Oct. 26, 1965 S. S. KAHN 3,213,742

COMBINATION THREAD SWAGING AND FASTENING SCREWS

Filed July 18, 1963 2 Sheets-Sheet 1

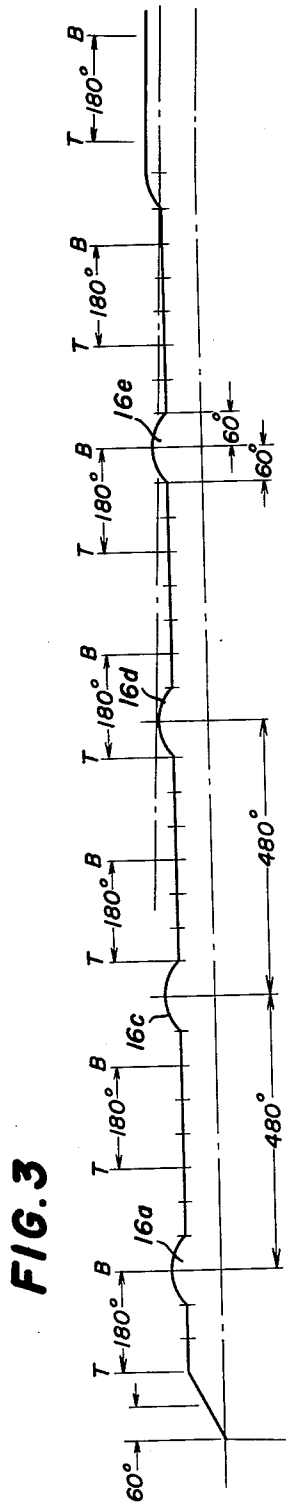

FIG. 3

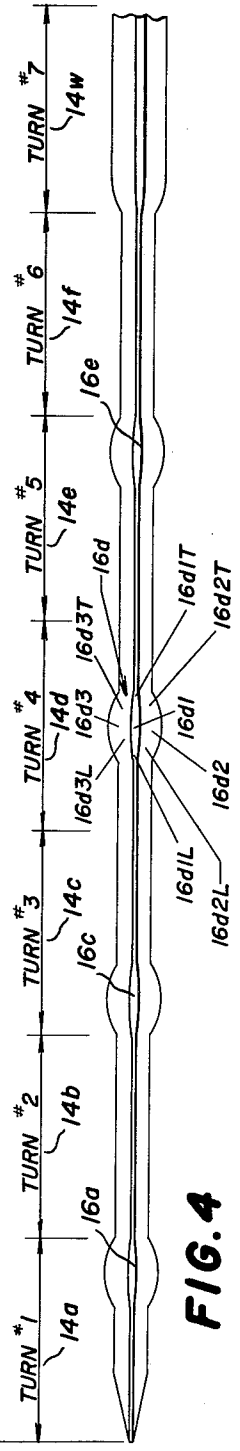

FIG. 4

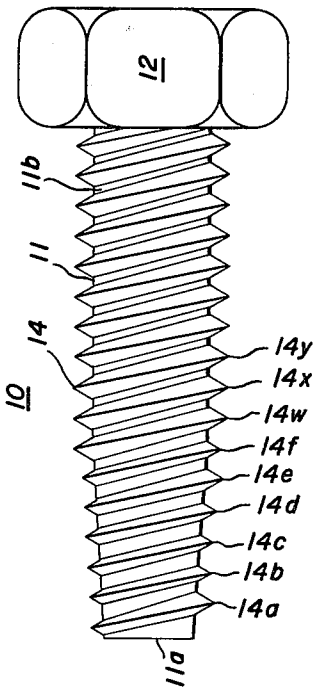

FIG. 2

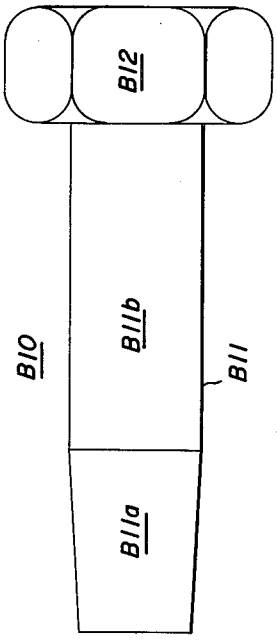

FIG. 1

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FIG. 5

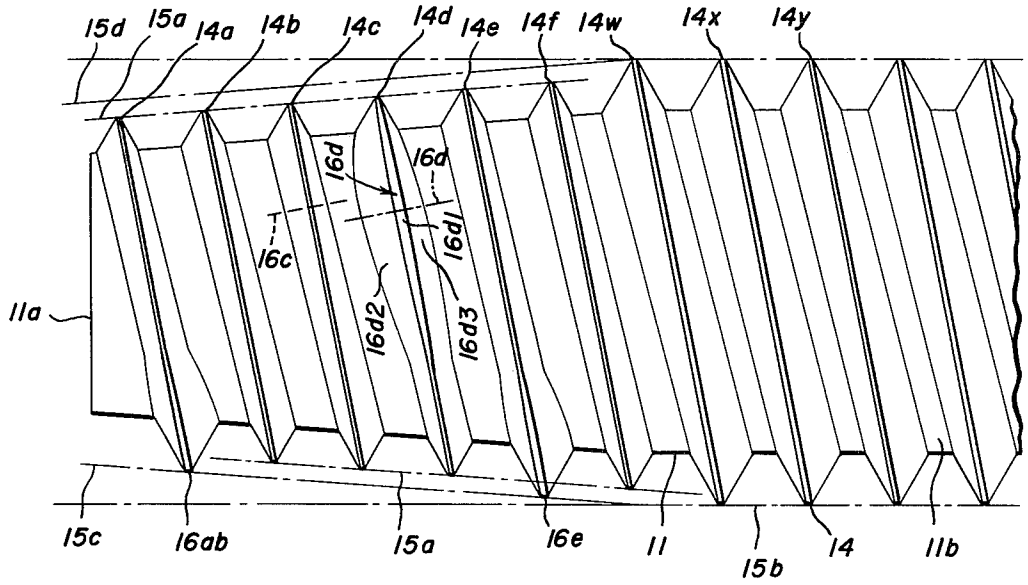
