United States Patent [19]

Carlson

[11] **3,878,759**

[45] **Apr. 22, 1975**

[54] **BI-LOBULAR SELF-THREAD FORMING FASTENER**

[75] Inventor: **Raymond H. Carlson**, Rockford, Ill.

[73] Assignee: **Textron Inc.**, Providence, R.I.

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[21] Appl. No.: **319,511**

[52] **U.S. Cl.** ..... **85/46**; 10/10 R; 151/22

[51] **Int. Cl.** **F16b 25/00**; F16b 33/02

[58] **Field of Search** ..... 85/41, 46, 47, 48; 151/22; 10/10, 152 T; 72/88

[56] **References Cited**

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3,398,625	8/1968	Ansingh	85/46
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Primary Examiner—Marion Parsons, Jr.
Attorney, Agent, or Firm—Olson, Trexler, Wolters, Bushnell & Fosse, Ltd.

[57] **ABSTRACT**

There is disclosed a novel self-thread forming fastener having a threaded shank portion, which includes a holding section having a straight thread of generally circular cross section, and a thread forming section including an underdeveloped thread formation providing a bi-lobular thread cross section symmetrically disposed with respect to the axis of the fastener. The thread forming section includes several thread turns disposed on a taper, with the bi-lobular thread merging with the circular thread formation of the holding section. The thread formation of the holding section has a radial height which is at least as great, or greater than, the maximum radial height of the bi-lobular thread formation on the forming section. Accordingly upon engagement of the holding section with a female thread formed by the forming section, flank to flank interference will be obtained to provide a locking action. Also disclosed is a novel method for fabricating the above-discussed fastener.

