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APPARATUS FOR FORMING SCREW THREADS

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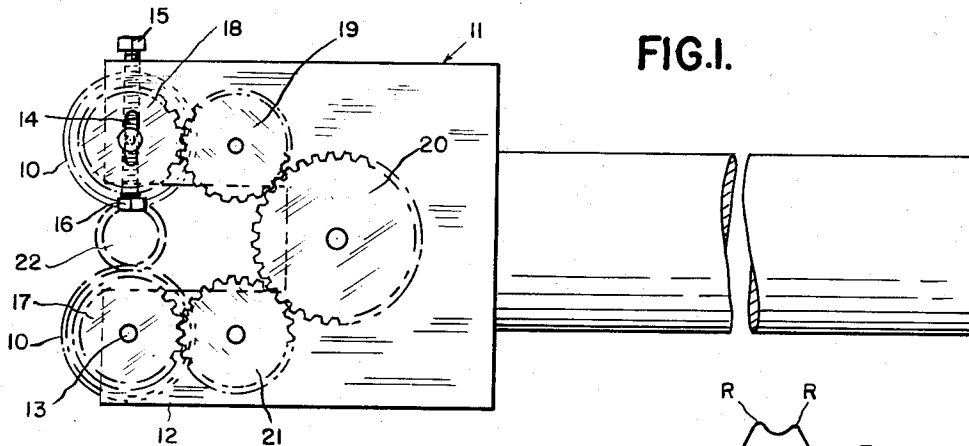


FIG. 1.

FIG. 4.

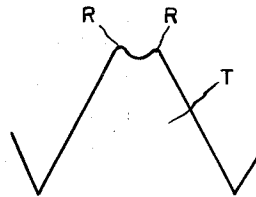


FIG. 2.

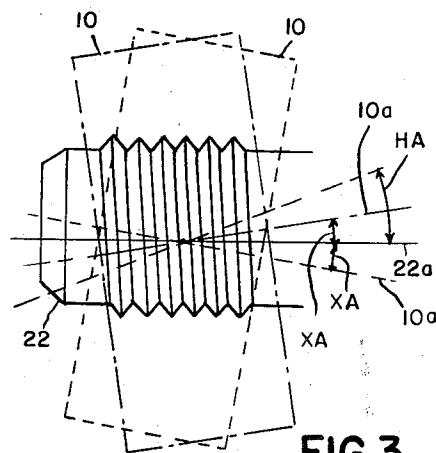
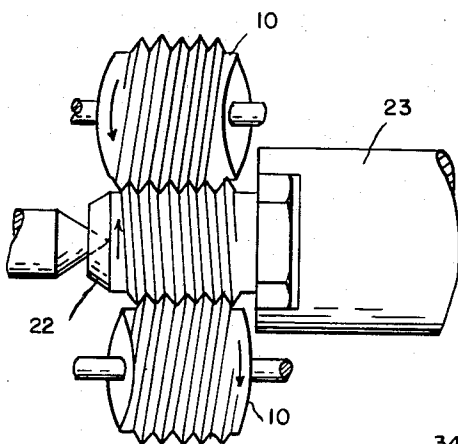
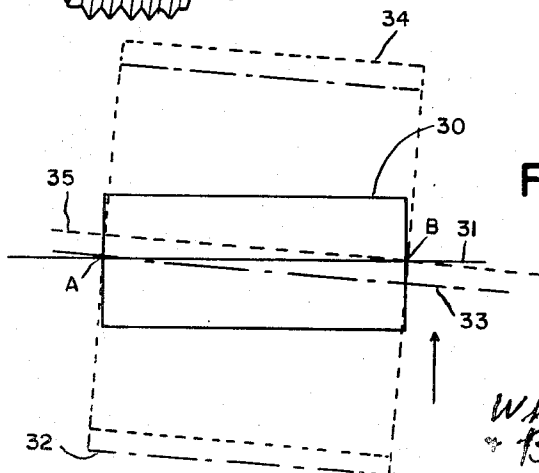


FIG. 3.

FIG. 5.



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APPARATUS FOR FORMING  
SCREW THREADSLeo W. Bedker, East Detroit, Mich., assignor of  
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11 Claims. (Cl. 80-6)

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The present invention relates to apparatus for forming screw threads.

