Aug. 30, 1955 O. J. POUPITCH 2,716,247

HELICALLY COILED WASHER STRIP AND METHOD OF AND APPARATUS FOR PRODUCING SAME

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Fig. 1.

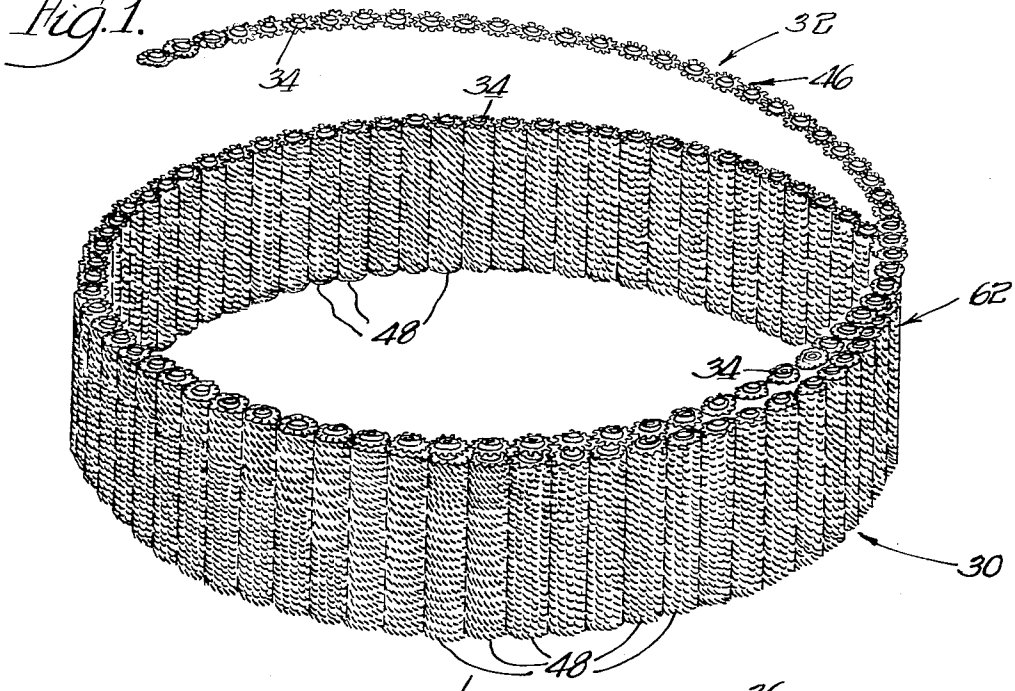


Fig. 2.

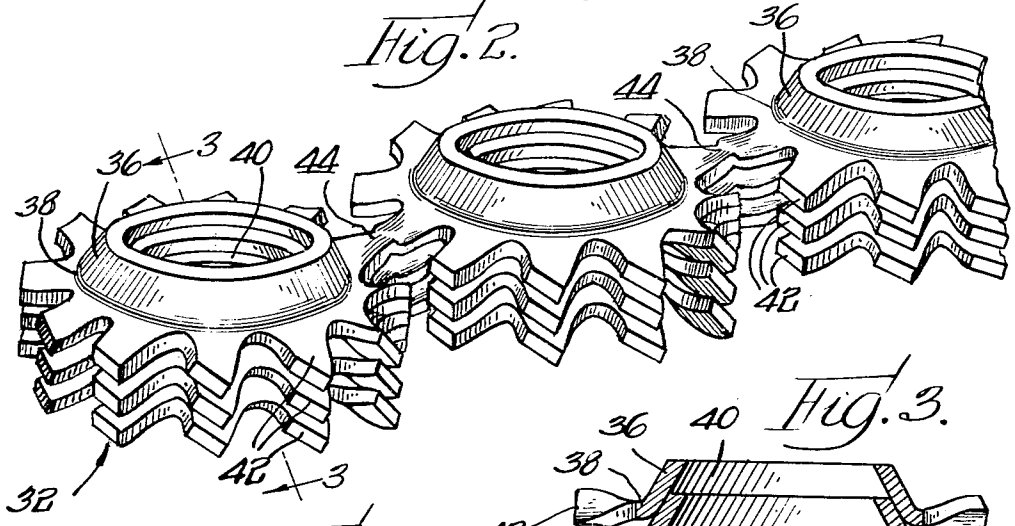


Fig. 3.

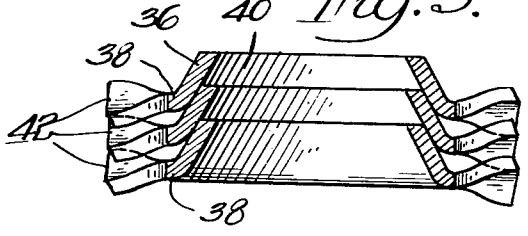
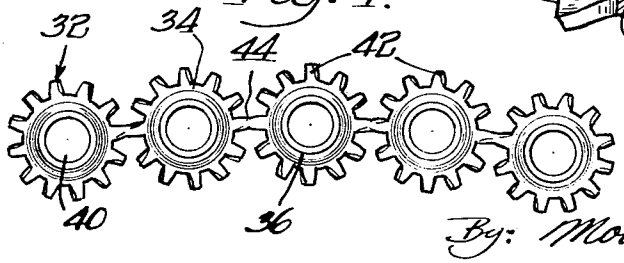


Fig. 4.



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HELICALLY COILED WASHER STRIP AND METHOD OF AND APPARATUS FOR PRODUCING SAME

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Fig. 5.

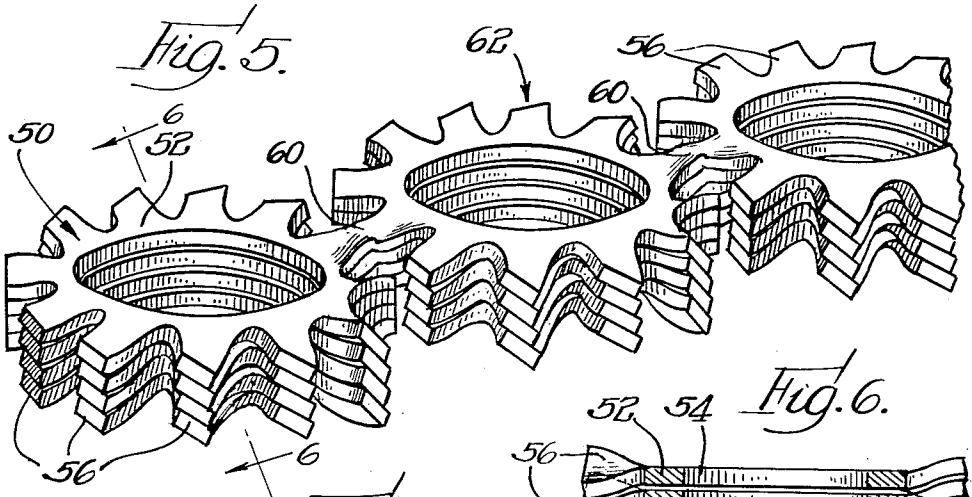


Fig. 6.

Fig. 7.

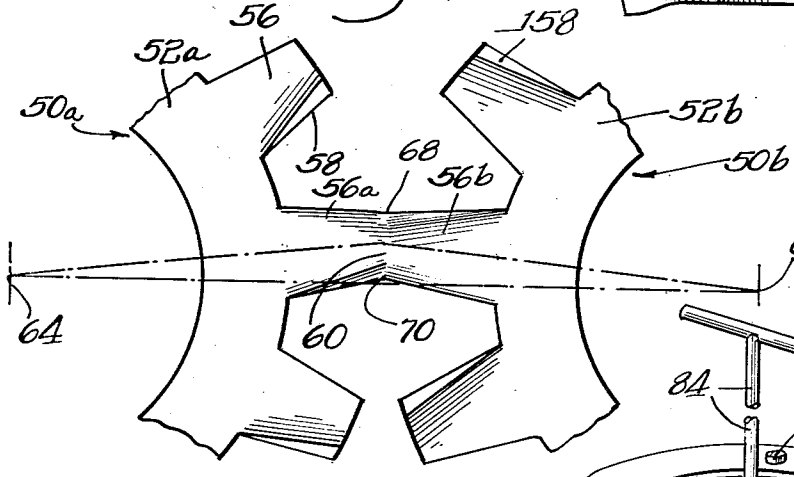


Fig. 9.

