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F. A. KLASEK

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APPARATUS FOR KNURLING ARTICLES

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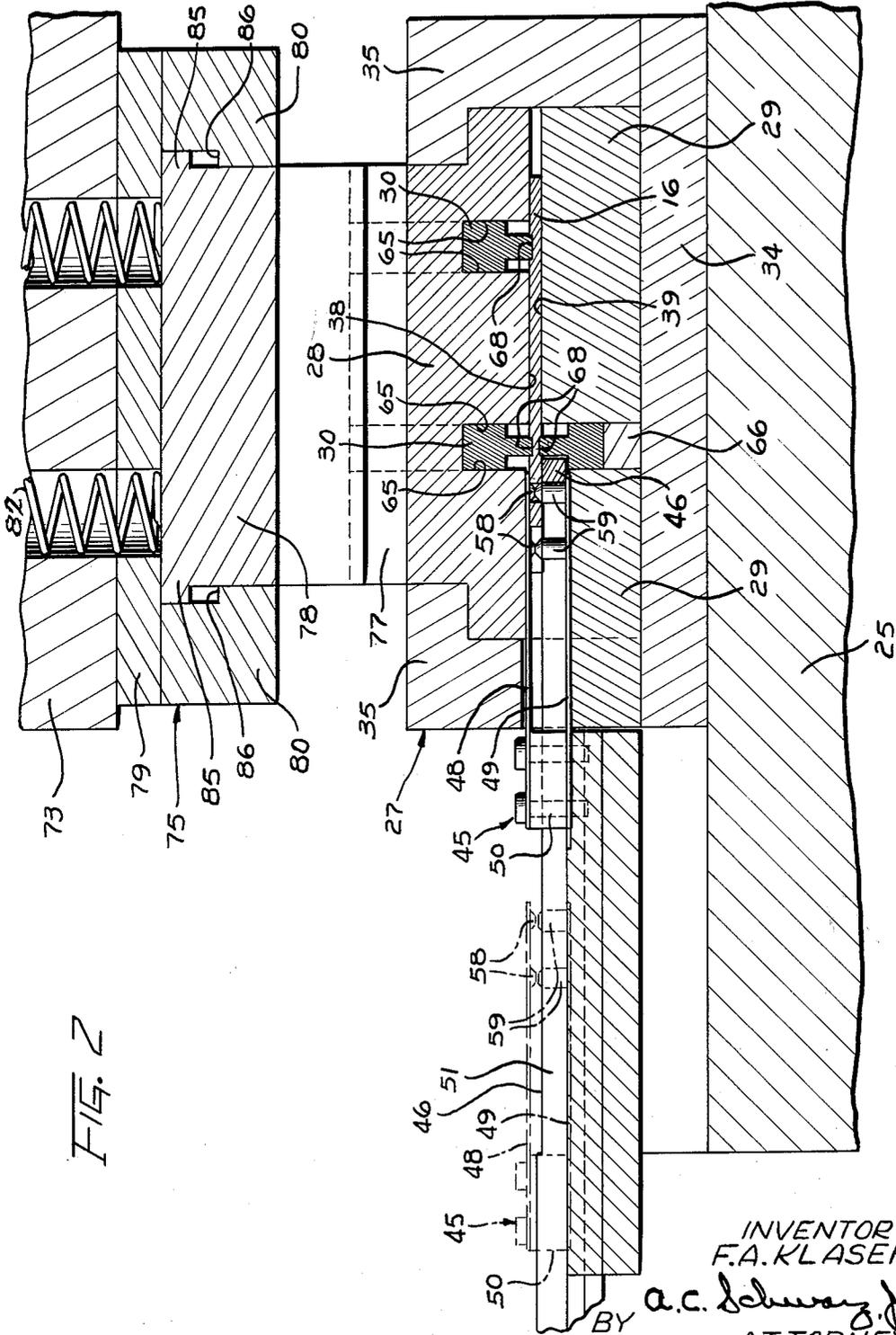


