May 8, 1956 R. W. BEART 2,744,268

METHOD OF MAKING LOCK WASHERS

Filed June 12, 1953 4 Sheets-Sheet 1

Fig. 1.

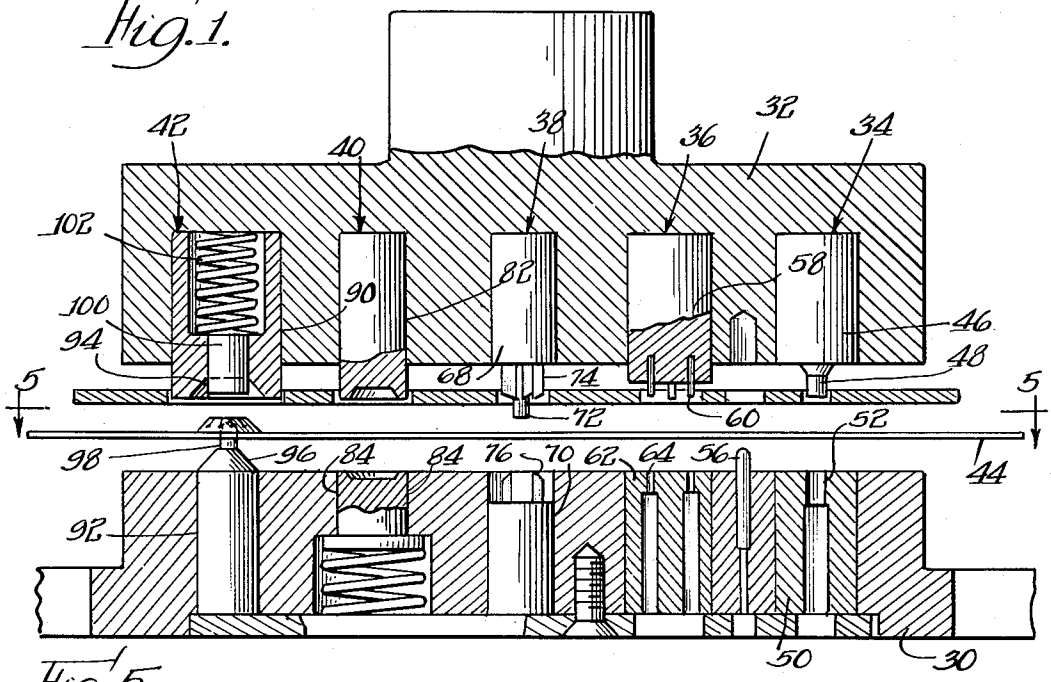



Fig. 5

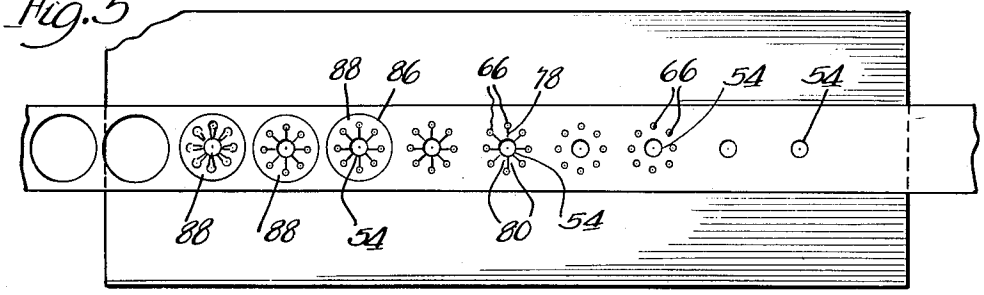



Fig. 23.

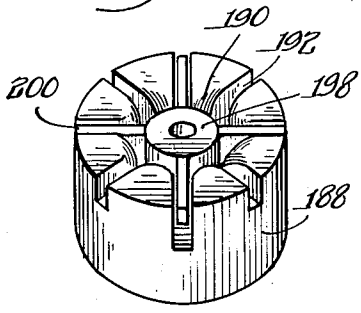



Fig. 24.

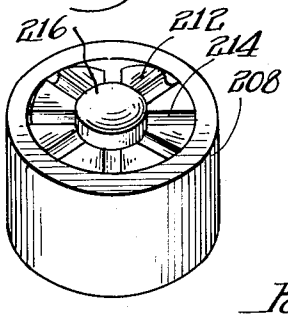
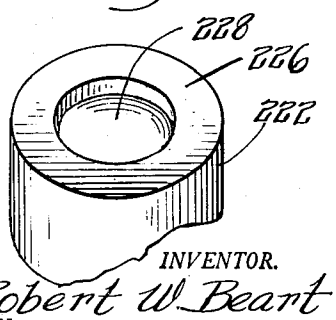



Fig. 25.




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METHOD OF MAKING LOCK WASHERS

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Fig. 2.

