Aug. 28, 1962 D. P. WELLES, JR 3,050,755

METHOD OF FORMING THREADS BY APPLYING SLIDING PRESSURE

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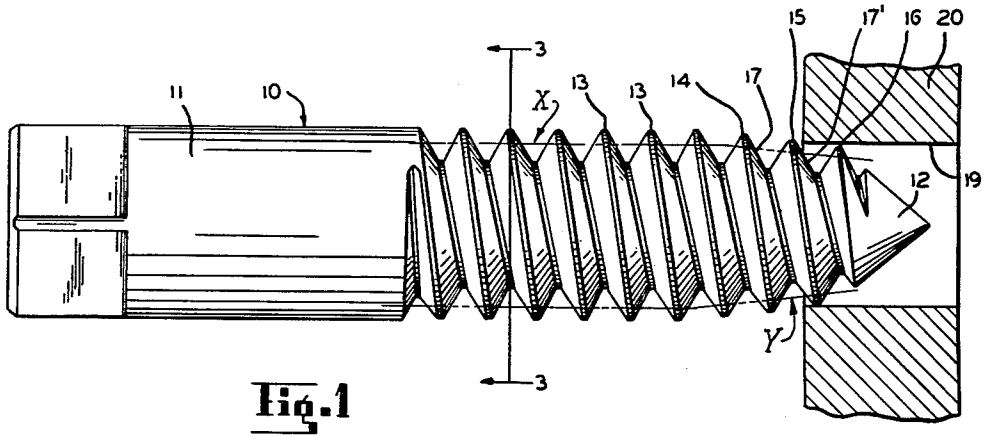


Fig. 1

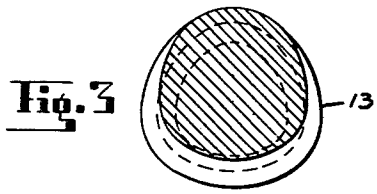


Fig. 3

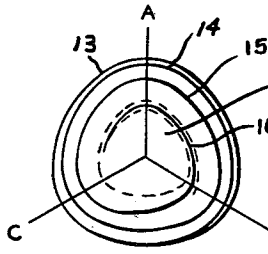


Fig. 2

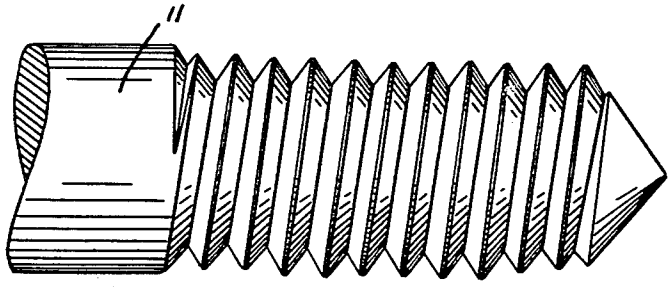


Fig. 4

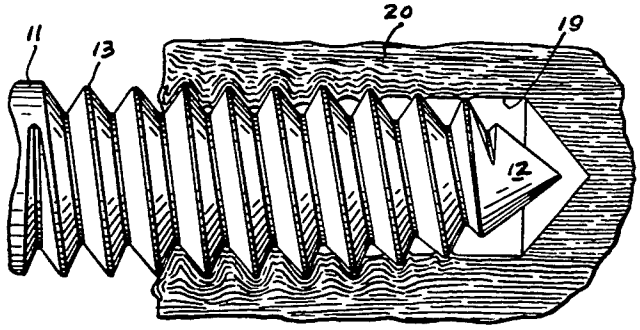


Fig. 5

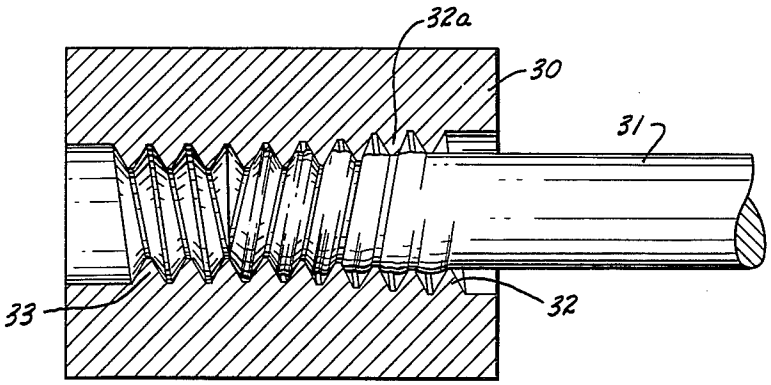
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Fig. 6.



