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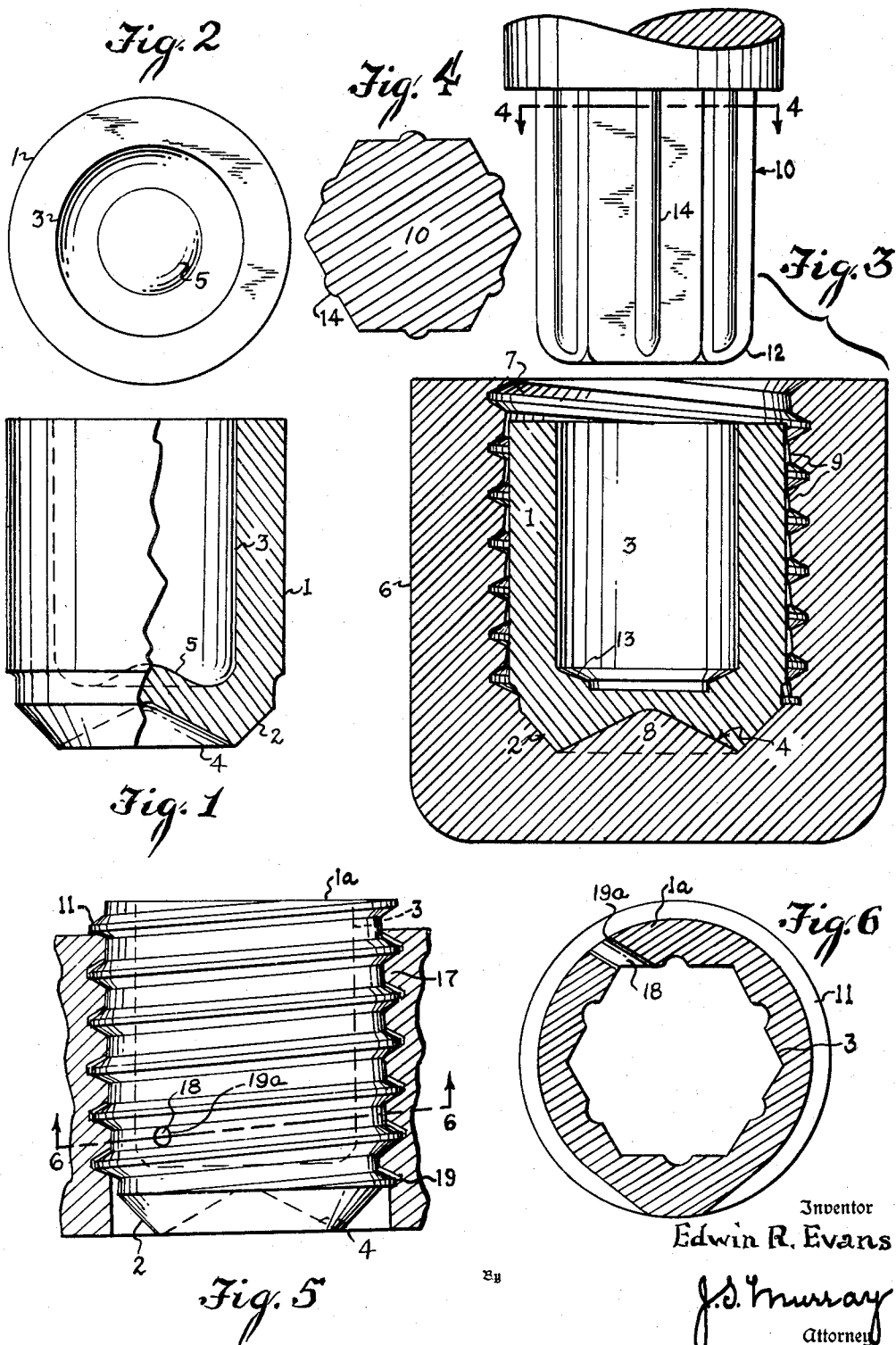
E. R. EVANS

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METHOD OF RADIALLY EXTRUDING PORTIONS OF A HOLLOW BLANK
TO FORM EXTERNAL THREADS OF WAVE FORM

