May 5, 1931. E. A. BAYTON 1,804,303

FEEDING MECHANISM FOR HOBBING MACHINES

Original Filed Dec. 22, 1926 4 Sheets-Sheet 1

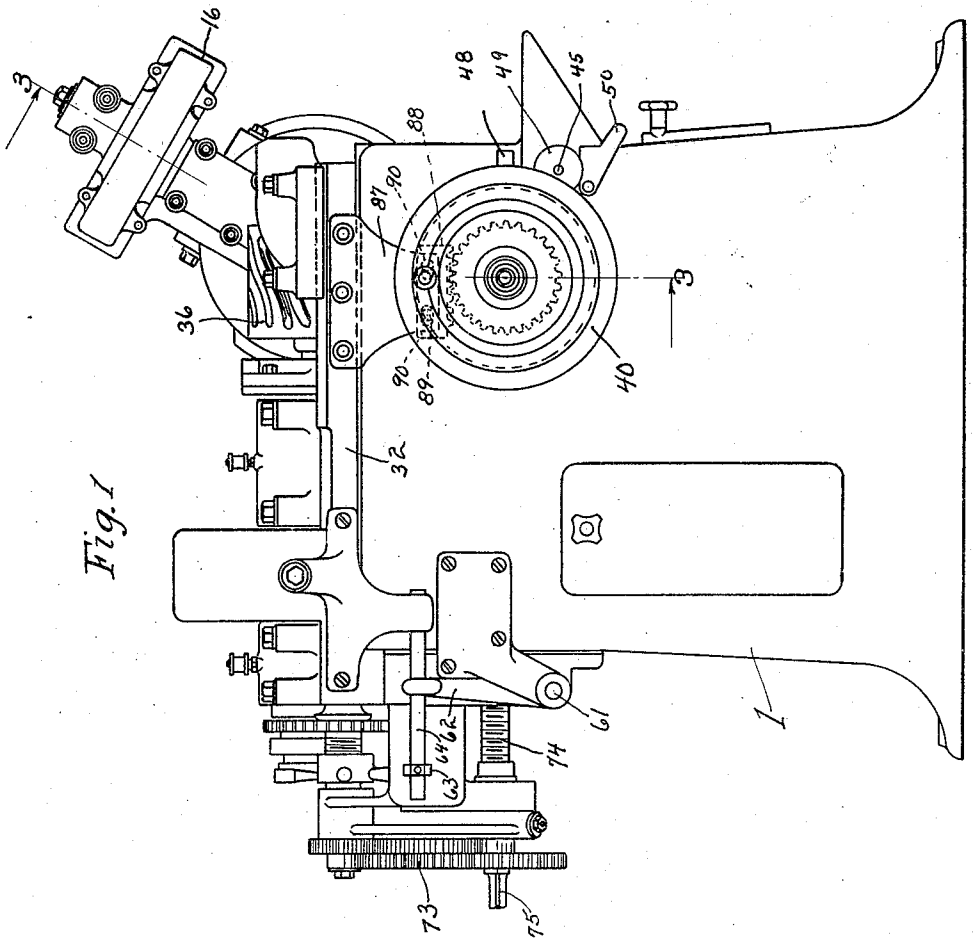


Fig. 1

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Fig. 2

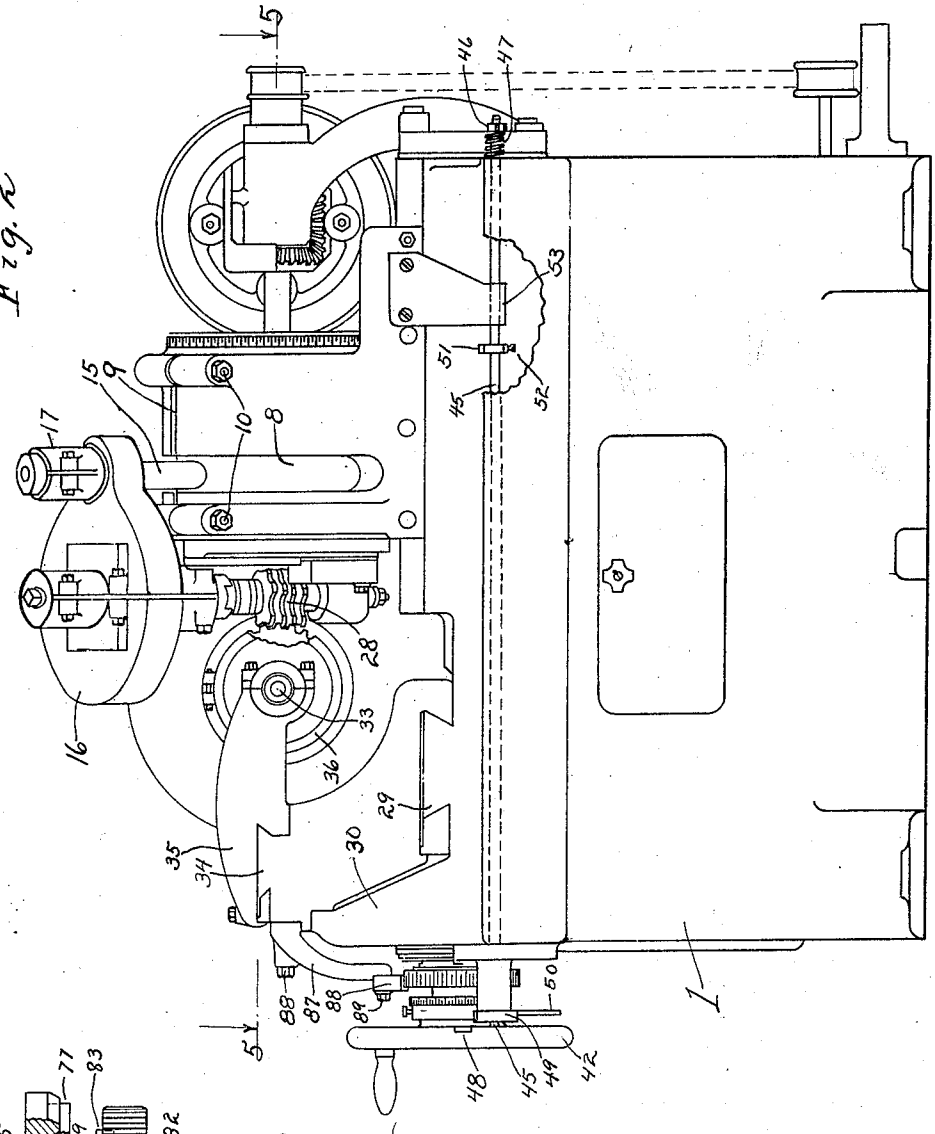


Fig. 8

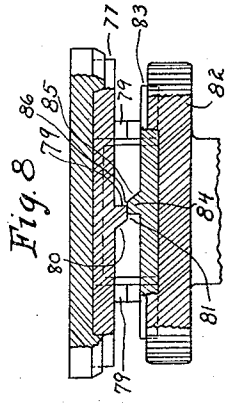


Fig. 9

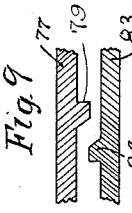
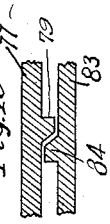