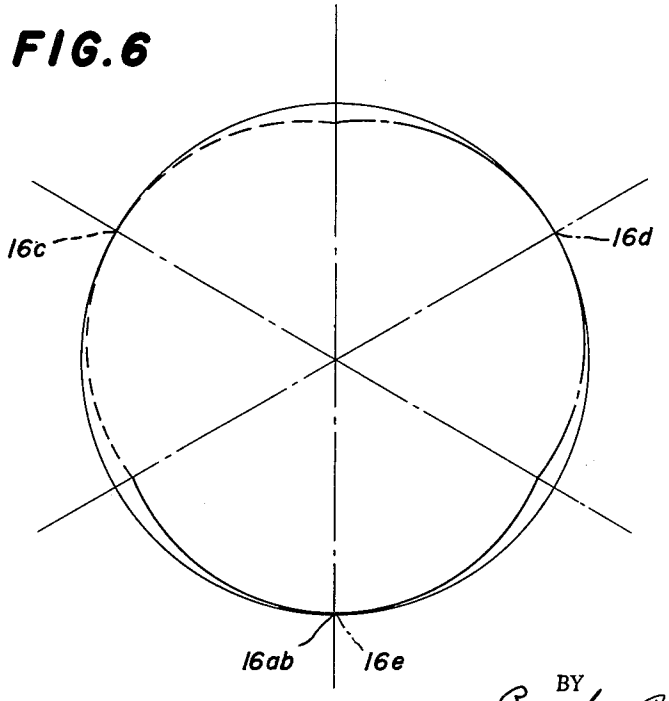


FIG. 6



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COMBINATION THREAD SWAGING AND FASTENING SCREWS

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7 Claims. (Cl. 85—46)

The present invention relates to combination thread-swaging and fastening screws, and more particularly to such screws adapted to swage threads of desired formation in generally cylindrical surfaces.

