

[54] **DIES FOR MAKING SELF-LOCKING
SCREWS AND METHOD OF MAKING
SAME**

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Related U.S. Application Data

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1968, Pat. No. 3,517,717.

[52] U.S. Cl. 72/88, 72/469
[51] Int. Cl. B21h 3/06
[58] Field of Search 72/88, 90, 469

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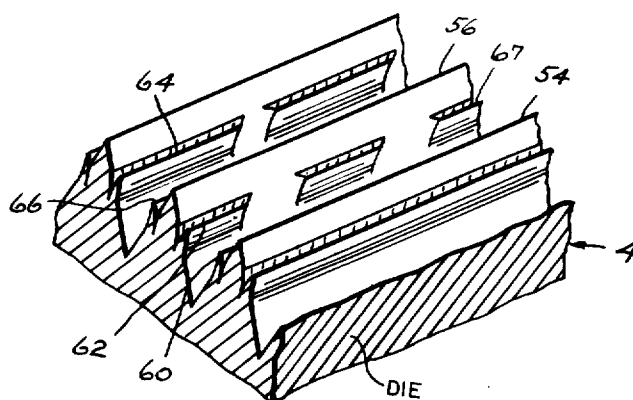
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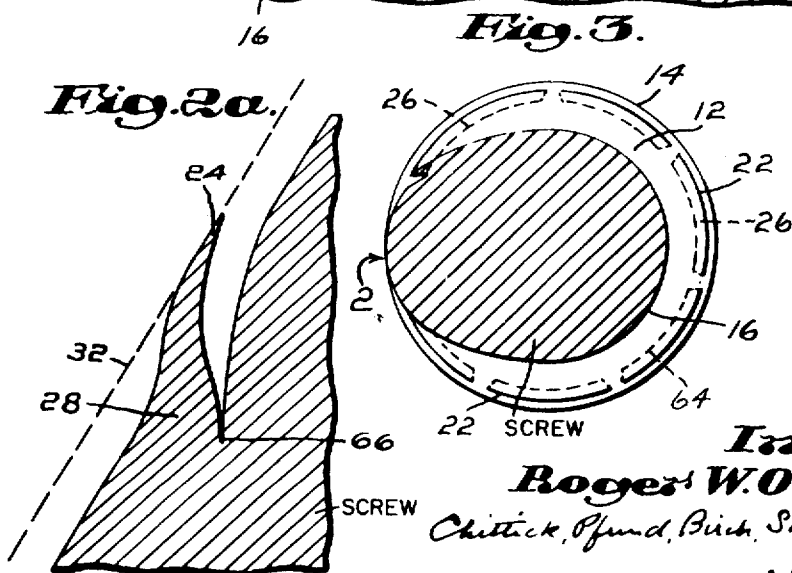
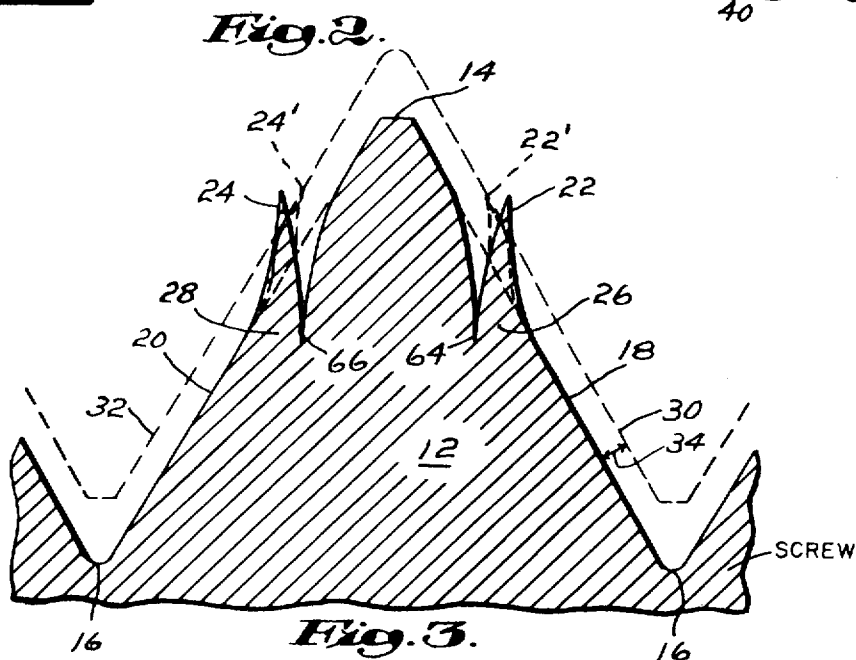
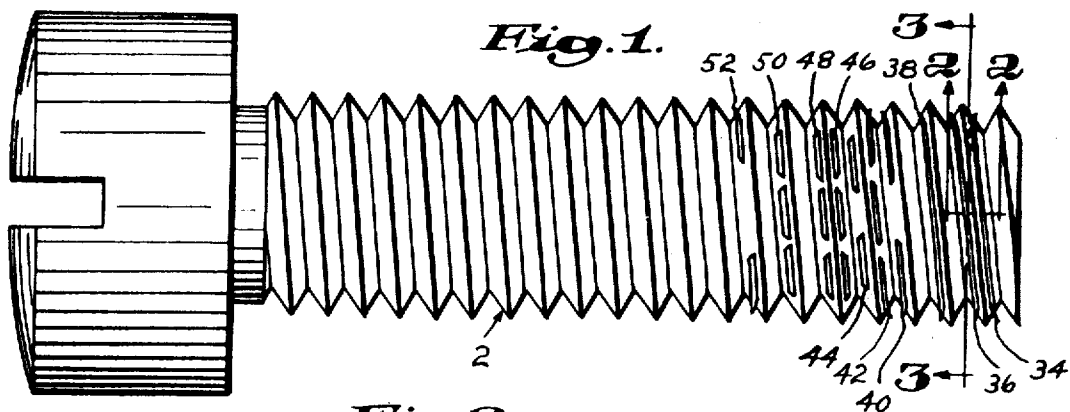
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[57] **ABSTRACT**

This invention relates to self-locking screws, thread rolling dies for and the method of making such screws. The self-locking result is achieved by forming one or more outwardly turned ribs, continuous or discontinuous, in the flank or flanks of one or more turns of the threads over a selected length of the screw. The screw threads and ribs therein may be made by the use of conventional thread rolling dies in which certain selected threads in one or both of the dies, over a suitable length have been deformed in a particular manner. The deformed die threads must be so located that the self-locking ribs formed in the threads of the screw will not be subsequently wiped out by encounter with the undeformed threads in the other die. Preferably, the ribs have the leading and trailing ends thereof faired back into the flank of the screw thread sufficiently to facilitate entry into and removal from the internal thread.

24 Claims, 46 Drawing Figures





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Fig. 4.

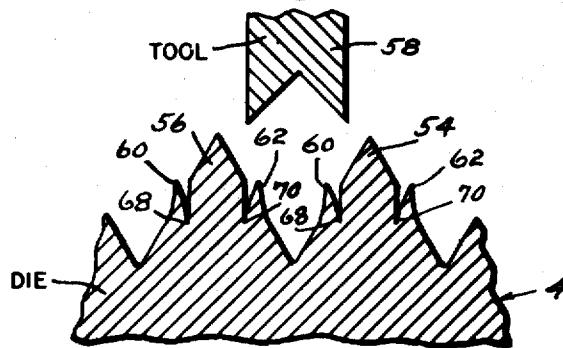


Fig. 5.

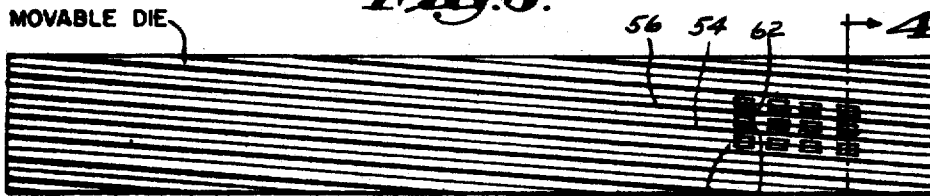


Fig. 6.

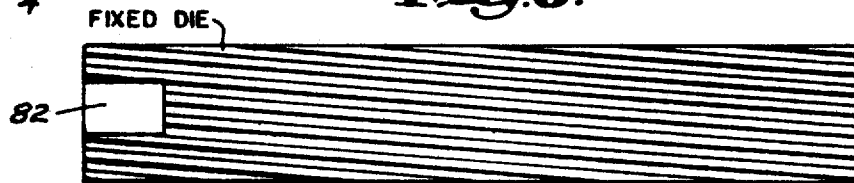
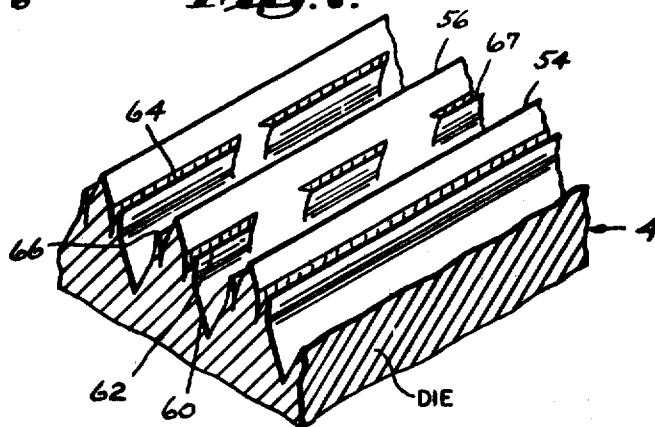
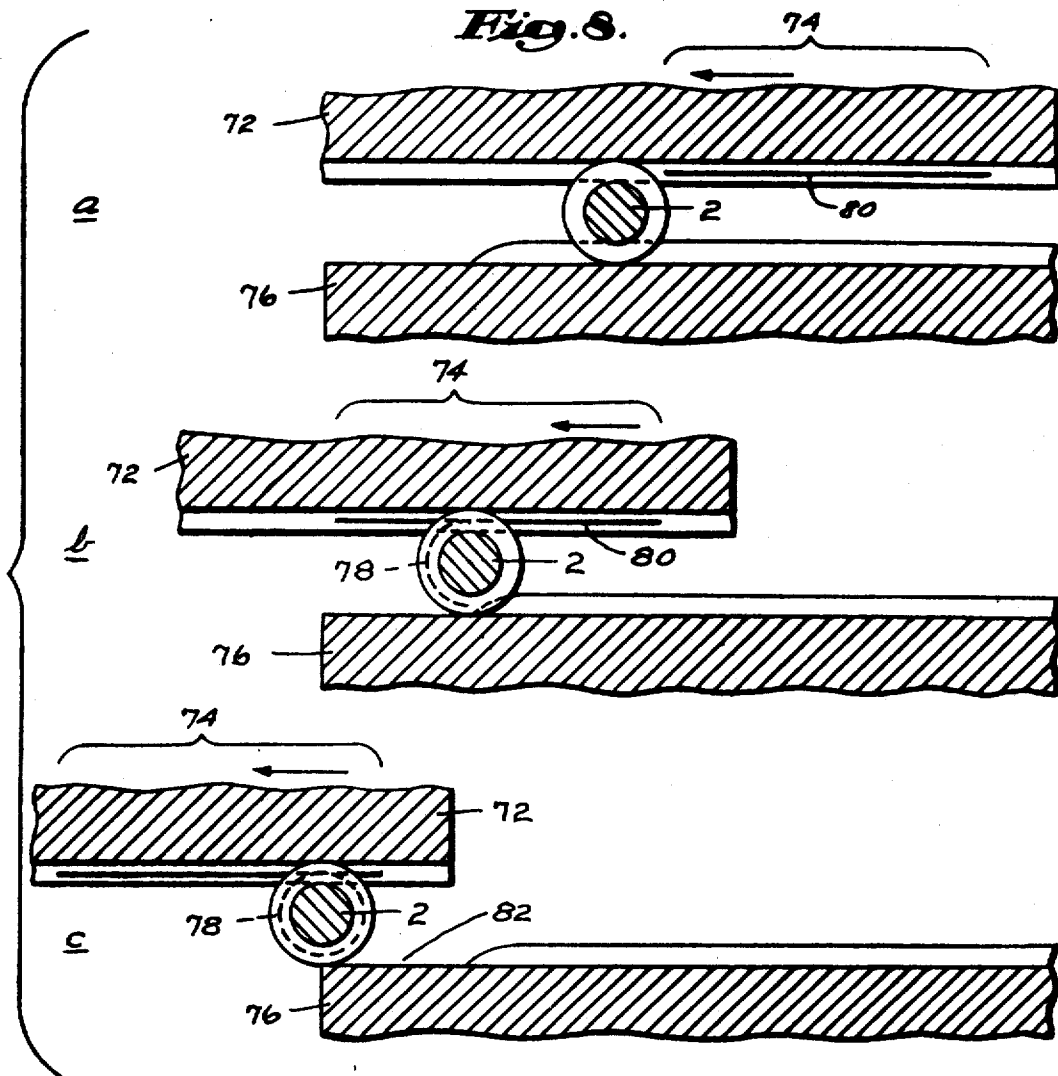


Fig. 7.



