

Oct. 5, 1965

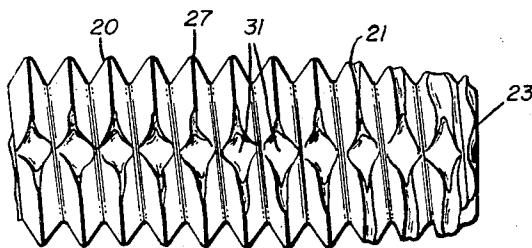
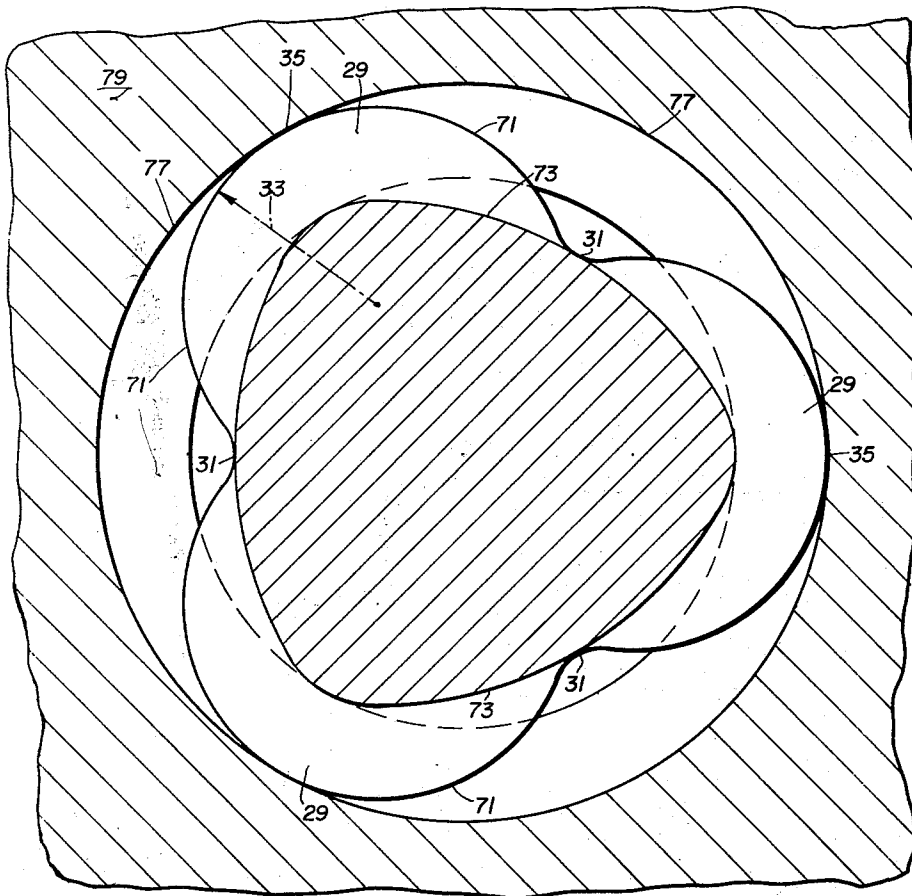
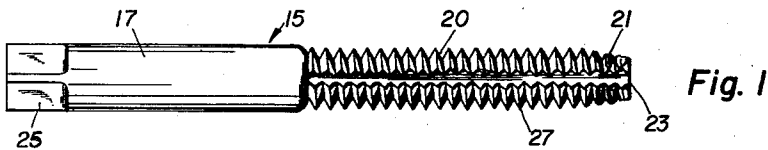
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3,209,383