Original Filed June 9, 1949

2 Sheets-Sheet 1



Inventor
Edwin R. Evans

J. S. Murray
Attorney

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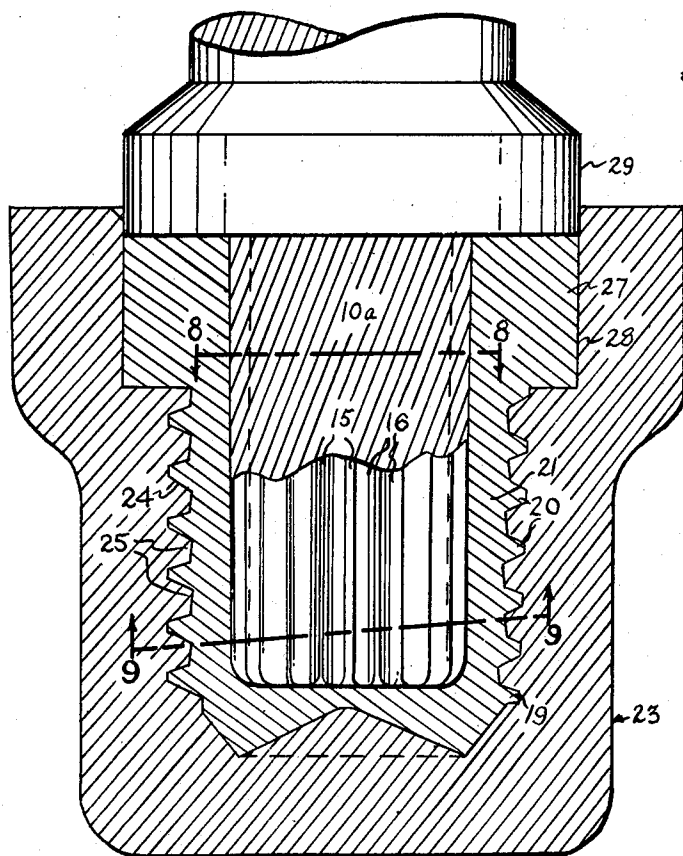


Fig. 7

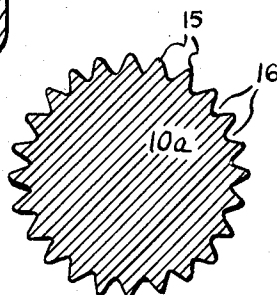


Fig. 8

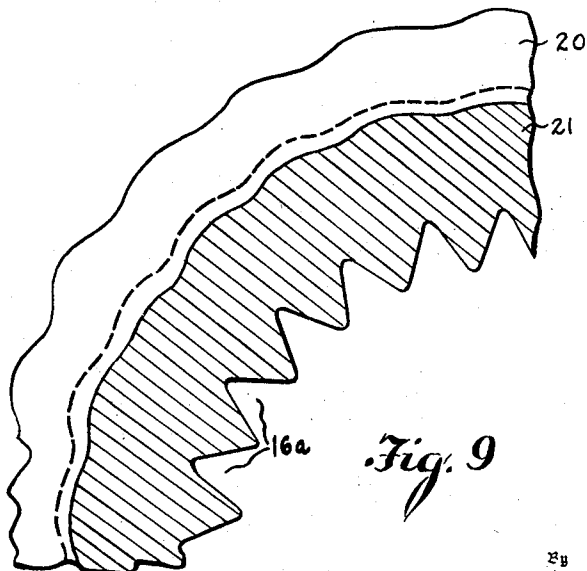


Fig. 9

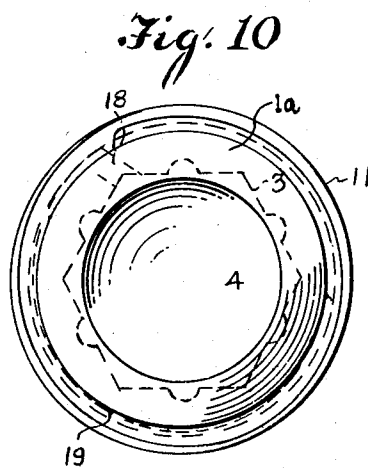


Fig. 10

Inventor
Edwin R. Evans

J. D. Murray
Attorney

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METHOD OF RADIALLY EXTRUDING PORTIONS OF A HOLLOW BLANK TO FORM EXTERNAL THREADS OF WAVE FORM**Edwin R. Evans, Detroit, Mich., assignor to Lock Thread Corporation, a corporation of Delaware****Original application June 9, 1949, Serial No. 98,139. Divided and this application April 5, 1954, Serial No. 420,978****3 Claims. (Cl. 10—10)**

This invention relates to screw threads and particularly to methods of forming male screw threads. The subject matter of the invention is divisional to that of my copending application filed June 9, 1949 under Serial Number 98,139, now abandoned.