3 Claims, 13 Drawing Figures

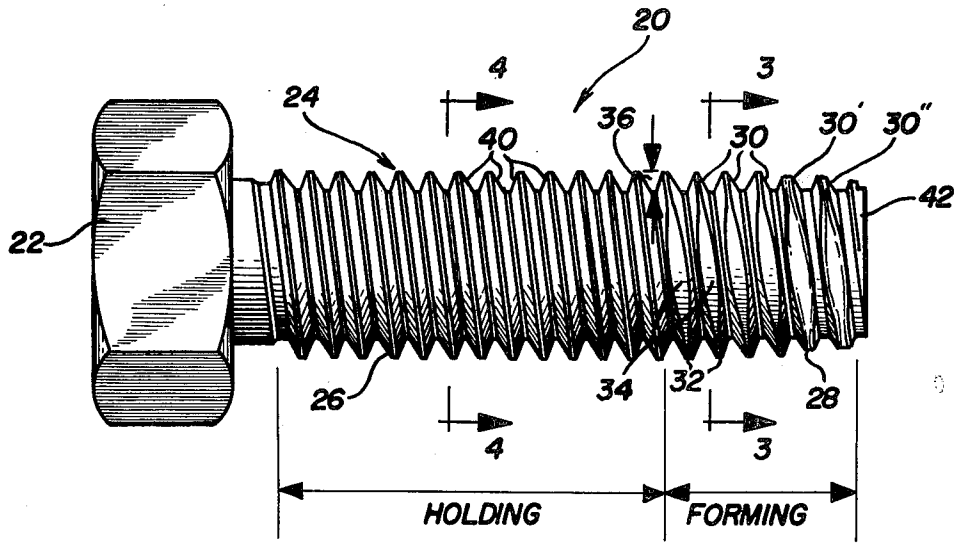


FIG.1

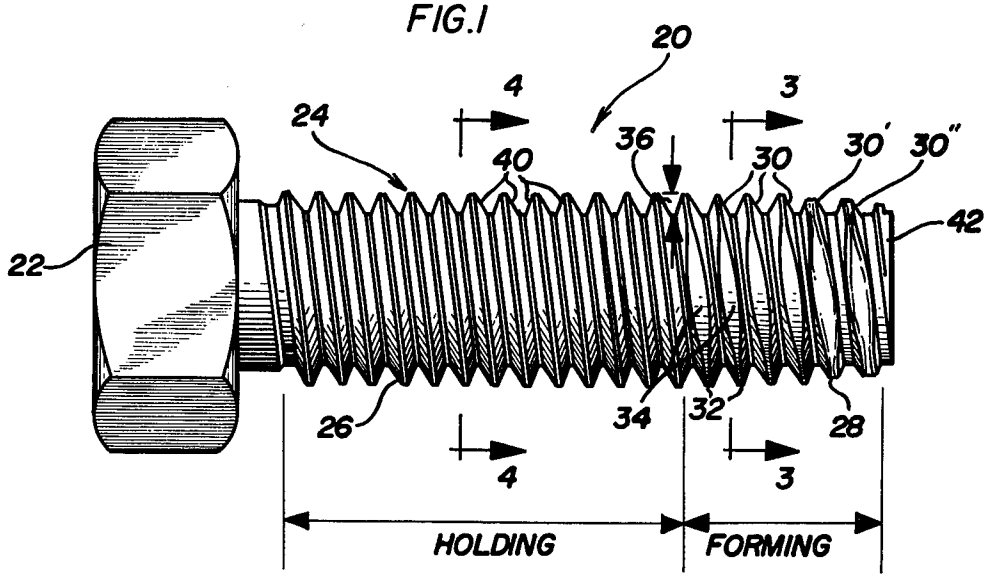


FIG.2

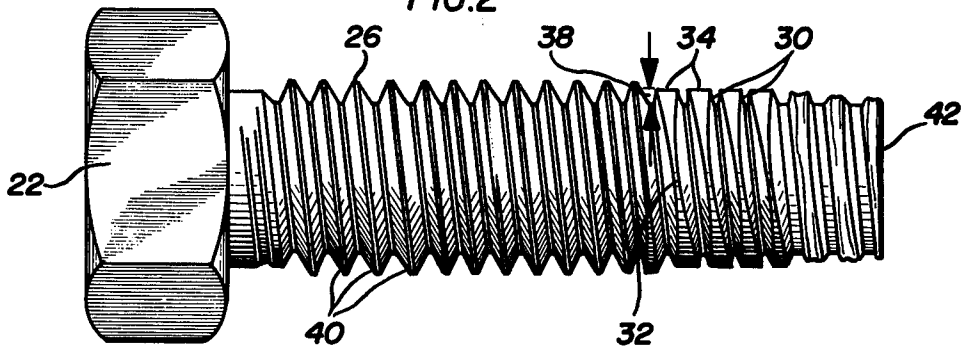


FIG.3

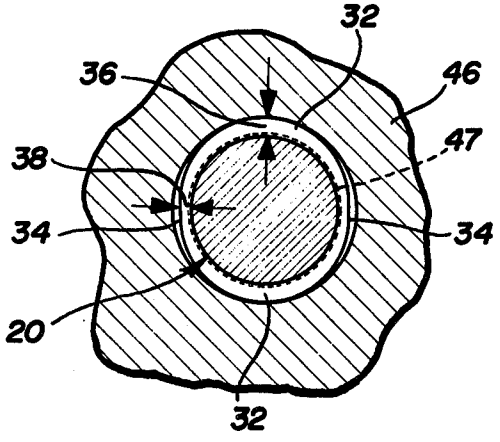


FIG.4

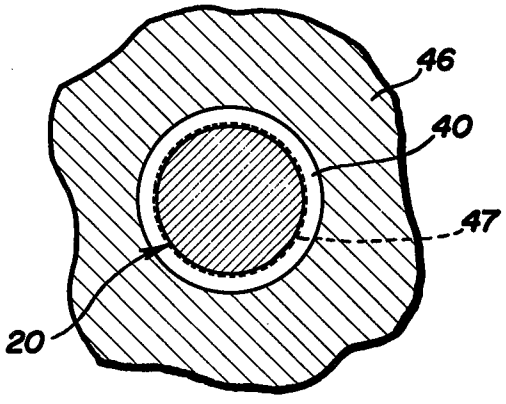


FIG. 5

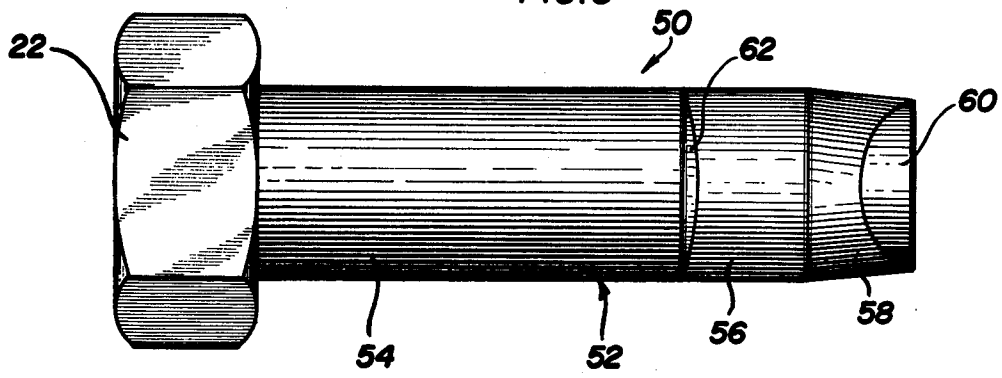
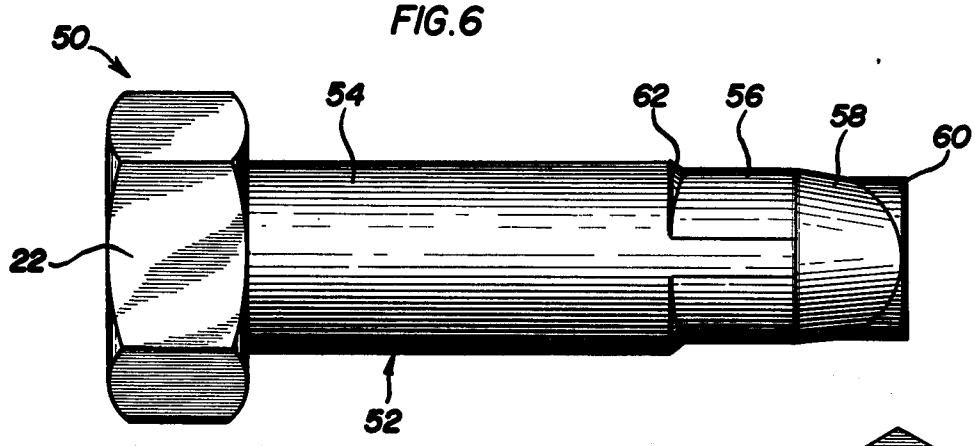


