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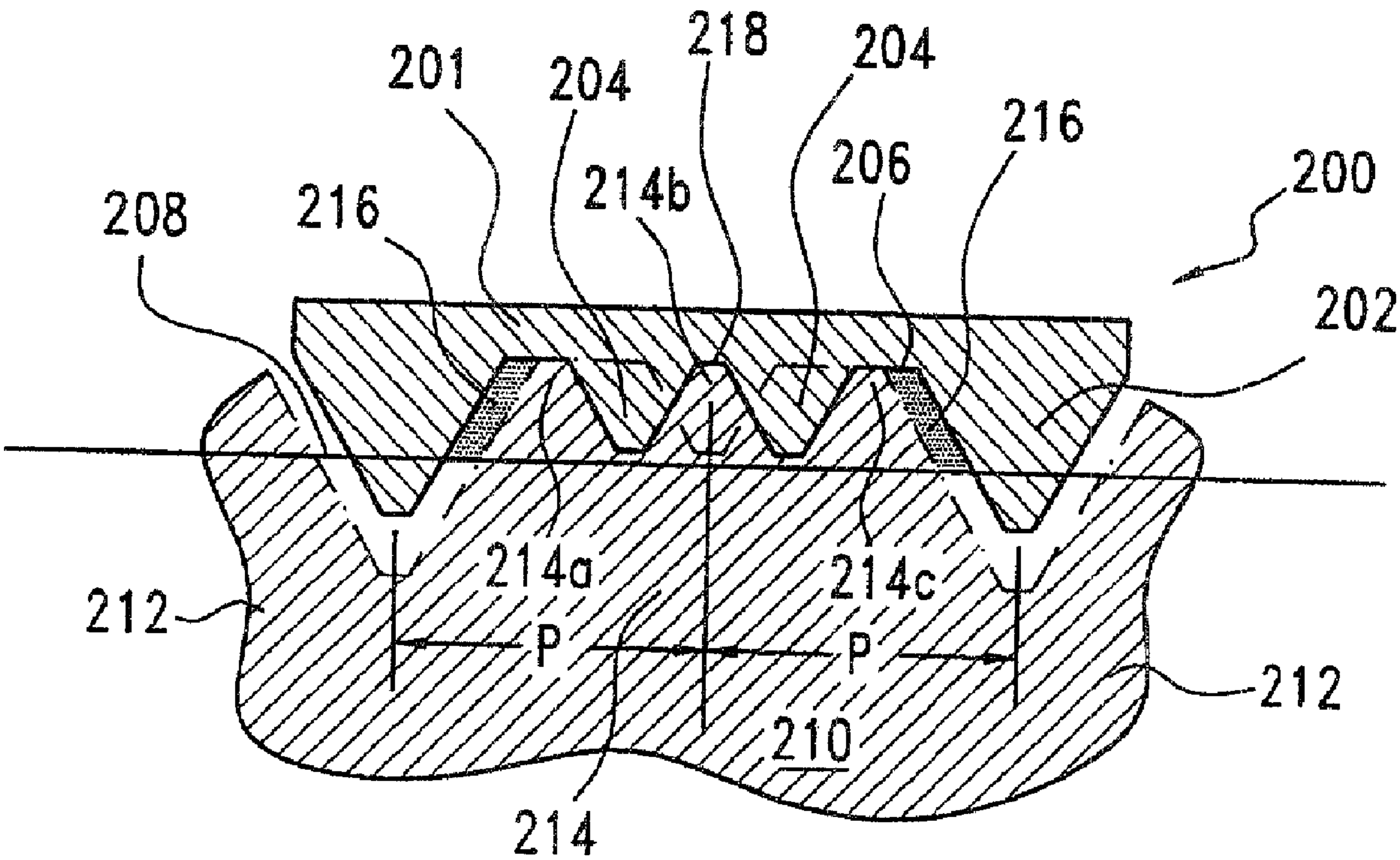


(57) Abrégé/Abstract:
Disclosed is a method of forming a threaded fastener using a pair of thread rolling dies wherein each one of the pair of thread rolling dies comprises a body portion having a longitudinal axis. A plurality of primary thread rolling die threads, are disposed upon a working face of the body portion and are oriented at a predetermined angle with respect to the longitudinal axis of the body portion.

(57) Abrégé(suite)/Abstract(continued):

These primary rolling die threads form a plurality of primary threads, upon a blank member during a thread rolling process, the primary threads being successively formed upon the blank member at first predetermined spaced positions. A plurality of sets of auxiliary thread rolling die threads are disposed upon the working face of the body portion at positions transversely interposed between the plurality of primary thread rolling die threads form a dual set of second, auxiliary threads upon said blank member during said thread rolling process. The distances through which material portions of the blank member utilized for forming the primary threads need be moved is minimized and mining the dimension of the dies.

ABSTRACT

Disclosed is a method of forming a threaded fastener using a pair of thread rolling dies wherein each one of the pair of thread rolling dies comprises a body portion having a longitudinal axis. A plurality of primary thread rolling die threads, are disposed upon a working face of the body portion and are oriented at a predetermined angle with respect to the longitudinal axis of the body portion. These primary rolling die threads form a plurality of primary threads, upon a blank member during a thread rolling process, the primary threads being successively formed upon the blank member at first predetermined spaced positions. A plurality of sets of auxiliary thread rolling die threads are disposed upon the working face of the body portion at positions transversely interposed between the plurality of primary thread rolling die threads form a dual set of second, auxiliary threads upon said blank member during said thread rolling process. The distances through which material portions of the blank member utilized for forming the primary threads need be moved is minimized and mining the dimension of the dies.

METHOD OF FORMING A THREADED FASTENER WITH DUAL REINFORCING LEADS

FIELD OF THE INVENTION

The present invention relates generally to threaded fasteners, and more particularly to a new and improved threaded fastener which has dual reinforcing lead structure integrally incorporated thereon for facilitating and simplifying the manufacture of the threaded fastener, and an improved entry or lead end portion for facilitating the insertion of the fastener into underlying substrates whereby enhanced depth penetration of the threaded fastener into the underlying substrate or workpiece can be achieved.

BACKGROUND OF THE INVENTION

One method or technique for conventionally forming threaded fasteners comprises the rolling of a blank member between a pair of thread rolling dies as is disclosed, for example, within United States Patent 4,716,751 which issued to Wozniak on January 5, 1988. In accordance with such a conventional manufacturing method or technique for forming threaded fasteners, as illustrated, for example, within **FIGURES 1-3**, which correspond to **FIGURES 1,1a,** and **2** of the aforenoted patent, a blank member 9 is adapted to be interposed between a pair of thread rolling dies 10,10a wherein, for example, a first one of the thread rolling dies 10 comprises a moving die while the second one of the thread rolling dies 10a comprises a stationary die. Each one of the thread rolling dies 10,10a comprises a tool steel body 11 having a working face 12, and, as best seen in **FIGURES 1** and **3**, and as described in connection with the thread rolling die 10, the working face 12 is provided with a plurality of die threads 13 which extend from a start end 14 of the thread rolling die 10 toward a finish end 16 of the thread rolling die 10, and which are disposed at a predetermined angle with respect to the axial or longitudinal extent or axis L of the thread rolling die 10 in order to in fact form the threads upon the blank member 9. As the blank member 9 is rolled between the two thread rolling dies 10,10a from the start end 14 of the thread rolling die 10 toward the finish end 16 of the thread rolling die 10, the material comprising the blank member 9 is progressively displaced and flows into or between the thread rolling die threads 13 whereby fully formed threads, which mate with or correspond to the thread rolling die threads 13 of the thread rolling dies 10, 10a, are produced upon the blank member 9. More particularly, as can best be appreciated from **FIGURE 3**, each one of the thread rolling die threads 13 comprises a plurality of crest portions 17, which are adapted to penetrate the blank member material during the thread rolling operation so as to effectively and ultimately form the root portions of the threads upon the blank member 9, and a plurality of root portions 19 which are adapted to ultimately form the crest portions of the threads upon the blank member 9 at the completion of the thread rolling operation. Lastly, flank portions 18 of the thread rolling die threads 13 define surfaces along which the blank member material flows during the formation of the crest and root portions of the threads upon the blank member 9, and the flank portions 18 of the thread rolling die threads 13 likewise form corresponding thread flank portions upon the blank member 9. It is further noted that as the rolling process proceeds, the material comprising the blank member continues to be displaced along the flank portions 18 of the thread rolling die threads 13 with the depth of penetration increasing as the rolling process continues until a fully formed thread is produced upon the blank member 9 at the finish ends 16 of the thread rolling dies 10,10a.