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Fig. 9.

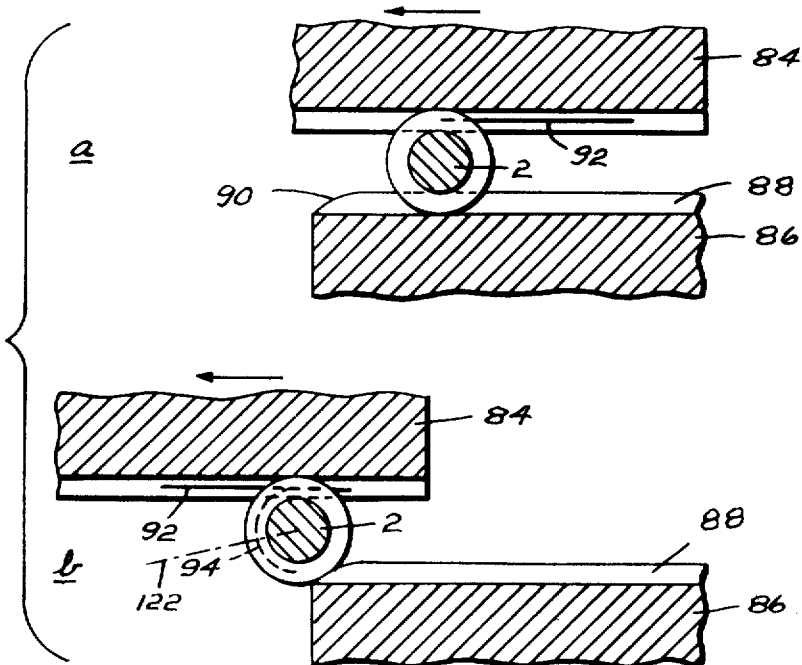
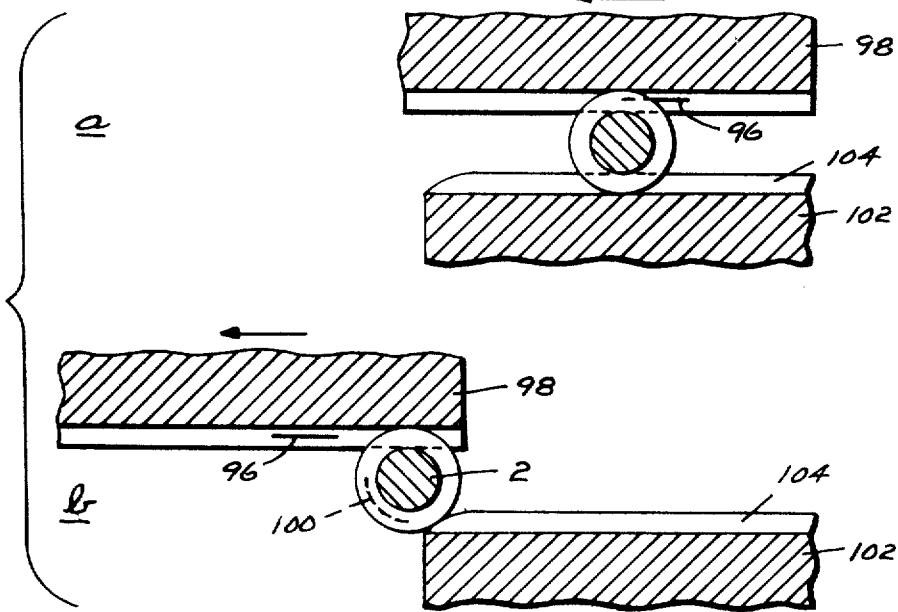


Fig. 10.

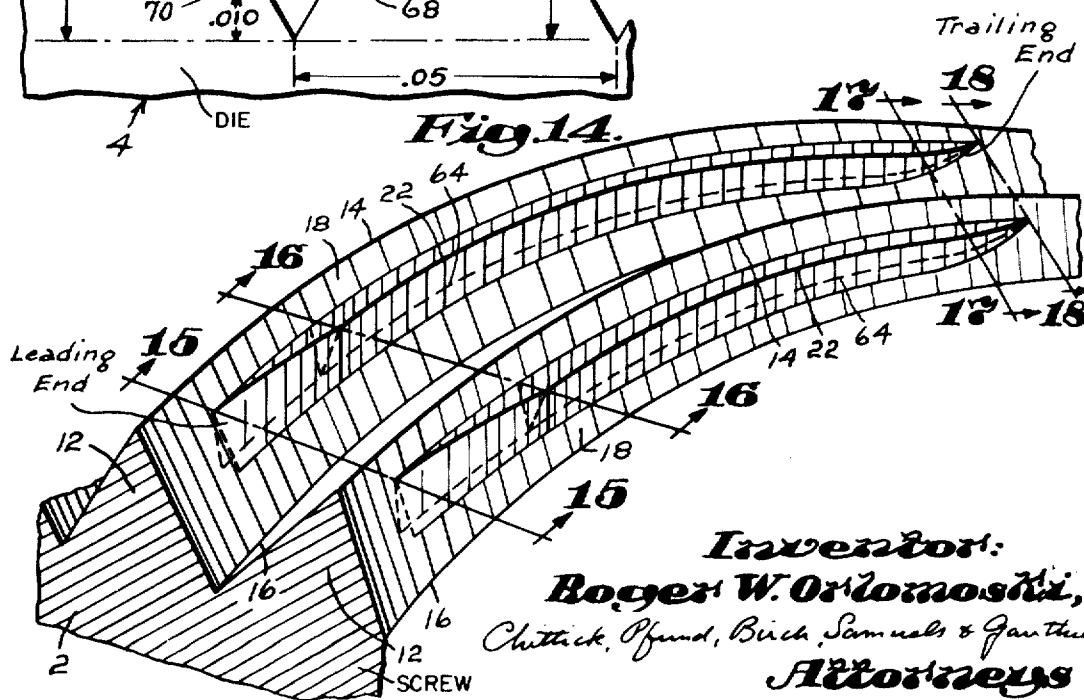
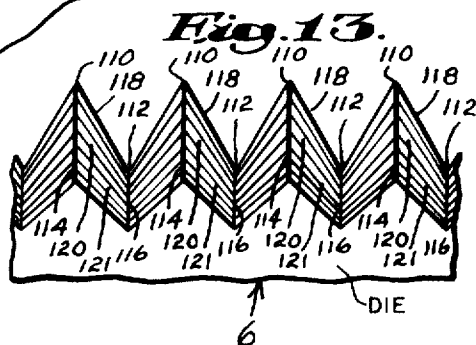
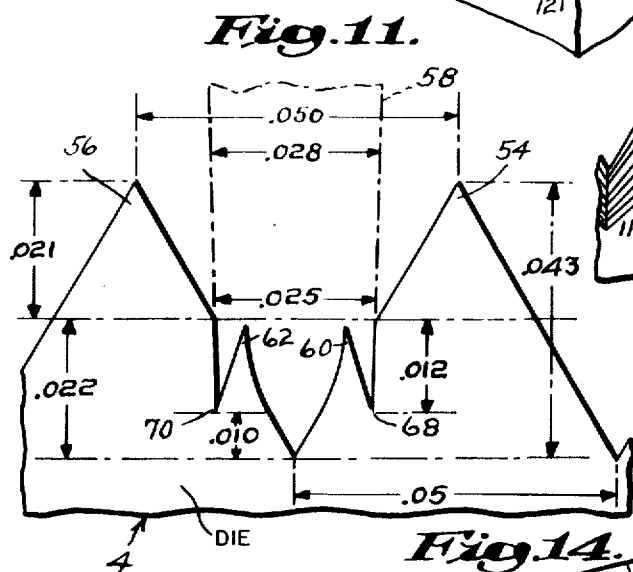
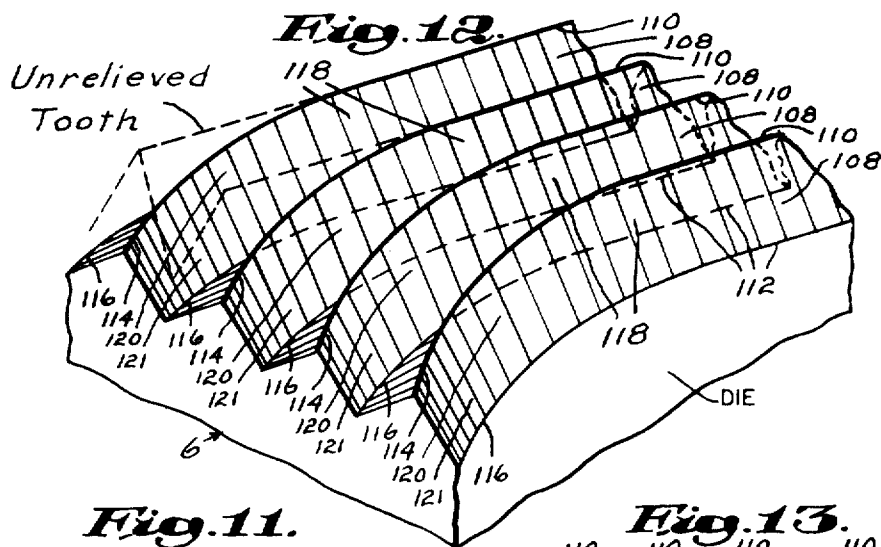


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Fig. 15.

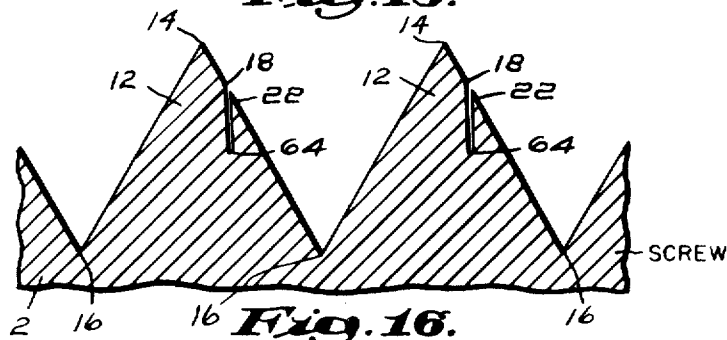


Fig. 16.

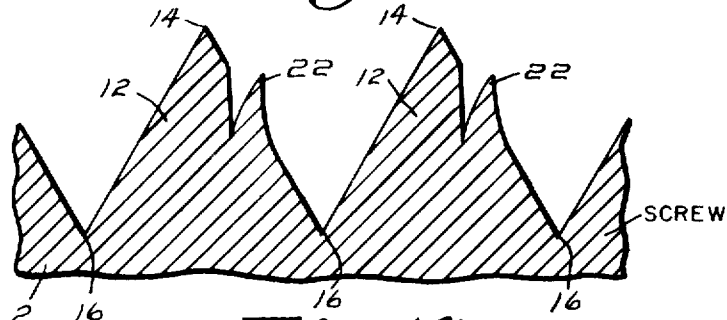


Fig. 17.