FLUTED LOBULAR THREAD-FORMING MEMBERS

Filed Sept. 15, 1961

3 Sheets-Sheet 1



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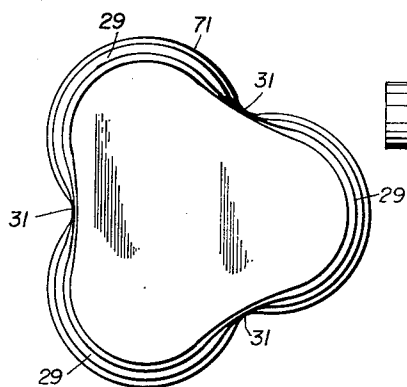


Fig. 3



Fig. 6

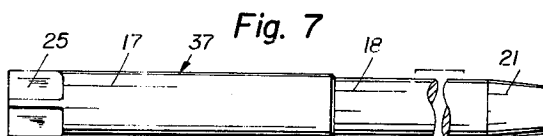


Fig. 7

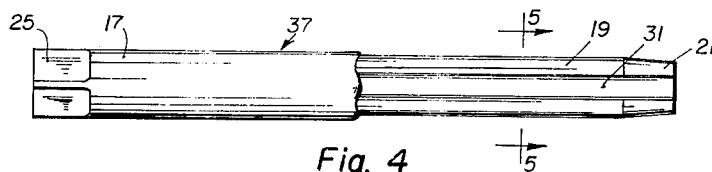


Fig. 4

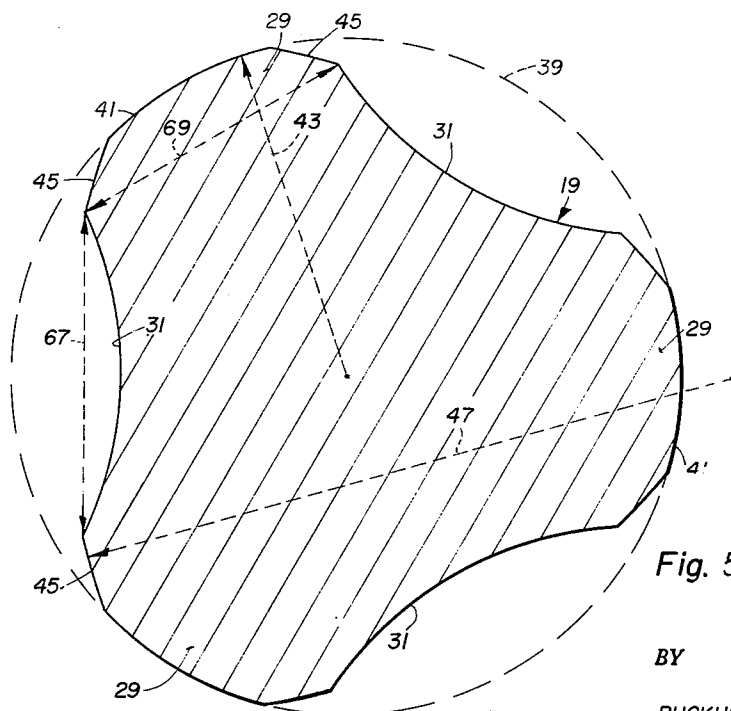


Fig. 5

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3 Sheets-Sheet 3

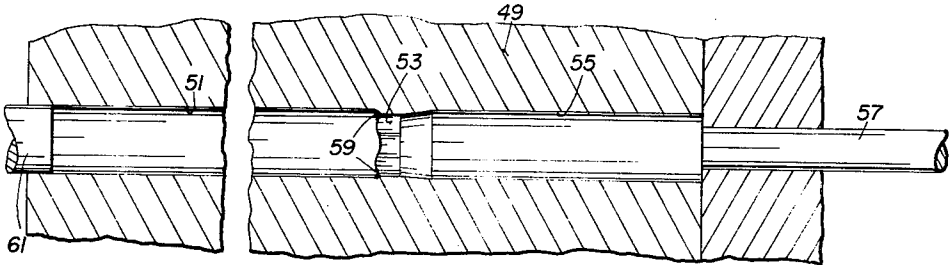


Fig. 8

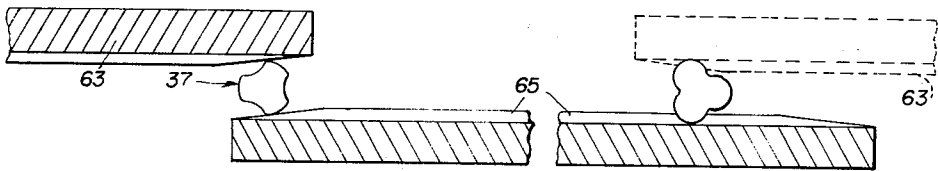


Fig. 9

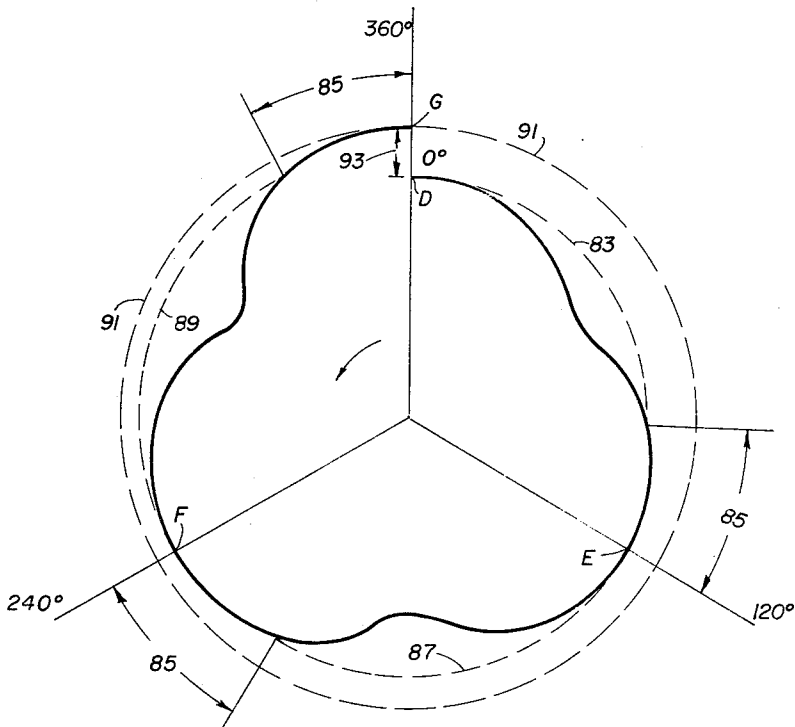


Fig. 10

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FLUTED LOBULAR THREAD-FORMING MEMBERS
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5 Claims. (Cl. 10-152)

This invention relates to fluted lobular thread-forming members, such as swaging taps and the like, and to a method for manufacturing such members.

Taps for swaging threads in a female member, as compared with taps for cutting threads in such members, have the advantages of generating a superior thread and of not producing chips during thread formation. While swaging taps have been made heretofore with lobular or non-circular cross sections to reduce the otherwise high driving torque characteristic of swaging taps they have been costly to manufacture. This high cost is due to the use heretofore of high grade tool steel in manufacture to obtain the necessary high tensile and yield strength, which use requires grinding the threads to form the desired lobular shapes.

Lobular swaging taps have not been provided with flutes since flutes on such taps were deemed unnecessary, flutes heretofore having been provided only on thread-cutting taps and screws to provide a cutting edge and chip reservoir. However, it has been found desirable to provide flutes on swaging taps for certain purposes, namely, for forming threads in plastic materials to permit periodic relaxation of the material being reformed into threads, to prevent cracks therein due to overstress.

It is, therefore, a primary object of this invention to provide a new and inexpensive method for manufacturing fluted, lobular, thread-forming members.

Another important object of this invention is to provide a new and improved lobular thread-forming member having flutes, which will swage threads in a parent body with an exceptionally low driving torque and without cutting any chips.