A general object of the invention is to provide a combination thread-swaging and fastening screw that comprises an elongated shank including a generally cylindrical rear body portion and a generally frusto-conical forwardly tapered front pilot end portion, a continuous thread carried on the shank and including both a plurality of helical turns on the rear body portion and a plurality of helical turns on the front pilot end portion, the thread having a fixed pitch, the turns on the rear body portion having substantially the same minor radius and successively forward ones of the turns on the front pilot end portion having gradually reduced minor radii, the turns on the rear body portion having a first crest projection from the root thereof and the turns on the front pilot end portion having a second crest projection from the root thereof, wherein the first crest projection is greater than the second crest projection, and a plurality of thread-swaging lobes carried by the turns on the front pilot end portion along the helix of the thread with a rotational angle A about the longitudinal axis of the shank between the centers of adjacent ones of the lobes, wherein $A=360°+B$, and wherein B is a fixed angle within the approximate range 60° to 120°, each of the lobes subtending a rotational angle C about the longitudinal axis of the shank, wherein C is a given angle within the approximate range 60° to 120°, each of the lobes including a crest provided with leading and trailing edges and a pair of flanks each provided with leading and trailing faces, the leading and trailing edges of each lobe crest respectively merging into the adjacent portions of the crest of the associated turn on the front pilot end portion, and the leading and trailing faces of each lobe flank respectively merging into the adjacent portions of the flank of the associated turn on the front pilot end portion.

Another object of the invention is to provide a screw of the character described, wherein each of the lobes has a variable crest projection from the root thereof that is maximized substantially at the center thereof and that at its maximum value is substantially greater than the second crest projection of the associated turn on the front pilot end portion, and wherein the maximum crest projection of the rearmost of the lobes is substantially equal to the first crest projection of the turns on the rear body portion.

Another object of the invention is to provide a screw of the character described, wherein each of the lobes has a variable flank width at the root thereof that is maximized substantially at the center thereof and that at its maximum value is substantially greater than the flank width of the associated turn on the front pilot end portion, and wherein the maximum flank width of the rearmost of the lobes is substantially equal to the flank width of the turns on the rear body portion.

A further object of the invention is to provide a screw of the character described, that includes an enlarged tool-engaging head on the rear end of the shank thereof, whereby the screw swages a thread in a preformed opening provided in an associated workpiece, as the screw is set in the workpiece.

Further features of the invention pertain to the particular arrangement of the elements of the screw, whereby the above-outlined and additional operating features thereof are attained.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification, taken in connection with the accompanying drawings, in which:

FIGURE 1 is a side view of a blank that is employed in making the fluteless thread-forming screw embodying the present invention;

FIG. 2 is a side elevational view of the thread-swaging and fastening screw embodying the present invention;

FIG. 3 is an enlarged diagrammatic illustration of the profile of the front portion of the thread provided on the front pilot end of the shank of the screw shown in FIG. 2;

FIG. 4 is an enlarged diagrammatic illustration of the plan of the front portion of the thread, as shown in FIG. 3;

FIG. 5 is a greatly enlarged fragmentary side elevational view of the front portion of the screw, as shown in FIG. 2, and illustrating in proper positions certain of the swaging lobes incorporated in the front portion of the thread and developed in FIGS. 3 and 4; and

FIG. 6 is an enlarged diagrammatic illustration of the proper angular positions of certain of the swaging lobes mentioned.