FIG. 2

INVENTOR  
F.A. KLASEK  
BY *a.c. Schwagerl*  
ATTORNEY

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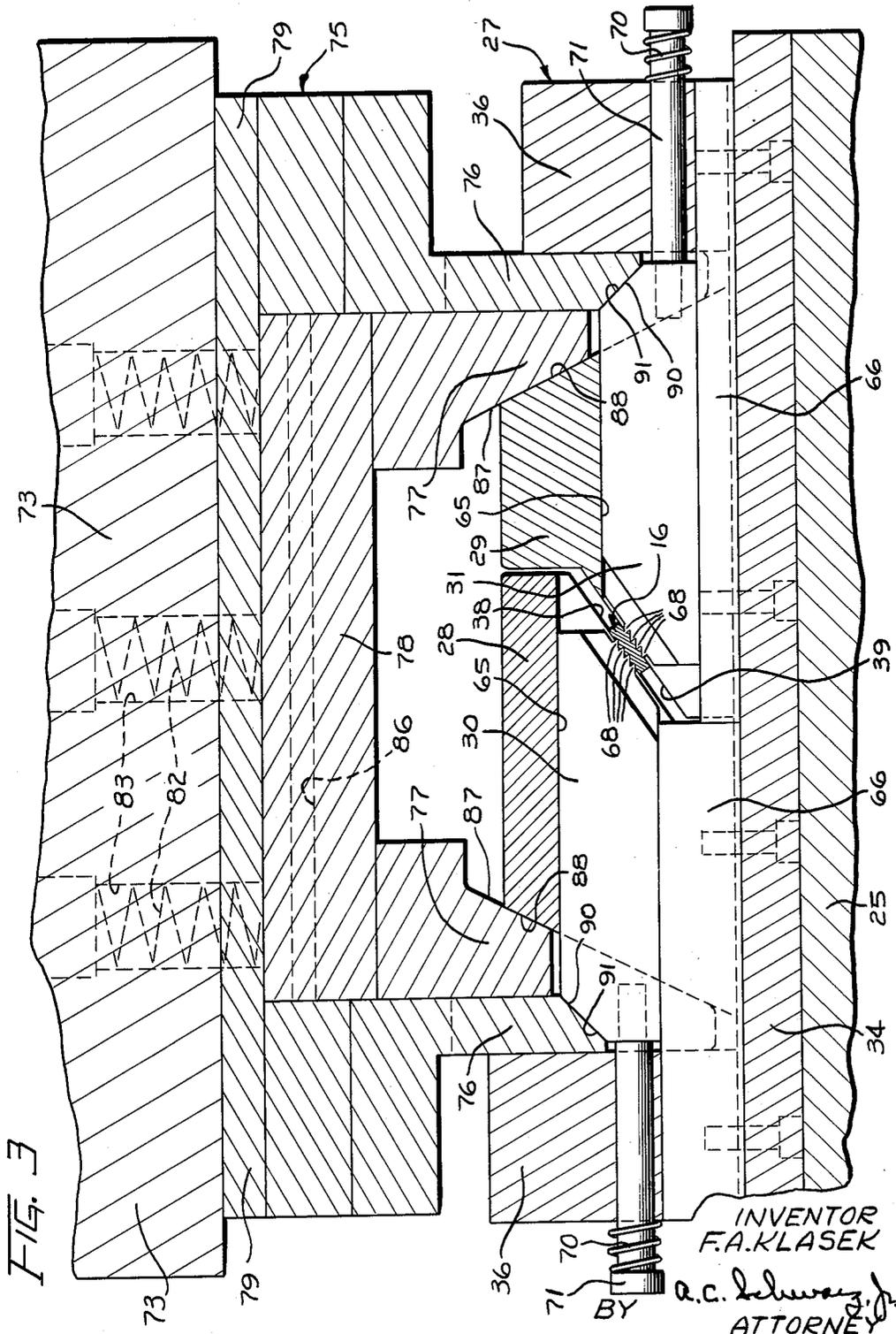
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5 Sheets-Sheet 3





