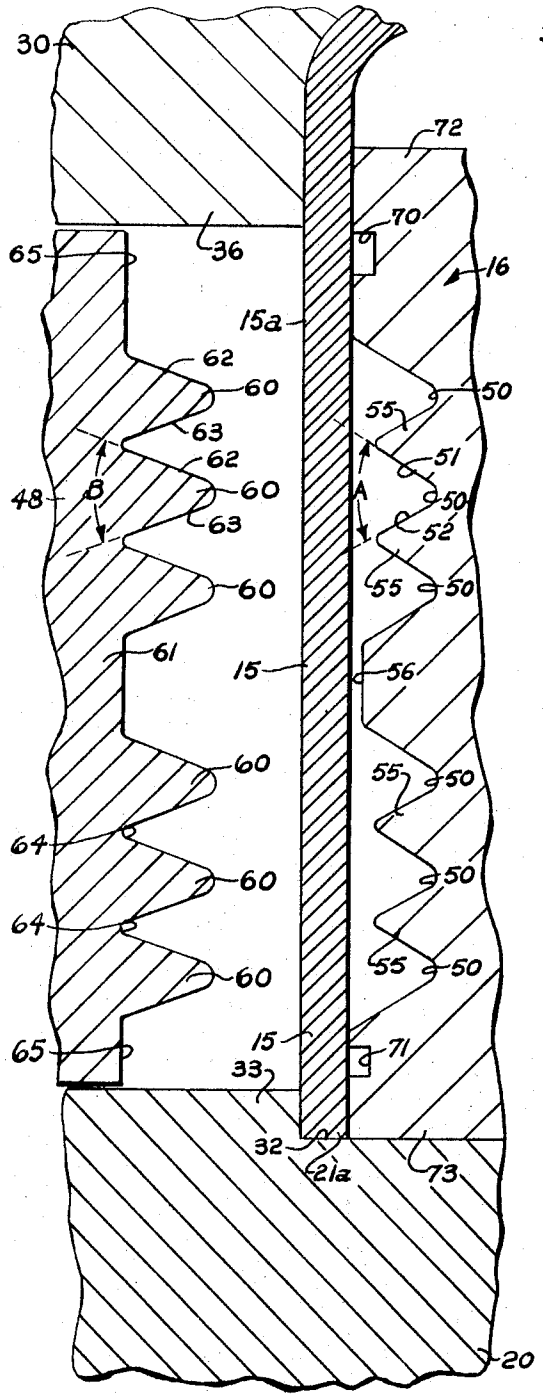

FIG.4

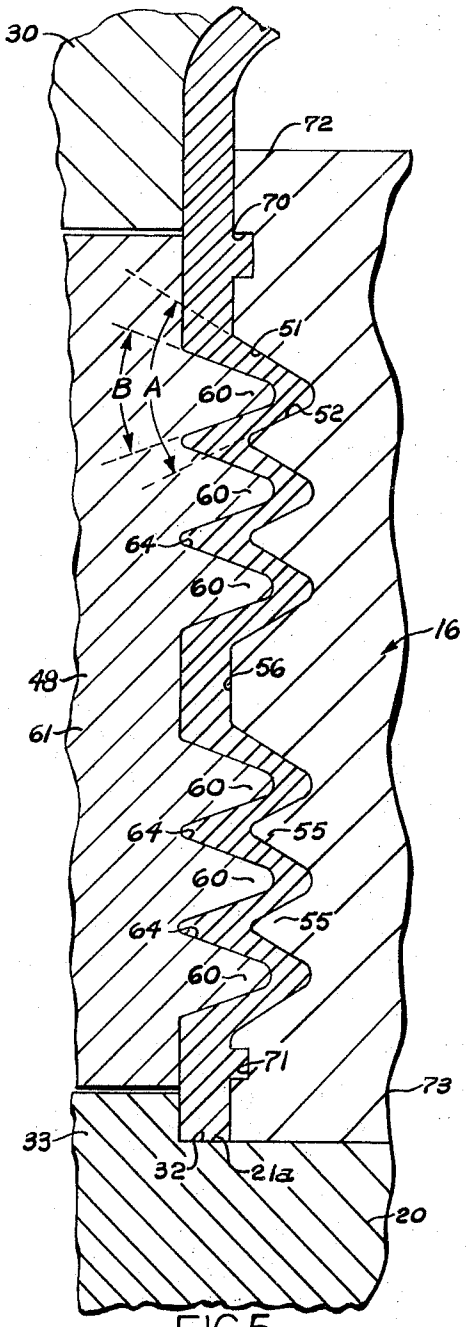

FIG.5

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METHOD AND APPARATUS FOR MAKING PULLEYS

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17 Claims. (Cl. 72—82)

The present invention relates to a method and apparatus for forming grooves in a metal blank and, in particular, relates to a method and apparatus for forming a plurality of V-grooves in a flange portion of a metal cup-shaped pulley blank.

The principal object of the present invention is the provision of a new and improved economical, simple, and reliable method and apparatus for forming a plurality of V-grooves in an integral flange portion of a cup-shaped metal pulley blank in which the metal of the pulley blank is readily displaced and the plurality of V-grooves are fully formed in a single operation of a set of working dies.

A further object of the present invention is the provision of a new and improved method and apparatus for forming a plurality of V-grooves in a flange portion of a cup-shaped metal pulley blank and in which the pulley blank is rotated and die members engage opposite radial sides of said flange portion to shape the flange portion, and wherein one of the dies has converging surfaces defining separate V-grooves therein of a given angle and the other die member has projections thereon defined by converging sides defining an angle smaller than the angle defined by the converging sides defining the groove, and wherein the die with the projections thereon is moved so as to engage the metal of the blank and force or displace the metal of the blank into the grooves formed in the other die member with the converging sides defining the grooves and projections cooperating to provide for a uniform displacement of metal of the blank, as well as a predetermined controlled radial outward displacement of the metal.

A still further object of the present invention is the provision of a new and improved method and apparatus for forming a plurality of V-grooves in an integral flange portion of a cup-shaped metal pulley blank, as noted in the next preceding paragraph, wherein the die having the grooves into which the metal is displaced comprises a die member located within the pulley blank and is rotatable upon rotation of the pulley blank and the die having the projections which displace the metal into the grooves comprises a roller-type die which rotates upon engagement with the flange portion of the pulley blank and, while rotated, is forced toward the other die member with a sufficient pressure to effect a forming or displacement of the metal into the V-grooves.

