3,089,362
THREAD ROLLING TOOL
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This invention relates to a tool for rolling an internal thread.

This application is a continuation-in-part of my application Serial No. 568,816 filed March 6, 1956 and now abandoned.

In the instance of providing internal threads, this is usually accomplished by resort to a conventional tap. Taps are expensive because of the one-piece nature of the tap, and moreover the life of a tap under severe circumstances is relatively short due to hard wear on the cutting edges. When broken or worn out, the entire tap needs to be replaced.

In providing external threads on standard screws and bolts, resort is sometimes had to a rolling operation using dies and wherein the threads are produced as a result of deformation of the work piece in contrast to the cutting of an internal thread by a tap, and it is recognized in some respects that a rolled thread is superior to a cut thread.

The primary object of the present invention is to enable an internal thread to be rapidly rolled in a novel manner rather than cut by a tap as has heretofore been the usual practice, and to accomplish this by thread rollers or dies that are relatively inexpensive so far as replacement is concerned. Another of the primary objects of the present invention is a thread rolling tool that is inexpensive to manufacture and which includes a plurality of self-centering thread rollers adapted to be revolved in unison about the internal wall of the work piece, and which are in-fed at the same time as an incident to rotation thereof so as to roll an internal thread in the work piece.

Specifically, the object of the present invention is a thread rolling tool comprising a rotatable arbor and thread rollers or dies engageable with the arbor so as to be fed inwardly of the wall of the work piece to be threaded and at the same time guidedly rotated about such wall upon rotation of the arbor. The arbor according to one modification is tapered at its leading end portion, and the position of the tapered portion is preferably located with respect to the rotating arbor. By inserting the tool in the opening of the work piece that is to be threaded and in-feeding the tapered arbor, the rollers are forcefully wedged outwardly against the wall of the opening and are caused to revolve forcefully to roll a thread therein. The tapered arbor can be used either for straight or pipe threads, but in another modification the arbor is straight and can be used for rolling a tapered or so-called pipe thread, all as will be explained.

The rollers in most instances will be tapered from one end to the other, and where a pipe thread is to be afforded, the narrow ends of the rollers are disposed at the leading end of the arbor, whether the arbor is straight or tapered, so that these narrow ends first enter the opening having the wall to be threaded.

Where a straight thread is to be rolled with a tapered arbor the rollers are inverted, which is to say that the ends having the larger diameters are at the narrow or leading end of the arbor.

So far as I am aware, this represents a new way of providing internal threads, and constitutes a further object of the present invention.

Other and further objects of the present invention will be apparent from the following description and claim and are illustrated in the accompanying drawing which, by way of illustration, shows preferred embodiments of the present invention and the principles thereof and what I now consider to be the best mode in which I have contemplated applying those principles. Other embodiments of the invention embodying the same or equivalent principles may be used and structural changes may be made as desired by those skilled in the art without departing from the present invention and the purview of the appended claim.

In the drawings:
FIG. 1 is a front elevation of one tool constructed in accordance with the present invention;
FIG. 2 is a perspective of the cage or head of the tool;
FIG. 2A is a fragmentary plan view of a portion of the cage;
FIG. 3 is a vertical section of the tool substantially on the line 3—3 of FIG. 4 and showing the threading of a pipe thread in an internal wall thereof;
FIG. 4 is a sectional view substantially on the line 4—4 of FIG. 1;
FIG. 5 is an elevation of a roller for rolling a pipe thread;
FIG. 6 is a detail sectional view on an enlarged scale showing the threads of the tapered arbor and the distortion thereof;
FIG. 7 is a detail sectional view on an enlarged scale showing the way in which the die edges of a pipe threading roller are distorted slightly;
FIG. 8 is a diagrammatic plan view showing the way in which a roller is tilted when mounted in the cage to be driven by the arbor;
FIG. 9 is a schematic view showing schematically the disposition of certain parts of the tool during rolling of a pipe thread with a tapered arbor;
FIG. 10 is a view similar to FIG. 9 showing the rolling of a straight thread with a tapered arbor;
FIG. 11 is a schematic view showing the rolling of a pipe thread using a tool of the present invention having an arbor with straight sides;
FIG. 12 is an elevational view of an arbor having straight sides;
FIG. 13 is an elevational view of a cage for the arbor shown in FIG. 12;
FIG. 14 is an elevational view of a cage to be used with the arbor and the cage of FIGS. 12 and 13 respectively; and
FIGS. 15 and 16 are fragmentary sectional views on an enlarged scale of the thread on the arbor of FIG. 12 and the die edges on the roller of FIG. 14.

