United States Patent [19]

Lewis

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[54] **THREAD ROLLING APPARATUS**

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[73] Assignee: **Armco Steel Corporation,** Middletown, Ohio

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[52] **U.S. Cl.** **72/68,** 72/95, 72/419, 72/427

[51] **Int. Cl.** **B21b 15/00**

[58] **Field of Search** 72/68, 80, 94, 95, 419, 72/426, 427

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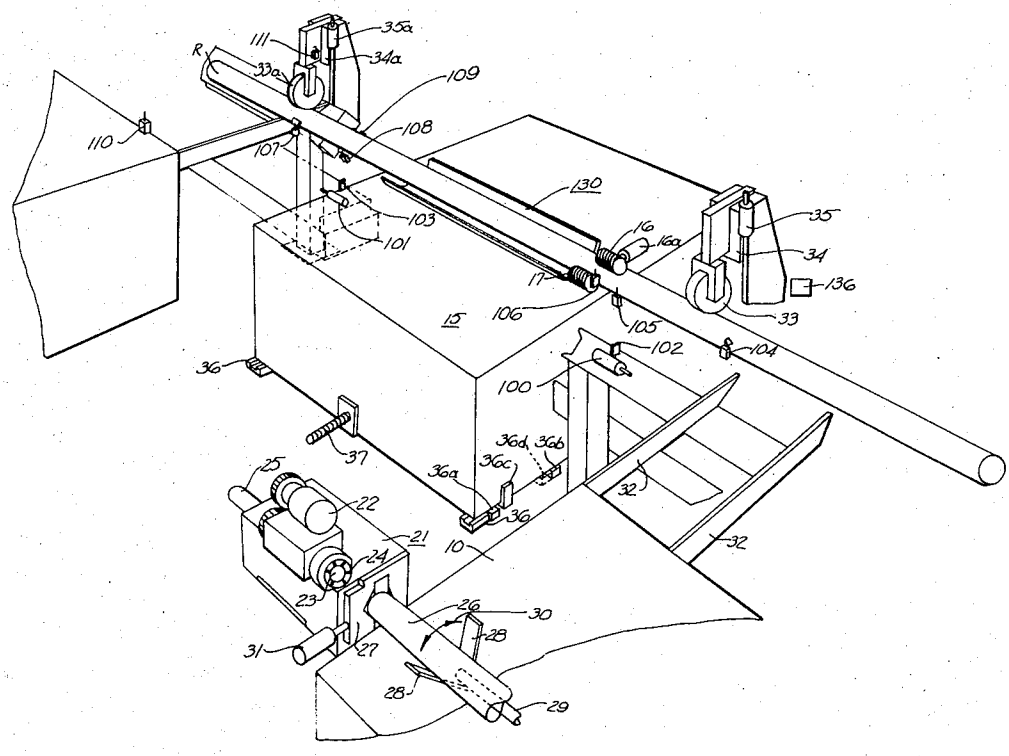
Primary Examiner—Charles W. Lanham
Assistant Examiner—D. C. Reiley, III
Attorney, Agent, or Firm—Melville, Strasser, Foster & Hoffman

[57] **ABSTRACT**

The application discloses an apparatus for rolling helical threads into rod or tube. The apparatus includes a stock table with which is associated a beveler to bevel the end of the rod to facilitate feeding into the thread rolls, a feed-in table, a thread roll table, a feed-out table, and a stock table onto which the threaded rod is discharged. The feed tables both in and out are substantially identical and comprise parallel rows of balls or rollers on which the rod rests, the banks of balls being movable in unison at a 45° angle to the vertical downwardly, outwardly, and away from the thread roll table. With the banks of balls in the lowermost position, the tables are arranged for the largest size rod to be threaded and when the banks are in the uppermost position, they are arranged for the smallest size rod to be threaded. A series of flip stops are provided for each nominal size of rod to be handled, so that the tables may be set automatically to the correct position for the particular size of rod to be threaded. The banks on the feed-in table are movable a small amount in opposite directions to shift the centerline of the rod to be threaded laterally, so that after the die plunge, the axis of the rod on the feed-in table will be colinear with the axis of the rod on the feed-out table.

The thread roll setup comprises one roll with a fixed axis and another roll arranged for movement toward and away from the fixed roll for die plunge. During die plunge the axis of the rod being threaded is shifted slightly by opposite movement of the banks on the feed-in table, automatically, to compensate for the plunge. The thread roll table is arranged for movement transversely of the axis of the rod for the accomodation of different sizes of rod to be threaded. Associated with both the feed-in and feed-out tables is a power driven feed roller which may be adjusted as to its angle to the axis of the rod and which may be raised and lowered to accommodate different diameters of rod. The feed rolls are synchronized with rod rotation, axle direction feed, and the helix angle setting, thereby avoiding excessive axle thrust which would either break the die threads or produce a product outside tolerances.