A further object of the present invention is the provision of a new and improved method and apparatus for forming a V-groove in a flange portion of a rotatable cup-shaped metal pulley blank and in which die members engage opposite radial sides of the flange portion of the blank and have surface portions which are shaped so as to displace the metal of the flange portion and provide the V-shaped groove, and wherein at least one of the dies is provided with a recess means located axially of the groove for receiving displaced metal from the pulley blank in the area contiguous to the recess thereby permitting sufficient movement of the dies so that the V-groove is completely formed.

A still further object of the present invention is the provision of a new and improved method and apparatus for forming a plurality of V-grooves in a portion of a flange of a cup-shaped metal pulley blank, and wherein the plurality of grooves are formed in the flange by die

members having working surfaces which engage opposite sides of the flange and one of the die members is movable toward the other so as to displace the metal of the flange portion and shape the metal into the desired V-groove configuration and wherein the other die member includes a pair of grooves located on opposite sides of the working surface of the other die to receive metal which is radially displaced due to engagement of a portion of the one die member with the side of the pulley blank opposite the pair of grooves.

A still further object of the present invention is the provision of a new and improved method and apparatus for forming a plurality of V-grooves in the flange portion of a cup-shaped pulley blank, wherein the V-grooves are formed by a pair of dies, one of which is located internally of the pulley cup and engages the inner side of the flange, the other of which engages the outer side of the flange and is movable inwardly so as to effect a shaping of the metal of the flange portion of the pulley cup, and wherein the outer die is movable under a sufficient pressure to form all of the V-grooves simultaneously in one operation of the cooperating dies.

