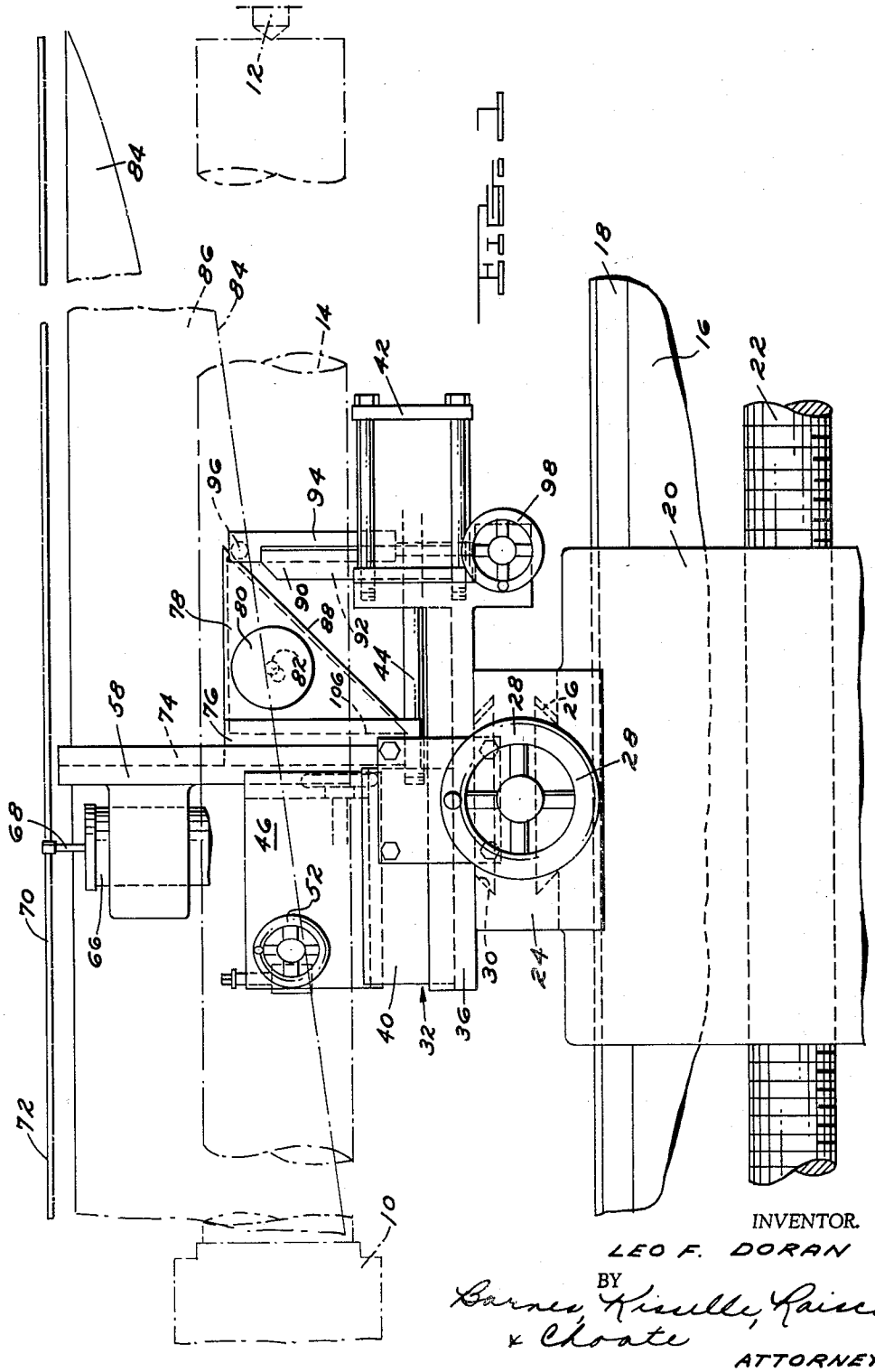
Aug. 25, 1964 L. F. DORAN 3,145,599

METHOD AND MACHINE FOR CUTTING THREADS OF VARYING PITCH

Filed June 15, 1962 3 Sheets-Sheet 1



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3 Sheets-Sheet 2

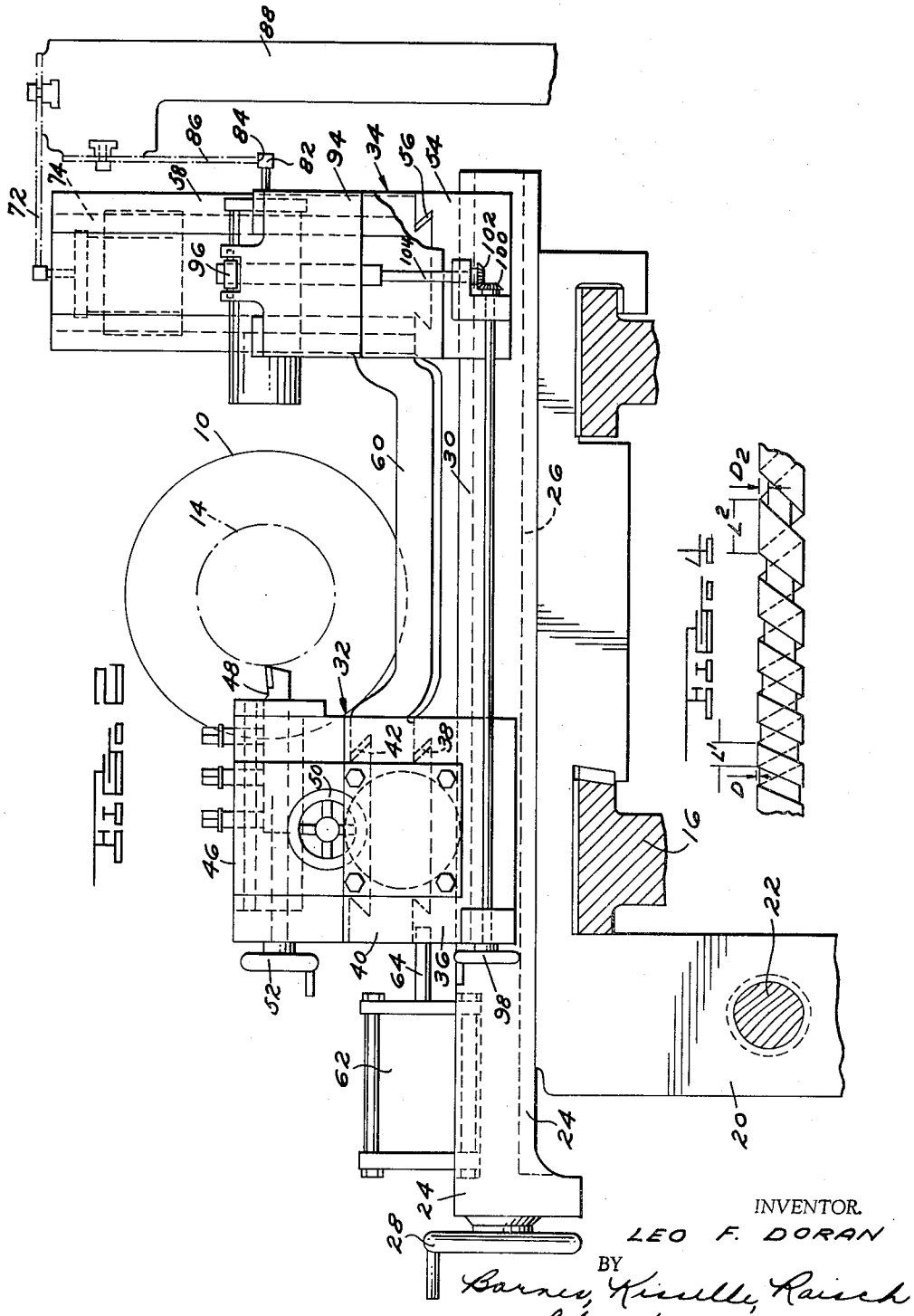

FIG. 2

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3 Sheets-Sheet 3

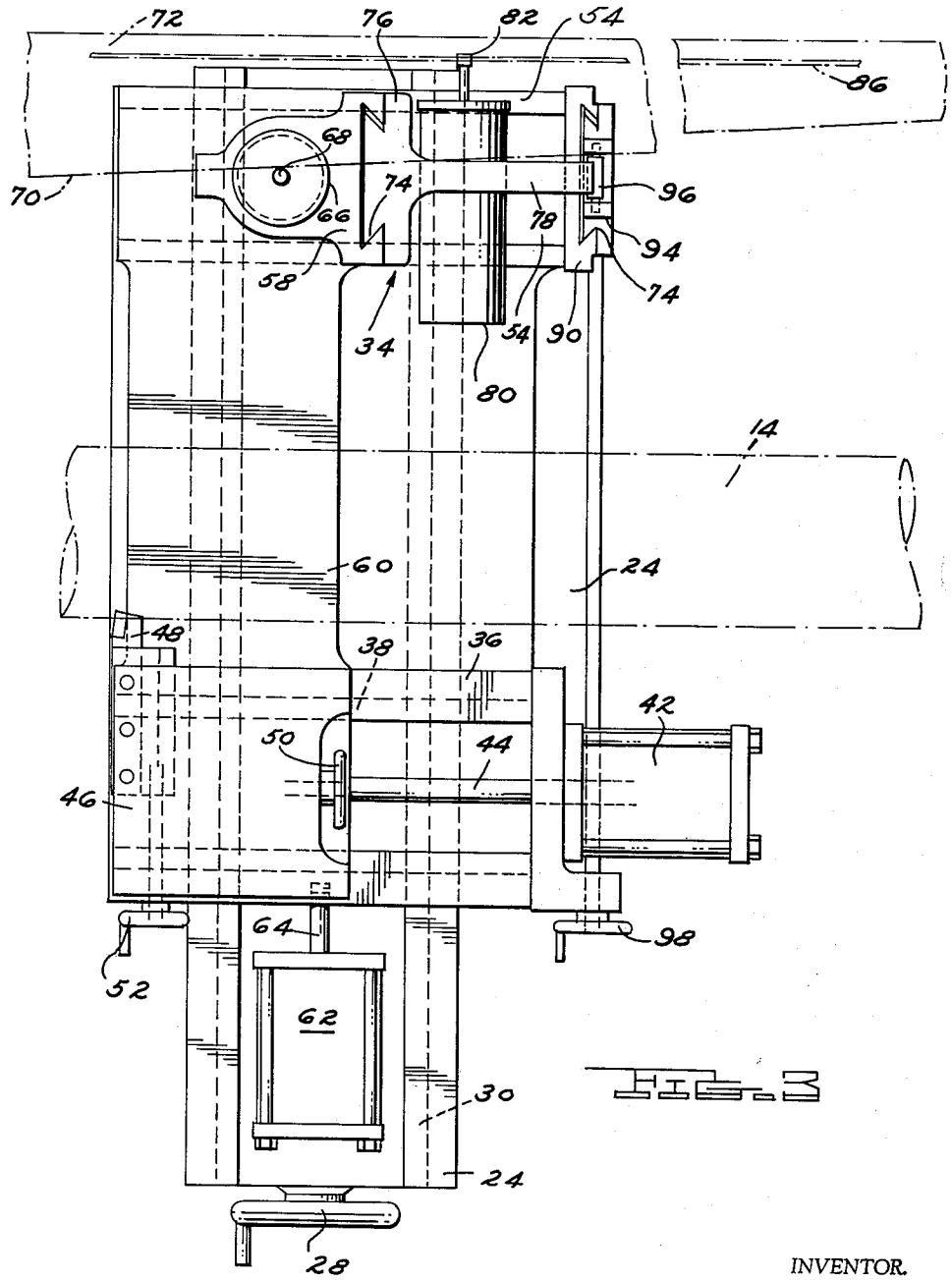

FIG. 3

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METHOD AND MACHINE FOR CUTTING THREADS OF VARYING PITCH

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5 Claims. (Cl. 82—14)

This invention relates to a method and machine for cutting threads or threadlike forms or grooves of varying lead or pitch.

Screws or other like shafts having a spiral configuration thereon are frequently used in manufacturing operations for the purposes of conveying or timing members connected therewith and are also used such as in the molding of plastic materials for the purpose of transferring or compacting material. With such screws or spirally configured shafts, it is often desirable to be able to cause some portions or all of the lead or pitch of the spiral thread or groove to accelerate or decelerate in order to obtain a speeding up or a slowing down of the member or material moved.