FIG. 6



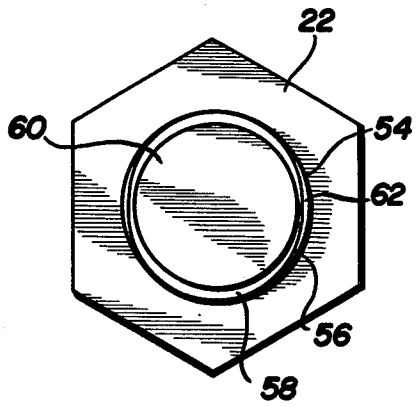


FIG. 7

FIG. 8

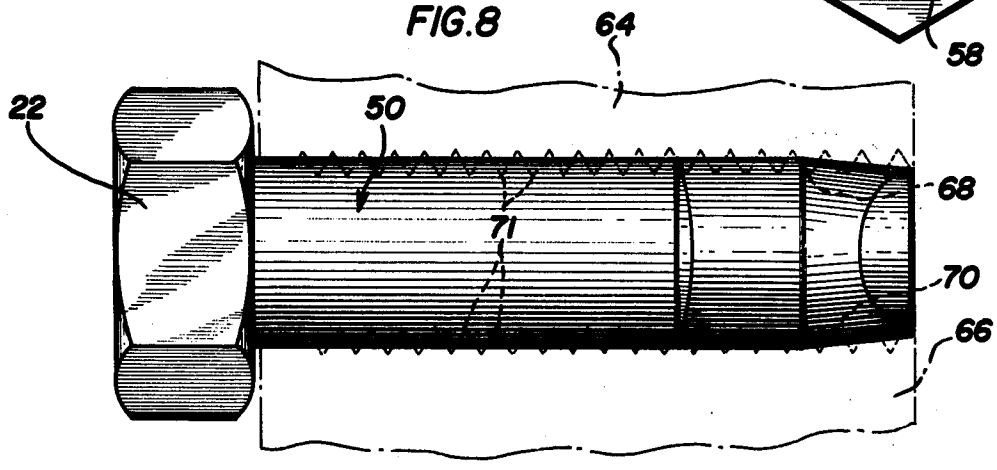


FIG. 9

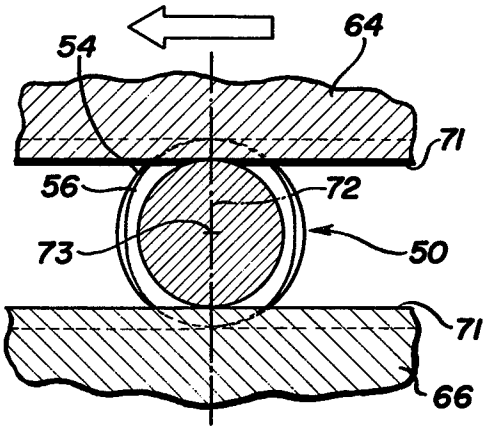


FIG. 10

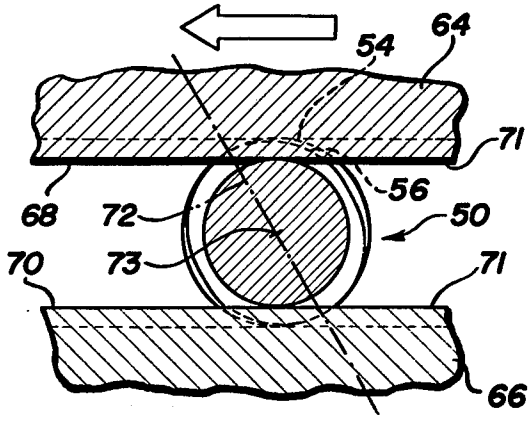


FIG. 11

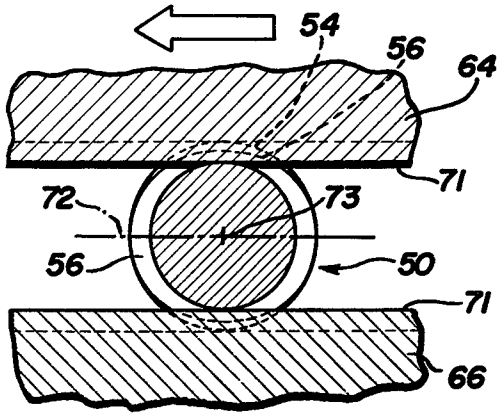


FIG. 12

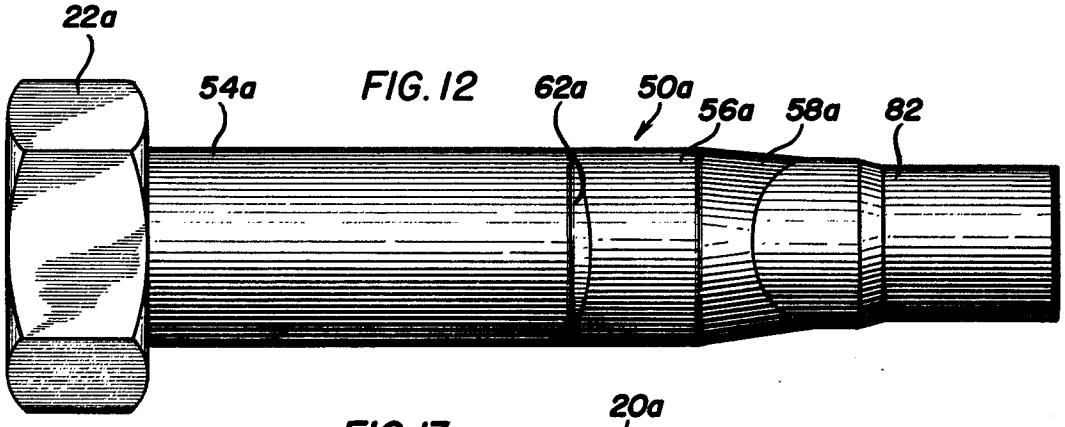
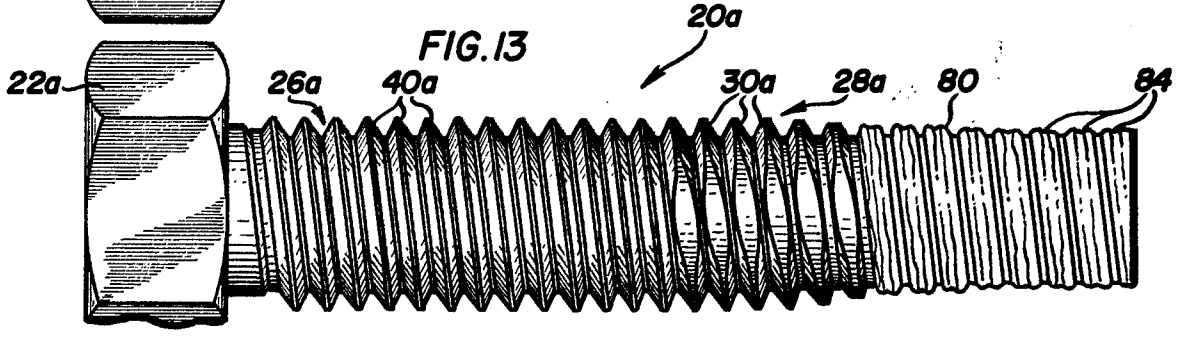