With reference now being made to **FIGURE 4**, there is disclosed a conventional threaded fastener 100 which is known in the industry as a "hi-low" thread form in view of the fact that the same comprises two different thread leads, that is, a first, primary thread lead 102, and a second, auxiliary thread lead 104 which provides reinforcement characteristics to the threaded fastener 100. The primary and auxiliary thread leads 102,104 are disposed upon the threaded fastener 100 in such a manner that successive portions of the auxiliary thread lead 104 are interposed between successive portions of the primary thread lead 102 along the axial extent of the threaded fastener 100, and it is particularly noted that the axial distance or pitch, as defined between each set of primary and auxiliary thread leads 102, 104, is denoted by P, while the axial distance or pitch, as defined between, for example, successive primary or successive auxiliary thread leads 102,102 or 104,104, is 2P. The root portion of the threaded fastener 100 is disclosed at 106, and it is noted that the crest height of the first, primary thread lead 102, as measured from the root portion 106 of the threaded fastener 100, is adapted to be at least twice the crest height of the second, auxiliary thread lead 104 as similarly measured from the root portion 106 of the threaded fastener 100. One of a pair of thread rolling dies, for forming the primary and auxiliary thread leads 102,104 upon a fastener blank member 108 in a manner similar to the aforenoted use of thread rolling dies 10,10a in connection with the formation of the threads upon the fastener blank member 9, is disclosed at 110, and it is seen that in order to ultimately form the primary and auxiliary thread leads 102,104 upon the fastener blank member 108, the thread rolling die 110 comprises a plurality of primary thread rolling die threads 112, and a plurality of auxiliary thread rolling die threads 114. In a manner corresponding to the alternative disposition of the first, primary thread leads 102 and the second, auxiliary thread leads 104 upon the threaded fastener 100, the plurality of primary thread rolling die threads 112 and the plurality of auxiliary thread rolling die threads 114 are similarly disposed in an alternative manner upon the thread rolling die 110.

More particularly, in connection with each one of the thread rolling die threads 114, it is seen that the crest portion of each auxiliary thread rolling die thread 114 actually comprises a pair of crest portions 114a,114b, wherein each one of the crest portions 114a,114b of each auxiliary thread rolling die thread has a lateral or transverse extent of between 0.003-0.010 inches, and wherein further, the crest portions 114a,114b are laterally or transversely spaced from each other by means of a predetermined distance so as to in fact form each one of the second, auxiliary thread leads 104 therebetween during the thread rolling process. In particular, recalling the fact that the depth of penetration of the thread rolling dies increases as the thread rolling process continues, and appreciating the additional fact that each one of the thread rolling die threads 112,114 is disposed at a predetermined angle with respect to the longitudinal or axial extent or axis of the thread rolling die 110, then it can be appreciated further that in order to fully form the first, primary thread lead 102 upon the threaded fastener 100, after the second, auxiliary thread lead 104 has been formed so as to have a predetermined depth, a predetermined amount of blank member material 116 must be displaced or moved a predetermined lateral or transverse distance during the thread rolling operation.

It is also conventionally known, however, that, in accordance with thread rolling manufacturing techniques, and the practical limitations inherently associated therewith, a predetermined amount of blank member material can only be displaced a predetermined distance during each rotation or revolution of the blank member along the pair of cooperating thread rolling dies in order to in fact achieve good, reliable, straight threads upon the blank member. Consequently, the greater the distance that the blank member material must be displaced, the greater the number of rotations or revolutions that the blank member must undergo during the thread rolling process until the thread leads are fully formed upon the original blank member. Accordingly, if the blank member must undergo a substantially large number of rotations or revolutions, then the longitudinal or axial length of each thread rolling die must be substantially large which, in turn, requires the use of a substantially large thread rolling machine which renders the manufacture of the threaded fasteners relatively costly. Since the practical problem in connection with the formation of, for example, the first, primary thread lead 102 upon the fastener blank member 108 resides in, or is a function of, the pitch spacing 2P between successive threads of the first, primary thread lead 102, and therefore the distance through which the blank material must be moved or displaced during the thread rolling process in order to form the successive threads of the first, primary thread lead 102, then one solution to this problem might be to shorten the pitch spacing between successive threads of the first, primary thread lead 102. The shortening of the pitch spacing between successive threads of the first, primary thread lead 102 would, however, increase the number of threads per inch that would be present upon the threaded fastener 100. This alteration in the number of threads per inch, as present upon the threaded fastener 100, however, adversely alters the operational characteristics of the threaded fastener 100, such as, for example, the amount of insertion torque required in connection with the driving of the threaded fastener into a substrate, the amount of time it takes to insert or drive the threaded fastener 100 into the substrate, the pull-out resistance of the threaded fastener 100 with respect to the substrate, and the like.

A need therefore existed in the art for a new and improved threaded fastener whereby the manufacturing process could be readily facilitated in view of the fact that, during the formation of the predetermined number of threads per inch comprising the thread leads of the threaded fastener in accordance with the thread rolling process, the blank member material only needed to effectively be displaced or moved through a smaller lateral or transverse distance in order to complete the formation of the thread leads upon the blank member such that, in turn, the longitudinal or axial length of the thread rolling dies could be substantially shortened so as to, in turn, require the use of a substantially shortened thread rolling machine which rendered the manufacture of the threaded fasteners more cost effective.

It has since been discovered, however, that while the threaded fastener as disclosed within the aforenoted United States patent application has in fact facilitated the fastener manufacturing process whereby relatively shortened thread rolling dies and thread rolling machines can be employed in a more cost-effective manner, it has been experienced that the insertion torque required to drive and fully insert such dual reinforcing lead threaded fasteners into an underlying substrate or workpiece is relatively high in view of the fact that the provision or presence of the second, auxiliary, dual reinforcing leads upon the shank portion of the fastener, whereby successive threads of the second, auxiliary dual reinforcing leads are interposed between successive threads of the first, primary lead of the threaded fastener, accordingly results in the forward ones of the threads of the second, auxiliary dual reinforcing leads interfering somewhat with the flow or discharge of chips or debris of the underlying workpiece or substrate which are generated during the self-tapping of the threaded fastener within the pre-drilled bore of the underlying workpiece or substrate as the threaded fastener is driven and inserted into the underlying workpiece or substrate. Consequently, still further, the fasteners are often not able to be fully driven and inserted into the underlying substrate or workpiece to their desired depths of penetration. More particularly, if the insertion torque normally required to rotationally drive and axially insert the threaded fasteners into the underlying substrate or workpiece exceeds or becomes greater than the torsional strength characteristics of the material from which the threaded fasteners are fabricated, then during the fastener driving and insertion operation with respect to the underlying substrate or workpiece, the head end portion of the threaded fastener will suffer or experience fracture whereby such head end portion of the fastener will separate from that portion of the threaded shank of the fastener which has already been driven and inserted into the underlying substrate or workpiece. Accordingly, the threaded fastener can no longer be rotated and obviously cannot be driven or inserted further into the underlying substrate to the desired or required depth so as to in fact achieve the desired or required degree of penetration within the underlying substrate or workpiece.

A need therefore exists in the art for a new and improved dual reinforcing lead threaded fastener wherein the driving or insertion torque required to rotate the threaded fastener in connection with the rotational driving and axial insertion of the same into an underlying substrate is sufficiently effectively reduced so as not to exceed the torsional strength characteristics of the material from which the threaded fastener is fabricated whereby the threaded fastener will be permitted to be inserted within the underlying substrate to its fully required or desired penetration depth without experiencing any fracture or separation of the driven head portion of the threaded fastener.

SUMMARY OF THE INVENTION

Accordingly, the present invention seeks to provide a new and improved dual reinforcing lead threaded fastener.

Another aspect of the present invention seeks to provide a new and improved dual reinforcing lead threaded fastener whereby the various operational drawbacks or disadvantages characteristic of **PRIOR ART** threaded fasteners are effectively overcome.

An additional aspect of the present invention seeks to provide a new and improved dual reinforcing lead threaded fastener wherein the driving and insertion torque characteristic of the threaded fastener is substantially reduced.

A further aspect of the present invention seeks to provide a new and improved dual reinforcing lead threaded fastener wherein the driving and insertion torque characteristic of the threaded fastener is substantially reduced such that the torsional strength characteristics of the material, from which the threaded fasteners are fabricated, are not exceeded so as to effectively eliminate fracture, rupture, and separation of the driving head portion of the threaded fastener from the threaded shank portion of the threaded fastener which has already been driven and inserted into the underlying substrate.

A last aspect of the present invention seeks to provide a new and improved dual reinforcing lead threaded fastener wherein the driving and insertion torque characteristic of the threaded fastener is substantially reduced such that the torsional strength characteristics of the material from, which the threaded fasteners are fabricated, are not exceeded so as to effectively eliminate fracture, rupture, and separation of the driving head portion of the threaded fastener from the threaded shank portion of the threaded fastener which has already been driven and inserted into the underlying substrate whereby enhanced penetration of the threaded fastener into the underlying substrate, to the desired or required depth, is able to be achieved.