Referring now to FIGS. 2 to 6, inclusive, of the drawings, there is illustrated a fluteless thread-forming tool, in the form of a combination thread-swaging and fastening screw **10**, and embodying the features of the present invention; which screw **10** comprises an elongated shank **11** including a forwardly tapered substantially frusto-conical front pilot end portion **11***a* and a substantially cylindrical rear body portion **11***b*. Also, the screw **10** comprises an enlarged head **12** terminating the extreme rear end of the rear body portion **11***b* of the shank **11**; which head **12** may be of any suitable type, a hexagon head **12** being illustrated for the purpose of the present description. The head **12** is adapted to be received in a cooperating driving tool, such as a socket wrench, not shown, that is employed to set the screw **10** in an obvious manner. Further, the screw **10** comprises a continuous rolled thread **14** carried on the shank **11** and including a plurality of front helical turns **14***a*, **14***b*, **14***c*, **14***d*, **14***e* and **14***f* disposed on the front pilot end portion **11***a* and a plurality of rear helical turns **14***w*, **14***x*, **14***y*, etc., disposed on the rear body portion **11***b*. Thus, there are six turns on the front pilot end portion **11***a*; whereby the turns **14***a*, **14***b*, **14***c*, **14***d*, **14***e* and **14***f* are sometimes referred to hereinafter, respectively, as the first, second, third, fourth, fifth and sixth turns on the front pilot end portion **11***a*.

The thread **14** has a fixed pitch; the turns **14***w*, **14***x*, **14***y*, etc., on the rear body portion **11***b* have substantially the same fixed minor radius; and successively forward ones of the turns **14***f*, **14***e*, **14***d*, etc., on the front pilot end portion **11***a* have gradually reduced minor radii. The turns **14***w*, **14***x*, **14***y*, etc., on the rear body portion **11***b* have substantially the same fixed major radius, and consequently a corresponding first fixed crest projection from the root thereof; and successively forward ones of the turns **14***f*, **14***e*, **14***d*, etc., on the front pilot end portion **11***a* have gradually reduced major radii and consequently a corresponding second fixed crest projection from the root thereof. In the arrangement, the first crest projection of the rear turns **14***w*, **14***x*, **14***y*, etc., is substantially greater than the second crest projection of the front turns **14***f*, **14***e*, **14***d*, etc.; all as clearly shown in FIGS. 2 and 5. Specifically, the radial distances between the two broken

lines **15***b* extending through the crests of the rear turns **14***w*, **14***x*, **14***y*, etc., and the respective root lines of the rear turns **14***w*, etc., are greater than the radial distances between the two broken lines **15***a* extending through the crests of the front turns **14***a*, **14***b*, **14***c*, etc., and the respective root lines of the front turns **14***w*, etc., as illustrated in FIG. 5. Each rear turn **14***w*, etc., includes a crest and a pair of flanks disposed with an angle of approximately 60° therebetween and with a first flank width at the root thereof; and each front turn **14***a*, etc., includes a crest and a pair of flanks disposed with an angle of approximately 60° therebetween and with a second flank width at the root thereof. Of course, the flank width mentioned of each rear turn **14***w*, etc., is substantially greater than the flank width mentioned of each front turn **14***a*, etc.

Also, the screw **10** comprises a plurality of thread-swaging lobes **16***a* provided on the front turn **14***a*, **16***c* provided on the front turn **14***c*, **16***d* provided on the front thread **14***d*, and **16***e* provided on the front thread **14***e*; all as shown in FIGS. 3 and 4. Thus, the lobes are four in number and are carried by the turns on the front pilot end portion **11***a* along the helix of the thread **14** with a rotational angle A about the longitudinal axis of the shank **11** between the centers of adjacent ones of the lobes; wherein $A=360°+B$; and wherein B is a fixed angle of approximately 120°, as illustrated. Hence, in the present example $A=480°$, as shown in FIGS. 3 and 4. Also, each of the lobes subtends a rotational angle C about the longitudinal axis of the shank **11**; wherein C is a given angle of approximately 120°, as illustrated. These relationships are shown in the developments of FIGS. 3 and 4; and also in FIG. 6, wherein it will be observed that the lobes **16***a*, **16***c*, **16***d* and **16***e* are respectively indicated in the clockwise direction. Further, this relationship is indicated in FIG. 5. Hence, in four complete turns of the thread **14** on the front pilot end portion **11***a*, or 1440° thereof, the lobe **16***e* falls directly behind and in alignment with the lobe **16***a*. The lobe **16***c* is angularly displaced by 480°, or by an apparent angle of 120°, with respect to the lobe **16***a*; the lobe **16***d* is angularly displaced by 480°, or by an apparent angle of 120°, with respect to the lobe **16***c*; and the lobe **16***e* is angularly displaced by 480°, or by an apparent angle of 120°, with respect to the lobe **16***d*.