Fig. 10



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FEEDING MECHANISM FOR HOBBING MACHINES

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Fig. 3

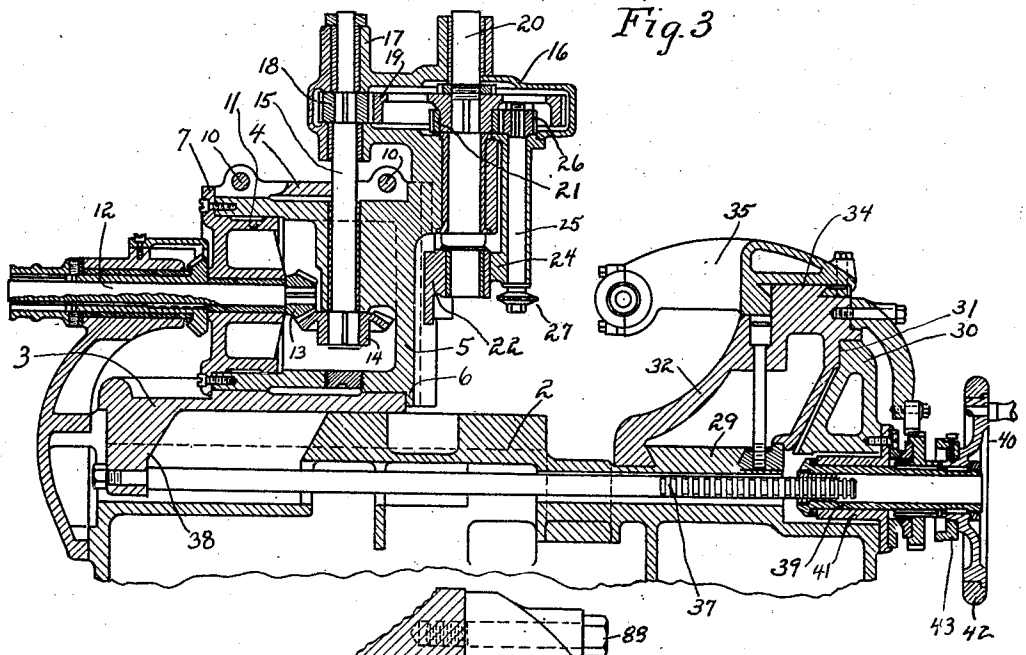
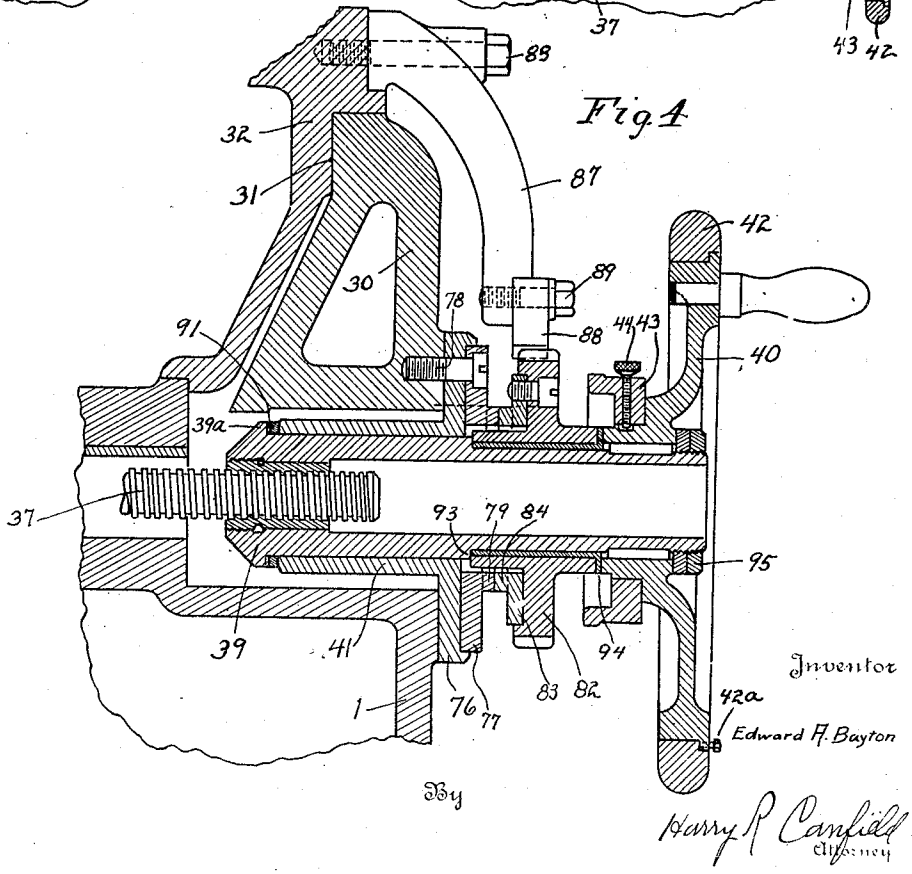


Fig. 4



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FEEDING MECHANISM FOR HOBBING MACHINES

