METHOD AND APPARATUS FOR MAKING TOOTED LOCK WASHERS

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14 Claims. (Cl. 72—335)

ABSTRACT OF THE DISCLOSURE

A method and apparatus for making toothed lock washers from sheet material wherein the body of the lock washer is blanked from the sheet material but is not removed therefrom and is held by frictional engagement in the sheet material so that the teeth of the lock washer body and the sheet material lying between the teeth are twisted while the body is retained in the sheet to establish locking edges on the teeth displaced axially from the surface of the remaining portion of the body.

The present invention relates generally to methods and apparatus for manufacturing toothed lock washers. More specifically, the invention pertains to methods and apparatus for fabricated toothed lock washers rapidly and accurately from a continuous elongated strip of sheet material.

Toothed lock washers of the variety which include a generally annular body portion with locking teeth projecting radially from the body portion and being twisted relative thereto have enjoyed wide commercial acceptance. While the configuration of such lock washers would appear to be relatively simple, such simplicity is deceptive when considered in light of the rapid and efficient fabrication which is necessary to reduce the cost of manufacture to a competitive minimum while maintaining the quality necessary for proper operation of such lock washers. It has been found that the locking properties of toothed lock washers are directly related to the amount and consistency of the twist in the teeth and to the establishment of adequate locking edges along the twisted teeth. Thus, it would be advantageous to have available methods and apparatus which are capable of attaining rapid manufacture with accurate control over the essential characteristics of such lock washers.

It is an object of the invention to provide a method and apparatus by which toothed lock washers may be fabricated rapidly and efficiently with increased uniformity and quality.

Another object of the invention is to provide a method and apparatus whereby toothed lock washers may be economically and accurately fabricated from an elongated strip of sheet material stock with the minimum waste of stock.

Still another object of the invention is to provide a method and apparatus by which the teeth of a toothed lock washer may be accurately formed and uniformly twisted to present the requisite locking edges along the teeth.

The invention may be described briefly as a method of making toothed lock washers from sheet material, each washer having a generally annular body portion with teeth projecting radially therefrom and being twisted relative thereto to establish locking edges displaced axially from at least one surface of the body portion, the method comprising the steps of forming a blank having a body with radially projecting portions corresponding to the teeth of the finished lock washer by severing the blank from the sheet of material around the entire outer periphery of the blank, retaining the formed blank within the sheet by frictional engagement of at least a portion of the severed periphery of the blank with the sheet material, subsequently twisting the radially projecting portions while the blank is retained in the sheet by the frictional engagement to establish the requisite locking edges, and removing the body with the twisted teeth from the sheet. The invention further contemplates apparatus for making toothed lock washers as described above, the apparatus comprising means for performing each of the steps set forth above. The means are located in such a manner as to foster economical utilization of manufacturing apparatus and conservation of sheet material stock.

The invention will be more fully understood and further objects and advantages thereof will be made apparent in the following detailed description of an embodiment of the invention illustrated in the drawings, it being understood that changes in the structure and details of the invention may be made without departing from its spirit or the scope thereof.
ment therewith while a stripper plate 41 is carried for resilient movement relative to the tool carrier 40, the stripper plate 41 being engaged with the tool carrier by means of locator pins 42 engaging complementary bushings 44. A lower tool carrier 46 is likewise fixed to the lower platen. The upper platen 32 is viewed from below so as to illustrate the various operating tools carried by the tool carrier 46 while the lower platen 34 is viewed from above so as to show the various stationary tools which are fixed in tool carrier 46 and are complementary to the reciprocating tools carried by the upper platen. The movable tools carried by the upper platen are duplicated to provide three separate series of tools, each series being capable of producing a lock washer 10 in strip 20 as the strip progresses through the die set. The reasons for providing three independent series of tools will be discussed later. For the purpose of the present discussion one such series will be described in detail and it is understood that the remaining series operate in a similar manner.

The three series of operating tools carried by the upper platen comprises a piercing punch 50, a blanking punch 52, an anvil 54, a forming punch 56, a push rod 58, and a cut-off blade 59, each fixed in the upper tool carrier 46 for reciprocating movement with the tool carrier 40. The tools 50, 52, 54, 56, 58, and 59 is located along a longitudinal line A corresponding with a longitudinal line AA in strip 20. Lower platen 34, which is normally stationary, likewise carries three independent series of tools in the lower tool carrier 44, each of which series is complementary to a like series in the upper relatively movable platen. Thus, the tools of the first series held in the lower tool carrier 46 of the lower platen comprise a die 60 for cooperating with piercing punch 50, a blanking die 62 including a concentric, resiliently supported, stop member 63 for cooperating with blanking punch 52, an anvil 64 complementary to anvil 54, a forming die 66 complementary to forming punch 56 and a stationary cut-off blade 69 for cooperating with reciprocating blade 59. The lower tool carrier and platen also include a first chute 70 below piercing punch 50 and a second chute 72 below push rod 58.