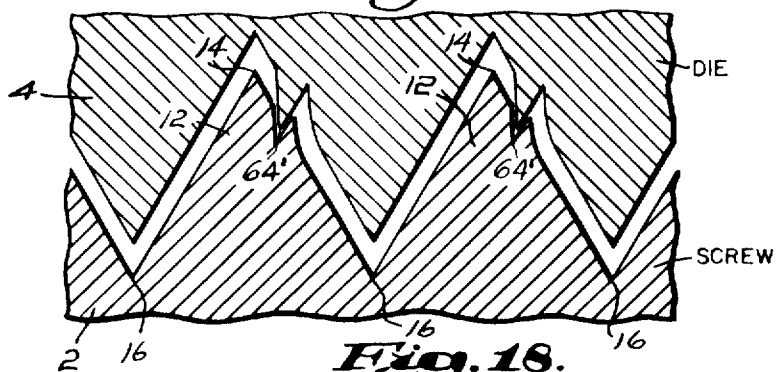
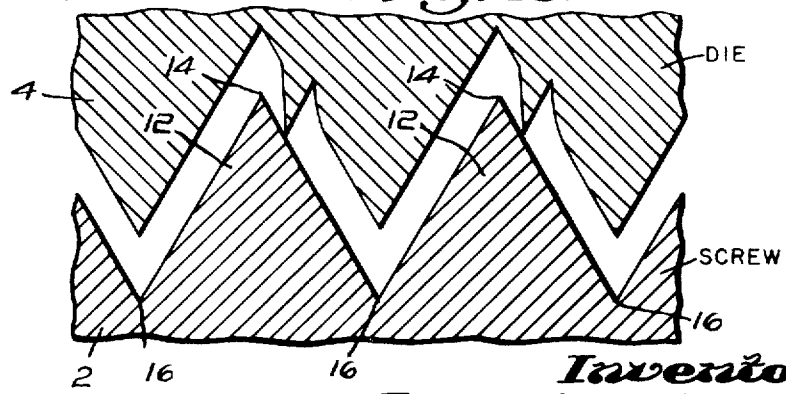
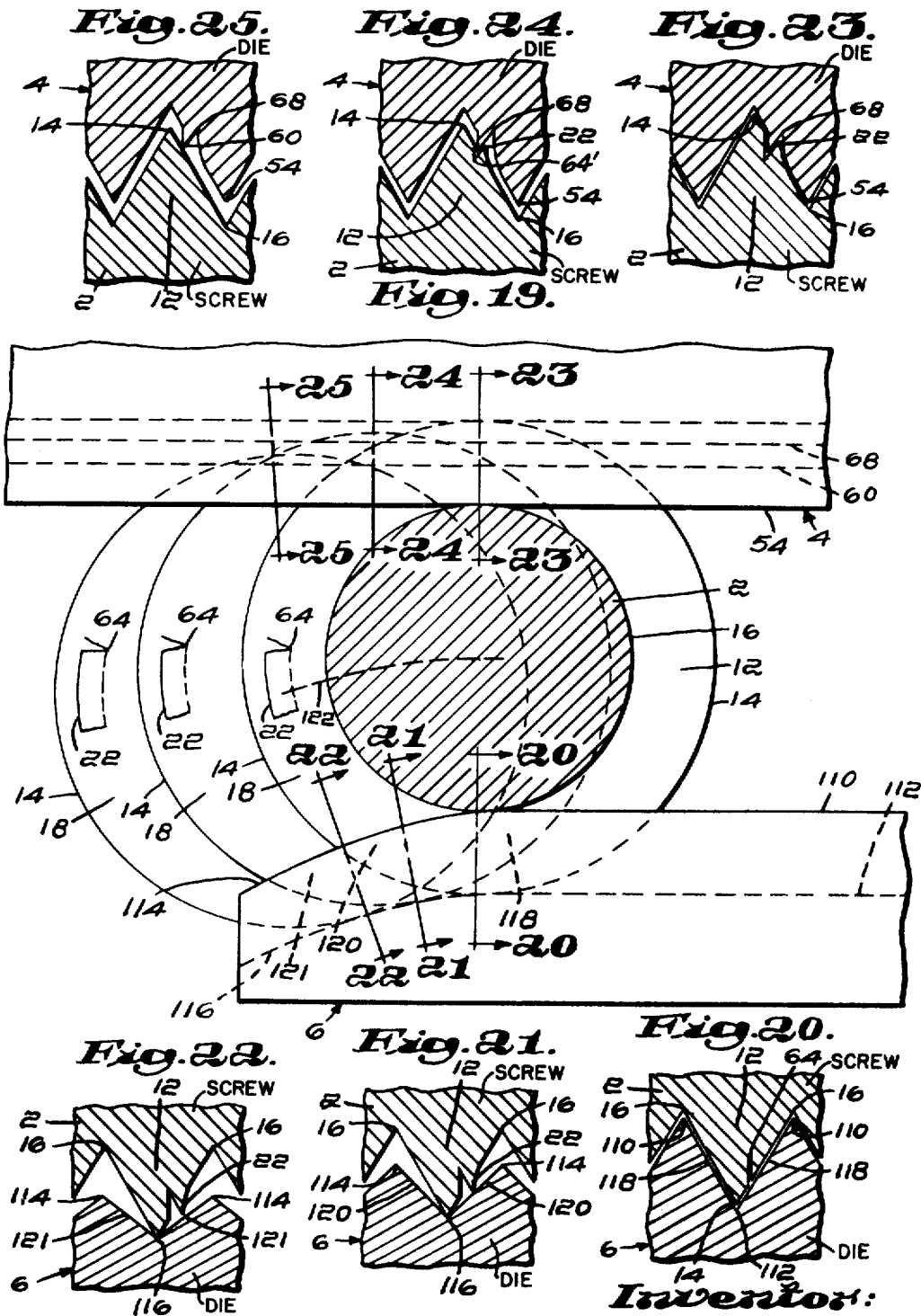


Fig. 18.



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Fig. 26a.

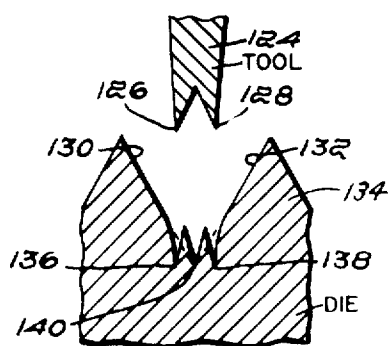


Fig. 26b.

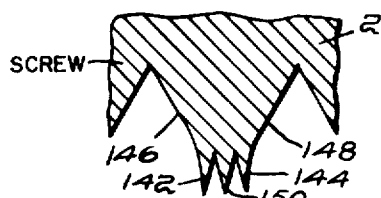


Fig. 29a.

Fig. 27a.

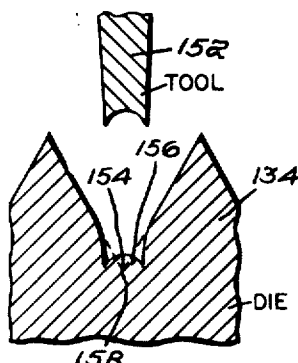


Fig. 27b.

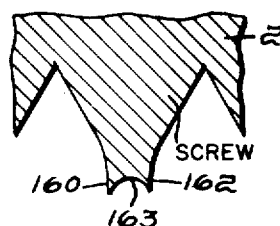


Fig. 28a.

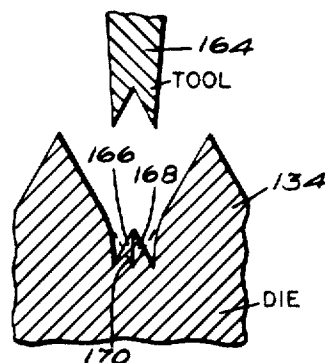


Fig. 28b.

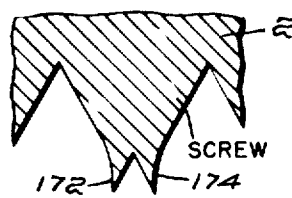
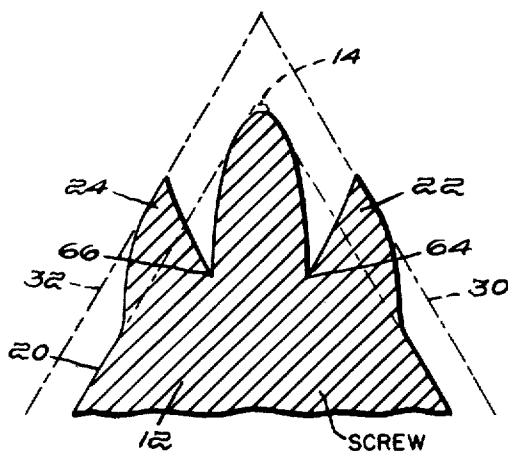


Fig. 30.