Still another object of the present invention is the provision of a new and improved apparatus for forming at least one V-groove in the flange portion of a cup-shaped pulley blank wherein a pair of die members engage opposite radial sides of the flange portion with one of the die members located internally of the pulley cup and comprising a circular die member having a diameter substantially the size of the diameter of the flange portion of the pulley cup and which is formed in segmental portions which are retractable inwardly so as to permit easy withdrawal of the pulley cup from the die member after formation thereof.

Further objects and advantages of the present invention will be apparent to those skilled in the art to which it relates from the following detailed description of the preferred embodiment thereof made with reference to the accompanying drawings forming a part of this specification and in which:

FIG. 1 is a sectional view illustrating an apparatus embodying the present invention;

FIG. 2 is a top plan view of the apparatus of FIG. 1 with parts removed;

FIG. 3 is a side elevational view, partly in section, of a pulley constructed by the appartus of FIG. 1; and

FIGS. 4 and 5 are enlarged sectional views illustrating portions of the apparatus of FIG. 1 in different operative positions.

The present invention provides a new and improved method and apparatus for forming grooves in a metal blank. The method and apparatus is particularly adapted to the forming of a plurality of V-grooves in a one-piece homogeneous integral flange portion of a cup-shaped pulley blank, and particularly relates to a method and apparatus wherein a plurality of V-grooves is formed by engaging opposite radial sides of the flange portion of a cup-shaped pulley blank with die members which are rotatable and movable radially relatively so as to effect a shaping of the flange portion of the cup-shaped pulley blank into the desired configuration.

As representing the preferred embodiment of the present invention, FIG. 1 illustrates an apparatus **10** for forming a plurality of V-shaped grooves in a cup-shaped metal pulley blank **11**. The pulley blank **11** comprises a bottom or disk portion **12** and a spherical ring portion **13** which encircles the bottom portion **12** and extends angularly outwardly away from the bottom portion **12**. The ring portion **13** connects with a disk or flat ring portion **14** which extends radially outwardly of the ring portion **13**. The disk portion **14** is connected at its outermost edge with a one-piece integral flange or skirt portion **15**

which, as shown in FIG. 1, projects axially of the pulley blank **11**.

The pulley blank **11** is made of a suitable metal material and is a one-piece integral blank. The cup-shaped pulley blank is formed by a metal drawing process, and the thickness of the flange portion of the blank varies due to the formation thereof. In the areas adjacent the ring portion **14**, the flange portion is thinnest while at its outermost end it is thickest. The V-grooves to be formed in the pulley cup blank **11** are formed in the flange portion **15** of the pulley cup **11** and the difference in thickness of the flange portion of the blank is an adverse condition in the forming of the V-grooves.

When the V-grooves are to be formed in the flange portion of the cup-shaped pulley blank **11**, the cup-shaped pulley blank **11** is placed in the apparatus **10**. The apparatus **10** includes an inner die member **16** which is located in the interior of the flange portion **15**. The inner die member **16** comprises a plurality of individual separate segments **17**. The individual segments **17** are movable between a retracted position and a working position, shown in the drawings. When the segments **17** are in their working position, the outer periphery of the segments form a circular configuration defining a continuous circular working surface **18** of substantially the same diameter as the inner diameter of the flange portion. The working surface **18** engages the inner surface of the flange **15** of the pulley blank so as to effect shaping thereof, as will be described hereinbelow.

The individual segments **17** are biased to an inward or retracted position by a plurality of springs **19** which act between the individual segments **17** and a portion of a spindle member **20** which carries the internal die **16**. The individual segments **17** are held in their outer or working positions by a central die member **21** which is located centrally of the segments **17**. The die member **21** has a projecting portion **22** with a bore therein and a spring member **23** is located in the bore and acts between a portion of the spindle **20** and a pilot pin member **24** which has a flange portion **25** which engages a shoulder at the upper end of the die member **21**. When this occurs, the spring **23**, due to this construction, biases the die member **21** to a vertical position. When the die member **21** is moved to its vertical position, the movement thereof is sufficient so that the die segments **17** move inwardly under the bias of the springs **19** to their retracted positions.