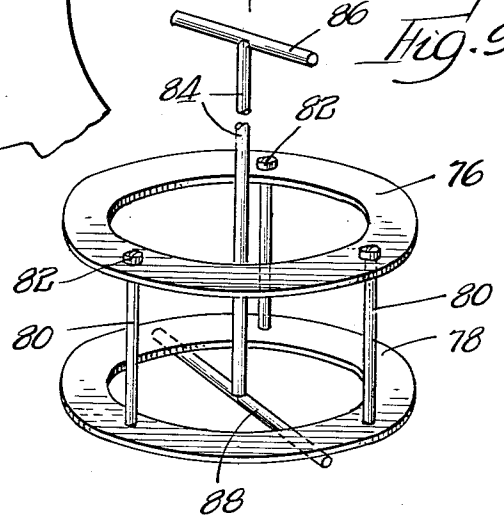
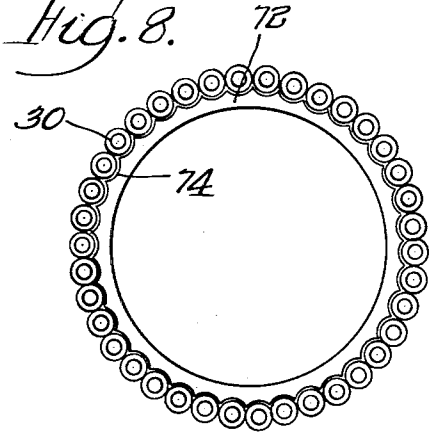


Fig. 8.



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HELICALLY COILED WASHER STRIP AND METHOD OF AND APPARATUS FOR PRODUCING SAME

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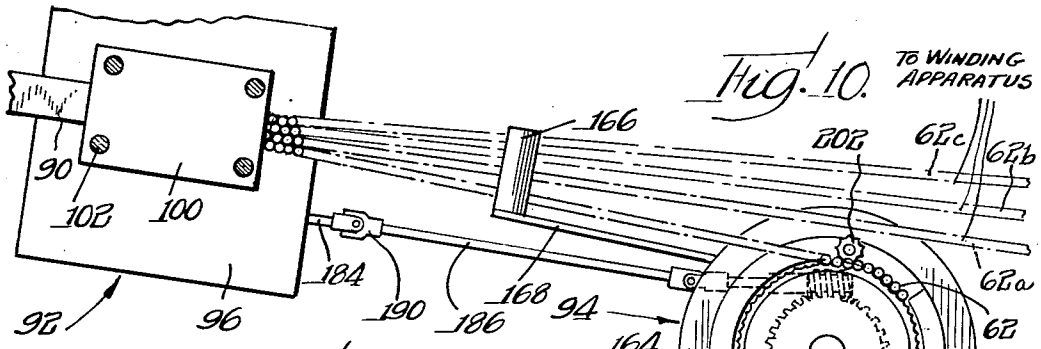


Fig. 10.

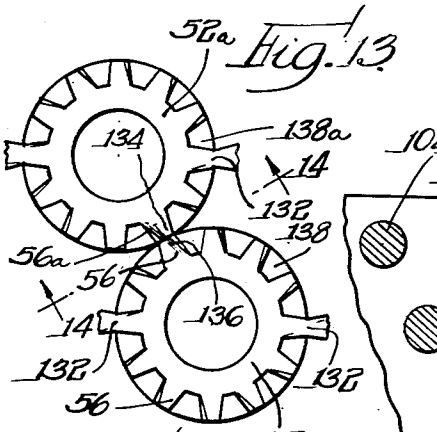


Fig. 13.

Fig. 14.

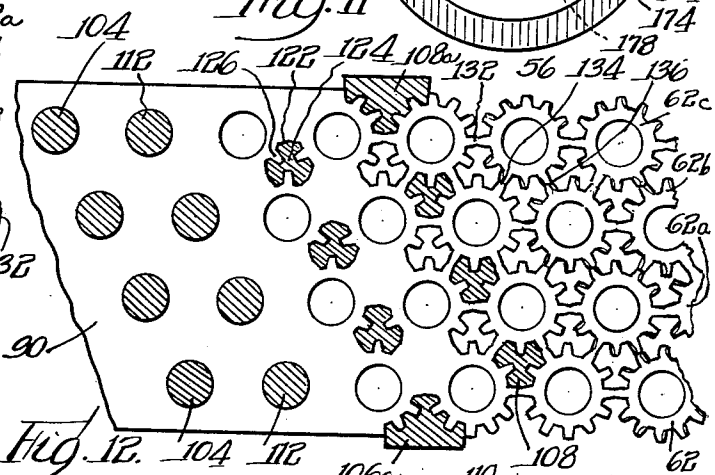


Fig. 11.

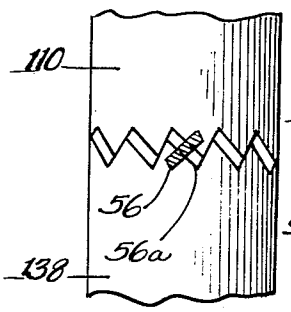


Fig. 15.

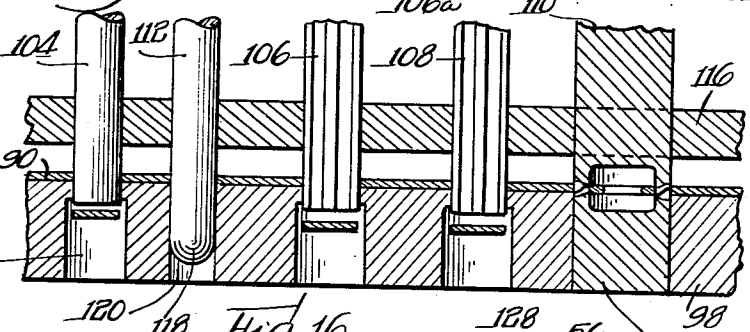


Fig. 12.

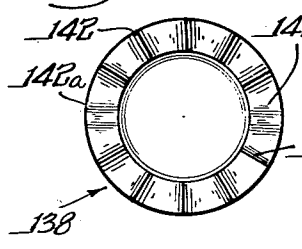
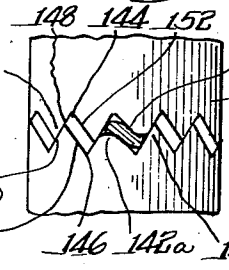


Fig. 16.



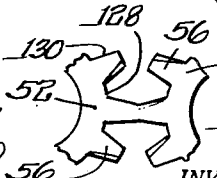


Fig. 17.

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HELICALLY COILED WASHER STRIP AND METHOD OF AND APPARATUS FOR PRODUCING SAME

Filed Aug. 3, 1950 4 Sheets-Sheet 4

Fig. 18.