An object of the invention is to exteriorly form a screw thread on a substantially cylindrical blank by disposing the blank in a die chamber having its peripheral wall threaded to serve as a matrix for the required thread, and then expanding the blank by driving an oversized punch into a socket in the blank, such expansion extruding the blank peripherally into the matrix, the punch being cross sectionally shaped to circumferentially vary its expansive effort at regular intervals, whereby a predetermined wave form is applied to the extruded thread. Such wave form is advantageous in deriving a maximum use of such elasticity as characterizes the extruded thread in subsequently effecting a tight engagement of such thread with a mating thread.

Another object of the invention is to form said blank with a socket having a substantially closed end and a protrusion from such end into said socket, and to utilize pressure applied by a novel form of punch to flow metal from the protrusion toward a closed end of the die chamber in which said blank is placed, which flow is additional to the lateral extrusion effect produced by said punch.

Another object is to subject a hollow cylindrical blank to an interior pressure such as to expand such blank and extrude its outer portion into a matrix-forming thread extending in the peripheral wall of a substantially cylindrical die chamber receiving said blank, the matrix thread being of a particular type lending itself to the desired extrusion.

These and various other objects are attained by the method hereinafter described and illustrated in the accompanying drawings, wherein:

Fig. 1 is a side elevational view, in partial section, of a blank from which a screw may be extruded by my improved method.

Fig. 2 is an end view of such blank.

Fig. 3 is a vertical sectional view of a blank slightly modified from the blank shown in Figs. 1 and 2, set into a thread-forming die, and showing a punch positioned for insertion in the socket in the blank to expand the latter.

Fig. 4 is a transverse sectional view of a novel form of punch, this view being taken on the line 4—4 of Fig. 3.

Fig. 5 is a side elevational view of a set screw formed from said blank by the apparatus of Fig. 3, this view showing a passage drilled in the screw subsequent to the extrusion operation, and showing, in fragmentary vertical section, a portion of the thread cutting die.

Fig. 6 is a transverse sectional view of the screw shown in Fig. 5, this view being taken on the line 6—6 of Fig. 5.

Fig. 7 is a vertical sectional view of a type of blank suited to form a headed screw, showing such blank set

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into a suitable die and expanded by a modified type of punch, shown partly in section, and adapted to extrude the blank into a thread-forming matrix of the die.

Fig. 8 is a vertical sectional view of the punch shown in Fig. 7, this view being taken on the line 8—8 of Fig. 7.

Fig. 9 is an enlarged fragmentary transverse sectional view taken on the line 9—9 of Fig. 7 and showing a wave form imparted to a thread by the extrusion apparatus shown in Fig. 7.

Fig. 10 is an end elevational view of the closed end of the screw shown in Fig. 5.

Referring now in greater detail to the drawings, Figs. 1 and 2 illustrate a substantially cylindrical metal blank 1 having a frusto-conical lower end 2, the base angle of which is preferably 45 degrees. Extended centrally into said blank from its upper end is a socket 3, preferably substantially cylindrical and closed at its lower end by a wall at the lower end of the blank. This wall is externally conically recessed at 4 and is internally centrally formed with a circular protuberance 5. Such a blank may be produced in various ways, as by stamping or extrusion. The exterior diameter of the blank is slightly less than the minor diameter of a thread to be formed on the blank.

The first step in carrying out my improved method lies in the formation of the blank 1, and the second step consists in inserting such blank into a die 6 (Fig. 3) having a chamber 7 preferably somewhat deeper than the blank for receiving the latter, the lower closed end of said blank resting on the inner surface of the wall defining the lower closed end of said chamber. Chamber 7 has the inner surface of its bottom wall coned as indicated by reference numeral 8, which coned portion fits into the recess 4 formed on the outer surface of the lower closed bottom of blank 1. The inner cylindrical surface of the die 6 is formed with a thread 9, proportioned to serve as an extrusion matrix for accurately forming a desired thread on the outer cylindrical surface of blank 1.