With specific reference to extrusion type screws used in plastic molding, it is also desirable in many instances to reduce the cross sectional area of the groove in a longitudinal advancing direction for the purpose of progressively increasing the compressing or compacting of the plastic material being conveyed by the screw. Thus, in the operations described, it is essential to have a screw or other spirally configured shaft wherein the lead or pitch of the spiral thread or groove deviates from a constant value at least along certain portions of the screw or shaft and in some instances, in addition to the acceleration or decleration of the thread or groove lead, it is also necessary to vary the depth of the thread or groove root.

It is an object of this invention to provide a method and apparatus for machining spiral threads or grooves in a manner such that the lead or pitch thereof can be varied in accordance with a predetermined requirement.

A further object of the invention resides in a method and apparatus for machining spiral threads or grooves in a manner such that both the lead or pitch of the thread or groove as well as the root depth thereof can be simultaneously varied in accordance with a predetermined requirement.

A further object of the invention is to provide a method and apparatus of the type described wherein the lead or pitch of the thread or groove is varied in accordance with the operation of a pattern controlled tracer.

A further object of the invention is the provision of a method and apparatus of the type described wherein the lead or pitch of the thread or groove is variably controlled by one tracer and the depth of the thread or groove is variably controlled by a second tracer.

Another object of the invention is to provide a method and apparatus of the type described which employs two tracers, one for controlling the pitch or lead of the thread or groove and the other for controlling the depth of the thread or groove, the two tracers being arranged to cooperate each with its respective template and the two templates having their tracing edges disposed in perpendicularly related planes.

Other features and objects of the invention will become apparent from the following description and drawings in which:

FIG. 1 is a fragmentary front elevational view of a machine tool incorporating the method and apparatus of the present invention.

FIG. 2 is a fragmentary side elevational view partly in section of the machine tool shown in FIG. 1.

FIG. 3 is a fragmentary top elevational view of the machine tool shown in FIG. 1.

FIG. 4 is a schematic view illustrating the type of thread or groove that is adapted to be machined by means of the method and apparatus of the present invention.

Referring to FIG. 1, there is shown by way of illustration a lathe incorporating the apparatus of the present invention. The machine tool with which the invention is usable is by no means limited to a lathe, the invention being applicable to other types of machine tools as well. The lathe illustrated includes a power-driven chuck 10 and a tail stock 12 between which the shaft 14 on which a thread or spiral groove to be machined is supported for rotation. As is conventional, the lathe includes a bed 16 provided with ways 18 for guiding the carriage 20 lengthwise of the shaft 14. Carriage 20 is arranged to be driven at a uniform rate axially of shaft 14 by means of a power-driven lead screw 22. A cross slide 24 is supported on carriage 20 and is guided for movement transversely of the axis of shaft 14 by ways 26. The adjustment of cross slide 24 transversely of shaft 14 is effected in a conventional manner by a hand wheel 28 which drives a screw, not illustrated, that interconnects the cross slide and carriage. Cross slide 24 is in turn provided on its upper face with ways 30 in which are mounted a tool block assembly 32 and a dual tracer mounting assembly 34 (FIG. 2).

Tool block assembly 32 includes a base plate 36 provided with ways 38 in which a tool block slide 40 is mounted for movement in a direction parallel to the ways 18 of the lathe bed. At one end of base plate 36, there is fixedly mounted a hydraulic cylinder 42 (FIG. 1) enclosing a piston, not illustrated, having a piston rod 44 connected with slide 40 such that when cylinder 42 is actuated, slide 40 is shifted longitudinally on base plate 36. A tool block 46 is mounted on slide 40 and is provided with means for rigidly supporting a cutting tool 48. Handwheels 50 and 52 enable adjustment of the cutting tool 48 lengthwise and transversely of slide 40, that is, in a direction axially and radially, respectively, of the shaft 14 supported between the head stock 10 and the tail stock 12 of the lathe.