18 Claims, 17 Drawing Figures



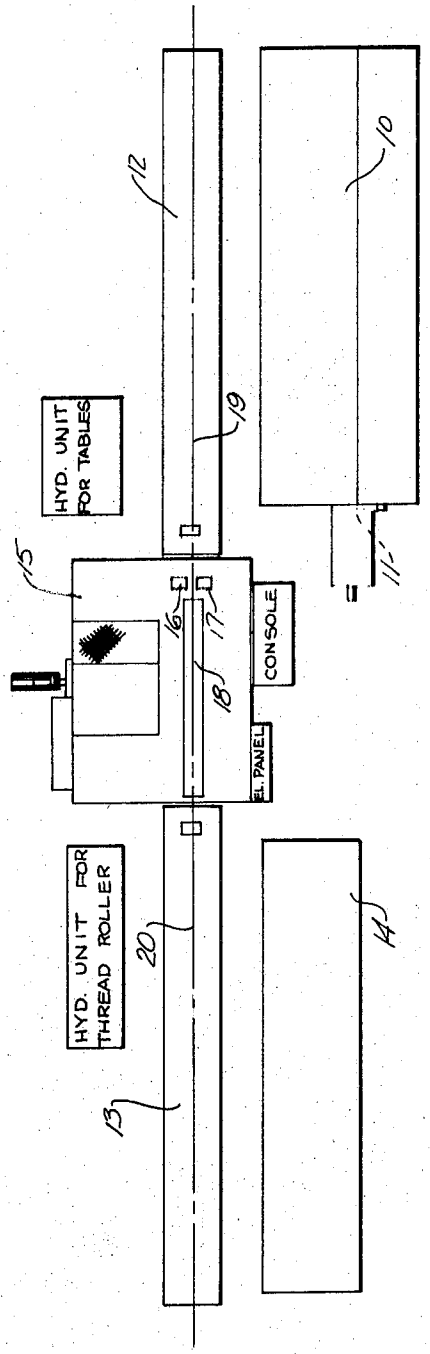

HYD. UNIT FOR TABLES
HYD. UNIT FOR THREAD ROLLER
CONSOLE
EL. PANEL
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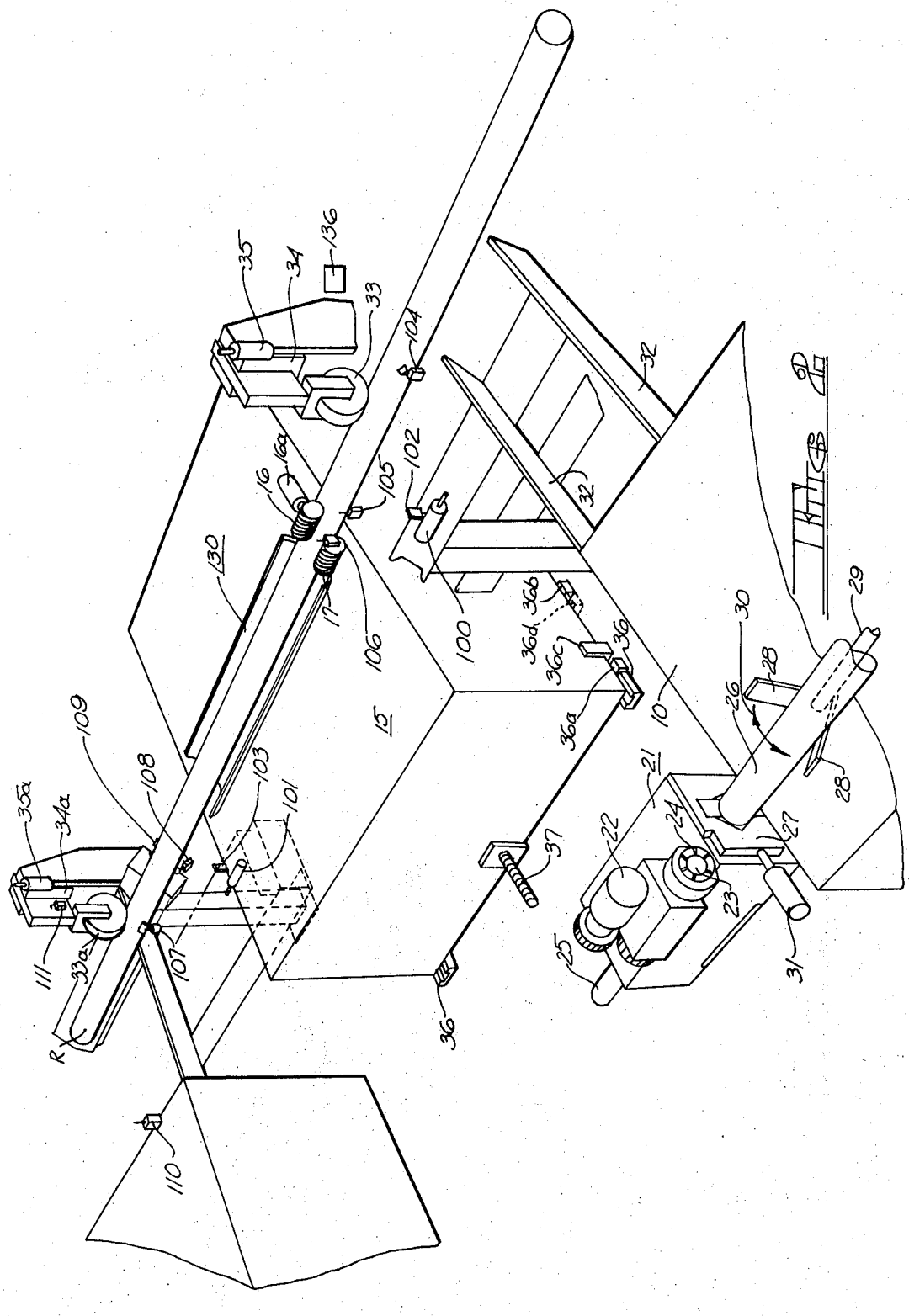
FIG. 1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109
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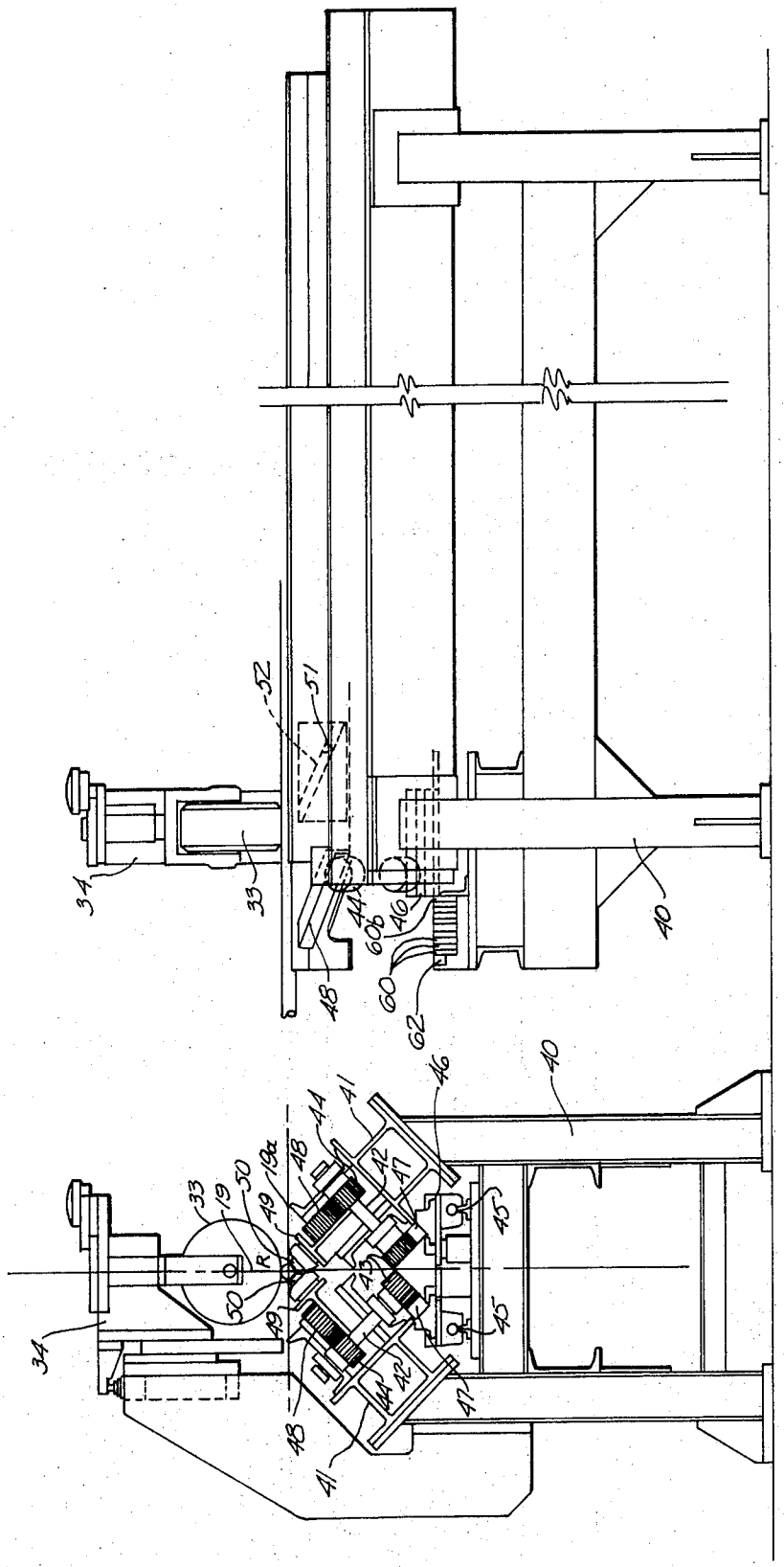