The die segments **17** are moved to their working position, as shown in the drawings, upon downward movement of the die member **21**. The die member **21** has an inclined surface **26** which engages an inclined surface **27** on the individual segments **17** upon downward movement when the segments are in their inner position. These inclined surfaces cooperate and effect a camming of the segments **17** outwardly upon downward movement of the member **21**. The member **21** eventually upon downward movement takes the position shown in the drawings wherein the outer radial surface **28** thereof engages an inward radial surface of each of the die segments **17** to hold the die segments **17** in their outer positions against the bias of the springs **19**.

The die member **21** carries at its upper end a plurality of driving pins **29** which are adapted to engage in openings **30***a* in the disk portion of the pulley blank so as to rotate the pulley blank upon rotation of the spindle **20**. The pilot pin member **24** is also adapted to extend through an opening in the disk portion of the pulley blank. The pilot pin member **24** is engaged and moved downwardly by a clamping member **30** which moves downwardly and clamps the pulley blank in position on the spindle **20**. The clamping member is movable vertically into the position shown in FIG. 1 and upon such movement engages the upper end of the pilot pin **24** and moves the pilot pin downward. The downward movement of the pilot pin causes the flange **25** thereof to move away from the shoulder on the die member **21** and causes the spring **23** to be compressed. Thus, the weight of the member **21** causes the member **21** to move downwardly, causing the member **21** to effect a radial movement of the die segments **17** to their working position. Either before or after the die segments are moved to their working positions, the pulley blank is placed in position in the apparatus **10**.

The pulley blank is placed in the apparatus **10** with the lower end **21***a* of the flange portion **15** of the pulley cup supported by a surface portion **32** of the spindle member **20**. The surface portion **32** of the spindle member **20** and an outer portion **33** of the spindle **20** which extends upwardly along the outer surface of the flange portion **15** function to trap the lower end **21***a* of the flange portion **15** and prevent radial or axial displacement of the metal therein during formation of the V-groove in the flange portion **15**. To compensate for the varying thickness of the flange portion **15** of the pulley blank, the outer or working surfaces of the inner dies member segments may be relieved or tapered somewhat. The clamping member **30** is also relieved at its upper end so as to provide a gap **35** between the upper surface of the bottom portion **12** of the pulley blank **11** and the clamping member **30** applies a clamping force parallel to the extent of the flange portion **15** and thereby restricts the lateral flow or displacement of material axially along the flange portion **15**.

When the cup-shaped pulley blank **11** is located and clamped in position, as shown in FIG. 1, a V-groove or a plurality of V-grooves in the flange portion **15** of the cup-shaped pulley blank **11** are formed. The V-grooves as formed in the blank **11** are illustrated in their final form in FIG. 3 which illustrates the final pulley formed by the apparatus in FIG. 1. The formed pulley includes six V-grooves, designated **41–46**. The V-grooves **41–43** are separated from the V-grooves **44–46** by a central land portion **47** of the flange **15**. The V-grooves **41–46** are formed on the outermost portion of the flange **15**, namely, the portion spaced outwardly farthest from the ring portion **14** thereof.

The plurality of V-grooves **41–46** formed in the flange portion **15** of the pulley blank **11** are formed by the cooperative action of an external die member **48** with the internal die **16**. The die member **48** is, in the preferred embodiment, a roller having an outer peripheral surface which cooperates with the outer peripheral surface of the die **16**, so as to effect the formation of the flange portion **15** of the pulley blank **11** into the desired configuration. The die member **48** is supported for movement by a hydraulic cylinder arrangement **49**, shown schematically, and is moved toward and away from the die **16** thereby. The die member **48** or roller is supported for rotation and rotates upon engagement with the flange portion **15** of the pulley blank **11** due to the pressure engagement therebetween and is actually rotated by this pressure engagement with the flange portion **15**.