One form of the present invention is illustrated in the drawings as embodied in a thread rolling tool 20 for rolling an internal thread about a wall W, FIG. 3, which in the present instance is represented by the neck of a tank T for containing fluid under pressure. The neck of the tank is to be threaded in order that a nozzle attachment can be threadedly mounted thereto as is well known.

The tool 20 embodies an elongated stem or arbor 21, preferably of air hardened tool steel, adapted to be forcefully turned as by a wrench applied to the squared upper end 21S, FIG. 1. In accordance with the present invention, the arbor 21 is preferably provided with threads 22 for a substantial length to assure an effective frictional drive as will be described, and the portion of the arbor 21 that is threaded is also tapered, as will be apparent from FIGS. 3, 9 and 10, noting that FIGS. 9 and 10 are dramatic views wherein the dimensions are exaggerated to illustrate certain operating principles that will be mentioned hereinbelow. In the present instance, the taper that is thus imparted to the threaded portion of the arbor 21 is approximately one-quarter inch per foot. This taper, it has been found, achieves a desirable in-feeding rate for a purpose to be mentioned, and hence is not critical.

Arranged concentrically about the arbor 21 is a cage
25 preferably of case hardened mild steel. The cage 25 includes a sleeve 26 having an elongated bore 27 which is slightly larger in diameter than the arbor 21, enabling the arbor 21 to be freely inserted in the bore 27 of the cage 25 as shown particularly in FIG. 3. In the lower portion beyond the sleeve 26, the cage is formed with what may be termed an enlarged head or socket member 30 having the outer wall thereof tapered between the points A and B, FIG. 2A, at about three-quarters of an inch per foot. Spaced equally about the head 30 are three elongated chambers or socket openings 31, FIGS. 2 and 4, which open at the outer face of the head 30 and also at the inner wall thereof as will be observed particularly in FIG. 4. The arrangement is such that the sockets 31 have upper and lower ends 32 and 33 inwardly of the upper and lower ends of the head 30, and this enables thread rollers 35 to be mounted for individual rotation in the sockets 31.

The longitudinal axes of the sockets 31 are tilted relative to the longitudinal axis of the cage 25, and the sides of the sockets 31 are distorted slightly. Thus, the angle D between the center line C–C, FIG. 2A, of the head 25 and that of each socket C–C is about 1° 40', this being the lead angle of the thread to be rolled on the work wall W. The sides L and R of each socket as 31 are preferably tilted relative to the center line C–C, because the rollers 35 are in this instance tapered from one end to the other, and it is desirable that the sockets 31 and the rollers 35 be complementarily related.

Thus, three thread rollers 35 are in the present instance disposed within the respective sockets 31 in equally spaced relation about the cage 25. The rollers 35 are disposed within the cage 25 by dropping each roller down through the bore 27 into the internal chamber 34 of the cage 25, FIG. 4, and the side edges as L and R of the chambers 31 are peened or swaged as at 34S, FIG. 4, to prevent the rollers 35 from escaping through the chambers 31 in a radial outward direction. The peens 34S are spaced from one another somewhat less than the outside diameter of the rollers 35 as shown in FIG. 4 to afford in effect what constitute fingers or guards which retain the rollers 35. It will be noted, however, that when operatively positioned as shown in FIG. 4, the rollers 35 have substantial peripheral portions exposed outwardly of the outer wall of the head 30 of the cage 25.

The bore 27 extends through the cage 25 so as to afford an opening 27A, FIG. 3, at the lower end of the head 30, and this enables the arbor 21 to be passed downwardly through the internal chamber in the head 30 so that the lower or leading end 21E thereof extends beyond the lower end of the cage 25 opposite the sleeve 26. After arranging the rollers 35 as described above within the head 30, the arbor 21 is then inserted so that the tapered, portion thereof is centered among the rollers 35 as shown particularly in FIG. 4. The arbor 21 can then be rotated in an in-feeding direction relative to the cage 25, and the taper thereof is gradually effective as a wedge of increasing dimension to force the rollers 35 radially outwardly toward their limit positions as illustrated in FIG. 4. The cage 25 being held stationary, the rollers 35 will rotate freely in their sockets during such in-feeding of the arbor. The arbor 21 can be completely in-locked without the rollers binding on the restraining means 31S.

