United States Patent [19]

Gohs

[11] 3,902,209

[45] Sept. 2, 1975

[54] **THREADED LOCK WASHER AND METHOD FOR FABRICATION THEREOF**

[75] Inventor: **Howard C. Gohs**, Syosset, N.Y.

[73] Assignee: **Electrical Fittings Corporation**, East Farmingdale, N.Y.

[22] Filed: **Sept. 14, 1971**

[21] Appl. No.: **180,337**

Related U.S. Application Data

[60] Division of Ser. No. 825,382, May 16, 1969, Pat. No. 3,608,601, which is a continuation-in-part of Ser. No. 703,494, Nov. 13, 1967, Pat. No. 3,453,672.

[52] **U.S. Cl.** ..... **10/73**; 10/86 B

[51] **Int. Cl.** **B21d 53/20**

[58] **Field of Search** ..... 10/73, 86 R, 86 B; 85/8.8; 151/36, 37

[56] **References Cited**

UNITED STATES PATENTS

3,260,293	7/1966	Gohs	151/37
3,397,726	8/1968	Gohs	151/37
3,453,672	7/1969	Gohs	10/73

Primary Examiner—Charles W. Lanham
Assistant Examiner—E. M. Combs
Attorney, Agent, or Firm—Howard C. Miskin

[57] **ABSTRACT**

The process and apparatus for fabricating a lock washer made of a strip of coil stock material. The fabricating apparatus is a multi-station forming die punch device wherein a strip of material is cut from stock and wound on a mandrel; a portion of the washer is axially displaced to engage an adjoining turn for preventing unwinding of the finished product, by the fabricating apparatus, which forms the notches and gripping edges of the washer.

8 Claims, 26 Drawing Figures

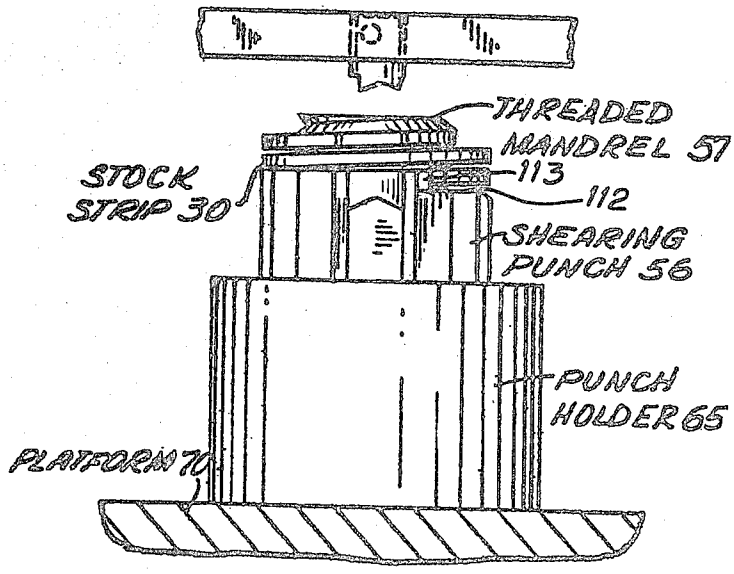
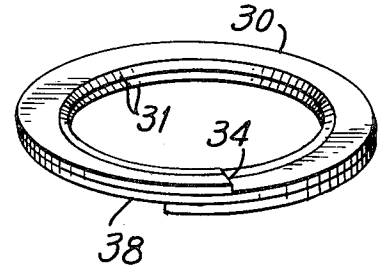


FIG. 1



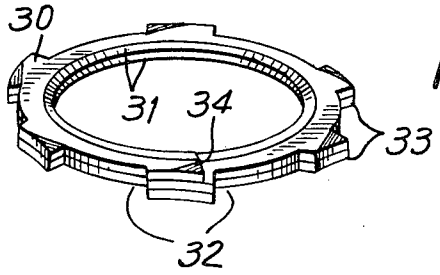
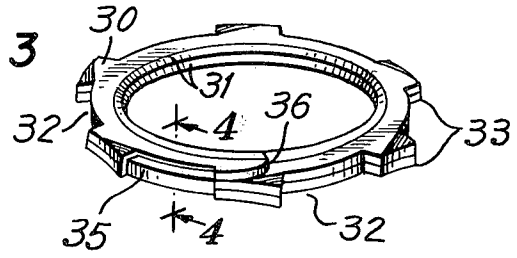