The foregoing and other aspects are achieved in accordance with the teachings and principles of the present invention through the provision of a new and improved dual reinforcing lead threaded fastener which comprises a first, primary thread lead, and a pair of second, auxiliary thread leads alternatively interposed between successive threads of the first, primary thread lead. The threaded fastener further comprises a pointed tip portion for initiating driving insertion of the threaded fastener into an underlying workpiece or substrate, and in accordance with the principles and teachings of the present invention, that portion of the dual reinforcing lead, which has previously been interposed between the tip portion and the primary thread lead, or between the first and second successive threads of the first primary thread lead, has been removed. In this manner, a circumferentially extending space is effectively created for permitting chips or debris, normally generated during the self-tapping of the threaded fastener into a bore previously pre-drilled within the underlying workpiece or substrate, to be temporarily accumulated within such circumferential space whereby such chips or debris can subsequently be automatically discharged from such space into the depths of the pre-drilled bore as threaded insertion of the threaded fastener into the pre-drilled bore of the workpiece or substrate continues or proceeds. Such accommodation of the debris reduces insertion torque levels and permits enhanced penetration of the fastener into the workpiece or substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

Various other aspects, features, and attendant advantages of the present invention will be more fully appreciated from the following detailed description when considered in connection with the accompanying drawings in which like reference characters designate like or corresponding parts throughout the several views, and wherein:

FIGURE 1 is a top plan view of a conventional **PRI-**

OR ART thread rolling die;

FIGURE 2 is a side elevational view of a pair of conventional **PRIOR ART** thread rolling dies, of the type illustrated within **FIGURE 1**, showing the use of the same in performing a thread rolling process in conjunction with a blank member interposed between the pair of conventional **PRIOR ART** thread rolling dies;

FIGURE 3 is a perspective view, partly in cross-section, of the conventional **PRIOR ART** thread rolling die illustrated within **FIGURE 1**;

FIGURE 4 is a schematic view showing one of a pair of conventional **PRIOR ART** thread rolling dies which is utilized for forming a conventional "hi-low" thread form upon a blank member, wherein the "hi-low" thread comprises a first, primary thread lead and a second, auxiliary thread lead, and wherein further, successive threads of the first, primary and second, auxiliary thread leads are formed at alternative axial positions along the blank member;

FIGURE 5 is a schematic view, similar to that of **FIGURE 4**, showing, however, one of a pair of new and improved thread rolling dies, which is utilized for forming a "hi-low" thread form upon a blank member, wherein the "hi-low" thread comprises a first, primary thread lead and a pair of second, auxiliary thread leads, and wherein further, successive threads of the first, primary and second, auxiliary thread leads are formed at alternative axial positions along the blank member; and

FIGURE 6 is an axial cross-sectional view of the new and improved dual reinforcing lead threaded fastener, constructed in accordance with the principles and teachings of the present invention wherein the desired attributes, are effectively preserved while effectively reducing the insertion torque characteristic of such threaded fastener whereby insertion of such threaded fastener into an underlying substrate or workpiece is facilitated so as to in fact enable full and complete depth penetration of the threaded fastener into the underlying substrate or workpiece to be achieved.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring again to the drawings, and more particularly and firstly to **FIGURE 5** thereof, there is disclosed a threaded fastener which has been developed which is generally indicated by the reference character 200. It is to be appreciated that in view of the fact that the threaded fastener 200, as well as the thread rolling dies 210 utilized in connection with the formation of the threaded fastener 200, are similar to the conventional threaded fastener 100 and the thread rolling dies 110 utilized in connection with the formation of the conventional threaded fastener 100, except as will be more specifically noted hereinafter, the threaded fastener 200, the thread rolling dies 210, and the various components of such structures will be denoted by reference characters which correspond to the reference characters used in connection with the description of the conventional threaded fastener 100 and the thread rolling dies 110 used in connection with the fabrication of the same, however, the reference characters used in connection with the description of the threaded fastener 200, as well as in connection with the description of the thread rolling dies 210 used in connection with the fabrication of the threaded fastener 200, will be within the 200 series.

As was the case with the conventional threaded fastener 100, the threaded fastener 200 is of the type which is known in the industry as a "hi-low" thread form in view of the fact that the same substantially comprises a shank portion 201 upon which two different thread leads, that is, a first, primary thread lead 202, and a second, auxiliary thread lead 204 which provides reinforcement characteristics to the threaded fastener 200. It is noted, however, that in lieu of the provision of a single second, auxiliary thread lead upon the threaded fastener 200, as was the case with the conventional threaded fastener 100, there is provided a pair of axially spaced second, auxiliary thread leads 204.

More particularly, it is seen that the primary and dual auxiliary thread leads 202,204 are disposed upon the threaded fastener 200 in such a manner that successive portions or threads of the pair of auxiliary thread leads 204 are interposed between successive portions or threads of the primary thread lead 202 along the axial extent of the threaded fastener 200. In particular, it is especially noted that the axial distance or pitch, as defined between each set of primary and auxiliary thread leads 202,204, is the same as the axial distance or pitch, as defined between each set of primary and auxiliary thread leads 102,104 which was characteristic of the conventional threaded fastener 100, and is accordingly denoted by the reference character P, while the axial distance or pitch, as defined between, for example, successive primary thread leads 202,202, or between, for example, successive sets of the auxiliary thread leads 204,204, is the same as the axial distance or pitch, as defined between, for example, successive primary thread leads 102,102, or between, for example, successive auxiliary thread leads 104,104 which was characteristic of the conventional threaded fastener 100 and is accordingly denoted by the reference character 2P. The root portion of the threaded fastener 200 is disclosed at 206, and it is noted that, as was the case with the conventional threaded fastener 100, the crest height of the first, primary thread lead 202, as measured from the root portion 206 of the threaded fastener 200, is adapted to be at least twice the crest height of the pair of second, auxiliary thread leads 204 as similarly measured from the root portion 206 of the threaded fastener 200.

One of a pair of thread rolling dies, for forming the primary and auxiliary leads 202,204 upon a fastener blank member 208, in a manner similar to the aforenoted use of the thread rolling dies 10,10a,110 in connection with the formation of the threads upon the fastener blank members 9, 108, is disclosed at 210, and it is seen that in order to ultimately form the primary and auxiliary thread leads 202, 204 upon the fastener blank member 208, the thread rolling die 210 comprises a plurality of primary thread rolling die threads 212, and a plurality of auxiliary thread rolling die threads 214. In particular, in a manner corresponding to the alternative disposition of the first, primary thread leads 202 and the set of second, auxiliary thread leads 204 upon the threaded fastener 200, the plurality of primary thread rolling die threads 212 and the plurality of auxiliary thread rolling die threads 214 are alternatively disposed upon the thread rolling die 210. More particularly, in connection with each one of the auxiliary thread rolling die threads 214 for forming the set or pair of second, auxiliary thread leads 204 upon the blank member 208 in conjunction with the ultimate formation of the threaded fastener 200, it is seen that the crest portion of each auxiliary thread rolling die thread 214 actually comprises three crest portions 214a,214b,214c. As was the case with each one of the crest portions 114a,114b of the conventional thread rolling die 110, each one of the crest portions 214a, 214b,214c has a lateral or transverse extent of between 0.003-0.010 inches, and in addition, the crest portions 214a,214b,214c are laterally or transversely spaced from each other by means of a predetermined distance so as to in fact form each one of the pair of second, auxiliary thread leads 204,204 therebetween during the thread rolling process.

The significance of providing each one of the auxiliary thread rolling die threads 214, so as to effectively comprise three, laterally or transversely spaced crest portions 214a,214b,214c for thereby forming the dual set or pair of second, auxiliary thread leads 204,204 upon the blank member 208, which is ultimately used to form the new and improved threaded fastener 200, will now be addressed. In particular, it has been noted that the depth of penetration of the thread rolling dies increases as the thread rolling process continues in order to ultimately form, or complete the formation of the first, primary thread lead upon the blank member, once the formation of, for example, the second, auxiliary thread lead has been formed so as to have a predetermined depth or crest height dimension. It is additionally noted that, as was the case with each one of the thread rolling die threads 112,114, each one of the thread rolling dies threads 212,214 is disposed at a predetermined angle with respect to the longitudinal or axial extent or axis of the thread rolling die 210. Consequently, it can be appreciated further that in order to fully form the first, primary thread lead 202 upon the blank member 208 which will ultimately serve as the threaded fastener 200, a predetermined amount of blank member material 216 must be moved or displaced a predetermined lateral or transverse distance. It is to be additionally recalled that, as is conventionally known in accordance with thread rolling manufacturing techniques and the practical limitations inherently associated therewith, a predetermined amount of blank member material can only be displaced a predetermined distance during each rotation or revolution of the blank member along the pair of cooperating thread rolling dies in order to in fact achieve good, reliable, straight threads upon the blank member.