Another object of this invention is to provide a new and improved fluted swaging tap having rolled threads, which will form substantially full threads in a parent body.

Briefly the above and other objects are carried out in the illustrated embodiments by providing a fluted swaging tap having an odd number of threaded lobes, the lobes having a radius of curvature substantially less than the distance from the tap axis to the lobe extremity of the tap. According to the method of this invention the tap is formed by extruding from a generally cylindrical work-piece a fluted lobular shank portion approaching the cross-sectional shape of the finished tap, and then rolling the lobular shank portion between conventional thread-rolling dies. This method is especially advantageous because inexpensive metal wire, or rod may be used, which is work-hardened during the extrusion and thread-rolling steps and subsequently heat-treated to produce a durable tap inexpensively as compared to the cost of manufacturing swaging taps heretofore commercially available.

The disclosure of this invention will be more fully set forth in the following detailed description which proceeds with reference to the accompanying drawings.

In the drawings:

FIG. 1 is a side view of a swaging tap made in accordance with and embodying the present invention.

FIG. 2 is an enlarged schematic cross section through the major threaded shank portion of the tap of FIG. 1 as seen within a threaded pilot hole in a female member.

FIG. 3 is an enlarged end view of the tap of FIG. 1.

FIG. 4 is a side view of a tap blank following the second forming operation.

FIG. 5 is an enlarged cross-sectional view of the tap blank of FIG. 4.

FIG. 6 is a side view of the initial cylindrical blank from which the illustrated thread-forming member is produced.

FIG. 7 is a side view of the tap blank following the first forming operation.

FIG. 8 is a sectional view of the extrusion die within which the blank of FIG. 4 is formed.

FIG. 9 is a schematic representation of one means for rolling threads on the tap blank of FIGS. 3 and 4.

FIG. 10 is a schematic view of the work-entering portion of a screw embodying the present invention.

FIG. 11 is an enlarged side view of the threaded portion of the tap of FIG. 1.

Referring first to FIG. 1, the invention will be described with reference to a tap 15 having a round cylindrical shank portion 17 and a lobular threaded shank portion 20 including a slightly tapered work-entering portion 21. The tap has a blunt tip 23 at the work-entering end and a driving means, for example, the square portion 25 at the opposite end for mounting in a handle or driver. The lobular shank portion 20 and work-entering end are provided with a rolled thread formation 27, which is substantially discontinuous through each thread convolution.

As shown by FIGS. 2 and 3, the lobular shank portion in cross section comprises an odd number of, in this instance three, convexly curved lobes 29 symmetrically arranged about the member axis and intermediate generally concave flutes or fluted surfaces 31 which may vary in width considerably depending upon the initial width of the flutes on the blank as discussed below and the depth of penetration of the ridges of the thread-rolling dies as the blank is threaded. The greater the die penetration, of course, the more will be the tendency for the flutes on the blank to close up or become narrower, particularly at the root of the thread thus formed as shown in FIG. 1. The threaded portion of each lobe is not concentric about the tap axis but has a radius of curvature 33, at least in the outermost portion thereof, substantially less than the distance from the tap axis to the lobe extremity 35. As shown in FIG. 2, the radius of curvature is about one-half such distance. However, the relationship will vary depending upon the size of the flutes extruded in the blank as compared to the size of the lobes and the width of chamfer provided, the limits of which are discussed below.