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Fig. 5

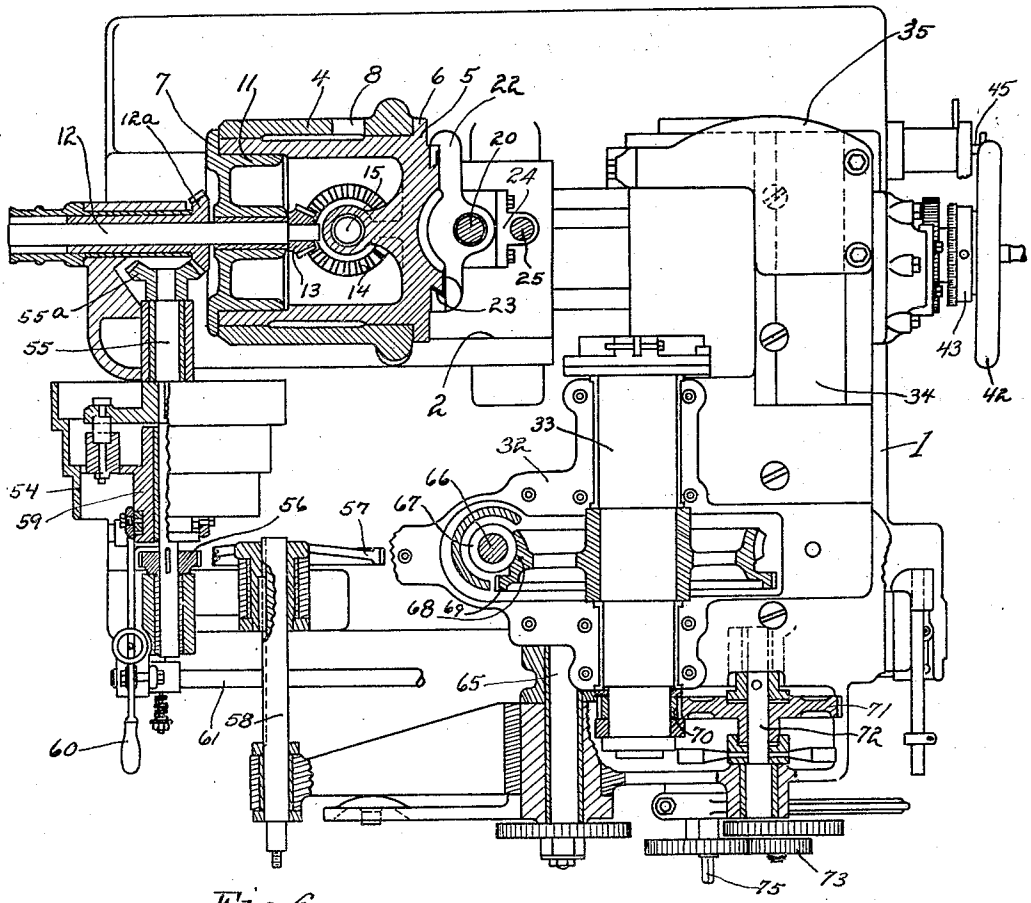
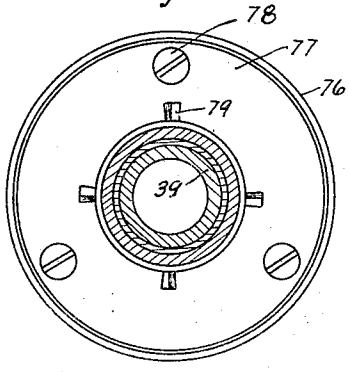


Fig. 6



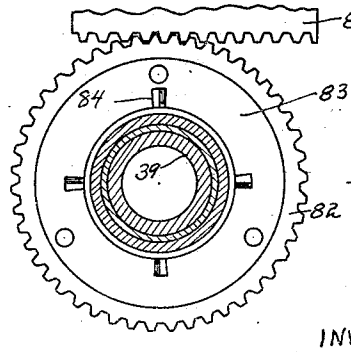


Fig. 7

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UNITED STATES PATENT OFFICE

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FEEDING MECHANISM FOR HOBBING MACHINES

Application filed December 22, 1926, Serial No. 156,488. Renewed March 23, 1931.

This invention relates to gear generating machines of the type in which the teeth are generated upon a gear blank by a rotating cutter having a relative movement with respect to the blank in the direction of the axis thereof. As well understood in the art, in machines of this character, the cutter may be a single cutter adapted to cut one groove at a time in the gear blank or the cutter may be a hob adapted to generate the completed gear during a single traverse of the blank. The gear so generated may have either straight or helical teeth of the desired form. When the cutter is a hob, the blank spindle is rotated at a proper speed relatively to the speed of rotation of the cutter and a relative movement of the cutter and blank in the direction of the axis of the blank is effected properly correlated to the speed of rotation of the blank and the rate of cutting by the tool. Likewise when a single cutter is employed a feed longitudinally of the axis of the blank is effected at the proper rate with respect to the rate of cutting by the tool.

It is the object of the present invention to provide gear generating machines of the character above referred to with automatic means for feeding the cutter in a direction transverse to the axis of the blank during the passage of the cutter in the direction of the axis thereof for determining the depth of cut along the length of the gear teeth, the invention being particularly useful for generating gears having teeth which terminate short of the ends of the gear blank and which lie within the cylindrical periphery of the blank.

The present invention provides automatically controlled relative movements of a cutter and blank in a direction transverse to the axis of the blank during the feed of the cutter in the direction of the axis of the blank to determine the longitudinal profile of the grooves cut by the cutter, and is applicable quite generally to gear generating machines, since it provides a feed movement in addition to the feed movements ordinarily provided in machines for generating spur or bevel gears with straight teeth or with teeth of helical or other curved form.

While it is to be understood that the present invention may be applied to various gear cutting machines, it is illustrated herein as applying to a machine such as disclosed in the patent of Lees 1,071,163 granted August 26, 1913.

The accompanying drawings and following description set forth in detail certain means embodying the invention, the disclosed means, however, constituting but one of the various mechanical forms in which the principle of the invention may be employed.

Reference should be had to the accompanying drawings forming a part of this specification in which Fig. 1 is a front elevation of the gear generating machine embodying the invention. Fig. 2 is a side elevation of the machine as viewed from the right hand side thereof in Fig. 1. Fig. 3 is a section taken on the line indicated on line 3—3 in Fig. 1. Fig. 4 is a sectional detail view showing the tool head adjusting mechanism on a scale larger than that of Fig. 3. Fig. 5 is a horizontal section taken on the line indicated at 5—5 in Fig. 2. Fig. 6 is a side elevation of one of the cams controlling the feed of the cutter head. Fig. 7 is a side elevation of the movable cam which cooperates with the cam shown in Fig. 6 showing also the pinion upon which the cam is mounted and the rack with which the pinion engages. Fig. 8 is a detail plan view of the feed controlling cams, parts of the cams being broken away and shown in section. Figs. 9 and 10 are detail views showing different positions of the cams shown in Fig. 8.