FIG. 2

FIG. 3



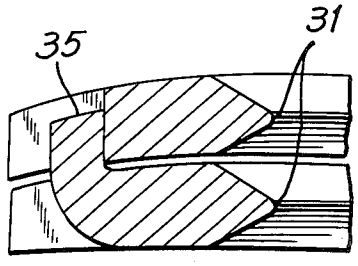


FIG. 4

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FIG. 5

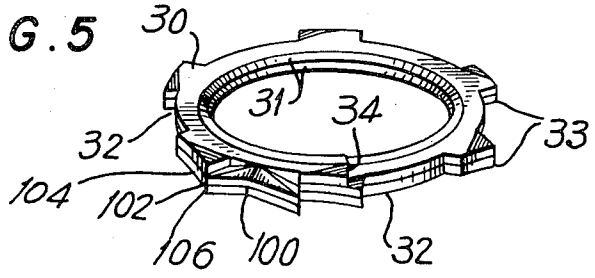

FIG. 6

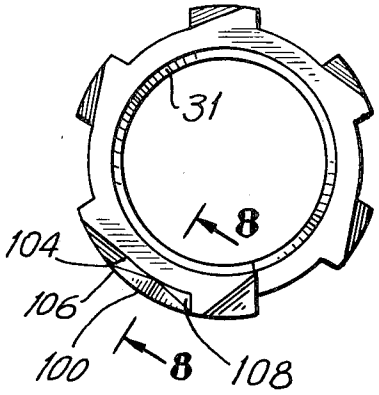

FIG. 6A

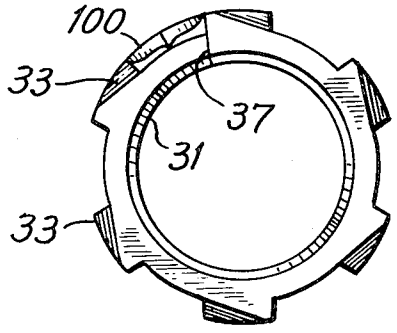

FIG. 7

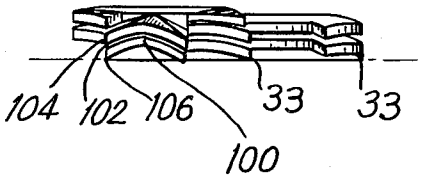

FIG. 8

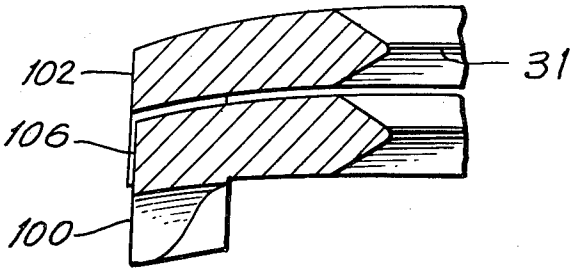

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FIG. 9

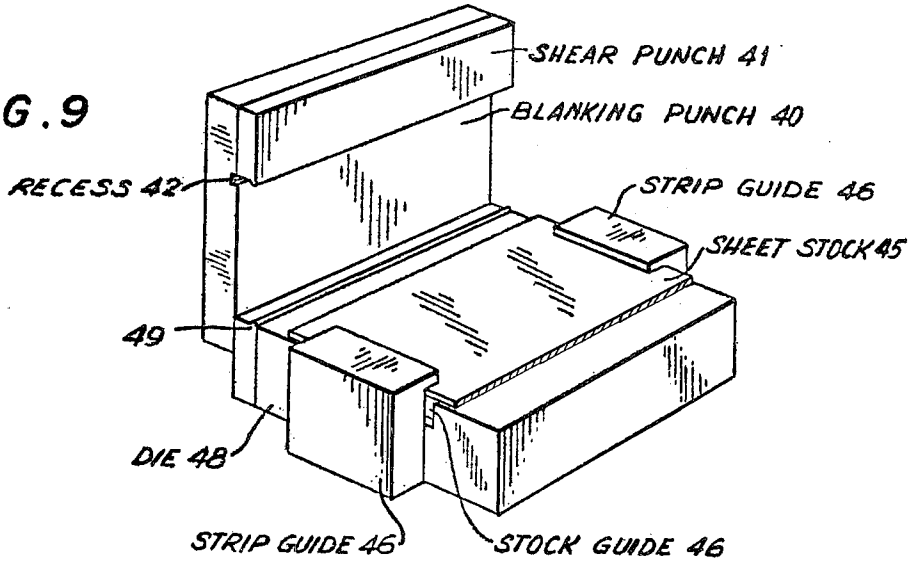


FIG. 10

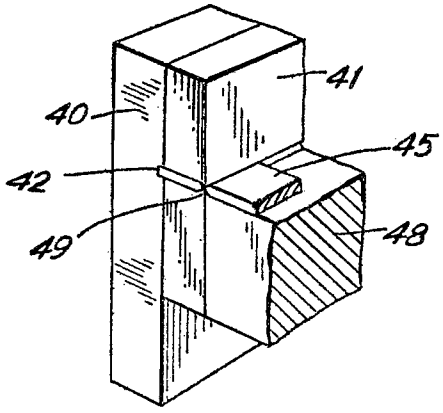


FIG. 11

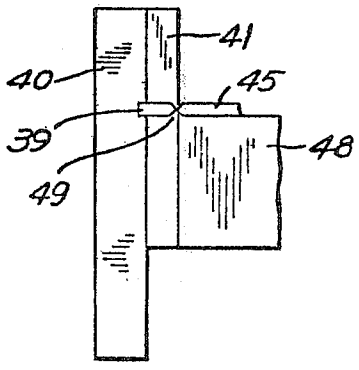