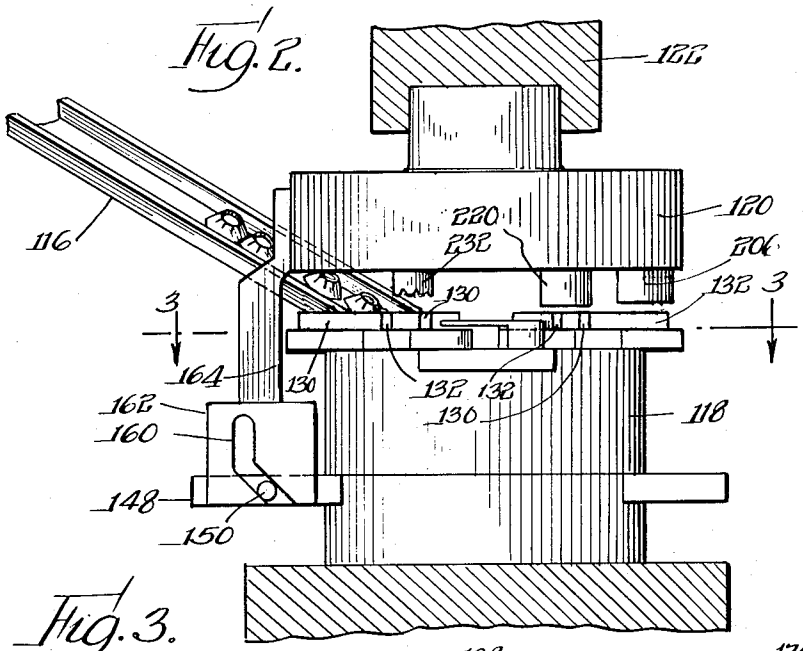
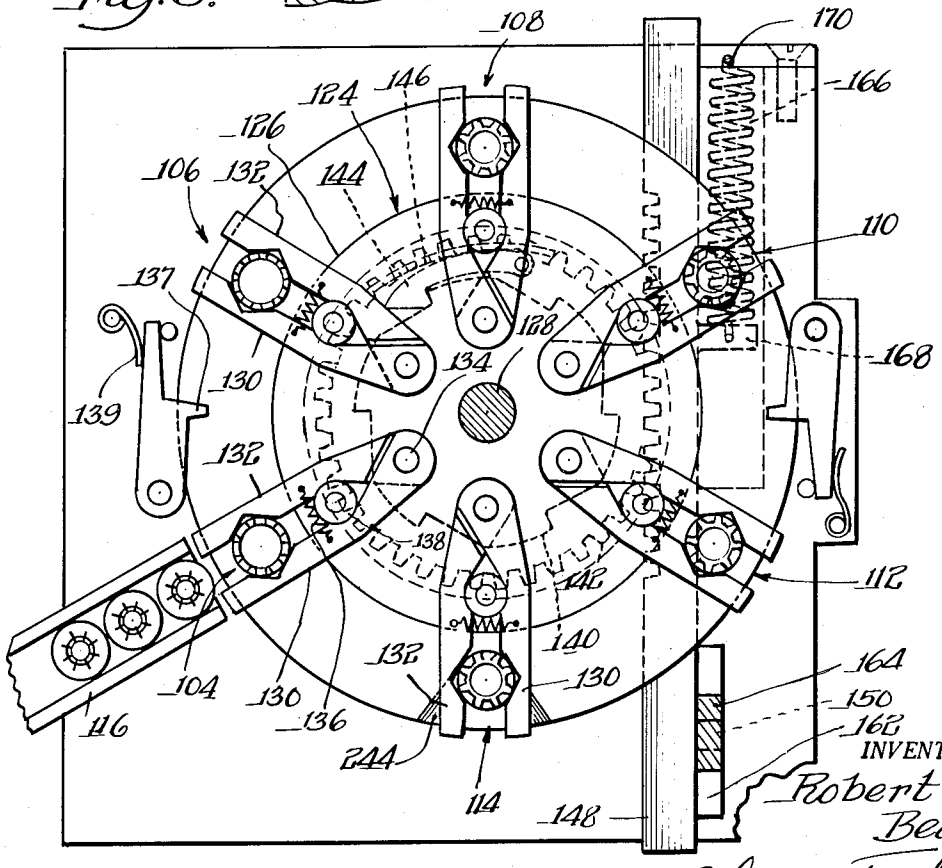



Fig. 3.