The tracer mounting assembly 34 includes a base plate 54 mounted on the transversely extending ways 30 of cross slide 24. Base plate 54 is provided with ways 56 parallel to the ways 38 on the base plate 36 on the tool block assembly 32. A column member 58 is mounted in the ways 56 of base plate 54 and is interconnected by a rigid brace 60 with the tool block slide 40. A hydraulic cylinder 62 mounted on cross slide 24 has its piston rod 64 interconnected with the base plate 36. Thus, the column member 58 is constrained to move axially and transversely of the axis of the work piece 14 with tool block slide 40.

A hydraulic tracer 66 of conventional design is mounted on column 58 so that its stylus or finger 68 projects upwardly and is adapted to follow the tracing edge 70 of a horizontally disposed template 72. Tracer 66 is operably associated with cylinder 62 so that in following the edge 70 of template 72, tracer 66 controls the movement of the tool 48 in a direction transversely of the axis of work piece 14 and thus determines the depth of the groove being cut along the axis of the work piece. Column 58 is provided with vertical ways 74 in which is slidably arranged a vertical slide 76 which rigidly supports a triangularly shaped cam plate 78. A tracer 80 is mounted on cam plate 78 and arranged so that its finger or stylus 82 is adapted to follow the tracing edge 84 of a vertically disposed template 86. Templates 72 and 86 are suitably mounted on one or more rigid supports 88. Tracer 80 is operably associated with cylinder 42 so that in follow-

ing the edge 84 of template 86, it controls the movement of tool 48 axially of the work piece on cross slide 24. Thus, the contour of the tracing edge 84 determines the advance of the tool 48 relative to cross slide 24 and thus determines the lead on the thread or spiral groove being cut.

In order to enable the tracer 80 to follow the tracing edge 84 of template 86, cam plate 78 is fashioned with a diagonally extending cam edge 88 which is disposed at an angle of 45° to the plane of horizontal movement. Base plate 54 at one end is formed with a vertically extending column 90 provided with vertically extending ways 92 in which a vertical slide 94 is arranged for sliding movement. Slide 94 supports a roller 96 which serves as a cam follower for the cam plate 78. The vertical position of slide 94 is adapted to be adjusted by turning a handwheel 98 which, through a pair of bevel gears 100, 102, rotates a shaft 104 which threads into the lower end of slide 94. Thus, as handwheel 98 is rotated, slide 94 and the cam follower roller 96 are caused to shift vertically. It will be appreciated that with this arrangement, when the column member 58 shifts axially of the work piece on the base plate 54 while the cam edge 88 of cam plate 78 is in engagement with cam roller 96, tracer 80 is shifted vertically. In the particular arrangement illustrated, the degree of vertical shifting of tracer 80 is exactly equal to the extent to which it is shifted horizontally on base plate 54.

In the above described arrangement, the horizontally disposed template 72 has its tracing edge 70 contoured so as to produce the desired variation in the depth of the thread or groove being machined and likewise, the tracing edge 84 of the vertically disposed template 86 is contoured so as to produce the desired lead in the thread being machined. It will be appreciated that suitable switches and mechanism not illustrated are provided for energizing lead screw 22 and the circuits of tracers 66 and 88. In the full retracted position of the tool block assembly 32, that is, with piston rod 44 fully extended and piston rod 64 fully retracted, the fingers 68 and 82 of both tracers are retracted to positions out of engagement with their respective templates. In the fully retracted position of the tool block assembly, the triangular cam plate 78 assumes the position indicated by broken lines 106 in FIG. 1 where the cam edge 88 is out of contact with the cam follower roller 96.

To initiate the thread cutting operation, start switches, not illustrated, are actuated to energize tracers 66 and 80. When tracer 66 is energized, cylinder 62 is actuated to shift the tool block assembly 32 and the tracer mounting assembly 34 inwardly until the stylus 68 contacts the tracing edge 70 of template 72. As is conventional, the engagement of the stylus 68 with the tracing edge 72 arrests the transverse inward movement of the tool. When tracer 80 is energized, piston rod 44 is retracted to shift the tool block 46 and the column 58 on which the two tracers are mounted in a direction toward the right as viewed in FIGS. 1 and 2 on the cross slide 24. As soon as the cam edge 88 of the triangular cam plate 78 engages cam roller 96, tracer 80 is shifted upwardly and its upward movement as well as its axial movement is arrested when its stylus 82 contacts the tracing edge 84 of template 86. The initial depth of cut and the axial positioning of the tool bit itself may be adjusted by turning handwheels 52 and 50, respectively. The point at which the thread to be machined is picked up on the work piece is adjusted by manipulating handwheel 98 so as to raise or lower tracer 80 and thereby shift the tool block axially on the cross slide.