FIG. 13



BI-LOBULAR SELF-THREAD FORMING FASTENER

BACKGROUND OF THE INVENTION

The present invention relates to self-tapping fasteners, and more particularly to an improved, novel fastener and method of manufacturing.

Self-tapping fasteners or screws are widely known and used in the art, and fall into two general categories; namely, thread cutting and thread forming fasteners. The former type forms the female thread in a pilot aperture by a metal removal process, that is metal is actually cut from the aperture walls to form the female thread. The latter type of fastener, a somewhat more recent development, employs a cold-forming operation, wherein the female thread is swaged into the wall of the pilot aperture. It is to this latter type of self-tapping fastener that the present invention is directed.

One form of self-tapping fastener of the cold-working type, employs a forming section having a thread form which includes a plurality of lobes. That is, the thread has a crest formation of an arcuate polygonal shape providing alternate high and low portions; said high portions defining the lobes, the low portions the radial relief of the thread form. Accordingly, as the fastener is engaged with the wall of the pilot aperture the high portion or lobes will cold-work the metal with the radial relief providing space permitting the metal to flow during formation, relative to the thread areas in contact. One commercial design of this type fastener utilizes a thread forming cross section of a generally triangular configuration with the lobes or high points of the thread crests corresponding generally to the apecies of a triangle, with the sides or low points of thread form corresponding to the sides of the triangle. This type of self-tapping fastener is designated a tri-lobular, examples of which are illustrated in U.S. Pat. Nos. 3,246,556; 3,681,963 and 3,180,126.

In addition to the tri-lobular type of self-tapping fastener, attempts have been made to provide a commercially acceptable bi-lobular fastener. In this regard, the theory is that by reducing the number of lobular portions, the areas in contact are correspondingly reduced while the amount of radial relief is increased, which factors materially reduce the driving torque. Examples of the aforementioned prior artbi-lobular fastener can be found in U.S. Pat. Nos. 3,192,819 and 3,398,625 both of which will be discussed hereinafter.

While the fasteners of the tri-lobular design are adequate in that they provide relatively low driving torques, they are expensive to produce and their holding strength leaves something to be desired. Accordingly, in an attempt to obtain both low driving torque and maximum holding or stripping strength it was proposed to employ a section of straight circular thread in conjunction with the tri-lobular forming thread, said straight thread to be engaged with the female thread of the pilot aperture after formation by the tri-lobular thread form. However simple in theory this concept appears, numerous problems were encountered in the production of such a fastener by commerical thread rolling procedures and apparatus. More specifically, with the method as taught by U.S. Pat. No. 3,246,556 mentioned above, special dies had to be constructed; with the fastener of U.S. Pat. Nos. 3,180,126 and 3,681,963; oscillation of the die blanks during rolling had to be accommodated, or more appropriately, tolerated.

The use of special dies is a factor which materially increases the price of the finished product, as the cost of such dies is extremely high. As to oscillation of the blank during formation, this factor gives rise to a number of problems or disadvantages. More specifically, the thread portion on opposite sides of the point of oscillation are necessarily of limited length. Further, where a relatively long fastener is contemplated, actual oscillation cannot be tollerated. In these instances, the fastener is actually cold worked, or bent axially by the dies during rolling, which adversely effects the thread quality. In both instances, excessive die wear results which materially shortens the life of the die and necessitates costly replacement.

While both U.S. Pat. Nos. 3,192,819 and 3,398,625, teach bi-lobular self-tapping fasteners, these fasteners suffer from one or more of the above-mentioned disadvantages. The fastener illustrated in U.S. Pat. No. 3,192,819 has a bi-lobular thread formation along its entire length. The thread formation is obtained by employment of a method wherein a round blank is used in conjunction with specially constructed, scalloped dies. Obviously, die undesirable costs are excessive, an entremely underirable factor. Further, the fastener as taught by this patent does not employ a holding section. The fastener disclosed in U.S. Pat. No. 3,398,625 utilizes a bi-lobular forming section and a rearwardly disposed section having a thread form of a generally circular cross-section. The fastener is fabricated using an eliptical blank and standard thread rolling dies. During rolling the dies must be maintained at a slight offset or angle to the axis of the fastener. This is extremely critical and is required to provide increased pressure on the eliptical blank rearwardly of the work entering end so that this rear portion can be cold-worked to a circular configuration. As such, the circular thread thus produced in the rearward portion of the fastener, has a crest diameter less than that of the thread forming section. That is to say, the circular thread on the fastener as disclosed will not engage the female thread of the pilot aperture with the sufficient flank interference to produce a locking action or increase holding strength; in fact, this is the stated purpose as a low running torque is desired.