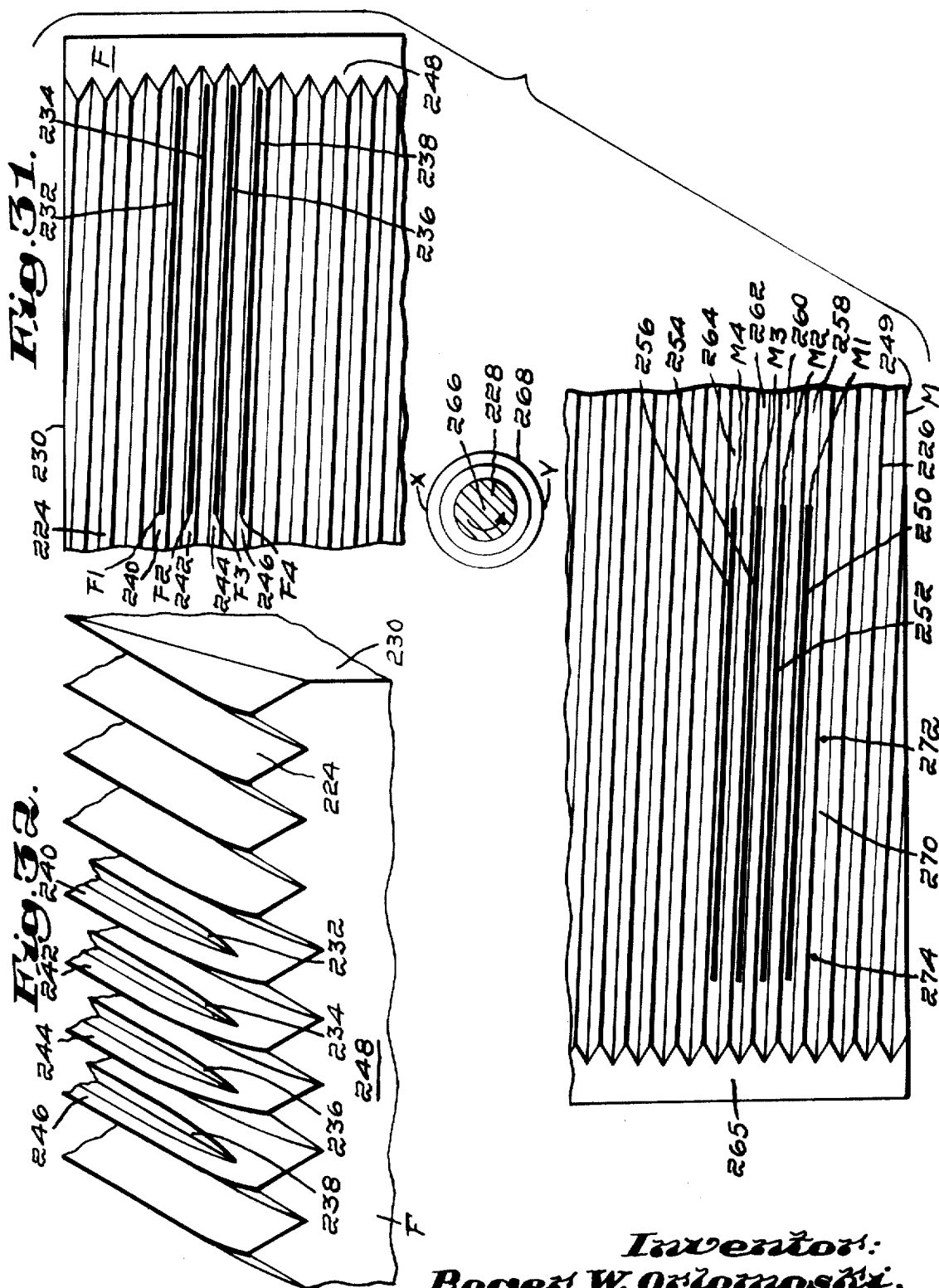


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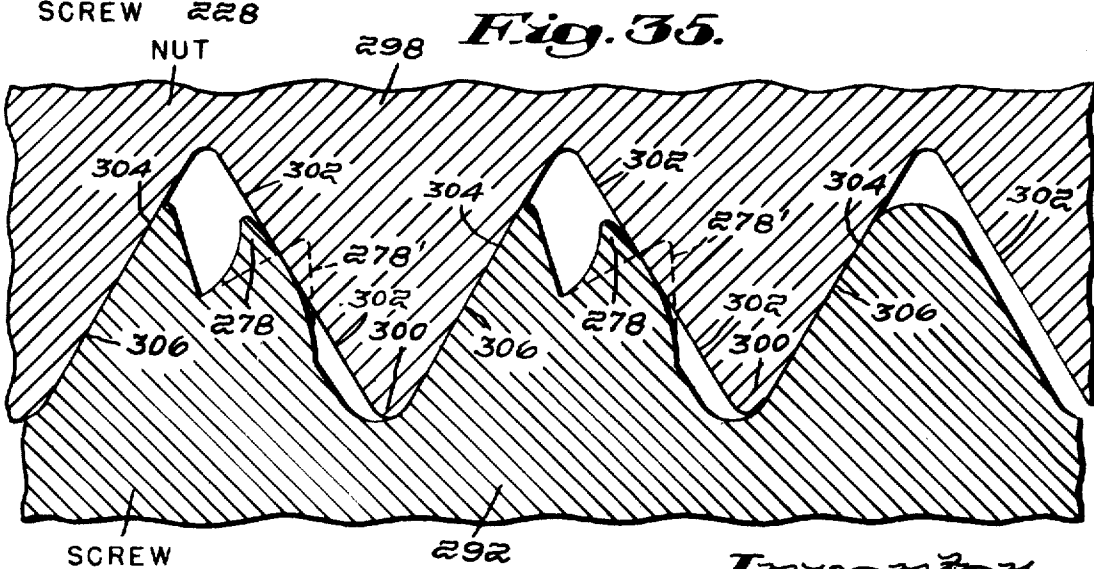
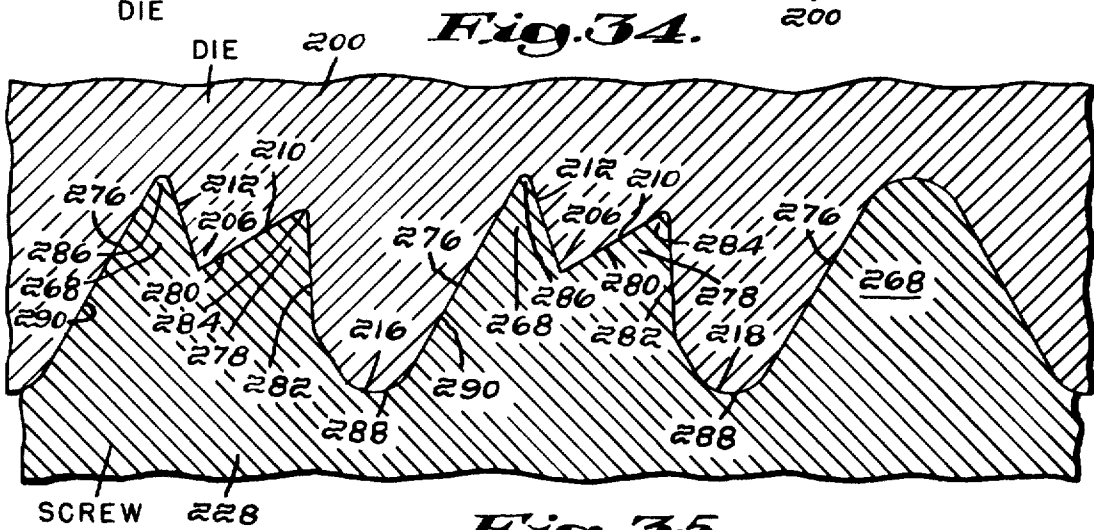
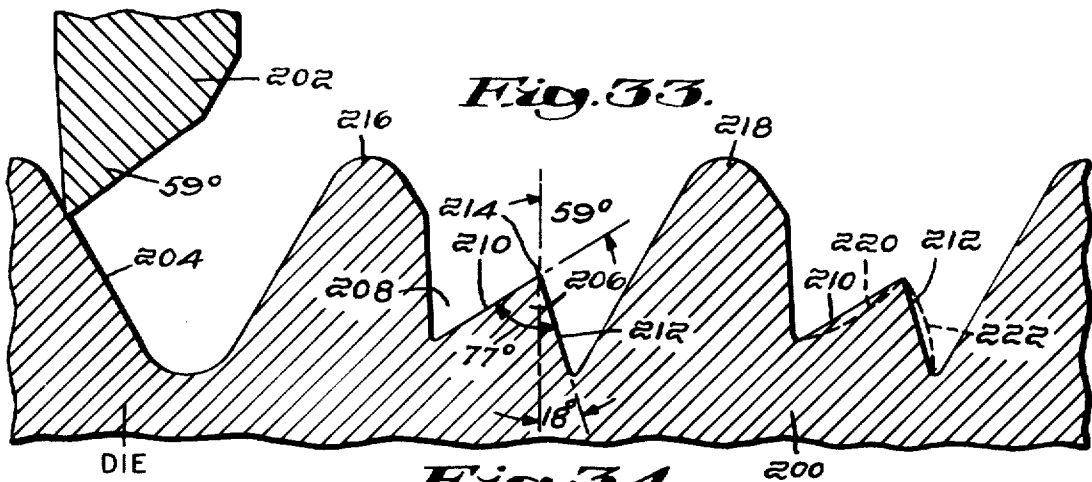
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Fig. 36.

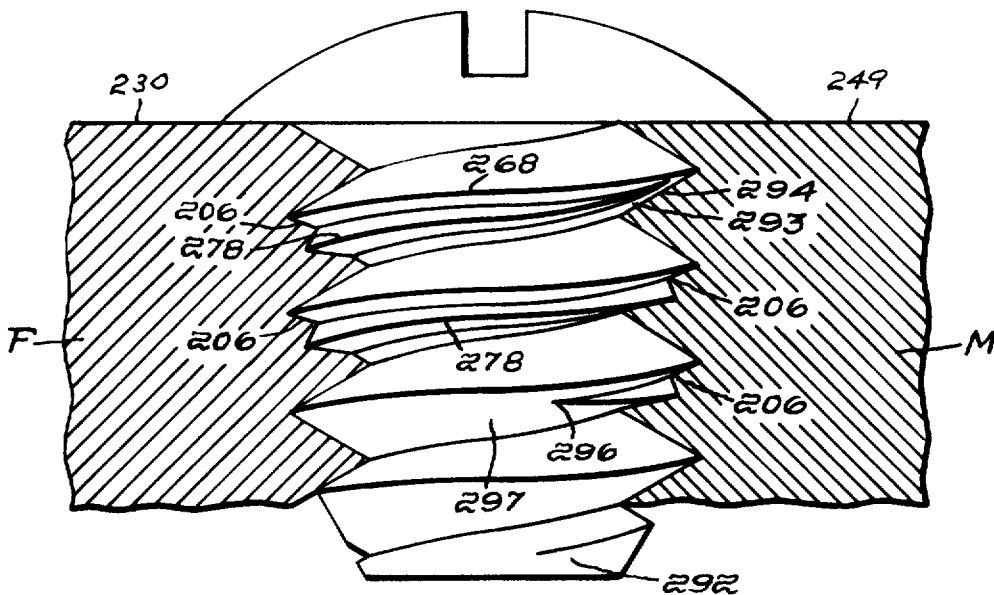
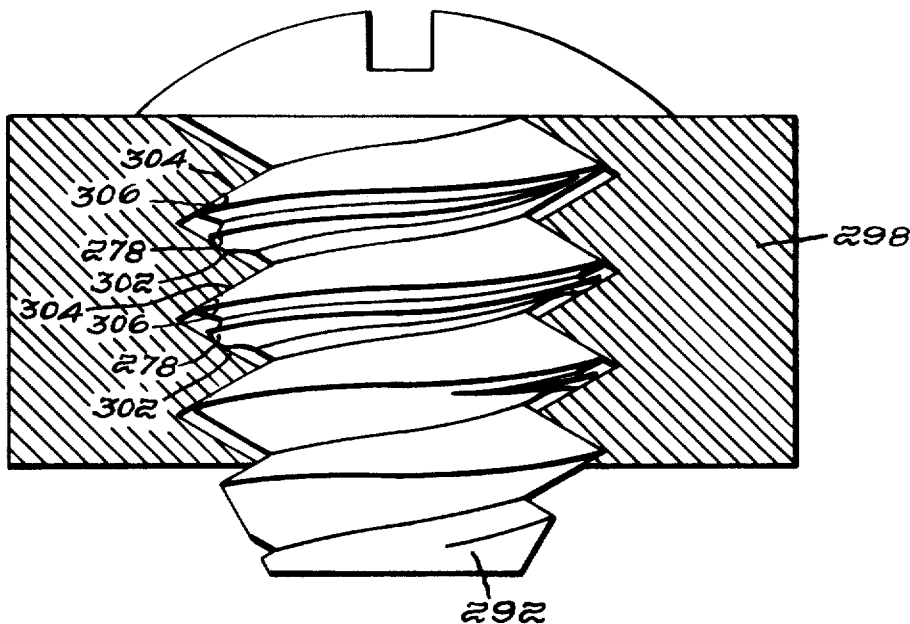


Fig. 37.



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DIES FOR MAKING SELF-LOCKING SCREWS AND METHOD OF MAKING SAME

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a Continuation-in-part Application of copending U.S. Patent application of Roger W. Orlomoski for SELF-LOCKING SCREWS, Ser. No. 734,833, filed May 3, 1968, now U.S. Pat. No. 3,517,717 issued June 30, 1970, which is a Continuation-in-part Application of U.S. Patent Application of Roger W. Orlomoski for SELF-LOCKING SCREWS AND DIES FOR MAKING SAME, Ser. No. 701,944, filed Jan. 31, 1968 (now abandoned).

BACKGROUND OF THE INVENTION

The need for screws which will be self-locking when screwed into correspondingly threaded nuts or apertures is self evident and much has been done heretofore to achieve this result. In fact, the Locking Fastener Section of the Industrial Fasteners Institute has established specifications for the locking characteristics of prevailing torque type locking screws. The standards generally contemplate that a self-locking screw of given size when screwed into a nut of correct size will require no more than an established amount of torque measured in inch-pounds to make the initial installation. This requirement is coupled with a minimum breakaway torque for the same screw after it has been removed, reinserted and removed four additional times. That is, the torque required to achieve the fifth removal must not be less than the established standard.

The prior art is fairly extensive in this field with the most common form of self-locking structure being of the type which embodies in or between the threads some kind of yieldable non-metallic material that has been secured to the threaded structure by a secondary operation. Other types are in the general class of deformed threads or mis-matched threads, which create increased friction between the threads of the screw and the corresponding internal threads of the nut.

SUMMARY OF THE INVENTION

In summary, the present invention, in which the claims are to the dies and method only, contemplates that the flank or flanks of the thread of the screw for a selected number of turns, or fractions thereof, be formed in a novel manner in which a portion of the body of the thread is wedged outwardly by special formations in one or both of the thread rolling dies to produce one or more ribs extending either continuously or intermittently around one or both of the flanks of the thread of the screw and the outer edge of the rib is intermediate the crest and root. In some instances, it may be considered desirable to have the rib well up on the screw flank to engage against the corresponding flank of the nut thread closer to the nut thread root. When this construction is made, the edges of the ribs may extend to a radius the same as or even slightly greater than the radius of the screw crest, but the ribs are still defined as being intermediate (between) the root and crest of the screw thread. In still other modifications, the die may be designed to produce the ribs while changing the character of the crest previously created in the thread rolling operation.

In all cases, the ribs extend away from the screw thread flank a distance somewhat greater than the normal clearance between the screw and the nut into which it is to be screwed so that part of the outer surface of the rib will come into contact with the corresponding flank of the thread of the nut. The rib, because of its particular configuration, has a degree of elasticity or flexibility so that when the screw is screwed into the nut or other internal thread, the rib bends back toward the flank of the screw to the extent required by the clearance. This produces a degree of friction between the screw and the nut that diminishes very slowly on repeated insertion and removal. Tests have shown that the frictional characteristics achieved by proper sized ribs cause screws so made to meet easily the installation and breakaway torque specifications set up by the Industrial Fasteners Institute. Repeated tests have shown that

on the fifth removal, screws made according to the present invention have a much higher breakaway torque than the standard called for and the breakaway torque is still exceeded after as many as fifteen removals. The frictional effect is achieved without detrimental galling or gouging of the flanks of the internal thread.

The invention further contemplates that the ribs may be placed on the flank or flanks of the screw threads either to extend continuously around the thread, intermittently around the thread, on one side or the other or on both sides of the threads, or in any desired staggered relationship. In other words, the user may select any configuration of rib arrangement he prefers and the thread rolling dies can readily be shaped to achieve this result.