As it is rotated, the roll die member **48** is maintained in a pressure engagement with the flange portion **15** by the hydraulic cylinder arrangement **49**. The V-grooves **41–46** are formed, as noted above, by the cooperative action of the outer peripheral surfaces of the die roll **48** and the internal die **16** which are located on opposite radial sides of the flange portion **15**. The internal die **16**, as best shown in FIG. 3, is provided with a plurality of V-grooves **50**. Each of the V-grooves **50** is defined by converging surface portions **51**, **52**. The converging surface portions **51**, **52** converge as they extend inwardly of the die, and the surfaces **51**, **52** define therebetween an acute angle, designated A in the drawings, and comprise the groove angle. The V-grooves **50** on the internal die are separated by projections **55**. As can be seen from FIG. 3, the V-grooves **50** in the die **16** are separated into groups of three by a central land portion **56**.

The external form roll die **48** includes a plurality of projections **60**, each of which are located in alignment with a respective one of the grooves **50**. The projections **60** upon inward movement of the die **48**, engage the outer radial surface **15***a* of the flange **15** and displace the metal of the flange **15** into the grooves **50** formed in the die **16**. The projections **60** are located in alignment with the grooves **50** and are located in sets of three projections **60** located on the upper side of a central portion **61** of the form roll **48**, as viewed in the drawings, and three projections **60** located on the lower side of the central portion **61** of the roller die **48**. The projections **60** are each defined by a pair of converging material shaping surfaces **62**, **63** which converge as they extend outwardly of the die and have grooves **64** located therebetween. The surfaces **62**, **63** form an acute angle, designated B on the drawings.

The angle B is substantially less than the angle A defined by the material shaping working surfaces **51**, **52** defining the groove **50** into which the metal is forced by the projections **60**. The angle B is preferably 20 degrees less than the angle A; however, the angle B may be 10–30 degrees less than the angle A. The difference in the inclination of the surfaces **62**, **63** and the surfaces **51**, **52** permits a more uniform radial displacement of the metal, as well as a controlled predetermined, radial outward displacement thereof. Moreover, these surfaces assist in guiding and shaping the metal so that the metal completely fills the grooves **64** and **50** when the die **48** is moved inwardly, as shown in FIG. 4.

Of course, it should be apparent that when the die **48** is moved into engagement with the flange portion **15** of the cup-shaped pulley blank **11**, all of the V-grooves **41–46** in the pulley are formed simultaneously and by the cooperative action of the dies **48**, **16**, and the projections **60** cooperate with the grooves **50** in the dies **48**, **16**, respectively, to effect a displacement of the metal and a complete filling of the grooves so as to provide a properly formed pulley. In the formation of the V-grooves of the pulley, the metal in the flange portion is, course, shaped and displaced and tends to move axially of the flange portion.

As noted above, the outer die **48** is moved during the formation of the V-grooves inwardly toward the inner die **16**. The present structure is constructed so as to readily permit complete formation of the V-grooves without "locking" of the die member **48** from inward movement before the V-grooves are completely formed. Locking occurs when the surfaces **65** on the opposite axial ends on the outer die **48** engage the flange portion **15** before the V-grooves are completely formed, and the outer die **48** is "locked" from further inward movement. In order to prevent this locking of the die **48** from movement inwardly and thereby provide for the complete formation of the peaks of the V-grooves, preferably the internal die **16** is provided with recess means so as to provide a relieved area where metal may flow during the completion of the formation of the pulley grooves.

The recess means formed in the internal die **16** is in the form of a pair of recesses **70**, **71** located in the upper and lower peripheral portions **72**, **73**, respectively, of the internal die **16**. The grooves **70**, **71** are located on opposite axial sides of the grooves **50** in the die **16**. These recesses permit metal of the flange portion **15** in the area contiguous to the recesses **70**, **71** to be radially displaced after the surfaces **65** engage the flange portion and allow a sufficient penetration of the roll form die **48** so that the V-grooves in the flange portion of the pulley blank are fully formed. These recesses result in providing arcuate ridges **80**, **81** in the finally formed pulley.