It is an object of the present invention to provide improved apparatus for forming screw threads which is characterized by the superior finish and accuracy imparted to the threads. It is a further object of the present invention to provide apparatus for forming screw threads characterized by the relatively greater strength of the threads formed thereby. It is a further object of the present invention to provide improved apparatus for forming screw threads characterized by the substantially equal displacement of material at opposite sides of each groove between adjacent threads.

It is a feature of the present invention to provide apparatus for forming screw threads characterized by the use of a thread roll having helically formed threads thereon which operates on a work piece with the axis of the work piece and the axis of the thread roll relatively inclined with respect to each other. It is a further feature of the present invention to provide the relative inclination of the axes referred to above in a direction which causes the portion of the threads on the thread roll which engage the work piece to extend more nearly perpendicular to the axis of the work piece. It is a further feature of the present invention to provide the relative inclination between the axes of the thread roll and the work piece as above described in an amount approximately equal to half the helix angle of the threads on the work piece.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawings, wherein:

Figure 1 is a side elevation of a pair of threading rolls mounted in a holder;

Figure 2 is a diagrammatic view in which the angle of inclination between the axes of the thread rolls and the axis of the work piece is illustrated in an exaggerated amount for clarity;

Figure 3 is a schematic view taken at right angles to the disclosure of Figure 2 in which the inclination between the axes of the rolls and axis of the work piece is exaggerated for clarity;

Figure 4 is a diagrammatic view illustrating the condition of a partially formed thread when produced in accordance with the present invention; and

Figure 5 is a diagrammatic view illustrating the finishing action obtained.

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In the past, there have been two distinct methods for rolling threads on a work piece. In one of these methods helical threads have been provided on the thread roll which extend at a helix angle equivalent to the helix angle of the threads to be formed on the work piece and of opposite hand. Thereafter the thread roll is fed into the rotating work piece to depth while the axes of the thread roll and work piece are maintained parallel. The second method involves the use of a thread roll having circular threads extending thereabout and which is fed into engagement with the rotating work piece with its axis inclined to the helix angle desired on the work piece. This last method results in a relatively axial feed between the thread roll and the work piece while parts are in engagement.

In both of the methods just described, it has been found that the major portion of the material of each thread is rolled out of a single space between adjacent threads, with the result that the material is moved a relatively large distance. In accordance with the present invention, it is found that each thread on the thread roll forms material outwardly in substantially equal amounts at opposite sides thereof. Thus when the thread roll is withdrawn from the work piece before completion of the thread it is found that each partially formed thread on the work piece has substantially identical rolls of material at its top, establishing the fact that the material for each tooth is brought in substantially equal amounts from the spaces at opposite sides of the thread.

Broadly described, the present invention consists in providing a thread roll having helical threads formed thereon which are of a helix angle equivalent to the helix angle of the thread to be formed on the work piece, and in which the helical threads on the roll are of opposite hand to the helical threads to be formed on the work piece. The thread roll is fed to depth in the rotating work piece while the axes of the thread roll and work piece are inclined at an angle approximately equal to one-half the helix angle of the threads to be formed on the work piece. The relative inclination between the axes of the thread roll and work piece is brought about in a manner equivalent to inclining the axis of the thread roll from a position in which it is parallel to the axis of the work piece in a direction which causes the portions of the threads on the thread roll which engage the work piece to assume a position more

nearly perpendicular to the axis thereof. By way of specific example, where the thread being formed on the work piece is a right-hand thread, the threads on the thread roll will be left-hand and will be formed at a helix angle equivalent to the helix angle of the threads to be formed on the work piece. The relative inclination between the axes of the thread roll and work piece is produced by rotating the thread roll in a direction which appears clockwise when viewed from the side of the work piece at which the thread roll is located.

Referring first to Figure 1, there is illustrated a pair of thread rolls 10 which are mounted for rotation in a holder 11 having a pair of forwardly projecting arms 12 provided with aligned openings in which roll-supporting shafts 13 are mounted. In order to provide for adjustment of a spacing between the thread rolls 10, one of the rolls is mounted in elongated slots 14 and is positioned therein by means of bolts 15 and 16. It will be evident that in order to move the rolls 10 closer together the bolts 16 are retracted and the bolts 15 are advanced to move the upper roll as seen in Figure 1 downwardly.