Accordingly, it has also been heretofore noted that the greater the distance that the blank member material must be moved or displaced during, for example, the complete formation of the primary thread lead upon the blank member, the greater the number of rotations or revolutions that the blank member must undergo during the thread rolling process until the primary thread lead is fully formed upon the original blank member. Still further, if the blank member must undergo a substantially large number of rotations or revolutions during the thread rolling process, then the longitudinal or axial length of each thread rolling die must be substantially large which, in turn, requires the use of a substantially large thread rolling machine which renders the manufacture of the threaded fasteners relatively costly. It has also been noted that since the practical problem in connection with the formation of, for example, the first, primary thread lead 202 upon the fastener blank member 208 resides in the fact that the pitch spacing defined between successive threads of the first, primary thread lead 202 is 2P, and that the distance through which the material of the blank member must therefore be moved or displaced during the thread rolling process is a function of such pitch spacing 2P, then the solution to this problem would seem to be to effectively reduce or shorten the distance, defined between the successive threads of the first, primary thread lead 202, through which the material of the blank member 208 needs to be displaced or moved in conjunction with the complete formation of the first, primary thread lead 202 and the successive threads thereof during the thread rolling process. The shortening of the actual pitch spacing 2P between successive threads of the first, primary thread lead 202 has been noted, however, as not being a viable solution to the aforenoted problem in view of the fact that such would increase the number of threads per inch of the threaded fastener 200 which would, in turn, adversely alter the operational characteristics of the threaded fastener 200.

However, as a result of the provision of the dual set or pair of second, auxiliary thread leads 204,204, which are axially spaced apart through means of a predetermined distance or space 218 of, for example, 0.003-0.010 inches, within the same space defined between successive threads of the first, primary thread lead 202, that is, within the same distance or lineal pitch dimension 2P, the effective distances 216,216, through which the material of the blank member 208 must be correspondingly moved or displaced in connection with the formation of the successive threads of the first, primary thread lead 202, are able to be substantially or significantly reduced. Since such distances 216,216, through which the material of the blank member 208 must be correspondingly moved or displaced in connection with the formation of the successive threads of the first, primary thread lead 202, are able to be substantially or significantly reduced, the number of rotations or revolutions that the blank member 208 must undergo during the entire thread rolling process in order to in fact achieve the complete formation of the first, primary thread lead 202, is able to be proportionally reduced. Accordingly, the longitudinal or axial length of each thread rolling die can be proportionally reduced or shortened whereby, in turn, the use of a substantially reduced or smaller thread rolling machine is able to be correspondingly employed which renders the manufacture of the threaded fasteners 200 more cost effective. In addition, the provision of the dual set or pair of second, auxiliary thread leads 204,204 upon the threaded fastener 200 increases the axial reinforcement characteristics imparted to the threaded fastener 200 over the axial extent thereof.

While the aforenoted structure of the thread rolling dies has facilitated the fastener manufacturing process whereby relatively shortened thread rolling dies and thread rolling machines can be employed in a more cost-effective manner, it has been experienced that the insertion torque required to drive and fully insert such dual reinforcing lead threaded fasteners into an underlying substrate is relatively high. It has been determined that the provision or presence of the second, auxiliary, dual reinforcing leads upon the shank portion of the fastener, wherein successive threads of the second, auxiliary dual reinforcing leads are interposed between successive threads of the first, primary lead of the threaded fastener, results in forward ones of the threads of the second, auxiliary dual reinforcing leads interfering somewhat with the flow or discharge of chips or debris of the underlying workpiece or substrate which is generated during the self-tapping of the threaded fastener within the pre-drilled bore of the underlying workpiece or substrate as the threaded fastener is driven and inserted into the underlying work-piece or substrate.

Accordingly, still further, the fasteners are often not able to be fully driven and inserted into the underlying substrate or workpiece to their desired depths of penetration. More particularly, if the insertion torque normally required to rotationally drive and axially insert the threaded fasteners into the underlying substrate or workpiece exceeds or becomes greater than the torsional strength characteristics of the material from which the threaded fasteners are fabricated, then during the fastener driving and insertion operation with respect to the underlying substrate or workpiece, the head end portion of the threaded fastener will suffer or experience fracture whereby such head end portion of the fastener will separate from that portion of the threaded shank of the fastener which has already been driven and inserted into the underlying substrate or workpiece. Consequently, the threaded fastener can no longer be rotated and obviously cannot be driven or inserted further into the underlying substrate or workpiece to the desired or required depth so as to in fact achieve the desired or required degree of penetration within the underlying workpiece or substrate.

Accordingly then, with particular reference now being made to **FIGURE 6**, a new and improved dual-reinforcing lead threaded fastener, constructed in accordance with the principles and teachings of the present invention, is disclosed and is generally indicated by the reference character 300. In view of the fact that the new and improved dual-reinforcing lead threaded fastener 300 is quite similar to the dual-reinforcing lead threaded fastener 200 as disclosed, for example, within **FIGURE 5**, a detailed description of the new and improved dual-reinforcing lead threaded fastener 300 will not be included herewith for brevity purposes, however, the detailed description will in effect concentrate upon the structural differences comprising the dual-reinforcing lead threaded fastener 200 and the new and improved dual-reinforcing lead threaded fastener 300. It is also to be noted that in view of the structural similarities which exist between the dual-reinforcing lead threaded fastener 200 and the new and improved dual-reinforcing lead threaded fastener 300, structural components of the new and improved dual-reinforcing lead threaded fastener 300 which correspond to the structural components of the dual-reinforcing lead threaded fastener 200 will be designated by corresponding reference characters except that the reference characters will be within the 300 series. More particularly, then, it is seen that the new and improved dual-reinforcing lead threaded fastener 300 comprises a shank portion 301, a hexagonally shaped head portion 320 integrally formed upon a first end portion of the shank portion 301, and a pointed tip portion

322 integrally formed upon a second opposite end portion of the shank portion 301. The head portion 320 is integrally connected to the shank portion 301 by means of a flanged portion 324 and a tapered or chamfered neck portion 326, and the pointed tip portion 322 has the configuration of a pyramid comprising a plurality of facets 328 and an included angle A, as defined between diametrically opposite sides of the tip portion 322, which is within the range of 43-47°.

The shank portion 301 of the threaded fastener 300 is provided with a threaded section 330 which, in accordance with the teachings and principles as previously set forth and described in conjunction with the formation of the threaded fastener 200 as disclosed within **FIGURE 5**, comprises a first, primary thread lead 302 and a pair of second, auxiliary thread leads 304,304. The single primary and dual auxiliary thread leads 302,304,304 are substantially identical to the single primary and dual auxiliary thread leads 202,204,204 of the threaded fastener 200 as disclosed within **FIGURE 5** in that the first, primary thread lead 302 comprises a plurality of successive, axially spaced primary threads 332, while each one of the second, auxiliary thread leads 304,304 comprises a plurality of successive, axially spaced auxiliary threads 334,334, and accordingly, a detailed description of the same will be omitted herefrom in the interest of brevity. It is noted, however, as disclosed within **FIGURE 6**, that the threaded section 330 of the threaded fastener 300 can have a predetermined axial extent, which may in fact be varied depending upon various factors or parameters, such as, for example, the particular workpiece or substrate into which the threaded fastener 300 is to be driven and inserted, the desired torque insertion and pull-out resistance values, and the like, however, as disclosed within **FIGURE 6**, for example, the axial extent of the threaded section 330 of the threaded fastener 300 can in fact comprise approximately at least one-half to two-thirds of the axial length of the threaded fastener 300.

In order to clearly appreciate the unique and novel teachings and principles of the present invention, the forwardmost primary threads have been designated as 332-1, 332-2, and 332-3 with the first primary thread 332-1 being axially located immediately upstream of the pointed tip portion 322 of the threaded fastener 300, while the second and third primary threads 332-2,332-3 being axially located upstream of the first primary thread 332-1 and respectively axially separated from each other through means of an axial distance or pitch of 2P in accordance with the teachings and principles as noted in connection with the structure set forth and described in connection with **FIGURE 5**. Recalling that the insertion torque required to drive and fully insert a fastener, such as that illustrated within **FIGURE 5**, into an underlying substrate or workpiece has been experienced as being relatively high in view of the fact that forward ones of the threads of the second, auxiliary dual reinforcing leads 204,204 have apparently interfered somewhat with the flow or discharge of chips or debris of the underlying workpiece or substrate which is generated during the self-tapping of the threaded fastener 200 within the pre-drilled bore of the underlying workpiece or substrate as the threaded fastener 200 is driven and inserted into the underlying workpiece or substrate, it is seen that in accordance with the principles and teachings of the present invention, the forwardmost ones of the auxiliary threads 334 of the second, auxiliary thread leads 304,304 have been removed from the forward end of the threaded section 330 of the threaded fastener 300.