Further, the leading and trailing ends of the ribs may be tapered gradually back into the flanks, the tapering being automatically accomplished by the action of the dies.

The invention further contemplates two types of die constructions for producing self-locking screws according to the foregoing description. The first type has ribs on the threads of only one of the pair of dies, as disclosed in the above referred parent application, Ser. No. 701,944. The second type, now disclosed in this application, has the ribs on the threads of both dies which facilitates producing ribs on the screw running continuously along any desired number of threads.

The dies of both types are made according to conventional practices up to the point where they are ready for hardening. Then, through the use of a suitable tool or tools, the walls or flanks of the thread forming grooves of one or both of the dies are deformed over a suitable number of threads, and for a proper length and at a particular longitudinal position in the die or dies in a manner which will result in the flank or flanks of the thread of the screw being correspondingly deformed just prior to discharge of the screw from the dies. After the threads of the die or dies have been deformed to produce the type of ribs required, the dies are hardened and are then ready for use in a conventional thread rolling machine.

In the case of the first type of dies which have ribs in one die only, it will be apparent to those familiar with this art that the deformed threads in the die must be located near the rear end of one of the dies (preferably the movable die) so that once the ribs have been created in the thread of the screw, they will not be washed out by coming into engagement with the finishing portion of the thread grooves at the end of the other die. For ease in discussion of the first type of dies, hereinafter it will be assumed that the movable die is the one with the deformed flanks. When the self-locking ribs are extended no more than 180° about the threads of the screw, then no special attention need be given to the fixed die. When the ribs are to completely encircle the screw, then in a preferred construction the corresponding threads in the fixed die which would normally tend to wipe out the ribs formed in the threads by the movable die are cut away to provide a relief area at the end of the fixed die, thus precluding any modification of the self-locking ribs just formed by the movable die. It will be understood, however, that in the preferred form the leading end of the rib in the screw thread will engage the fixed die before discharge to taper the rib back into the flank.

In the case of the second type of die, the ribs are formed in both dies at locations near the ends of the dies. Preferably, but not necessarily, the ribs are so positioned that when the leading ends of the ribs come opposite each other, the axis of the then threaded workpiece will be more or less between the leading ends. Thus, the commencement of rib generation in the workpiece threads will occur at approximately the same time at positions 180° apart. The ribs on one die, preferably the short stationary die, are one half pitch closer to the top edge than the ribs on the other die. This is necessarily so if the screw threads are to be simultaneously engaged by the die ribs. The die ribs of both dies may extend along the die threads for a length more or less equal to the circumferential length of the screw thread ribs without damaging the ribs just created in the screw threads. The reason for this is that the screw thread

rib created by one die falls into the cavity of the other die after 180° of rotation and joins the rib created by the other die.

The ends of the ribbed threads of the short die are preferably relieved enough to clear the screw thread ribs produced by the other die as the screw rolls off the end of the short die. This relief compensates for machine spring-back which is common to this type of thread rolling and substantially eliminates deformation of the screw thread rib as it passes the relieved end section. Also, the end of the uppermost screw thread rib will encounter a smooth flank in the other die after 180° rotation to be faired back into its flank.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation, considerably enlarged, of one type of screw that may be made by conventional thread rolling dies. At the right hand end are shown a number of different arrangements the ribs may take. There are intermittent ribs on one flank only, intermittent ribs on two flanks, intermittent ribs staggered from one flank to the other, a continuous rib on one flank only, and continuous ribs on two flanks. The leading and trailing ends of the ribs are preferably tapered back into the screw thread flanks to provide for a non-galling contact with the flanks of the internal thread on both conditions of entry and backing out.

FIG. 2 is a greatly enlarged section of one thread taken on the line 2—2 of FIG. 1 showing the relationship of the ribs to the internal thread.

FIG. 2a is an enlarged fragmentary view of a portion of FIG. 2 showing in greater detail an approximation of the character of the engagement of the rib with the internal thread.

FIG. 3 is an enlarged section taken on the line 3—3 of FIG. 1.

FIG. 4 is an enlarged transverse section of two adjacent threads of the movable die of a pair of thread rolling dies taken on the line 4—4 of FIG. 5 showing the manner in which the threads are deformed. A tool capable of achieving such deformation is positioned thereabove.

FIGS. 5 and 6 represent a pair of cooperating thread rolling dies showing schematically the appearance of the grooved faces thereof and the location of the deformed grooved walls in the movable die, FIG. 5, and the relieved area in the fixed die, FIG. 6, which is necessary when the ribs are to extend for more than 180°.

FIG. 7 shows an enlarged perspective view of a few adjacent threads of a die illustrating a few different arrangements in which the threads may be deformed by the use of suitable tools according to the suggested procedure in FIG. 4.

FIGS. 8a, 8b and 8c show three sequential views of the rolling operation in which the ribs are generated to extend a full 360° about the threads. The fixed die is relieved at the end to prevent washing out of the ribs as they pass this area.

FIGS. 9a and 9b show two sequential views of the fixed and movable dies arranged to produce a rib extending 180° more or less about the threads.

FIGS. 10a and 10b show two sequential views in which the dies are arranged to create a rib of less than 180° in the screw thread.

FIG. 11 is an enlarged cross sectional view of two adjacent threads of a rib forming die showing details of a construction that has been used to produce satisfactory ribs on the threads of a ¼×20 screw.

FIG. 12 is a perspective view of the discharge end of the fixed dies showing the relief of the ends of the threads which causes the ends of the ribs on the thread of the screw to be tapered back in against the flank.

FIG. 13 is an end view of FIG. 12.

FIG. 14 is a fragmentary perspective view of ribs of any length in two adjacent threads. The leading end of the rib has been faired back into the flank by the relieved threads at the end of the fixed die. The trailing end of the rib tapers back to the flank because of the decreasing rib producing effect of the movable die against the screw thread as the screw moves away

from the die as permitted by the relieved threads at the end of the fixed die.

FIG. 15 is a section taken on the line 15—15 of FIG. 14.

FIG. 16 is a section taken on the line 16—16 of FIG. 14.

FIG. 17 is a section taken on the line 17—17 of FIG. 14 showing the movable die only partially in contact with the screw thread.

FIG. 18 is a section taken on the line 18—18 of FIG. 14 showing the movable die out of contact with the screw thread.

FIG. 19 is an enlarged plan view generally similar to the position of the dies and screw shown in FIG. 9b. This illustrates the progressive movement of the screw thread and rib thereon with respect to the relieved fixed die that fairs the leading end of the rib into the flank and the movement of the rib away from the movable die to eliminate gradually the rib thus to taper the trailing end of the rib into the flank.

FIG. 20 is a cross section taken on line 20—20 of FIG. 19.

FIG. 21 is a cross section taken on line 21—21 of FIG. 19.

FIG. 22 is a cross section taken on line 22—22 of FIG. 19.

FIG. 23 is a cross section taken on line 23—23 of FIG. 19.

FIG. 24 is a cross section taken on line 24—24 of FIG. 19.

FIG. 25 is a cross section taken on line 25—25 of FIG. 19.

FIG. 26a shows in cross section a die construction in which the rib forming grooves are on a level with the root.

FIG. 26b shows in cross section a thread of a screw having ribs produced by the die of FIG. 26a.

FIG. 27a and 27b show a further modification in the die and the ribs in the screw thread produced thereby. The conventional crest has been eliminated but the ribs remain.

FIGS. 28a and 28b show another variation of die and the ribs in the screw thread with the conventional crest eliminated.

FIGS. 29a and 29b show still another variation of die and thread created thereby.

FIG. 30 is an enlarged fragmentary section of a screw thread showing the ribs near the crest and engaging the nut flanks close to the nut root.

FIG. 31 shows a pair of the second type of dies with their faces turned from vertical operating position to horizontal with the workpiece therebetween.

FIG. 32 is an enlarged broken away perspective view of the trailing end of the short die of FIG. 31 with the ends of the threads containing the die ribs relieved.

FIG. 33 is an enlarged fragmentary section of one of the dies showing the rib formation and tool used to create the ribs.

FIG. 34 is an enlarged fragmentary section of two ribbed threads of the die and the resulting ribs created in the screw as the threaded workpiece rolls between the dies.

FIG. 35 is an enlarged fragmentary section showing the screw of FIG. 34 screwed into a nut with the ribs bent to create the self-locking effect.

FIG. 36 is an enlarged fragmentary vertical section of the ribbed dies of the second type creating ribs on the threads of a screw passing therebetween.

FIG. 37 shows the screw of FIG. 36 screwed into a nut with the ribs bent by engagement with nut flank to create the self-locking result.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring first to FIG. 1, it will be understood that the threaded screw therein indicated at 2 is representative of any type of screw capable of being made by conventional thread rolling dies. Such dies are indicated generally at 4 and 6 in FIGS. 5 and 6. The construction of these dies and the method of using them is well understood and details need not be shown herein. Suffice it to say that the shorter die 6 is held stationary in the machine, the longer die 4 is moved back and forth parallel to die 6, the round workpiece is introduced between the properly spaced dies, and as it rolls therebetween, the metal of the workpiece is progressively deformed by the teeth of the dies. When the movable die 4 has carried the rotating workpiece to the end of the fixed die, the threads of

the screw will be fully formed and the completed screw will fall away.

According to the present invention, it is proposed that certain of the threads of the die 4 at a suitable location, as for example at the area 8, be deformed in the manner generally indicated in FIG. 4. The result of this die construction is that when the workpiece has reached a point between the dies where it is about to commence to roll through the deformed threads at the area 8, the screw threads themselves will have been fully formed and hence ready to take the deformation provided by the deformed walls of the threads in section 8 and as shown in cross section in FIG. 4.

Reference will now be made in FIGS. 1 to 4 and 7 to point out more particularly the nature of the deformation that is made in the flank or flanks of the thread of the screw to provide the self-locking characteristics.

Referring first to FIGS. 2 and 3, the crest of the screw thread 12 is indicated at 14, the root at 16, and the flanks at 18 and 20. The rib which acts as the self-locking means is indicated at 22 in flank 18 and at 24 in flank 20. The thread 12 has initially been formed by the thread rolling dies 4 and 6 in conventional manner. On reaching a certain part of the movable die near the discharge end thereof, the completed screw thread rolls along a portion of the die which in cross section has the configuration shown in FIG. 4 and produces ribs in the screw threads. These ribs 22 and 24 taper from a thin outer portion to a thicker base as at 26 and 28. The configuration of each rib is determined by the extent of the entry of the corresponding portion of the movable die into the screw thread flanks.

The dotted lines 30 and 32 in FIG. 2 represent the corresponding walls of the internal threads into which the screw is threaded. The distance 34 is representative of the clearance available according to standard design practice. Accordingly, it is essential that the ribs 22 and 24 extend away from the flanks of the thread a distance somewhat greater than the clearance 34 so as to bring a frictional force against the walls 30 and 32 when the screw 12 is in position within the internal threads. As the screw is forced therein, the ribs 22 and 24 come into engagement with the walls of the nut and are sprung inwardly to positions indicated at 22' and 24' which positions may or may not be within the elastic limits of the ribs 22 and 24. If the degree of bending of the rib when the screw is initially inserted in the nut exceeds the elastic limit, then upon removal of the nut the rib will spring away from the flank to assume an expanded position of less dimension than the original rib size. When the nut is reapplied to the screw, the bending of the rib will then be within the elastic limit. Subsequent removals and reapplications of the nut will not cause any further bending of the rib beyond its elastic limit at its new position and the locking capacity of the rib against the nut flank, diminished only by wear between the engaging surfaces, will be continuously maintained. When the nut is applied, the inner wall of the rib is placed in compression and the outer wall in tension.

The ribs 22 and 24 which extend continuously or intermittently over a selected number of turns of the screw thread provide a resistance to turning within the internal threads that meets the standards for both installation and breakaway torque. Since the displacement of the ribs to the positions at 22' and 24' against the walls of the internal threads is generally within the elastic limit of the rib structure, it follows that when the screw is removed, the ribs in spite of wear will more or less resume their original expanded positions. Thereafter, when the screw is reinserted, the ribs will reassume the dotted line position 22' and 24' shown in FIG. 2 to provide the required self-locking force.