As best seen in FIGURE 5 viewed in connection with FIGURES 3 and 7 through 11, lock washers 10 are fabricated by the following procedure: Strip 20 is advanced from left to right, as viewed in each of these figures in predetermined increments so as to position any given tool above the strip, as indicated by lateral dashed line L in FIGURE 3, between one of the complementary sets of tools in a particular series. The strip is first pierced by piercing punch 50 to establish an aperture 74 which will correspond to the central aperture 76 of the strip. The strip is then indexed to position anvil 54 and reciprocating punch 52 so as to blank a portion of the strip 20, as shown in FIGURE 3, and the blanked body 76 is completely severed along its entire periphery from the strip 20 but is retained in the strip solely by the frictional engagement between the periphery of the blanked body and the surrounding sheet. The die set is again opened and the strip is again advanced to position location L between forming punch 56 and forming die 66. The forming punch 56 is provided with angled faces 68 and the forming die 66 has complementary angled faces 86 such that reciprocation of the upper platen will bring the complementary punch 56 and die 66 into engagement with the blanked body 76 and the angled faces 84 and 86 will twist the blanked body 76 through a desired angle to establish teeth 14 with locking edges 15 displaced axially from the surfaces of body portion 12. It is noted that each tooth is formed accurately, and all of the teeth are uniformly twisted since none of the teeth is attached to the strip other than by frictional engagement of the periphery of the blanked body 76 with the surrounding sheet material. Furthermore, the sharp-cornered edges 18 originally formed by the blanking punch and die are preserved since the cooperating facing of the forming punch and die will twist the sheet material lying between radially projecting portion 78, as illustrated in FIGURE 4, and not the projections 78 themselves and will not tend to wipe the sharp-cornered edges against surrounding sheet material which might otherwise remain stationary during twisting. The die set is again opened and the strip is indexed to place location L below the push rod 58 and the upper platen is reciprocated thereby bringing the push rod into contact with the blanked body 76 which now has twisted teeth and is actually a completed lock washer so as to push the blanked body with the twisted teeth out of engagement with the strip whereupon a finished toothed lock washer 19 is delivered through chute 72.

In the manufacture of toothed lock washers of generally standard sizes from commonly available sheet materials, the relative proportions of the washer and the material thickness are such that the operation of the blanking punch and the blanked dies as described above will actually cut a blank completely through the strip so that the blanked body 76 is severed from the surrounding sheet material completely around the entire periphery of the body 76. The pushing of the body back into the strip by the operation of inserts 54 and 64 then serves to increase the frictional force and grip the body within the strip for transport throughout the remaining steps of the lock washer forming procedure. For example, in the fabrication of a typical toothed lock washer of spring steel for engagement with a threaded bolt having a nominal diameter of a quarter of an inch, the sheet material would have a thickness of about 0.025 inch and the blanking punch would displace the blanked body about two-thirds of the way out of the sheet, or about 0.017 inch downwardly, as seen in FIGURE 5, and the blanked body would be completely severed from the surrounding sheet around the entire periphery thereof, but would be held within the sheet by frictional engagement with sufficient force to be transported and placed between the anvils at the next station in the apparatus where the blanked body is pushed back into the sheet so as to establish an even greater frictional force and grip the body within the strip for transport throughout the subsequent twisting operation of the forming punch and die. However, it is conceivable that under certain conditions the dimensions and materials may be such that the partial blanking performed by the blanking punch and die would form the blanked body completely around the entire outer periphery thereof but would not necessarily sever the blanked body completely from the surrounding sheet material around the entire periphery thereof. In such instances, the severance will be completed by pushing the blanked body back into the sheet at the next subsequent station so that a completely
severed blanked body is presented to the forming punch and die.