More particularly, the axial section of the shank portion 301 of the threaded fastener 300, which is defined between the tip portion 322 of the threaded fastener 300 and the first primary thread 332-1, is totally devoid of any of the auxiliary threads 334 of the second, auxiliary thread leads 304,304 so as to effectively define a first peripherally or circumferentially extending space, recess, or pocket 336-1 within which chips or debris of the underlying workpiece or substrate, into which the threaded fastener 300 is being driven and inserted, can be temporarily accommodated or accumulated as the pointed tip portion 322 of the threaded fastener 300, as well as the first primary thread 332-1 of the threaded fastener 300, begin to enter the workpiece or substrate and thereby start generating or forming such chips or debris. In a similar manner, the axial section of the shank portion 301 of the threaded fastener 300, which is defined between the first primary thread 332-1 and the second primary thread 332-2, is likewise totally devoid of any of the auxiliary threads 334 of the second, auxiliary thread leads 304,304 so as to effectively define a second peripherally or circumferentially extending space, recess, or pocket 336-2 within which chips or debris of the underlying workpiece or substrate, into which the threaded fastener 300 is being driven and inserted, can likewise be temporarily accommodated or accumulated. It can be readily appreciated that such debris or chips will subsequently fall into the bottom depths of the bore pre-drilled within the underlying workpiece or substrate and that the provision of the recesses or pockets 336-1,336-2 effectively provide for the accommodation of such debris or chips until such debris or chips do in fact fall down into the bottom region of the pre-drilled bore. As a result of such an accommodation of the debris or chips within the recesses or pockets 336-1,336-2, such debris or chips do not interfere with or adversely hinder the self-tapping advancement of the forwardmost ones of the primary threads 332-1,332-2 whereby insertion torque levels can be dramatically reduced. While it has been noted that the pockets or recesses 336-1,336-2 may be operatively provided in conjunction with the first and second primary threads 332-1,332-2, a similar pocket or recess may optionally be provided in conjunction with additional primary threads, such as, for example, between the second primary thread 332-2 and the third primary thread 332-3 as torque insertion levels may dictate or require.

Thus, it may be seen that in accordance with the principles and teachings of the present invention, there has been developed a new and improved threaded fastener wherein not only has the thread rolling process or technique for manufacturing the threaded fastener been substantially facilitated, but in addition, torque insertion levels have been dramatically reduced due to the elimination of any interference between debris or chips and the threaded fastener during the fastener driving and insertion procedure. In addition, as a result of the aforenoted reduction in the torque insertion levels, the threaded fasteners will not experience premature rupture or failure whereby the threaded fasteners will be capable of being driven and inserted into the underlying substrate or workpiece to the desired penetration depth.

Obviously, many variations and modifications of the present invention are possible in light of the above teachings. For example, while particular dimensions of the threaded fastener, the axial distances defined between successive threads, or the relative sizes of the thread leads, have been noted, such dimensions, distances, or sizes can of course be altered as may be desired in order to correspondingly alter the performance characteristics of the threaded fastener without departing from the principles and teachings of the present invention. It is therefore to be understood that within the scope of the appended claims, the present invention may be practiced otherwise than as specifically described herein.

WHAT IS CLAIMED IS:

1. A method of forming a threaded fastener, comprising the steps of:

providing a pair of thread rolling dies wherein each one of said pair of thread rolling dies comprises a body portion having a longitudinal axis;

a working face disposed upon said body portion;

a plurality of first, primary thread rolling die threads, disposed upon said working face of said body portion and oriented at a predetermined angle with respect to said longitudinal axis of said body portion, for forming a first, primary thread lead, comprising a plurality of first, primary threads, upon a blank member during a thread rolling process, wherein said plurality of first, primary thread rolling die threads are spaced from each other by means of first predetermined transversely spaced distances such that said first, primary threads will be successively formed upon said blank member at first predetermined positions which are spaced from each other by means of first predetermined axially spaced distances; and

a plurality of sets of second, auxiliary thread rolling die threads, disposed upon said working face of said body portion at positions transversely interposed between said plurality of first, primary thread rolling die threads and oriented at a predetermined angle with respect to said longitudinal axis of said body portion, for forming a dual set of second, auxiliary thread leads, each comprising a plurality of second, auxiliary threads, upon said blank member during said thread rolling process, wherein said plurality of second, auxiliary thread rolling die threads, comprising each one of said plurality of sets of second, auxiliary thread rolling die threads, are spaced from each other by means of second predetermined transversely spaced distances;

positioning said pair of thread rolling dies with respect to each other such that said working faces of said pair of thread rolling dies are oppositely disposed toward each other in a spaced apart mode;

interposing said blank member between said oppositely disposed spaced apart working faces of said pair of thread rolling dies; and

rolling said blank member between said pair of spaced apart thread rolling dies such that, as a result of said disposition of said plurality of sets of second, auxiliary thread rolling die threads, for forming said dual set of second, auxiliary threads, between said plurality of first, primary thread rolling die threads, when said plurality of first, primary threads are successively being formed upon said blank member at the first predetermined positions, the distances, through which material portions of said blank member utilized for forming said plurality of first, primary threads upon said blank member need to be moved, is effectively minimized thereby, in turn, minimizing the length dimensions of said pair of thread rolling dies required to completely form said threaded fastener from said blank member.

2. The method as set forth in claim 1, further comprising the step of:

forming each one of said plurality of sets of second, auxiliary thread rolling die threads, disposed upon said working face of said body portion of each one of said pair of thread rolling dies, so as to comprise three, transversely spaced auxiliary thread rolling die threads for forming said dual set of second auxiliary thread leads upon said blank member.

3. The method as set forth in claim 2, further comprising the step of:

forming each one of said three, transversely spaced auxiliary thread rolling die threads so as to have a transverse width dimension within the range of 0.003-0.010 inches such that the transverse distance defined between said second, auxiliary thread leads, comprising each one of said dual set of second, auxiliary thread leads, formed upon said blank member, is within the range of 0.003-0.010 inches.

4. The method as set forth in claim 1, further comprising the step of:

forming said plurality of sets of second, auxiliary thread rolling die threads upon said working face of each one of said body portions of said pair of thread rolling dies at positions such that said plurality of sets of second, auxiliary thread rolling die threads are transversely spaced from each other by means of third predetermined distances which are substantially equal to said first predetermined distances through which said plurality of first, primary thread rolling die threads are spaced from each other.

5. The method as set forth in claim 1, further comprising the step of:

forming said plurality of first, primary thread rolling die threads, and said plurality of second, auxiliary thread rolling die threads, upon said working face of each one of said body portions of said pair of thread rolling dies such that the depth of said plurality of first, primary thread rolling die threads is at least twice the depth of said plurality of second, auxiliary thread rolling die threads.

6. The method as set forth in claim 1, further comprising the step of:

forming said plurality of first, primary thread rolling die threads, and said plurality of second, auxiliary thread rolling die threads, upon said working face of each one of said body portions of said pair of thread rolling dies such that the depth of said plurality of first primary thread rolling die threads increases continuously throughout the axial length of each one of said pair of thread rolling dies, while the depth of said plurality of second, auxiliary thread rolling die threads is constant after attaining a predetermined depth.

7. The method as set forth in claim 1, further comprising the steps of:

forming said plurality of sets of second, auxiliary thread rolling die threads upon said working face of each one of said body portions of said pair of thread rolling dies such that each one of said plurality of sets of second, auxiliary thread rolling die threads is transversely spaced from each one of said plurality of first, primary thread rolling die threads by means of predetermined fourth distances; and

forming said plurality of first, primary thread rolling die threads upon said working face of each one of said body portions of said pair of thread rolling dies such that said first predetermined transversely spaced distances, defined between said plurality of first, primary thread rolling die threads, are equal to twice said predetermined fourth axially spaced distances defined between said plurality of sets of second, auxiliary thread rolling die threads.

8. A method of forming a threaded fastener from a blank member, comprising the steps of:

providing a pair of thread rolling dies wherein each one of said pair of thread rolling dies comprises a body portion having a longitudinal axis;

a working face disposed upon said body portion;

a plurality of first, primary thread rolling die threads, disposed upon said working face of said body portion and oriented at a predetermined angle with respect to said longitudinal axis of said body portion, for forming a first, primary thread lead, comprising a plurality of first, primary threads, upon a blank member during a thread rolling process, wherein said plurality of first, primary thread rolling die threads are spaced from each other by means of first predetermined transversely spaced distances such that said first, primary threads will be successively formed upon said blank member at first predetermined positions which are spaced from each other by means of first predetermined axially spaced distances; and

a plurality of sets of second, auxiliary thread rolling die threads, disposed upon said working face of said body portion at positions transversely interposed between said plurality of first, primary thread rolling die threads and oriented at a predetermined angle with respect to said longitudinal axis of said body portion, for forming a dual set of second, auxiliary thread leads, each comprising a plurality of second, auxiliary threads, upon said blank member during said thread rolling process, wherein said plurality of second, auxiliary thread rolling die threads, comprising each one of said plurality of sets of second, auxiliary thread rolling die threads, are spaced from each other by means of second predetermined transversely spaced distances;

positioning said pair of thread rolling dies with respect to each other such that said working faces of said pair of thread rolling dies are oppositely disposed toward each other in a spaced apart mode;

interposing said blank member between said oppositely disposed spaced apart working faces of said pair of thread rolling dies; and

rolling said blank member between said pair of spaced apart thread rolling dies such that, as a result of said disposition of said plurality of sets of second, auxiliary thread rolling die threads, for forming said dual set of second, auxiliary threads, between said plurality of first, primary thread rolling die threads, when said plurality of first, primary threads are successively being formed upon said blank member at the first predetermined positions, the distances, through which material portions of said blank member utilized for forming said plurality of first, primary threads upon said blank member need to be moved, is effectively minimized thereby, in turn, minimizing the number of revolutions that said blank member must undergo during said entire thread forming process whereby, in turn, the length dimensions of said pair of thread rolling dies, required to completely form said threaded fastener from said blank member, may be correspondingly minimized.