As best illustrated in FIG. 5, the lobes **16***a*, **16***c*, **16***d*, and **16***e* are of substantially identical construction and arrangement, except the sizes of the lobes **16***a*, etc., progressively increase rearwardly along the front pilot end portion **11***a*. Thus, by way of example, and as best illustrated in FIG. 4, the lobe **16***d* provided on the front turn **14***d* comprise a crest **16***d***1** provided with leading and trailing edges **16***d***1**L and **16***d***1**T, and a pair of flanks **16***d***2** and **16***d***3** respectively provided with leading and trailing faces **16***d***2**L, **16***d***2**T and **16***d***3**L, **16***d***3**T. The leading and trailing edges **16***d***1**L and **16***d***1**T of the lobe crest **16***d***1** respectively merge into the adjacent portions of the associated front turn **14***d*; the leading and trailing faces **16***d***2**L and **16***d***2**T of the lobe flank **16***d***2** respectively merge into the adjacent portions of the corresponding flank of the associated front turn **14***d*; and the leading and trailing faces **16***d***3**L and **16***d***3**T of the lobe flank **16***d***3** respectively merge into the adjacent portions of the corresponding flank of the associated front turn **14***d*. The leading crest edge **16***d***1**L rises gradually radially out of the crest of the associated front turn **14***d*; and the trailing crest edge **16***d***1**T falls gradually radially back into the crest of the associated front turn **14***d*. Hence, the lobe **16** has a variable crest projection from the root thereof that is maximized substantially at the center thereof and that at its maximum value is substantially greater than the second crest projection of the associated turn **14***d*. The leading flank face **16***d***2**L rises gradually both radially and axially forwardly out of the corresponding flank of the associated front turn **14***d*, and the trailing flank face **16***d***2**L falls gradually both radially and axially rearwardly back into the corresponding flank of the associated front turn **14***d*; and similarly, the leading flank face **16***d***3**L rises gradually both radially and axially rearwardly out of the corresponding flank of the associated front turn **14***d*, and the trailing flank face **16***d***3**T falls gradually both radially and axially forwardly back into the corresponding flank of the associated front turn **14***d*. Hence, the lobe **16***d* has a variable flank width at the root thereof that is maximized substantially at the center thereof and that at its maximum value is substantially greater than the flank width of the associated front turn **14***d*.

The progressively increasing sizes of the lobes **16***a*, **16***c*, **16***d* and **16***e* rearwardly along the front pilot end portion **11***a* is best illustrated in FIG. 4, wherein it will be observed that the lower broken line **15***c* passing through the bottoms of the crest of the lobes **16***a* and **16***c* is disposed below the adjacent lower broken line **15***a*. Also, the upper broken line **15***d*, corresponding to the lower broken line **15***c*, is disposed above the corresponding upper broken line **15***a* passing through the tops of the front turns **14***a*, etc., so as further to indicate that the maximum crest projections of the lobes **16***a*, etc., are substantially greater than the crest projection of the front turns **14***a*, etc. Thus, the maximum crest projection of the rearmost lobe **16***e* is substantially equal to the crest projection of the rear turns **14***w*, **14***x*, etc.; and similarly, the maximum flank width **16***e* is substantially equal to the flank width of the rear turns **14***w*, **14***x*, etc.