It will be noted that there is no appreciable weakening of the threads of the screw at the self-locking portions so that the screw does not lose its effectiveness as a securing element. Thus, because of the springlike character of the ribs, the self-locking nature of the unit remains present through repeated insertions and removal from the internal threads as in a nut or other threaded aperture.

The ribs 22 and 24 may be continuous around the threads as suggested at 34 and 36 in FIG. 1. This arrangement gives maximum self-locking capacity. A continuous rib on one flank only is shown at 38. Intermittent ribs on one flank only are shown at 40. Staggered ribs on both flanks are shown at 42 and 44. Intermittent ribs, but oppositely disposed on the flanks, are shown at 46 and 48. Short ribs closely spaced are shown at 50 on one flank only; longer ribs widely spaced are shown at 52 on one flank only.

The foregoing enumerated arrangements are not to be considered in any way limiting as the ribs may assume any desired pattern according to the rib producing configurations that are made in the threads of the movable die.

Turning now to FIGS. 4 and 7, there is illustrated a greatly enlarged cross section of the movable die showing threads taken on the line 4-4 of FIG. 5. When the thread creating portions 54 and 56 of the die were originally formed, the flanks thereof were undistorted in the manner of a normal thread. Thereafter, at selected areas, and for selected distances along the flanks, a tool 58 of a length to produce the required length of rib is driven downwardly against the unhardened die flanks forcing part of the metal outwardly to create ribs 60 and 62. After all of the ribs of the selected character and length have been formed in the movable die (some varieties of which are shown in the perspective view in FIG. 7,) the die is hardened. The die then becomes ready for use to create first the normal screw threads and then the ribs such as for example 22 and 24 shown in FIG. 2 when the screw reaches the area 8 of the movable die 4 and the screw threads are pressed against the ribs 60 and 62 of the die.

In FIG. 7, intermittent ribs are shown at 64; shorter intermittent ribs are shown at 66 and 67. The length of the ribs in the die flank is, of course, determined by the length of the tool 58.

In further explanation of the relationship of the die of FIG. 4 to the thread of FIG. 2, the leading edges of the ribs 60 and 62 of the die enter the flanks of the screw thread and form the base of the cavities in FIG. 2 as at 64 and 66 between the ribs 22 and 24 and the body of the thread 12. The ribs 22 and 24 are simultaneously created as the displaced metal of the screw thread 12 enters the cavities 68 and 70 of the die teeth.

It should also be noted that the self-locking feature of the screw as herein disclosed is effective with nuts or other internally threaded units having varying degrees of tolerances. The ribs 22 and 24 provide self-locking with a sloppy 2-b fit, or with a good 3-b fit. That is to say, the distance that the ribs 22 and 24 have been forced away from the body of the thread is sufficient to engage the wall or walls of loosely or close fitting nuts with sufficient frictional effect to meet the industry standards.

Attention is now called to FIGS. 8, 9 and 10 showing more particularly the location of the distorted walls or flanks on the movable die and the relative movement of the dies and screw threads while the ribs are being applied. While a continuous rib is shown in the movable die, it is to be understood that the rib in the die may be intermittent according to the manufacturer's preference. No limitation is to be placed on the length of the rib placed in the die for transfer to the thread of the screw.

In FIG. 8a the movable die is shown at 72 moving to the left. The selected thread grooves of the die have had ribs 80 formed over the length 74 at least equal to one full revolution of the screw 2. In FIG. 8b the movement of die 72 with respect to the fixed die 76 has caused the screw 2 to rotate 180° and has embossed on the screw thread the rib 78 which corresponds, for example, to rib 22 shown in FIG. 2. The rib 80 of the die has traveled a corresponding distance beyond the screw. In FIG. 8c the movable die 72 has traveled to the left an additional amount to cause the screw 2 to turn another 180° so that the rib 78 now extends around the thread for one full turn. In order to prevent the rib 78 from being washed out through engagement with the finishing thread grooves of the fixed die 76, the corresponding threads in the fixed die have been ground away to provide the relief area at 82. This relief area is also shown in FIG. 6.

In FIG. 9a, the movable die is shown at 84 and the fixed die at 86. The thread grooves of the fixed die 88 extend to the left hand end of the die in conventional fashion being relieved as at 90. The rib 92 of the movable die is shown ready to commence the development of the rib on the screw 2. In FIG. 9b, the movable die 84 has reached a point where the rib 92 has developed a corresponding rib 94 in the screw thread after 180° rotation of the latter, and at this point the screw 2 has reached the end of fixed die 86 and is ready to drop free. These illustrations are believed to make it clear that so long as the length of the die rib 92 is equal to or less than one-half a circumference of the screw thread, and if the leading end of the rib 92 is positioned the correct distance from the right hand end of the movable die 84, then the rib created in the screw thread will not thereafter engage any portion of the finishing threads of the fixed die, and accordingly will not be wiped out. It is, however, considered desirable for the leading end of the rib 94 to engage the fixed die enough to give a good lead on the screw thread rib and full explanation of this feature will be made hereinafter.

FIG. 10 is illustrative of a construction generally similar to that shown in FIG. 9 but in which the rib 96 of the movable die 98 is of shortened length to produce a correspondingly short rib 100 on the screw 2. Again if the leading end of rib 96 is correctly placed with respect to the right hand end of movable die 98, the screw will reach the end of the fixed die 102 before the newly created rib can engage any part of the threads 104 of the fixed die.

FIG. 11, considered with FIG. 4, is useful in explaining in more detail the construction of the ribs in the movable die which have produced satisfactory self-locking ribs in a ¼ in. × 20 machine screw. The ribs in the die are preferably on the root side of the pitch line so that the resulting ribs on the screw thread will be well up toward the crest. A 0.012 in. deep cut into the die flank starting at about the pitch line produces a suitable sized rib. The dimensions given are representative but in no way limiting. Other dimensions for producing different sized ribs on the screw threads may, of course, be used.

FAIRING THE RIBS INTO THE SCREW THREAD FLANKS

In the discussion heretofore, principal emphasis was directed to the self-locking ribs per se. Tests have shown that when the ribs at their leading and trailing ends extend abruptly away from the flank, there is a tendency or even likelihood that the cooperating internal threads may be galled or gouged by the end of the rib which acts in the nature of a cutting tool. This gouging does not destroy the self-locking character of the screw as it is not sufficient to eliminate the frictional effect of the ribs against the internal threads. However, the insertion and breakaway forces are reduced on repeated insertions and removals of the screw.

Accordingly, it has been found desirable to create the ribs in such manner that the leading and trailing ends are faired or tapered back to positions substantially flush with the screw thread flanks. This result is achieved automatically by the dies just prior to discharge of the completed screw.

For clarity in further discussion, the front end of the rib as it is initially created by the movable die will be called the leading end and the other end of each rib the trailing end. When the screw is put to use, the trailing end of the rib being nearer the point of the screw will then become the leading end as it initially enters the internal threads of the receiving element.

The leading end of the rib is forced and tapered back into the thread flank by engagement with the ends of the threads of the fixed die just before discharge. The ends of the threads of the fixed die have been relieved in such manner that after the leading end of the rib has been forced back into the flank, the rib is caused to taper gradually outward from the flank to its full width position. This tapering is done automatically by the relieved threads of the fixed die just prior to the discharge of the completed screw.

The trailing end of the rib is tapered back into the flank by a totally different procedure which occurs automatically and substantially simultaneously with the tapering of the leading end.

As the self-locking rib is being created in the screw thread by the rib in the thread of the movable die, the screw is, of course, under full pressure as it rolls between the dies. The die rib thus penetrates the screw thread flank to full depth.

As the screw closely approaches the end of the fixed die, it moves into the relieved area of the fixed die threads which, as explained above, automatically taper the leading end of the rib back into the flank. As this occurs, the relief of the fixed die threads permits the axis of the screw to move slightly but progressively away from the face of the movable die. The result is that the depth of entry of the movable die rib into the flank of the screw thread is correspondingly decreased at a designed rate so that just as the screw drops free of the dies, the depth of entry of the die rib will be zero.

In this way, the leading and trailing ends of the rib are faired back into the screw thread flank, the leading end by having the dislodged metal forced back against the flank in tapered pattern, and the trailing end by progressive withdrawal of the die rib.

From the above explanation, it is obvious that the tapered ends of the ribs are not identical, but they are equally effective in preventing galling or gouging of the internal thread walls upon insertion (in which the trailing end becomes the leading end) and upon removal (in which the leading end is the leading end).

Reference is now made to FIGS. 12 to 25. FIGS. 12 and 13 illustrate the relieved ends of the threads in fixed die 6. (The special relieved area 82 shown in FIG. 6 is omitted in this case because the rib will not extend for 360°.) The die threads 108 have crests 110 and roots 112 which are curved downwardly as at 114 and 116, respectively. Thus, as the leading ends of the screw thread ribs roll into the fixed die threads 108, the ends initially engage the unrelieved die walls at the areas 118. These areas act to force the rib ends back flush with the screw flank. As screw rotation proceeds, the ribs 22 (see FIGS. 15, 16, 19, 20, 21 and 22) progressively engage the receding areas 120 and 121 of the relieved threads 108 to result in the tapered condition of the leading ends of the ribs as illustrated in FIG. 14.

In further explanation of the above, in FIG. 14 the closed condition of the rib 22 at section line 15—15 as shown in FIGS. 15 and 20 is produced when the ribs 22 engage the unrelieved areas 118 of the die 6. As rotation of the screw continues, the rib 22 progressively opens, or putting it conversely, is progressively less closed as it engages the increasingly relieved areas 120 and 121 of die 6 to reach the fully open position indicated at section 16—16 in FIG. 14 and as shown in FIGS. 16, 21 and 22.

As further illustrated in FIG. 19, it is thought to be apparent that the axis of the screw 2 as it approaches the end of the fixed die 6 (or die 86 of FIG. 9, or die 102 of FIG. 10) will not hold to its normal course of parallelism with the faces of dies 4 and 6 but instead will fall away somewhat as indicated by the dotted line 122 in FIGS. 9b and 19.

The effect of this falling away is to decrease the depth of penetration of die rib 60 into the thread flank (see FIGS. 19, 23, 24 and 25). This results in the tapering of the trailing end of the rib 22 back into the flank 18 as illustrated at the right of FIG. 14 and by the sections shown in FIGS. 17, 18, 23, 24 and 25. The bottom 64 of the rib cavity is at a substantially constant depth at the leading end of the rib, but because of progressive withdrawal of the die rib 60 at the trailing end, the depth of the rib cavity decreases as at 64' in FIGS. 17 and 24 until it reaches zero depth as in FIGS. 18 and 25.

It will be understood that the length of the rib 22 shown in FIG. 14 is not to be considered as limiting in any way. It is representative of a rib of any angular length having a leading and a trailing end which regardless of the rib length may be faired back into the screw thread flank to produce a rib forma-

tion that will facilitate entry and removal of the self-locking screw into and out of a cooperating internal thread.

TEST RESULTS

A $\frac{1}{4}$ in. $\times$ 20 hardened set screw having ribs on four adjacent teeth, each rib being approximately one-half inch long and 0.012 in. deep was repeatedly screwed into and unscrewed from a $\frac{3}{8}$ in. thick nut, soft and unplated and threaded by a GH 3 Tap.

The results were as follows:

Insertion No.	Installation Prevailing Torque in in.-lbs.	Removal No.	Breakaway Prevailing Torque in in.-lbs.
1	39	1	49
2	27	2	32
3	24	3	28
4	22	4	26
5	21	5	24
6	20	6	23
7	20	7	22
8	19	8	22
9	17	9	20
10	17	10	20
11	16	11	19
12	15	12	18
13	15	13	18
14	15- $\frac{1}{4}$	14	18
15	14	15	16

In all of the above tests, it will be noted that the breakaway torque exceeded the installation torque. The standards of the Industrial Fastener Institute were fully met. The standard for $\frac{1}{4}$ in. screw calls for a first installation torque not greater than 40 inch-pounds, on the first removal of a breakaway torque of not less than 6.0 inch-pounds and on the fifth removal a breakaway torque of not less than 3.5 inch-pounds.

Note particularly that in the tests the breakaway torque on the 15th removal of 16 inch-pounds was far in excess of 6.0 inch-pounds standard for the first removal, to say nothing of the 3.5 inch-pounds minimum for the fifth removal.

Since the breakaway torque is the figure that determines the security of the screw in the nut or other internal thread, the test figures emphasize the unusual holding power achieved by the pressure of the ribs against the flanks of the corresponding internal threads.