From the above, it should be apparent that a plurality of V-grooves are formed simultaneously in the flange portion **15** of the cup-shaped pulley blank **11** due to the cooperative action of the roll form die **48** and the internal die **16**. The means for moving the external roll die **48** into engagement with the flange **15** and for shaping the flange portion **15**, applies a sufficient force so as to effect a forming of the plurality of V-grooves due to a single operation of the two dies. Thus, the plurality of V-grooves in the pulley is formed in substantially a one-step process, utilizing the two dies.

It should be apparent that the preferred embodiment of the present invention has been described in great detail hereinabove, and that certain modifications, changes, and adaptations may be made therein by those skilled in the art to which it relates, and it is hereby intended to cover all such modifications, changes, and adaptations which come within the scope of the appended claims.

Having described my invention, I claim:

1. An apparatus for forming a plurality of V-grooves in a flange portion of a pulley blank comprising first and second rotatable die members engageable with the opposite sides of said flange portion, said first die member having a material shaping die surface provided with a plurality of grooves defined by inwardly converging surface portions which define a first angle therebetween, said second die member also having a material shaping die surface and including a plurality of projections defined by outwardly converging surface portions which define a second angle therebetween less than said first angle, said projections on said second die member being located opposite said grooves in said first die member, and means for moving said second die member toward said first die member to cause said projections to force the material of said flange into said grooves with said converging surfaces of different angularity directing the material of said flange portion.

2. An apparatus for forming a plurality of V-grooves in a flange portion of a pulley blank as defined in claim **1** wherein said second die member is located outwardly of said flange portion so as to engage the outer surface of said flange portion and said first die member is located internally of said flange portion so as to engage the internal surface of said flange portion.

3. An apparatus for forming a plurality of V-grooves in a flange portion of a pulley bank as defined in claim **1** wherein said second angle defined by said converging surface portions on said second die is 10–30 degrees smaller than said first angle defined by the converging surfaces defining the grooves in said second die member.

4. An apparatus for forming a plurality of V-grooves in a flange portion of a pulley blank as defined in claim **1** wherein one of said die members includes recess means spaced from the die surface thereof for receiving radially displaced metal during the formation of said V-grooves thereby allowing for the complete formation of the V-grooves.

5. An apparatus for forming a plurality of V-grooves in a flange portion of a pulley blank as defined in claim **1** wherein said first die member is located internally of said pulley blank and supports said pulley blank, and further including means for rotating said first die member and said pulley blank, and said second die member is located outwardly of said pulley blank and is in the form of a roller and is rotated upon engagement with the rotating flange portion of the pulley blank due to the pressure and frictional engagement therebetween.

6. An apparatus for forming a plurality of V-grooves in a flange portion of cup-shaped pulley blank as defined in claim **5** further including recess means located in said internal die for receiving radially displaced metal during the formation of said V-grooves and including a pair of recesses located on opposite axial sides of said plurality of V-grooves.

7. An apparatus for forming at least one V-groove in the flange portion of a pulley blank comprising first and second die members engageable with opposite respective sides of said flange portion, said first die member having a material shaping die surface provided with at

least one groove defined by inwardly converging surface portions, said second die member also having a material shaping die surface and including a projection defined by outwardly converging surface portions, said projection on said second die member being located opposite said groove in said first die member, means for moving said second die member toward said first die member to cause said projection to force the material of said flange into said groove, and recess means in at least one of said die members located on one side of said V-groove for receiving radially displaced metal during the formation of said V-groove thereby allowing for the complete formation of the V-groove.

8. An apparatus as defined in claim **7** wherein said first die member is rotatable and has a first planar side surface portion with a plurality of V-grooves adjacent thereto and supports said blank for rotation therewith and said second die member is rotatable and has a second planar die surface portion opposite said first planar surface portion and a plurality of projections thereon, and said recess means comprises a pair of recesses formed in said first planar die surface portion of said first die member to receive metal radially displaced due to pressure engagement of the second planar surface with the flange portion adjacent the recess during the shaping of said flange portion.