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METHOD OF MAKING LOCK WASHERS

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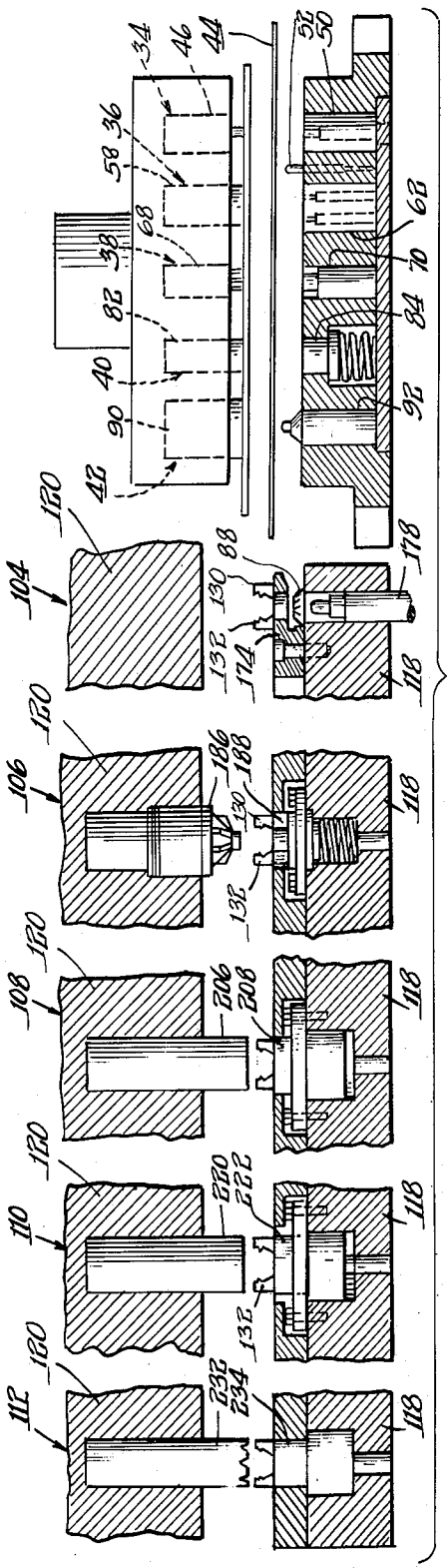


Fig. 4.

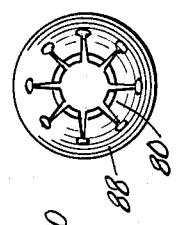


Fig. 6

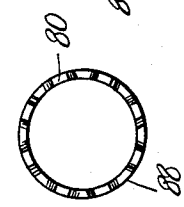


Fig. 7.

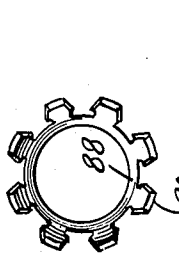


Fig. 8.

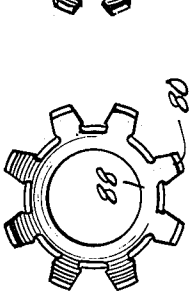


Fig. 9.

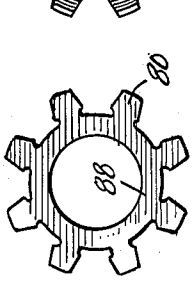


Fig. 10.

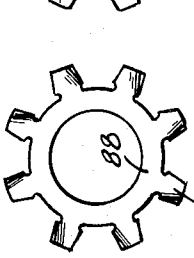


Fig. 11.

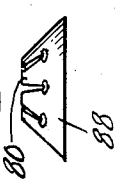


Fig. 12.

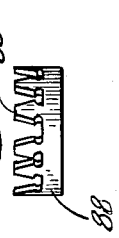


Fig. 13.

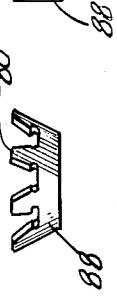


Fig. 14.



Fig. 15.



Fig. 16.



Fig. 17.

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Fig. 19.

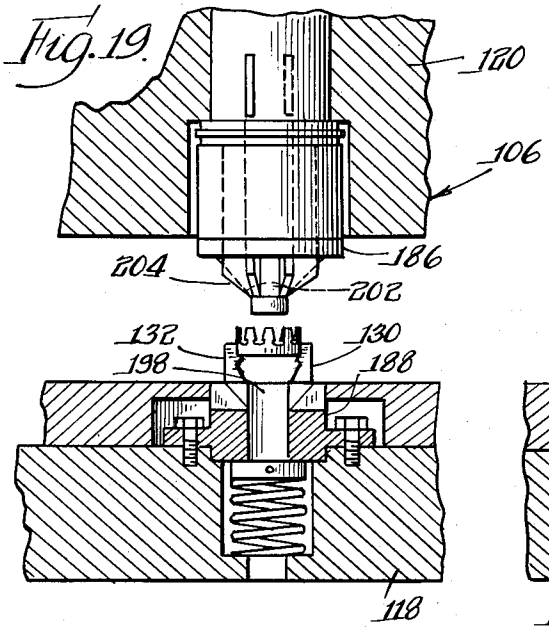



Fig. 18.

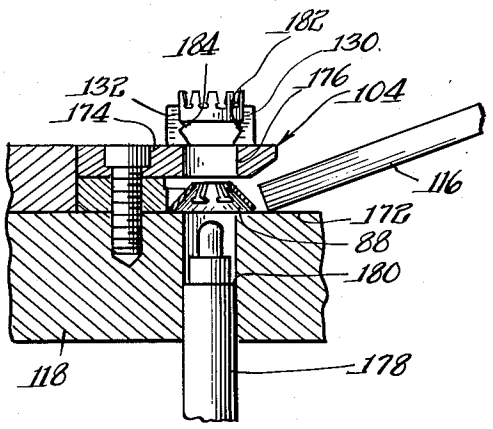



Fig. 22.