FIG. 12

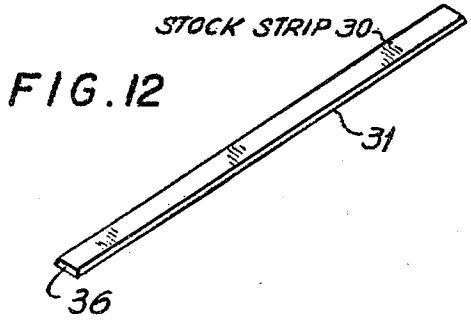


FIG. 14

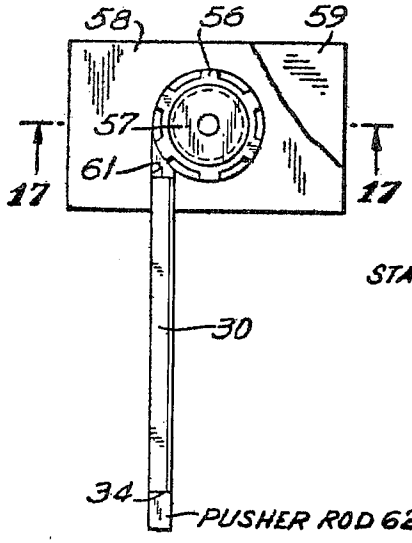


FIG. 13

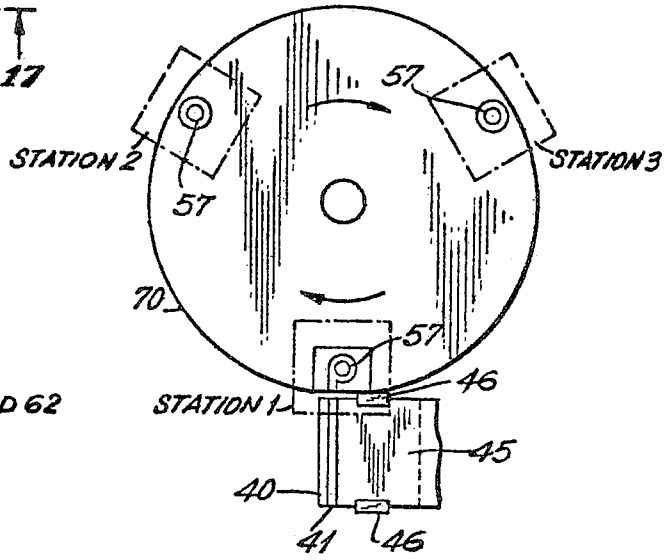


FIG. 15

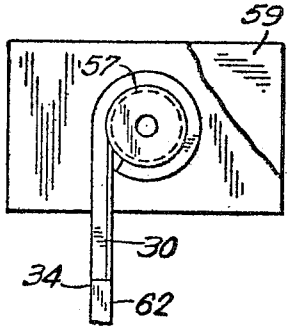


FIG. 17

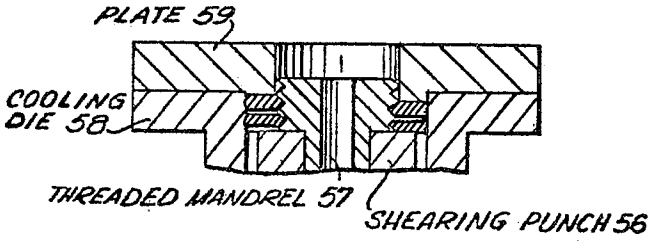


FIG. 16

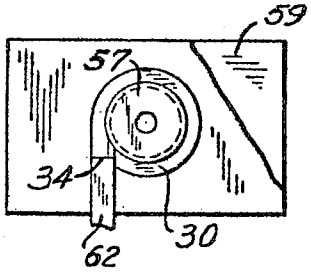


FIG. 18

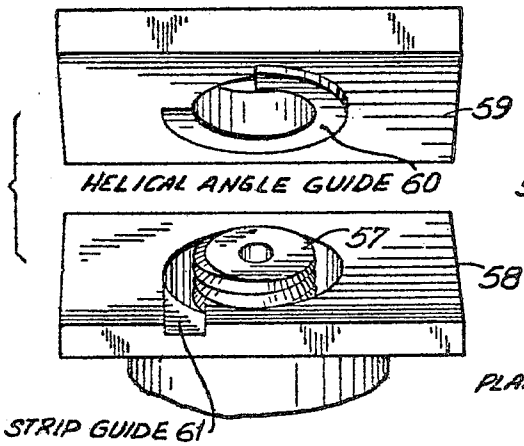


FIG. 19

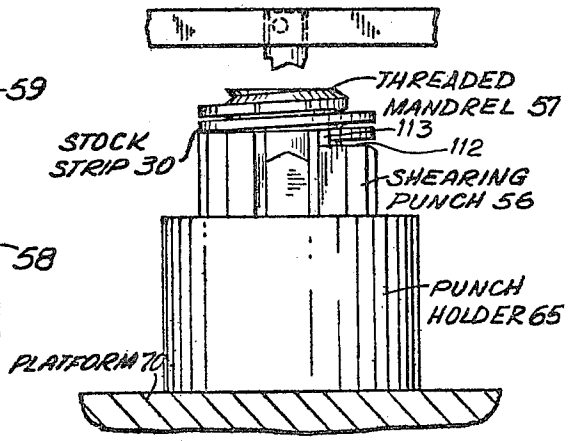


FIG. 20

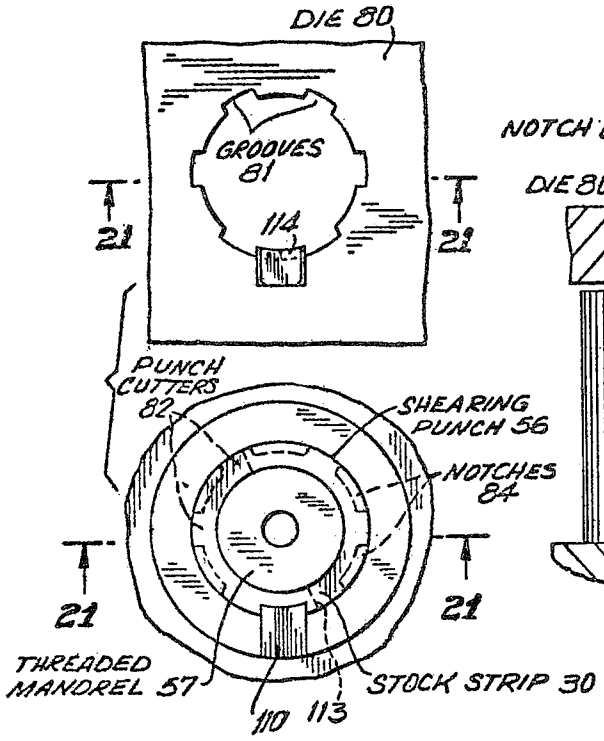


FIG. 21

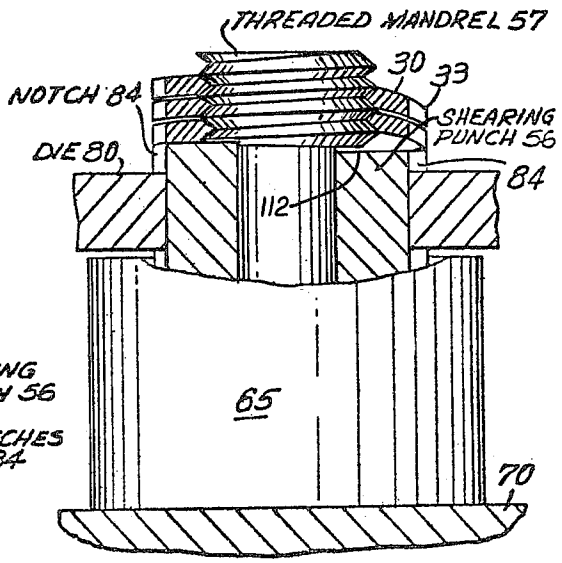
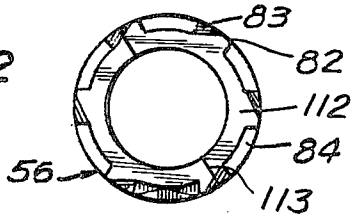