Referring to the accompanying drawings, the machine has a supporting frame 1 which is provided upon its upper surface with a horizontal slideway 2 which extends transversely of the frame from the rear side toward the front thereof. Mounted upon this slideway there is a tool carriage 3 which is provided with a hollow cylindrical seat 4 which has its axis horizontal and parallel with the slideway. Mounted in the cylindrical seat 4 there is a tool head 5 which is formed at one end with an integral flange 6 and at the other with a removable head 7, the flange 6 and head 7 engaging opposite ends of the cylindri-

cal seat 4 to secure the head to the seat. The tool head seat or bearing member 4 is provided with a transverse arcuate slot 8 and is split longitudinally at 9 and provided with suitable bolts 10 for drawing the split portions together in order to bind the tool head in its seat in any position of angular adjustment thereof. The flange head 6 is provided with an axial bearing 11 in which is mounted a horizontal tool driving shaft 12, and the inner end of this shaft carries a bevel gear 13 which meshes with a second bevel gear 14 which is secured to the lower end of a transversely disposed shaft 15 which projects through the arcuate slot 8 of the tool head seat. The tool head 5 includes a gear housing 16, as shown in Fig. 3, and in this housing is formed a bearing 17 in which the outer end of the shaft 15 is journaled. Within the housing 16 and secured to said shaft 15, is a pinion 18 which meshes with the gear 19 secured to a main tool driving spindle 20, which is parallel with the shaft 15 and extends down in front of the forward end of the tool head bearing 4. A second gear 21, smaller than the gear 19, is formed on or secured to the hub of the same for a purpose that will be presently described. A bearing support 22 is mounted upon the front end of the head 5 and is adjustable in the slideway 23 which is parallel to the axis of the spindle 20, the support 22 being provided with suitable means for securing the same in adjusted positions in the slideway.

For supporting an auxiliary cutter spindle, a bearing support 24 is secured upon the forward end of the head 5 by being bolted to the bearing support 22 as shown in Fig. 5 and in this support is mounted an auxiliary tool spindle 25. The upper end of the spindle 25 extends into the gear housing 16 and has fixed thereto at its upper end a pinion 26 which meshes with gear 21 on the spindle 20. The pinion 26 is made of considerably less diameter than the gear 21, so that spindle 25 will be rotated at a higher rate of speed than the spindle 20. The spindle 25 may be employed to carry a single cutter such as shown at 27 in Fig. 3, but when a hob is used it is mounted upon the spindle 20, since in this case a slow rate of rotation is desirable. When a hob is employed the bearing support 22 may be adjusted upon its slideway and used as a bearing for the lower end of a mandrel fixed to the spindle 20 and carrying a hub such as shown at 28 in Fig. 2.

A horizontal slideway 29 is formed upon the frame of the machine adjacent to the front thereof and extends at right angles to the slideway 2. The frame 1 is also provided at the front thereof with an upwardly extending guide portion 30 which is formed with a vertically and longitudinally extending bearing surface 31 on the inner side thereof. A work carriage 32 is mounted upon the slideway 29 and upon this carriage are mounted work carrying and rotating means which will be hereinafter described, the said means including a rotatable work carrying spindle 33, the axis of which is parallel with the slideway 29. The work carrying slide is so mounted that it may be moved across the front of the tool supporting head so as to carry the work past the cutting tool as is necessary in order to permit the tool to operate upon the blank lengthwise thereof. The work carrying slide 32 has a forward portion formed to bear against the vertical bearing surface 31 of the upwardly extending portion 30 of the frame, this additional bearing serving to rigidly hold the work slide against lateral movements during the operation of the cutter on the blank. The carriage 32 has upon its upper surface a slideway 34 parallel with the slideway 29 and upon this slideway is mounted a tail stock 35, which is provided with a suitable bearing for a work mandrel. A work blank 36 may be mounted in the usual manner upon a suitable mandrel, one end of which is fixed to the work spindle 33 and the other end of which is journaled in the tail stock 35.

The tool carriage 3 is adjusted back and forth on the slideway 2 by means of a feed screw 37, the rear end of which is fixed to a downwardly projecting portion 38 on the carriage, the forward end of the screw being threaded and engaged by an interiorly threaded sleeve 39 which is rotatably mounted in frame 1. A hand wheel 40 is keyed to the forward end of the sleeve 39 and by means of this hand wheel the sleeve may be turned to shift the screw 37 and the tool carriage 3 to which it is attached. The sleeve 39 is journaled in a bearing support 41 which forms a part of or is fixedly secured to the frame 1, and suitable means is provided to limit endwise movement of the sleeve with respect to the bearing support 41 in which it is mounted for a purpose to be described.

The purpose of the adjustment of the tool carriage 3 on the slideway 2 is to properly position the cutter preparatory to making a desired depth of cut in the blank operated upon. This adjustment is preferably effected manually and means are provided whereby the cutter after it has been shifted away from the blank may be returned to exactly the same position with respect thereto as it occupied preparatory to a preceding cut, as will now be explained. A ring 42 is mounted upon the hand wheel 40 and forms the outer rim thereof. This ring may be fixedly secured in any desired angular position to the body of the wheel by means of a set screw 42*a*. A disc 43 which has a graduated periphery is mounted upon the inner side of the hand wheel 40 and may be secured in any position of angular

adjustment upon the hub of the hand wheel by means of a thumb screw 44.

Mounted upon the side of the frame 1 and extending from the front to the rear thereof is a reciprocable rod 45, slidably mounted on the frame and provided at the rear end thereof with a nut 46, against which a coil spring 47 which is interposed between the frame 1 and the nut, exerts a pressure tending to move the rod rearwardly. The front end of the rod 45 is so located that when the rod is shifted forwardly (manually or automatically) against the action of the spring 47, it will project into the path of movement of a projection 48 carried by the ring 42 on the hand wheel. A cylindrical collar 49 is secured to the rod 45 adjacent to the forward end thereof and this collar is so positioned that in the forward position of the rod its rear face may be engaged by a manually operable dog 50, to prevent its retraction by the spring 47 and to hold the forward end of the rod into the path of movement of the projection 48. The rod 45 may be shifted forward manually and the dog 50 may be raised manually to hold the rod or depressed manually to release it. Intermediate the ends of the rod 45 there is a collar 51 which may be fixedly secured in any desired position along the length of the rod by means of a suitable set screw 52 and cooperating with the collar 51 there is a rigid stop member 53 which is fixed to the tool carriage 3 and is provided with a bore through which the rod 45 extends.