In accordance with the present invention, the thread rollers 35 are provided with parallel, axially spaced thread rolling die edges 40, FIGS. 5 and 7, having grooves 40G therebetween. The rollers 35 are hard tool steel, and for rolling pipe thread are preferably tapered from top to bottom with a taper T that is complementary to that of the threaded portion of the arbor 21, which is to say that the taper T indicated in FIG. 5 is preferably one-quarter inch per foot. Thus, as is well known, a standard pipe thread is tapered three-quarters of an inch per foot, and the taper of the arbor 21 plus the taper of the rollers 35 is selected to produce a standard pipe thread taper. In this connection, it should be borne in mind that the taper of the arbor 21 is 1° 40' whereas the taper of the threads 22 has been found to produce an advantageous in-feeding rate, and in those instances where this degree of taper is altered the taper T of the rollers 35 will likewise be altered if it is desired to roll a standard pipe thread taper.

The threads 22 of the arbor 21 are adapted to mesh with the grooves 40G of the rollers 35 within the chamber 34 of the head, and in this way forced rotation of the rollers 35 is assured by rotating the arbor 21. In rolling an internal pipe thread, a tool as 20 is selected having rollers defining the diameter of the wall W that is to be threaded. The rollers 35 for a pipe thread are arranged within the sockets 31 so that the smaller ends thereof are down, that is, point toward the leading end 21E of the arbor 21, and it is for this reason that the walls L and R of the sockets 31 are inclined relative one to the other. In other words, the lower end wall 33 of each socket 31 is more narrow than the upper end wall 21E, and the rollers 35 are complementally mounted in the sockets 31. Moreover, it is advantageous that the leading ends of the rollers 35 that will first engage the wall W be further tapered as at 2T2, FIG. 5, to facilitate insertion of the tool. The taper 2T2 is about 6° and when initial insertion has been accomplished the arbor 21 is then rotated in an in-feeding direction, the tapered portion thereof acting as a wedge gradually forcing the rollers radially outwardly against the internal diameter of the wall W. The inclination of the socket openings 31 tips the rollers 35, FIG. 8, to the desired lead angle of the thread WT, FIG. 3, that is to be rolled in the work piece W, and the threads 22 of the arbor frictionally engage the grooves 40G in the rollers in an effective manner to cause the rollers 35 to be rotated upon rotation of the arbor 21. Further in-feeding causes the rollers 35 to bite equally in to the wall W thereby achieving self-centering, and the cage 25 then commences to revolve and the rollers 35 to rotate independently and relative to the arbor 21. The rollers 35 thus use the wall W as a track, and the rollers in effect drive the cage 25 independently about the arbor much as the nature of a planetary gear system, so that for each transit of the cage 25 about the wall W the arbor makes several turns.

As the cage 25 thus revolves about the wall W, the rollers circumnavigate the wall W and roll in the wall W a descending thread WT, which, as shown in FIGS. 3 and 9, is tapered in accordance with the standard nature of a pipe thread.

As is well known, the bisectors of the crests of internal pipe threads are to be perpendicular to the axis of the internal wall as W, not perpendicular to the face of the wall. It is therefore essential for a standard tapered pipe thread that the die edges 40 of the rollers 35 be designed accordingly. In FIG. 7, angle M is the angle between the axis RA of the roller 35 and the line RL which bisects the angle at the crest RP of the groove 40G, noting that the angle M is on the side of the line RL which is toward the smaller end of the roller 35. This angle M is greater than 90° by the amount required to compensate for the taper of the threaded portion of the arbor as well as the taper T of the rollers 35 so as to assure that the bisectors of the threads WT are properly perpendicular to the axis of the wall W. In other words, the tool used to cut or grind the grooves 40G in the rollers 35 is held at an angle from the perpendicular of a longitudinal axis of the roller being formed, and the result is that one side 40G1 of the groove 40G is longer than the opposite or leading side 40G2. It will thus be apparent then that the grooves 40G are cut so that the resultant die edges 40 will bite in to the wall W properly to roll a standard pipe thread.