Keyed or otherwise secured to the roll-carrying shafts 13 are gears 17 and 18. Mounted on the holder 11 are gears 19, 20 and 21 forming a connecting train which insures synchronous rotation of the rolls 10. In addition, suitable means (not shown) are provided for effecting fine adjustment between one of the rolls 10 and the gear 17 or 18 rotatable therewith in order to insure that threads on one roll will match properly with the threads on the work piece formed by the threads on the other roll.

While the rolls 10 are geared together for synchronous rotation, these rolls and their interconnecting gear train are adapted to be driven by engagement with the rotating work piece indicated at 22. As best seen in Figures 2 and 3, the axes of the rolls 10 are inclined with respect to the axis of the work piece 22. In Figure 2 there is indicated diagrammatically a chuck or the like 23 supporting the work piece 22 and adapted to drive the same in rotation, as for example in the direction shown by the arrow. It will be observed that the thread rolled on the work piece 22 is a right-hand thread. It will similarly be observed that the threads provided on the rolls 10 are each of left-hand, and that the thread rolls 10 have been inclined from a position in which their axes are parallel to the axis of the work piece 22 to the position indicated, as a result of which inclination the portions of the threads of the rolls 10 which are in contact with the work piece 22 are caused to extend more nearly perpendicular to the axis of the work piece. In Figure 3 the work piece 22 is illustrated and the positions of the thread rolls 10 are indicated by broken lines. In this figure the axis of the work piece 22 is indicated at 22a, the axes of the thread rolls 10 are indicated at 10a, and the helix angle of the threads on the work piece 22 is indicated by the angle HA. It will be appreciated that this is a diagrammatic view and that the angles are exaggerated for clarity.

While it has been found that the precise angle at which the axes of the thread rolls are set with respect to the axis of the work piece is not critical, best results are obtained when this angle is approximately equal to half the helix angle of the threads on the work piece. Thus,

as seen in Figure 3, angles XA, which indicate the angles of inclination between the axes of the rolls and work piece, are substantially half the angle HA, which is the helix angle of the threads on the work piece. By way of specific example, right-hand threads having a helix angle of 1° 57 minutes were rolled on a work piece. The outside diameter of these threads was  $\frac{1}{16}$ " and there were 18 threads per inch. For this a roll was provided whose pitch diameter was 1.501" and which was provided with three starts. The helix angle of the threads on the roll was 2° 11 minutes, left-hand. It will be appreciated that the helix angle on the roll and work piece while approximately equal are nevertheless slightly different, depending upon the pitch diameter of the roll. It has long been common practice to arrive at a final pitch diameter on the roll by successive grindings and in some cases it is found that a substantially freer rolling tool results when the pitch diameter is reduced below the theoretically complementary pitch diameter. The roll as described above was positioned relative to the work piece so that the axes of the roll and work piece were inclined relative to each other at an angle of approximately 1°, which it will be noted is substantially half the helix angle on the work piece.

By way of another specific example, 14 pitch straight pipe threads were formed on a work piece with an O. D. of .8355", the threads having a helix angle of 1° 42 minutes, right-hand. In this case a three-start roll was employed having an O. D. of 2.193", the helix angle on the roll being 1° 59 minutes, left-hand, to correspond to the 1° 42 minute helix angle on the work piece. In this case the roll was presented to the work with its axis inclined thereto at an angle of 51 minutes, which it will be observed is precisely half the helix angle of the thread on the work piece.

With the specific examples given above, it will be observed that the angle between the axes of the roll and work piece is very close to half the helix angle of the thread on the work piece, but it will be appreciated that this angle may be any angle which is less than the helix angle of the thread on the work piece. Best results, however, are obtained when the angular setting is roughly half the helix angle of the thread on the work piece.

Referring now to Figure 4, there is illustrated diagrammatically a thread T which has been partially rolled and withdrawn from contact with the threading roll. It is found that when threads are rolled in accordance with the present invention, a partially finished thread such as the thread T of Figure 4 has formed thereon substantially equal rolls R of metal, indicating that the metal which is shaped into the thread is brought in substantially equal amounts from opposite sides thereof or from thread spaces at opposite sides thereof. This is to be contrasted with results obtained with helical rolls on parallel axes or with straight rolls on inclined axes, in which a partially rolled thread shows that substantially more metal is being brought into the thread from one side than from the other. This unequal movement of the metal gives rise to axial thrusts between the roll or rolls and work piece, which in some cases may draw the work piece out of its chuck and which at all events is undesirable from the standpoint of efficient metal working. It has further been demonstrated that the herein

disclosed method exerts substantially no axial thrust on the work piece.