Assuming that the slide 3 has been adjusted to an operative position to which it is desired that the slide shall be again or repeatedly adjusted with exactness, after a movement away therefrom, the disc 43 is loosened from the hub of the hand wheel and turned so as to register zero on a scale 100 in a well known manner, after which it is then secured in place. The ring 42 is then loosened and the rod 45 is shifted forwardly by hand to bring the forward end thereof into the path of the projection 48 and the dog 50 is manually raised to hold it there.

The ring 42 is then turned to bring the projection 48 into engagement with the rod 45 and is then secured in that position. The collar 51 is then loosened and slid backwardly upon the rod until it engages the adjacent face of the stop member 53 and is then fastened by means of the set screw 52. The dog 50 is then depressed manually out of engagement with the collar 49 so that when the tool head slide is shifted away from the blank spindle, the rod 45 will be shifted by the spring 47 out of the path of movement of the projection 48. When the hand wheel is again turned in a direction to shift the tool carriage toward the work spindle, the stop member 53 will engage with the collar 51 when the tool head approaches its preparatory working position, the movement of the rod 45 being less than the pitch of the screw 37 so that the rod will be shifted during the last revolution only of the hand wheel. It will be apparent that when the tool head occupies exactly the same position which it occupied when the above described adjustments of the hand wheel ring 42 and rod actuating collar 51 were made, the hand wheel will have been stopped with the projection 48 in engagement with rod 45.

The machine is driven by means of a main driving pulley 54 which is loosely mounted upon a shaft 55 extending along the rear side of the machine, and the shaft 55 has fixed thereto a bevel gear 55*a* which meshes with the bevel gear 12*a* fixed to the tool driving shaft 12. The shaft 55 has also adjacent the opposite end thereof a pinion 56 which is keyed to the shaft and meshes with a gear 57 fixed to a countershaft 58 which may be connected by a suitable train of change gears to the work spindle 33. The pulley 54 may be connected to or disconnected from its shaft 55 by means of a suitable clutch 59 which is provided with a shifter which may be actuated either by means of a hand lever 60 or automatically by means of a rock shaft 61 which is connected at one end with the clutch shifter and at its opposite end is provided with an arm 62 which is engaged by collar 63 attached to a rod 64, which is fixed to the work slide 32. By means of the rock shaft 61 and its connections to the work slide and to the clutch shifter the power may be automatically disconnected upon completion of the feed movement of the work slide. Rotation is imparted to the work spindle 33 through a drive shaft 65 which is driven through the usual change gears from counter shaft 58, and the shaft 65 extends through a housing carried by the work slide and within this housing is connected by suitable driving connections with a vertical shaft 66 which has a worm 67 thereon meshing with worm gear 68 fixed to the spindle 33. The work spindle may also be driven through a spur gear 69, fixed to the worm gear 68, and a gear on the shaft 65, the two drives being selectively operable for driving the work spindle at different speeds as fully described in the Lees patent above referred to.

Means are also provided for operating the work slide feed mechanism from the work spindle so that the longitudinal movement of the work spindle shall be at the proper rate with respect to the speed of rotation thereof. To this end the pinion 70 is fixed to the work spindle 33 and meshes with the gear 71 fixed to a countershaft 72, which is connected by a suitable train of change gears 73 with the work carriage feed screw 74, which engages with a suitable nut fixed to the work carriage to move the same along the slideway 29. The outer end of the feed screw 74 is preferably provided with a squared end 75 so that it is adapted to receive a suitable crank han-

dle and be turned manually to shift the work slide.

The machine insofar as it has been described above is old and well known, being substantially the same as that shown in the Lees patent above referred to. The present invention, as applied to the machine above described, and which consists of means by which feed movements may be automatically imparted to the tool carrying head to advance the cutter to the desired depth into the blank and to control the depth of cut during traverse of the blank, will now be described.

The fixed bearing member 41 in which the screw adjusting sleeve 39 is mounted is provided at its outer end with an annular flange 76 which bears against the front face of the supporting frame 1 and, fixed to the flange 76, there is a cam plate 77 which is secured to the flange 76 and to the frame 1 by means of suitable screws 78. Upon the face of the cam plate 77 there are a series of outwardly projecting cam lugs 79 which are spaced equiangularly about the axis of the sleeve 39 and which have a form that is determined by the longitudinal contour of the root surfaces of the gear to be generated. As shown herein, each of the cam lugs 79 has an inclined face 80 and an outer flat face 81, the flat faces 81 of the lugs being in a plane parallel with the face of the plate and at right angles to the axis of the sleeve 39. Between the cam plate 77 and the hand wheel 40, pinion 82 is rotatably mounted on the sleeve 39 and upon the inner face of this pinion there is secured an annular cam plate 83 which is provided upon its inner face with a series of cam lugs 84, spaced about the axis of the sleeve in exactly the same way as the cam lugs on the plate 79 and which may have the same form, these cams as shown herein being provided with inclined side faces and flat outer faces 85 and 86 which are adapted to simultaneously engage the corresponding faces of the cam lugs 79.

In order to automatically impart the desired lateral feed movements to the cutter by the coaction of the cams, means is provided for actuating the movable cam 83 from the work carriage during its movement in the direction of the axis of the blank. As shown herein, a rigid bracket 87 is fixed to the slide 32 above the sleeve 39 by means of suitable bolts 98 and, upon the lower end of this bracket, there is fixed a horizontally disposed rack 88 which meshes with the pinion 82. The rack 88 is adjustably secured to the bracket 87 by means of bolts 89 extending through slots 90 in the rack 88, the slots 90 being disposed longitudinally of the rack and permitting the rack to be adjusted endwise on bracket 87, so that it may be properly position with respect to pinion 82.

The movement of the work carriage 32 along its guide way toward the cutter head causes rack 88 to travel over the pinion 82 and to impart a rotary movement thereto. This rotary movement causes the cam lugs 84 to ride up upon the fixed cam lugs 79 so that the adjusting sleeve 39 and screw 37 are shifted forwardly to shift or feed the tool carrying head toward the axis of the blank during the movement of the work carrying slide.