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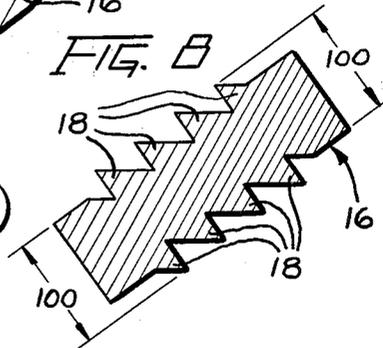
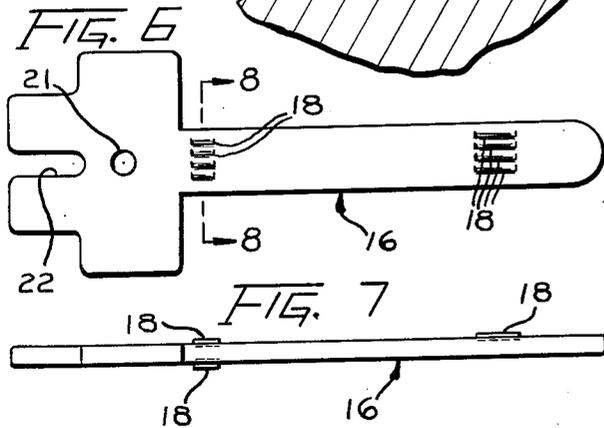
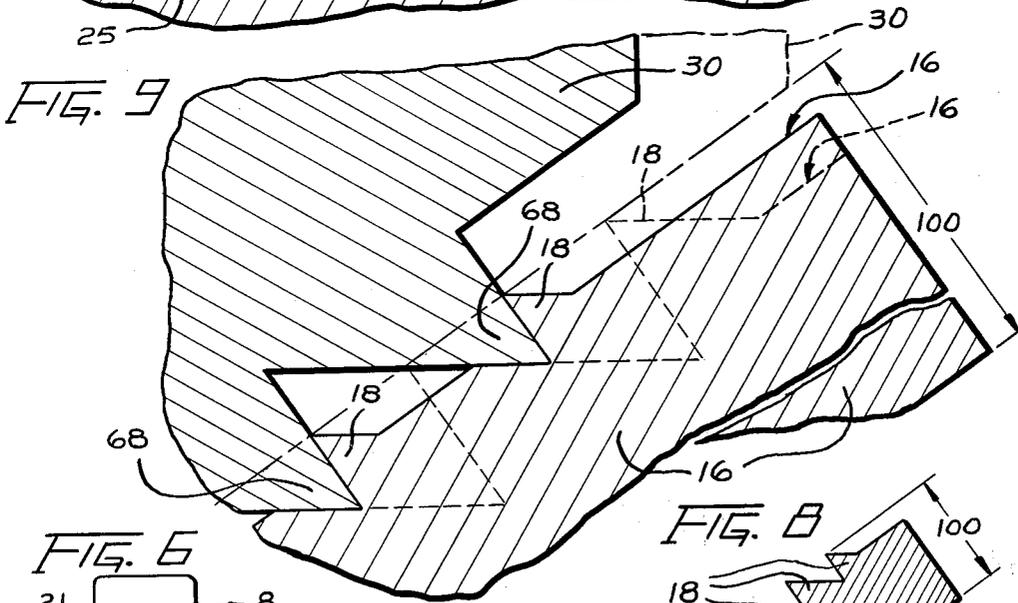
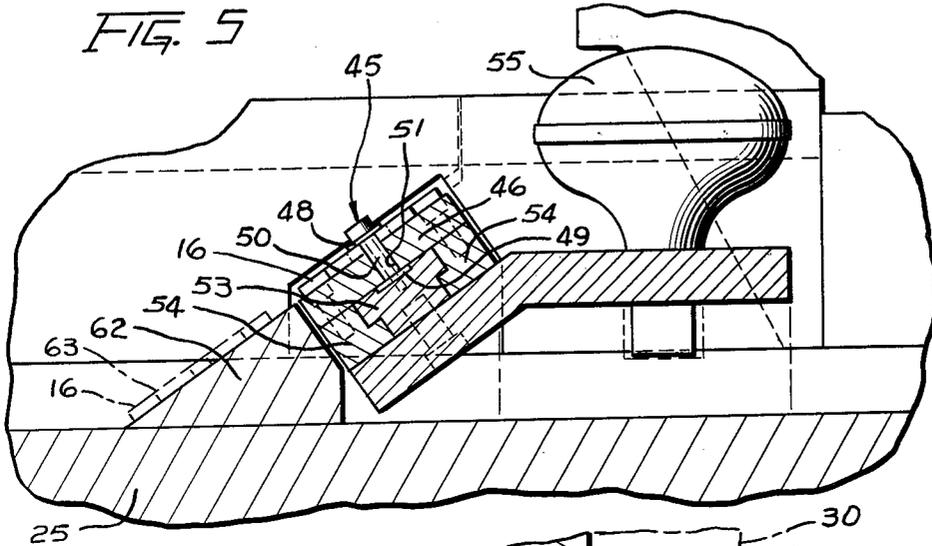
F. A. KLASEK

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APPARATUS FOR KNURLING ARTICLES

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5 Sheets-Sheet 5



INVENTOR  
F.A. KLASEK  
BY *A.C. Schwarz, Jr.*  
ATTORNEY

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3,101,633

**APPARATUS FOR KNURLING ARTICLES**

Frank A. Klasek, La Grange Park, Ill., assignor to Western Electric Company, Incorporated, a corporation of New York

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10 Claims. (Cl. 78-45)

This invention relates to an apparatus for knurling articles, and more particularly to apparatus for forming knurls of various heights on one or both sides of flat articles in accordance with the thickness of the articles.