FIG. 4

FIG. 3

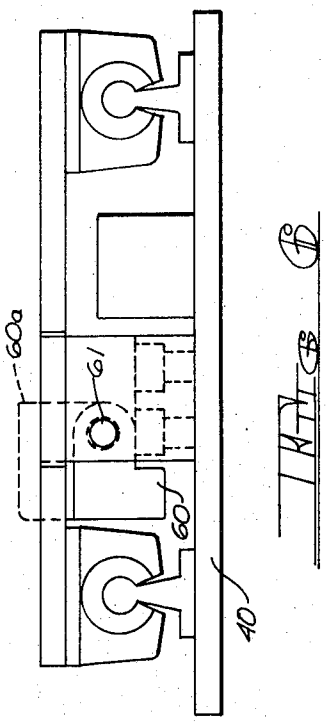

FIG. 6

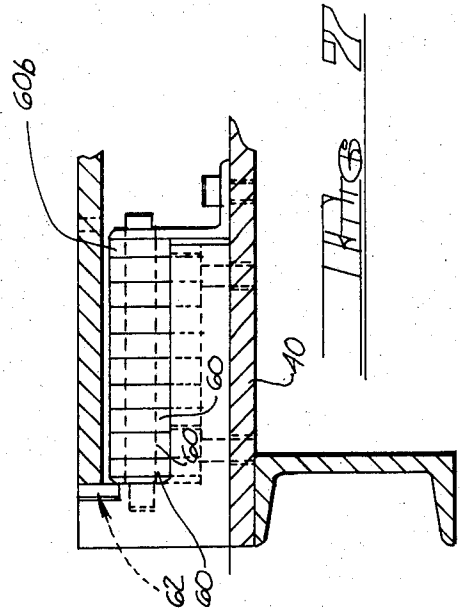

FIG. 7

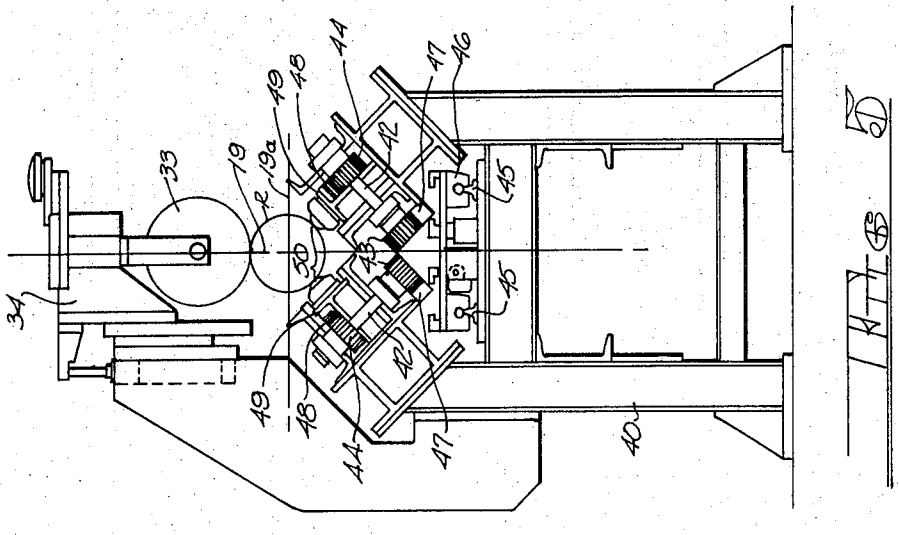

FIG. 5

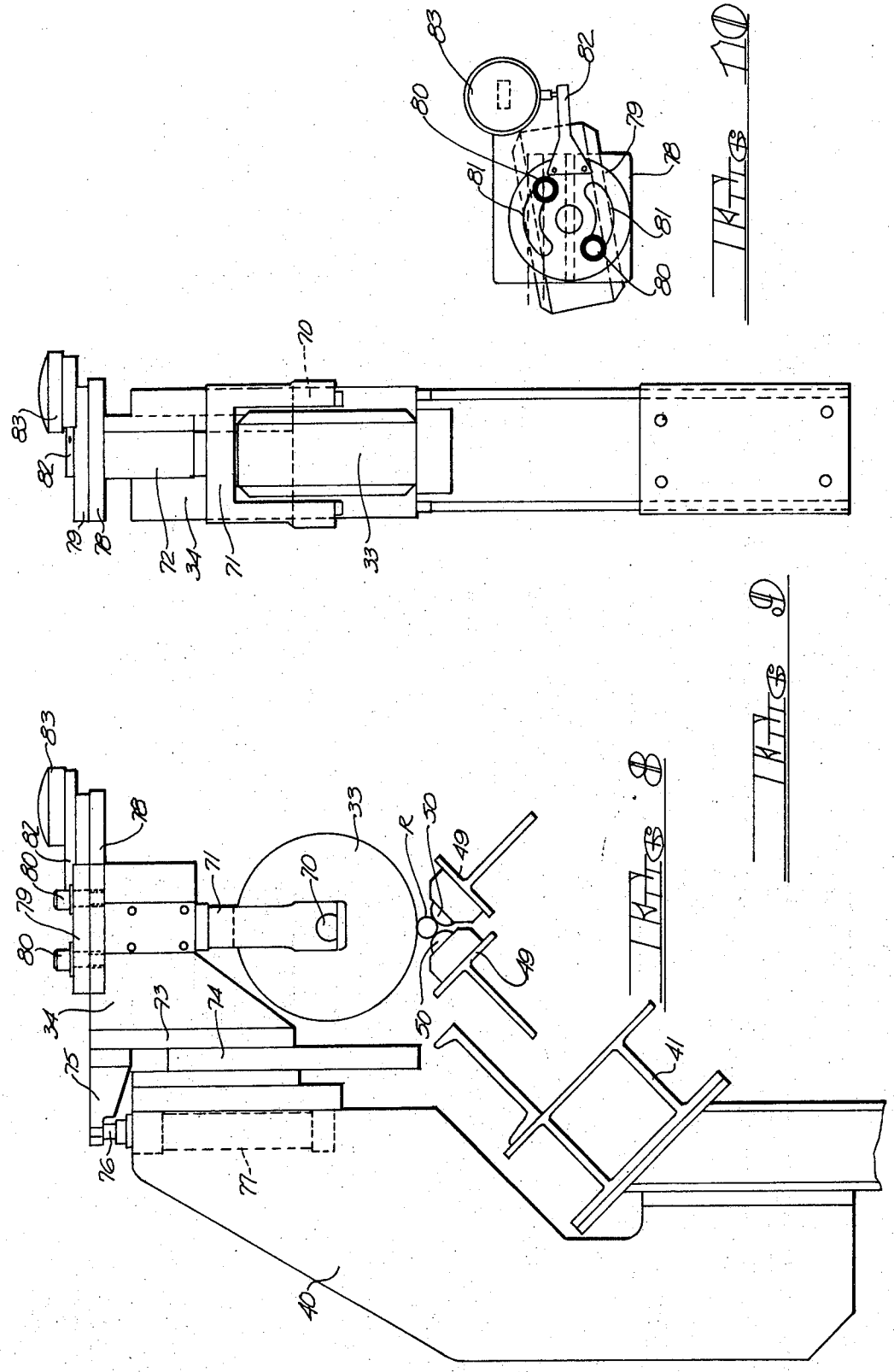
83
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FIG 10
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FIG 9
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FIG 8