It is common knowledge that the economical operation of presses of the type which would accept and operate the set 39 is fostered by providing more than one series of tools with all series operating simultaneously so that for each operating stroke of the press, a plurality of lock washers can be being fabricated. It is also well known that the several series of tools can be arranged so that a saving is realized in sheet material stock by seeing that the blanked bodies are placed close enough together in the strip to make use of that material which might ordinarily become waste. However, in fabricating devices such as lock washers 10, it has been found that the simultaneous operation of several series of tools will place such a great deal of stress upon the strip of material as it passes through the apparatus that distortion will occur in the form of unwanted stretching of the sheet both laterally and longitudinally. Since the amount of such stretching is relatively small, the lateral stretching can be compensated for rather easily or even completely disregarded. However, the longitudinal stretching becomes critical since each small amount of elongation in the strip along the line of the travel of the strip imparted by the operation of a particular tool is cumulative to those amounts already imparted as the strip travels through the apparatus and the overall elongation can become so great as to cause problems in registering a particular blank with the several tool stations through which it must pass. The method and apparatus of the instant invention overcomes the problem of elongation of the strip while still providing several simultaneously operating series of tools in a manner which will now be explained.

Returning now to FIGURES 3 and 4, the additional two series of tools in the upper and lower tool holders have been identified with reference characters corresponding to the already described first series, the second series being comprised of a piercing punch 150, a blanking punch 152, an anvil 154, a forming punch 156, and a push rod 158 each fixed in the upper tool carrier 40 and lying along line B which is aligned with a longitudinal line BB in the strip 26, tools 150, 152, 154, and 156 each having complementary tools in the form of a die 160 for cooperating with piercing punch 150, a blanking die 162, a forming die 156, and a pushing back die 164 for cooperating with punching blanking punch 152, an anvil 154 for forming operations, and a forming die 166 complementary to forming punch 156, all carried in lower tool carrier 46 which also has third and fourth chutes 170 and 172 passing therethrough, while the third series of tools is comprised of like tools 250, 252, 254, 256, and 258 in the upper tool carrier and lying along line C which is aligned with a longitudinal line CC in strip 20, the above tools of series C having complementary tools 260, 262, 263, 264 and 266 in the lower tool carrier with fifth and sixth chutes 270 and 272 passing there through. Thus, the first series will be referred to as the A series while the second and third series will be referred to as the B and C series, respectively.

Strip 20 enters the apparatus as a solid, elongated sheet and, as described above, the strip is advanced from left to right as viewed in the figures. By following any one given longitudinal location in the strip, such as that denoted by lateral dashed line L as the strip progresses through the apparatus, it can be seen that the sequence of operations set forth in the method will first be performed simultaneously along the outermost lines AA and BB by the tools of series A and B which are longitudinally spaced along outermost lines A and B in the apparatus. Thus, the strip will first be pierced simultaneously along both lines A and B at the station marked "pierce" (see FIGURE 3), then partially blanked out of the sheet at the station marked "punch." Then the blank is pushed back into the sheet at the station marked "push-back," and subsequently portions of the blank are twisted at the station marked "twist" and pushed back into the sheet at the station marked "lock washer." Since the lock washer 10 is still retained in the strip after completion at the twisting station, it is carried to the removal station where the completed washer is pushed out of the strip by the push rod 58. Lines AA and BB are laterally spaced apart to provide enough material therebetween for the simultaneous fabrication of a third lock washer 10 along inner line CC by the operation of the tools of series C. However, the series C tools are staggered longitudinally downstream of the series A and B tools so that they do not begin to operate upon the strip 20 until after the completion of the lock washers in the outermost lines AA and BB. Thus, piercing punch 250 is located beyond forming punches 56 and 156 in the direction of travel of strip 20 and the solid material which exists between the outermost lines during fabrication of the lock washers therein serves as an unbroken web to reinforce the strip and preclude unwanted elongation or longitudinal strain in the strip which might otherwise result from the stresses arising out of the simultaneous operation of the tools of series A and B. Since only one series of tools operates along the inner central line CC, the stress placed upon the strip is insignificant from the standpoint of strain produced, especially in view of the reinforcement provided by the remainder of the strip. Waste of stock is minimized by the nesting of the lock washers formed along the inner line between the perforations remaining in the sheet after the lock washers already formed along the outer lines have been removed. It will be apparent that the relative location of the three illustrated tool series could be repeated to provide any desired odd number of laterally spaced longitudinal lines along which lock washers will be fabricated by a series of tools along those lines and the station sequence would be the same; that is, the outermost lines would be operated upon to complete lock washers therein prior to the commencement of operations upon the innermost lines in such sequence that a reinforcing web is always provided between lines which are being operated upon simultaneously at any given longitudinal location in the strip of sheet material. Finally, as the strip 20 leaves the apparatus, the strip is cut by blades 59 and 69 at the station marked "cut-off" into relatively short pieces of scrap for ready disposal.

It is to be understood that the above detailed description of an embodiment of the invention is presented by way of example only. Various details of steps, design and construction may be modified without departing from the true spirit and scope of the invention as set forth in the appended claims.