In the manufacture of certain types of electromagnetic relays, a prewound coil is assembled onto a soft iron core member and held in position thereon by a pair of spool heads which engage knurls on the core member. One of the spool heads, provided with an aperture of a predetermined size, is telescoped over the core member and pressed into engagement with knurls formed on opposite sides of the core member to effect a locking engagement therewith, after which the coil is assembled onto the core member. The second spool head which has an aperture of a predetermined smaller size than that of the first spool head is then telescoped over the core member and pressed into engagement with knurls formed on one side of the core member to effect a locking engagement therewith.

The core members are made from flat stock which varies in thickness within a predetermined acceptable range. Due to the variation in the thickness of the core members, it is necessary to form knurls of various heights in accordance with the thickness of the core members to obtain a predetermined uniform distance between the extremity of the knurls and the opposite side of the core member so as to secure an interlocking connection between the spool heads and the knurls on the core member sufficient to anchor the spool heads to the core member.

An object of the present invention is to provide a new and improved apparatus for knurling articles.

Another object of the invention is to provide an apparatus for forming knurls of various heights on flat articles.

A further object of the invention is to provide an apparatus for forming knurls of various heights on one or both sides of flat articles in accordance with the thickness of the article.

With these and other objects in view, the invention contemplates the provision of a pair of jaws mounted on a support for horizontal movement toward each other for clamping flat articles of various thickness therebetween. A pair of knurling dies are mounted on the support on opposite sides of the article for horizontal movement toward each other through various distances for forming knurls of various heights on opposite sides of the article.

The jaws are actuated to clamp the article by a pair of cams mounted in fixed relation to each other on a gage plate which is yieldably mounted on a holder above the jaws for vertical movement with the holder and for limited movement relative thereto. The gage plate is stressed downward to a normal advanced position on the holder which is secured to a ram for vertical reciprocatory movement. During downward movement the gage plate and cams are arrested at different levels depending on the thickness of the article clamped therebetween, and the gage plate serves to stop the holder after a limited further downward movement. During this further downward movement of the holder, a pair of cams fixedly mounted thereon actuate the knurling dies horizontally through various distances in accordance with the vertical position of the gage plate to effect the forming of knurls of various heights on opposite sides of the article in accordance with the thickness of the article.

Other objects, advantages and novel aspects of the invention will become apparent upon consideration of the

following detailed description, in conjunction with the accompanying drawings, in which:

FIG. 1 is a fragmentary plan sectional view of the knurling apparatus embodying the present invention;

FIG. 2 is a fragmentary vertical longitudinal cross-sectional view of the apparatus taken on line 2-2 of FIG. 1 and showing the apparatus in operative position with the knurling dies in engagement with the article;

FIG. 3 is a fragmentary vertical transverse sectional view of the apparatus taken on the line 3-3 of FIGS. 1 and 2 showing the apparatus in operative position;

FIG. 4 is a fragmentary vertical transverse sectional view of the apparatus taken on the line 4-4 of FIG. 1 and showing the apparatus in unoperative condition with the punch holder and actuating cams in raised position;

FIG. 5 is a fragmentary cross-sectional view of the apparatus showing a movable holder for feeding an article into the apparatus;

FIGS. 6 and 7 are plan and side views respectively of an article having knurls formed thereon by the present apparatus;

FIG. 8 is an enlarged cross-sectional view of the article taken along line 8-8 of FIG. 6 and showing the knurls formed thereon; and

FIG. 9 is a greatly enlarged fragmentary view showing in full lines a portion of a knurling die pressed into an article of maximum thickness and showing in dotted lines the knurling die pressed into an article of minimum thickness.

Referring to the drawings, the present apparatus is designed to knurl one or both sides of flat articles 16 (FIGS. 6-8) and to form raised ridges or knurls 18 thereon which vary in height in accordance with the thickness of the article so as to obtain a predetermined distance between the extremities of the knurls and the opposite side of the article. In the present instance, the article 16 is in the form of an iron core member for electro-magnetic relays on which first and second sets of knurled ridges 18 are formed on one side of the core in spaced relation to each other and a third set of ridges is formed on the opposite side of the core member in opposed relation to the first set. The knurls 18 serve to engage and form interlocking connections with spool heads which have apertures of a predetermined size and are assembled onto the core member. At one end thereof the article 16 is provided with an aperture 21 and a slot 22 as indicated in FIG. 6.