9. An apparatus as defined in claim **8** wherein said first die member comprises an internal die member located internally of the flange portion to engage the inner radial surface of the flange portion and including a plurality of retractible segments and said second die member comprises an external die member in the form of a roller located to engage the external radial surface of the flange portion.

10. An apparatus as defined in claim **9** wherein said converging surface portions defining the grooves in said first die member define a first angle therebetween and said converging surface portions which define the projections on said second die member define a second angle therebetween substantially less than said first angle.

11. An apparatus for forming a plurality of V-grooves in an integral flange portion of a pulley blank comprising a first rotatable die member constituting an internal die member located internally of said flange portion to engage the inner surface thereof, a second rotatable die member located outwardly of said flange portion to engage the outer surface of the flange portion, said first die member having a material shaping die surface provided with a plurality of grooves therein, said second die member also having a mateiral shaping die surface including a plurality of projections for forcing the material of said flange into said grooves in said first die member, said projections on said second die member located opposite said grooves in said first die member and in alignment therewith, means for rotating said first die member and said pulley blank, and means for moving said second die member toward said first die member and into pressure engagement with said flange portion to cause said projections to force the material of said flange into said grooves simultaneously in a single inward movement of said second die member.

12. An apparatus for forming a plurality of V-grooves as defined in claim **11** wherein said grooves on said first die member are defined by converging surface portions which define a first angle therebetween and said projections on said second die member are defined by outwardly converging surface portions which define a second angle therebetween substantially less than said first angle.

13. An apparatus for forming a plurality of V-grooves as defined in claim **12** wherein said first die member includes recess means for receiving metal which is radially displaced during the formation of the V-grooves, and further including means for at least partially confining the opposite axial ends of said flange portion to minimize axial displacement of the material thereof during the formation of the V-grooves.

14. An apparatus as defined in claim **11** wherein said internal die member comprises a plurality of die segments movable betwen a retracted position and a working position, said die segments when in their working position defining a circular die surface having a diameter substantially the same as the inner diameter of the flange portion of the pulley blank and when in their retracted position having a diameter substantially less than the inner diameter of the flange portion of the pulley blank, and means operable to effect movement of said die segments between their working and retracted positions.

15. A method of forming a plurailty of V-grooves in a cylindrically shaped flange portion of a pulley blank comprising the steps of positioning said pulley blank with one surface of said flange portion adpacent a material shaping die surface of a first die member including a plurality of grooves, engaging the other surface of said flange portion with a material shaping die surface of a second die member including a plurality of projections corresponding to said grooves, rotating said pulley blank and said first and second die members, moving said second die member toward said first die member while said die members are rotating and under pressure to force the material of said flange portion into the grooves formed in said first die member simultaneously and in a single inward movement of said second die member.

16. A method of forming a plurality of V-grooves in a cylindrically shaped flange portion of a pulley blank as defined in claim **15** further including the steps of at least partially confining the opposite axial ends of said cylindrically shaped flange portion to limit axial displacement of the material of said flange portion during the formation of said V-grooves, and receiving radially displaced material in recesses in one of said dies.

17. A method of forming a plurality of V-grooves in a cylindrically shaped flange portion of a pulley blank as defined in claim **16** further including the step of shaping said material as said second die member is moved inwardly of said first die member between inwardly converging surfaces on said first die member defining a groove angle therebetween and outwardly converging surfaces on said second die member defining a projection angle therebetween substantially less than the groove angle.

References Cited

UNITED STATES PATENTS

1,828,464	10/1931	Harrison	72—82
2,159,290	5/1939	Penkala	72—179
2,685,856	8/1954	Wickwire et al.	72—82
2,730,795	1/1956	Bloss	29—159
2,892,431	6/1959	Killian et al.	72—82

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