The present invention contemplates a novel fastener design and method of manufacturing which overcomes many of the disadvantages of the prior art, fasteners, and methods, while attain most of the advantages. More specifically, the present invention provides a fastener which utilizes a symmetrical bi-lobular forming section capable of forming a female thread while providing for relatively low driving torque in the process. Further, there is provided a holding section disposed rearwardly of the thread forming section, which employs a straight, circular thread formation capable of being engaged with the female thread formed by the bi-lobular threaded section to produce maximum holding strength. In addition, with the method of the present invention, a blank of special design is employed which permits the roll threading of the fastener with conventional dies. This blank incudes a section of generally circular cross section, in conjunction with a symmetrical bi-lobular section. As such, the bi-lobular thread formation obtained upon rolling is also symmetrical. Furthermore, the thread rolling operation may be ac-

complished without oscillation of the fastener blank; nor is it required that the dies be offset axially. As such, not only is die life increased by the elimination of oscillation and offsetting, but no limitation is placed on the length of the circular and bi-lobular threaded sections. Accordingly, if desired, the fastener may be employed with a relatively long lead-in or pilot portion of a circular configuration, such as that taught in U.S. Pat. No. 3,633,455.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is an elevational view of a fastener constructed in accordance with the present invention;

FIG. **2** is a top view of the fastener of FIG. **1** illustrating the thread formation rotated 90° with respect to FIG. **1**;

FIG. **3** is a partial sectional view of the fastener of FIG. **1** being engaged in a pilot aperture, the view being taken approximately along the line **3—3** of FIG. **1**;

FIG. **4** is a partial sectional view of the holding section of the fastener of FIG. **1** engaged in a pilot aperture, said view being taken generally along the line **4—4** of FIG. **1**;

FIG. **5** is a side view of a blank employed in forming the fastener of the present invention;

FIG. **6** is a top view of the blank of FIG. **5**;

FIG. **7** is an end view of the blank of FIG. **5**;

FIG. **8** is a somewhat schematic showing of the blank of FIG. **5**, engaged between a pair of thread rolling dies, illustrated in phantom;

FIGS. **9–11** are partial sectional views illustrating the rolling of the bi-lobular thread on the blank of FIG. **5**;

FIG. **12** is a side view of a blank similar to that of FIG. **5**, but employing an elongated circular end portion adapted to have a pilot thread formed thereon; and

FIG. **13** is a fastener fabricated in accordance with the present invention, from the blank of FIG. **12**.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

With reference to FIGS. **1** and **2**, a fastener **20** constructed in accordance with the present invention, is illustrated. As will be explained, FIG. **2** illustrates a top view of the fastener **20** of FIG. **1**, the fastener in effect having been rotated 90° relative to said FIG. **1**. The fastener **20** includes a driving head **22** and a threaded shank portion **24**. The driving head **22**, as illustrated, is of the hex head type, it being understood that various alternate forms of driving heads may be employed.

The threaded shank **24** of fastener **20** includes a holding section, designated generally **26**, and a thread forming section **28**. Holding section **26** is disposed generally adjacent the driving head **22**; it being understood that an unthreaded neck portion of substantial length may be employed intermediate the head **22** and the holding section **26**, if desired. The thread forming section **28** is disposed proximate the work entering end of the fastener, and forward of the holding section **26**.

As mentioned above, in use the fastener forming section **28** will be engaged with an unthreaded pilot aperture formed in a workpiece (not shown in FIGS. **1** and **2**) to form a female thread in said aperture wall. Upon advancement of the fastener into the pilot aperture, the holding section **26** will come into engagement with the female thread thus formed by the forming section **28**. This engagement will produce flank-to-flank engagement of sufficient degree to attain the desired locking action. The manner in which this holding or locking action is attained will be considered hereinafter.

Considering first the thread forming section **28**, the thread turns on this section which are designated **30**, are of a specific configuration designed to facilitate forming of the female thread in the pilot aperture. More specifically, each thread turn **30** is of a bi-lobular configuration. In this regard, the thread turns **30** are what are termed in the art as "underfilled". In this regard, each thread turn **30** includes a pair of lobe portions **32** and a corresponding pair of side portions **34** which merge smoothly with said lobes. Looking to FIG. **1**, the lobe portions **32** are shown in profile, the thread-height of said lobes **32** being indicated at **36**. The term "thread-height" is employed to indicate the perpendicular distance from the thread root to the thread crest. In FIG. **2**, which in effect illustrates fastener **20** rotated 90° with respect to FIG. **1**, the side portions **34** of the thread turns **30** are illustrated in profile, the thread-height of said side portions being indicated at **38**. Accordingly, upon comparison of FIGS. **1** and **2**, it can be seen that the thread-height of the side portions **34** is considerably less than that of the lobe portions **32**. This difference is the radial relief of each thread turn, as referred to previously.

The thread turns **30** on the forming section **28**, as illustrated, include a number of individual turns, **30'** and **30''** disposed on a taper, and merging smoothly with the thread turns **30** rearwardly thereof, which latter turns are of a relatively straight configuration. It can be seen that the crest formtion of the lobes and side portions **32** and **34** of the tapered thread turns **30'** and **30''** are somewhat less developed than that of the straight thread turns **30** on the forming section **28**.