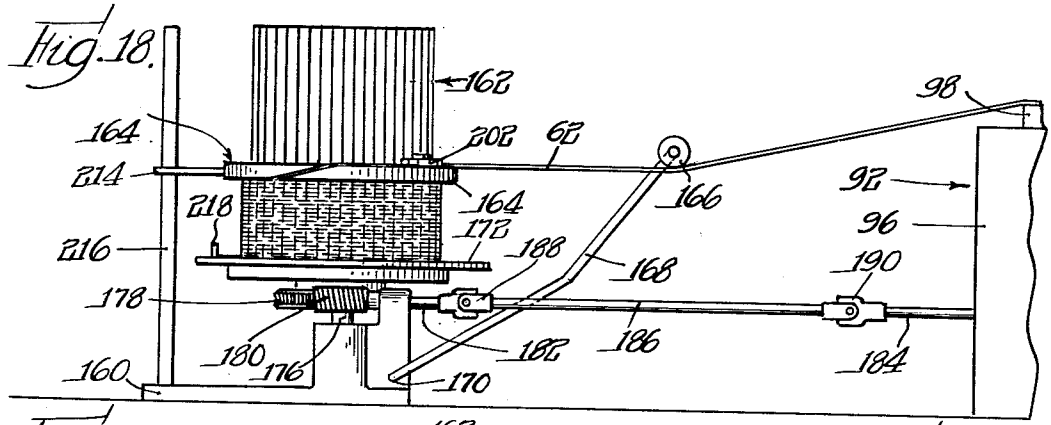


Fig. 19.

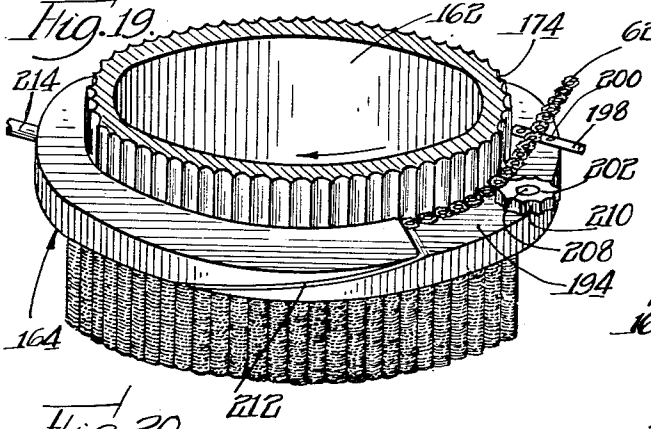


Fig. 21.

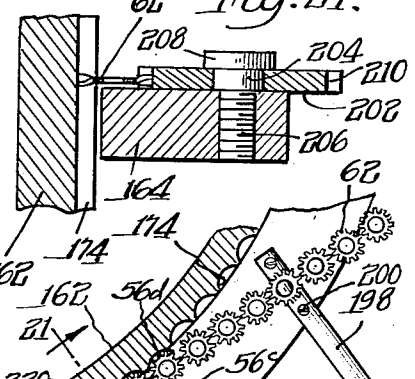


Fig. 20.

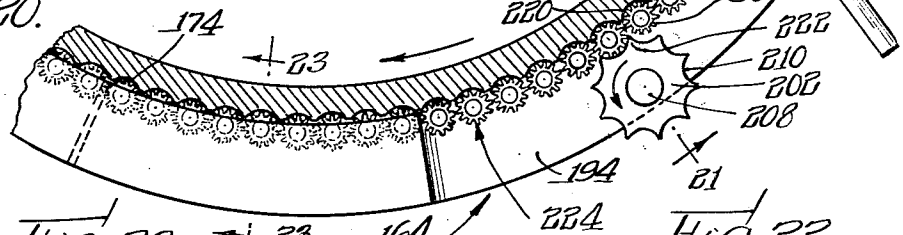


Fig. 23.

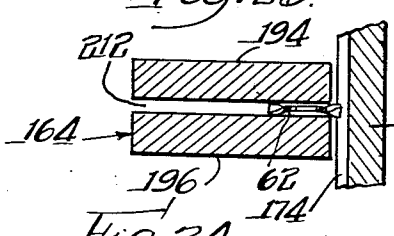


Fig. 22.

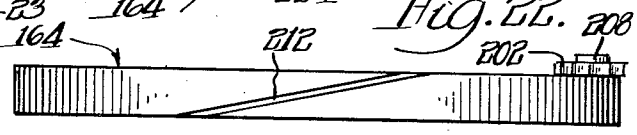


Fig. 24.

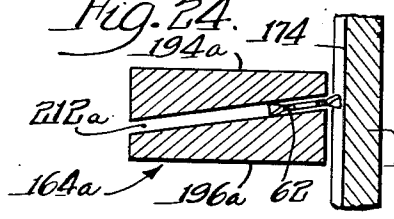
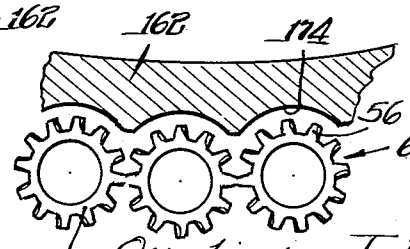


Fig. 25.



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2,716,247

HELICALLY COILED WASHER STRIP AND METHOD OF AND APPARATUS FOR PRODUCING SAME

Ougljesa Jules Poupitch, Chicago, Ill., assignor to Illinois Tool Works, Chicago, Ill., a corporation of Illinois

Application August 3, 1950, Serial No. 177,535

25 Claims. (Cl. 10—86)

This invention relates to washer strips and more particularly to helically coiled washer strips and the method and apparatus for forming the same.

There is shown and described in my Patent No. 2,352,118, issued June 20, 1944, a method of forming a strip of integrally attached washers and a spirally wound roll of washers formed from the described washer strip. In spirally wound rolls of the type disclosed in the above patent, each successive convolution or turn of the roll is slightly greater in diameter than the preceding convolution or turn, and as a consequence there is no possibility for corresponding washers in adjacent convolutions or turns to coincide or nest.

One consequence of the structure of a spirally wound roll described above is that the roll is unstable, i. e. the roll tends to unwind and the inner convolutions tend to be displaced laterally from the roll unless the roll is suitably supported. In addition, when the washers in the strip have projections formed thereon such as locking teeth or frusto-conical body portions, these projecting parts of corresponding washers in adjacent convolutions tend to become entangled. This entanglement seriously interferes with the unwinding of the roll, and when the roll is used in a high speed machine, there is a tendency of the washers to break apart at the points of joining. If the strip is broken during feeding to the machine, the machine must be shut down, the washers disentangled and the strip from the roll again manually fed into operative position.

Non-registration of washers in adjacent convolutions and particularly the non-registration of teeth, deformations on the body portion of the washer, and other projections cause adjacent convolutions to be held spaced apart and hence there is produced a loose roll which is relatively bulky for a given number of washers contained therein.

Some difficulty has heretofore been experienced in the heat treatment and hardening of washers in a spirally wound roll. Since corresponding washers in adjacent convolutions do not register or align, there are no unimpeded fluid passages through the body of the roll which will admit the heating and hardening medium. In the case of toothed lock washers, certain of the teeth in the inner convolutions of a spirally wound roll, cannot be reached by the treating medium and consequently improper heat treatment of these teeth is obtained. If the teeth of a lock washer are not hardened, no locking action is obtained since the teeth can be readily twisted to a non-locking position.

The present invention overcomes the above disadvantages of a spirally wound roll of washers by providing a helically wound roll or coil of washers and a method and apparatus for forming such a roll or coil.

It is accordingly an important object of the present invention to provide, as a new article of manufacture, a helically wound strip of washers, and more particularly, a helically and edgewise wound strip of integrally attached washers.

It is another object of the invention to provide a helically wound roll of the type set forth in which the washers in the stacked convolutions of the roll register and are aligned, and more specifically, to provide a roll in which the washers of all the convolutions are aligned in a direction substantially parallel to the axis of the roll.

Yet another object of the invention is to provide a helically wound roll of lock washers having portions projecting out of the plane of the body of the lock washers, the corresponding parts of washers in adjacent convolutions nesting with each other.

Still another object is to provide a helically wound washer roll which is compact and stable, and which can be easily and effectively heat treated and hardened.

Still another object of the invention is to provide a helically wound roll of lock washers having continuous openings and channels formed therein.

A further object of the invention is to provide a method and apparatus for forming a helically wound roll of washers from a strip of washer stock.

A still further object of the invention is to provide a method and apparatus for forming a plurality of single strips from a multiple washer strip during the formation of the individual washers.