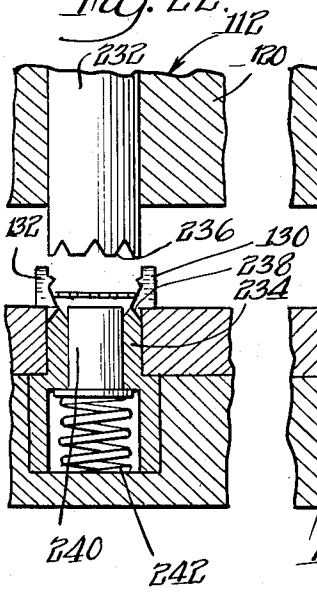



Fig. 21.

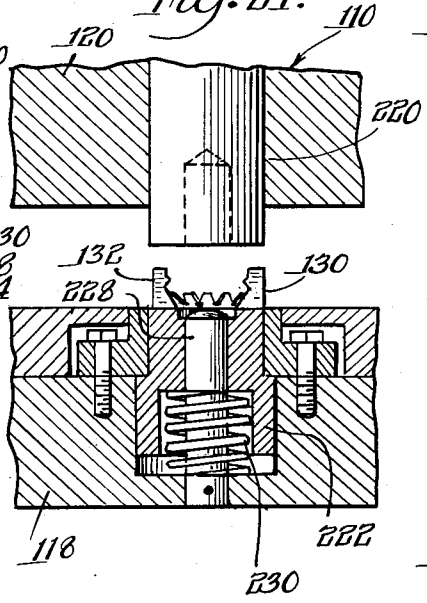
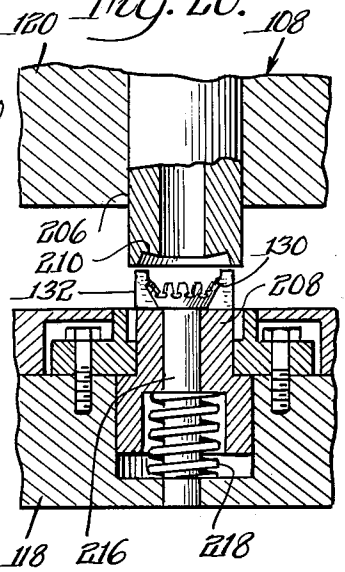



Fig. 20.




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United States Patent Office 2,744,268 Patented May 8, 1956



2,744,268

# METHOD OF MAKING LOCK WASHERS

Robert W. Beart, Park Ridge, Ill., assignor to Illinois Tool Works, Chicago, Ill., a corporation of Illinois

Application June 12, 1953, Serial No. 361,270

9 Claims. (Cl. 10—72)

The present invention relates to a novel method and apparatus for making lock washers, and more particularly to a novel method and apparatus for making lock washers of the twisted tooth type.

When making lock washers by methods heretofore known, round slugs or blanks are usually stamped from sheet material stock at some stage of the process, and, in addition, such blanks are stamped to provide a centrally located aperture therein. The material of the sheet stock which is left between the slugs or blanks and the material which is punched out to provide the centrally located apertures is generally discarded as waste. Since the waste makes up a substantial portion of the sheet material stock, the cost of the washer blanks or slugs is unnecessarily increased. It is, therefore, a primary object of the present invention to reduce substantially the waste or scrap necessary for a given size washer, thereby effecting substantial manufacturing economies.

Another object of the present invention is to provide a novel method of making a lock washer of predetermined outside diameter from a slug or blank having a smaller outside diameter, thereby to reduce material costs of the washers.

A more specific object of the present invention is to provide a novel method of making a twisted tooth type lock washer by which method scrap or waste material is substantially reduced.

Still another object of the present invention is to provide a novel apparatus for making lock washers of the above described type by which apparatus scrap or waste material may be substantially reduced.

Other objects and advantages of the present invention will become apparent from the following description and the accompanying drawings, wherein:

Fig. 1 is a vertical cross sectional view, showing one form of an apparatus which may be used for carrying out the novel method of this invention;

Fig. 2 is an elevation view, showing another portion of the apparatus used to carry out the novel method of this invention;

Fig. 3, is a horizontal cross sectional view taken along line 3—3 in Fig. 2;

Fig. 4 is a somewhat schematic view, showing from right to left the various work stations utilized to carry out the novel method of this invention;

Fig. 5 is a cross sectional view taken along line 5—5 in Fig. 1 and illustrating the manner in which lock washers are initially formed from a strip of sheet material stock in accordance with the novel method of this invention;

Figs. 6 through 11 are plan views, showing a lock washer at various stages of manufacture when made in accordance with this invention;

Figs. 12 through 17 are side elevational views of the lock washer as shown in Figs. 6 through 11, respectively;

Figs. 18 through 20 are enlarged fragmentary cross sectional views, showing in greater detail the work stations of the apparatus shown in Figs. 2 and 3; and



Figs. 23 through 25 are perspective views, showing various dies utilized in the novel apparatus of this invention.