The apparatus includes a stationary platen 25 which is mounted on a bed of a hydraulically operated press (not shown) and which has fixedly mounted thereon a holder 27 for supporting a pair of clamping jaws 28 and 29 and a pair of knurling dies 30 and 31. The holder 27 includes a base plate 34, a pair of side gibs 35 (FIG. 2) forming a guideway for the clamping jaws 28 and 29 and a pair of end walls 36 (FIGS. 1 and 3).

The clamping jaws 28 and 29 which are mounted slidably in the holder 27 for limited horizontal movement toward and from each other are provided with obliquely disposed flat article gripping surfaces 38 and 39 that are disposed at an angle of approximately 35° from the horizontal and are engageable with opposite sides of the article 16 for clamping the article therebetween. Headed screws 41 (FIG. 1) secured to the clamping jaws and extending through bores in the end walls 36 are stressed by springs 42 thereon for moving and yieldably maintaining the clamping jaws 28 and 29 in normal retracted positions against the end walls 36 of the holder 27 to provide clearance between the gripping surfaces 38 and 39 for the feeding of an article 16 therebetween.

An article holder 45 (FIGS. 1, 2 and 5) for feeding the article into knurling position in the apparatus is slidably mounted on a guide bar 46 secured at one end to the

3

clamping jaw 29 and extending laterally therefrom with the upper surface thereof disposed obliquely in alignment with the clamping surface 39 of the clamping jaw. The article holder 45 comprises a pair of parallel flat leaf springs 48 and 49 secured at one end in spaced relation to each other to a spacer block 50 which is slidable in a slot 51 in the guide bar 46. The holder 45 is secured to a slide 53 which is mounted for reciprocatory movement on a pair of gibs 54 secured to the lower side of the guide bar 46. A handle 55 is secured to the slide 53 by means of which the holder 45 may be reciprocated.

The upper leaf spring 48 of the holder is positioned above the upper surface of the guide bar 46 a distance slightly greater than the thickness of the article 16 and has a pair of spaced conical positioning elements 58. These elements cooperate with the conical surfaces of a pair of spaced positioning elements 59 mounted on the leaf spring 49 for engaging the article 16 in the aperture 21 and slot 22 to releasably support the article 16 in a predetermined position for movement on the upper surface of the guide bar 46 to and from knurling and retracted positions in the apparatus as shown in full and dotted lines respectively in FIG. 2.

With the article holder 45 in retracted position, the operator may place an article 16 on an inclined upper surface of a fixed article supporting member 62 in laterally aligned relation with the holder 45 as indicated in dotted lines at 63 in FIG. 1, and slide the article 16 laterally and upwardly onto the upper surface of the guide bar 46 and into operative engagement with the holder 45 and with the elements 58 and 59 of the holder engaging the aperture 21 and the slot 22. This movement of the article 16 into operative engagement with the article holder 45 effects the ejection from the holder 45 of an article which has just been knurled.

As seen particularly in FIGS. 3 and 4, the knurling dies 30 and 31 are mounted for limited horizontal movement relative to each other in slots 65 in the clamping jaws 28 and 29, respectively, and are supported at different elevations on spacers 66 secured to the bottom plate 34 of the holder 27. At their inner ends, the knurling dies 30 and 31 are each provided with a row of V-shaped teeth 68 disposed parallel to the gripping surfaces 38 and 39 of the clamping jaws for engaging opposite sides of the article 16. Springs 70 (FIG. 1) in cooperation with headed screws 71 secured to the knurling dies 30 and 31 and slidable in apertures in the end walls 36 of the die holder 27 serve to move the knurling dies to and yieldably retain them in retracted positions in engagement with the end walls 36 and with the teeth 68 of the dies spaced apart sufficient to provide clearance therebetween for the reception of an article 16.

One side of each of the V-shaped cutting teeth 68 is disposed horizontally and the other side thereof is disposed substantially perpendicular to the gripping faces 38 and 39 of the clamping jaws. In response to actuation of the knurling dies into engagement with opposite sides of the article 16, the cutting teeth 68 cut V-shaped recesses into the sides of the article and displace V-shaped knurls 18 laterally from the side of the article. The shape and size of the knurl 18 formed is substantially equal to the shape and size of the recess formed in the article. Thus, the height of the knurls 18 is determined by the extent of movement or the depth of penetration of the knurling teeth 68 into the article 16.