Other and further objects and advantages of the invention will be apparent from the following description when taken in connection with the accompanying drawings. In the drawings wherein like reference numerals have been used to indicate like parts throughout:

Figure 1 is a perspective view of a helically wound roll of washers made in accordance with and embodying the principles of the present invention, the topmost convolution of the roll being shown in an upraised position for illustrative purposes;

Figure 2 is an enlarged, fragmentary, perspective view of the roll shown in Figure 1 and illustrates the manner in which the corresponding washers of the convolutions fit and nest one within the other;

Figure 3 is a fragmentary view in vertical section taken along the line **3—3** of Figure 2;

Figure 4 is a plan view of a portion of a convolution of the helically coiled roll of washers shown in Figure 1;

Figure 5 is a fragmentary, perspective view, similar to Figure 2, showing another form of washer coiled helically and showing the manner in which the teeth of washers in adjacent convolutions of the roll fit and nest with each other;

Figure 6 is a fragmentary view in vertical section taken along the line **6—6** of Figure 5;

Figure 7 is a further enlarged, fragmentary view illustrating the junction between adjacent washers in the washer strip shown in Figure 5 and particularly illustrating the manner in which the junction between the washers is bent to form a helical convolution;

Figure 8 is a plan view showing the manner in which a helically coiled strip of washers is packaged for storage and shipment;

Figure 9 is a perspective view of a second form of support for a coiled strip made in accordance with the present invention;

Figure 10 is a fragmentary plan view of an apparatus for forming a plurality of washer strips in a machine for helically coiling the washer strips;

Figure 11 is a plan view, partly in section, and diagrammatically illustrating a method and apparatus for forming a multiple strip of washers;

Figure 12 is a fragmentary view in vertical section, illustrating diagrammatically the apparatus shown in Figures 10 and 11;

Figure 13 is a fragmentary enlarged view of the lower

members of adjacent tooth forming dies with a washer strip positioned thereon, and particularly illustrating the manner in which the interconnecting teeth of adjacent washers may be severed;

Figure 14 is a view in vertical section taken along the line **14—14** of Figure 13, the upper member of the die being shown in operative position;

Figure 15 is a plan view of the tooth forming surface of one of the dies shown in Figure 13;

Figure 16 is a view similar to Figure 14 and illustrating the manner in which the teeth joining adjacent washers in the finished washer strip are formed;

Figure 17 is an enlarged view showing the manner in which adjacent washers in a straight washer strip are joined by tooth portions;

Figure 18 is a side view in elevation of the coiling mechanism shown in Figure 10;

Figure 19 is a fragmentary, enlarged perspective view of the winding mandrel shown in Figure 18;

Figure 20 is a further enlarged partial plan view partly in cross section of the winding mandrel and slotted ring shown in Figure 19;

Figure 21 is a fragmentary, enlarged view in vertical section taken along the line **21—21** thereof;

Figure 22 is an elevation view of the slotted ring shown in Figures 18–20;

Figure 23 is an enlarged vertical cross sectional view taken along the line **23—23** of Figure 20;

Figure 24 is a vertical cross sectional view similar to Figure 23 but showing a modified form of guide ring; and

Figure 25 is a fragmentary enlarged view illustrating that the washer roll is normally spaced away from the winding drum after the roll has been formed.

Referring now to the drawings and more particularly to Figure 1, there is shown an edgewise and helically wound roll or coil **30** made in accordance with and embodying the principles of the present invention. Roll **30** is formed from a strip **32** of integrally attached lock washers **34**, the strip being best illustrated in Figure 4. The washer strip **32** may be made of any suitable material, a preferred material being metal.

As may be best seen in Figure 2, each washer **34** comprises an annular frusto-conoidal body **36** at the base of which is formed a laterally and outwardly extending portion **38** which lies in a plane substantially normal to the axis of the washer. The annular body **36** has an aperture **40** in the center thereof which is adapted to receive a cooperating element as is understood in the art. Integrally attached to portion **38** is a plurality of radially and outwardly extending teeth **42** having their root portions lying in the plane of and integrally attached to portion **38**. Each tooth has the radially extending edges thereof twisted out of the plane of portion **38**, whereby to provide biting edges which give a locking action when the washers are applied between a pair of work surfaces. Teeth of adjacent washers **36** are integrally connected as at **44** whereby to join the adjacent washers **34** and thereby form the washer strip **32**.

The washer strip **32** is bent or curved laterally substantially in its plane to form a plurality of convolutions or turns **46** which are stacked or placed one above another to form the coil **30**. Each convolution **46** is coiled edgewise so that the inner edge is disposed towards the axis of the coil **30**. Each convolution **46** has the same diameter and therefore the diameter of coil **30** is constant throughout the length thereof.

As shown in Figure 3, the inner diameter of portion **38** is slightly greater than the outer diameter of the upper edge of body **36** whereby the upper edge of body **36** nests within the portion **38** of an adjacent washer. All the teeth **42** of each washer **34** are bent or deformed in the same manner, and therefore the teeth of superimposed washers are complementarily shaped. It will be seen that the bodies **36** and teeth **42** of superimposed washers **34** nest within each other and corresponding portions thereof

interlock when the washers **34** are aligned and superimposed.

Each and every washer in coil **30** is aligned with and nests within the corresponding washers in adjacent convolutions. These aligned washers in adjacent convolutions form rows **48** whose axes extend substantially parallel to the axis of coil **30**, the number of rows **48** in coil **30** corresponding to the number of washers **34** in each convolution **46**. The apertures **40** in the washers aligned in rows **48** form unimpeded channels or passages which extend throughout the length of coil **30**. The other corresponding parts of the washers in rows **48**, including the frusto-conical bodies **36**, portions **38**, and the teeth **42** are similarly aligned. The parts of the washers which are disposed out of the plane of portion **38** nest and interlock in the manner described above and best illustrated in Figures 2 and 3. This interlocking action of corresponding parts of washers in rows **48** effectively prevents lateral displacement of convolutions **46** and thereby gives great structural stability to the coil **30**.

The provision of openings and channels in coil **30** is particularly advantageous during heat treatment and hardening in that the treating medium can pass through coil **30** and come into contact with each and every portion of each washer therein. More specifically, the treating medium can pass through the aligned apertures **40** of washers disposed in the axially extending rows **48** and through the channels formed by aligned interdental spaces of washers in row **48**. The intimate contact between the treating medium and all parts of each washer in coil **30** insures proper treatment of each washer.

The compact nesting of the washers in rows **48** produces a coil **30** having a minimum length for a given number of convolutions **46** and for a given number of washers contained therein. No entanglement between parts of adjacent washers is obtained when the washers are aligned and nested as shown in coil **30**. The convolutions **46** of coil **30** are readily separated in a direction axially of coil **30** by simply lifting the convolutions **46** axially from each other. This unwinding of coil **30** is particularly important and advantageous when washers of coil **30** are to be used as an input to a high speed machine. As has been explained before, the continuity of the coil **30** may be broken if washers of adjacent convolutions become entangled. The present invention completely eliminates this possibility.

There is shown in Figures 5, 6, and 7, a second form of toothed lock washers **50** which can be advantageously incorporated in an edgewise and helically wound coil such as coil **30** of Figure 1. Any suitable material of construction, such as metal, may be used as stock to fabricate washer **50**. Washer **50** comprises a generally flat annular body **52** having an aperture **54** formed in the center thereof. Integrally attached to and extending radially from body **52** is a plurality of teeth **56**, twelve teeth being shown for purposes of illustration. Each tooth **56** has the radially extending edges thereof twisted out of the plane of body **52** to form locking or biting edges **58** which engage the surfaces of work pieces associated with washer **50** whereby to provide a locking action. This twisting of the edges of the teeth **56** in conjunction with the subsequent hardening of the teeth makes the junction between the teeth relatively frangible whereby the washers can be removed from the strip by subsequent twisting and bending operations.