In accordance with one form of this invention, lock washers of a given size are formed from a substantially smaller generally annular sheet material blank or slug, whereby a substantial saving in sheet material stock is effected. In addition, twisted tooth type washers may be formed with generally radially extending tooth elements or prongs spaced around the outer margin of the annular washer body by slitting the washer blank to provide the tooth elements and then stretching the annular body of the washer to space the tooth elements from each other. This process entirely eliminates scrap or waste material heretofore made when cutting away a portion of the washer blank in order to space the tooth elements. More particularly, the novel method of this invention includes the steps of providing an annular washer blank having tooth elements extending radially inwardly from the inner margin of the blank and then turning the blank inside out. The resulting washer has tooth elements extending from its outer margin, and since the body portion of the washer is stretched while it is being turned inside out, the tooth elements will be spaced from each other, and the internal diameter of the washer will be greater than the original internal diameter of the blank. It is, thus, seen that for a given size washer, a substantial saving in sheet material stock is obtained. For example, when making one standard size lock washer in accordance with prior art practices, blanks or slugs are stamped from sheet material stock in a manner so that there is a minimum of scrap between adjacent blanks, and the distance between centers of the adjacent blanks is about .688 of an inch. It has been found that the same size lock washer may be formed by the novel method of this invention by stamping blanks from sheet material stock in a manner so that the distance between the centers of adjacent blanks is only .562 of an inch. Thus, when using a strip of sheet material stock about twelve inches long and 2.59 inches wide, about 69.76 of the larger blanks can be obtained, and about 106.75 of the smaller blanks can be obtained. This results in an increase of about fifty-three per cent in the number of washers which can be obtained from the same amount of sheet material stock.

Referring now more specifically to the drawings, wherein like parts are designated by the same numerals throughout the various figures, an apparatus for initially forming washer blanks from a strip of sheet material stock is shown best in Fig. 1. This apparatus includes a stationary die block 30 and a movable die holder 32 adapted to be mounted on a reciprocable ram of any suitable punch press, not shown. The die plate and holder have mounted thereon suitable cooperating die elements which provide five work stations generally designated 34, 36, 38, 40, and 42. Suitable means, not shown, is provided for intermittently feeding a strip 44 between the die plate and die holder, as illustrated in Fig. 1. The strip 44 may be of any suitable sheet material for forming washers and is preferably spring steel.

At the work station 34, there is provided an upper die member 46 including a punch 48 which is adapted to cooperate with a lower die member 50 having a central aperture 52. Upon each downward stroke of the die holder, the punch 48 cuts a relatively small aperture 54 in the strip 44, as shown in Fig. 5. It is, of course, understood that after each stroke of the die holder, the strip 44 will be advanced. The strip is advanced until the aperture 54 registers with a pilot pin 56 mounted in the die block 30 so that upon the next downstroke of the die holder 32, the pilot enters the aperture 54 to hold the strip 44 at the desired position.

The work station 36 includes an upper die member 58 having a plurality of punches 60 and a lower die member

62 having a plurality of apertures or bores 64 for receiving the punches 60. In the embodiment illustrated, eight of these punches 60 will be provided so as to cut eight small apertures 66 in the sheet material strip 44, as shown best in Fig. 5. It will be noted that the apertures 66 are spaced evenly about a circuit which is concentric with the central aperture 54.

Upper and lower die members 68 and 70 are provided at the work station 38. The upper die member 68 includes a pilot pin 72 adapted to enter the aperture 54 in the sheet material strip. A plurality of shearing members 74 are arranged to cooperate with complementary shearing edges 76 on the lower die member 70 to cut a plurality of radially extending slits 78 in the strip 44 between the central aperture 54 and the surrounding relatively small apertures 66, as shown best in Fig. 5. The material of the strip 44 between the slits 78 provides tooth elements 80 for the finished washer, as will appear from the description hereinbelow.

The work station 40 includes upper and lower die members 82 and 84 having suitable cooperating circular shearing edges for circularly cutting the strip 44, as at 86 (see Fig. 5). This action provides an annular blank or slug 88 having the inner margins thereof slit to provide the above mentioned inwardly directed tooth elements. While the annular blank 88 is separated from the strip 44, the blank remains within the opening in the strip and is fed by the strip to the work station 42. Any suitable means, not shown, may be provided for supporting the annular blank 88 within the strip 44.

The work station 42 includes an upper die member 90 and a lower die member 92. The upper die member is provided with a conical surface 94 adapted to cooperate with the conical surface 96 on the lower die member to form and draw flat annular blank 88 into a frusto-conical member shown best in Figs. 6 and 12. The lower die member 92 also includes a pilot pin 98 adapted initially to enter the aperture 54 in the blank 88. The upper die member 90 is preferably provided with a knockout member 100 yieldably urged toward its lower position by spring 102 to insure the removal of the partially formed washer.