The third step in my thread-forming method consists in forcing a punch or hob 10 which is oversized with respect to the diameter of socket 3, into the socket 3 to expand the blank 1 and substantially conform it to the wall of the chamber 7, whereby the matrix established by the thread 9 is metal-filled to form from the blank a screw 1a with a thread 11. This thread, as illustrated, is of the American National Dardelet type, combining a 60 degree included angle between the thread flanks with a root face of a width far exceeding American National practice, such face having a few degrees of locking inclination to the thread axis, as is a Dardelet characteristic. Such a thread particularly lends itself to the described method of my present invention, in being materially more shallow than an American National thread and hence requiring metal extrusion through a relatively less distance. It is an important and essential feature of my present invention that the diameter of the punch 10 is greater than the diameter of the socket 3 in blank 1, and that said punch is peripherally shaped to exert greater expansive pressure along certain radii of blank 1 than at points between such radii, and that said punch has a total capacity for displacing the material of the blank which is slightly less than that required to completely fill the matrix with the extruded material of the blank. In a preferred construction, the front end of the punch is sufficiently rounded at its periphery 12 to impose the required outward reflection on the socket wall. Excess of cross sectional area of the punch over that of said socket 3 is of course accurately predetermined to displace a volume of metal substantially equaling but slightly less than the capacity of the die matrix. It is pre-

ferred to displace a small volume of metal from the wall defining the lower closed end of the socket 3, additional to the peripheral displacement, and for this purpose said end face is formed either with the aforementioned central protuberance 5, shown in Fig. 1, or with the annular shoulder 13, shown in Fig. 3. Such protuberance or shoulder is substantially eliminated by the punch 10 as its insertion is completed, affording sufficient metal flow in the lower portion of the blank 1 to completely fill the corresponding portion of the die matrix. It will be observed in this connection that the required thread on the blank has at least a portion of its leading convolution extending below the inner surface of the wall defining the lower closed end of the socket 3, thus entailing some downward as well as lateral flow of metal to substantially fill the lower inner end portion of the matrix.

The punch 10 might be cylindrical if it served no other purpose than to fill the die matrix. It has, however, the further function of reshaping the socket 3 and fitting it to a screw-driving tool, as for example, the well-known Allen wrench (not shown). Thus the punch 10 may have the hexagonal cross section best seen in Fig. 4, or any other desired polygonal form. It will be appreciated that a polygonal punch inserted in a smaller cylindrical socket must displace materially more metal at its apices than at its minimum radii, which bisect its lateral faces. The tendency, therefore, of the punch 10 shown in Figs. 3 and 4 is to completely fill the die matrix at points outwardly opposed to the longitudinal edges of such punch and to leave slight vacancies along the crest of the extruded thread outwardly from the center portions of the lateral faces of the punch. It is not desired to eliminate the resultant slight variations of radius in the extruded thread, the variations of the thread being useful, as will presently appear, but provision is made against excessively large variations. Thus in the aforementioned hexagonal punch, it is preferred to form each lateral face thereof with a rib 14, preferably semi-cylindrical, bisecting such face from end to end, the maximum radii of such rib as measured from the punch axis substantially equaling the radii of the punch apices. Provision of such ribs shortens the intervals between points of maximum radius in the extruded thread. It is apparent that various driving contours may be imparted to the socket 3 by forcing therein different oversized punches. Thus Figs. 7 and 8 show a punch 10a of generally cylindrical form but having its entire effective peripheral area formed with alternating ribs 15 and grooves 16 parallel to the punch axis. Such a punch adapts the resultant screw to be driven, if desired, by an ordinary screw driver inserted in diametrically opposed socket grooves 16a (Fig. 9) resulting from the use of such a punch. The use of a punch 10 such as that described above, results in very numerous but quite slight variations or waves in the periphery of the extruded thread.

Fig. 9 illustrates in highly magnified form, the wavy thread resulting from varying the amount of metal extrusion at regular intervals along the spiral length of the thread. The advantage derived from this wave form pertains to interference. For many purposes, an interfering engagement of male and female threads is desirable to assure ample resistance to heavy vibration and stresses. In establishing such an agreement, if a maximum advantage is taken of such elasticity as is possessed by the interfering materials, mutilation of the threads is minimized and the feasible number of separations and repeated engagements is increased. The wave form exemplified in Fig. 9 is suited to produce an extensive series of alternating high and relatively low stress regions in the thread when the illustrated male screw has interfering engagement with a female thread. Such alternate regions lend themselves strongly to utilizing the slight elasticity of metal, affording its expansion with slight molecular travel into the low stress regions from intervening regions of high stress.

The punch 10a, like the punch 10 previously described, is, of course, of a diameter greater than the diameter of the socket in the blank into which it is inserted, and has a total capacity for displacing the material of said blank slightly less than that required to completely fill the matrix with the extruded material of the blank.