It will also be apparent to those skilled in this art, that the number and size of ribs on the screw threads in relation to the clearance of the nut thread can be varied to control the degree of holding friction therebetween.

The modifications shown in FIGS. 26a to 29b inclusive will now be referred to. In all of these forms, the ribs have been positioned as close to the crest of the screw thread as possible. This result is accomplished by deforming the flanks of the movable die at a position close to the root.

In FIG. 26a, the tool 124 has been narrowed so that the cutting edges 126 and 128 enter the flanks 130 and 132 of the die 134 well below the pitch line so that the rib forming grooves created thereby extend downwardly to the positions 136 and 138 to be substantially on the same level as the root 140.

The rib formations made in die 134 as shown in FIG. 26a will produce ribs in the screw thread such as those shown in FIG. 26b. Here the ribs 142 and 144 are well out on the flanks 146 and 148 and have substantially the same radius over their length as the crest of the thread 150. Obviously, the length of the rib 142 about one turn of the thread will be somewhat greater than a rib located more inwardly along the flank 146. Thus the area of engagement of the rib 142 with the corresponding flank of the nut will be slightly greater. The ability to shift the location of the rib along the screw thread flank increases the various possibilities for control of the locking effect in varying situations.

In FIG. 27a, the tool 152 has been designed differently at its cutting end. It is not only narrow, but the interior has been

curved in a manner that will cause the two inner walls 154 and 156 that are created as the tool enters the die 134 to swing toward the center line and engage each other along a common wall 158. The die of FIG. 27a will produce the ribs shown in FIGS. 27b, 160 and 162, but the conventional thread crest will disappear as it is forced inwardly at 163 toward the body of the screw while the ribs are created. The ribs, however, function in exactly the same manner as the ribs shown in all of the other forms illustrated herein.

FIG. 28a shows another modification in which the tool 164 is shaped so that the inner walls 166 and 168 come together along a common surface 170. This type of die formation will create the thread shown in FIG. 28b in which the ribs 172 and 174 are longer and somewhat more flexible than the ribs 160 and 162, for example, shown in FIG. 27b.

Another modification is shown in FIG. 29a in which the tool 176 will produce a die formation with the inner adjacent walls 178 and 180 meeting along the surface 182 for part of their length, leaving a V-shaped center notch 184. This die configuration will produce the thread formation shown in FIG. 29b. Here the ribs 186 and 188 are similar to all of the other ribs described heretofore as far as their effectiveness in locking the screw within the nut is concerned, but a crest 190 of slightly reduced diameter is created.

The construction shown in FIG. 30 is included for the purpose of illustrating by comparison with FIGS. 2 and 2a that the invention is in no way limited to a particular rib configuration either in cross section or location along the flank of the screw thread.

The second type of dies in which the ribs are present in both dies, and as illustrated in FIGS. 31 to 37, will now be described.

Each of the dies of the second type has the ribs formed, preferably in one flank only, in the selected threads at the proper locations in the same manner as the ribs are formed in the dies of the first type. FIG. 33 illustrates one way of forming the single ribs in the die threads. The die 200 has already had the threads formed therein by any of the known procedures, such as cutting, grinding, forging, or otherwise. The die at this stage is fully annealed. A coining tool 202 preferably of the same length as the rib to be formed, is then forced downwardly into the die thread flank 204. When the tool 202 has entered the flank to the proper extent, a rib 206 will have been created in the flank 204 along with a generally complementary cavity 208. The cutting edge on tool 202 has wide angled faces with an included angle in a preferred form of approximately 59°. This creates an inner wall 210 of about the same angularity and an outer wall 212 which is about 18° to the vertical. Thus, the included angle in a preferred form of rib 206 between the intersecting inner and outer walls 210 and 212 is approximately 77°. It is to be understood, however, that this rib configuration may be varied according to the desired configuration of rib to be produced on the screw threads. It will also be noted that the edge 214 of the rib 206 is close to being midway between the crests of the two adjacent teeth 216 and 218. It will be understood, however, that the tool 202 can be caused to enter the thread flank 204 at any selected place along the flank so that the resulting crest 214 can be shifted more to the left according to the type and position of the rib that is to be subsequently created in the screw thread.

If the annealed die is particularly soft, the rib formation created by tool 202 may, because of the way the metal flows, automatically assume a form in which the inner rib wall 210 is slightly concave as suggested by the dotted lines 220 and the outer wall 212 is slightly convex as suggested by the dotted lines 222. It has been found that this concave-convex rib wall shape tends to add to the strength of the rib when the die is used in production.

The length of the ribs in the die threads, in the ordinary case, will be slightly more than the circumferential length of the rib to be created in the screw thread flank. The number of ribs in the die threads will be determined by the self-locking requirements of the screw to be produced. With the ribs

formed, the dies are hardened and then are ready for use in the screw thread rolling machine.

A pair of dies F and M are shown in FIG. 31. The normally vertical threaded faces 224 and 226 of the dies have for clarity been laid face up in horizontal position so that the relationship of the ribs in the die threads to the workpiece 228 may be better understood. The die F is the shorter of the two, and in accord with conventional practice is the fixed die. The top of the die F is at 230 and it will be seen that four ribs 232, 234, 236 and 238 have been formed in the up-facing flanks 240, 242, 244, and 246 of four adjacent threads. The reason for putting the ribs in the upward facing flanks is so that the ribs created in the screw threads will be on the non-pressure flanks away from the head of the screw. This is the preferred location because the flank of the screw thread on the head side is the flank that bears tightly against the opposing flank of the nut when the screw is set up. The ribs 232, 234, 236 and 238 when originally created in the die threads extended to the end 248 of the die F, but for reasons that will be explained, the ends of these threads containing the ribs have been ground away an additional amount beyond the normal relief found at the ends of the other threads of the fixed die. See FIG. 32. This additional relief prevents deformation of the screw thread rib created by the other die as the finished screw leaves the end of the fixed die. It should be explained that the end 248 is a vertical surface and would not be visible as the die F is viewed in FIG. 31. However, for clarity, end 248 and also end 265 of die M have been turned through 90° in FIG. 31 to face the viewer.

Similarly, as also shown in FIG. 31, the top of the movable die M is at 249 and the threads 226 have had ribs 250, 252, 254 and 256 formed in the upward facing flanks 258, 260, 262 and 264 of four adjacent threads. The effective lengths of these ribs are substantially the same as the lengths of ribs 232, 234, 236 and 238 in the fixed die F. The ribs could run to the end of the die M, but obviously would be ineffective over the end portions after the screw had dropped clear after reaching the end of die F.

It will also be noted that the axis 266 of workpiece 228 (see FIG. 31) on which have already been formed the threads 268 is, at this state of its movement, between the dies and aligned with the starting ends of the four ribs on fixed die F and the four ribs on the movable die M. It will also be noted that the distance of the leading end of rib 250 of die M is one-half pitch farther from the top 249 of the die M than the leading end of the rib 232 of die F. This half pitch difference in position of the opposed ribs is essential because the ribs on one die necessarily engage the already created threads on the workpiece 228 a half pitch apart from the point of initial and subsequent engagement of the ribs on the other die.

The ends F-1, F-2, F-3 and F-4 of the ribs of the fixed die F simultaneously engage the downward facing flanks of the workpiece threads 268 at the circumferential position X, while the leading ends M-1, M-2, M-3 and M-4 of the ribs of the movable die M simultaneously engage the downward facing flanks of the same threads 268 on the workpiece at the circumferential position Y. As the workpiece 228 rolls along die F toward end 248 and simultaneously rolls along die M toward the end 265, it is believed apparent that the ribs of the fixed die will create ribs in the threads of the workpiece running from position X clockwise to position Y, and simultaneously the ribs of the movable die M will create ribs in the corresponding threads of the workpiece running clockwise from position Y to position X. In other words, with a relative movement of the two dies sufficient to create 180° of rotation in the workpiece, a single continuous rib will have been formed in each turn of the screw threads running for 360°. Since the ribs in the die threads are identical, the screw thread ribs created by the fixed die F will mesh exactly with the ribs in the movable die M as the workpiece 228 continues its rotation beyond the first 180°. Correspondingly, the ribs created in the workpiece by the movable die M will mesh with the ribs in the fixed die F.

This meshing enables the leading ends of the screw thread ribs created by the opposite dies to be smoothed out as rotation of the workpiece continues for about a total of 360° and is immediately followed by discharge when the workpiece reaches the end 248 of the fixed die F.

The remaining problem is to fair the leading end of the rib nearest the head of the screw back into the flank and to fair the trailing end of the rib farthest from the head back into its flank so that galling or gouging of the nut into which the screw is subsequently placed will be minimized.

The leading end of the rib in the screw created initially at the point X by the leading end F-1 of rib 232 will, after 180° of rotation, encounter the plane upper flank 270 of the other die M at approximately the position 272 (see FIG. 31). Thus, the rib created in the screw thread flank by die rib 232 during the first 180° of rotation of the workpiece 228 will be pressed back into the screw thread flank by the surface of flank 270 for a distance of 180° running from about point 272 to point 274. In this way, the leading end and following half turn of the uppermost rib in the screw thread is faired back into its flank.

Similarly, the trailing end of the lowermost rib in the workpiece created by die rib 256 of die M is faired back into its flank by virtue of the grinding away of the ends of the threads which contain the ribs 232, 234, 236 and 238 as illustrated in FIG. 32. Thus, as the workpiece is being discharged from the dies, it falls away from the trailing ends of ribs 250, 252, 254 and 256 to create a relatively tapered trailing end of the lowermost rib on the screw thread.

FIG. 34 shows in enlarged detail the configuration of the ribs formed in the underflanks of the screw threads by the dies made according to the foregoing description of FIG. 33. The die 200 made in accord with FIG. 33 has one or more ribs 206 defined by outer wall 212 and inner wall 210. Two adjacent crests 216 and 218 are illustrated, as well as the undistorted opposite die flanks 276. As the workpiece 228 is rolled between the dies F and M shown in FIG. 31 full bodied threads 268 are created thereon. Then, when the workpiece 228 reaches the position between the dies as illustrated in FIG. 31, the die ribs 206 of FIG. 34 (which are the same as ribs 232, 234, 236, 238, 250, 252, 254, and 256 of FIG. 31) create the corresponding ribs 278 (see FIG. 34) in the workpiece. Each screw thread rib 278 has an inner wall 280 and an outer wall 282 which intersect to form an edge 284. The crest of each thread 268 as at 286 may be pushed by the die ribs somewhat beyond the midpoint between the adjacent roots 288 but without causing appreciable, if any, distortion of the screw thread flanks 290.

When the screw 228 is finished, it will have one or more ribs 278 extending for 360° about one or more adjacent pitches of the screw thread. If there are to be four pitches of the screw thread having a continuous rib thereabout, then four ribs will be created in the die threads as illustrated in FIG. 31. If the screw is to have more or fewer ribs in the screw threads, then the number of ribs in the die threads will be made to agree, and their positions with respect to the tops of the dies will be chosen to give ribs on the screw threads wherever required.

As a modification, see for example, FIG. 36 which is a vertical section of the two dies F and M with the screw 292 in elevation just prior to discharge of the screw. The dies in this case are designed to create a rib in the screw thread running for two full turns and starting only one thread down from the top of the dies. In FIG. 36, there is suggested the manner in which the rib 278, created by the short die F, will have its leading end faired back into the flank 293 when, upon further rotation, it comes into engagement with the plane flank 294 of die M. Likewise, the trailing end of the rib 278 is faired back into its flank 297 as at 296 after further rotation as the screw falls free from its position between the two dies.

FIGS. 35 and 37 illustrate the behavior of the screw ribs 278 when the screw is inserted into a cooperating nut. As can best be seen in the enlarged section of FIG. 35, the threads of nut 298 are illustrated at 300 with flanks 302 and 304. The screw 292 has its pressure flanks at 306 which flanks engage flush

against the pressure flanks 304 of nut 298 when the screw is tightened. The ribs 278 created by the dies as in FIG. 34 provide the locking effect by engaging against the non-pressure flanks 302 of nut 298. When screw 292 is screwed into the nut 298, the ribs 278 are bent to assume more or less the form shown in FIG. 35. The distortion of ribs 278 from their original form shown by dotted lines 278' may, in the illustration, seem a trifle exaggerated but tests have shown that this amount of deformation may occur according to the relative hardness of the screw in relation to the nut. It is to be understood, however, that there is no attempt to illustrate exactly in the drawings the extent of the deformation of rib 278 as numerous factors are involved: (1) the exact configuration of the rib, (2) the extent of the normal clearance between the nut and the threads of the screw, and (3) the relative hardness of the rib and nut. In any event, the rib 278 is bent more or less as the screw is inserted into the nut. The self-locking effect is the result of the friction between the bent rib and the non-pressure flank of the nut and the friction between the pressure flanks of the screw and the nut.