Mechanism is provided for sequentially actuating the clamping dies 28, 29 and the knurling dies 30, 31 through various distances in accordance with the thickness of the article 16. The mechanism includes a movable platen 73 (FIGS. 3 and 4) secured to the ram of the hydraulically operated press and guided by aligning pins 74 (FIG. 1) for vertical reciprocatory movement relative to the stationary platen 25. Secured to the movable platen 73 is a movable holder 75 (FIG. 2) for supporting a pair of cams 76 (FIGS. 3 and 4) for actuating the knurling dies

4

30, 31 and a pair of cams 77 for actuating the clamping jaws 28, 29. The cams 77 are secured to a carrier or gage plate 78 in fixed relation to each other.

The movable holder comprises a horizontal backup plate 79 and a pair of gibs 80 (FIG. 2) forming a guide-way for supporting the gage plate 78 and the cams 77 for vertical movement with the holder 75 and for limited vertical movement relative thereto. Springs 82 seated in recesses 83 in the movable platen 73 extend through apertures in the backup plate 79 into engagement with the gage plate 78 for moving the gage plate downwardly relative to the platen 73 to a normal advanced position, in which position the gage plate is supported by the engagement of laterally disposed flanges 85 on the gage plate 78 (FIG. 2) with shoulders 86 on the gibs 80.

Referring to FIGS. 3 and 4, the cams 77 have inclined cam surfaces 87 which are disposed at approximately 26° 34' from the vertical and which cooperate with cam surfaces 88 on the clamping jaws to impart horizontal movement to the clamping jaws in response to vertical reciprocation of the cams 77. The cams 76 which are rigidly secured to the holder 75 for vertical movement therewith have inclined cam surfaces 90 which are disposed at an angle of 45° from the vertical and cooperate with cam surfaces 91 on the knurling dies 30 and 31. With the arrangement of cam surfaces 87 and 90, the die actuating cams 76 impart a greater movement to the knurling dies 30 than the cams 77 impart to the clamping jaws during the downward travel of the cams and the holder 75, the ratio of movement of the knurling dies to the clamping jaws being approximately 2 to 1.

The resilient and lost motion mounting of the gage plate 78 on the holder 75 permits limited relative movement between the jaw actuating cams 77 and the knurling die actuating cams 76 and provides for the sequential operation of the clamping jaws and the knurling dies to effect the clamping of the article 16 prior to the knurling of the article.

After an article 16 has been fed to knurling position between the clamping jaws and the knurling dies, the press is actuated to effect the downward movement of the movable platen 73 and the carrier 75 thereon. During the downward movement of the holder 75, the cams 77 on the gage plate 78 engage the clamping jaws 28, 29 and impart movement thereto toward each other to clamp the article 16 firmly therebetween at which time movement of the clamping jaws is arrested and the inclined surfaces 88 of the clamping jaws serve as stops to arrest the downward movement of the cams 77 and the gage plate 78 at a predetermined level depending on the thickness of the article 16. As the platen 73 and holder 75 continue their downward movement, the cams 76 on the holder 75 move the knurling dies 30 and 31 toward each other and force the knurling teeth 68 into the article 16 until the backup plate 79 of the holder 75 engages the gage plate 78 and is stopped thereby. The length of travel of the knurling dies 30 and 31 is controlled by the lower level at which the gage plate 78 is stopped.

When the press is actuated, hydraulic pressure is applied to the ram causing the ram, the platen 73, the holder 75 and the cams 76 and 77 to move downwardly to effect the sequential clamping of the article 16 between the jaws 28, 29 and the knurling of the article. Hydraulic pressure builds up to predetermined value which is sufficient to insure the knurling of the article and which actuates controls to effect the return of the ram, the platen 73, the holder 75 and the cams 76 and 77 carried thereby to their normal retracted positions. As the cams 76 and 77 rise, the springs 42 and 70 effect the return of the clamping jaws 28 and 29 and the knurling dies 30, 31 to their normal retracted positions, after which the article holder 45 may be manually retracted to remove the knurled article 16 from the apparatus preparatory to the knurling of another article.

The arrangement of the elements of the apparatus is

such that when an article 16 of a minimum thickness (FIG. 8) within a predetermined acceptable range of stock thickness is being knurled, knurls 18 of maximum height are formed thereon to maintain a uniform overall dimension 100 between the extremity of the knurl 18 and the opposite side of the article 16. When an article of the maximum thickness of stock (FIG. 9) within the specified limits of stock thickness is acted upon, knurls 18 of minimum height will be formed on the article so as to provide the uniform overall dimension 100 between the extremity of the knurl 18 and the opposite side of the article 16. Thus, with this arrangement, the height of the knurls 18 varies inversely in proportion to the thickness of the article so as to obtain the above referred to overall dimension.