9. The method as set forth in claim 8, further comprising the step of:

forming each one of said plurality of sets of second, auxiliary thread rolling die threads, disposed upon said working face of said body portion of each one of said pair of thread rolling dies, so as to comprise three, transversely spaced auxiliary thread rolling die threads for forming said dual set of second auxiliary thread leads upon said blank member.

10. The method as set forth in claim 9, further comprising the step of:

forming each one of said three, transversely spaced auxiliary thread rolling die threads so as to have a transverse width dimension within the range of 0.003-0.010 inches such that the transverse distance defined between said second, auxiliary thread leads, comprising each one of said dual set of second, auxiliary thread leads, formed upon said blank member, is within the range of 0.003-0.010 inches.

11. The method as set forth in claim 8, further comprising the step of:

forming said plurality of sets of second, auxiliary thread rolling die threads upon said working face of each one of said body portions of said pair of thread rolling dies at positions such that said plurality of sets of second, auxiliary thread rolling die threads are transversely spaced from each other by means of third predetermined distances which are substantially equal to said first predetermined distances through which said plurality of first, primary thread rolling die threads are spaced from each other.

12. The method as set forth in claim 8, further comprising the step of:

forming said plurality of first, primary thread rolling die threads, and said plurality of second, auxiliary thread rolling die threads, upon said working face of each one of said body portions of said pair of thread rolling dies such that the depth of said plurality of first, primary thread rolling die threads is at least twice the depth of said plurality of second, auxiliary thread rolling die threads.

13. The method as set forth in claim 8, further comprising the step of:

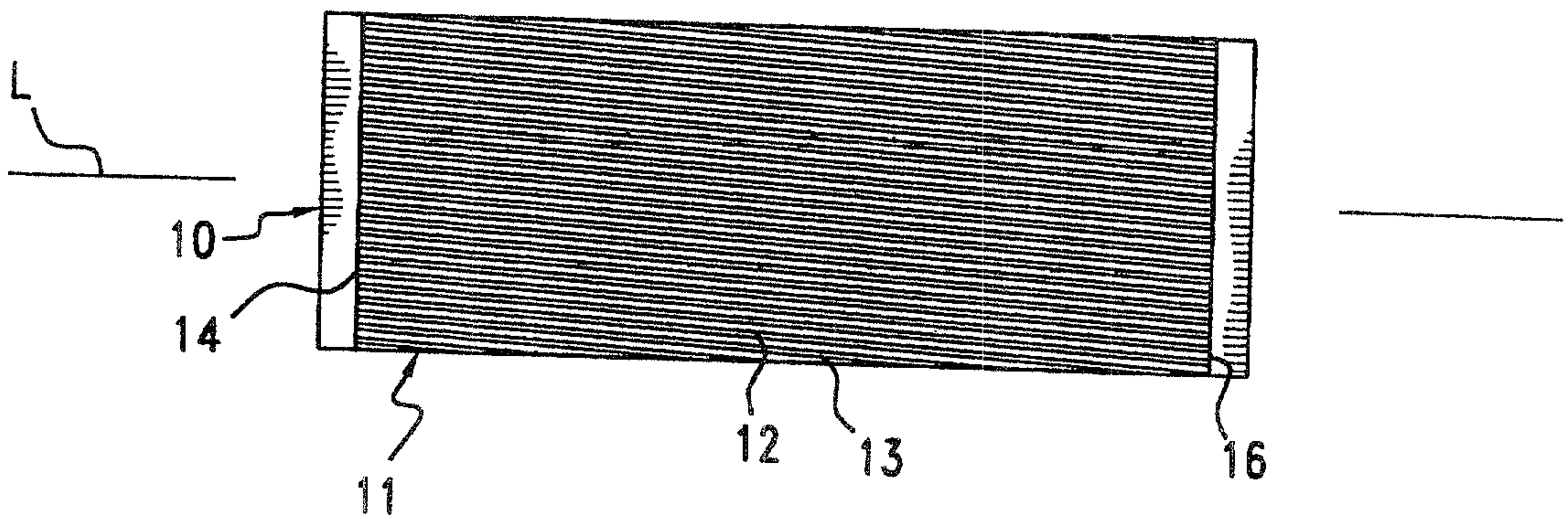
forming said plurality of first, primary thread rolling die threads, and said plurality of second, auxiliary thread rolling die threads, upon said working face of each one of said body portions of said pair of thread rolling dies such that the depth of said plurality of first primary thread rolling die threads increases continuously throughout the axial length of each one of said pair of thread rolling dies, while the depth of said plurality of second, auxiliary thread rolling die threads is constant after attaining a predetermined depth.

14. The method as set forth in claim 8, further comprising the steps of:

forming said plurality of sets of second, auxiliary thread rolling die threads upon said working face of each one of said body portions of said pair of thread rolling dies such that each one of said plurality of sets of second, auxiliary thread rolling die threads is transversely spaced from each one of said plurality of first, primary thread rolling die threads by means of predetermined fourth distances; and

forming said plurality of first, primary thread rolling die threads upon said working face of each one of said body portions of said pair of thread rolling dies such that said first predetermined transversely spaced distances, defined between said plurality of first, primary thread rolling die threads, are equal to twice said predetermined fourth axially spaced distances defined between said plurality of sets of second, auxiliary thread rolling die threads.

FIG.1
(PRIOR ART)



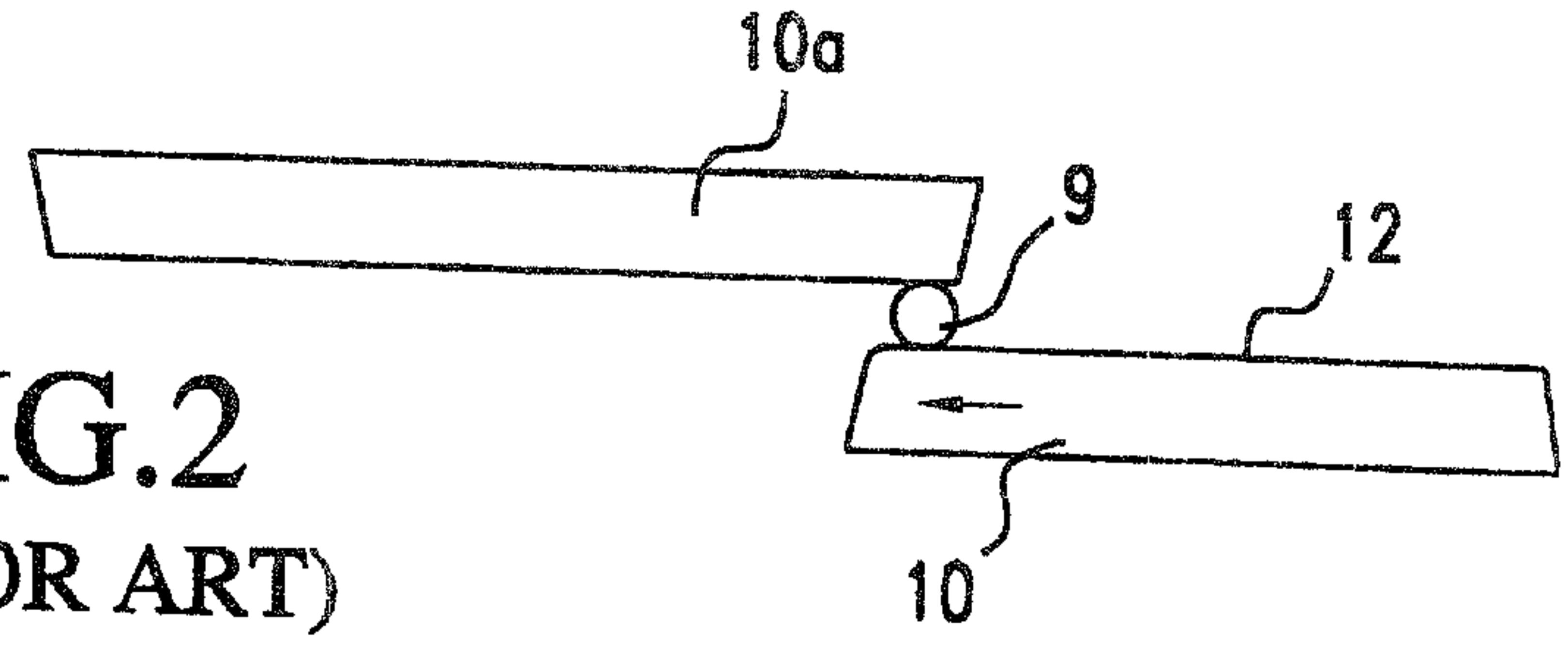


FIG.2
(PRIOR ART)