After these adjustments have been made, the switch for energizing the lead screw 22 is actuated and the tool bit 48 will thereafter follow a path determined by the contours of the tracing edges 70 and 84 of their respective templates 72 and 86. It will be appreciated that the speed of rotation of chuck 10 is related to the speed of rotation

and the lead of screw 22 as is conventional in a thread cutting lathe so as to determine the initial pitch of the thread to be cut. As the stylus 68 follows the tracing edge 70, the tool 48 will move progressively into the work piece 14 as it travels lengthwise thereof to progressively increase the depth of the thread or groove being machined. In the same manner as the stylus 82 of tracer 80 follows the tracing edge 84 of template 86, the tool will be shifted progressively to the right on the cross slide 24 as viewed in FIG. 1 and thus, the lead of the thread or spiral groove being cut will be progressively increased over that which would be otherwise produced by the lead screw 22 alone. In this connection, it will be noted that the cam plate 78 maintains the stylus 82 of tracer 80 in contact with the tracing edge 84 of template 86. By arranging the tracer 80 so that it is shifted vertically, it will be appreciated that the necessary deflection required of the finger or stylus 82 is very small and consequently, the amount of oil controlled by the tracer valve is relatively small.

In the embodiment illustrated herein, the contours of the tracing edges of the two templates 72 and 86 are designed to produce a progressively increasing depth of groove and a progressively increasing lead. The progressively increasing lead is illustrated schematically in FIG. 4 as by L^1 and L^2 and the increasing depth of the thread is illustrated as D and D_2. It will be appreciated that the tracing edges of these templates can be designed to produce any variation in depth of groove or lead desired. It will also be appreciated that the templates can also be designed to produce a decreasing pitch and depth of groove.

In the claims, the term "thread" is used in a broad sense to designate any helical or spiral groove.

I claim:

1. In a machine or cutting a thread, the lead of which varies along the axis of the thread, the combination comprising a base, means on the base for supporting a workpiece to be threaded and for rotating the workpiece about a horizontal axis, a carriage on said base, means for moving the carriage horizontally on the base in a direction axially of the rotating workpiece and at a uniform rate in timed relation to the speed of rotation of the workpiece so that the carriage moves lengthwise of the thread to be cut at a rate corresponding to the initial lead of the thread to be cut, a cross slide on said carriage and movable horizontally thereon in a direction normal to the direction of travel of the carriage, a support member mounted on the cross slide for movement horizontally in a direction parallel to the path of movement of the carriage, a cutting tool on said support member, a hydraulic cylinder interconnecting the cross slide and said support member for moving the support member on said cross slide in said direction parallel to the path of movement of the carriage, a template on said base having a tracing edge extending generally in a vertical plane and lengthwise of the thread to be cut, a vertically movable slide on said support member, a tracer mounted on the vertical slide and having a stylus extending generally horizontally and adapted to follow the tracing edge of the template, said tracer being operably connected with said cylinder to move the support member together with the vertical slide on the carriage in said parallel direction and said tracing edge having a smooth, continuous contour for gradually and progressively changing the position of the support member and the vertical slide on the carriage, whereby as the carriage travels axially of the workpiece at said uniform rate, the cutting tool cuts a thread on the workpiece, the lead of which varies in accordance with the relative movement between the support member and the carriage in the direction of the carriage travel, said vertical slide having a straight cam edge extending in a vertical plane and inclined to the horizontal at an angle of less than 90°, said cross slide having an abutment thereon adapted to engage said cam

edge such that relative horizontal movement between the support member and the cross slide produces sufficient vertical movement of the vertical slide to maintain the tracer stylus in contact with said tracing edge.

2. The combination set forth in claim 1 including means for adjusting the position of said abutment vertically on said cross slide.