FIG. 22



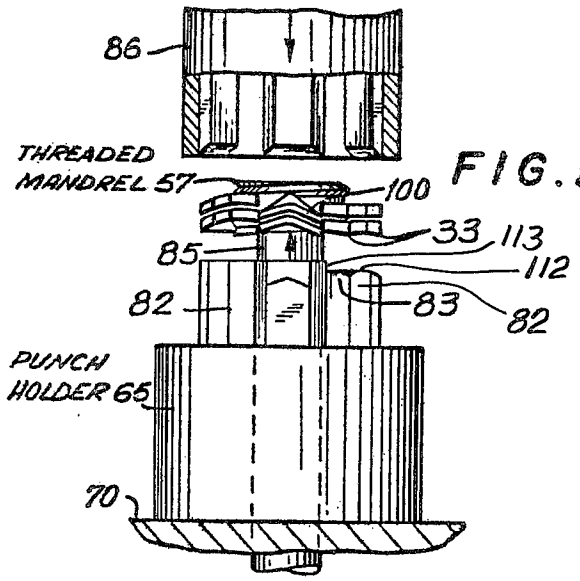


FIG. 23

FIG. 24

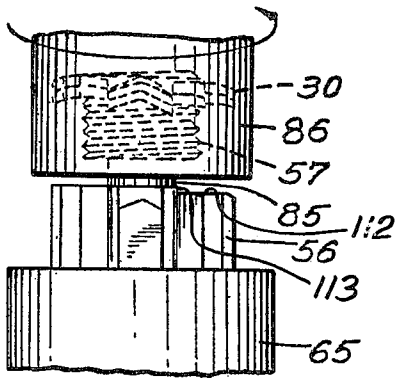
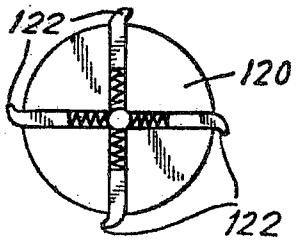


FIG. 25



THREADED LOCK WASHER AND METHOD FOR FABRICATION THEREOF

This is a divisional application of Ser. No. **825,382,** filed May **16, 1969,** now U.S. Pat. No. **3,608,601,** which in turn is a continuation-in-part of application Ser. No. **703,494,** entitled "Threaded Lock Washer and Method for Fabrication Thereof", filed Nov. **13, 1967,** now U.S. Pat. No. **3,453,672.**

This invention relates to threaded lock washers, and more particularly to threaded lock washers having improved locking characteristics and methods and equipment for the fabrication thereof.

Threaded lock washers, which are used in the millions each year, are essentially cylindrical bodies each having a threaded central bore and spaced gripping or biting tabs along its outer periphery. There are many uses for such washers, typical of these being the locking of a threaded pipe to an outlet box. Prior art washers have generally been fabricated by an appropriate stamping operation on sheet stock.

There are three major problems encountered in the use and fabrication of prior art lock washers. First, in the stamping operation up to **80%** of the stock material may be wasted because the material which is punched out to form the central bore and the rounded periphery configuration is wasted. Second, in the manufacture of the prior art lock washer once the bore is formed it must be threaded, and the threading step is a relatively expensive one from the points of view of the initial cost of the threading equipment and the time which is required for the operation. Third, prior art lock washers are known to often work loose after attachment to an outlet box or similar device, due primarily to the difficulty of tapping smooth **100%** threads.

In my parent application, Ser. No. **394,160** filed Sept. **3, 1964** and entitled "Threaded Lock Washer," now U.S. Pat. No. **3,260,293** there is disclosed an improved lock washer and a method for its construction. A strip of flat wire material, with a beveled edge, is wound to form a helical coil. The coil is wound such that the beveled edge of the strip defines a central threaded bore. The coil may then be stamped to form the gripping tabs. This method of fabrication is advantageous for three reasons. Because the wire strips which eventually form the final lock washers may be cut from sheet stock with very little material being wasted, a considerable savings is realized in the cost of the material. And because the beveled edge is formed on each strip before the winding operation, there is no need for the threading operation in the manufacturing process. (Additionally, a **100%** thread is formed.) As for the final lock washer itself it is vastly superior to the prior art type of lock washer. If two turns are made in the winding operation, the final washer has the characteristics of two separate washers, one on top of the other. When the "combined" lock washer is used in practice and tightened to an outlet box, the outer convolution rotates slightly with respect to the inner convolution which rests against the box wall. This slight rotation provides a dual locking characteristic which in the prior art can be obtained only with the use of two separate washers. A single washer constructed as described in my aboveidentified application is substantially foolproof from working loose after attachment.

It has been found that electricians and other persons, when using the lock washer disclosed in my above-identified application, are sometimes apt to ruin it. A

lock washer is generally tightened to an outlet box or other wall by placing a screwdriver against one of the gripping tabs and hitting it with a hammer. The force applied by the hammer causes the washer to turn on the threaded pipe and the gripping tabs to bite into the box wall. If an electrician follows the same procedure when using my abovedescribed lock washer there is no problem. However, it is possible that due to the construction of the washer an attempt will be made to tighten it in another manner. Because the washer is basically a helically-wound strip of flat wire, the surface furthest away from the box wall, the surface subject to view during installation, exhibits a cut end of flat wire. An electrician is apt to place the tip of the screwdriver against this edge and strike it with a hammer to force the turning of the washer. In so doing, the helically-wound wire may uncoil to too great an extent and the washer may have to be discarded.

To overcome this problem, my copending application, Ser. No. **534,837,** filed March **16, 1966** entitled "Threaded Lock Washer and Method of Fabrication Thereof" now U.S. Pat. No. **3,397,726,** disclosed an improved lock washer having a locking tab provided on the washer itself. This tab is a radial extension of the lower convolution and is bent upward to fit between two of the gripping tabs extending from the upper convolution. The locking tab, in the illustrative embodiment of the invention, engages the upper convolution near its end. This has the effect of rigidly attaching the end of the upper turn to that part of the wire coil beneath it. In fact, the entire upper turn is a rigid unit, and even if the upper edge of the strip is struck, the washer turns without unfurling.

Because of the locking tab, however, the manufacturing process requires more steps than merely the coiling of a wire strip followed by the stamping of it to form the gripping tabs. For example, the locking tab must be bent to engage the upper turn of the coil. And the stamping process must not destroy the tab after it is bent, if the bending step is first, or before it is bent, if the stamping step in first. Moreover, an additional punching operation may be required to form a slot on the side (interior or exterior) of the upper end of the coil into which the bent tab may fit. Thus, all things considered, the manufacturing process for constructing a helically-wound lock washer with a locking tab is considerably more complex than the process for constructing the simpler lock washer disclosed in my aboveidentified application.