With reference now to FIGS. 4 and 5, according to the method of the invention, the above-described tap is made from a blank 37 which approaches in cross section the configuration of the finished tap and comprises the cylindrical shank portion 17 and the generally lobular shank portion 19. For purposes of this disclosure the effective diameter of the cross section of the lobular portion 19 of the blank is defined as the diameter of a circle 39 circumscribed about the outermost portions of the three lobes 29 as shown in FIG. 5. The lobes 29 are generally convex and correspond to the number of lobes in the finished tap, being separated by the intermediate concave flutes 31. In the preferred embodiment, the lobes of the blank are concentric about the blank axis through the major portion thereof, as for example through the arcuate surface 41, and have a radius of curvature 43 equal to one-half the diameter of such shank portion. However, the edges 45 of each lobe adjacent the fluted surfaces 31 are chamfered and have a radius of curvature 47 substantially greater than the distance from the blank axis to the lobe extremity. In the preferred form shown this radius of curvature is about equal to the effective diameter of the lobular portion of the blank, or alternatively, twice the distance from the blank axis to the lobe extremity and has a center of curvature outside the opposite lobe extremity. This is

also the center of curvature for the nearest chamfered edge 45 of the adjacent lobe. Of course, the radius of curvature of the chamfer 45 is so large relative to the width of such chamfer that for practical purposes, the surface can be considered flat.

The blank 37 may be shaped from an initially cylindrical workpiece 43, shown in FIG. 6, in a two-stage operation. In the first stage, the workpiece 43, which is sheared from a length of rod or wire stock, is transferred to a first die station (not shown) where it is transformed into the intermediate blank shape shown in FIG. 7. At this station the square driver or handle-mounting portion 25 is formed at one end, and the opposite end portion 21 is provided with a slight taper, such as 5 degrees. In addition, in most instances the cylindrical shank portion 18 is reduced in diameter slightly from the diameter of the initial workpiece to a predetermined value in order that standard thread sizes can be provided on the shank. This enables the use of a wide range of stock sizes having various initial diameters, therefore, eliminating the necessity for keeping a large inventory of one stock size on hand for each different thread size.

In the second stage, the intermediate blank is transferred to a second, extrusion die, 49, FIG. 8, wherein the blank shape shown in FIG. 4 is formed by extruding the flutes 31 in the reduced shank portion 18. The die 49 is provided with an outer cylindrical cavity sidewall portion 51 of a diameter and length to receive entire workpiece of FIG. 7, an extrusion orifice 53 corresponding to the cross-sectional shape of the lobular shank portion 19 of FIG. 4, and an inner cylindrical sidewall portion 55 to receive the extruded portion of the blank. A knockout pin 57 serves to eject the extruded workpiece. The concave die surface 59 extends from the outer sidewall portion 51 to the orifice 53 and merges smoothly with the two portions. The extrusion of the flutes in the reduced shank 18 of FIG. 7 is effected by applying endwise pressure to the square end 25 of the workpiece by means of the extrusion punch 61. Since only the flutes and chamfered edges 45 of the lobe are extruded in this die, the maximum effective diameter of the extruded shank portion 19 will be substantially the same as the cylindrical shank portion 18 so that the taper at the work-entering end 21 of the blank will be maintained.

The amount of extrusion which takes place in the second die 49, and thus the amount of resistance of the blank to extrusion is not so great as to cause any deformation or upsetting of the previously squared end portion 25 or the slightly reduced shank portion 18.

As shown schematically in FIG. 9, following extrusion, the lobular shank portion is threaded by rolling it between conventional, uniformly spaced apart thread-forming dies, 63 and 65. Other thread-rolling means such as uniformly spaced apart arcuate rolling dies could likewise be used.

The blank form described previously and as shown in FIG. 5, will roll readily between such thread-rolling dies because the blank has an approximately uniform rolling width across the rounded lobes. The chordal width 67 of the concave flutes 31 is not so great as to cause the flutes to interfere with the ability of the blank to roll between uniformly spaced apart dies. This width should not exceed substantially the chordal width 69 across the generally convex lobes, or, alternatively, the distance from the blank axis to the lobe extremity. With the maximum width of the flutes as shown in FIG. 5 it is desirable to provide the chamfered lobe edge portions 45 as previously described, having a greatly increased radius of curvature. These chamfered edges provide enough frictional contact between the lobes and the die surfaces to start and maintain the rolling of the lobular portion in conventional flat rolling dies without the necessity of scoring or otherwise notching the dies. The concave flutes 31 may be of any depth desired consistent with strength requirements and limitations of percentage reduction imposed by extrusion.