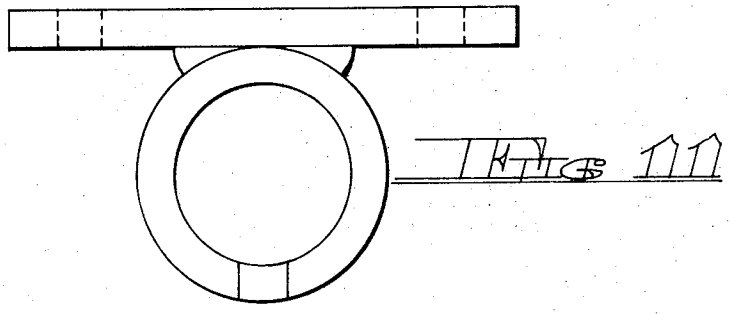


FIG 11

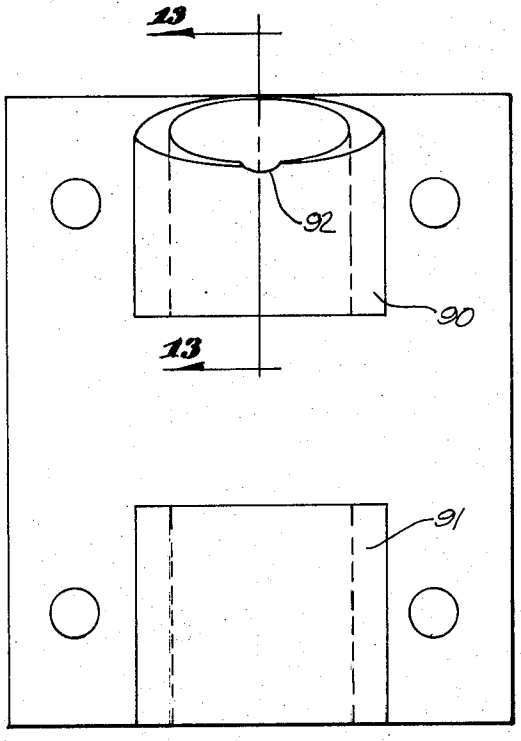


FIG 12

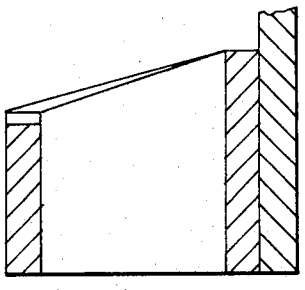


FIG 13

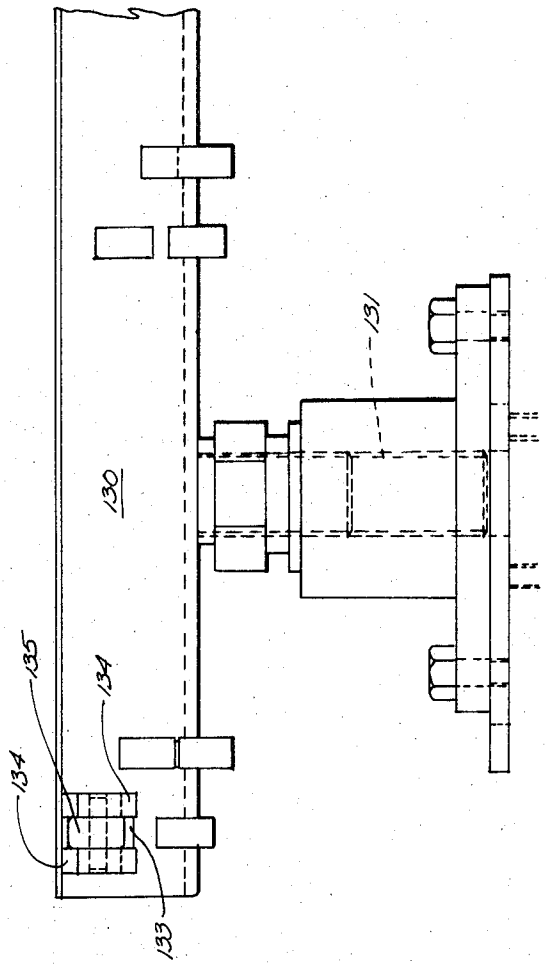


FIG 11D

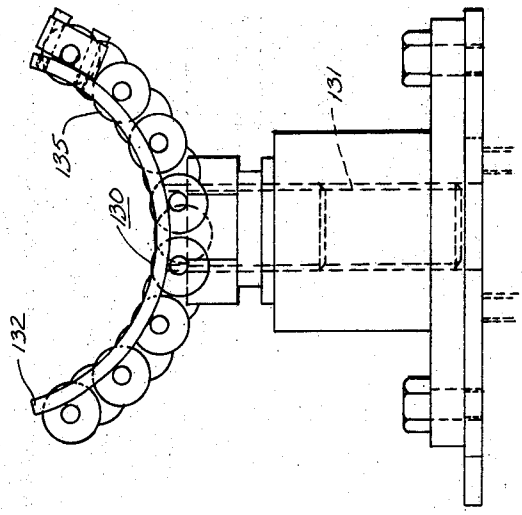
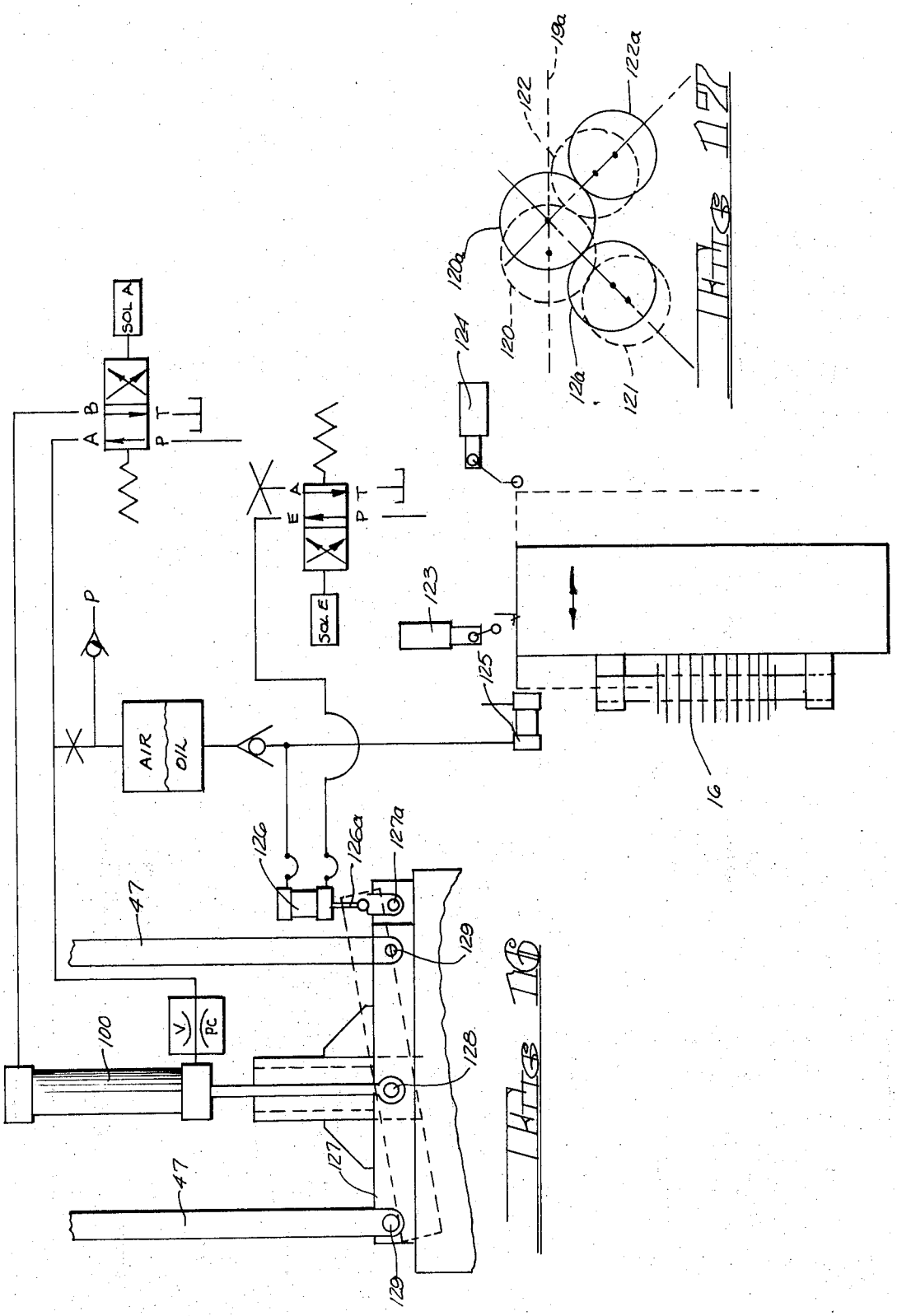