To stop the outward movement of the sleeve 39 so that the adjustment of the tool head slide can be accomplished by operation of the hand wheel 40, the inner end of the sleeve is provided with an outwardly projecting shoulder 39*a* which is adapted to engage with a washer 91 surrounding the sleeve 39, between the inner end of the fixed bearing member 41 and the shoulder 39*a*. To limit the inner movement of the sleeve 39, the inner edge of the hub of the pinion 82 engages with the flange 76 of the fixed bearing 41 and when so engaged there is a space between the washer 91 and shoulder 39*a* thus providing for a limited outward axial movement of the sleeve 39 which movement is effected by the cams 79 and 84 as described. The sleeve 39 is rotatable in the hub of the pinion 82 in a sleeve bearing 101 therein which has a flange 94 on its outer end disposed between the outer edge of the hub of the pinion 82 and the hub of the hand wheel 40. The hand wheel 40 and the sleeve bearing 101 are clamped together and to the sleeve 39 by means of nuts 95 upon the outer exteriorly threaded end of the sleeve 39, the nuts 95 serving to force the hand wheel inwardly against the flange 94 and the end of the sleeve 101 inwardly against the shoulder 93. The hubs of the pinion 82 abut against the flange 94 and the shoulder 93 as upon end bearings.

In the operation of the machine a cutter is placed upon the spindle 20 or upon the spindle 25 and the gear blank is secured upon the work spindle 33. The hand wheel 40 is then turned in a clockwise direction turning the sleeve 39 and advancing the same along the screw 37 until the inner edge of the hub of the pinion 82 is brought into engagement with the flange 76 of the fixed bearing. Since the sleeve 39 is free to shift rearwardly the tool slide 3 will remain stationary during this part of the hand wheel movement. This adjustment of the sleeve 39 shifts the cams to the position shown in Fig. 10 of the drawings. The movement of the hand wheel 40 is continued and, through the agency of the sleeve 39 and screw 37, the tool slide 3 is caused to approach the gear blank until the distance between the periphery of the cutter and the root circle of the gear is equal to the total distance through which the cams 79 and 84 can move the sleeve 39 endwise in going from the position shown in Fig. 10 to

the position shown in Fig. 8 of the drawings. The rod 45 is now moved forward against the action of the spring 47 and the dog 50 is swung into position back of the collar 49, thus advancing the rod an amount proportional to the thickness of the dog 50. This is preferably made an amount less than the pitch of the screw 37 but sufficient to move the end of the rod 45 into the path of the lug 48 on the hand wheel rim 42. The collar 51 is then brought into contact with the stop member 53 depending from the work carriage 32 and is fastened in this position to the rod 45 by the set screw 52, the rod being thus held in advanced position so that the dog can be returned to its neutral position. The screw 42*a* is now loosened to free the rim 42 which is rotated on the hand wheel 40 until the projection 48 strikes the rod 45 at which time the rim 42 is again locked to the hand wheel by the screw 42*a*. All of the above operation is preliminary to cutting the gear teeth and is for the purpose of automatically controlling the depth of the subsequent cut. When the slide 3 is withdrawn by a counterclockwise movement of the hand wheel 40, the rod 45 will be withdrawn by the spring 47 from the path of movement of the projection 48, and the hand wheel may be turned through any number of counterclockwise revolutions; and when this operation is reversed, the rod 45 will be shifted into the path of the projection 48 during the last revolution of the hand wheel and the tool slide 3 will have been returned to exactly the same position which is occupied when the adjustments of the collar 51 and the hand wheel rim 42 were made.

With the cam lugs 79 and 84 in the position shown in Fig. 10 and the inner edge of the hub of the pinion 82 in engagement with the flange 76 of the fixed bearing member, the machine is started, causing power to be applied to rotate the screw 74 and move the carriage 32 along the slideway 29. The movement of the carriage 32 causes the pinion 82 and the cam plate 83 attached thereto, to be rotated on the sleeve 39 by reason of the movement of the rack 88 over the pinion 82. This will cause the inclined faces 80 and 85 of the cam lugs 79 and 84 to ride upon each other forcing the pinion 82, and the sleeve 39 on which it is mounted outwardly, and shifting the tool slide toward the axis of the gear blank until the outer faces 81 and 86 of the cam lugs are in engagement as shown in Fig. 8. The movement of the cutter slide caused by the engagement of the inclined faces 80 and 85 of the cam lugs causes the cutter to enter the blank to the desired depth and while the outer flat faces 81 and 86 of the cam lugs are in engagement, the cutter will be held at this depth while the gear blank is being moved past the same. When the cam lugs 84 are moved beyond the cam lugs 79, the cutter head is released and may be moved to free the cutter from the blank. The cam lugs may be so positioned that the cutter will enter the blank intermediate the ends thereof, cut the required depth in the blank while the blank is traveling a predetermined distance and be freed from the blank before reaching the end thereof to generate gear teeth intermediate the ends of a blank.

Where a hob is employed the entire gear will be generated upon a single traverse of the blank but where a single cutter is employed it will be necessary to index the blank after each cut, as is well understood in the art. After a gear is completed, it is removed from the spindle and the work carriage returned to its original position causing the cams 79 and 84 to assume the position shown in Fig. 9 of the drawings. The hand wheel 40 is then rotated in a counterclockwise direction causing the shoulder 39*a* of the sleeve 39 to engage the washer 91 and to act through the screw 37 to retract the tool carriage 3. A new gear blank is then inserted and the hand wheel 40 is turned in a clockwise direction until the projection 48 strikes the rod 45, at which time the inner end of the hub of the pinion 82 will engage with the flange 76 and the cutter will have assumed its proper position preliminary to cutting, the cams 79 and 84 being in the position shown in Fig. 10 of the drawings, so that upon starting the machine into operation the cutting cycle will be repeated.

It will be obvious that the cam plates 77 and 83 can be readily replaced by other cam plates provided with cam lugs of different sizes or configuration and that by providing cam lugs of the proper size and shape the cutter may be caused to follow the desired path longitudinally of the gear blank.

Having described my invention, I claim:

1. In a machine of the class described, a stationary main frame, a movable support mounted on the frame and adapted to support a work piece, a tool carriage movable on the frame, a rotatable tool on the carriage, a movable carriage operating element mounted on the main frame, mechanical connections between the operating element and the carriage, means whereby movement of the operating element in one direction is adapted to move the tool carriage to position the tool adjacent to the work piece, and means responsive to movement of the work support whereby movement of the operating element in another direction is effected to feed the tool into the work piece.