Reconsidering the rotational angle A between the centers of the adjacent ones of the lobes **16***a*, **16***c*, **16***d* and **16***e*, this angle $A=360°+B$, but B may be in the general range 60° to 120°; whereby with a smaller angle B, the number of lobes on the turns carried on the front pilot end portion **11***a* is increased, assuming that there are six such turns thereon, as described above. Also, the provision of six such turns on the front pilot end portion **11***a* is not critical, and such number may be correspondingly increased by lengthening the front pilot end portion **11***a*, assuming a fixed pitch of the thread **14**, as described above. Of course, a shorter pitch of the thread **14** will produce an increased number of turns on the front pilot end portion **11***a*, assuming a given length thereof.

Now in this formula, the angle B may have any desired value in the approximate range 60° to 120°. When the angle B has a value (30°, 36°, 40°, 45° or 60°) that is evenly divisible into 360°, the lobes in the thread **14** are disposed in straight rows extending longitudinally along the front shank portion **11***a*; and when the angle B has a value that is not evenly divisible into 360°, the lobes in the thread **14** are disposed in skewed rows extending longitudinally along the front shank portion **11***a*. In these several embodiments of the thread **14**: when the angle B is 60°, there are 6 longitudinally extending rows of lobes; when the angle B is 72°, there are 5 longitudinally extending rows of lobes; when the angle B is 80°, there are 9 longitudinally extending rows of lobes; when the angle B is 90°, there are 4 longitudinally extending rows of lobes; and when the angle B is 120°, there are 3 longitudinally extending rows of lobes. In each case, the rows of lobes are equally spaced-apart about the longitudinal center line of the shank **11**. While a wide variety of these thread formations are entirely satisfactory, it has been found that these designs involving an odd number of rows of lobes are generally preferred, since these thread formations are easier to drive and provide a better balance of the torque required in the starting of the front pilot end portion of the thread **14** into the pilot hole provided in the associated workpiece, not shown.

Reconsidering the rotational angle C that is subtended by each of the lobes **16***a*, **16***c*, **16***d* and **16***e*, the illustrated example of 120° is not critical, although this angle C should be substantial; whereby C may be in the general range 60° to 120°.

The preferred embodiment of the screw **10** illustrated, wherein both the angle $B=120°$ and the angle $C=120°$, is very advantageous, since the same is characterized by an exceedingly small torque, as compared to other of the embodiments mentioned, required to effect rotation of the screw **10** to cause setting thereof in a standard preformed pilot hole provided in a standard workpiece used herein in testing various thread formations of the screws **10**, embodying the present invention and of the construction and arrangement described above. It is believed that this result is produced by the cooperation between the dimensional and positional arrangements of the elements of the thread **14** in the preferred embodiment of the screw **10**, as previously described.

Turning now to the present method of making the screw **10**, a corresponding blank B**10** is provided, as illustrated in FIG. 1. The blank B**10** is forged or formed of metal and comprises an elongated shank B**11** including a substantially frusto-conical front pilot end portion B**11***a* and a substantially cylindrical rear body portion B**11***b*. Also, the blank B**10** comprises the hexagon head B**12** terminating the rear end of the rear body portion B**11***b*. Also, there are provided a pair of rolling dies, not shown, of flat plate-like construction. The shank **11**B of the blank B**10** is subjected to rolling pressure between the complementary and mating dies, whereby the flutes and lands disposed in the rolling dies mentioned produce the continuous thread **14** in the shank **11** of the screw **10**; all in a well-known manner.

Ordinarily, the metal blank B**10** is formed of low carbon steel; and after the screw **10** is formed therefrom in the present rolling method, the same is subjected to heat treatment so as to case harden it, in a well-known manner. Specifically, it is highly desirable that the front helical turns **14***w*, etc., be quite hard, since the screw **10** is frequently employed in forming an internal thread in a cylindrical hole provided in a workpiece, when such workpiece is formed of steel, or other hard material.