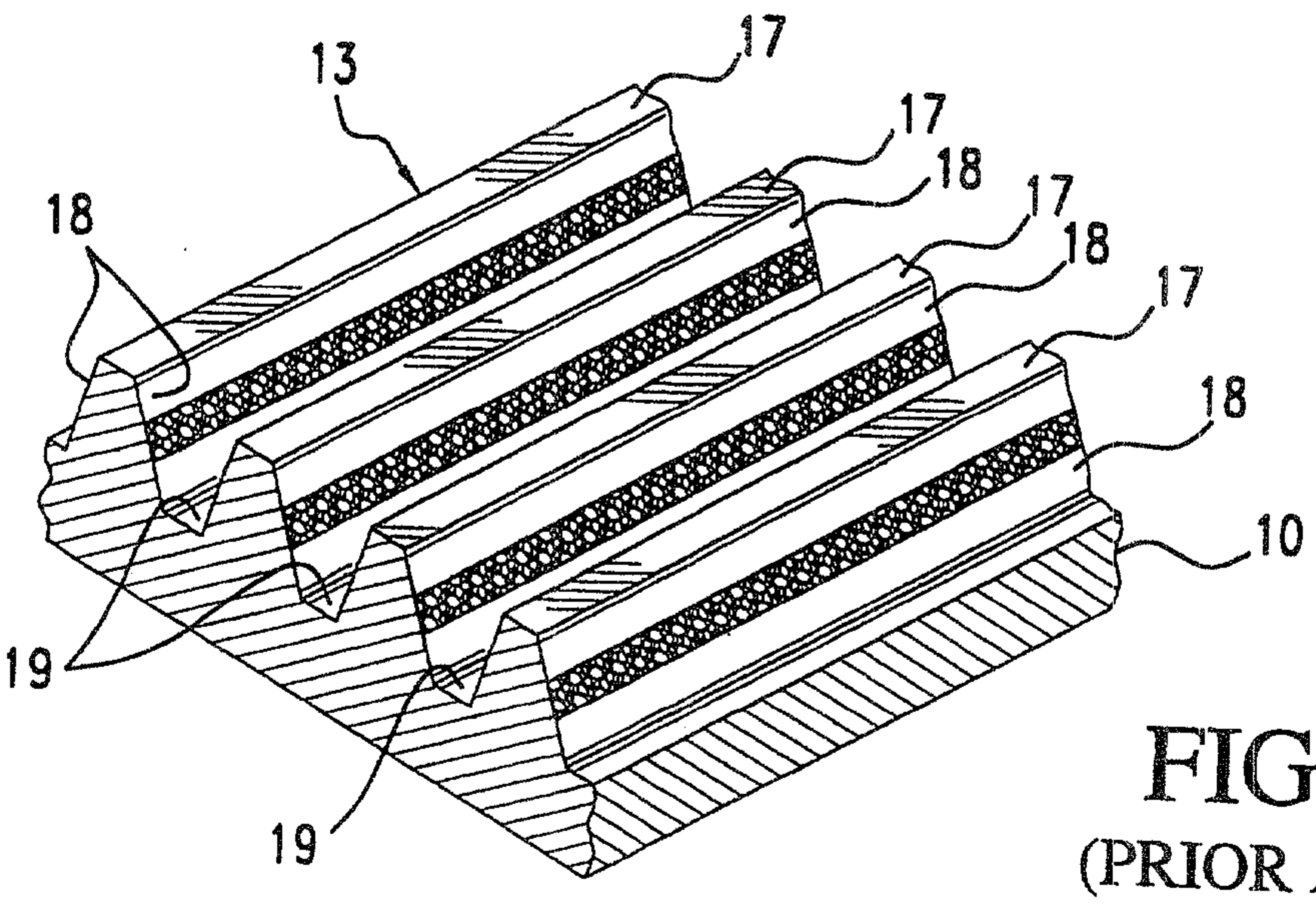


FIG.3
(PRIOR ART)

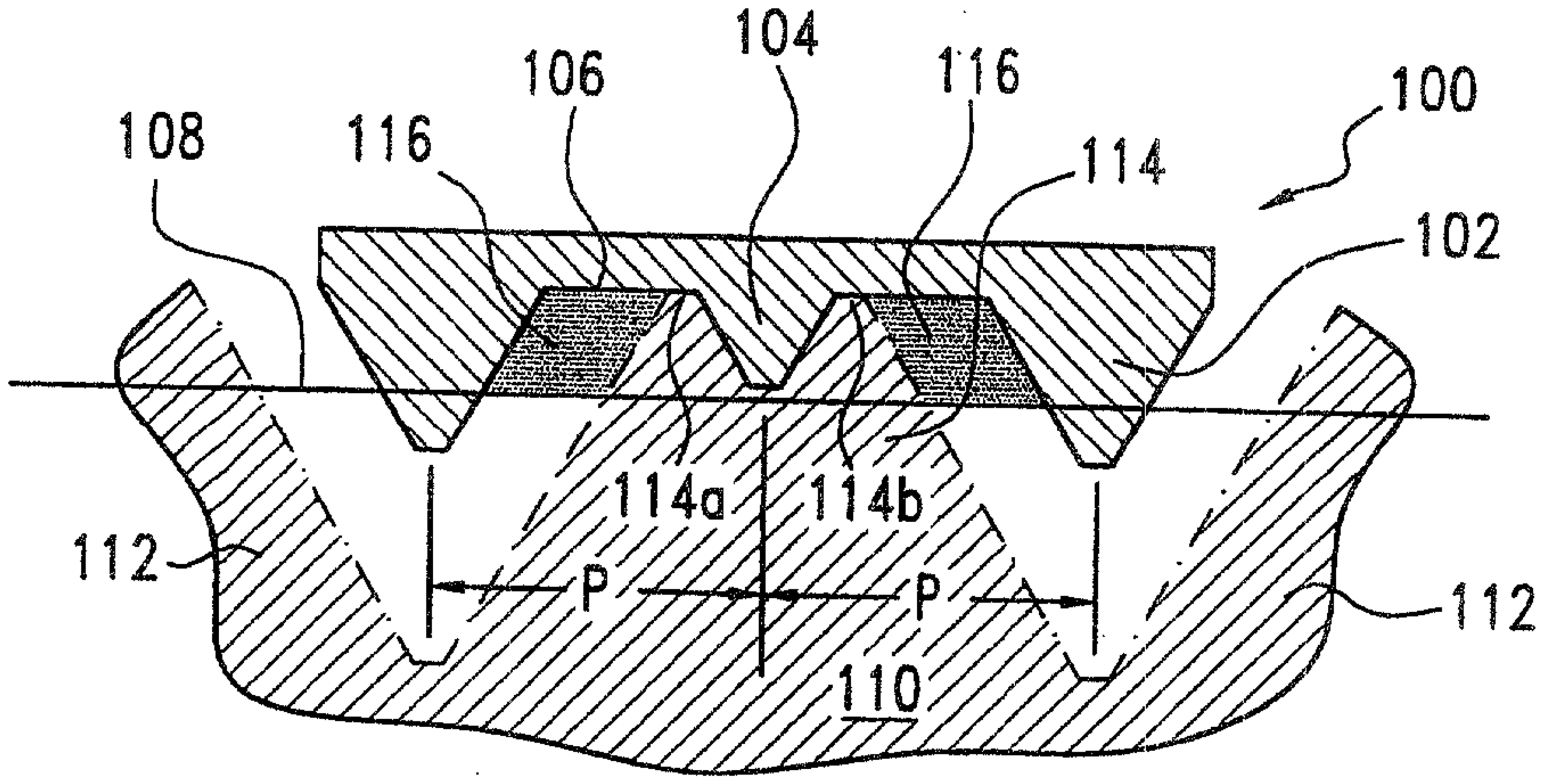


FIG.4
(PRIOR ART)