It is to be understood that the above-described arrangements are simply illustrative of the application of the principles of this invention. Numerous other arrangements may be readily devised by those skilled in the art which will embody the principles of the invention and fall within the spirit and scope thereof.

What is claimed is:

1. In a knurling apparatus, a support, a pair of jaws mounted on said support for movement relative to one another for clamping articles therebetween of various thicknesses within predetermined limits, a pair of knurling dies movable on said support for knurling opposite sides of such an article, means for actuating said jaws into clamping engagement with the article, said jaw actuating means being stopped by said jaws in various positions in accordance with the thickness of the article between said jaws, means for actuating said knurling dies, and stop means on said jaw actuating means to limit the movement of and stop said die actuating means in various positions in accordance with the thickness of the article to control the height of the knurls being formed on the article.

2. In a knurling apparatus, a support, a pair of jaws movable on said support for clamping articles therebetween of various thicknesses within predetermined limits, a knurling die movable on said support for knurling one side of such articles, a first means for actuating said jaws into clamping engagement with the article, said first means being stopped by said jaws in various positions in accordance with the thickness of the article clamped therebetween, a second means for actuating said knurling die, and stop means on said first actuating means for arresting the movement of said second actuating means in various positions in accordance with the thickness of the article to control the height of the knurls being formed on the article.

3. An apparatus for forming knurls of different heights on articles of different thicknesses within predetermined limits to provide a uniform distance between the extremity of the knurls and the opposite side of the articles which comprises a support, a pair of jaws movable on said support for clamping such articles individually therebetween, a pair of knurling dies movable on said support for knurling the article therebetween, a first movable means for actuating said jaws into clamping engagement with the article, and a second movable means for actuating said knurling dies to knurl said article, said first actuating means being stopped by said jaws in various positions in accordance with the thickness of the article between the jaws and serving to limit the movement of and to stop said second actuating means in various positions to control the height of the knurls being formed on the article.

4. An apparatus for forming knurls on articles of different thicknesses comprising a support, a pair of jaws mounted on said support for movement toward each other along a predetermined path for clamping the article therebetween, a pair of knurling dies mounted on said support for movement toward each other for knurling the article therebetween, a first member having a pair of cams

fixedly secured thereto for actuating said jaws, a second member having a pair of cams fixedly secured thereto for actuating said knurling dies, and means for mounting said first and said second members for movement toward said support along an axis transversely of said path for actuation of said first member and said jaws to clamp the article and for actuation of said second member and said dies to knurl the article, the movement of said first member toward said support being arrested by said jaws in various positions in accordance with the thickness of the article and said first member serving to limit the movement of said second member to control the height of the knurls being formed on the article.

5. An apparatus for knurling articles comprising a first holder and a second holder mounted for movement relative to each other along an axis, a pair of clamping jaws mounted on said first holder for movement toward and from each other perpendicular to said axis for clamping the article therebetween, a knurling die mounted slidably on said first holder for movement perpendicular to said axis toward the article held by said clamping jaws, a pair of first cams for actuating said clamping jaws to clamp the article therebetween, means for mounting said first cams on said second holder in fixed relation to each other for limited movement relative to said second holder along said axis, resilient means for urging said pair of first cams toward said first holder to an advanced position on said second holder so that in response to relative movement between said first and said second holders toward each other said first cams will effect the actuation of said jaws into clamping engagement with the article and thereafter allow relative movement between said first cams and said second holder, and a second cam fixedly mounted on said second holder operable in response to relative movement between said first cams and said second holder for effecting the actuation of said knurling die to knurl said article.

6. An apparatus for knurling articles comprising a first holder and a second holder mounted for movement relative to each other along an axis, a pair of jaws mounted on said first holder for movement of one jaw toward and from the other jaw perpendicular to said axis for clamping the article therebetween, a knurling die mounted slidably on said first holder for movement perpendicular to said axis toward the article held by said clamping jaws, a first cam for actuating said movable jaw to clamp the article against the other jaw, means for mounting said first cam on said second holder for movement therewith and for limited movement relative thereto along said axis, resilient means for urging said first cam toward said first holder to an advanced position on said second holder so that in response to relative movement between said first and said second holders toward each other said first cam will effect the actuation of said movable jaw to clamp the article against the other jaw and thereafter allow relative movement between said first cam and said second holder, and a second cam fixedly mounted on said second holder operable in response to relative movement between said first cam and said second holder for effecting the actuation of said knurling die to knurl said article.