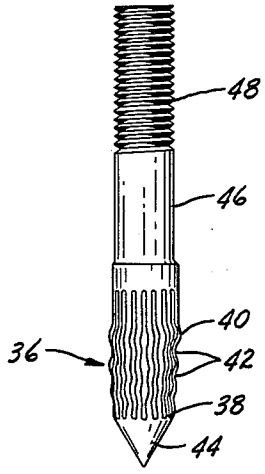


Fig. 7.

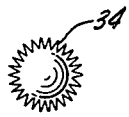


Fig. 8.

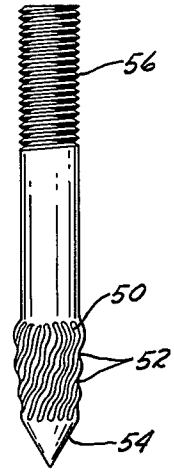


Fig. 9.

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METHOD OF FORMING THREADS BY APPLYING SLIDING PRESSURE

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4 Claims. (Cl. 10—152)

This is a continuation-in-part of application Serial No. 686,521, filed September 26, 1957, now abandoned, which was a continuation-in-part of application Serial No. 575,733, filed April 3, 1956, now Patent No. 2,807,813, issued October 1, 1957.

This invention relates to improvements in forming threads in metal objects.

A principal object of my invention is an improved method of forming internal or external threads by displacing or swaging the metal rather than by cutting or otherwise displacing the metal.

Another object is a new metal or material working method for forming threads or a threaded configuration on a generally cylindrical surface, either external or internal.

Another object is a method of threading relatively ductile metal that requires much less torque.

Another object is a method of working metal or material, such as plastic, of a cylindrical nature to displace such material to provide a series of symmetric lands and grooves.

The invention may best be understood by reference to the accompanying drawings, in which:

FIGURE 1 is a side view, partly in section, illustrating one construction for performing my method, this construction taking the form of a tap and showing the manner in which it is introduced into the bore of a hole for working the same;

FIGURE 2 is an end view of the particular tap shown in FIGURE 1;

FIGURE 3 is a section taken along line 3—3 of FIGURE 1;

FIGURE 4 is a side view of a modified device for carrying out the invention in the form of a tap with left-hand rather than right-hand threads;

FIGURE 5 is a side view, partly in section, showing the use of the FIGURE 1 device in an advanced state of the method;

FIGURE 6 is a side view, partly in section, of an alternate form;

FIGURE 7 is a further modification on a reduced scale;

FIGURE 8 is a bottom view of FIGURE 7; and

FIGURE 9 is a modification of FIGURE 7.

Referring now to details of the embodiment of the invention shown in FIGURES 1 to 3 inclusive, a metal working tool generally in the form of a fluteless tap, indicated generally at 10, has a shank 11 of conventional cylindrical form in which the threads of the tap are formed at one end, terminating in a point 12 of conventional form. Several thread turns 13, 13 adjacent the shank are formed with a uniform maximum diameter which constitutes the main thread forming or working portion of the tool and determines the final shape of the thread in the work, but a few of the thread turns 14, 15 and 16 are of gradually reduced diameter as they approach the point 12 so as to form, in effect, a tapered thread adjacent the point.

As will be seen from FIGURES 2 and 3, the thread turns of the tapered portion and most, if not all, of the adjacent thread turns are formed with varying outside, pitch and root diameters for each turn of the thread circumferentially of the tool. As seen in FIGURE 2, these variations in the three diameters mentioned are produced

uniformly in three sections A—B, B—C and C—A of each thread turn by gradually decreasing these three diameters, which are at maximum size at radial line A, to a minimum diameter at a point approximately midway of said section, and then gradually increasing these three diameters to the maximum size at line B. The same variation in diameters is then repeated for sections B—C and C—A of each turn of the thread. For convenience, this variation in the outside, pitch and root diameters through each sector may be termed a "radial relief."