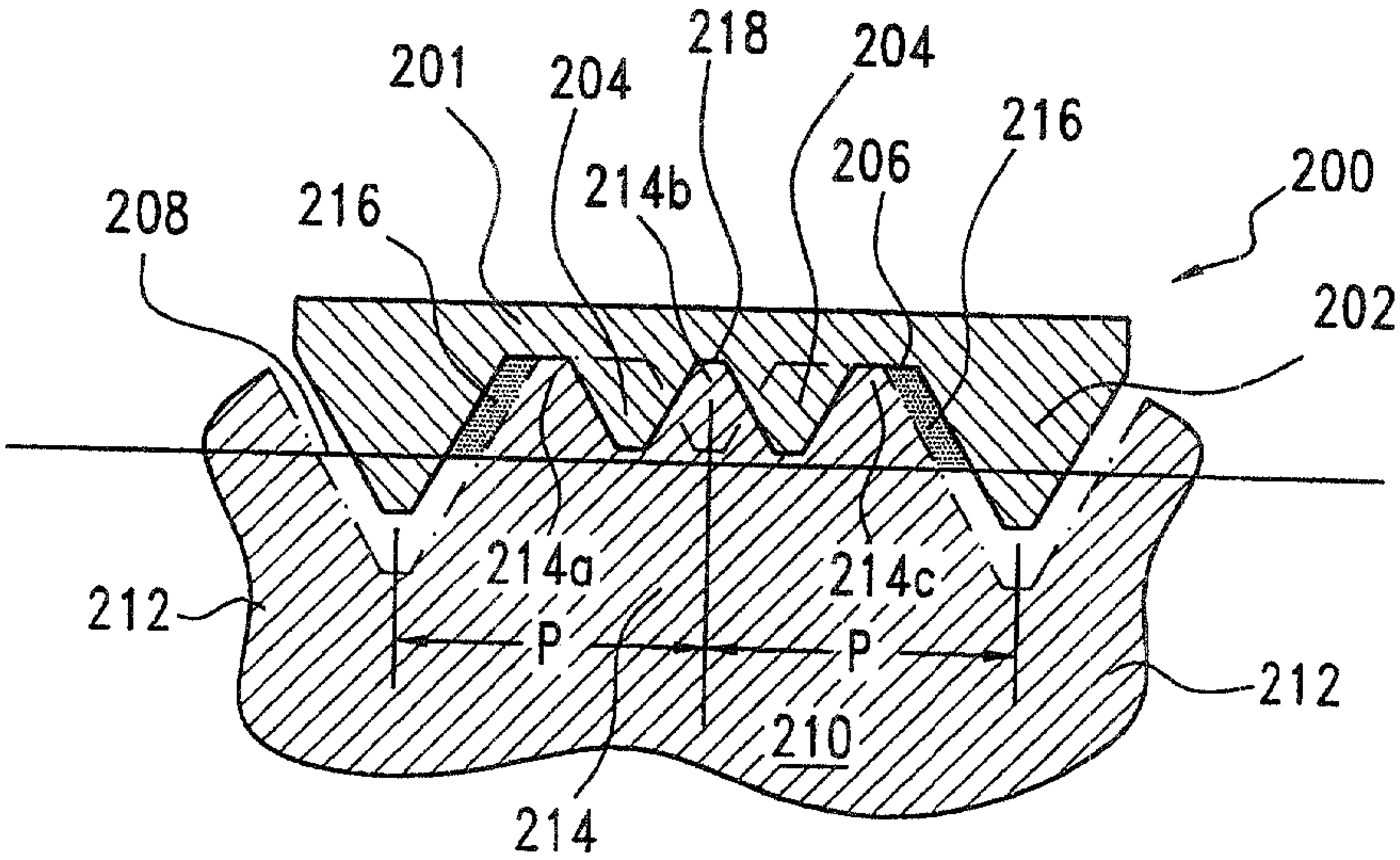
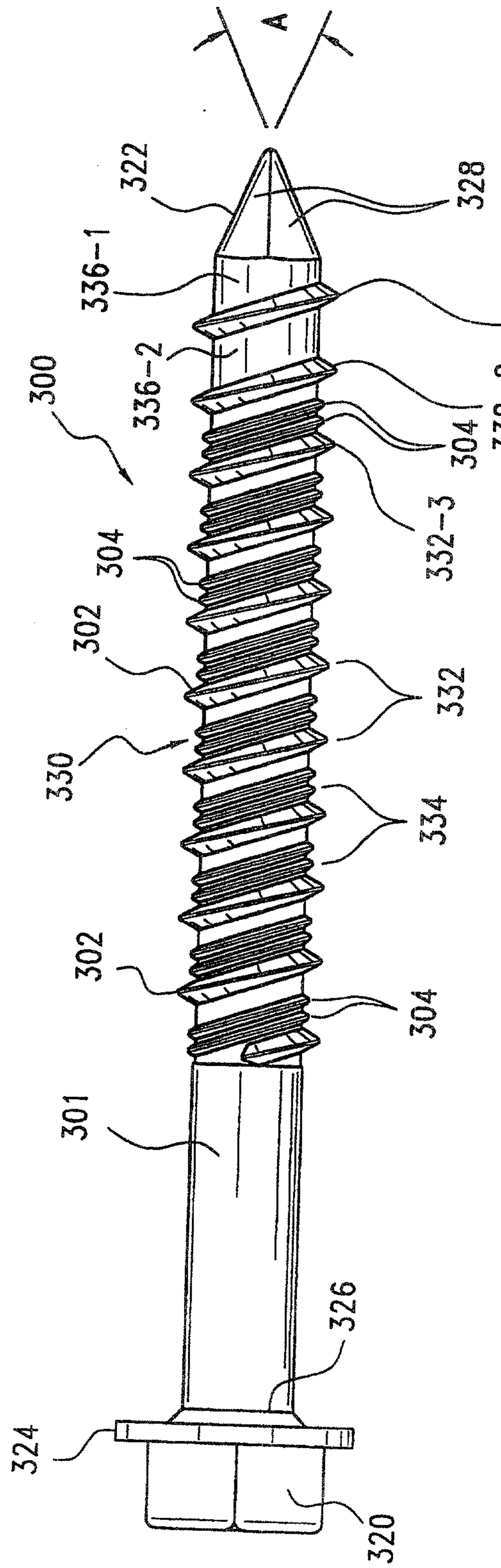


FIG.5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332-1
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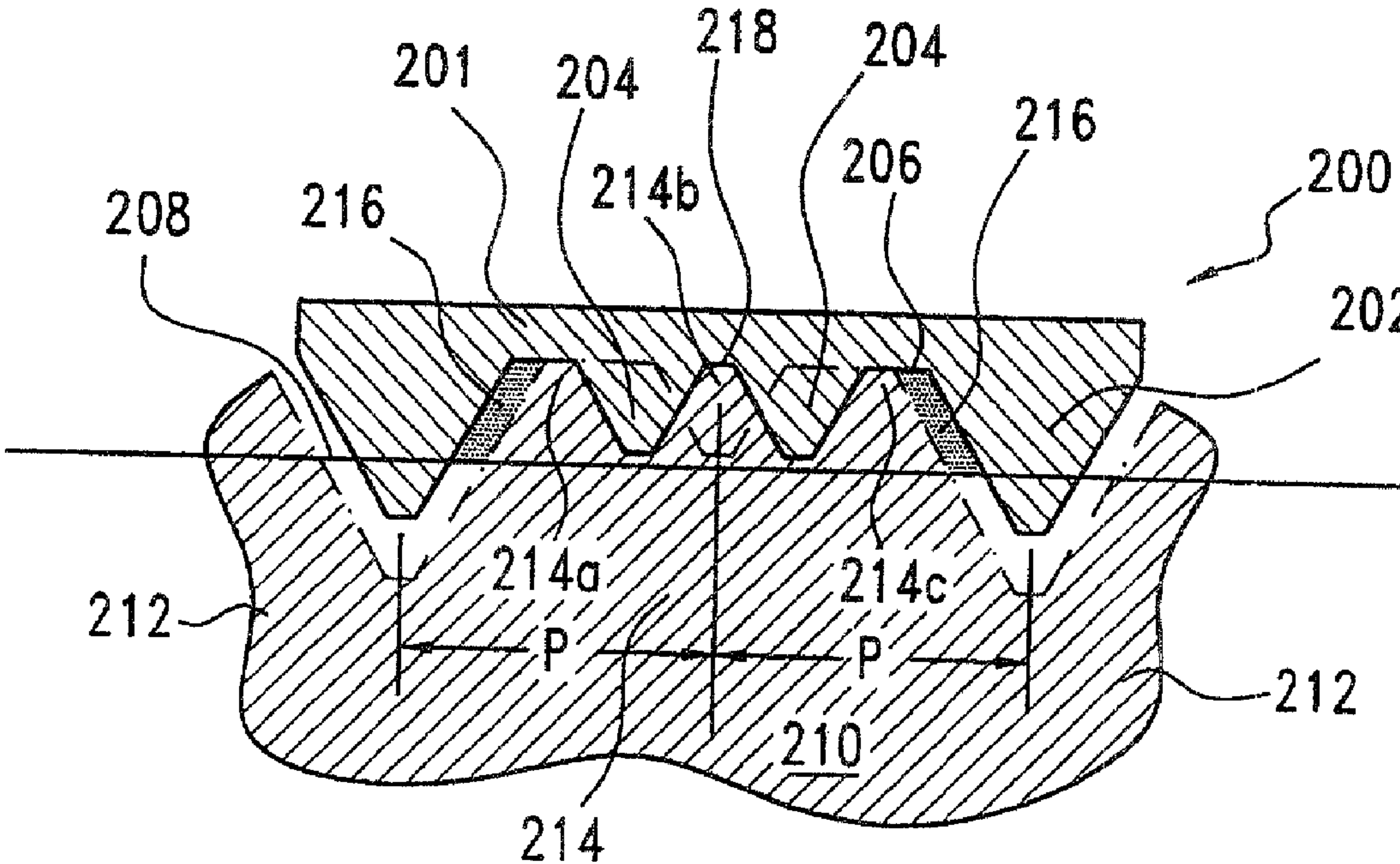
FIG.6



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