It is a general object of this invention to provide a lock washer, and a method and equipment for the fabrication thereof which are improvements over those disclosed in my above identified application.

In accordance with the principles of my invention a portion of the turns of the final coiled configuration is displaced longitudinally after being coiled on a threaded mandrel so that adjoining portions of the turns engage. This displacement may take place while a shearing punch and die forms a series of notches and gripping tabs with biting edges on the coiled strip. The interactions between the various punches and dies is described in much greater detail below. The displaced portion of turns urns are so offset and bent that the portion of the upper turn engages the adjoining lower turn, so as to effectively rigidly attach the upper turn to the lower turn. Then, if the upper turn is struck by the user, the washer turns without unfurling. Because the upper

turn is still free for relative slight rotational movement with respect to the lower turn, the dual-locking characteristic of the lock washer is not lost even though the upper turn is in fact a rigid unit. Thus, the offset portion insures that the washer will not be deformed during installation by an absent-minded technician, without, however, destroying any of the beneficial characteristics of the washer.

Before the flat wire strip is coiled it is necessary to form a beveled V-shape along that edge which will subsequently define the threaded central bore. In my above-identified application the strip is shown with such a beveled edge. While such an edge may be formed in accordance with prior art techniques I have discovered a particularly advantageous method for doing so. The simplest process for forming the beveled edge would appear to be stamping, or punching. The strip may be placed on a die whose upper surface is flat but inclined upward directly beneath the edge of the strip to be beveled. A shear punch may then be forced downward against the strip, the lower surface of this punch being flat but inclined downward directly above that edge of the strip to be beveled. When the die and punch surfaces come against each other the beveled edge will be formed from the previously straight edge. This deceptively simple process has one major drawback. In forming the beveled edge the wire material is not cut away but merely squeezed together. The material must flow somewhere. Unfortunately the material is apt to flow in such a manner that the punch is pushed away from the die. The force which is generated by the flowing metal is exceedingly large. In fact, early punches used experimentally in this manner flew off the die with considerable force when contact was made; the heavy securing bolts were completely severed.

To overcome this difficulty I provide a groove or indentation in the shear punch mechanism. The mechanism consists of a vertically flat blanking punch having various punch forms thereon and at its upper end the beveled-edge forming shear punch. The sheet stock is first fed up against the flat blank wall of the punch. This wall is used as a stop to obtain the exact width of material required. As the mechanism in lowered the flat blanking punch fits flush against the vertical end of the die, on top of which rests the sheet stock from which the wire strip is to be formed. As the blanking punch falls the various punch forms cut rounded ends and the tab slot on the sheet stock. As the blanking punch continues to fall the shear punch strikes the sheet stock and exposes the recess to cut off a strip and at the same time to form a beveled edge. It is at this time that the strip would be forced out against the blanking punch to break the securing bolts. To eliminate this problem the blanking punch is provided with a groove or recess into which the metal may flow as the strip grows in width. Because the groove is included in the blanking punch it is possible to utilize a simple punching mechanism for forming the rounded edges, the locking tab slot, and the beveled edge all in a single operation.

It is a feature of this invention to provide a lock washer having gripping tabs and a screw-threaded central bore, with a plurality of helically-coiled wire strip convolutions having a portion of the turns longitudinally offset and bent for securing the upper end of the wire strip to the strip material beneath it.

It is another feature of this invention to provide a series of apparatus interacting with each other in such a manner that the wire strip is cut from sheet stock, wound and punched such that the final lock washer may be fabricated in an exceedingly simple and efficient manner.

It is a still further feature of this invention to provide a mechanism for cutting a wire strip from sheet stock, cutting it with a punch form, and forming with a shear punch a beveled edge thereon, all in a single operation.

Further objects, features and advantages of the invention will become apparent upon consideration of the following detailed description in conjunction with the drawing in which:

FIG. **1** is a perspective view illustrating a helical coil of flat wire material employed to form a lock washer in accordance with the invention disclosed in my above-identified parent application;

FIG. **2** is a perspective view of the final lock washer constructed from the helical coil of FIG. **1**, and disclosed in my above-identified parent application;

FIG. **3** is a perspective view of a final lock washer constructed in accordance with the invention disclosed in my above-identified application;

FIG. **4** is a sectional view of the lock washer taken along line **4—4** of FIG. **3**;

FIG. **5** is a perspective view of a lock washer constructed in accordance with the principles of the present invention;

FIG. **6** is a top plan view of the lock washer of FIG. **5**;

FIG. **6A** is a bottom plan view of the lock washer of FIG. **5**;

FIG. **7** is an elevational view of the lock washer of FIG. **5**;

FIG. **8** is a sectional view of the lock washer of FIG. **5** taken along the line **8—8** in FIG. **6**; and

FIGS. **9–25** depict illustrative mechanisms for constructing the lock washer of FIG. **3**.

Like numbers refer to like elements in the various embodiments.

In my above-identified application the first step in constructing the lock washer of FIG. **2** is to form a helical coil **30** from a straight strip of stock material as shown in FIG. **1**. The material is substantially rectangular in crossection, except that one lengthwise edge **31** is beveled. As the strip is wound a screw-threaded central bore is formed. The coil is then stamped or punched on a die. Notches **32** are cut out along the outer periphery of the coil. In addition, in the same step the remaining material at the periphery of the unit is bent slightly to form gripping teeth or tabs **33**. The over-all assembly is similar to that of the prior art. But the only wasted material is that cut out of notches **32**. And because of the initial beveled edge of the wire strip **30**, which strip is used to form the washer, a threading operation is not required. In addition to the advantages in the fabrication of the washer, the completed washer exhibits an unusual characteristic — it functions in practice as two separate lock washers. As the washer is turned clockwise from above, the teeth of the lower turn of the helix grip the connecting surface, such as the wall of an outlet box. After the lower convolution stops turning the upper convolution still turns slightly if sufficient force is applied. While it may rotate only slightly with respect to the lower turn, it functions as a second lock washer. This dual locking characteristic is

described in greater detail in my above-identified parent application.