This "radial relief" of the several sectors can perhaps be clearly visualized by explaining that if the continuous thread were developed along a plane instead of circumferentially of the tap, the thread would follow a substantially sinuous curve relative to said plane.

In the illustrated form shown in FIGURES 1, 2 and 3, each turn of the thread has three sectors and the sectors of each turn are in axial registering relation to each other. It will be readily understood that the number of sectors for each turn of the thread may be varied, if desired, although in practice I find that three or four sectors are preferable.

It will be furthermore noted that the threads have a substantially uniform cross section taken on any plane intersecting the axis of the tap, for the full length of the threaded portion of the tap. Thus, the thread is of substantially uniform V-shape in cross section, excepting for minor differences in the widths of the thread flanks 17 and 17' due to the tapered end thread turns 14, 15 and 16.

In FIGURE 1 the pitch diameter of the maximum section 13 is indicated generally at X. It is important that the initial or forward portion be properly formed since the majority of the work or energy is expended in initially starting the thread formation. For example, the threads, designated 14, 15 and 16, may be considered to be reduced progressively in diameter toward the point or tip 12. But, at the same time, the full depth of thread is maintained in this area. In effect, I take the pitch diameter X and bend it in, as at Y, at a suitable angle and the depths of the threads in this portion are maintained constant and the same as the thread depth in maximum section or area 13. This is important since the vast majority of the work performed or required for the method is carried out in the tapered portion and when the maximum area 13 becomes effective in the hole, most if not all of the metal has been moved from the areas of directly applied pressure to the intermediate areas. In a sense, the majority of the maximum area 13 floats or rides through after the work is done by the tapered portion 14, 15 and 16 and the first turn or so of the maximum area 13. It should also be understood that the radial reliefs, such as set forth in FIGURE 2, are maintained both in the maximum area 13 and in the tapered portion so that the radius varies circumferentially in a cyclical sinusoidal or sine wave manner with both constant amplitude and constant frequency in the maximum area 13 and constant frequency and amplitude but on a different axis in the tapered area.

In the modified form of fluteless tap shown in FIGURE 4, the same form of relief is utilized in the thread turns, but in this instance all of the threads are maintained at a uniform maximum and minimum diameter throughout the threaded portion of the tap.

In practice, I find an advantageous method of producing the novel form of thread above described is by means of a grinding operation, in which the grinding wheel is moved toward and away from the tap while the latter is being rotated relative to the grinding wheel.

In practice, my improved form of fluteless tap is preferably introduced in a previously bored hole 19 of a workpiece indicated at 20, which hole is of substantially the same diameter as the final pitch diameter of the thread as indicated in FIGURES 1 and 5. The tool is then ro-

tated so as to screw it into the hole. The internal threads are formed by displacing the metal with a swaging action, as illustrated diagrammatically in FIGURE 5. It has been demonstrated that due to the novel form of the tap thread with its radial relief, an interior thread may be produced in the work with greater ease, and with much less torsional effort and generation of heat, than with a tap of corresponding size without the radial relief which characterizes my invention.

The thread arrangement which makes it possible for the threads of a die or tap type tool to displace or swage the metal of a nut or bolt by displacing it rather than by cutting it may equally well be applied to the outside of a fluteless tap or to the inside of a fluteless thread forming die. FIGURES 1 to 5 inclusive disclose in detail the application to a thread forming fluteless tap. FIGURE 6 discloses in general the reverse whereby the die forms the thread on a bolt or other cylindrical member, the peculiar characteristics of the thread forming element of the die being basically an inversion of the characteristic thread forming arrangement of the tap.

Referring to FIGURE 6, a die **30** is constructed to form a workpiece **31**, in this case taking the form of a cylindrical rod. The die is interiorly threaded, as at **32**, the threads being tapered as at **32***a* so that the work may enter just the reverse of the tapering of the tap of FIGURE 1. In the tapered area **32***a*, the full thread depth is maintained. The full size threads **33** may have the same contour as the threads shown in FIGURES 2 and 3 except that they are internal instead of external threads and the die produces on the work a thread which would enable the screw to be threaded into a nut in the usual way after the threads are formed by the peculiar die threads.