The tapered thread turns **30'** and **30''** thus provide for a gradual increase in the amount of metal being swaged or cold worked in the aperture wall during formation of the female thread. The straight thread turns of the forming portion **28** in effect size the female thread to the desired, final dimension. If desired, all of the threads on the forming section **28** could be disposed on a gradual taper with only the last lobe portion **32** being used to size the female thread to its final dimension.

The holding section **26** comprises a plurality of thread turns **40** which are substantially fully developed and are of a circular cross section, as compared to the bi-lobular thread turns **30** on section **26**. The thread turns **40** have a generally constant thread height about their peripheral extent, there being a general absence of any radial relief. In addition, the radial height of the threads **40**, that is the distance from the axis of the fastener to the thread crest, is at least as great as the maximum radial height of the lobe portions **32** of thread turns **30** on forming section **26**. Accordingly, the thread turns **40** will have substantial flank-to-flank contact when engaged with the female thread of the pilot aperture thus formed by the bi-lobular thread turns **30**.

With a bi-lobublar thread, initial coaxial engagement of the fastener in the pilot aperture is important. While slight misalignment can be tolerated, if this is substantial, the amount of material being cold-worked during driving is materially increased, producing excessive driving torques. To assure some measure of the alignment initially, fastener **20** includes a circular nose portion, designated **42**. The nose portion **42** has a partial

thread formed thereon and in the embodiment of FIGS. 1 and 2, this thread extends for only a relatively short distance, approximately one-half to two-thirds of a thread turn. The thread formed on the nose portion 42 is circular and merges smoothly with the bi-lobular thread of the tapered thread turns 30′ and 30″. The radial height of the thread formation on nose portion 42, at its forwardmost extent is less than the radius of the pilot aperture and increases to a radial height sufficient to achieve initial purchase with the walls of the pilot aperture before merging with the bi-lobular thread turns 30′ nd 30″ on the forming section 28. As such, engagement of the pilot portion 42 with the aperture wall will provide a lead-in for the bi-lobular thread turns 30 and will assure the desired initial alignment. As will be discussed in more detail with regard to FIGS. 12 and 13, a more extensive nose or lead-in portion may be employed if desired.

In FIGS. 3 and 4 there is illustrated the situation existing upon engagement of the fastener 20 in a pilot aperture. It should be noted, that these figures correspond generally to sections taken at lines 3—3 and 4—4 of FIG. 1, but are of a somewhat schematic nature for purposes of discussion and illustration. Such is the case, in that the thread turns 30 and 40 are disposed on a spiral or helix, and a perpendicular section would not expose to view the entire thread turn, as is shown in FIGS. 3 and 4.

In FIG. 3, the forming section 28 of the fastener 20 is shown as engaged with a workpiece 46 having a pilot aperture therein. This partial sectional view is taken generally at the line 3—3 of FIG. 1, such that a female thread 47 has been substantially completely formed in said workpiece; the crest of said thread being illustrated in dotted outline. In this regard, the lobes 32 of the bi-lobular thread turns 30 will cold-work or swag the material of the aperture wall to form the female thread 47. The difference in the thread-height 38 of the side portions 34 and the thread-height 36 of the lobes 32 is best illustrated herein, with the difference in said thread heights being the radial relief. It should be noted that the female thread thus produced is of a generally circular configuration as to both the root and crests thereof, this is due to the symmetrical nature of the bi-lobular thread turns 30, with the root diameter of female thread 47 corresponding to approximately twice the maximum radial height of said bi-lobular thread turns 30.

FIG. 4 is a view generally similar to FIG. 3, but illustrating the situation obtained upon engagement of the thread turns 40 of the holding section 26 with the female thread 47 as formed by thread turns 30. In this view, it can be seen that the thread turns 40 are of a generally circular configuration. Accordingly, since the radial height of the thread turns 40 is at least as great, or greater than the maximum radial height of the bi-lobular thread forming turns 20, substantial flank-to-flank engagement is obtained about the full extent of the engaged thread turns 40. This engagement will resist inadvertent withdrawal of the fastener and improve the holding and stripping strength thereof, over that of the prior art designs.

Referring now to FIGS. 5 and 6, the blank from which the fastener 20 of FIG. 1 is formed is illustrated and designated generally 50. Tne blank has the driving head 22 formed thereon, and includes an elongated unthreaded shank portion 52. The shank portion 52 of the illustrated embodiment is divided into a plurality of distinct sections. Adjacent to the head 22 is a first section 54 of generally circular cross section which section corresponds to the length of the holding section 26 dicussed previously. Immediately forward of the circular section 54 is a straight bi-lobular section 56. In this regard, the maximum diameter of the section 56 taken through the lobular portions thereof is substantially equal to that of the circular blank portion 54. On the other hand, the diametrical distance taken through the flat or side area of this portion is considerably less than the diameter of the circular section 54. Forward of the straight bi-lobular section 56 is a tapered bi-lobular section 58 which merges with a circular nose section 60. A relatively short sloping transition section 62 joins the side portions of the straight bi-lobular section 56 with the circular shank section 54 which permits threads to be rolled smoothly and continuously over the length of the blank despite the differences in cross-sectional dimensions. The second and third sections 56 and 58, will provide the thread forming portions 28 of the fastener and conform generally in shape to the thread turns 30, i.e. bi-lobular in shape. More specifically, a sectional view taken through either of the respective blank sections will include a pair of diametrically opposed arcuate lobes separated by arcuate, somewhat flattened side portions. In both instances, however, the respective lobes and side portions of the blank sections 56 and 58 are symmetrically disposed with respect to the longitudinal axis of the blank.