Certain teeth of adjacent washers **50** are joined together as at **60** to form strip **62** of integrally attached lock washers. The strip **62** is bent laterally in the plane of the strip to form helical convolutions or turns similar to convolutions **46** described above. These convolutions can be helically and edgewise wound to form a coil similar to coil **30**.

The corresponding parts of washers **50** in adjacent convolutions are aligned and nest against each other in a manner substantially analogous to that described above

with respect to washers **34**. More particularly, the bodies **52** and the teeth **56** are aligned in rows parallel to the axis of the coil. The teeth **56** interlock or nest whereby to give lateral stability to the formed coil. Alignment of bodies **52** also provides continuous channels through the coil since apertures **54** in the centers of bodies **52** will be aligned. Similarly the interdental recesses between adjacent teeth will form channels extending the length of the coil in a direction parallel to the coil's axis. As a consequence, a helically and edgewise coil formed from a strip of washers **50** can be readily heat treated and hardened and can be readily unwound.

The washer strips **32** and **62** described above are generally formed with the centers of the washers in the strip disposed in a straight line in the plane of the strip. As will be described more fully hereinafter, a straight washer strip must first be bent laterally in the plane of the strip in order to form an edgewise and helically wound coil. In the case of externally toothed washers, such as washers **34** and **50**, substantially all of the bending of the strip occurs at points **44** and **60** of strips **32** and **62** respectively, i. e., at the points of joining between the teeth of adjacent washers in the strip.

There is shown diagrammatically in Figure 7, the manner in which the bending occurs at the junction of adjacent teeth. There has been shown for the purposes of illustration a portion of the washer strip **62** comprising washers **50***a* and **50***b* but it is to be understood that a similar structure is found in washer strip **32**. The points **64** and **66** indicate respectively the centers of washers **50***a* and **50***b*. The straight line interconnecting points **64—66** represents the line along which the centers of the teeth **56***a* and **56***b* are disposed before the strip **62** is bent. After bending strip **62**, the centers of teeth **56***a*—**56***b* are displaced from the straight line interconnecting points **64—66** and this displacement produces a curvature in strip **62** laterally in the plane of strip **62**. It will be apparent that in order to bend the material interconnecting teeth **56***a* and **56***b* in the manner described above, the edge marked **68** will tend to be elongated and the edge marked **70** will tend to be compressed or shortened. The elongation of edge **68** and the compression or shortening of edge **70** ordinarily causes the washer strip **62** to be bent out of the plane thereof, i. e., the elongated edge **68** tends to be moved upwardly or to be canted. A coil formed from convolutions in which the convolutions are canted is unsatisfactory and more particularly tends to be unstable. The method and apparatus to be described hereinafter provides means for correcting this tendency of the convolutions to cant inwardly toward the center of the coil.

In Figure 8 there is shown a carrying mandrel **72** used for storing and transporting coil **30**, mandrel **72** is substantially circular in cross section and has an external diameter slightly greater than the internal diameter of coil **30**. Mandrel **72** has recesses **74** formed on the periphery thereof which extend in a direction axially with respect to coil **30** and mandrel **72**, and which have a cross section which is shaped as an arc of a circle in order to receive the inner edges of the washers in coil **30**. Mandrel **72** is preferably made of papier-mache.

An alternate structure for storing and transporting the helically and edgewise wound coil of washers is shown in Figure 9. The structure shown in Figure 9 comprises generally a pair of plates **76** and **78** which are interconnected by a plurality of rods **80**. Plates **76—78** are annular in shape and have an internal diameter slightly less than the internal diameter of a washer coil and have an external diameter slightly greater than the external diameter of an associated washer coil. The rods **80** have a diameter slightly less than the diameter of the apertures in the body of the washers, whereby the rods **80** can be passed through the channel formed by the aligned washers apertures. Plates **76—78** are provided with apertures therein to receive the ends of rods **80**, both ends of rods **80** being provided with screw threads to receive nuts **82**. The plates **76—78** are placed on either side of a coil and the rods **80** are inserted through aligned apertures of the washers of the coil. The nuts **82** are then tightened whereby to press the plates **76—78** against the top and bottom of the coil. There is also shown in Figure 9 a handle which may be used to conveniently transport the coil and its associated fixtures. The handle comprises a shank **84**, a gripping portion **86**, and a coil engaging portion **88** which fits under ring **78**.

Referring now to Figure 10, there is shown an apparatus for forming a helically and edgewise wound coil of washers from a strip of washer stock **90**. The forming and coiling mechanism comprises generally a punch press **92** and a coiling and winding mechanism **94**. The formation and coiling of a washer strip of the type shown in Figures 5 and 7 are described for purposes of illustration. The same method can be used for forming and coiling a washer strip of the type shown in Figure 4; the apparatus must be slightly modified to form the washer strip of Figure 4 by providing dies of the proper shape to extrude the frusto-conical body thereof.

Punch press **92** comprises a press bed **96** on which is mounted a lower die block **98**, see Figure 12. Mounted above press bed **96** is the usual press head (not shown) on which is mounted an upper die support block **100** which carries the forming tools. A plurality of guide posts **102** are mounted on the lower die block **98** and extend through apertures in the upper die block **100** whereby to form guiding means for die block **100**.

The strip of washer stock **90**, usually metal, is fed intermittently by any suitable and appropriate mechanism (not shown) to the die block **98**. As strip **90** passes over die block **98**, it is operated upon by a plurality of stamping dies **104**, **106**, and **108**, a set of tooth forming dies **110**, and positioning or piloting plungers **112**. The dies and plungers **104** to **112** are suitably mounted on the upper die block **100** for simultaneous actuation by the downward movement of the press head. The lower ends of stamping dies **104—106—108** and plunger **112** are received by suitable apertures in block **98**, these apertures being complementary in shape and adapted to receive and guide the lower ends of these dies and plungers.

As may be best seen in Figure 11, the washer stock **90** is of sufficient width to have formed therefrom simultaneously four washer strips **62**, **62***a*, **62***b*, and **62***c*, which are positioned side by side and extend the length of the washer stock **90**. The individual washers of each of the washers strips are aligned in a direction at an angle to the side edges of the stock **90**. Accordingly, four sets of the dies and plungers **104** to **112** are provided whereby to simultaneously form four washer strips.

As the washer stock **90** is fed to the die block **98**, the leading edge thereof first encounters the stamping dies **104**. Dies **104** are circular in cross section and cooperate with apertures in block **98** when the upper die block **100** is lowered to punch circular holes which form the opening in the center of the finished washers. The material so removed drops through an opening **114** formed in the die block **98**. When the die block **100** is raised the stamping die **104** is removed from opening **114** and a stripper plate **116** is provided to insure that the die **104** is removed from the strip stock **90** before the stock **90** is advanced.

After the upper die block has been raised and the strip stock **90** advanced, the head is again lowered and the plungers **112** enter the apertures originally formed by dies **104**. Plungers **112** comprise cylinders whose diameters are equal to the diameters of dies **104** whereby to fit in the holes formed thereby. The ends of plungers **112** are rounded as at **118** and are received

by openings **120** in die block **98**. The length of plungers **112** is slightly greater than the dies **104** to **110** whereby plungers **112** engage the strip stock **90** before the dies thereby accurately to control and determine the position of the strip with respect to the stamping dies before the dies operatively engage the strip stock **90**.

The dies **106** may be referred to as clover-leaf stamping dies since their cross section is shaped similar to clover leaves. More particularly, each die **106** is is formed to provide 3 wings **122** radiating from a central core **124** and are separated by recesses **126** complementary in shape to the washer teeth **56**. Each wing **122** is defined by opposed arcuate edges corresponding to the arcuate edge **128**, see Figure 17, between adjacent washer teeth and substantially straight adjacent edges corresponding to the opposed radial edges **130** of each washer tooth **56**. The outermost stamping die **106***a* is shaped differently whereby to complete the outer configuration of the washers formed along the lower edge of the stock **90** as viewed in Figure 11.