Attention is now directed to Figure 5, which illustrates the manner in which the thread rolling operation takes place. In this figure there is indicated in full lines at 30 a work piece having an axis 31. The thread roll is shown in dot and dash lines at 32 in the position relative to the work piece at which the first portion of the threads rolled on the work piece are rolled to final depth. In the position 32 of the tool it will be noted that its axis 33 crosses the axis of the work piece at a position designated A. In this case the movement of the thread roll is tangential of the work piece and in the direction shown by the arrow. It will be appreciated that the point A represents the closest distance between centers of the thread roll and work piece and that accordingly with the thread roll in the position shown at 32 the threads at the left-hand end of the work piece 30 will be finished to full depth.

As the thread roll moves relative to the work piece in a direction which appears as upwardly in Figure 5, the thread roll eventually reaches a position indicated in broken lines at 34 and its axis at that time has reached the position indicated at 35. It will be observed that at this time the axis 35 of the thread roll and the axis 31 of the work piece cross at a position indicated as B. Accordingly, at this time the thread roll has completed the rolling operation of the thread. It will further be apparent that this rolling operation has progressed from the left-hand end of the piece 30 to the right-hand end as shown in Figure 5.

For purposes of clarity, only one thread roll has been indicated in Figure 5. However, it will be appreciated that if a pair of opposed thread rolls were provided the other thread roll would have its axis inclined in an opposite direction to the axis of the work piece and that accordingly as it moved in the direction of the arrow in Figure 5 it would initiate its thread rolling action in the right-hand end of the work piece 30, which action would progress from the right-hand end toward the left-hand end. In practice, therefore, employing a pair of opposed thread rolls, the thread rolling operation is initiated at opposite ends of the work piece and progresses to the center thereof, at which time the thread rolling operation is complete.

One of the results of the crossed axes relationship between the thread roll and the work piece is that the zone in which the thread is finished to full depth is a relatively small zone adjacent the center of crossed axes, as seen in Figure 5. This means that a progressive finishing action takes place so that in effect different portions of the thread roll operate momentarily as a finishing roll, imparting a very smooth accurate finish to the threads of the piece. It also results in substantially less total pressure between the thread roll and the piece, inasmuch as the operation is taking place at all times over a zone which is reduced as compared to the action which would be obtained with parallel axes.

The present invention has been illustrated for purposes of clarity as applied to a threading operation in which a pair of opposed thread rolls are provided. It is to be distinctly understood, however, that the invention is not limited to the use of two thread rolls in conjunction with a single work piece. It may be practiced with a single roll or with a plurality of

rolls, such for example as three. In all cases, whether a single roll is employed or a plurality of rolls, the inclination of the axis of the roll or axes of the rolls, as the case may be, results in a substantially freer rolling action and produces threads which exhibit superior qualities as to accuracy, surface finish and strength characteristics.

While there has been illustrated and described a particular arrangement of thread rolling mechanism, it will be appreciated that this has been done merely to enable those skilled in the art to practice the invention, the true scope of which is indicated by the appended claims.

What I claim as my invention is:

1. In thread rolling apparatus, a holder movable perpendicular to the axis of a work piece driven in rotation without axial advance, a thread roll support on said holder, a rotatable thread roll on said support having a helical rib extending at a helix angle of opposite hand to the helix angle of the thread to be rolled and corresponding to and approximately equal in amount to the helix angle of the thread to be rolled on the work piece, said support being inclined to support the thread roll with its axis inclined to the axis of the work piece about an axis perpendicular to the axis of the work piece and intersecting the axis of the thread roll, the angle of inclination being less than the helix angle of the thread to be rolled and the direction of inclination being that which causes the portions of the ribs adjacent the work piece to extend more nearly perpendicular to the axis of the work piece than they would if the axes of the work piece and thread roll were parallel or coplanar.

2. Structure as defined in claim 1 in which aforesaid inclination of the axis of the thread roll to the axis of the work piece is approximately equal to one-half the helix angle of the thread to be rolled.

3. Structure as defined in claim 1 in which the support is located to position the thread roll for generally tangential movement with respect to the work piece.