2. In a machine of the class described, a stationary main frame, a movable support mounted on the frame and adapted to support a work piece, a tool carriage movable on the frame, a rotatable tool on the carriage, a movable carriage operating element

mounted on the main frame, mechanical connections between the operating element and the carriage, means whereby movement of the operating element in one direction is adapted to move the tool carriage to position the tool adjacent to the work piece, and automatic means responsive to movement of the work support for moving the operating element in another direction to feed the tool into the work piece.

3. In a machine of the class described, a stationary main frame, a work carriage movable on the frame, a work spindle on the work carriage adapted to support a work piece, means for moving the carriage on the frame with a lead movement to give a lead movement to the work piece, a tool carriage movable on the frame, a rotatable tool on the tool carriage, a movable tool carriage operating element mounted on the main frame, mechanical connections between the operating element and the tool carriage, means whereby movement of the operating element in one direction is adapted to move the tool carriage to position the tool adjacent to the work piece, and automatic means whereby the lead movement of the work carriage is adapted to move the operating element in another direction to feed the tool into the work piece.

4. In a machine of the class described, a main frame, a work carriage movable on the frame, a work spindle on the work carriage adapted to support a work piece, means for moving the carriage on the frame to give a lead movement to the work piece, a tool carriage on the frame, a rotatable tool on the tool carriage, a movable tool carriage operating element, a stop on the operating element and a stop on the frame, means whereby movement of the operating element in one direction to engage the stops is adapted to move the tool carriage to position the tool adjacent to the work piece, and automatic means whereby the lead movement of the work carriage moves the operating element in another direction with the stops in engagement to feed the tool into the work piece.

5. In a machine of the class described, a stationary main frame, a movable support mounted on the frame and adapted to support a work piece, a tool carriage movable on the frame, a rotatable tool on the carriage, a carriage operating element mounted on the main frame and rotatable thereon on an axis and movable thereon axially, mechanical connections between the operating element and the carriage, means whereby rotary movement of the element is adapted to move the carriage to position the tool adjacent to the work piece, and means responsive to movement of the work support whereby axial movement of the element is effected to feed the tool into the work.

6. In a machine of the class described, a main frame, a work spindle mounted on the frame and adapted to support a work piece, a tool carriage movable on the frame, a rotatable tool on the carriage, a carriage operating element rotatable on an axis and movable axially, a stop on the operating element and a stop on the frame, mechanical connections between the operating element and the carriage, means whereby rotary movement of the element to bring the stop on the element into engagement with the stop on the frame is adapted to move the carriage to position the tool adjacent to the work piece, and whereby axial movement of the element is adapted to feed the tool into the work.

7. In a machine of the class described, a main frame, a work carriage movable on the frame, a work spindle on the work carriage adapted to support a work piece, means for moving the work carriage with a lead movement, a tool carriage movable on the frame, a rotatable tool on the tool carriage, a carriage operating element rotatable on an axis and movable axially, mechanical connections between the operating element and the tool carriage, means whereby rotary movement of the element is adapted to move the carriage to position the tool adjacent to the work piece and whereby axial movement of the operating element is adapted to feed the tool into the work, and connections between the operating element and the work carriage for moving the element axially and feeding the tool into the work during lead movement of the work carriage.

8. In a machine of the class described, a main frame, a work carriage movable on the frame, a work spindle on the work carriage adapted to support a work piece, means for moving the work carriage with a lead movement, a tool carriage movable on the frame, a rotatable tool on the tool carriage, an operating element for the tool carriage rotatable on an axis and movable axially, a stop on the element and a stop on the frame, mechanical connections between the element and the tool carriage, means whereby rotary movement of the element to bring one stop against the other is adapted to move the tool carriage to bring the tool into a predetermined position adjacent to the work piece, and whereby axial movement of the element is adapted to feed the tool into the work, and connections between the work carriage and the element for automatically moving the element axially and feeding the tool into the work during lead movement of the work carriage.

9. In a machine of the class described, a main frame, a movable tool support on the frame, a movable work support on the frame, a screw-threaded rod and a nut element threaded therewith associated with one of the supports and means for setting up relative rotation between the threaded rod and

nut to propel said support on the frame, and means responsive to movement of the other support on the frame for moving the nut element and rod together in the direction of the rod axis to propel the propelled support with a supplemental movement.

10. In a machine of the class described, a main frame, a movable support on the frame adapted to support a work piece, ways on the frame, a carriage on the ways, a rotary cutting tool on the carriage, a screw-threaded rod mounted on the main frame with its longitudinal axis fixed laterally thereon and a nut element threaded therewith associated with the carriage, means for setting up relative rotation between the rod and nut to propel the carriage on the ways and correspondingly move the tool to position it relatively to the work piece and automatic means responsive to movement of the work support for moving the nut element and rod together in the direction of the rod axis to propel the carriage on the ways to feed the tool into the work piece.

11. In a machine of the class described, a main frame, a work carriage movable on the frame, a work spindle on the work carriage adapted to support a work piece, means for moving the work carriage on the frame with a lead movement, a tool carriage movable on the frame, a rotary cutting tool on the tool carriage, a screw-threaded rod and a nut element threaded therewith associated with the tool carriage, means for setting up relative rotation between the threaded rod and nut to propel the tool carriage on the frame for positioning the tool relative to the work piece and feed control means connected to the work carriage and operable by movement thereof for moving the nut element and rod together in the longitudinal direction of the rod to propel the tool carriage on the frame to feed the tool into the work piece concurrently with the lead movement of the work carriage.

12. In a machine for cutting, in cylindrical blanks, teeth beginning at a point between the ends of the blank, a main frame, a work carriage movable on the frame, a work spindle on the work carriage adapted to support a work piece, a tool carriage movable on the frame, a rotary cutter on the tool carriage, a screw-threaded rod and a nut element threaded therewith associated with the tool carriage, means for setting up relative rotation between the threaded rod and nut to propel the carriage on the frame for positioning the tool with respect to the work piece, means for rotating the tool and concurrently moving the work carriage on the frame with a lead movement, and feed control means connected to the work carriage and operable by the movement thereof for moving the nut element and rod together in the longitudinal direction of the rod to propel the tool carriage on the frame for feeding the tool into the work piece to a predetermined depth only during lead movement of the work carriage.