In practice, the washer is tightened by placing the tip of a screwdriver in one of the notches **32** against the upper section of one of the gripping tabs. As the screwdriver is struck with a hammer the washer is turned. It should be noted, however, that end **34** of the metal strip is in full view at the top of the washer. An absent-minded individual might mistakenly place the screwdriver against this edge rather than against one of the biting tabs. In such a case, if sufficient force is applied, after the teeth grip the outlet box wall the washer may unravel and have to be discarded.

To eliminate this possibility the improved lock washer of the above-identified application Ser. No. 534,837 shown in FIGS. **3–4,** is different from the washer of FIG. **2** in two major respects. First, end **36** in FIG. **3** is rounded rather than being straight as is end **34** in FIG. **2.** (The lower end of the coil can also be rounded, although this is not as important.) With a rounded edge the installer is more likely to place his screwdriver against the biting edges. But this is not a sufficient guarantee and for this reason my improved washer includes a locking tab **35.** With this tab it may not even be necessary to provide a rounded edge because the tab prevents the uncoiling of the washer even if the upper end of the helix is struck.

While the six notches of the washer of FIG. **2** are formed by punching through the entire coil at six sections on its periphery, in the washer of FIG. **3** only five of these notches are formed. The sixth notch is similar to the other five only in that the upper turn of the wire strip is cut through. The material in the lower turn directly beneath the half-notch is not cut out. Instead, it is bent up into the notch (slot) in the upper turn, as shown in FIG. **4.** Thus, the upper end of the coil is in effect locked to the material directly underneath it and cannot unravel if it is struck at its end **36.**

Although the construction of this washer is easily understood it is readily apparent that the method for making it is considerably more complex than that required for fabricating the washer of FIG. **2.** After the wire strip is wound it is not sufficient to provide a single punching operation. The problem arises with the notch in the upper turn near edge **36.** While this notch must be cut out, the material below it, which forms locking tab **35,** must not be cut out. It is difficult to build a punch which will form five full notches **32** and an additional half-notch. Moreover, even after the half-notch is formed a punching operation is required to form the locking tab **35** itself. This requires a separate operation as taught in the prior application.

To avoid the complex method of producing the lock washer shown in FIGS. **3** and **4** and yet produce a rigid lock washer, which will not unravel, even if end **34** is struck inadvertently, the improved lock washer of the present invention is shown in FIGS. **5–8,** and differs from the washers of FIGS. **2** and **3** by displacing a portion **100** of the turns axially or longitudinally and bending the ends of this portion, so that at least one end **102** of the top turn of this portion is aligned with the bottom turn of the washer adjacent this displaced portion, indicated at **104.** Because the top turn is then rigidly attached to the bottom turn, end **34** may be straight as in the lock washer of FIG. **2.** However, the end can be rounded, as at **36** if desired, but this will require a separate punching step. The washer of FIG. **5** has five notches **32** formed by punching through the entire coil at five sections on its periphery, with portion **100** overlapping two consecutive tabs **33.** All of this punching and bending is done in one operation. Opposite ends of portion **100** are bent downwardly, such as shown at **106** and **108,** so that the end **102** of the top turn of portion **100** is aligned with the facing end **104** of the bottom turn of tab **33.** Thus, the upper end of the coil is in effect locked to the material directly underneath it and cannot unravel, if it is struck at its end **34,** since end **102** of the top turn of portion **100** will engage end **104** of the bottom turn. The washer still exhibits the dual-locking characteristic. The upper washer is a rigid unit which can be viewed best by following the helix of FIG. **1** from end **34** all the way around to approximately that part indicated at **38.** The second washer extends from this point to the lower end of the helical strip. These two washers can move slightly relative to each other. FIGS. **6, 6A** and **7,** show three different views of the washer. In FIGS. **7** and **8** a considerable space is shown between the coil layers. In construction, this dimension would be minimal but it is shown exaggerated in the drawing for the sake of clarity.

The strip **30** which is used to form the lock washer is shown in FIG. **12.** This strip is cut from sheet stock, and the lengthwise edge **31** is beveled. If the strip of FIG. **12** is wound as shown in FIGS. **1, 3** or **5,** it is evident that in the teeth forming step, it is only necessary to punch out five full notches **32.** Simultaneously, portion **100** is punched and bent as shown. The locking portion **100** may be constructed merely by cutting and bending that portion of strip **30** overlapping two adjacent gripping tabs **33** in the wound configuration. Thus, the first step in the process is to form the strip **30** shown in FIG. **12.** The strip is then wound, and following the formation of the coil the five notches **32** are punched out and the locking portion **100** is bent down. The various figures on sheet **2** of the drawing show the method for obtaining stock strip **30.** Sheet **3** of the drawing shows the manner in which the strip may be wound on a mandrel. The remaining figures show how notches **32,** gripping tabs **33** and locking portion **100** may be formed while the helical coil is contained on the same mandrel.

Referring to FIG. **9** it is seen that sheet stock **45** is moved along the upper surface of die **48** toward blanking punch **40.** The blanking punch fits snugly against the vertical end of the die. The upper rear end **49** of the die has a shape which is shown most clearly in FIG. **11.** It is flat near the blanking punch and inclined upward slightly away from it. Sheet stock **45** must slide over the little hump thus formed on the upper surface of die **48.** For this reason within strip guides **46** there are two stock lift pads **47.** These pads not only minimize the friction of the sheet stock against the die, but in addition lift the stock sufficiently such that it slides over the hump and comes to rest against blanking punch **40.**

As punch **40** is forced down, the cutting edge of shear punch **41** bites into the sheet stock. As seen most clearly from the perspective view of FIG. **10** and the side view of FIG. **11,** shear punch **41** and die **48** cause strip **30** to be cut from the sheet stock and at the same time to have its edge **31** beveled.

Recess or groove **42** is included in the blanking punch as shown in FIGS. **8–11.** In the formation of the beveled edge the strip material is squeezed. The metal must flow somewhere, and in fact it is projected in a horizontal direction toward the blanking punch. With-

out recess 42 the flowing metal is forced against blanking punch 40 with such force that the punch may be broken off whatever mechanism (not shown) holds it in place against die 48. Because of the positioning of recess 42, however, in the blanking punch just below the lower surface of the shear punch, the squeezed metal flows into the recess as shown in FIG. 11 without applying any force against the blanking punch. Thus, in a single step, the falling motion of the punch unit, the strip 30 of FIG. 12 is completely formed with its beveled edge.