After the partially formed washer blank leaves the work station 42, it may be discharged into a suitable hopper, not shown, and then advanced to the apparatus shown best in Figs. 2, 3, and 18 through 22. This apparatus includes work stations 104, 106, 108, 110, and 112 and a discharge station 114. The partially formed washer blanks are fed from the above mentioned hopper to the work station 104 by any suitable means such as an inclined chute 116.

As shown best in Figs. 2 and 3, the work stations 106 through 112 are disposed on an apparatus which includes a stationary die block 118 and a movable die holder 120. The die holder 120 is connected with a reciprocating ram 122 of any suitable punch press. The work stations 104 through 112 are circularly arranged, and in order to convey the washer blanks from one work station to the next, a dial or turret transfer means is provided.

The transfer means 124 includes a plate 126 mounted on a rotatable shaft 128. A plurality of pairs of gripping jaws 130 and 132 are provided for gripping a washer blank and carrying the blank from one work station to the next. The gripping jaws of each pair are pivotally connected to each other and to the rotatable plate 126 by a suitable pin 134. The free ends of each pair of gripping jaws are normally yieldably biased toward each other by a spring 136. A suitable member 138 is provided between each pair of gripping members, as illustrated, for limiting the movement of the gripping members toward each other and for properly positioning the gripping members with respect to each work station.

In order to position a washer body held between the gripper jaws for proper alignment with the dies at work station 106, a locating finger having a washer engaging projection 137 is pivotally mounted by any suitable means and yieldably biased toward a washer engaging position by a spring 139. As the rotatable plate or dial 124 moves to advance the washer blank from the work station 104 to the station 106, the projection 137 engages a prong or tooth element on the washer blank and turns the blank within the gripping jaws 130 and 132 until the washer is properly positioned. A similar locating finger is positioned between the work stations 110 and 112 to locate the prongs of the washer blank for proper registration with the prong twisting dies at the work station 112, described hereinbelow.

In order intermittently to drive the rotatable plate 126 in timed relationship with the reciprocating movement of the die holder, drive means is provided which is operatively connected with the die holder. This drive means includes a ratchet wheel 140 which is keyed or otherwise secured to the rotatable shaft 128. An annular gear 142 surrounds the ratchet wheel and carries a pivotally mounted pawl 144, which pawl is engageable with the teeth on the ratchet wheel. A spring 146 is suitably mounted for yieldably biasing the pawl into engagement with the ratchet wheel. The annular gear 142 meshes with and is driven by a rack 148, which rack is mounted for reciprocating movement by any suitable means. A pin 150 extends from the rack and is slidable within a suitable cam slot 160 in cam member 162, as shown best in Fig. 2. The cam member 162 is secured by any suitable means to an arm 164, which arm is in turn secured to the reciprocable die holder 120. Thus, as the die holder moves up and down, the cam member likewise moves up and down, and the rack 148 is reciprocated to drive the transfer mechanism in timed relationship with the die holder. In the embodiment illustrated, as the cam member 162 is raised, the rack 148 will be moved to the left, as viewed in Fig. 2, and in order to assist in the return stroke of the rack, a tension spring 166 is provided, which spring is connected to the rack by means of a pin 168. The opposite end of the spring is connected to the frame of the apparatus, as at 170, by any suitable means.

Referring particularly to Fig. 18, it will be seen that the washer blanks are fed from the chute 116 onto a supporting surface 172. A suitable die 174 is mounted above said supporting surface. The die 174 has a bore 176 which is adapted to receive and cooperate with a reciprocating plunger 178 to form the washer blank into the cylindrical shape shown best in Figs. 7 and 13. It should be noted that the diameter of the bore 176 is about equal to the diameter of the washer body 88 at the junction of the washer body with the prongs or tooth elements 80. Thus, as the washer blank is forced through the bore 176, the annular body portion 88 of the blank is compressed, as it is formed into the cylindrical shape shown in Figs. 7 and 13. This compression of the annular body portion substantially reduces any possibility of the body portion cracking or breaking during the subsequent flattening and stretching operations described below. The plunger 178 is actuated by any suitable means, not shown, through a stroke which is sufficiently long to carry the upper end of the plunger well above the die 174. The plunger is provided with a shoulder 180 which engages the lower edge of the washer blank to carry the blank above the die 174. As the plunger and washer blank emerge from the top of the die 174, the gripping members 130 and 132 are forced apart to permit the plunger to reach the top of its stroke. As the plunger begins its downstroke, the gripping members strip the washer blank from the plunger. The gripping members 130 and 132 are preferably provided with shoulders 182 and 184, respectively, for supporting the cylindrical shaped washer blank, as shown in Fig. 18.