The dies **108** are shaped the same as dies **106** but are oriented 180 degrees with respect to dies **106**, i. e., they are rotated about their axes 180 degrees. In addition, the dies **108** are displaced laterally across the strip from dies **106** whereby to complete the external toothed configuration of all of the washers in the strip.

After the strip stock **90** leaves the dies **106**, alternate teeth of each washer are integrally joined as at **132**, **134**, and **136**. At this point in the formation of the washer strips all portions of teeth **56** lie in the plane of the strip stock **90**.

Means is provided for forming the teeth whereby to produce biting edges and simultaneously severing the connection points **134—136** between adjacent washer strips in the form of the tooth forming die **110** and insert **138** positioned in die block **98** and shaped complementary with respect to the operating face of forming die **110**. As may be best seen in Figures 15 and 16, the faces of die **110** and insert **138** are provided with saw tooth-shaped projections **140** and **142**, respectively, presenting complementarily shaped recesses **144** and **146** respectively. The projections **140—142** have surfaces **148—150** formed thereon respectively which are positioned to normally mate as shown in Figure 16 and the other side of the projections **140—142** are provided with surfaces **152—154** respectively, which are adapted to engage a tooth of a washer therebetween.

Two sets of projections **140***a* and **142***a* formed on die **110** and insert **138** respectively are rounded off for a purpose to be more fully explained hereinafter. These sets of projections **140***a*—**142***a* are disposed on opposite ends of a diameter of the die **110** and this diameter of die **110** is aligned in a direction parallel with the axis of strip stock **90**.

The projections **140—142** are further oriented in such a manner that the teeth **56** of the washers acted on by die **110** and insert **138** lie between the surfaces **152—154**. When the die **110** first engages a tooth **56**, the plane of the tooth is disposed substantially normally to the axis of die **110** and therefore at an angle with respect to surfaces **152—154**. As die **110** is further lowered, the surfaces **152—154** act to twist the teeth so that the surfaces of the teeth are substantially parallel to the surfaces **152—154**. By this means the edges of each washer are twisted out of the plane of strip stock **90** and thereby form the biting edges described above which give the locking action when the lock washer is used between two work pieces.

In addition to twisting the teeth **56**, the die **110** and its associated insert **138** serve to sever the connections at points **134** and **136**. The manner in which this is accomplished is best understood by referring to Figures 13 and 14. Figure 13 is an enlarged view of adjacent inserts **138** and **138***a* with a pair of washers thereon and shown in the condition obtained after die **110** has been lowered and raised. Tooth **56** has been twisted in one direction and tooth **56***a* has been twisted in the opposite direction as may be best seen in Figure 14. Twisting the teeth **56—56***a* in opposite directions in addition to forming the teeth, tends to sever the material therebetween at point **132**. The teeth joined at points **134** and **136** are all subjected to a similar twisting and severing operation whereby to separate the teeth at these points.

To form a strip of integrally attached washers, the connection between the teeth at points **132** must be maintained after the stamping action of die **116**. To accomplish this the rounded projections **140***a*—**142***a* are oriented to engage these teeth as has been explained above. By rounding the projections **140***a*—**142***a* the teeth engaged thereby are not twisted so far as the teeth twisted by projections **140—142**, and accordingly severance is not obtained at points **132**. Although the material between the teeth at points **132** is not separated, the strip is weakened at these points whereby to provide a weakened point which can be easily and readily fractured to separate adjacent washers.

After the above series of operations, the stock **90** issues from the punch press in the form of four parallel strips **62**, **62***a*, **62***b*, and **62***c* of toothed lock washers. The lock washers in each strip are connected to each other by bars or tooth connections at points **132** which are readily severable. The four strips **62**, **62***a*, **62***b*, and **62***c* are preferably fed directly to individual winding mechanisms such as the one shown in Figures 18–24. Only one winding mechanism has been shown for purposes of illustration but it is to be understood that each of the other three strips is wound in a similar manner.

The strips **62** are shaped into a helical coil by bending the substantially flat strip laterally in the plane of the strip and then bending the strip out of the plane of the strip to form a plurality of convolutions. These convolutions are then stacked one upon the other and preferably with corresponding washers of adjacent convolutions placed in registration and nesting one within the other.

The winding mechanism shown in Figures 18 through 25 is adapted to perform the above operations upon strips **62** whereby to form a coil of the type shown in Figure 1. This winding mechanism comprises generally a base **160**, a winding drum or mandrel **162** rotatably mounted on the base, a slotted ring **164**, and a tension roller **166** mounted on an arm **168** which is in turn pivotally mounted as at **170**.

Winding drum **162** is substantially cylindrical in shape and has one end thereof fixedly attached to support plate **172**. The external diameter of drum **162** is equal to or slightly less than the diameter of the finished coil to be wound thereon. A plurality of arcuate grooves or recesses **174** are formed around the outer periphery of drum **162** and extend in a direction substantially parallel to the axis of drum **162** the entire length thereof. The curvature of grooves **174** is formed complementary to the external shape of the washer strip which is to be wound thereon. The number of grooves corresponds to the number of washers to be contained in each convolution of the finished coil.

As may be best seen in Figure 18, support plate **172** is greater in diameter than drum **162** whereby to accommodate and support a coil formed about drum **162**. Support plate **172** is in turn rotatably mounted upon a shaft **176**, the shaft **176** being fixedly mounted in base **160**. Means is provided for rotating support plate and its associated parts in the form of a gear **178** attached thereto and mounted concentric with respect to shaft **176**. Gear **178** is driven by a worm gear **180** which is supported on a shaft **182** journaled in a portion of base **160**. Motive force for driving worm gear **180** is obtained from a shaft **184** which is driven by the mechanism which drives and actuates press **92**. Shafts **182—184** are drivingly interconnected by means of a connecting shaft **186** and a pair of universal joints **188** and **190**. By the above described

mechanism drum **162** can be driven at a uniform speed in a clockwise direction as viewed in Figures 19 and 20 and in synchronism with the operation of punch press **92**.

Since the motion of the strip leaving the punch press is intermittent and the winding drum **162** rotates continuously, means is provided to give uniform tension on strip **62** at all times. Roller **166** provides the necessary tensioning means and serves to take up the slack in the washer strip **62** at all times whereby to continuously and smoothly feed the strip to the winding drum **162**.

The slotted ring, generally designated by the numeral **164**, operatively cooperates with winding drum **162** and forms a part of the winding mechanism. Ring **164** aids in bending strip **62** laterally in the plane of the strip, bends the strip downwardly out of the plane of the strip, guides the bent portion of the strip to the washer roll being formed, and serves to hold the formed and stacked washer convolutions in position during winding.

Ring **164** is annular in shape and has a circular internal aperture therein having a diameter slightly greater than the greatest diameter of winding drum **162**. Two substantially radially extending surfaces **194** and **196** define the thickness of ring **164**. The radial width of surface **194** is sufficient to mount thereon the parts to be hereinafter described and the thickness of ring **164** is preferably slightly less than the radial width of the surface **194**. Mounted on surface **194** and extending outwardly with respect to ring **164** is a support guide **198** which is suitably attached to ring **164** such as by machine screws **200**. As may be best seen in Figure 20, support guide **198** extends in a direction substantially transversely with respect to the linear portion of strip **92** which is being fed to the winding drum **162**.

Means is provided for bending strip **62** laterally in the plane thereof in the form of bending roller **202** which cooperates with winding drum **162**.

Bending roller **202** is mounted in a position opposite the point at which the washer strip **62** tangentially contacts the outer periphery of winding drum **162**. Means is provided for rotatably mounting bending roller **202** in the form of a stud **204**. Stud **204** includes a threaded portion **206** which is received in a threaded aperture in ring **164** and a head **208** which retains roller **202** in position. The external periphery of bending roller **202** has grooves or recesses **210** formed therein which are shaped substantially the same as recesses **174** in drum **162**. More specifically, recesses **210** are shaped to conform with and receive the external periphery of a washer of the strip being wound.