The blanking punch is preferably not raised at this time for the purpose of gaining access to the cut strip 30. Because the outer edge of the strip is fitted into recess 42, it may not be advisable to lift the blanking punch to gain access to strip 30. Instead, the punch remains stationary and a pusher rod used to push the strip out from between shear punch 41 and die 48.

FIGS. 9–11 merely show illustrative apparatus to carry out the first step in the over-all process of fabricating the lock washer of FIG. 5, namely, the formation of the strip 30 as shown in FIG. 12. The remaining FIGS. 13–28 show illustrative apparatus for performing the remaining steps in the fabrication process.

FIG. 13 illustrates generally the manner in which the various steps of my method of fabrication are carried out. Circular platform 70 contains three punch end mandrel assemblies, to be described in greater detail below. Only the upper portions of mandrels 57 are shown in FIG. 13. The platform rotates and makes one complete revolution in three steps. At each of the three stations certain operations are performed. In the remaining figures of the drawing various units are shown as operating upon strip 30. Some of these mechanisms are included in the three punch and mandrel assemblies, which move from station to station. Others, however, are unique to individual stations. While various units are shown in the drawing, and described as being included at particular stations, the mechanisms for operating these units are not shown. These mechanisms will be apparent to those skilled in the art.

At station 1 strip 30 is formed as shown by numerals 40, 41, 45 and 46 in FIG. 13. As described above, strip 30 is forced out of the punch and die assembly and wound around a threaded mandrel 57. A pusher rod 62, as seen in FIGS. 14–16, has an end which fits flush against end 34 of strip 30. The pusher rod has the same cross-section as strip 30 and, consequently, can move between shear punch 41 and die 48 to force the strip around the mandrel.

Threaded mandrel 57 includes a shaft which is extended through a center bore in shearing punch 56. The details of the shearing punch and the additional units between the mandrel and platform 70 need not be understood at this point for an appreciation of the manner in which the strip is coiled around the mandrel. At station 1 a coiling die 58 is lowered around the mandrel and on top of this die is placed a plate 59. This is shown most clearly in the perspective drawing of FIG. 18. FIG. 17 is a cross-section of the complete unit, with the coiling die 58 and plate 59 lowered into position, seen along line 17—17 of FIG. 14. As shown in FIGS. 1, 4 and 18 coiling die 58 includes a strip guide 61. Pusher rod 62 forces stock strip 30 into this guide 61 and as it is forced in, it is wound around threaded mandrel 57. Coiling die 58 functions to bend the strip into a helical shape as it travels around the grooves in the threaded mandrel. The lower surface of plate 59 includes a helical angle guide 60. In forming a helix in the manner disclosed in the drawing the most difficult part of the process is at the beginning. The helical angle guide prevents the front end of the stock strip from rising out of the grooves of the mandrel, and forces the strip down as it is pushed in. In FIG. 17 the strip is shown completely wound.

FIGS. 14–16 show the coiling in three stages. In FIG. 14 the strip is shown just entering strip guide 61. Although the top of shearing punch 56 is visible, it need not be considered in the coiling process since the strip is wound only around the threaded mandrel which is above the shearing punch as seen in FIG. 17. In FIG. 15 the strip is shown approximately half-wound. Finally, in FIG. 16 the strip is shown fully wound on the mandrel and resting on top of shearing punch 56. It should be noted that pusher rod 62 is pushed into strip guide 61 far enough such that the top plan view of the wound strip comprises two concentric circles.

Platform 70 is then rotated and the punch-mandrel assembly is moved to station 2. FIG. 19 shows the complete assembly with the previously wound helical coil on the mandrel.

The shearing punch 56 consists of a series of six punch cutters 82, five notches 84, and the forming die 110 for locking portion 100, shown most clearly in FIG. 20. It is at this station that the coiled strip is stamped to form the biting tabs 33, the five notches 32 and the locking portion 100 of FIG. 5. Shearing punch 56 is directly beneath the lower surface of coiled strip 30. As seen most clearly in FIG. 22, the shearing punch has six punch cutters 82, five with a sloped edge 83, five separated by notches 84 and two having forming die 110 between them. Die 110 is below the surface of shearing punch 56 a predetermined distance. One-half of the upper surface of punch 56 is tapered so as to form a wedge-shaped surface 112. This taper is dimensioned to allow for the height of the end of the bottom turn so that the washer remains flat on punch 56 as seen best in FIGS. 19 and 21. The coiled strip 30 is wound at station 1 such that the bottom end of the strip abuts the higher part 113 of surface 112, as seen best in FIG. 20. Die 80 is forced down over the threaded mandrel to strike the upper surface of coiled strip 30. The die includes six grooves 81, which fit around the six punch cutters 82 on the mandrel, and the punch 114 forming portion 100. As die 80 is lowered the five notches 32 in the lock washer are formed. The metal in the coiled strip directly above the five notches 84 in the shearing punch is cut out and falls down as scrap. At the same time the notches which form the biting tabs are formed. Die 80 applies considerable pressure to the coiled strip on the mandrel as it bears down to cut out the notches. The coiled strip is forced down against the upper surface of shearing punch 56 and edges 83 on the punch cutters from the biting tabs 33.

Die 80 contains punch 114, which has opposite sides downwardly extending as at 116. Punch 114 extends below the surface of die 80 the same distance as die 110 extends below the surface of shearing punch 56, so as to deflect portion 100 of the washer axially downwardly a distance equal to a turn of the washer. The upper turn of portion 100 remote from end 34 is thus aligned with lower turn, as seen in FIG. 19. The metal strip is cut at the sides of locking portion 100 in order that it be deflected downwardly. The two edges 118

and 120 of the locking portion punch 114, FIG. 19, are sharp and serve to cut the sides of the portion 100. As punch 114 is lowered, locking portion 100 is formed against die 110 in punch 56.

Referring to FIG. 20, it will be seen that the interior shape of the die matches the exterior shape of the shearing punch.