FIG 11A


SOL A
A B
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OIL
V
PC
100
47
47
126
126a
127a
127
129
129
128
123
125
16
120a
122
122a
124
120
121a
121

FIG 1D

FIG 1C

THREAD ROLLING APPARATUS

BRIEF SUMMARY OF THE INVENTION

In the past, in the roll forming of threads and the like in smooth wall rod, pipe, conduit, drums, etc., the feed has generally been manual and with power assist support rolls. There has never been means of controlling the positive feed rotation or the positive helix angle rotation and axle travel. While this is not too objectionable in light weight small diameter short length rod, even there a positive feed will produce best results. With large diameter rod and rod of considerable length, as for example twenty feet, these criteria become highly important. Excessive axle thrust will quickly break the rills in the roll forming threads or will affect the product beyond acceptable tolerances. There has also never been a satisfactory way of compensating for the die plunge motion which, as mentioned above, produces a shift in the axis of the rod. If, for example, threads of a depth of one-eighth inch are to be formed in a rod, the movable die must force the rod against the fixed axis die until the fixed axis die has plunged into a resulting depth of one-eighth inch and the movable die has also plunged into a resulting depth of one-eighth inch. Under these circumstances, the movable die is required to move a quarter inch and the axis of the rod is displaced one-eighth inch. According to the present invention, the axis of the rod is shifted laterally, automatically, to compensate for the die plunge.

In order to make the machine more versatile, it is desirable that rod of different diameters can be threaded without elaborate time consuming setup. According to the present invention, the feed-in and feed-out tables are arranged so that they comprise two banks of balls or rollers to support the rod and the banks of balls or rollers are arranged on tracks which are disposed at an angle of 45° to each other, and means are provided to move the banks along this plane outwardly, downwardly, and away from the thread roll table. In the lowermost position, the banks will accept the largest size rod to be threaded, and in the uppermost position they will accept the smallest size rod to be threaded. A series of flip stops are provided so that by flipping a suitable stop, the banks will automatically come down from their initial top position to the proper setting for a particular nominal rod size. The movement of the banks of balls is achieved by means of rack and pinion arrangements which will be described in more detail hereinafter.

This arrangement of the feed-in and feed-out tables provides for a constant initial location of the axis of the rod to be threaded regardless of its diameter. With the automatic lateral shift mentioned above, the axes of the rod in the feed-in and feed-out table will always be on the proper pass line of the thread roll after the plunge, regardless of the diameter of the rod to be threaded.

Associated with each of the feed-in and feed-out tables is a clamping and driving roller which is opposed to the sets of balls adjacent the die table end of the respective tables. This drive roller is arranged for up and down movement and for powered rotation of the wheel, and the axis of the wheel may be adjusted to provide the desired helix angle. In the present machine, the desired helix angle is set manually and then the drive roller is fed downward into contact with the rod hydraulically, and when the requisite pressure has been

attained, rotation of the drive roller is initiated. The roller therefore both rotates the rod and feeds it axially into the thread rolling dies.

At this point it should be mentioned that there are two kinds of thread rolling dies. The first is the so-called annular die which simply has annular rills with no helix angle. The other kind of dies are called combination dies and they actually have a helix angle to the rills so that they are really threads. In either case, the axes of the dies are skewed slightly in opposite directions vertically. With annular dies, the degree of skew is equal to the helix angle, and the driving and clamping rolls mentioned above are set to that same helix angle as skew angle. With combination type dies, the helix angle is preferably divided between the amount of skew of the die rollers and the thread die angle. Thus, for example, if it was desired to roll a helix angle of three degrees into the rod, the die rolls could have their axes skewed by one and a half degrees in opposite directions and a thread die angle of one and a half degrees could be selected. This would give the total helix angle required, of three degrees, and in this case the driving roller would be set at one and a half degrees also.

The banks of rolls on which the rod is supported are normally in their uppermost position in which they would accept the smallest size rod for which the machine is designed, say, for example, one inch diameter. If the rod is more than one inch in diameter, the banks of guide rollers on the feed-in and feed-out tables retract downwardly and outwardly and rearwardly to a position determined by the number of flip stops which are flipped into position for the nominal diameter of the rod to be threaded. After the rods are correctly positioned in their guide rolls, the feed and drive roller comes down to contact the rod and when suitable clamping pressure has been built up rotation is initiated.

It is extremely important that the speed of the entrance drive roll and the exit drive roll be synchronized with the speed of the thread dies. Each of these elements has a tach generator which sends a signal to a meter which reads in surface feet per minute. Because of the fact that dies wear and also the driving wheels (which are of hard rubber) wear, it is impossible to use revolutions per minute for this measurement. However, with a measurement with surface feet per minute read on the dials, the degree of roll wear or die wear does not affect the signal. Synchronization may of course be accomplished manually by observing the dials and controlling the speed until they are the same, or of course the synchronization can be done by means of a suitable servo mechanism if desired. The helix angle of the drive rolls may be adjusted for either right-hand threads or left-hand threads and the setting of the helix angle may be accomplished very accurately by means of an indicator which may be read to degrees and hundredths of degrees.

It has been pointed out that the banks of guide rolls move inwardly, forwardly and upwardly and this movement is compound, i.e. the forward movement is in proportion to change in diameter and the upward movement is in proportion to change in radius. For example, the net change in going from one inch diameter rod to six inch diameter rod being five inches, the carriage would move five inches rearwardly and two and a half inches downwardly. The angle at which they move downwardly and rearwardly is approximately twentysix

and a half degrees, and the angle at which they move outwardly is 45°. The beams on which the guide rollers are supported are disposed at a 45° angle and maintain their parallelism and the banks are guided by cam rollers in angularly disposed slots.

As mentioned above, the feed-in table and feed-out table are substantially identical. However, the guide rollers on the feed-in table are preferably balls, whereas on the feed-out table they may be rollers. One of the banks of rollers on the feed-out table is preferably provided with a separate actuating cylinder to move that bank by itself to raise it upwardly and forwardly so as to kick out a completely finished threaded rod after both banks have been raised to their top position. The banks on the feed-out table move in unison except during the kick-out. The banks on the feed-in table move in unison except during die plunge.

Preferably a stock table will be provided adjacent the feed-in table and stock will be fed to the stock table manually. Associated with the stock table is a beveling apparatus. Vee arms are provided to center a rod with respect to the beveling apparatus and means are provided to clamp the rod in position. The beveler is then caused to move toward the end of the rod and is rotated to cut a bevel on the end of the rod. The beveler moves up against a fixed stop and is permitted to run a few revolutions after the cut is completed so as to finish the bevel smoothly. Thereafter, the beveler assembly retracts and the Vee arms rotate so as to permit the rod to roll off onto the feed-in table. Preferably the stock table and feed-in table are separated by sufficient width to permit walk-through, and swing supports are provided for the rod to roll from the stock table onto the feed-in table. These stops swing by gravity to an operative position but may be moved aside if it becomes necessary to walk through between the tables.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

FIG. **1** is a diagrammatic plan view of the layout of the apparatus of the present invention.

FIG. **2** is a diagrammatic perspective view showing the various limit switches and cylinders and rolls necessary for operation of the apparatus.

FIG. **3** is an end elevational view of the feed-in table as seen from the left of FIG. **4,** showing the arrangement of the beams supporting the guide balls and the arrangement for raising and lowering them. In this Figure, the arrangement is for the smallest diameter rod to be threaded.

FIG. **4** is an elevational view of the structure of FIG. **3,** but with the beams in their lowermost position.

FIG. **5** is a view similar to FIG. **3** but showing the beams supporting the guide balls in their lowermost position for threading the largest diameter rod to be threaded.

FIG. **6** is an axial elevational view of the end of the lower portion of the feed-in table showing a flip stop.

FIG. **7** is an elevational view thereof.

FIG. **8** is a fragmentary view showing the arrangement of the drive roller seen in a view axially of the rod.

FIG. **9** is a view of the same seen transversely of the rod being threaded.

FIG. **10** is a top plan view of FIG. **8** showing how the helix angle of the drive roller is adjusted.

FIG. **11** is a plan view of one of the gudgeons for the swing arms.

FIG. **12** is an elevational view thereof.

FIG. **13** is a cross sectional view taken on the line **13—13** of FIG. **12.**

FIG. **14** is an end elevational view of a support cradle which is disposed between the thread rolling dies and the feed-out table.

FIG. **15** is a side elevational view thereof.

FIG. **16** is a diagrammatic view of the connection between the movable thread rolling die and the banks of rollers on the feed-in table for die plunge compensation.

FIG. **17** is a diagram to assist in understanding the lateral shift of the rod during die plunge.

DETAILED DESCRIPTION

Referring first to FIG. **1,** there is shown in plan somewhat diagrammatically the general layout of the apparatus. The stock table is indicated at **10.** Associated with it is the beveler **11.** Adjacent the stock table is the feed-in table **12** and at the opposite end of the apparatus is the feed-out or exit table **13.** Adjacent the exit table **13** is another stock table **14** where the completed work may be accumulated. The thread rolling apparatus is indicated generally at **15** and includes the thread rolling dies **16** and **17.** The pass line for the rod to be threaded is indicated at **18,** and it will be noted that after die plunge, and throughout the threading operation, the axis of a rod on the feed-in table **12** indicated at **19,** and the axis of a rod on the feed-out table **13** indicated at **20** are colinear with the pass line **18** regardless of the diameter of rods being thread rolled. It should be noted at this point that hereinafter where the term "rod" is used it is intended in the broadest sense to be inclusive of tubing and other cylindrical material on which threads are to be formed. The thread rolling apparatus **15** is mounted on ways transversely at the pass line so that it may be shifted to accommodate rods of different diameter. As long as rods of a given diameter are being threaded, the apparatus **15** is not adjusted.

Referring now to FIG. **2** which is likewise a diagrammatical representation of the entire apparatus, there is shown adjacent the stock table **10** the beveler indicated generally at **21.** This apparatus comprises a hydraulic motor **22** which drives a spindle **23** carrying a beveling cutter **24.** A cylinder **25** having a piston therein hydraulically feeds the cutter head toward the end of the piece of stock **26** which is to be beveled. A clamping device is provided at **27.** The stock table will preferably be provided with two or more Vee arms **28** mounted upon a shaft **29.** These arms are arranged to swing both ways as indicated by the arrow **30.** Thus, they may be swung toward the viewer so that a rod **26** may be rolled into the Vee arms whereupon they elevate to the position shown, in which position the rod **26** is centered with respect to the cutter element **24.** The clamp element **27** is also mounted on the beveler unit **21** so that as the beveler unit advances toward the end of the rod, the end of the rod projects through the clamping element **27** whereupon, by means of a suitable hydraulic cylinder **31,** the rod is clamped to position. The cutter continues to advance and bevels the end of the rod. It will come up against a stop so that a few rotations after hitting the stop will make the bevel smooth. Thereupon, the clamping element **27** releases, and the entire unit

21 retracts, and the Vee arms 28 on their rod 29 are tilted away from the viewer so that the bar or rod being worked upon can roll over the stock table to the feed-in table 12 (not shown in FIG. 2). In passing from the stock table 10 to the feed-in table 12, the rod rolls over the swing arms 32. These swing arms may be swung aside to permit personnel to walk between the stock table and the feed-in table and they will then automatically swing back to their work supporting position as shown in FIG. 2. The manner in which these swing arms are mounted will be described in more detail hereinafter.

When the rod arrives at the feed-in table, it will rest upon two banks of balls which will be described in more detail hereinafter. Feeding and rotation of the rod is accomplished by means of a drive wheel 33. The drive wheel is mounted so that its axis may be rotated in a horizontal plane to the desired helix angle and the wheel mounting 34 is arranged for vertical movement which is produced by means of the cylinder 35. The details of the drive wheel and its mounting will be described in more detail hereinafter.

The thread dies are again indicated at 16 and 17 and on the exit table which will be described in more detail hereinafter, there is another drive wheel 33*a*, also rotatable in a horizontal plane to a suitable helix angle, and again the carriage 34*a* is movable vertically be means of the cylinder 35*a*.

The thread rolling dies 16 and 17 are on the threader 15 and the threader unit as a whole is mounted on relatively short ways 36 and by means of a screw 37 the theader unit as a whole may be shifted a small amount transversely of the rod being threaded to take care of rods of different diameters. Fixed stops 36*a* and 36*b* may be provided for abutment by a lug 36*c* to define the positions for the largest and smallest rod to be threaded. Accurately dimensioned intermediate blocks may be provided as at 36*d* for various nominal rod diameters.

FIG. 2 shows various cylinders and limit switches, the function of which will be described in more detail hereinafter.

Referring now more particularly to FIGS. 3, 4 and 5, the feed-in and feed-out tables and their operating mechanisms will be described. The tables are mounted on a framework generally indicated at 40. Mounted on the framework 40 are two parallel beams 41 which are arranged at right angles to each other. Each beam carries a shaft 42 on which are mounted the lower pinions 43 and the upper pinions 44. Between the beams the frame carries the rails 45 and a carriage 46 rides on these rails. Mounted on the carriage are the two racks 47 also disposed at right angles to each other, which cooperate with the pinion 43 so that as the carriage 46 is moved back and forth perpendicular to the plane of the paper, the pinions 43 are caused to rotate. Since the pinions 44 are on the same shafts as the pinions 43, the pinions 44 also rotate and they drive the racks 48. It will be seen that the racks 48 are angled at 45° to the vertical and at right angles to each other. They also slope upwardly toward the thread roll die table and it will be apparent that by movement of the carriage 46 backward and forward, the beams 49 will be caused to move apart and downwardly and outwardly and away from the thread roll apparatus and, conversely, toward each other, upward, and toward the thread rolling apparatus.

On the top of each beam 49 are mounted a series of balls or rollers 50 which support the rod during the feeding and exit operations.

As has been pointed out heretofore, the two banks of rollers on the feed-in table generally move in unison. However, to compensate for die plunge, it is necessary that they move in opposite directions. In order to understand what is being done, reference may be had to FIG. 17 which is a diagram showing the positions of the rolls and of the rod to be threaded before and after the die plunge. The broken line circles indicate the positions of the banks of rollers at 121 and 122, respectively, and the rod to be threaded at 120. The solid line circles represent the positions of the banks of rollers 121*a* and 122*a* and the position of the rod 120*a* after die plunge. It will be observed that the banks of rollers 121 and 122 are initially out of alignment and during die plunge the banks are caused to move in opposite directions to bring them into alignment as indicated in solid circles and thus to shift the position of the rod from the position indicated at 120 to the position indicated at 120*a*. This is accomplished automatically during the die plunge as will now be described.

In FIG. 16 the adjustable thread rolling die is generally indicated at 16. Limit switches 123 and 124 define define the limits of movement of the carriage 16*a* of the movable thread rolling die. The carriage 16*a* is connected to the piston of a hydraulic cylinder 125 which is directly connected to a hydraulic cylinder 126 having a piston and a piston rod 126*a*. The piston rod 126*a* is pivotably secured to a cross bar 127 at 127*a*. The cross bar 127 is pivoted centrally at 128 and it is connected to the two racks 47 as at 129. It will be understood that the cylinder 100 is a cylinder which causes the carriage 46 to move the racks in unison. However, as the movable thread die 16 plunges, its movement is transmitted to the cross bar 127 causing it to pivot, as indicated in broken lines, in one direction or the other. This causes the rack 47 to move a small amount in opposite directions and it is this movement of the racks 47 in opposite directions which produces the shift diagrammatically illustrated in FIG. 17.

From the foregoing, it will be apparent that a rod resting upon the two banks of rollers 50 will have its centerline on the line 19 after the plunge. Because of the arrangement described, no matter what diameter rod R is being threaded, its center will remain on the horizontal centerline 19*a*. This is perhaps more readily apparent by comparing FIGS. 3 and 5. In FIG. 3 the apparatus is set up for the smallest nominal diameter rod to be threaded while in FIG. 5 it is set up for the largest diameter rod to be threaded. It will be observed that in FIG. 3 the racks 48 are at their upper limit while in FIG. 5 these racks are at their lower limit. Parallelism of movement of the beams 49 is assured by means of cam rollers 51 operating in the slots 52. As mentioned above, the angle of the slot 52 to the horizontal is approximately twenty-six and one half degrees. Actually, the compound forward and upward movement is based upon forward movement in proportion to change in diameter of rod and upward movement in proportion to change in radius of the rod. For example, the net change in going from a 6 inch diameter rod to a 1 inch diameter rod is 5 inches. In this situation the carriage would move 5 inches forward and two and a half inches upward. During the movement of the beams, they

maintain their parallelism by virtue of being guided in the slots **52** as just described.

In order to make it possible to change rapidly from operating upon one size of stock to another size of stock without elaborate setup, a plurality of swing stops are provided. These are seen in FIG. **4** at **60.** As best seen in FIG. **6** these swing stops are more or less L-shaped elements mounted for pivotal movement on a rod **61,** such that they may be swung from the solid line position to the broken line position indicated at **60***a*. Preferably, one swing stop is provided for each nominal size of rod between the smallest and largest to be operated upon. Normally the beams are in the uppermost positions, and when all of the swing stops are swung aside, the carriage **46** simply rides over them until it abuts the fixed stop **62.** When the stop **62** is abutted, the beams **49** with their roller balls **50** will be in the position shown in FIG. **5.** When all of the swing stops **60** are flipped up as shown in FIG. **4,** the carriage will abut the last swing stop **60***b* and the beams will then be in the position shown in FIG. **3.**

Referring now to FIGS. **8, 9** and **10,** the driving wheel **33** is mounted on a shaft **70** in a fork element **71** secured to a shaft **72.** The carriage on which the wheel **33** is mounted is provided with ways **73** which cooperate with ways **74** on the frame **40.** An extension **75** is secured to the end of the piston rod **76** operating in the cylinder **77** so that by applying fluid to the cylinder **77** the carriage **34** can be raised and lowered with respect to the frame. The shaft **72** passes through a fixed plate **78** and is secured to a movable plate **79.** Clamping bolts **80** pass through the plate **79** and are threaded into the plate **78,** the plate **79** having the arcuate slots **81** to accommodate the bolts. An arm **82** is attached to the plate **79** and the arm cooperates with an indicator **83.**

In this manner, the helix angle of the drive roller **33** may be adjusted for either left-hand or right-hand threads. Thus, by moving the arm **82** upward in FIG. **10,** the axis **70** is shifted to a helix angle to produce a right-hand thread. Movement of the arm **82** downwardly as seen in FIG. **10** will set the axis of the drive wheels **33** for the production of a left-hand thread. The indicator is preferably calibrated so that one complete revolution of the pointer is one degree and it is then preferably calibrated into one hundred divisions. With a small supplemental dial which counts the number of revolutions of the pointer the angle can be read in degrees and hundredths of degrees. As pointed out above, there are two kinds of dies in general use in thread rolling. The so-called annular dies simply have annular rills with no helix angle. The so-called combination dies actually have a helix angle to the rill. In either case, in a thread rolling apparatus the axes of the thread rolling dies are skewed in vertical planes in opposite directions a small amount. With annular dies, the degree of skew is equal to the helix angle and therefore the angle of the axle **70** of the drive roller **33** will be set to this helix angle. However, with combination type dies it is preferable to divide the helix angle between the amount of skew of the die rollers and the thread die angle; however the drive roller angle will still be equal to the skew angle. For example, if a helix angle of three degrees is desired for the thread on the rod, the die rolls may have their axes skewed by one and one-half degrees in opposite direction, and the thread die angle will be one and one-half degrees. The combination of the two angles gives the total helix angle of three degrees.

The swing arms **32** heretofore mentioned in connection with the description of FIG. **2** are mounted pintle and gudgeon fashion. In FIG. **12** there are shown the upper gudgeon **90** and the lower gudgeon **91.** The upper gudgeon **90** has its upper edge cut at an angle as best seen in FIG. **13** and centrally of its outboard diameter it is provided with a small depression **92.** The lower gudgeon is simply a cylindrical piece of tubing. It will be clear that gravity will cause the swing arms **32** to always return to a central position even through they may be swung aside to permit walking through. Referring again to the feed-in and feed-out tables, it has been mentioned that these are substantially identical in construction and operation. The only real difference between them is that on the feed-out table means are provided to move the one bank of rollers **50** individially so that this bank of rollers may be raised above the other to effect a kick-out of the rod onto the stock table **14** of FIG. **1.** It will also be understood that swing gates **32** may be provided between the exit table and the stock table **14** the same as between the stock table **10** and the feed-in table.

At the start of operations the banks of rollers on the feed table are in the up position and in the offset position shown in broken lines in FIG. **17.** The drive for the drive wheels is off and the drive wheels are in their raised position. The rod is supported on the rollers **50** on the horizontal centerline **19***a*. The run-out table likewise is in its up position but not offset, with its drive wheel off and in the raised position. When the starting push button is actuated, the banks of guide rollers on the feed-in and feed-out tables are lowered by actuation of the cylinders **100** and **101.** The drive wheel **33** is lowered by means of the cylinder **35** by a pressure switch on the hydraulic line to the cylinder **100.** The clamping pressure is light, but sufficient to prevent the roller from turning before good contact is achieved on the rod. Once the clamping pressure is sufficient, a signal by a pressure switch may start the roller turning, and the clamping pressure builds to the desired level rapidly while the rod is advancing. A pressure reducing valve and pressure gauge readout for this purpose is indicated in FIG. **2** at **136.** The pressure switch is indicated at **102.** Assuming that the thread dies **16** and **17** have been skewed to the correct position and the helix angle for the wheel **33** has been correctly set, the rod will be rotated and fed into the thread dies. As the trailing end of the rod clears the limit switch **104,** cylinder **35** is actuated to raise the wheel **33** and stop rotation of the wheel. As the trailing end of the rod passes limit switch **105,** the cylinder **100** is again actuated to raise the feed table back to its starting position.

As the rod enters the thread dies, limit switch **106** actuates the cylinder **16***a* and causes the die **16** to plunge, and this action produces the shift of the axis of the rod on the feed-in table to compensate for the die plunge, as heretofore described. As the leading end of a threaded rod contacts the limit switch **107,** it actuates the cylinder **35***a* to lower the wheel **33***a* and to start rotation thereof in the same way as described in connection with the wheel **33.** As the trailing end of the rod clears the limit switch **108,** the cylinder **35***a* is actuated to raise the wheel **33***a* and to stop rotation thereof. When the wheel **33***a* is raised to its up position, it actuates the limit switch **111** which operates the cylinder

101 to raise the exit table rollers to their starting position. A cylinder 109 is provided to actuate the rear bank of rollers separately to raise them for dumping. It is actuated by a pressure switch from the hydraulic line to the cylinder 101, this pressure switch being indicated at 103. As the rod is dumped by actuation of the cylinder 109 and rolls out onto the exit stock table, it actuates the limit switch 110 which actuates the cylinder 109 to return the exit table from its dumped position to its original centerline position.

As pointed out heretofore, while the entrance feed-in table preferably is provided with balls, the exit table may, if desired, have rollers.

As also mentioned heretofore, it is important to synchronize the entrance drive roll and exit drive roll with the speed of the thread dies. Preferably, a tach generator is provided for each of these drives and these generators send signals to a meter reading in surface feet per minute. By using surface feet per minute, the factors of die wear and driving wheel wear do not complicate matters. This synchronization may be accomplished manually by observing the dials and controlling the speeds until they are the same. It will of course also be within the skill of the worker in the art to provide automatic controls by means of a servo mechanism or the like.

It is necessary to support the threaded rod from the time it leaves the thread rolling dies until it reaches the runout table and a supporting trough is indicated generally in FIG. 1 at 130. This trough is shown in more detail in FIGS. 14 and 15. The trough is preferably mounted on the piston of a hydraulic cylinder 131 so that it may be raised and lowered for different sizes of pipe. It may consist of a nearly semi-circular piece of pipe 132 having windows 133 cut therein at spaced intervals. Adjacent each window 133 a pair of pillow blocks 134 are mounted and these carry a roller 135. The roller 135 projects through the piece of pipe 132 by virtue of the window 133. As clearly seen in FIGS. 14 and 15, these rollers 135 are spaced along the trough 130 and peripherally thereof as seen in the end view of FIG. 14 so as to give rolling support to a rod or the like issuing from the thread rolling dies.

It will be understood that numerous modifications may be made without departing from the spirit of the invention. No limitation not specifically set forth in the claims is therefore intended or should be implied.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A thread rolling apparatus for rod and the like having a passline, comprising means for feeding and rotating a rod, a feed-in table, a die table, and a feed-out table, said die table carrying a pair of thread rolling dies, one of said dies being fixed, and the other being movable to accommodate various rod diameters and having means to urge it toward the fixed die in a die plunge, said die table being adjustable transversely of the pass line for various rod diameters so as to place the axis of the rod being threaded on said pass line after die plunge and during the threading operation, means on said feed-out table to receive the threaded rod moving along said pass line, and means on said feed-in table to receive the rod to be threaded with its axis off said pass line, and an operative connection between said movable die and the means on said feed-in table to bring the axis of the rod to be threaded onto said pass line during said die plunge.

2. Apparatus according to claim 1 wherein said feed-in table comprises two parallel banks of rollers for receiving a rod to be threaded, said banks being arranged for movement in unison from an initial rod receiving "up" position, downwardly, outwardly and away from said die table, the "up" position corresponding to the smallest diameter rod to be threaded, and the "down" position corresponding to the largest diameter rod to be threaded.

3. Apparatus according to claim 2, wherein stops are provided for one, at least, of said banks, to stop said banks in the "up" position and "down" position respectively, and wherein a plurality of intermediate stops, each having an operative and an inoperative position, are arranged to be selectively placed in operative position before the "down" stop, to stop said banks selectively in an number of lower positions corresponding to different nominal diameters of rods to be threaded.

4. Apparatus according to claim 2, wherein means are provided to move said banks simultaneously in opposite directions, whereby to shift the axis of a rod received on said rollers laterally.

5. Apparatus according to claim 4, wherein said last named means includes an operative connection between said movable threading die and one of said banks, and a reversing connection between said banks, whereby the axis of a rod received on said rollers is shifted laterally concurrently, and in accordance with the die plunge, to bring the axis of said rod onto said pass line.

6. Apparatus according to claim 1, wherein a loading table is provided adjacent to said feed table, said loading table having at least two Vee arms tiltable in unison from a position in which a rod may roll into the Vees, to a position in which the Vees are upright and serve to center the rod, and to a position in which a rod may roll out of the Vees and onto the feed table, a beveling unit mounted on said loading table for movement axially of a rod centered in said Vees and having means for clamping engagement with such rod, a beveling tool reciprocably mounted on said beveling unit, means for reciprocating said beveling tool into beveling relation to such rod and for retracting it, means for rotating said beveling tool, and stop means for limiting the depth of the bevel.

7. Apparatus according to claim 6, wherein said loading table is spaced from said feed table for walk-through purposes, and a plurality of gravity centered swing gates are mounted on said loading table, said gates being of sufficient structural strength to support a rod rolling thereover from the loading table to the feed table, but capable of being swung aside for permitting walk-through.

8. Apparatus according to claim 2, wherein said means for feeding and rotating includes a clamping and feeding roller mounted for vertical movement with its center on the centerline between said banks, and having a horizontal rotational axis arranged for adjustment both ways from parallel to the rod axis, and means for rotating said clamping and feeding roller.

9. Apparatus according to claim 8, wherein power means are provided to urge said clamping and feeding roller against the rod resting on said ball roller, and means are provided to synchronize rotation of said

clamping and feeding roller with the axial direction of feed and helix angle setting.

10. Apparatus according to claim **9,** wherein the rotating means for said clamping and feeding roller is provided with a stall-out means and an over-ride means, to prevent die thread damage or out-of-tolerance threads caused by excessive axial thrust, or breaking action caused by slight variations in synchronizing action.

11. Apparatus according to claim **9,** wherein the rotating means for said feeding and clamping roller is powered by a hydraulic system, said system having means to adjust pressure and volume to produce a desired torque, and having a spill-over arrangement to permit over-riding.

12. Apparatus according to claim **1,** wherein said feed-out table comprises two parallel banks of rollers for receiving the threaded rod from said die table, said banks being arranged for movement in unison from an "up" position, downwardly, outwardly and away from said die table, the "up" position corresponding to the smallest diameter of threaded rods, and the "down" position corresponding to the largest diameter of threaded rods.

13. Apparatus according to claim **12,** wherein stops are provided for one, at least, of said banks, to stop said banks in the "up" position and "down" position respectively, and wherein a plurality of intermediate stops, each having an operative and an inoperative position, are arranged to be selectively placed in operative position before the "down" stop, to stop said banks selectively in a number of lower positions corresponding to different nominal diameters of threaded rods.

14. Apparatus according to claim **12,** wherein means are provided to cause said banks to move in unison to the "up" position after a completely threaded rod has been received thereon, and then to cause one of said banks to move upwardly alone, a small amount, to kick off the completed rod.

15. Apparatus according to claim **12,** wherein said means for feeding and rotating includes a clamping and feeding roller mounted for vertical movement with its center on the centerline between said banks, and having a horizontal rotational axis arranged for adjustment both ways from parallel to the rod axis, and means for rotating said clamping and feeding roller.

16. Apparatus according to claim **15,** wherein power means are provided to urge said clamping and feeding roller against a threaded rod resting on said roller, and means are provided to initiate rotation of said clamping and feeding roller upon attainment of a predetermined pressure of said clamping and feeding roller on said threaded rod.

17. Apparatus according to claim **15,** wherein a stop is provided for, at least, one of said banks in order to stop said banks in said "up" position, and a plurality of intermediate stops, each having an operative and an inoperative position, are arranged to be selectively placed in operative position before said first mentioned stop, to stop said banks selectively in a number of lower positions corresponding to different nominal diameters of threaded rods.

18. Apparatus according to claim **15,** wherein means are provided independently to move one of said banks upwardly, inwardly and toward said die table, whereby to kick a finished rod laterally off said run-out table.

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