Referring now to Fig. 19, it will be seen that the work station 106 includes an upper die member 186 mounted on the tool holder 120 and a lower die member 188. The lower die member 188, which is shown best in Fig. 23, is provided with a central conical surface 190 and a plurality of radially extending slots 192. A knockout

member 198 is provided for removing a washer blank from the die member 188 and positioning the blank above the die member so that the blank may be engaged by the gripping members. The knockout member 198 is provided with a plurality of radially extending fingers 200 which project into the slots 192 in order to engage the tooth elements or prongs of the washer blank to keep the blank from tilting. The upper die member 186 at the work station 106 includes a plunger having a conical surface 202 which is adapted to cooperate with the conical die surface 190 to form the washer blank 88 into the frusto-conical shape shown best in Figs. 8 and 14. The die member 186 also includes finger-like elements 204 which are adapted to engage the tooth elements of the washer blank and force them into the slots 192 in the lower die member. It will be noted that as the annular body portion 88 of the washer blank is formed into the shape shown in Figs. 8 and 14, the body portion of the blank will be drawn or stretched, whereby the outside diameter thereof is increased and the tooth elements or prongs are further spaced apart.

After the washer blank has been worked upon at the station 106, it is engaged by the gripping members 130 and 132 in the manner shown best in Fig. 20 and carried to the work station 108. The work station 108 includes an upper die member 206 and a lower cooperating die member 208. The upper die member includes an annular inclined surface 210 which is adapted to engage the prongs and the annular body portion of the washer blank to flatten the washer blank partially, as shown in Figs. 9 and 15. The lower die member 208, which is shown best in Fig. 24, includes a plurality of surfaces 212 which cooperate with the annular surface 210 to form the washer blank. Preferably, the surfaces 212 are provided by a plurality of segments spaced by grooves 214, and the surfaces of adjacent segments may be inclined slightly relative to each other. By this structure, the annular body portion of the washer blank is slightly undulated, and it has been found that by such working of the washer body, stretching of the annular washer body is facilitated without cracking of the original internal margin of the blank. The lower member 208 is also provided with a pilot pin 216 which is fixed to the die block 118. As shown best in Fig. 20, the die member 208 is mounted within a suitable aperture in the die block and is yieldably supported by a compression spring 218.

The washer blank is carried by the gripping members 130 and 132 from the work station 108 to the work station 110. The work station 110 includes upper and lower die members 220 and 222, respectively. The upper and lower die members are provided with substantially flat cooperating surfaces 224 and 226 for substantially completely flattening the washer blank, as shown best in Figs. 10 and 16. The lower die member 222 also includes a pilot pin 228, as shown in Figs. 21 and 25. The pilot pin 228 is fixed to the die block 118, and the die member 222 is yieldably supported within a recess in the die block by a compression spring 230.

The work station 112 includes upper and lower die members 232 and 234 which are provided with suitable cooperating inclined surfaces 236 and 238 for engaging the tooth elements or prongs of the washer blank and twisting the prongs about their radial axes, as shown best in Figs. 11 and 17. The lower die member 234 is provided with a knockout member 240 which is yieldably supported by a spring 242 for insuring the removal of the washer blank. After the washers have been completed at the work station 112, the gripping members carry the washers to the discharge station 114, shown best in Fig. 3. Suitable means, not shown, is provided for opening the gripping members to release the washer, whereupon the washer falls onto an inclined surface 244 formed on the die block and from there to a suitable hopper or the like, not shown.



The operation of the above described apparatus when practicing the novel method of this invention is as follows. Referring particularly to Fig. 4, it will be seen that the strip 44 of sheet material is fed from right to left into the apparatus and to the work stations 34 through 42. As the strip is intermittently advanced past stations 34 through 40, it is punched and slit in a manner described more fully hereinabove to provide a flat annular washer blank or slug having tooth elements or prongs extending radially inwardly. While the above described small apertures 66 in the blank may not always be necessary for all types of materials, it has been found that these apertures, which are located at the roots of the tooth elements or prongs, facilitate the subsequent operations on the washer blanks by greatly reducing the possibility of injury to the blanks. The flattened washer blank is then formed and drawn at the work station 42 into the frusto-conical shape shown best in Figs. 6 and 12. It will be noted that at this point, the annular portion 88 of the washer blank has been stretched somewhat to space the tooth elements or prongs 80 from each other.

From the work station 42, the washer blank is transferred to the work station 104. This transfer may be accomplished by any suitable means, and, if desired, the washer blanks may first be discharged into a hopper and then fed to the work station 104 by means of the chute 116. At the work station 104, the blank 112 is formed into the cylindrical shape shown in Figs. 7 and 13. As described fully hereinabove, the material of the annular body portion 88 of the washer blank is preferably compressed somewhat during this step. The blank is then transferred progressively to the work stations 106, 108, and 110, whereat the blank is progressively flattened, as described above. At each station, the annular body portion 88 of the blank is drawn or stretched so as to increase the outer diameter thereof and space the tooth elements farther apart from each other. During all of these steps, it will be noted that it is only the annular body portion of the blank that is being drawn and formed, while the tooth elements substantially retain their initial shape. Thus, the strength and flexibility of the tooth elements formed from a given thickness of sheet material stock are not substantially affected by the process of this invention. The final step is performed at the work station 112, whereat the tooth elements or prongs 80 are axially twisted to present locking edges on opposite sides of the annular body portion 88 of the washer. It will be obvious that the final washer, as shown in Figs. 11 and 17, will have internal and external diameters substantially greater than the internal and external diameters of the washer blank provided at work station 40.