As explained previously with respect to the rib created by the first type of dies, the initial deformation of ribs 278 may or may not be within the elastic limit of the ribs. If within the elastic limit, the ribs 278 will spring back substantially to their original position when the screw is removed from the nut. If the elastic limit is exceeded, then when the screw is removed from the nut, the ribs 278 will spring back a lesser degree so that upon subsequent reinsertions into the nut, the bending of the ribs 278 will be within the elastic limit.

The overall position of the screw 292 originally created by the dies as illustrated in FIG. 36, is shown in its self-locking position within the nut 298 in FIG. 37. In this figure and in the detailed showing in FIG. 35, the pressure flanks 306 of the screw are up tightly against the pressure flanks 304 of the nut, and the ribs 278 are deformed as shown by their engagement with the nut flanks 302.

From the foregoing explanation of the various forms the invention may take, it is apparent that the rib in all cases is formed by forcing outwardly a portion of the thread flank. The rib may be described generally as being someplace between the root and the crest of the thread. In the ordinary case, the crest of the thread will be of greater radius than the rib, but in some cases the crest may be of less radius as shown, for example in FIGS. 27b, 28b and 29b. The inner wall of the rib necessarily must commence at a point within the thread flank, but the angularity of the inner and outer walls of the rib are in no way limited as to their specific configuration.

Unless clearly to the contrary, it is to be understood that when the die ribs are recited in the claims in the singular, such language is to include a plurality of ribs and, conversely, if the ribs are recited in the plural, such language is to include the construction in which the die has but a single rib.

The invention is equally applicable to dies designed to produce double or triple threads. The principles above explained are adequate to enable one skilled in this art to know where to place the ribs on the die threads to create the ribs on any selected threads of the screws being produced by the dies.

In the preferred form of the invention, the ribs on the die thread flanks and the ribs on the screw thread flanks will be parallel to their respective thread crests, but it is to be understood that deviations from parallelism are within the scope of the claims so long as the ribs stay within their respective flanks.

It is intended to cover all changes and modifications of the example of the invention herein chosen for purposes of the disclosure which do not constitute departures from the spirit and scope of the invention.

I claim:

1. A thread rolling die for rolling self-locking threads on a screw, said die having an overall configuration of a plurality of parallel threads adapted to form corresponding threads on a cylindrical work piece and having at least one integral thread in which a portion of the flank of said thread is cut and

deformed significantly along a path parallel to the thread crest away from its normal flank configuration to form a rib extending outwardly beyond said flank and a cavity in said flank coextensive with said rib.

2. A thread rolling die for rolling self-locking threads in a screw, said die having an overall configuration of a plurality of parallel threads adapted to form corresponding threads in a screw, said die having at least one thread which is an integral part of said die in which a portion of the flank of said die thread adjacent the root of said thread is cut and deformed away from its normal flank configuration to produce a tapered rib and an adjacent cavity in said flank, the face of said deformed portion that was cut from said flank being moved transversely until it is placed in engagement with part of the flank material of the next laterally adjacent die thread.

3. A thread rolling die for rolling self-locking threads in a screw, said die having a plurality of parallel threads whose operative crests and roots are undeformed throughout their length and at least one thread of said die having at least one straight rib paralleling throughout the major portion of its length the crest of said one die thread and extending outwardly from the flank of said one die thread and being intermediate the crest and root of said one thread, the said rib having inner and outer walls intersecting at an acute angle, the inner wall commencing at a position interiorly of said flank thereby to form a cavity in said die thread flank, the said rib being adapted to form a cavity in the flank of a screw thread when said thread is rolled under sufficient pressure against and past the said rib, and the said cavity in the flank of said die thread is adapted to receive material displaced from said screw thread by said rib.

4. A thread rolling die as set forth in claim 3, said die rib having an inner wall commencing at a point inside said die thread flank and an outer wall commencing at said die thread flank, said intersection of said outer wall and said inner wall forming an edge parallel to said die thread crest.

5. A thread rolling die as set forth in claim 3, the length of said die rib effectively in engagement with said screw thread being not more than the 360° circumferential length of the rib to be formed in the screw thread.

6. A flat thread rolling die having a vertical face with die threads therein, at least one flank of one thread of said die having at its finishing end a rib and cavity paralleling the crest of said thread, said die rib shaped so as to be capable of creating in the flank of a screw thread rolled thereagainst, a complementary rib and cavity, all said die threads that do not have ribs therein being relieved at their finishing ends in such manner that their crests, roots and flanks curve away from the normal vertical plane of the face of the die, and all die threads having said ribs therein being relieved to a greater degree than those die threads without ribs therein.

7. A pair of relatively movable dies for producing screws with self-locking ribs thereon, said dies having a plurality of parallel threads whose operative crests and roots are undeformed throughout their lengths, one or more of the threads of one of the dies having ribs intermediate the said crests and roots, said ribs paralleling said crests and extending along the flanks of said threads near the discharge end of said die for creating ribs in the threads of each successively created screw during at least part of the last 360° of rotation of said screw, the terminal ends of the threads of the other die being formed to receive the ribs created in the screw by the said one die without causing deformation of said screw thread ribs over the major portion of their circumferential lengths, whereby each of said screws produced by said dies will be discharged from said dies with the said screw thread ribs unchanged from the configuration created by said one die over at least the major portion of their circumferential lengths.

8. A pair of dies as set forth in claim 7 and means on the said other die for fairing the leading end of said screw rib back against its flank prior to discharge of said screw from said dies, and means on said other die for causing gradual separation of each said screw thread flank from its said die rib thereby to

gradually diminish the said screw rib at its trailing end from maximum to zero immediately following the said fairing of the said leading end by said other die.

9. A pair of dies for producing self-locking screws, one of said dies being relatively movable with respect to the other of said dies, some of the threads of one of the dies having ribs extending along the flanks of said threads near the discharge end of said die for creating corresponding ribs in the threads of the screw during not more than the last 360° of rotation of said screw, the terminal ends of the threads of the other die being relieved in the following manner: The crests and roots and flanks therebetween of the threads curving away from said one die, whereby as a rib on the screw threads is created by a rib on said one die, the leading end of said screw thread rib after 180° of rotation is engaged first by an unrelieved wall of the corresponding thread of said other die and then progressively by the relieved wall of the thread of said other die and caused to assume a tapered form, and said screw, due to said relieved threads on the said other die, moves correspondingly away from the said one die to cause continuous decrease in the depth and width of the screw thread rib of the trailing end thereof.

10. A pair of dies as set forth in claim 9, the said ribs on said one die including inner and outer walls, each said inner wall commencing within the flank of its thread and each said outer wall commencing at the flank of its thread, said walls intersecting to form an edge capable of penetrating the flank of a screw thread when the latter is rolled between said dies and engaged by said rib.

11. A pair of dies for rolling threads on a cylindrical workpiece and means on said dies for creating a continuous rib on one flank only of one or more pitches of said screw threads after said threads have been substantially fully formed by said dies, said means comprising on each said die a rib extending outwardly beyond one flank only of at least one thread of each said die near the discharge end of each said die, said rib configuration being such as to be capable of creating a complementary rib in the flank of said substantially fully formed screw thread when the workpiece moves through the latter part of its travel between said dies, said die ribs so located on their respective dies that when the said ribs of both dies are opposite each other during the threading operation, the axis of the workpiece will be transversely between said die ribs and the said die ribs at their points of engagement with said screw thread flank will be one-half pitch apart axially of said workpiece whereby after the workpiece has made one-half a revolution about its axis between said opposed die ribs while the die ribs are simultaneously and progressively engaging the flank of said screw thread at positions 180° apart, there will have been formed at least one continuous 360° rib on one flank of said screw thread for one full pitch.

12. The construction set forth in claim 1, one of said dies being shorter than the other and having its die ribs and the related die threads relieved at their discharge ends to prevent subsequent deformation of that part of said rib created in the flank of said screw thread by said other longer die.

13. The construction set forth in claim 11, one of said dies being longer than the other, the upper flank of the thread of the said longer die next above said uppermost die rib acting to fair the leading end of said screw thread rib created by the uppermost rib in said shorter die back into the screw thread flank prior to discharge of said threaded screw from said dies.

14. The construction set forth in claim 11, the leading ends of the die ribs on both said dies being so positioned on their respective die thread flanks that the said leading ends will substantially simultaneously engage a flank of said screw thread at diametrically opposite positions.

15. The construction set forth in claim 11, and means integral with said dies for fairing back into the screw thread flank the leading end of the screw thread rib nearest the head of said screw and means for causing the path of the axis of said workpiece to curve away from one of said dies, thereby to reduce progressively the size of the end of said rib most distant from said screw head.

16. A pair of flat thread rolling dies, each die having conventional die threads for rolling conventional screw threads on a cylindrical workpiece, one die being shorter than the other, said shorter die adapted to be the fixed die in a thread rolling machine, each die having on at least one flank of one thread a rib formed from the material of each said flank, said ribs located near the finishing end of its said die so that, as the said rib on said dies pass each other, said workpiece will be therebetween, said ribs so shaped as to be capable of producing a complementary rib on the flank of the thread of a screw rolling between said die ribs, all threads of the shorter die that do not have ribs therein being relieved at their finishing ends sufficiently to prevent a roll off mark from occurring on said screw as the finished screw leaves said dies, and all threads of the shorter die containing said die ribs being relieved at their finishing ends to a greater extent whereby a rib created in the flank of the screw thread by the die rib in the longer die will not be adversely affected by the die threads at the finishing end of said shorter die.

17. The method of forming a rib on the flank of a screw thread which rib will act as a self-locking element when in frictional engagement with a cooperating internal thread, said method comprising the steps of first forming the threads by rolling a cylindrical workpiece between thread forming dies, and then after the threads have been at least substantially fully formed, progressively cutting into at least one flank of at least one thread for a predetermined circumferential distance and to a predetermined depth and in a direction parallel to the thread crest, said cutting being done by using wedge shaped tool surfaces to cause the formation of a rib having leading trailing end portions and tapered in cross section and lying in part outside said thread flank surface.

18. The method set forth in claim 17, said cutting being done by rolling the screw thread flank against said tool surfaces under sufficient pressure against the opposite side of said screw to hold the path of the screw axis parallel to the edge of the said tool.

19. The method set forth in claim 18 and after said screw has rotated approximately 180° from the point of initial engagement with said tool surfaces, applying pressure to the leading end portion of said rib to force the said leading end portion back into said flank in decreasing degree to produce a finished rib that gradually develops outwardly from the said thread flank at the said leading end.

20. The method set forth in claim 18 and before said screw has been discharged from said dies, progressively decreasing the pressure of said screw against said tool surfaces to gradually decrease to zero the depth of the cut and the size of the rib at the trailing end of said rib.

21. The method set forth in claim 18 and after said screw has rotated approximately 180° from the point of initial engagement with said tool surfaces, applying pressure to the leading end portion of said rib to force the said leading end portion back into said flank in decreasing degree to produce a finished rib that gradually develops outwardly from the said thread flank at the said leading end, and before said screw has rotated 360° along said tool surfaces, progressively decreasing the pressure of said screw against said tool surfaces to gradually decrease to zero the depth of the cut and the size of the rib at the trailing end of said rib.

22. The method set forth in claim 17, said cutting into said flank of one pitch being done simultaneously at positions 180° apart by rolling said screw thread flank between oppositely disposed tool surfaces.

23. The method set forth in claim 22, and thereafter fairing the leading end of the rib produced by said cutting back into the flank from which it was cut.

24. The method set forth in claim 22, the leading end of the rib produced by cutting the flank on one side merging into the trailing end of the rib produced by cutting the flank on the opposite side after the screw has rolled through 180° thereby to produce a continuous rib of 360° on one pitch of said screw thread.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,653,241 Dated April 4, 1972
Inventor(s) Roger W. Orlomoski

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

Col. 11, Line 52: "The ends F-1," should read:

--The leading ends F-1,--.

Col. 15, Line 53: "The construction set forth in Claim 1"

should read: --The construction set forth
in Claim 11--.

Col. 16, Line 29: "suing" should read: --using--.

Signed and sealed this 3rd day of October 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents