March 24, 1953 C. W. HOPKINS 2,632,345

APPARATUS FOR FORMING RODS, BOLTS OR THE LIKE

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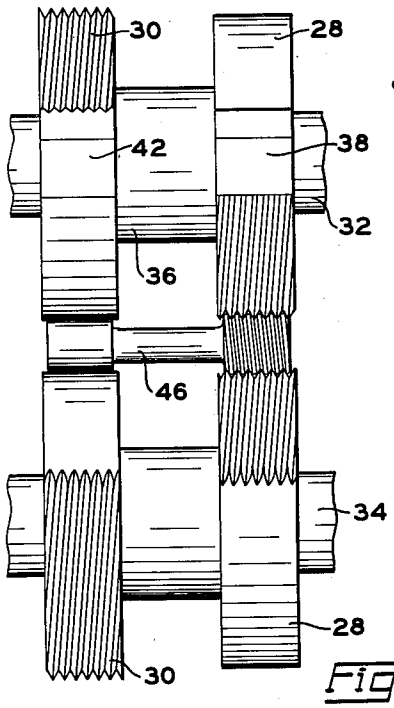


Fig. 2

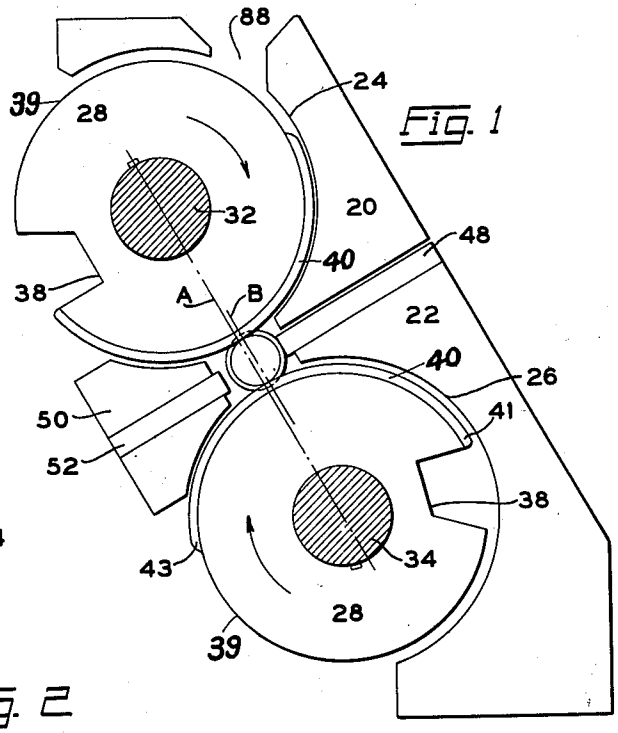


Fig. 1

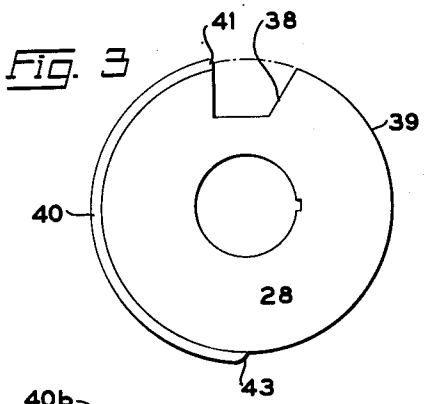


Fig. 3

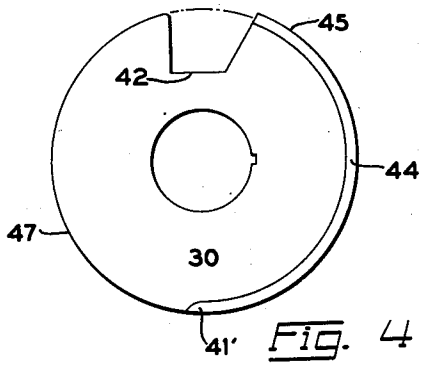


Fig. 4

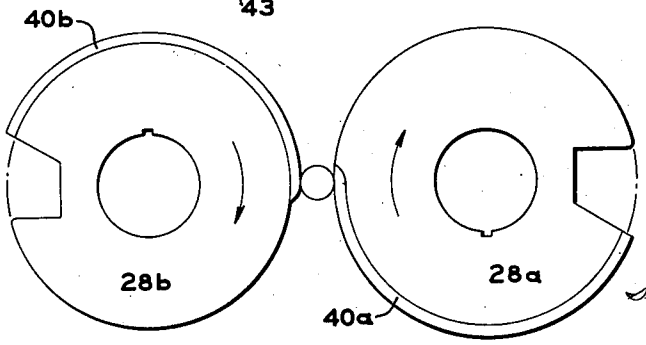


Fig. 4A

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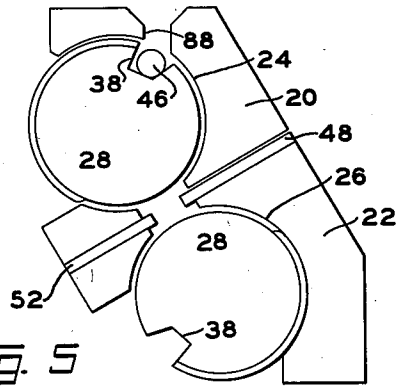


Fig. 5

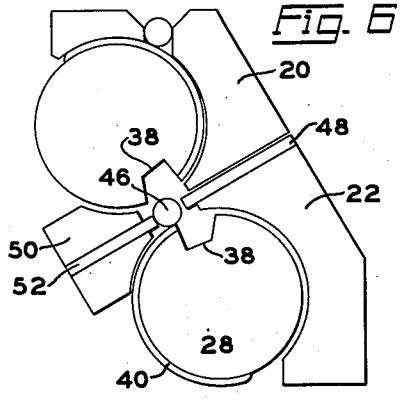


Fig. 6

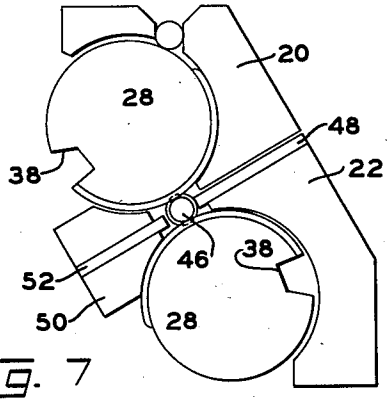


Fig. 7

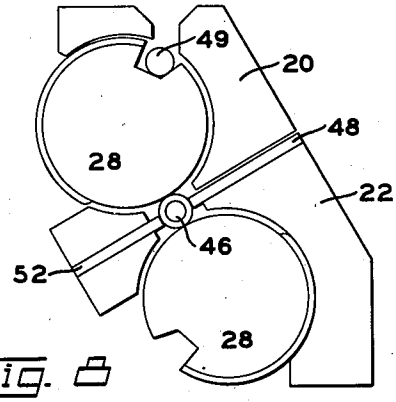


Fig. 8

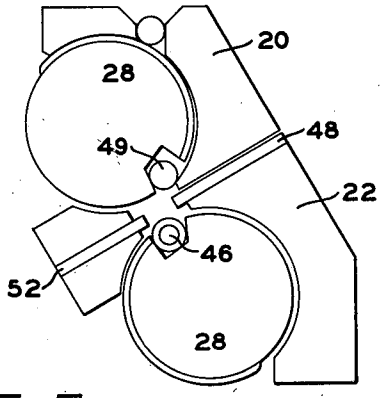


Fig. 9

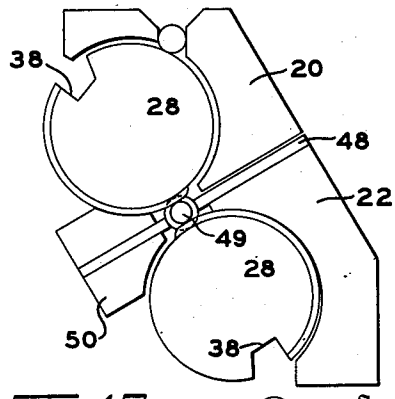


Fig. 10

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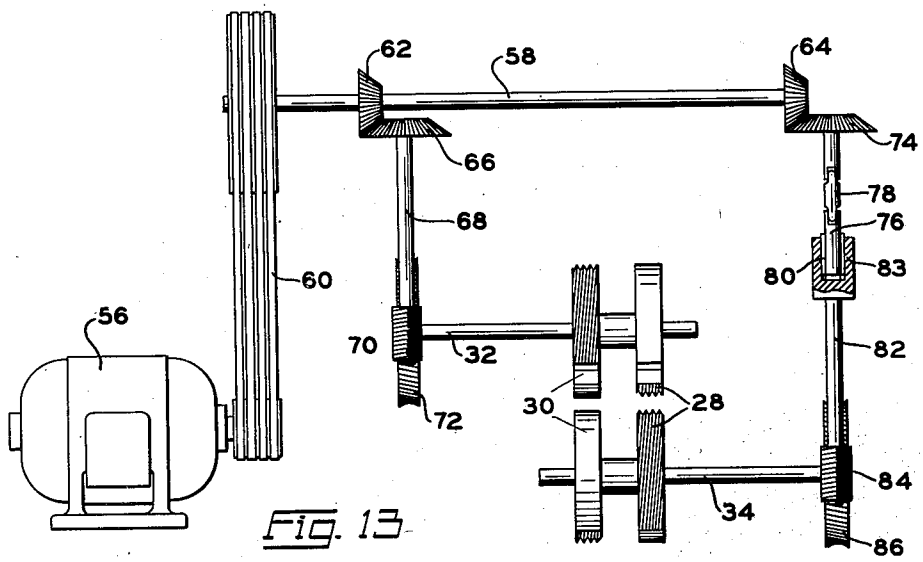


Fig. 13

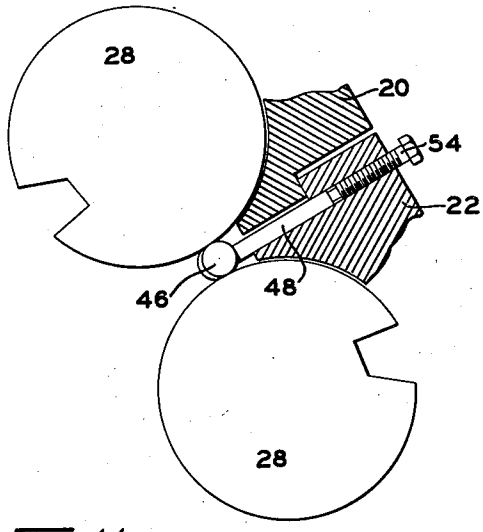


Fig. 11

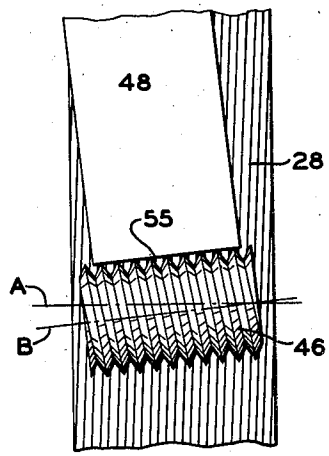


Fig. 12

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FIG. 15

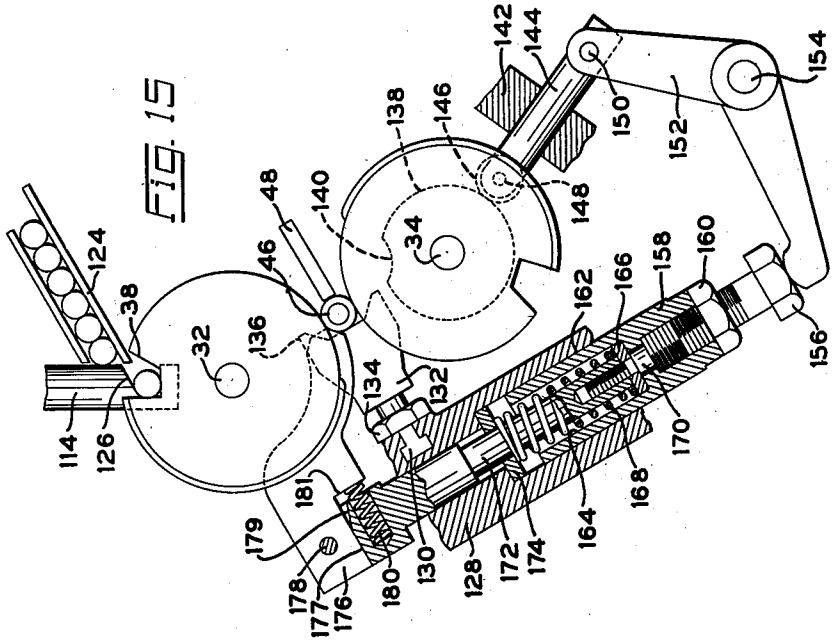
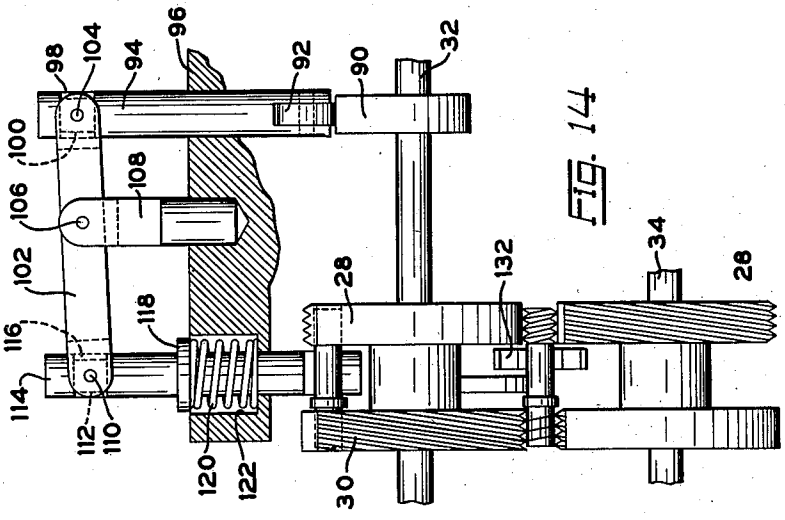


FIG. 14



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Patented Mar. 24, 1953 2,632,345

UNITED STATES PATENT OFFICE

2,632,345

APPARATUS FOR FORMING RODS, BOLTS, OR THE LIKE

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Application January 16, 1946, Serial No. 641,575

7 Claims. (Cl. 80—6)

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This invention relates to an improved method and apparatus for forming rods, bolts or the like and contemplates the rapid quantity production of such articles, with one or more parts thereof having an accurate predetermined structural configuration. While the machine or apparatus has certain of the general characteristics of a centerless grinding machine, in the operation of the present invention, the desired form is not produced upon the work blank by a grinding action, but by the displacement of the metal stock of the work blank under pressure contact of peripheral forming means provided on opposed rolling or rotating die members.

It is one of the principal objects of my invention to provide a novel method of producing the desired form on the work blank which comprises rotating the die members in the same direction in pressure forming contact with the blank and progressively and equally displacing the metal in the relative rotation of said die members and blank during a portion of the revolution of said members, with a following forming operation upon the displaced metal in the continued revolution of the die members. This method has been found particularly desirable for accurately forming a clean screw thread on the work blank having the required helix angle and pitch diameter.

Another object of the invention is to provide a method of machine rolling the desired form in the work blank between rotating pressure dies in which the work blank is transferred from a work receiving station through a circumferential path between one of the die members and the machine frame to a work forming station between the die members and the formed or finished work blank is transferred through a circumferential path between the other of said members and the machine frame from the work forming station to a discharge station.

A further object of the invention is to provide a machine having multiple sets of thread rolling dies capable of rolling screw threads having the same or different structural characteristics on different portions of a single work blank in each revolution of the die members. Thus a desirable economy is realized and the additional time, labor and expense involved in forming each thread on the work piece in a separate machine operation is obviated.

A more particular object of the invention resides in the provision of the forming dies with work receiving pockets or notches so that the threading dies will also function as transfer members for transferring a work blank from a

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receiving station to a work forming station and from the work forming station to the discharge station respectively. Thus the relatively complicated transfer mechanisms found in former machines of this kind are eliminated, greatly simplifying the machine construction and reducing maintenance expense to a minimum.

It is also an additional object of the invention to provide simple and easily adjustable means for correcting the position of the work blank between the thread rolling dies to produce a tapered or non-tapered thread thereon.

The invention further comprehends the provision of simply constructed and positively operated means for singly delivering work blanks from a magazine at the work receiving station of the machine and also for removing or displacing the finished work piece from the thread rolling station.

With the above and other subordinate objects in view, the invention comprises the method and apparatus for forming rods, bolts and the like, as will hereinafter be more fully described, illustrated in the accompanying drawings and subsequently incorporated in the subjoined claims.

In the drawings, wherein I have illustrated several simple and practical embodiments of the present invention and in which similar reference characters designate corresponding parts throughout the several views:

Figure 1 is a semi-diagrammatic elevation showing essential parts of the machine, and a preferred mounting or arrangement of the work forming dies therein;

Figure 2 is a front elevation;

Figure 3 is a detail side elevation of one of a pair of opposed dies shown in Figures 1 and 2;

Figure 4 is a similar side elevation of one of the other pair of dies shown in Figure 2;

Figure 4A is a semi-diagrammatic view illustrating a modified form of the thread rolling dies.

Figures 5 to 10, inclusive, are semi-diagrammatic views similar to Figure 1 illustrating successive stages in the cycle of operation of the machine;

Figure 11 is a detail elevation partly in section showing the adjustable work rest blade associated with each pair of dies for correcting taper of the work piece;

Figure 12 is a fragmentary plan view of one of the dies and the adjustable work rest blade disposed in the position shown in Figure 11;

Figure 13 is a semi-diagrammatic view showing one form of driving mechanism for the work forming dies;

Figure 14 is a front elevation partly in section illustrating the mechanism at the work receiving station; and

Figure 15 is a side elevation partly in section more particularly illustrating the mechanism for directing the work blank to and positively displacing the furnished work piece from the work forming station.

Referring first to Figures 1 and 2 of the drawings, upper and lower shafts 32 and 34 respectively are suitably journalled in the machine frame. Preferably these shafts are also laterally spaced apart so that the center line A intersecting the axes of said shafts is obliquely inclined at a substantial angle. The machine frame includes the two sections 20 and 22 respectively provided with the concave surfaces 24 and 26 substantially concentric with the respective shafts 32 and 34. In the embodiment of the invention which has been selected for purposes of illustration, on each of the shafts 32 and 34 axially spaced apart die members 28 and 30 are keyed or otherwise suitably fixed. These members are of general cylindrical form and are retained in spaced apart relation by the sleeves 36 on the respective shafts 32 and 34. From reference to Figure 2 it will be noted that the die members 28 and 30 respectively on the two shafts are disposed in vertical alignment to thereby provide axially spaced pairs of peripherally opposed dies for operation upon individual work blanks or upon different portions of the same work blank. It will of course be evident that the number of pairs of cooperating die members might be further multiplied, with the proper relative location of the peripheral work forming means on said pairs of dies, to successively produce the desired forms on spaced sections of the work blank in each revolution of said dies. As seen in Figure 1, the corresponding die members 28 and 30 are peripherally opposed to the concave surfaces 24 and 26 respectively of the frame members and, in cooperation therewith, form circumferential transfer paths for the work piece, as will be later explained.

In the illustrated embodiment of the invention, the dies 28 and 30 in each pair serve the dual purpose of transferring the work blanks to and from the work forming station between the dies and also producing the desired structural form on the work piece. For the latter purpose, in the present instance, the dies in each pair are provided with peripheral means for forming a continuous screw thread on the work blank. However, it will be understood that the die members may be provided with other forming means for knurling the work blank or producing a peripheral surface thereon of any desired predetermined configuration.

To the above end, each of the die members 28 is provided with a notch 38 opening upon the periphery thereof, and which is of sufficient depth to receive and retain a work piece for rolling contact with the concave frame surfaces 24 and 26 respectively in the work transfer operation of the dies. As shown in Figure 1 of the drawings, the shafts 32 and 34 and the die members mounted thereon are rotated in a clockwise direction and at equal speed. Therefore, each of the dies 28 is provided upon its periphery with a predetermined number of thread forming serrations 40, beginning at one side of the notch 38 and extending therefrom in a counter-clockwise direction for approximately 180° of the circumference of the die. These serrations are of the same general cross-sectional form throughout their length, and

are circumferentially continuous without interruption or structural deformation of any kind.

As the screw thread must be gradually formed on the work piece as it is subjected to rolling pressure between the dies 28, the starting or leading ends 41 of the serrations 40 have an outer diameter which is such that, when these peripheral portions of the two die members are in substantially opposed relation, an unthreaded work blank will fit loosely therebetween. The outer and inner diameters of the thread serrations 40 are parallel and gradually increase or extend eccentrically with respect to the die axis to an intermediate point in their length. From this point, to the other ends 43 of the serrations 40, the major and minor diameters of said serrations are constantly parallel and concentric to the die axis and when the work piece completes slightly more than one revolution beyond said eccentric portions the thread will be fully formed on the work piece. During the latter peripheral travel of the die members relative to the work piece, no further radial displacement of metal takes place but the flanks of the thread thereon are smoothly finished to provide a final thread on the work piece of the required predetermined size and form. As is well understood in the art, the diameter of the blank upon which the thread is to be rolled is approximately half-way between the major and minor diameters of the resultant thread. Since it is evident that the work piece is rotated in a counter-clockwise direction between the dies at a relatively high speed, the finished thread will have been formed to its full depth on the work piece in approximately 180° of peripheral travel of the die members. The remaining cylindrical circumferential surface 39 of each die 28 is concentric with the axis of rotation and is of such diameter, that when these portions of the two die members are in opposed relation, a finished work piece will fit loosely therebetween.

It will be apparent from the above description that after the work blank has been introduced to rolling position between the dies 28, a completely finished thread is rolled thereon during the first half revolution of said die members while the following half revolution of said die members is idle with respect to the work piece.

As shown in Figures 2 and 4 of the drawings, each die member 30 is also provided with a work receiving notch or recess 42 substantially identical in form or shape with the notch 38 in the corresponding die member 28. Each of these die members is also provided with a predetermined number of peripheral thread forming serrations 44, but it will be noted, from reference to Figure 4, that in this case, the starting or leading ends 41' of said serrations are located substantially, diametrically opposite the work receiving notch 42 and merge into the cylindrical surface 47. As in the case of the dies 28, the outer and inner diameters of the serrations 44 progressively increase in the counter-clockwise direction with respect to the die axis from the leading ends 41' to a point intermediate of their ends and continuing from this point said major and minor diameters are concentric to said axis to the clockwise side of the notch 42 to fully form and finish the thread, as indicated at 45. The cylindrical surface sections 47 of die members 30 extending from the leading ends 41' of the serrations 44 to the counter-clockwise side of notches 42 loosely receive an unthreaded part of the work blank therebetween when said surface sections are in opposed relation.

Of course, as is clearly seen in Figure 2 of

the drawings, the thread forming serrations upon all of the die members are disposed at an angle with respect to the axis of rotation which is substantially equal to the helix angle of the thread to be formed on the work piece. As the diameter of the dies is usually much greater than that of the work piece, multiple serrations are provided on the dies for the required number of starts necessary to create the correct helix angle, and therefore thread lead on the work. Thus, if the pitch diameter of the finishing thread on the dies is five times the pitch diameter of the thread on the finished work, then a quintuple or five start forming thread must be provided upon the thread rolling dies.

Referring again to Figure 2 of the drawings, it will be noted that the two die members **28** and **30** are mounted on the respective shafts **32** and **34** with the notches **38** and **42** respectively thereof in the same radial position relative to said shafts and therefore in alignment with each other axially of the shaft. The threading serrations **40** and **44** respectively adjoin the notches **38** and **42** at relatively opposite sides thereof. Therefore, while a thread is being produced upon one portion of the work blank between the dies **28**, an axially spaced portion of the work blank rotates loosely between the dies **30**. Thus when the dies **28** have completed the rolling of the thread on one portion of the work blank **46** and continue to rotate idly with respect thereto, a second thread is being formed on the portion of the work blank **46** disposed between die members **30**. By providing appropriate thread forming serrations on the two sets of die members, this arrangement permits the threading of widely different diameters on the same work piece with different thread pitch and lead, which would obviously be impossible if the attempt were made to simultaneously roll both threads on the work piece.

Of course, if it is desired to roll only one thread on the work blank, the other pair of die members may be formed with entirely cylindrical peripheral surfaces to serve as guides if the work blank is of considerable length, or they may be removed from the machine, if the work blank is short. As heretofore noted, additional pairs of dies may be mounted on shafts **32** and **34** with the thread forming portions of the respective pairs of dies so arranged that only one section of the work blank will be threaded at any given time, and the threading of all sections completed in a single revolution of the die members. Further, it will be apparent that in providing a single thread on a work piece, using a single pair of dies, the threading serrations on the dies may extend continuously around the circumference thereof except for that portion occupied by the work transfer notch. Also, if desired multiple work transfer notches may be provided in the dies so that a number of work pieces may be successively threaded by the serrations extending between the notches in a single revolution of the die members.

In Figure 4A of the drawings, I have shown a modified form of the thread rolling dies in which only one die **28***a* has thread forming serrations **40***a* similar to those of the die **28** shown in Figure 3. The other die member **28***b* is provided with serrations **40***b* on approximately 180° of its periphery the major and minor diameters of which are concentric to the die axis throughout the length of the serrations. In forming the eccentric portions of the serrations **40***a* all allowances are made so that a full depth thread is progressively formed on the work blank as the latter is rotated in a partial revolution of the die member **28***a* in the manner above described. The work blank is also urged laterally against the serrations **40***b* of the die member **28***b* so that these serrations aid in forming and finishing the screw thread on the work piece.

As seen in Figure 1 of the drawings, a work rest blade **48** is disposed between and suitably mounted upon one of the frame sections **20** or **22**. In this instance I have shown said blade mounted on frame section **22** and disposed in a plane substantially normal to the center line A between the axes of shafts **32** and **34**. In opposed relation to the blade **48** a fixed guide blade **52** is suitably supported in another section **50** of the machine frame.

The work rest blade **48** is so adjusted relative to the center line A of the dies that the high speed rotation of the work piece in a direction opposite to the rotation of the dies produces a force component tending to constantly urge the work piece laterally and hold the same in contact with the adjacent edge of the blade **48** so that the axial center line B of the work piece and the point of tangential contact of the dies therewith is slightly spaced from the center line A of the dies towards the blade **48**. Thus the possibility of undesirable relative movement between the dies and the work piece is eliminated. A work rest blade **48** and a guide blade **52** is provided for each pair of dies, and it will be understood, that the beginning of the threading operation, the work blank is of substantially smaller diameter than the space between the blades **48** and **52** so as to allow for the increase in work diameter resulting from displacement of the metal stock in forming the thread.

In Figure 11 of the drawings, I have shown means for individually adjusting the work rest blades **48** associated with the respective pairs of threading dies so that the taper of the work piece being threaded between one pair of dies may be corrected without disturbing the situation existing between the other pair of dies. For this purpose, a number of screws **54** are adjustably threaded in the frame member **22** and by relatively adjusting said screws, the inner end **55** of the work rest blade having contact with the work piece, may be disposed at any desired predetermined angle relative to the axes of the die members as shown in Figure 12. These adjusting screws of course prevent any movement of the blade **48** in a direction perpendicular to the center line A of the dies. It will be apparent that by properly adjusting the blade **48**, the work piece will be positioned between the dies with its axis at one end thereof disposed closer to the center line A of the dies than at the opposite end of the work piece. Thus the end of the work piece nearest to the the center line of the dies will be compressed to a relatively small diameter which progressively increases with the divergence of the work piece axis from said center line to the opposite end of the work piece.

While any preferred means may be provided for driving the work forming dies, in Figure 13 of the drawings, I have shown for this purpose a suitable motor **56** which transmits power to a shaft **58** by means of belts **60**. This shaft carries spaced bevel gears **62** and **64** respectively, the former being in constant mesh with a bevel gear **66** on the shaft **68** disposed at right angles to

shaft 58. The shaft 68 carries a worm 70 having driving engagement with worm wheel 72 suitably secured to the die driving shaft 32. A shaft 76 having one or more universally jointed sections 78 is driven by a gear 74 which is in constant mesh with the gear 64. One end portion of the shaft 76 is provided with splines 80 slidably engaged with similar splines internally formed on the telescoped tubular end 83 of a shaft 82 which drives the other die carrying shaft 34 through worm 84 and worm wheel 86. Thus the flexible shaft 76 permits the shafts 32 and 34 to be angularly adjusted relative to each other and maintained in exact parallelism despite unequal wear of the shafts and their bearings while the telescopic connection 83 between shaft 76 and shaft 82 enables the distance between the axial centers of shafts 32 and 34 to be varied in accordance with work of different diameters.

In Figures 5 to 10 of the drawings, I have diagrammatically illustrated the successive stages in a complete operating cycle of the machine, to which reference should now be had. The work blanks are supplied at the top of the machine by means of any suitable automatic device of the hopper or magazine type to the entrance opening 88. When the notch 38 in the upper die 28 arrives at the position shown in Figure 5, the work blank drops through the opening 88 into said notch. It will of course be understood that if spaced sections of a long work blank are to be threaded, one end of the blank will be received in the notch 42 of the corresponding die member 30. In the continued clockwise rotation of the upper die, the work piece is moved downwardly by said die in a circumferential path in rolling contact with the surface 24 of frame member 20, until the notch 38 arrives at the position seen in Figure 6 when the work blank 46 will drop downwardly from said notch into a position between the work rest blade 48 and the guide blade 52.

It will be noted that at this time the notch 38 of the lower die 28 has arrived at a position beneath the inner opposed ends of the blades 48 and 52 somewhat ahead of the notch in the upper die so that the work blank positioned between the blades 48 and 52 rests upon the leading ends 41 of the thread forming serrations 40 on the lower die 28. The thread rolling operation now begins in the continued rotation of the dies upon that part of the blank which is disposed between the dies 28, it being understood that the other portion of the blank 46 between the dies 30 is idly rotating between the cylindrical portions of the latter dies. Figures 1 and 7 of the drawings show the threading operation somewhat more than half completed. As the dies continue to rotate, the threading of the blank section between dies 28 is completed with a final forming and finishing operation of the thread as above explained. The other pair of dies 30 now begin to form a thread on the other portion of work piece 46, during which time the finished thread on the work piece idly rotates between the cylindrical portions of dies 28 as shown in Figure 8 while a second work blank 49 enters the notches in the upper dies 28 and 30. In the final half revolution of the dies, this second threading operation on the work piece between dies 30 is completed, at which time, as shown in Figure 9, the notches in the lower die members 28 and 30 arrive beneath the thread rolling station and the threaded ends of the work piece 46 drop into said notches while work blank 49 is at the point of release from the notches of the upper dies 28 and 30 to drop into the space between the blades 48 and 52. In the succeeding first half revolution of the upper and lower dies, as work blank 49 is threaded by the dies 28, the finished work piece 46 is transferred in a circumferential path and in contact with the surface 26 of frame member 22 and discharged from the machine as seen in Figure 10, approximately at the time that the formation of the thread on work piece 49 is completed by the dies 28.

In Figures 14 and 15 of the drawings I have shown mechanism for positively singly delivering work blanks from a magazine to the work receiving notches of the upper die members instead of by gravity and also for positively ejecting the finished work piece from the work forming station into the transfer notches of the lower die members. On the drive shaft 32 of the upper dies a cam 90 is suitably fixed and has peripheral contact with a roller 92 mounted in the lower end of a rod 94 vertically movable through a suitable guide opening in part 96 of the machine frame. At its upper end, opposite sides of this rod are provided with rectangular grooves or channels 98 receiving the slidable blocks or shoes 100 pivotally mounted on the inner sides of the arms of the bifurcated end of a lever 102, as shown at 104. This lever intermediate of its ends is pivotally mounted as at 106 upon the upper end of a post 108 fixed in the frame part 96.

The other end of lever 102 similarly carries the blocks or shoes 112 mounted on pivot pins 110, said shoes being slidable in the horizontal grooves or channels 116 in opposite sides of a plunger rod 114, the lower end of which is movable between the upper die members 28 and 30.

A collar 118 on the rod 114 bears upon the upper end of a compression spring 120 mounted in recess 122 in the frame part 96. This spring constantly urges plunger 114 upwardly, therefore transmitting downward movement to rod 94 and maintaining resilient contact of roller 92 with the periphery of cam 90.

The lower end of the plunger 114 is vertically movable in closely adjacent relation to the egress end of an inclined chute or magazine 124 for a column of work blanks, as seen in Figure 15 of the drawings. This end of the plunger is formed with a notch or recess 126 which, in the normal raised position of the plunger rod 114, receives the lowermost blank from the chute 124. Either manual or automatically operated means may be provided for loading the magazine chute.

It will be understood that the cam 90 is so arranged on shaft 32 and is of such configuration, that at the time the notches 38 and 42 of upper dies 28 and 30 arrive at the position shown in Figure 15 said cam forces rod 94 upwardly and moves plunger 114 downwardly against the resistance of spring 120 to carry a single work blank below the egress end of chute 124 and position the ends thereof in the notches of said die members, from which it is carried and transferred to the work forming station by said upper die members in the manner previously explained. The cam 90 then permits the spring 120 to force plunger rod 114 upwardly returning the same to its original position to receive another work blank from chute 124.

As seen in Figure 15 of the drawings, the work guiding member 52 above described has been replaced by the guide member 132 having a stem provided with a T-shaped head for engagement in a T-slot 130 formed in the machine frame part 128 which corresponds to the frame section 50 previously referred to. As seen in Figure 14, the member 132 extends vertically between the upper

and lower pairs of dies and after adjusting the same laterally along the T-slot 130, it is locked in position by means of a nut 134. An upwardly extending wing 136 of this guide member has an inclined edge surface facing the direction from which the work piece 46 arrives at the threading station between the dies. Contact of the work piece with this wing of the guide member results in the work piece being positively removed or displaced from the notches in the upper die members 28 and 30, assuring its proper deposit in threading position between the upper and lower die members.

I have also provided a mechanism for positively forcing or ejecting the finished work piece from the threading station into the notches of the lower die members. For this purpose, cam member 138 is suitably fixed to shaft 34 and is of concentric circular outline except for the notch or cavity 140 formed in the periphery thereof. An axially movable follower rod 144 is mounted in frame part 142, and roller 146 journalled on pin 148 in one end of this rod is in constant contact with the periphery of cam 138. The opposite end of the rod 144 is pivotally connected as at 150 with one arm of a bell crank lever 152 journalled on fixed pivot 154 suitably secured to the machine frame. The other crank arm has bearing engagement at its extremity against the head of the screw 156 which has threaded engagement in the lower end of a sleeve 158 and is adjustably locked in position relative thereto by nut 160.

The sleeve 158 has axial sliding movement in a bore 162 formed in the frame portion 128. The upper end portion of the sleeve 158 has a cylindrical bore 164 receiving a washer member 166 and a spring 168. A screw 170 secures washer 166 to the lower end of a rod 172. A washer 174 is seated in the upper end of bore 164 in the frame part 128 around the rod 172 so that the spring 168 is held under compression between said washer and the washer member 166 to constantly urge sleeve 158 and rod 172 downwardly and hold roller 146 in contact with the cam 138.

The rod 172 at its upper end is formed with a rectangular enlargement which is bifurcated to receive one end of an ejector member 176 mounted upon the pin 178. This ejector member projects inwardly between the upper die members 28 and 30 in a downwardly extending arc, as seen in Figure 15, and is yieldingly held in its normal position by means of a spring 180 carried by the rod 172 and bearing at one end against a shoulder 181 on the ejector member 176. In this normal position the ejector member 176 is constrained by the force of spring 168 to press at its free end against the work piece 46. This pressure however is very light due to the limiting action of spring 168 and bell crank lever 152. Rocking movement of member 176 in counterclockwise direction on the pin 178 from its normal position is prevented by contact of the outer end of said member against the abutment surface 177 of rod 172 at one side of the pivot pin 178. At the opposite side of said pin, the end of rod 172 has a bevelled surface 179 permitting of limited clockwise movement of the member 176 against the resistance of spring 180 for a purpose which will presently appear.

It will be apparent from the above that when the depression 140 of the cam 138 receives roller 146 and allows the crank 152 to rotate, the pressure of spring 168 urges the ejector 176 downwardly as a unit with rod 172 and causes said ejector to force the workpiece downwardly into the notches of the lower die members 28 and 30. The return of the ejector 176 to its normal position occurs when roller 146 moves out of the cavity or depression 140 in the cam member, thereby compressing the spring 168 as the screw 156 and sleeve 158 are forced upwardly by the crank 152. In this upward movement of the member 176, the spring 180 permits the inner free end of said ejector member to move downwardly to clear the second workpiece which has arrived at the thread rolling station while the finished workpiece was being ejected and discharged.

By the provision of such automatically operating mechanism as above described, rapid and positive transfer of the workpiece from the receiving to the working forming station and from said station to the discharge station is insured, while the cutting dies may be operated at higher speeds than would otherwise be permissible.