A thread is formed on the exterior surface of the blank 50 in accordance with the standard thread rolling procedures as discussed hereinafter, said operation being performed with standard, conventional thread dies. This thread rolling operation is illustrated somewhat schematically in FIGS. 8–11.

Referring first to FIG. 8, the blank 50 is initially disposed between a pair of standard thread rolling dies 64 and 66, illustrated in phantom. The dies 64 and 66 include opposed die faces 68 and 70 respectively which are generally flat and have a plurality of thread forming ridges 71, shaped and arranged thereon in the usual manner, as is known in the art. The ridges 71 at the entering end of the dies are quite shallow and increase in depth in the direction of movement of the blank 50 relative to the die surface during rolling. Accordingly, a gradual penetration of the blank 50 is effected which increases to the full thread depth prior to blank 50 leaving the dies.

The blank 50 is disposed between the dies 64 and 66 in the conventional manner, and the dies are moved relative to each other thereby causing blank 50 to roll relative to each said die. Upon set up, the dies 64 and 66 are spaced a prescribed distance apart which will insure that the ridges 71 penetrate the die blank 50. Accordingly, as the blank rolls relative to the dies, the thread forming ridges 71 will cold work the blank material to form a desired thread configuration thereon.

At this point, it should be noted that for proper thread rolling it is important that the blank roll smoothly relative to the dies. If any slippage of the blank is encountered, unacceptable thread distortion arise. This problem of slippage is one that has plagued fastener manufactures in the rolling of lobular thread formations. In this regard, with blanks of a lobular configuration along their entire length, there is a tendency for the blank to slip relative to the dies, rather than to

roll smoothly. With the aforementioned prior art trilobular configuration, considerable care must be taken in the formation of the blank side portion in order to provide sufficient curvature to enable the blank to roll, rather than slip during forming. Another manner of overcoming this problem is to employ extremely high die pressure, so that the forces created by engagement of the die with the blank will overcome any tendency of the blank to slip. Obviously, this method is undesirable as it shortens die life. With the present invention, these prior art problems are, to a great extent, eliminated. That is to say, the die pressures employed may be no greater than that normally employed with standard, round blanks. Also, the tolerances that need be observed during formation of the lobularblank sections are not critical to attainment of proper rolling. In addition to these problems, numerous other problems are eliminated by the present invention, as will be apparent from the foregoing discussion.

Any tendency of blank **50** to slip during thread rolling is completely eliminated by the employment of the circular blank section **54.** In this regard, the thread forming ridges **71** of the die blanks **64** and **66,** will continuously engage said circular section **64,** thus providing sufficient force to keep the blank **50** rolling smoothly during the entire thread forming operation. This aspect of the invention is illustrated in FIGS. **9–11.**

With reference to FIGS. **9–11,** there is shown somewhat schematically, the conditions existing during various stages of the rolling of blank **50.** For reference purposes, a datum line **72** has been provided through the opposed lobe portions of the straight bi-lobular section **56.** Further, dotted lines **74** and **76** indicate the maximum depth of the thread ridges **71.**

Looking first to FIG. **9,** it will be noted that datum line **72** is disposed generally vertically with the ridges **71** penetrating the lobular portions of section **56** to a maximum extent. As to blank **50,** rolls, datum line **72** will move to a position illustrated in FIG. **10** disposed approximately at 45° to the vertical. In this condition, while the thread forming ridges **71** are still in full engagement with the straight circular section **54** of the blank, the degree of penetration of said ridges in the bilobular section **56** is reduced. In FIG. **11,** the blank **50** is rotated 90° from the position illustrated in FIG. **9,** with the datum line **72** disposed substantially horizontally. In this condition, the thread forming ridges **71** are no longer engaged with the lobular portions of section **56,** but are engaged with the side portions of section **56;** as such the degree of penetration is at a minimum. It will be noted that throughout the thread rolling operation, the degree of penetration or engagement of the ridges **71** with the circular portion **54** of the blank **50** remains constant, which factor produces continuous, smooth rolling of the blank **50.**

Referring again to FIGS. **1** and **2,** it will be recalled the lobular sections **32** of thread turns **30** were completely filled while the side portions **34** were underfilled. This condition results due to the degree of penetration of the thread forming ridges **71,** as illustrated in FIGS. **9–11.** That is to say, where the degree of penetration is to the full extent, such as shown in FIG. **9,** the thread form thus produced will be substantially, completely filled. On the other hand, where the degree of penetration is at a minimum, as is the case with the side portions of the blank, the condition illustrated in FIG. **11** the resulting thread formation will be underfilled. It should also be noted that where the blank portion is undersized, such as the nose portion **60,** penetration by ridges **71** is also insufficient to provide a completely filled or formed thread.

In addition to the provision for continuous rolling of the blank **50** during thread forming, certain additional features are illustrated in FIGS. **9–11.** First of all, it should be noted that throughout the rolling operation, the degree of engagement are the ridges **71** with the opposed lobes of the blank section, is substantially equal for all orientations. Thus, the forces established during cold rolling of the blank material will also be of approximately equal magnitude and oppositely directed. Accordingly, the dynamic stress acting upon the dies **64** and **66** are equal at all times, thus providing a dynamically balanced condition.

This dynamic balance is also manifest in another manner, that is the elimination of blank wobbling. In this regard, the longitudinal axis **73** of the blank **50** does not change positions with respect to the dies during rolling. This is a significant feature, in that wobbling of the blank **50** will limit the length of the fastener and also produce excessive die wear thereby shortening the effective life of the die. Since no wobbling of the blank **50** is encountered, unlike the prior art structures and methods, there is no limit upon the length of the various fastener sections that can be formed. Thirdly, the elimination of any tendency of the blank to wobble or slip improves the quality of the thread thus formed.