7. An apparatus for knurling opposite sides of flat articles comprising a first holder and a second holder mounted for movement relative to each other along an axis, a pair of clamping jaws mounted on said first holder for movement toward and from each other perpendicular to said axis and having a pair of flat parallel clamping surfaces for clamping the flat article therebetween, a pair of knurling dies mounted on said first holder for movement perpendicular to said axis toward and away from each other on opposite sides of an article clamped between said jaws, said knurling dies each having knurling teeth arranged in a row parallel to the clamping surfaces of said jaws, a pair of cams for actuating said clamping jaws, means for mounting said jaw actuating cams on said second holder for limited movement relative there-

7

to along said axis and in fixed relation to each other, resilient means for urging said jaw actuating cams toward said first holder to an advanced position on said second holder for movement therewith so that in response to relative movement between said first and said second holders toward each other said jaw actuating cams will effect the actuation of said jaws to clamp the article therebetween and thereafter allow for relative movement between said jaw actuating cams and said second holder, and a pair of die actuating cams fixedly mounted on said second holder and operable in response to relative movement between said jaw actuating cams and said second holder for effecting the actuation of said knurling dies to knurl said article therebetween.

8. An apparatus for knurling flat articles comprising a lower holder, an upper holder mounted above said lower holder for vertical movement relative thereto, a pair of clamping jaws mounted on said lower holder for horizontal movement toward and from each other and having a pair of clamping surfaces for clamping the article therebetween, a pair of knurling dies mounted slidably on said lower holder for horizontal movement toward and away from the article held by said clamping jaws, said dies each having knurling teeth arranged in a row parallel to said clamping surfaces, a pair of cams for actuating said clamping jaws, means for mounting said cams on said upper holder for limited relative vertical movement between said cams and said upper holder, resilient means for urging said cams downward to an advanced position on said upper holder so that in response to downward movement of said upper holder said cams will effect the actuation of said jaws to clamp the article therebetween and allow further downward movement of said upper holder relative to said cams, and a pair of die actuating cams fixedly mounted on said upper holder and operable in response to downward movement of said upper holder relative to said jaw actuating cams for effecting the actuation of said knurling dies to knurl the article therebetween.

9. An apparatus for knurling opposite sides of flat articles comprising a lower holder, an upper holder mounted above said lower holder for vertical movement relative thereto, a pair of clamping jaws mounted on said lower holder for horizontal movement toward and from each other and having a pair of parallel clamping surfaces for clamping the article therebetween, a pair of knurling dies mounted slidably on said lower holder for horizontal movement toward and away from the article held by said clamping jaws, said dies each having knurling teeth arranged in a row parallel to said clamping surfaces, means mounted on one of said clamping jaws for feeding an article to an operative position between said knurling dies, a pair of cams for actuating said clamping jaws, means for mounting said cams on said upper holder for vertical movement therewith and for limited vertical

8

movement relative thereto, resilient means on said upper holder for urging said cams downwardly to advanced position on said upper holder so that in response to downward movement of said upper holder said cams will effect the actuation of said jaws toward each other to clamp the article therebetween and to allow further downward movement of said upper holder relative to said cams, and a pair of die actuating cams fixedly mounted on said upper holder for vertical movement therewith and operable in response to downward movement of said upper holder relative to said jaw actuating cams for effecting the actuation of said knurling dies toward each other to knurl the article therebetween.

10. An apparatus for knurling opposite sides of flat articles comprising a lower holder, an upper holder mounted above said lower holder for vertical movement relative thereto, a pair of clamping jaws mounted on said lower holder for horizontal movement toward and from each other and having a pair of obliquely disposed flat parallel clamping surfaces for clamping the flat article therebetween, a pair of knurling dies mounted slidably on said lower holder for horizontal movement toward and away from the article held by said clamping jaws, said dies each having knurling teeth arranged in a row parallel to said clamping surfaces, a pair of cams for actuating said clamping jaws, means for mounting said cams on said upper holder for vertical movement therewith and for limited relative vertical movement between said cams and said upper holder, resilient means on said upper holder for urging said cams downwardly to advanced position on said upper holder so that in response to downward movement of said upper holder said cams will effect the actuation of said jaws toward each other to clamp the article therebetween and be stopped thereby and to allow further downward movement of said upper holder relative to said cams, a pair of die actuating cams fixedly mounted on said upper holder for vertical movement therewith and operable in response to downward movement of said upper holder relative to said jaw actuating cams for effecting the actuation of said knurling dies toward each other to knurl the article therebetween, said clamping surfaces being disposed at approximately 35° from the horizontal, said jaw actuating cams having cam surfaces disposed at an acute angle of approximately 26° 34' from the vertical, and said die actuating cams having cam surfaces disposed at approximately 45° from the vertical.

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