The thread on the arbor should likewise be distorted,
so as to assure a complementary mesh with the grooves of the rollers 35. Referring to FIG. 6, the angle N is the angle between the axis AA of the arbor 21 and the lines BB which bisects the angle at the crest AA of a groove in the arbor between threads 22; and angle N is on the side of the line AL away from the leading end 21E of the arbor. The angle N will be larger than 90° by twice the amount that the angle M is larger than 90°.

While the invention has been described above primarily from the standpoint of rolling an internal threaded frictional contact, the invention may be used for the rolling of an internal straight thread as indicated diagrammatically in FIG. 10. In this instance, the corresponding thread roller is indicated at 35A, and is arranged so that the end thereof having the larger diameter is at the leading end of the arbor 21. Thus, in comparison to the thread roller 35 described above, the rollers as 35A for a straight thread are inverted in a manner of speaking, and this will align the rollers 35A so as to produce a standard straight thread ST in the work piece W, FIG. 10. Again, since the bisectors of the crests of the threads ST are to be perpendicular to the axis of the internal wall, the die edges formed at 35A are truncated slightly to compensate for the taper of the arbor 21.

It will be appreciated from the foregoing that one specific form of the invention has been described. In the instance of a pipe thread, the taper of the arbor is less than the taper of the thread to be rolled, since otherwise it has been found that the in-feed rate of the arbor 21 is excessive, and it is for this reason that the rollers 35 are also tapered to supplement the taper of the arbor 21. This can be appreciated from the fact that where a straight thread is to be rolled, the rollers as 35A are then tapered in a reverse sense in comparison to the arbor only to compensate the taper of the arbor.

It will be appreciated that in rolling a thread, this occurs as a gradual and progressive deformation of the internal wall of the work piece as the arbor 21 continues to be in-fed. The die edges 40 of the rollers may be of any accepted form. These have been shown as of common sharp V-form but may be truncated if desired in accordance with a United States Standard thread, and, as was mentioned, the bisectors of the crests of the grooves 40G in the roller 35 are related non-perpendicular to the longitudinal axis of the roller to compensate for the taper of the arbor or the taper of the roller or both.

In the embodiment of the invention illustrated in FIGS. 11 to 16, a pipe thread, FIG. 11, is adapted to be formed by an arbor 121 having straight sides cooperating with die rollers 135 that are tapered and which have the narrow ends thereof oriented so as to first enter the opening to be threaded. It will be appreciated that FIG. 11 is somewhat simplified to illustrate structural principles, and this is likewise true with respect to FIGS. 9 and 10. Thus, the configuration of the arbor primarily affects the in-feeding rate of the rollers (of whatever form) so that by having a non-tapered arbor as 121 the lowest in-feeding rate is attained which is desirable in many instances for rolling pipe threads. It should be further mentioned that in the description of parts to follow, a "100" reference character series is utilized so as to clearly identify the embodiment of FIGS. 11 to 16 to what has been described hereinabove.

Thus, the arbor 121 is in many respects similar to the geometry of the arbor 21 described above, the important difference being the truly cylindrical or non-tapered nature thereof. As in the foregoing embodiment, the arbor 121 is preferably provided with threads 122 to achieve good contact with the grooves 140G of the rollers 135, FIG. 14, that are to be used therewith, the arbor 121 having, as an example, fourteen threads per inch. The threads 122 of the arbor 121 are truncated, FIG. 16, as in the foregoing embodiment.

The arbor 121 is adapted to be telescoped in a cage or head 125 having an enlarged stub sleeve 126 at what constitutes the upper end thereof. The cage 125 is formed with an internal bore 127 which extends between and opens at the opposite ends thereof, and the bore 127 is enlarged at 134 at what constitutes the socket portion 130 of the cage 125 wherein the rollers 135 are to be mounted and be engaged by the threaded portion 122 of the arbor 121. Each socket 130 is formed with a plurality, preferably three in number, of generally rectangular socket openings 131 in which three rollers as 135 are to be individually mounted so that inner peripheral portions thereof communicate with the enlarged bore portion 134 while outer peripheral portions thereof project outwardly of the peripheral outer side of the socket portion 130 of the cage 125. This relation is identical to that illustrated in FIG. 4. Each socket 131 has an upper end 132 and a lower end 133 and these are spaced apart substantially equal to the axial length of each roller 135 so that a roller 135 fits neatly in its socket opening 134 so as to be rotatable freely therewith. As in the foregoing embodiment, the socket opening 131 are canted or inclined relative to the center line 100C—1 of the cage 125, and the left and right hand side edges 100L and 100R of each socket opening 131 are tapered complementally to the taper of the rollers 135. In FIG. 13, 100C—2 identifies the center line of the socket opening 131 illustrated, and the included angle 100D corresponds to the lead angle of the pipe thread to be rolled.