As illustrated in the preferred embodiment of FIG. 2, this depth is defined by the distance from the member axis to the bottom of each of such flutes, which distance is substantially less than the maximum distance from such axis to the periphery of the root cylinder, or root, of the final thread at the midportion of each lobe. However, for strength, such distance to the bottom of each flute is substantially no less than the minimum distance from the member axis to the periphery of the root cylinder.

Now comparing FIGS. 2 and 5, during thread-rolling the lobular shank portion 19 will change in cross-sectional shape to form the threaded lobular shank portion 20 by raising a thread having a crest outline 71 which is not concentric but has a radius of curvature 33 which is less than the distance from the member axis to the crest extremity 35. To describe the final thread shape in greater detail with reference to FIG. 2, the thread formation on the lobes is rolled to its final shape such that in cross section through such lobes the final curvature of the root and crest of such thread formation, at least at the midportions of such lobes, is defined by root and crest radii of curvature which are substantially less than the distance from the member axis to the lobe extremity at the corresponding root and crest, respectively. Although due to irregularities and rolling pressures in actual practice the thread crest throughout the entire lobe may not be uniformly curved, at least the crest at the outermost midportion thereof will have a radius of curvature substantially as stated. The radius of curvature along the sides of the lobes is immaterial due to the fact that thread forming is performed only by the outermost portions of each lobe in a manner to be described. The thread root outline, or cylinder, 73 of the threaded shank and work-entering end portions in cross section is substantially of arcuate polygonal, in this case triangular, configuration having arcuate sides merging with each other substantially at the midportion of the lobes 29 and which are substantially internally tangential to the bottoms of the flutes 31. Thread rolling causes the flutes 31 to close up considerably from their original width 67, and at the same time the crest extremity 35 is raised above the original concentric surface 41 of the blank. Through the major portion of the threaded lobe, the thread depth is substantially uniform, because the thread crest and root outlines have substantially the same center of curvature through such portion. However, toward the edges of each lobe, the thread crest gradually vanishes into the flute and merges smoothly with the root outline 73 so that the thread is discontinuous through one thread convolution, having a zero thread depth at each flute, as illustrated more clearly in the enlarged view of FIG. 11. However, depending upon the initial width of the flutes and chamfered surfaces provided in the blank, the relationships between the thread crest, thread root, and flutes may vary considerably, the important consideration being the shape of the lobes at their midportions as previously pointed out.

The fact that the thread crest 71 on the lobe has a lesser radius of curvature than the distance from the tap axis to the lobe extremity and is therefore internally tangential to the circular thread root 77 generated in the parent body 79, results in the tap having a very low driving torque due to a minimum of frictional contact between the generating and generated threads, which contact occurs only along each lobe extremity 35, at least in the straight shank portion of the tap. The parent body will have fully formed threads with a circular root outline 77 generated by the crest of the tap.

It should be appreciated that the actual formation of the thread in the parent body is caused by the tapered work-entering portion 21 of the tap of FIG. 1 which portion is shown having a decreasing height and an increasingly unfinished thread crest toward the work-entering end. Referring now to FIG. 10, the thread formation in that portion will have more than a point contact with the parent body since, as the tap rotates, each suc-

5

ceeding lobe extends outwardly from the axis a slightly greater distance from the preceding lobe, thus, each succeeding lobe swages a slightly deeper groove and raises a slightly higher crest in the parent body than its preceding lobe. As the tap turns in the direction indicated by the arrow, the lobe D will generate a thread represented by the arc 83 and the succeeding lobe E will come into contact with the thread 83 of the parent body below the crest extremity and maintain contact along the crest of the lobe E through the arc 85 to generate a deeper thread represented by the arc 87. Each succeeding lobe E, F and G builds up a slightly higher thread 87, 89 and 91, respectively, in the parent body so that, in one thread convolution or 360 degrees a partial thread of the height 93 is generated. The inclination of the working portion through the arc 85 of the thread crest in each of the lobes is not so great as to cause it to cut a thread in the parent body and, in fact, probably has on the average a slightly greater, though irregular, radius of curvature than the thread in the major shank portion 19 since it is less fully formed and therefore will approach more closely the concentric configuration of the lobes of the original blank.