It is evident that removal of a screw formed by the above-described method entails a relative rotation of the screw and die, and that the punch may serve as a means for imparting such a rotation to the screw. It is to be understood, therefore, that the punch is suited to rotation, as well as reciprocation.

The screw produced by the method so far described will, for many purposes, be complete. If, however, it is desired to set up an accurately predetermined interference between such screw and a female thread 17, the passage 18 shown in Figs. 5 and 6 will be drilled. Such passage extends from a starting convolution or fractional convolution 19 of the screw and opens into the forward or inner end of the socket 3. Said passage is illustrated as parallel to a screw diameter from which said passage is materially spaced, so that it intersects the screw thread at a sufficiently acute angle (Fig. 6) to form a cutting edge 19a, effective during insertion of the screw in a female thread. The starting portion 19 of the screw thread is progressively reduced in diameter from its juncture with the normal thread to its entering end, and the cutting radius of the edge 19a may thus be predetermined by selecting a desired point for said opening along the spiral length of the starting thread. Chips removed from the female thread by the edge 19a are delivered through the passage 18 to the socket 3, wherein they may be retained by a little oil or grease. In the case of a thread characterized by a wide root face, as shown, it is preferred to let the passage 18 open completely or at least primarily in such face, so that the edge 19a will take effect on the crest of a mating female thread. This particularly suits a screw bearing an American National Dardelet thread to mesh with an ordinary American National female thread, removing from the latter such excess crest material as necessary for a desired fit.

Fig. 7 illustrates an alternative form of my extrusion apparatus, suited to extrude a thread 20 upon a hollow blank 21 and showing such thread extruded. As in the first described method, the blank is set into a die 23 having a chamber 24, accommodating the blank without material lost motion. The peripheral wall of the die is formed, as in the first described method, with a matrix thread 25 receiving metal extruded from the blank and thus forming the male thread 20. The oversized punch 10a is forced into the socket in the blank for extrusion purposes, the punch illustrated being that heretofore mentioned having alternating ribs 15 and grooves 16 to impart a driving contour to the socket of the blank. Departing from the form of blank set forth in the previous description, the blank 21 is formed with a head 27 suited to limit insertion, in use, of the screw resulting from the described method. The die is countersunk at 28 to accommodate the head 27, and a collar 29 on the punch may impart any desired top face to said head.

Formation of screws by the described method derives numerous advantages. Such waste as is entailed by screw machine or other thread-cutting methods is avoided. Time and labor are saved, and likewise some material is saved by giving the screw a hollow or socket form and in imparting a driving contour to the blanks by the same operation that extrudes the thread. It will be appreciated that the method described is particularly suited to the production of set screws since for almost every purpose such screws either are or may be of a headless type. The described method is believed the only one so far conceived that lends itself to production of such a wave form of thread as Fig. 9 exemplifies, with resultant major use of elasticity of the metal in obtaining interfering fits.

The root face of the starting or ramp-forming con-

volution or partial convolution 19, as shown in Fig. 7, is preferably parallel to the axis of the thread, as shown in said figure, merging gradually into the normal root face which has a locking inclination to said axis.

It will be appreciated that in forming a headed screw by my method, as per Fig. 7, the head 27 may be given any desired thickness and peripheral form, and that either the head or die may be chambered to impart such peripheral form.

What I claim is:

1. The method of forming a male screw thread, said method consisting in forming a substantially cylindrical blank of a diameter substantially equal to the root diameter of the required thread, and having a central socket extending from at least one end of the blank, inserting such blank in a substantially cylindrical die chamber which substantially conforms in diameter to the blank and is peripherally formed with a thread serving as a matrix for the required thread, and extruding the blank into said matrix by driving into said central socket a punch having a greater diameter than the diameter of said socket, said punch being peripherally shaped to exert greater expansive pressure along certain radii of the blank than at points between such radii and having a total capacity for displacing the material of said blank slightly less than that required to completely fill the matrix with

the extruded material of said blank so as to impart a superficial wave form to the surface of the extruded thread.

2. The method of forming a male screw thread as set forth in claim 1, said socket having a closed end, and the die chamber having a closed end abutted by the closed end of the socket.

3. The method of forming a male screw thread as set forth in claim 1, the punch being peripherally formed with a set of circumferentially spaced ribs elongated in the driving direction of the punch, whereby the expansive pressure exerted on the blank is circumferentially varied as said blank is extruded by said punch.

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