The rollers 135 are elongated in comparison to the roller 35 described above, but this difference of course has primarily to do with the diameter and length of the opening in the wall as which is to be rolled with an internal thread. It may be mentioned however that the rollers 135 to be used with the arbor 121 have fourteen grooves 140G per inch between the parallel die edges 140 and have an axial length of 1,430 inches. Each roller 135 is tapered from 0.305 inch outside diameter at the wide end to 0.260 inch outside diameter at the narrow end, and when the rollers 135 are mounted in the cage 125 the narrow ends are down as viewed in FIG. 13.

A detailed explanation was set forth above in connection with FIGS. 6 and 7 regarding distortion of the threads in the arbor 21 and the grooves of the rollers 35 in order to assure the proper formation of internal threads. Some distortion is likewise required in the threads of the arbor 121 shown here because of the tapered nature of the rollers 135. These distortions are indicated in FIGS. 15 and 16. Inasmuch as the various parts indicated by reference character in FIGS. 15 and 16 correspond to FIGS. 6 and 7, further identification of the parts in FIGS. 15 and 16 is not necessary. Thus, to contrast the two embodiments, it is merely necessary to point out that whereas the angle M, FIG. 7, may be 91°10', the angle 100M, FIG. 16, is 90°54'; and whereas the angle N, FIG. 6, may be 92°20', the angle 100N, FIG. 15, is 91°48'. It will be seen from the foregoing that the angular distortion for the threads of the arbor 121 and the die edges 140 of the rollers 135 is less than the necessary distortions required in those instances where a tapered arbor is to be used.

In use of the embodiment of FIGS. 11 to 16, the tool is assembled so that the narrow ends of the rollers 135 will first enter the opening to be rolled with an internal pipe thread (see FIG. 11). The arbor 121 is rotated causing the individual rollers to rotate in the cage 135 and the cage 125 to revolve about the arbor 121. Inasmuch as the rollers are inclined relative to the center line of the cage 125, the rollers 135 scribe a spiral track, FIG. 11, forming a standard pipe thread, and since the rollers 135 are tapered, the opening in the wall W, FIG. 11, will likewise be tapered to afford a pipe thread.

Hence, while I have illustrated and described preferred
embodiments of my invention it is to be understood that these are capable of variation and modification, and I therefore do not wish to be limited to the precise details set forth, but desire to avail myself of such changes and alterations as fall within the purview of the following claim.

I claim:

A tool for rolling a thread about an internal wall and comprising, a solid rotatable arbor having a tapered portion that is provided with a screw thread, a cage concentric to the threaded portion of the arbor, said tapered portion being uniformly tapered in one direction only and said arbor having an extended portion disposed externally of the cage in coaxial alignment therewith and which has the free end thereof formed to be rotated by a separate tool, said cage having a plurality of sockets opening about the circumference thereof and which communicate with a bore in the cage, said sockets having the axes thereof inclined relative to the axis of the arbor, a plurality of rollers having tapered outer sides and disposed freely and loosely in said sockets in non-fixed axial positions for free radial in and out movement and adapted to rotate individually therein and having peripheral portions thereof disposed outwardly of said sockets beyond the outer side of the cage so as to engage the internal wall that is to be threaded, said rollers in the sockets being tilted at the angle of inclination of the sockets, said rollers being continuously grooved to provide spaced parallel thread rolling die edges and adapted to roll a thread on said internal wall upon forcing the rollers radially outwardly against the wall to be threaded and at the same time revolving the cage and the rollers as a unit about said wall by in-feeding the arbor, said grooves of the rollers being meshed with the threads of the arbor centered among the rollers within the bore of the cage for revolving and in-feeding frictionally the cage and rollers as a unit relative to said wall upon rotation of the arbor causing the arbor to advance axially of the cage, said arbor being the only member within the cage for spacing the rollers, and the thread on the arbor and the die edges on the rollers being non-perpendicularly related to the longitudinal axes of the arbor and the rollers, respectively, so that the rolled thread will be of standard form.

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