My metal working tool deforms or swages or works the metal on which it operates as a result of the peculiar action of the swaging thread or threads as they contact the work. This peculiar action occurs whether the thread is internal or external or is spiral so long as the tool works in opposition to and rotates in relation to the work.

Whether the tool is internally or externally threaded and whether the thread is spiral or in a plane perpendicular to the axis, and whether the radial reliefs are parallel to the axis or helical, the thread is formed with varying pitch and root diameters in each circumferential turn.

If the tool takes the form of a die or tap, the work supports the tool and the different dimensional relationships between the work and the tool makes the means for imparting relative rotation all that is needed. On the other hand, if the tool is working on a surface where it is not surrounded by the work, the tool will be supported at both ends and held down to the work as it rotates in relation to it.

The threads or work forming areas on the tool need not necessarily be helical. For example, in FIGURES 7 through 9, I have shown modifications in which the threads **34** are in the form of axially disposed lands and grooves arranged longitudinally along the outer surface of the working area **36**. As such, the working area **36** may be considered as a multi-start screw with infinite pitch. It will be noted that the lands increase in diameter from the smallest **38** at the bottom to the largest **40** at the top, and relieved areas in the form of spaced rings or grooves **42** are provided which increase in diameter upwardly. These annular rings or reliefs operate substantially in the same manner as the radial reliefs in the A, B, C sectors in FIGURE 2.

A tool of this nature is intended to be forced through a tube. The material raised from the inner surface of the tube will not be in the form of a spiral thread, but rather will be axially disposed flutes or fins. In FIGURE 7 the end of the tool may be pointed, as at **44**, to facilitate entry. The shank **46** might be threaded at **48** to accept a suitable connecting element. Instead of being turned or screwed into a hole, this tool might be driven by a hammer or otherwise. The flutes and relieved areas deform the material on the inner surface of the hole inwardly into radially disposed fins which project inwardly of the original diameter. As the tool progresses, the projecting areas from **38** to **40** in the form of rings penetrate deeper into the surface of the tube. The relieved areas **42** substantially reduce the torque or force required to drive the tool. The initial diameter of the hole should be approximately the same as the pitch or mean diameter of the largest ring **40**. Also, additional rings of the same size as **40** might be provided above it on the shank.

In FIGURE 9 a variant form has been shown in which the flutes or grooves **50** are formed with a slight helix or right-hand twist, when viewed from above. As before, annular relief areas **52** are used and a tapered nose portion or point **54** may be disposed below to facilitate entry. When this tool is driven into the inside of a tube or hole, the shaft will turn slightly clockwise, when viewed from above, due to the helix or twist of the grooves **50**. The upper end of the shaft may be threaded at **56** so that any suitable connecting means may be used. But other than the differences noted, the FIGURE 9 form may be the same as that shown in FIGURES 7 and 8.

The use, operation and function of the invention are as follows:

I provide a metal or material working method which involves primarily the step of applying material working pressure radially to a surface, either inwardly or outwardly, at uniformly spaced but limited areas. The pressure applying tool or instrument may take the form of a tap or threaded instrument, but it might be otherwise. It is important that the pressure be initially applied at spaced areas since thereafter the area of the spaced areas of directly applied pressure is increased and the intensity of the applied pressure is increased so that the material or metal will be worked into the intermediate areas without cutting. When the pressure is initially applied and, thereafter, as it is increased, it is alternately applied and relieved on a cyclical basis in a uniform pattern.

The metal will be forced or flowed into the intermediate areas beyond or within the original diameter of the surface being worked upon. As much material must flow into the intermediate areas and beyond the original diameter, either inwardly or outwardly, as it is displaced directly from the areas of applied pressure.

In the form of the invention in FIGURE 1, since the original diameter of the hole **19** in the workpiece **20** is approximately at the pitch diameter of the maximum section **13**, as much metal may flow inwardly into the roots or cavities between the threads as is displaced by the crowns or crests of the threads. It is important that, when using a tool such as shown in FIGURE 1, the pitch diameter along the radii A, B, C, be approximately the same as the original diameter of the hole **19**. It is also important that the pressure be discontinued when the width of the areas of directly applied pressure is still less than the width of the intermediate area. Otherwise, binding of the solid tool will occur and the thread formation will take on a distorted appearance.