From the foregoing description, it will be appreciated that I have provided a very novel method and apparatus whereby the quantity production of rods, bolts and similar workpieces having one or more parts thereof provided with screw threads or other desired structural formations, may be greatly expedited. By utilizing the rotating die members for the purpose of automatically transferring the workpiece between the several machine stations in closely timed relation with the thread forming operations of the die members, the time loss incident to the use of separate transfer mechanisms for discharging the finished workpiece from the machine and for transferring a new workpiece from the hopper or other supply source to the work forming station, are avoided. In the forming of a screw thread on a workpiece, the novel construction of the threading serrations on the die members insures an accurately formed and perfectly finished thread on the workpiece. The adjustable work rest between the die members for accurately positioning the workpiece to correct or control the taper thereof is also an important feature of the invention. The mechanism for insuring the positive displacement of the workpiece relative to the dies to and from the work forming position enables the machine to be operated at maximum speed and is therefore a material aid to large quantity production. Finally it will be noted that the described apparatus provides a very compact and efficiently operating organization of the several mechanical parts, the initial production cost of which is comparatively low while the operating and maintenance expense thereof is reduced to a minimum.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. In apparatus for sequentially threading axially spaced portions of different diameter on a work blank, a plurality of pairs of dies, means mounting the dies of each pair in peripherally opposed relation and mounting the corresponding dies in each pair for unitary rotation in axially

spaced apart relation, said corresponding dies each having a smooth peripheral portion and having work forming means of relatively different diameters extending partly about its circumference at relatively opposite sides of the axis of the respective dies for pressure forming contact at different times with different axially spaced portions of a work blank positioned between the dies in each pair, said forming means on the dies in one pair simultaneously operating upon one of said portions of the work blank while the other of said portions of said work blank are supported by said smooth peripheral portions of said other pairs of dies, means for rotating said pairs of dies in the same direction at equal speeds, and means carried by said corresponding dies respectively operable to transfer a work blank from a receiving station to forming stations between the dies of the respective pairs, and to transfer the formed work blank from said forming stations to a discharge station.

2. The apparatus defined in claim 1, in which said transfer means comprises peripheral axially aligned notches in the corresponding dies receiving said spaced portions of the work blank.

3. In combination, upper and lower work forming dies in peripherally opposed relation and means for rotating said dies in the same direction, each of said dies having a peripheral work transfer notch, a member mounted for bodily angular movement relative to the dies and having means operable in one position thereof to hold the work blank in forming position between the dies, means for moving said member from the latter position to move the work blank from the forming position into the notch of the lower die, and means controlling the operation of said last named means operable in timed relation with the rotation of the dies.

4. In combination, upper and lower work forming dies mounted in peripherally opposed relation to provide a work forming station between said dies, means for rotating said dies, each of said dies having a peripheral work receiving notch, relatively movable means for directing a work piece from the notch in said upper die and supporting said work piece at the work forming station, and means for actuating said relatively movable means in timed relation to the rotation of the dies to release the formed workpiece for movement into the work receiving notch of the lower die.

5. In apparatus for forming a screw thread on a work blank, a machine frame, vertically spaced peripherally opposed dies rotatably mounted in adjacent relation to concentric guide surfaces on said frame and each having thread forming serrations extending partially about the circumference thereof, each of said dies having a peripheral work receiving notch immediately adjoining the leading ends of said serrations, and means for rotating said dies in the same direction and at equal speeds, said notch in the upper die transferring a work blank from a work receiving station in rolling contact with one guide surface on the machine frame, relatively stationary means for ejecting said blank from said notch in said upper die and delivering said blank between the leading ends of said serrations on the dies, and means moving in timed relation with the movement of said dies for moving a formed work piece away from the upper die and into the notch of the lower die for movement therewith in rolling contact with the other guide surface on said frame to a discharge station.

6. Apparaus for rolling screw threads of relatively different pitch on axially spaced parts of a work blank having different diameters, comprising two pairs of rotatably mounted dies axially spaced apart, with the dies in each pair in peripherally opposed relation and each die having thread rolling serrations extending about its circumference for not more than 180 degrees and of different diameter from the serrations on the other pair of dies, each die also having a smooth peripheral section extending about another portion of its circumference, said serrations on the axially aligned die members being disposed at relatively opposite sides of their axis of rotation, whereby the serrations of the respective pairs of dies have alternate thread rolling engagement with the spaced parts of the work blank disposed between the opposed die members during different periods of time, one of said parts of the work blank being supported for idle rotation between the smooth peripheral sections of the dies of one pair, while the other pair of dies is in thread rolling engagement with the other part of the work blank, and means for rotating the dies in each pair in the same direction and at equal speeds.

7. Apparatus for sequentially threading axially spaced portions of a work blank comprising, at least two pairs of dies, each of said dies having thread rolling serrations extending about a portion of its periphery for not more than 180° and having a smooth peripheral section extending about another portion of its periphery, said serrations of one pair of dies being of different diameters than the serrations on the other pairs of dies, rotatable mounting means for mounting the dies of each pair in peripherally opposed relation, each die of one pair being in spaced coaxial relation with a die of the other pairs, said mounting means being arranged to dispose the serrations on the said spaced coaxial dies at relatively opposite sides of the axis of rotation of said mounting means, and means for rotating said dies in the same direction at equal speeds whereby said work forming means of one pair of dies will be in pressure forming contact with one of said axially spaced portions of the work blank while the smooth peripheral portions of the other pairs of dies is in supporting contact with a different portion of said work blank.

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