FIG. 21 is a sectional view taken along the line 21—21 in FIG. 20, after the die has been forced down to cut notches 32 in the washer and to form gripping tabs 33, and locking portion 100. FIG. 21 shows the die fitting into the shearing punch notches 84. After the biting tabs are formed, the die is raised. The completed lock washer is contained on the threaded mandrel. It is screwed on, however, and a mechanism must be provided for screwing it off. This is accomplished at station 3.

Thus far threaded mandrel 57 has been stationary in the over-all process. The mandrel, however, is forced up slightly at station 3. Rod 85, which connects the mandrel to platform 76, is forced up at station 3 as shown in FIG. 23. The purpose of raising the mandrel is to disengage the completed lock washer from shearing punch 56 to facilitate the screwing off of the washer from the mandrel. Socket tool 86 is lowered as the mandrel is raised. The socket tool is a cylindrical wrench whose inner surface matches the outer surface of the lock washer. After the socket tool is fitted over the washer it is rotated counterclockwise as shown in FIG. 24. As it rotates the washer is screwed off the threaded mandrel. Once it is screwed off the socket tool moves over to a bin, not shown, where the completed lock washer falls down out of the tool. Rod 85 is then lowered and platform 70 moves once again to return the mandrel-punch assembly to station 1 for the fabrication of another lock washer.

To eliminate unwinding the washer from the mandrel, a smooth arbor 120 may be used, as shown in FIG. 25. Arbor 120 has spring loaded teeth 122 radially extending from the periphery of arbor 120 and facing in clockwise direction. Teeth 122 prevent unwinding of the locknut, but yet allows removal of the locknut from the arbor by conventional knockout pins, not shown.

The various punch and die arrangements disclosed on the drawing are particularly advantageous because of their low tooling cost. Not only is there a great savings in the cost of the metal required to make the washers, since there is very little waste scrap, but in addition the set-up costs are minimal.

What I claim is:

1. A method for making a threaded lock washer, comprising the steps of:
   1. cutting a strip of lengthwise material,
   2. forming a bevel shape along one of the lengthwise edges of said strip,
   3. winding said lengthwise material around a threaded mandrel to form a helical coil with a central threaded opening, said threaded mandrel being supported by a shearing punch of large diameter and having a plurality of punch cutters mounted thereon with sloped edges at the tops thereof separated by a series of notches and a locking die mounted on said shearing punch which abuts a punch cutter and is positioned below the surface of said cutter, said lengthwise material being wound around said threaded mandrel such that the lowest turn of said coil abuts the upper surface of said shearing punch,
   4. forcing down on said coiled material die means having a series of grooves conforming to said punch cutters in said shearing punch and a punch mounted on said die means which conforms to the locking die on said shearing punch for cutting out the material in said coil above the notches in said shearing punch and deflecting a portion of the upper turn radially to be aligned with the bottom turn, and for causing the remaining material in said lowest turn to conform to the shape of the surface of said shearing punch, and
   5. unscrewing said coiled material from said threaded mandrel.

2. A method for making a threaded lock washer, comprising the steps of:
   1. cutting a strip of lengthwise material,
   2. forming a bevel shape along one of said lengthwise edges,
   3. winding said lengthwise material into a plurality of side-by-side abutting but relatively slidable turns in accordance with a screw thread convolution to form a helical coil with a central threaded opening,
   4. forming a series of tabs extending radially from the outer periphery of said turns and bent at an incline with respect to a plane perpendicular to the axis of said central opening, said tabs projecting axially beyond said lowest turn of said coil, and
   5. deflecting a portion of one of said tabs on the uppermost surface axially beyond its lowermost surface to engage and be aligned with a tab on the lowermost turn.

3. A method for making a lock washer, comprising the steps of:
   1. cutting a strip of lengthwise material,
   2. winding said strip into a plurality of side-by-side abutting but relatively slidable turns to form a helical coil,
   3. deflecting a portion of the material in the uppermost of said turns to abut a portion of the lowermost turn while simultaneously forming a series of biting teeth extending radially and axially away from the center of said coil.

4. A method for making a threaded lock washer in accordance with claim 3, further including the step of:
   4. forming a bevel shape along one of the lengthwise edges of said strip.

5. An apparatus for making a threaded lock washer from sheet stock, comprising means for cutting a strip of lengthwise material from said sheet stock, means for forming a bevel shape along one of said lengthwise edges, a threaded mandrel, a chearing punch having a diameter larger than the diameter of said threaded mandrel and having a plurality of punch cutters mounted thereon with sloped edges at the tops thereof separated by a series of notches, means for winding said lengthwise material around said threaded mandrel to form a helical coil with a central threaded opening, said winding means winding said material around said threaded mandrel such that the lowest turn of said coil abuts the upper surface of said shearing punch, a locking die mounted on said shearing punch and positioned below the surface thereof and overlapping two adjoining punch cutters, die means having a series of grooves conforming to said punch cutters in said shearing punch for bearing down on said coil to cut out the ma-

terial in said coil above the notches in said shearing punch and to cause the remaining material in said lowest turn to conform to the shape of the upper surface of said shearing punch, a punch mounted on said die means and vertically aligned with said locking die on said shearing punch, said punch extending beyond the surface of said die means toward said locking die, and means for unscrewing said coiled material from said threaded mandrel.

6. An apparatus for making a threaded lock washer from sheet stock, comprising means for cutting a strip of lengthwise material from said sheet stock, means for forming a bevel shape along one of the lengthwise edges of said strip, means for winding said lengthwise material to form a helical coil with a central threaded opening defined by the beveled edge of said strip of material, and means for stamping said coiled material to form a series of gripping tabs extending radially and axially away from the center of said coil.

7. An apparatus for making a threaded lock washer from sheet stock in accordance with claim **6,** wherein said stamping means includes a shearing punch for supporting said coil and having a plurality of punch cutters mounted thereon with sloped edges at the tops thereof separated by a series of notches with a locking die mounted on said shearing punch and positioned below the surface of one of said cutters, and die means having inner shape conforming to the exterior shape of said shearing punch for bearing down on said coil supported by said shearing punch, said die means being further provided with a punch cooperating with said locking die for deflecting a portion of the upper turn to engage the lower turn.

8. An apparatus for making a threaded lock washer as in claim **6,** further including means for preventing rotation of said coil, said means adapted to release said coil axially.

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