What is claimed is:

1. A method of making toothed lock washers from sheet material, each washer having a generally annular body portion with teeth projecting radially from said body portion and being spaced circumferentially from one another and twisted relative thereto to establish locking edges displaced axially from at least one surface of the body portion, said method comprising the steps of:

a. at least partially blanking a body with radially projecting portions spaced circumferentially from one another and corresponding to said teeth in the sheet such that the blanked body is completely formed around the entire outer periphery thereof and is not displaced completely out of said sheet;
b. pushing said blanked body back into said sheet such that the body is retained in the sheet solely by frictional engagement of the periphery of the body with the sheet material;
c. twisting said radially projecting portions of the blanked body and the sheet material lying between the radially projecting portions while the blanked body...
is retained in the sheet by said frictional engagement to establish said locking edges; and removing said body with the twisted teeth from the sheet.

2. A method of making toothed lock washers from sheet material, each washer having a generally annular body portion with teeth projecting radially from said body portion and being spaced circumferentially from one another and twisted relative thereto to establish locking edges displaced axially from at least one surface of the body portion, said method comprising the steps of: forming a blank having a body with radially projecting portions spaced circumferentially from one another and corresponding to said teeth by severing said blank from the sheet of material around the entire outer periphery of said blank; retaining said blank within the sheet by frictional engagement of at least a portion of the severed periphery of the blank with the sheet material; twisting radially projecting portions of the blanked body and the sheet material lying between the radially projecting portions while the blank is retained in the sheet by said frictional engagement to establish said locking edges; and removing said body with the twisted teeth from the sheet.

3. The method of claim 2 wherein the sheet material is in the form of an elongated planar continuous longitudinal strip of material and said forming step includes punching said blank and displacing the punched blank out of the plane of the strip until the blank is severed from the sheet around the entire outer periphery of the blank; and said retaining step includes pushing said severed blank back into the strip for establishing sufficient frictional engagement of the severed periphery with the strip to retain the blank for the twisting step.

4. The method of claim 3 wherein the sheet material is in the form of an elongated planar continuous longitudinal strip of material, the lock washer includes an annular body portion with a central aperture and the teeth of the lock washer project radially outwardly from the outer periphery of the body, and said forming step includes piercing said strip to establish said central aperture and punching said blank and displacing the punched blank out of the plane of the strip until the blank is severed from the strip around the entire outer periphery of the blank including the outwardly projecting portions, but not removed from engagement with the strip; and said retaining step includes pushing said severed blank back into the strip for establishing sufficient frictional engagement of the severed periphery with the strip to retain the blank for the twisting step; said twisting step serving to complete the lock washer.

5. The method of claim 4 wherein the strip is advanced longitudinally and the steps are performed sequentially at spaced positions along a longitudinal line in the strip to fabricate lock washers in said line, said strip having an odd number of such lines spaced laterally across the strip with corresponding steps in each line being performed simultaneously, each step performed along the outermost of said lines at any given longitudinal location along the strip being completed prior to the commencement of the fabrication of the lock washers in the innermost of said lines whereby the outermost of said lines are connected by an unbroken, relatively strong web of strip material at least at the lock washers in the outermost of said lines at said given location in the strip.

6. The method of claim 5 wherein the steps are sequentially performed along each of at least three longitudinal lines with like steps being performed simultaneously along the outer two of said three lines at any given longitudinal location along the strip and each such steps being completed prior to the commencement of a corresponding step performed along the inner of the three lines at said given location in the strip such that the lock washers are completed in the outer two lines prior to the commencement of the fabrication of the lock washers in the inner third line whereby the outer two lines are connected by an unbroken, relatively strong web of material at least until completion of the lock washers in the outer two lines at said given location in the strip.

7. The method of claim 6 wherein the twisting step is completed along each of the outer two of said three lines at said given location in the strip prior to the commencement of the piercing step performed along the inner third line at said given location in the strip.

8. Apparatus for making toothed lock washers from sheet material, each washer having a generally annular body portion with teeth projecting radially from said body portion and being spaced circumferentially from one another and twisted relative thereto to establish locking edges displaced axially from at least one surface of the body, said apparatus comprising: opposed platens arranged for relative reciprocating motion; means associated with said platens for at least partially blanking a body with radially projecting portions spaced circumferentially from one another and corresponding to said teeth in the sheet such that the blanked body is completely formed around the entire outer periphery thereof and is not displaced completely out of said sheet; means associated with said platens for forming said blanked body back into said sheet such that the body is retained in the sheet solely by frictional engagement of the periphery of the body with the sheet material; means associated with said platens for twisting said radially projecting portions of the blanked body and the sheet material between the radially projecting portions while the blanked body is retained in the sheet by said frictional engagement to establish said locking edges; and means associated with said platens for removing said body with the twisted teeth from the sheet.