The inventive method requires much less torque to perform, and since the material is only worked on in a cyclically varying schedule of applied and relieved pressure up to a certain maximum, the intensity will always be below a certain distortion limit. The result is that the thus developed surface, be it in a thread formation or otherwise, will have no fractures or fissures since the metal will not be cut or chipped. Rather, the metal will be worked into a uniform pattern which alternates on a cyclical undulating basis dictated by the initial pattern of directly applied pressure.

The areas of initially applied pressure, while limited, may be circumferentially disposed, as in the forms shown in FIGURES 1 through 6, or they may be radially disposed, as in FIGURES 7 through 9, or a combination thereof. Thereafter, these areas are increased. In FIG-

URE 1, this increase takes place in an axial direction, while in FIGURES 7 through 9 the increase is circumferential. In both cases the pressure is alternately or cyclically applied and relieved.

In FIGURES 7 and 9, the intermediate areas into which material is forced are disposed circumferentially intermediate, while in the FIGURE 1 form or arrangement the intermediate areas are axial.

In all cases, the original or initial diameter of the hole should be approximately at the pitch diameter of the full thread, meaning the section 13 in FIGURE 1 and 40 in FIGURE 7, for example.

Whereas the preferred form and several modifications of the invention have been suggested, it should be understood that suitable additional modifications, changes, substitutions and alterations may be made without departing from the invention's fundamental theme. It is, therefore, wished that the invention be unrestricted, except as by the appended claims.

I claim:

1. A method of threading a cylindrical surface of a member subject to plastic deformation, comprising applying radial sliding pressure in pressure areas to said surface at a plurality of equally circumferentially spaced locations on said cylindrical surface, the said radial pressure areas comprising portions of maximum pressure all positioned in the same helical path with the radial pressure diminishing substantially equally on opposite sides of said portions of maximum pressure axially of said cylindrical surface and said radial pressure diminishing in each direction helically of the portions of maximum pressure, and advancing said radial pressure areas along said cylindrical surface along said helical path from one end of said cylindrical surface, said radial pressure areas increasing in size and pressure from the first pressure area applied to said one end of said cylindrical surface, gradually deforming said cylindrical surface at said spaced locations into substantially complementary form to the axial cross sectional shape of said radial pressure areas throughout at least a plurality of turns of said helical path, and thereafter applying sliding pressure in pressure areas substantially equal in size and pressure to the last pressure area at a plurality of helically spaced locations, each being on said helical path and radially overlapping the initial cylindrical surface by approximately the same amount on each side thereof and advancing said last mentioned areas along said helical path to form the threaded cylindrical surface to a shape that is substantially complementary to the axial cross sectional shape of said last mentioned plurality of helically spaced areas.

2. The method of claim 1 further characterized in that the cylindrical surface is internal and the radial sliding pressure is applied outwardly.

3. A method of threading a cylindrical surface of a member subject to plastic deformation, comprising the steps of applying a radial sliding pressure area of limited arcuate helical extent to the surface, said pressure area comprising a portion of maximum radial pressure with the radial pressure diminishing uniformly and substantially equally on opposite sides axially of the cylindrical surface and also diminishing on opposite sides helically of the cylindrical surface, advancing a first series of such pressure areas along a helical path on the cylindrical surface from one end thereof, the areas in the first series all being disposed in the same helical path and being graduated so as to increase in size and pressure intensity from the first such area applied to the said one end of the cylindrical surface, and thereafter advancing a second series of such pressure areas along the same helical path on the cylindrical surface from the said one end, the areas in the second series all being disposed in the same helical path and being substantially the same in size and pressure intensity and being substantially equal to the last such pressure area in the first series and radially overlapping the initial cylindrical surface by approximately the same amount on each side thereof to thereby deform and size the cylindrical surface into a thread form which is substantially complementary to the axial cross section of the second series of such pressure areas.

4. The method of claim 3 further characterized in that the cylindrical surface is internal and the radial sliding pressure is applied outwardly.

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