4. In thread rolling apparatus, in combination, a holder comprising a pair of spaced arms, a thread roll support on each of said arms, a rotatable thread roll carried by each of said supports, said thread rolls each having helical ribs thereon extending at a helix angle of opposite hand to the helix angle of the threads to be rolled and corresponding to and approximately equal in amount to the helix angle of the threads to be rolled, said supports being inclined to incline the axes of the thread rolls about an axis perpendicular to the axis of the work and intersecting the axes of the thread rolls, and at an angle to the work axis less than the helix angle of the thread to be rolled, and in a direction which causes the portions of the helical ribs on the thread rolls at the side adjacent the work piece to be more nearly perpendicular to the axis of the work than they would be if the axes of the work piece and rolls were coplanar or parallel.

5. Structure as defined in claim 4 in which said supports are directly opposite to each other and spaced apart a distance such that as the holder is advanced radially with respect to a work piece the thread rolls move generally tangentially of the work piece and initially engage the work piece at opposite ends of the zone to be threaded.

6. Structure as defined in claim 4 in which the aforesaid inclination of the axes of the thread rolls relative to the axis of the work piece is approximately equal to half the helix angle of the thread to be rolled.

7. For use in thread rolling apparatus comprising a work support for rotating a work piece without axial advance, and a tool support movable perpendicularly of the axis of the work support: a holder comprising a pair of spaced arms adapted to straddle the work piece, a rotary thread roll on each of said arms, said thread rolls having helical ribs of opposite hand to the thread to be rolled corresponding in helix angle to that of the helical thread to be rolled, the axes of said thread rolls being equally and oppositely inclined to the axis of the work piece by an angle less than the helix angle of the thread to be rolled and in a direction which causes the portions of the ribs at the sides of the rolls adjacent the work to extend more nearly perpendicular to the axis of the work than would be the case if the rolls were parallel to the work, the inclination of the axes of the rolls being measured as inclination about an axis perpendicular to the axis of the work piece and intersecting the axis of the roll.

8. Thread rolling apparatus comprising a holder having spaced arms adapted to straddle a rotating work piece, a pair of thread rolls having helical ribs of opposite hand to the thread to be rolled carried by said arms in position to engage opposite sides of a work piece, the axes of said thread rolls being equally and oppositely inclined relative to the axis of the work about an axis perpendicular to the work axis and the axes of said rolls, the amount of such inclination being less than the helix angle of the threads to be rolled.

9. Thread rolling apparatus comprising a holder having spaced arms adapted to straddle a rotating work piece, a pair of thread rolls having helical ribs of opposite hand to the thread to be rolled carried by said arms in position to engage opposite sides of a work piece, the axes of said thread rolls being equally and oppositely

inclined relative to the axis and the axes of said rolls, the amount of such inclination being approximately half the helix angle of the threads to be rolled.

10. A thread roll device for positioning a pair of thread rolls at opposite sides of a rotary work piece to be threaded, comprising a holder, a pair of spaced threads rolls having helical ribs of opposite hand to the thread to be rolled and of corresponding and approximately equal helix angle, means for supporting said rolls for rotation on said holder with their axes inclined in space to the work axis so as to cause the engaged portions of the ribs to extend at smaller helical angle to the work than the resulting threads on the work.

11. A thread roll device for positioning a pair of thread rolls at opposite sides of a rotary work piece to be threaded, comprising a holder, a pair of spaced thread rolls having helical ribs of opposite hand to the thread to be rolled and of corresponding and approximately equal helix angle, means for supporting said rolls for rotation on said holder with their axes inclined in space to the work axis so as to cause the engaged portions of the ribs to extend at a helical angle to the work approximately half the helix angle of the threads on the work.

# References Cited in the file of this patent

## UNITED STATES PATENTS

| Number    | Name        | Date           |
|-----------|-------------|----------------|
| Re. 3,998 | Cochrane    | May 31, 1870   |
| 248,167   | Harvey      | Oct. 11, 1881  |
| 345,959   | Fairbairn   | July 20, 1888  |
| 631,159   | Echols      | Aug. 15, 1899  |
| 702,919   | Boyd et al. | June 24, 1902  |
| 859,643   | Cummings    | July 9, 1907   |
| 1,085,643 | Tewksbury   | Feb. 3, 1914   |
| 1,145,661 | Bailey      | July 6, 1915   |
| 2,054,182 | Unke        | Sept. 15, 1936 |
| 2,204,182 | Gould       | June 11, 1940  |
| 2,218,574 | Gould       | Oct. 22, 1940  |
| 2,349,863 | Hallberg    | May 30, 1944   |