Formed in ring **164** and positioned a short distance from bending roller **202** is a guide slot **212** which serves to bend strip **62** downward out of its plane and to guide the washers from the upper surface **194** after engagement with bending roller **202** to the lower surface **196**. As may be best seen in Figure 22, the surfaces defining slot **212** lie in planes and these planes are inclined with respect to the upper and lower surfaces **194—196** when viewed from the side. In the form of slot shown in Figure 23, the surfaces defining the slot contain those radii disposed normally to the circumference of ring **164** extending through and perpendicular to the axis of the winding drum, i. e. these planes are normal with respect to the circumference of the drum. When winding certain types of washers it is desirable to incline the radial width of slot **212** with respect to the radii of the drum as shown by the form of the slot **212***a* in Figure 24. When the slot **212***a* is inclined with respect to the radius the outermost edge of the slot is preferably disposed below the innermost edge of the slot.

Means is provided for holding ring **164** stationary with respect to base **160** when winding drum **162** is being rotated in the form of an arm **214** which extends therefrom and which is attached thereto. Arm **214** contacts an upstanding stationary post **216** which is in turn attached to base **160**. Engagement between arm **214** and post **216** positively prevents rotation of ring **164** with respect to base **160** when drum **162** is rotated during the winding operation.

The operation of the winding mechanism is as follows: The formed washer strip **62** is fed from the forming die block **98** under the tension roller **166** to the support guide **198**. When a new coil is started the free end of strip **62** is manually passed between the bending roller **202** and the periphery of winding drum **162** across the upper surface **194** of ring **164** and down through the guide slot **212**. One of the washers is engaged on a post **218** mounted on the support plate **172**. Support plate **172** and the winding drum **162** mounted thereon are then rotated in a direction indicated by the arrows in Figures 19 and 20 by the drive mechanism including gears **178–180** and shafts **182**, **184**, and **186** from the press **92**. At the beginning of a new coil the ring **164** is positioned adjacent the support plate **172**. As the coil is formed the ring **164** is lifted by the coil.

Referring now more particularly to Figures 19 and 20, the manner in which a substantially straight washer strip **62**, i. e., a washer strip in which the centers of each washer lie in a straight line in the plane of the washer, is bent into a convolution will be described. After the strip **62** passes across support guide **196**, it lies along and is supported by the upper surface **194** of ring **164**. Strip **62** is substantially tangentially disposed with respect to the periphery of winding drum **162** and the forward edge of each washer first contacts the forward edge **220** of one of the grooves **174** in drum **162** and a projection **222** which defines one of the grooves **210** in roller **202**. The edges of grooves **174** and **210** are so shaped as to receive the external periphery of a washer in strip **62**.

The strip **62** is driven during the winding operation by the rotation of drum **162**, ring **164** being held stationary by means of arm **214** acting against post **216**. As the washers are driven past bending roller **202**, roller **202** is rotated in the direction indicated by the arrow thereon. At first the periphery of groove **210** which is disposed in a clockwise direction from projection **222** is slightly spaced away from the edge of the washer **56***c* engaged by projection **222**. As winding drum **162** is rotated the periphery of this groove **210** will be gradually pressed and urged against the edge of washer **56***c* and will force this washer into the corresponding groove **174** in drum **162**. The simultaneous engagement of washer **56***c* by the grooves **174** and **210** serves to bend the teeth joining washer **56***c* and the washer **56***d* which is attached thereto into the shape shown in Figure 7.

The winding drum **162** and the bending roller **202** engage each washer of strip **62** individually whereby to bend and deform the interconnecting teeth and form a convolution. The diameter of the convolution formed in this manner is determined by the diameter of winding drum **162**. Since the material from which strip **62** is fabricated is usually resilient, the convolutions tend to spring from the bent position and thereby form a convolution which is slightly greater in diameter than drum **162**.

As has been explained above the strip is driven by engagement with the drum **162** and the roller **202**. The portion of the strip **62** between roller **202** and the punch press is under tension, but the bent portion of the strip, generally designated by the numeral **224** in Figure 20, is not under tension and can therefore be so moved axially of the winding drum **162** in the grooves **164**. After the bent portion **224** leaves the bending roller **202**, it is guided by the upper surface **194** of ring **192** into the guide slot **212**. The guide slot **212** keeps the bent washer strip **224** with its inner edge disposed toward the axis of the winding drum **162** and with the plane of the washer strip disposed substantially perpendicularly to the circumference or surface of the winding drum **162**.

The guide slot **212** is effective to bend the strip out

of the plane thereof and to transfer the bent washer strip **224** from the upper surface **194** of ring **164** to the lower surface **196** thereof. Each washer is guided in one of the grooves **174** in drum **162** throughout its path of travel across surface **194** and down through guide slot **212**. After initial contact of the washers with the drum **162** adjacent the bending roller **202**, each washer remains associated with the adjacent groove **174** in drum **162**. Consequently, as each washer leaves the guide slot **212** it is dropped in substantially exact registration on the washer of the preceding or lower convolution which is positioned in the same groove. In this manner registration and nesting of each washer with the washers in adjacent convolutions is obtained.

After a convolution has passed through guide slot **212** the lowered surface **196** of ring **164** engages the upper surface of the convolution and holds the convolution in place until the next convolution is superimposed thereon. Successive convolutions are in effect stacked one upon another by the action of ring **164**. Ring **164** is preferably formed of metal and is therefore heavy enough to press the convolutions against each other to keep them in an aligned and nesting relationship. As each additional convolution is deposited on the coil being formed, the ring **164** is raised a distance equal to the thickness of a convolution.

After a coil of the desired height has been formed, the strip forming and coiling mechanism is stopped and the strip **62** is broken preferably adjacent the bending roller **202**. The slotted ring **164** may then be removed from the top of the formed coil and the coil may then be removed from the winding drum **162**. As was explained above, the natural resiliency in the washer strip results in convolutions which are slightly greater in diameter than the external diameter of winding drum **162** and therefore the coil may be readily lifted therefrom. Care must be exercised to insure that the free ends of the coil are secured to the coil so that premature unwinding of the coil axially thereof is not obtained.

With certain types of washer strips it is desirable to slant the guide slot in ring **162** in the manner illustrated in Figure 24. The operation of such a slot is substantially the same as the operation of guide slot **212**.

By the method and apparatus illustrated in Figures 10 through 24, an edgewise and helically coiled strip of integrally connected annuli such as washers may be formed from a strip of stock material. A plurality of wound coils may be formed from a single strip of stock material simultaneously by utilizing a plurality of forming dies and a plurality of coiling mechanisms. The formed coil may be heat treated and hardened and the structure of the coil renders such heat treating or hardening processes particularly effective, i. e. the coil may be uniformly and satisfactorily heat treated and hardened.

Although certain forms of washer strips have been used to illustrate the formation of the improved coil of the present invention, and while certain examples of washer strip forming and coiling apparatus and methods have been given for purposes of illustration, it is to be understood that various changes may be made therein without departing from the spirit and scope of the invention. Accordingly, the invention is to be limited only as set forth in the following claims.

The invention is hereby claimed as follows:

1. An article of manufacture comprising a plurality of superimposed convolutions, each convolution including a strip of regularly spaced annuli connected by bars, the two halves of each bar being twisted in opposite directions to provide a weakened point of severance at the middle of each bar, the strip being bent primarily through such points of severance into said convolutions, each of said convolutions having substantially the same diameter.

2. A method of forming a coil from a strip of integrally attached washers comprising bending said strip laterally in the plane thereof to form a succession of convolutions, bending said strip transversely about an axis lying in the plane of the strip, and bending said convolutions out of the plane of the strip in a direction longitudinally of the strip to form helical convolutions having the same diameter and stacking said convolutions in superimposed relation with the corresponding washers of the convolutions positioned in alignment axially of the coil.

3. The method set forth in claim 2, wherein the bending of the strip laterally in the plane thereof is effected principally in the attachments between the washers.