9. Apparatus for making toothed lock washers from sheet material, each washer having a generally annular body portion with teeth projecting radially from said body portion and being spaced circumferentially from one another and twisted relative thereto to establish locking edges displaced axially from at least one surface of the body portion, said apparatus comprising: opposed platens arranged for relative reciprocating motion; means associated with said platens for forming a blank having a body with radially projecting portions spaced circumferentially from one another and corresponding to said teeth by severing said blank from the sheet of material around the entire outer periphery of said blank; means associated with said platens for locating said blank relative to said sheet for retention of said blank within the sheet by frictional engagement of at least a portion of the severed periphery of the blank with the sheet material; means associated with said platens for twisting said radially projecting portions of the blanked body and the sheet material between the radially projecting portions while the blank is retained in the sheet by said frictional engagement to establish said locking edges; and means associated with said platens for removing said body with the twisted teeth from the sheet.

10. The apparatus of claim 9 wherein the sheet material
is in the form of an elongated planar continuous longitudinal strip of material and said forming means includes a blanking punch for punching said blank out of the plane of the strip until the blank is severed from the sheet around the entire outer periphery of the blank; and said means for locating said blank relative to said sheet for retention of said blank within the sheet include anvill means for pushing said severed blank back into said strip until said blank is sufficiently frictionally engaged with the strip along the severed periphery to retain the blank within the strip for presentation to said twisting means.

11. The apparatus of claim 10 wherein the sheet material is in the form of an elongated planar continuous longitudinal strip of material, the lock washer includes an annular body portion with a central aperture and the teeth of the lock washer project radially outwardly from the outer periphery of the body, and said forming means includes a piercing punch for piercing said strip to establish said central aperture and a blanking punch for punching said blank and displacing the punched blank out of the plane of the strip until the blank is severed from the strip around the entire outer periphery of the blank including the outwardly projecting portions, but not removed from engagement with the strip; and said means for locating said blank relative to said sheet for retention of said blank include anvill means for pushing said several blank back into said strip until said blank is sufficiently frictionally engaged with the strip along the severed periphery to retain the blank within the strip for presentation to said twisting means wherein the lock washer is completed.

12. The apparatus of claim 11 wherein the strip is advanced longitudinally through the apparatus and the individual means are located in spaced positions along a longitudinal line corresponding with a longitudinal line in the strip to fabricate lock washers in said line in the strip, said apparatus having an odd number of such lines of spaced means spaced laterally across the strip with corresponding means in each line being capable of simultaneous operation, the spaced means along the innermost of said lines of spaced means being staggered longitudinally relative to corresponding spaced means in the outermost of said lines such that the operation of any means upon the strip along the outermost of said lines at any given longitudinal location in the strip is completed prior to the commencement of the operation of corresponding means along the innermost of said lines at the same given location in the strip and the lock washers are completed in the outermost of the lines in the strip prior to the commencement of the fabrication of the lock washers in the innermost of the lines in the strip whereby the outermost of said lines in the strip are connected by an unbroken, relatively strong web of material until completion of the lock washers in the outermost of said lines at said given longitudinal location in the strip.

13. The apparatus of claim 12 including means for simultaneously operating all of said longitudinally spaced means, said longitudinally spaced means being located at spaced positions along one of at least three longitudinal lines corresponding with at least three longitudinal lines in said strip, said operating means operating said spaced means along the outer two of said three lines simultaneously at any given longitudinal location along the strip such that the operation of any one means in each of said outer two lines is completed prior to the commencement of the operation of corresponding means in the inner of said three lines at said given location in the strip such that the lock washers are completed in the outer two lines in the strip prior to the commencement of the fabrication of the lock washers in the inner third line in the strip whereby the outer lines in the strip are connected by an unbroken relatively strong web of material until completion of the lock washers in the outer two lines at said given location in the strip.

14. The apparatus of claim 13 wherein the piercing punch of the inner of the three lines of spaced means is located longitudinally beyond the twisting means of each of the outer two of said lines of spaced means in the direction of travel of the strip.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,381,514 May 7, 1968

Fred Schmidt et al.

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 27, "fabricated" should read -- fabricating --.
Column 2, line 68, "platen" should read -- platten --.
Column 5, line 71, "outermost" should read -- outermost --.
Column 8, line 34, "mean" should read -- means --.
Column 9, line 30, "several" should read -- severed --.

Signed and sealed this 14th day of October 1969.

(SEAL)
Attest:

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Commissioner of Patents