3. The combination set forth in claim 1 wherein said cam edge is inclined at an angle of approximately 45° to the horizontal whereby a horizontal movement of the tracer relative to the cross slide produces an equal vertical displacement of the tracer relative to the cross slide.

4. In a machine for cutting a thread, the lead and depth of which varies along the axis of the thread, the combination comprising a base, means on the base for supporting a workpiece to be threaded and for rotating the workpiece about a horizontal axis, a carriage on said base, means for moving the carriage horizontally on the base in a direction axially of the rotating workpiece and at a uniform rate in timed relation to the speed of rotation of the workpiece so that the carriage moves lengthwise of the thread to be cut at a rate corresponding to the initial lead of the thread to be cut, a cross slide on said carriage and movable horizontally thereon in a direction normal to the direction of travel of the carriage, a first slide mounted on the cross slide and movable horizontally thereon in a direction normal to the direction of travel of the carriage, a second slide mounted on said first slide and movable horizontally thereon in a direction parallel to the path of travel of the carriage, a hydraulic cylinder assembly interconnecting the cross slide and the first slide for moving the first slide in said direction normal to the path of travel of the carriage, a second hydraulic cylinder assembly interconnecting the first slide and the second slide for moving the second slide on the first slide in said direction parallel to the path of travel of the carriage, means for mounting a cutting tool on the second slide for movement therewith, a first template on said base having a tracing edge extending lengthwise of the thread to be cut and being curved in a generally horizontal plane, a first tracer on said second slide mounted for movement therewith and having a vertically disposed stylus adapted to follow the tracing edge of said first template, said first tracer being operably connected with said first hydraulic cylinder assembly to move said second slide in said direction normal to the path of travel of the carriage in response to deflection of the stylus of the first tracer, a second template on said base having a tracing edge which extends and is curved in a generally vertical plane lengthwise of the thread to be cut, a vertical slide on said second slide, a tracer mounted on said vertical slide for movement therewith and having a horizontally disposed stylus adapted to follow the tracing edge of the second template, said second tracer being operably connected with said second cylinder assembly to move said second slide horizontally in said direction parallel to the path of travel of the carriage in response to deflection of the stylus of the second tracer, said vertical slide having a straight cam edge thereon which extends in a vertical plane and is inclined to the horizontal at an angle of less than 90°, said first slide having an abutment thereon adapted to engage the cam edge of the vertical slide such that horizontal movement of the second slide relative to the first slide produces a corresponding vertical movement of the vertical slide so as to maintain the stylus of the second tracer in contact with the tracing edge of the second template.

5. In a machine for cutting a thread, the lead of which varies along the axis of the thread, the combination comprising a base, means on the base for supporting a workpiece to be threaded and for rotating the workpiece about a horizontal axis, a carriage on said base, means for moving the carriage horizontally on the base in a direction axially of the rotating workpiece and at a uniform rate in timed relation to the speed of rotation of the workpiece so that the carriage moves lengthwise of the thread to be cut at a rate corresponding to the initial lead of the thread to be cut, a cross slide on said carriage and movable horizontally thereon in a direction normal to the direction of travel of the carriage, a support member mounted on the cross slide for movement horizontally in a direction parallel to the path of movement of the carriage, a cutting tool on said support member, a hydraulic cylinder interconnecting the cross slide and said support member for moving the support member on said cross slide in said direction parallel to the path of movement of the carriage, a template on said base having a tracing edge which is curved in a vertically extending plane and which extends lengthwise of the thread to be cut, a tracer on the support member mounted for movement therewith and having a tracing stylus adapted to follow the tracing edge of the template, said tracer being operably connected with said cylinder to move the support member on the carriage in said parallel direction and said tracing edge having a smooth continuous contour for gradually and progressively changing the position of the support member on the carriage whereby as the carriage travels axially of the workpiece at said uniform rate, the cutting tool cuts a thread on the workpiece, the lead of which varies in accordance with the relative movement between the support member and the carriage in the direction of carriage travel, a vertically shiftable slide on said support member on which the tracer is mounted, and means for shifting said vertical slide and the tracer thereon vertically in response to horizontal movement of the support member relative to the carriage so as to maintain the tracer stylus in contact with the vertically curved tracing edge of the template.

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