Although a three-lobed thread-forming member is preferred under most circumstances, a five-lobed or seven-lobed member may be desirable for providing internal threads in pilot holes of extremely large diameter.

While the present invention has been described with reference to certain specific illustrated embodiments and with reference to particular limitations as to size and shape, it is to be understood that the invention is not to be limited thereby, it being intended to cover all such forms of the invention as fall within the spirit and scope of the following claims.

I claim:

1. A thread-forming member for swaging threads in a parent body comprising,
 - a lobular fluted shank portion including a tapered work-entering end,
 - said shank midportion in cross section comprising an odd number of symmetrically arranged roll-threaded lobes separated by intermediate concave flutes,
 - the radius of curvature of at least the outermost portion of said lobes being substantially less than the distance from said member axis to the lobe extremity substantially at the midpoint of said lobe, and the radius of curvature of the root of said lobes being substantially less than the maximum distance between said axis and said root.
2. A thread-forming member for swaging threads in a parent body comprising:
 - (a) a lobular shank portion terminating at a tapered work-entering end,
 - (b) said shank portion and work-entering end having an odd number of longitudinally extending lobes symmetrically disposed about the axis of said member, separated by intermediate flutes,
 - (c) said lobes being provided with a rolled thread formation,
 - (d) said lobes in cross section having a curvature defined by the root and crest of said thread formation,
 - (e) the radii of curvature of the root and crest of said thread formation at least at the midportions of said lobes being substantially less than the distance from the member axis to the extremities of said lobes at the corresponding root and crest respectively.
3. A thread-forming member for swaging threads in a parent body comprising:

6

- (a) a lobular shank portion terminating in a tapered lobular work-entering end,
 - (b) said shank portion and work-entering end including three longitudinally extending threaded lobes symmetrically arranged about the member axis, separated by intermediate flutes,
 - (c) the thread formation on said lobes being rolled to its final shape such that in cross section through said lobes the final curvature of the root and crest of said thread formation at least at the midportions of said lobes is defined by root and crest radii of curvature which are substantially less than the distance from the member axis to the lobe extremity at the corresponding thread root and crest, respectively,
 - (d) the root cylinder of the threaded shank and work-entering end portions in cross section being arcuate triangular in shape with the arcuate sides of the triangle being substantially internally tangential to the bottoms of said flutes.
4. A fluted lobular thread-forming member for swaging threads in a parent body, comprising:
- (a) a lobular threaded shank portion terminating at a tapered work-entering end,
 - (b) said shank portion and said work-entering end including an odd number of equally circumferentially spaced lobes extending longitudinally of the member axis separated by intermediate longitudinally extending flutes,
 - (c) said lobes being provided with a rolled thread formation with said thread formation decreasing progressively in height in a direction toward the free extremity of said work-entering end,
 - (d) said thread formation in any cross section through said lobes having a curvature at the midportion of said lobes defined by root and crest radii of curvature which are substantially less than the distance from the member axis to the lobe extremity at the corresponding thread root and crest respectively,
 - (e) the distance from said member axis to the bottom of each of said flutes being substantially less than the distance from said axis to the root of said thread at the midportion of said lobes.
5. A thread-forming member according to claim 4 wherein in any cross section through said shank portion the root cylinder is of arcuate lobular cross section and the distance from the member axis to the bottoms of said flutes is less than the maximum distance from the member axis to the periphery of the root cylinder and is substantially no less than the minimum distance from said axis to the periphery of said root cylinder.

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