Another advantage of the method of this invention is that certain steps can be eliminated to obtain different types of washers. For example, after the washer blank has been formed at work station 42 into the shape shown in Figs. 6 and 12, the tooth elements 80 could be twisted to provide an internal tooth countersink washer. Furthermore, the tooth elements of the washer blank could be twisted after the blank has been formed into the shape shown in Figs. 8 and 14 at the work station 108 to provide an external tooth countersink washer.

From the above description, it is seen that the present invention has provided a novel method and apparatus, whereby substantial material economies may be effected when manufacturing a given size washer by starting with a washer blank substantially smaller than the washer ultimately desired. Furthermore, it will be seen that since the tooth elements or prongs of the washer blank are not drawn or stretched during the formation of the washer, the strength and holding power of washers formed by the novel method of this invention will compare favorably with similar sized washers formed in accordance with the prior art practices.

While the preferred embodiment of the present invention has been shown and described herein, it is obvious

that many changes may be made without departing from the spirit and scope of the appended claims.

I claim:

1. A method of making a washer from a generally annular blank having predetermined internal and external diameters and tooth elements on the inner margin thereof; and comprising coning the blank by application of pressure to the central portion thereof, forming the coned blank into substantially cylindrical form, and then expanding the toothed margin of the substantially cylindrical blank to stretch the margin outwardly and provide a washer having internal and external diameters greater than the said predetermined internal and external diameters of the blank and with the tooth elements disposed exteriorly of the washer.

2. A method of making a washer as claimed in claim 1, wherein the externally coned toothed margin of the blank is subsequently substantially flattened to provide tooth elements projecting radially from the outer margin of the body.

3. A method of making a washer as claimed in claim 2, wherein the tooth elements are pressed to lie substantially in the plane of the body and thereafter twisted to provide locking teeth projecting beyond the bounding planes of the body.

4. A method of making a lock washer from a generally annular blank having predetermined internal and external diameters, and comprising radially slitting the blank from an intermediate portion to the inner margin thereof to provide tooth elements, coning the blank by application of pressure to the central portion thereof, forming the coned blank into substantially cylindrical form to stretch the blank and further separate the tooth elements, and then expanding the toothed margin of the substantially cylindrical blank to stretch the margin outwardly and provide a washer having internal and external diameters greater than the said predetermined internal and external diameters of the blank and with the tooth elements disposed exteriorly of the washer.

5. A method of making a lock washer as claimed in claim 4, wherein the body and tooth elements are then substantially flattened and the tooth elements twisted to provide locking teeth projecting beyond the bounding planes of the body.

6. A method of making a lock washer from a generally annular blank having predetermined internal and external diameters, and comprising punching the blank to provide an annular row of apertures therethrough, slitting the blank from the apertures to the inner margin thereof to provide tooth elements, coning the blank by application of pressure to the central portion thereof, forming the coned blank into substantially cylindrical form to stretch the blank and further separate the tooth elements, and then expanding the toothed margin of the substantially cylindrical blank to stretch the margin outwardly and provide a washer having internal and external diameters greater than the said predetermined internal and external diameters of the blank and with the tooth elements disposed exteriorly of the washer.

7. Apparatus for making lock washers with locking teeth from a generally annular blank of sheet material having a predetermined internal diameter; and comprising means for feeding a strip of stock material to stations including means for punching the strip to provide openings spaced longitudinally thereof, shearing means for radially slitting the strip around each opening and through the margin of the opening to provide tooth elements, means for cutting the strip to form an annular blank around each opening and including the slits, means for feeding each blank to stations including coning means for forming the slit blank into substantially conical form with the tooth elements forming the minor diameter thereof, means for expanding the toothed margin of the substantially conically formed blank into substantially cylindrical form with the tooth elements projecting substantially axially from one edge thereof, and coning means for expanding the toothed margin of the blank outwardly toward a flattened position for stretching the toothed margin of the blank outwardly of the initial outer margin of the blank with the tooth elements projecting beyond the same.

8. Apparatus for making lock washers as claimed in claim 7, wherein there is provided punching means in advance of the shearing means to form an annular series of apertures through the blank at the outer ends of the slits formed therein.

9. Apparatus for making lock washers as claimed in claim 7, wherein there is provided means for substantially completely flattening the blank and included tooth elements into a common plane, and wherein means are provided for thereafter twisting the tooth elements to provide locking teeth extending beyond the bounding planes of the body.

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