4. An apparatus for forming a roll from a strip of integrally attached washers comprising means for bending said strip laterally in the plane thereof to form a succession of convolutions, means for bending said strip transversely about an axis lying in the plane of the strip, means for bending said convolutions out of the plane of the strip longitudinally of the strip to form helical convolutions having the same diameters, and means for placing said convolutions in superimposed relationship with the corresponding washers of superimposed convolutions aligned axially of the roll.

5. Apparatus as set forth in claim 4, wherein the means for bending the strip laterally in the plane thereof comprises means for bending the attachments between said washers.

6. An apparatus for forming a coil from a strip of integrally attached washers comprising a winding drum, a laterally and outwardly extending flange formed on one end of said drum, the outer periphery of said drum having a plurality of recesses formed therein extending longitudinally of the drum, a ring surrounding said drum and mounted for movement in a direction axially of the drum, a bending roller mounted on said ring, the periphery of said bending roller having recesses formed therein, the recesses in said drum and in said roller being shaped to receive a washer of said strip, means for rotating said drum relative to said ring, said drum and said bending roller being effective to bend a washer strip positioned therebetween in a direction laterally in the plane of the washer strip, said ring having a slot therein extending from the upper surface of the ring to the lower surface of the ring, said slot being adapted to bend said washer strip downwardly out of the plane of the strip to form helical convolutions and to convey the bent portion of said strip from the bending station to a position below said ring, said flange being adapted to support said convolutions, the recesses in said drum being adapted to align the corresponding washers in the superimposed convolutions in a direction axially of the drum, said ring being adapted to hold said convolutions in aligned superimposed relation.

7. An apparatus for forming a plurality of rolls of integrally attached toothed washers from a single strip of washer stock comprising means for forming a plurality of strips of a plurality of washers from said washer stock, said washers having portions interconnecting the washer teeth in directions longitudinally and transversely of said washer stock, means for displacing some of the washer teeth to a limited extent from the plane of the strip to weaken the longitudinal interconnections, means for displacing others of the washer teeth to a greater extent from the plane of said strip for severing said transverse interconnecting portions to form a plurality of longitudinally extending strips of integrally attached washers, and a plurality of coiling means for individually coiling said washer strips edgewise into helical rolls, each of said coiling means including means for bending said strip laterally in the plane of said strip through the weakened longitudinal interconnections to form a plurality of convolutions, and means for placing said convolutions in superimposed relation.

8. Apparatus for coiling a strip of integrally attached annuli comprising a winding drum having a plurality of

axially extending flutes of substantially the same diameter as said annuli, a ring surrounding said drum, means for effecting relative rotation between said ring and said drum, a bending roller rotatably mounted on said ring adjacent said drum and having a serrated periphery, said serrations being of substantially the same extent as the flutes of the drum, said serrations and flutes engaging annuli between them for bending said strip principally at the attachments laterally in the plane of the strip about said winding drum into convolutions having a common diameter, and guide means on said ring for guiding said strip from said bending roller to a position below said ring whereby to wind said strip about said drum with the ring pressing against the last formed convolution of the strip.

9. A method of forming a helical coil of integrally attached washers which comprises forming a washer strip by removing from a strip of stock pieces of waste material complementary to a succession of washers and integral connections therebetween, bending said washer strip laterally in the plane thereof to form a succession of convolutions, bending said washer strip transversely about an axis lying in the plane of the washer strip, bending said convolutions out of the plane of the washer strip in a direction longitudinally of the washer strip to form helical convolutions having the same diameter, and stacking said convolutions in superimposed relation with the corresponding washers of the convolutions positioned in alignment axially of the coil.

10. A method of forming a helical coil as set forth in claim 9, wherein the step of forming the washer strip includes twisting teeth on the washers.

11. A method of forming a helical coil as set forth in claim 9, wherein a plurality of washer strips is formed simultaneously, including the further steps of removing pieces of waste material to form a succession of washers and lateral and longitudinal connections, and severing the lateral connections.

12. An apparatus for forming a coil of washers comprising means for removing from a strip of stock waste material complementary in form to a strip of washers having integral connections, means for bending said strip laterally substantially in the plane thereof to form a succession of convolutions, means for bending said convolutions from the plane of the strip to form helical convolutions, means for bending said strip laterally about an axis lying substantially in the plane of said strip, and means for placing the helical convolutions in superimposed relationship with the corresponding washers of superimposed convolutions aligned axially of the coil.

13. Apparatus as set forth in claim 12, wherein the means for removing waste material includes means for removing waste material complementary in form to a plurality of strips of washers having longitudinal and lateral connections, and further including means for severing the lateral connections to separate said strips.

14. An article of manufacture as set forth in claim 1, wherein the annuli comprise lock washers having radially extending, twisted locking teeth arcuately spaced thereabout, the connecting bars comprising confronting locking teeth of adjacent washers.

15. An article of manufacture comprising a helically coiled washer strip, said strip comprising a plurality of washers connected by limited areas of twisted weakened stock adapted for eventual severing, the strip being laterally curved substantially in the plane thereof by being bent through the twisted weakened areas and forming a plurality of superimposed convolutions of equal diameter.

16. An article of manufacture as set forth in claim 15, wherein limited areas of weakened stock are of reduced cross sectional area relative to the immediately adjacent portions of the strip.

17. A method of forming a strip of attached lock washers into a coil of helical convolutions with the individual washers nested and aligned vertically, which method comprises feeding the strip, laterally bending the strip substantially in the plane thereof by engaging the individual washers at one side thereof to confine them in spaced guides on a curvilinearly movable guide means at the opposite side of the strip, and thereafter bending the strip laterally out of the plane thereof to form a plurality of convolutions while maintaining the individual washers in the spaced guides.

18. A method of forming a helical coil of integrally attached toothed washers which comprises forming a washer strip by removing from a strip of stock pieces of waste material complementary in form to a succession of washers and integral connections therebetween, laterally bending the strip substantially in the plane thereof by engaging the individual washers at one side thereof to confine them in spaced guides on a curvilinearly movable guide means at the opposite side of the strip, and thereafter bending the strip laterally out of the plane thereof to form a plurality of convolutions while maintaining the individual washers in the spaced guides.

19. The method as claimed in claim 18, wherein the step of forming the washer includes twisting the teeth on the washers.

20. The method as claimed in claim 18, wherein a plurality of washer strips is formed simultaneously, including the further steps of removing pieces of waste material to form a succession of washers with lateral and longitudinal connections, and severing the lateral connections.

21. An apparatus as claimed in claim 4, wherein the means for bending the strip transversely about an axis lying in the plane of the strip comprises a guideway engaging opposite faces of the strip.

22. Apparatus for forming a helical coil of integrally attached washers which comprises means for feeding a strip of washers along a predetermined path, means adjacent the predetermined path for bending the strip laterally substantially in the plane thereof and including a fluted drum and means for pressing each individual washer into a flute on the drum as the strip is fed therebetween, and means adjacent the lateral bending means for bending the laterally bent strip out of the plane thereof to form a plurality of helical convolutions.

23. Apparatus as claimed in claim 22, wherein there is provided means adjacent the lateral bending means for twisting the strip of washers about an axis extending generally longitudinally of the strip.

24. Apparatus for forming a coil of washers comprising means for removing from a strip of stock waste material complementary in form to a strip of washers having integral connections, means for feeding a strip of washers along a predetermined path, means adjacent the predetermined path for bending the strip laterally substantially in the plane thereof and including a fluted drum and means for pressing each individual washer into a flute on the drum as the strip is fed therebetween, and means adjacent the lateral bending means for bending the laterally bent strip out of the plane thereof to form a plurality of helical convolutions.

25. Apparatus as claimed in claim 24, wherein the means for removing the waste material includes means for removing waste material complementary in form to a plurality of strips of washers having longitudinal and lateral connections, and also including means for severing the lateral connections to separate the strips.

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