Attention is now directed to FIGS. **12** and **13** wherein a modified form of the present invention is shown. In this regard, attention is invited to the previous discussion of the problems encountered with the prior art fasteners and methods due to wobbling of the blank during forming. It will be recalled that with the prior art method the relative length of the fastener was limited. As such, relatively long pilot portions could not be employed economically. No such limitation exists with the present invention. Accordingly, where operating conditions so presribe, a self-tapping lobular fastener can be provided with an elongate work entering pilot portion to facilitate pickup of the forming threads and produce proper alignment during the initial stages of the thread forming operation.

A fastener constructed in accordance with the present invention and employing an elongate pilot portion is illustrated in FIG. **13** and designated generally **20*a***. The blank employed in producing the fastener **20*a*** as shown in FIG. **12.** Basically, the fastener **20*a*** and the method of manufacturing is similar to that discussed above, with one exception. That is, in place of the relatively short circular pilot portion **42,** the fastener **20*a*** is provided with a relatively long pilot portion **80,** having a thread configuration which will assure proper alignment and engagement of the thread forming turns with the walls of the pilot aperture. The pilot portion **80** is preferably, but not necessarily, constructed in accordance with the teachings of the U.S. Pat. No. 3,633,455.

The fastener **20*a*** is formed in accordance with the present invention in a manner generally similar to fastener **20** of FIGS. **1** and **2.** As such, corresponding structural features of the fastener **20*a*** are designed by the same reference character as employed with regard to fastener **20,** followed by a small "a". Accordingly, as shown in FIG. **12,** said fastener **20*a*** includes a driving head **22*a***, a holding section **26*a***, provided by circular

thread turns **40***a*, and forming section **28***a*, including bi-lobular thread turns **30***a*. Disposed forwardly of the forming section **28***a* is the pilot portion **80** to be discussed hereinafter.

The blank for forming the fastener **20***a* is shown in FIG. **12** and designated **50***a*. Similar to the blank **50** discussed previously, the blank **50***a* includes an elongate circular section **54***a*, a straight, bi-lobular section **56***a* and a tapered bi-lobular section **58***a*. In place of the nose portion **60** of the blank **50,** the blank **50***a* includes an elongate, circular section **82.** As can be seen in FIG. **12,** section **82** is of a reduced diameter, which is required for formation of the under-developed thread form for nose portion **80,** discussed hereinafter.

The elongate pilot portion **80** has an underdeveloped thread configuration **84** formed thereon. This thread configuration **84** is of a substantially circular cross-section and is step tapered along the length thereof. The radial height of the thread **84** on the pilot portion **80** increases from a beginning height less than the diameter of the pilot hole to a height somewhat greater than said diameter, and then merges smoothly with the thread turns **30***a* of the thread forming portion. Accordingly, as the pilot portion **80** is engaged with the pilot hole, the thread **84** will achive progressively greater purchase with the aperture walls establishing proper alignment and thread pickup prior to engagement of said wall by the thread forming turns **30***a*. Thus, sufficient alignment and purchase is attained at relatively low levels of driving torque prior to initiation of the thread forming operation.

The fasteners and method of manufacture illustrated in the drawings and described above constitute preferred forms of the present invention. It is envisioned and contemplated that those skilled in the art may readily devise various modifications; however insofar as they are covered by the appended claims, they fall within the spirit and scope of said invention.

The invention is claimed as follows:

1. A self-thread forming fastener for forming a female thread in a pilot aperture and effecting a locking action with said female thread, said fastener comprising: a driving head and a shank having a cold rolled threaded portion, said threaded portion of the shank including a thread-forming section, and a holding section, said thread-forming section having a plurality of helically disposed thread turns formed thereon, each said thread turn being defined by a generally circular root, a pair of helically disposed spaced flank surfaces which are disposed at an acute angle to each other converging in a radially outward direction, and a helically disposed crest surface, the height of said crest surface as measured from the root of said thread varying about the helix of each turn such that said flank surfaces and said crest surfaces define a pair of diametrically opposed arcuate lobe portions and a corresponding pair of diametrically opposed arcuate side portions for each thread turn, the height of the crest surface for said side portions being less than that at said lobe portions, said angle of convergence remaining substantially constant about said thread turn, and said side portions and lobe portions merging smoothly such that said flank surfaces and crest surfaces for each thread turn are continuous and uninterrupted, thereby providing each said thread turn with a truncated profile in section throughout the entire thread turn, and further providing said forming section with a bi-lobular thread formation capable of forming said female thread in the pilot aperture, and said holding section including a plurality of thread turns having a crest formation of a substantially circular configuration, the radial height of said thread turns on the holding section being at least as great as the maximum radial height of the lobe portions on the forming section, such that upon engagement of the thread turns on the holding section the female thread formed by the forming section flank-to-flank engagement will be obtained thereby establishing a locking action.

2. A fastener as defined in claim **1** wherein a number of the thread turns on said forming section are disposed on a taper, with the radial height of the respective lobe portions increasing in a direction toward the holding section.

3. A fastener as defined in claim **1** further including a threaded pilot end portion of circular cross-section, the thread formation on said pilot end being disposed on a taper and having a minimum crest diameter less than the diameter of said pilot aperture and increasing to a maximum crest diameter sufficient to afford engagement with said pilot aperture, said thread on said pilot end portion merging with the bi-lobular thread formation on the thread forming section of the fastener.

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