In view of the foregoing, it is apparent that there has been provided a fluteless thread-forming tool, and specifically a fastening screw of improved construction and arrangement. This tool is very advantageous, since the same is operative to form the internal thread in the generally cylindrical surface of a pilot hole formed in a workpiece altogether by a swaging action, and without the formation of chips or cuttings from the workpiece. Moreover, the improved tool is substantially easier to operate in its thread-forming action than is a comparable conventional tool of the chip-forming type, in the sense that the improved tool requires substantially less driving torque than does the conventional tool mentioned.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications may be made therein, and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A combination thread-swaging and fastening screw comprising an elongated shank including a generally cylindrical rear body portion and a generally frusto-conical forwardly tapered front pilot end portion, a continuous thread carried on said shank and including both a plurality of helical turns on said rear body portion and a plurality of helical turns on said front pilot end portion, said thread having a fixed pitch, the turns on said rear body portion having substantially the same minor radius and successively forward ones of the turns on said front pilot end portion having gradually reduced minor radii, the turns on said rear body portion having a first fixed crest projection from the root thereof and the turns on said front pilot end portion having a second fixed crest projection from the root thereof, wherein said first fixed crest projection is greater than said second fixed crest projection, and a plurality of separate and distinct thread-swaging lobes carried entirely by the turns on said front pilot end portion along the helix of said thread with a rotational angle A about the longitudinal axis of said shank between the centers of adjacent ones of said lobes, where $A=360°+B$ and wherein B is a fixed angle within the approximate range 60° to 120°, each of said lobes subtending a rotational angle C about the longitudinal axis of said shank, wherein C is a given angle within the approximate range 60° to 120°, each of said lobes including a crest provided with leading and trailing faces, the leading and trailing edges of each of said lobe crests respectively merging into the adjacent portions of the crest of the associated turn on said front pilot end portion, the leading and trailing faces of each of said lobe flanks respectively merging into the adjacent portions of the flank of the associated turn on said front pilot end portion, each of said lobes having a variable crest projection from the root thereof that is maximized substantially at the center thereof and that at its maximum value is substantially greater than said second fixed crest projection of the associated turn on said front pilot end portion and each of said lobes having a variable flank width at the root thereof that is maximized substantially at the center thereof and that at its maximum value is substantially greater than the flank width of the associated turn on said front pilot end portion, the maximum crest projection of the rearmost of said lobes on said front pilot end portion being substantially equal to said first fixed crest projection of the turns on said rear body portion and the maximum flank width of the rearmost of said lobes on said front plot end portion being substantially equal to the flank width of the turns on said rear body portion.

2. The screw set forth in claim **1**, wherein B is approximately 120°.

3. The screw set forth in claim **1**, wherein C is approximately 120°.

4. The screw set forth in claim **1**, wherein B and C are approximately equal.

5. The screw set forth in claim **1**, wherein B is approximately 120° and C is approximately 120°.

6. The screw set forth in claim **1**, wherein the leading edge of the crest of each of said lobes rises gradually radially out of the adjacent portion of the crest of the associated turn on said front pilot end portion and the trailing edge of the crest of each of said lobes falls gradually radially back into the adjacent portion of the crest of the associated turn on said front pilot end portion.

7. The screw set forth in claim **1**, wherein the leading face of each flank of each of said lobes rises gradually both radially and axially out of the adjacent portion of the flank of the associated turn on said front pilot end portion and the trailing face of each flank of each of said lobes falls back gradually both radially and axially into the adjacent portion of the flank of the associated turn on said front pilot end portion.

References Cited by the Examiner

UNITED STATES PATENTS

66,766	7/67	Young	85—47
2,167,559	7/39	Upson	85—46
2,352,982	7/44	Tomalis	85—46
2,991,491	7/61	Welles.	

FOREIGN PATENTS

1,265,999	5/61	France.

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