13. In a machine of the class described, a main frame, a carriage movable on the frame, a propelling screw on the main frame with its longitudinal axis fixed laterally thereon secured to the carriage, an operating nut element threaded on the screw and rotatable thereon and engaging the main frame to move the screw in the direction of its axis and thereby propel the carriage on the frame, means for so rotating the nut element, and means for moving the nut element in the direction of the screw axis to move the screw in that direction to propel the carriage on the frame with a supplemental movement.

14. In a machine of the class described, a main frame, a work spindle on the frame adapted to support a work piece, a carriage movable on the frame, a rotary cutting tool on the carriage, a propelling screw on the main frame with its longitudinal axis fixed laterally thereon secured to the carriage, an operating nut element threaded on the screw and rotatable thereon and engaging the frame to move the screw in the direction of its axis and thereby propel the carriage on the frame to position the tool relative to the work piece, means for so rotating the nut element, and means for moving the nut element in the direction of the screw axis, to move the screw in that direction to propel the carriage on the frame with a movement suitable for feeding the tool into the work piece.

15. In a machine of the class described, a main frame, a work carriage movable on the frame, a work spindle on the work carriage adapted to support a work piece, means for moving the work carriage on the frame with a lead movement, a tool carriage movable on the frame, a rotary cutting tool on the tool carriage, a propelling screw secured to the tool carriage, an operating nut element threaded on the screw and rotatable thereon and engaging the frame to move the screw longitudinally and thereby propel the carriage on the frame for positioning the tool relative to the work piece, means for so rotating the nut element, and feed control means connected to the work carriage and operable by movement thereof for moving the nut element and screw together in the longitudinal direction of the screw to move the screw in that direction to propel the tool carriage on the frame to feed the tool into the work piece concurrently with the lead movement of the work carriage.

16. In a machine for cutting, in cylindrical blanks, teeth beginning at a point between the ends of the blank, a main frame, a work carriage movable on the frame, a work spindle on the work carriage adapted to support a work piece, a tool carriage movable on the frame, a rotary cutter on the tool

carriage, a propelling screw secured to the tool carriage, an operating nut element threaded on the screw and rotatable thereon and engaging the frame to move the screw longitudinally and thereby propel the tool carriage on the frame for positioning the tool relative to the work piece, means for so rotating the nut element, means for rotating the tool and concurrently moving the work carriage on the frame with a lead movement, and feed control means connected to the work carriage and operable by movement thereof for moving the nut element and screw together in the longitudinal direction of the screw to move the screw in that direction to propel the tool carriage on the frame to feed the tool into the work piece to a predetermined depth only concurrently with the lead movement of the work carriage.

17. In a machine of the class described, a main frame, a work carriage movable on the frame, a work spindle on the work carriage adapted to support a work piece, means for moving the carriage on the frame with a lead movement to give a lead movement to the work piece, a tool carriage movable on the frame, a rotatable tool on the tool carriage, a movable tool carriage operating element, mechanical connections between the operating element and the tool carriage, means whereby movement of the operating element in one direction is adapted to move the tool carriage to position the tool adjacent to the work piece, and feed control means connected to the work carriage and operable by lead movement thereof for moving the operating element in another direction to feed the tool into the work piece, said feed control means comprising a cam and a cam follower one of which is adapted to be moved on the other by means of connections between it and the movable work carriage to effect the cam action and one of which is associated with the operating element to move it when the cam action is effected.

18. In a machine of the class described, a main frame, a work carriage movable on the frame, a work spindle on the work carriage adapted to support a work piece, means for moving the work carriage with a lead movement, a tool carriage movable on the frame, a rotatable tool on the tool carriage, a tool carriage operating element rotatable on an axis and movable axially, mechanical connections between the operating element and the tool carriage, means whereby rotary movement of the element is adapted to move the tool carriage to position the tool adjacent to the work piece and whereby axial movement of the operating element is adapted to feed the tool into the work, and feed control means connected to the work carriage and operable by movement thereof to move the operating element axially to feed the tool into the work during lead movement of the work carriage said means comprising a cam and a cam follower one of which is adapted to be moved on the other by means of connections between it and the movable work carriage to effect the cam action and one of which is associated with the operating element and adapted to move it axially when the cam action is effected.

19. In a machine of the class described, a main frame, a work carriage movable on the frame, a work spindle on the work carriage adapted to support a work piece, means for moving the work carriage on the frame with a lead movement, a tool carriage movable on the frame, a rotatable tool on the tool carriage, a screw threaded propelling rod and a nut element threaded therewith associated with the tool carriage, means for setting up relative rotation between the threaded rod and the nut to propel the tool carriage on the frame for positioning the tool with respect to the work piece, and feed control means connected to the work carriage and operable by the movement thereof for moving the nut element and rod together in the longitudinal direction of the rod to propel the tool carriage on the frame for feeding the tool into the work piece concurrently with the lead movement of the work carriage; said feed control means comprising a cam and a cam follower, one of which is adapted to be moved on the other by means of connections between it and the movable work carriage to effect the cam action and one of which is associated with the nut element and rod and adapted to move them when the cam action is effected.

20. In a machine of the class described, a main frame, a work carriage movable on the frame, a work spindle on the work carriage adapted to support a work piece, means for moving the work carriage on the frame with a lead movement, a tool carriage movable on the frame, a rotary cutting tool on the tool carriage, a propelling screw secured to the carriage, an operating nut element threaded on the screw and rotatable thereon and engaging the frame to move the screw longitudinally and thereby propel the carriage on the frame for positioning the tool relative to the work piece, means for so rotating the nut element, and feed control means connected to the work carriage and operable by movement thereof for moving the nut element and screw together in the longitudinal direction of the screw to move the screw in that direction to propel the tool carriage on the frame to feed the tool into the work piece concurrently with the lead movement of the work carriage, said feed control means comprising a cam and a cam follower, one of which is adapted to be moved on the other by means of connections between it and the movable work carriage to effect the cam action and one of which is associated with the nut element and adapted to move it in the longitudinal direction of the screw when the cam action is effected.

21. In a machine of the class described, a stationary main frame, a tool carriage movable on the frame, a work spindle on the frame adapted to support a work piece, a threaded push and pull rod connected to the tool carriage for moving it, a nut element threaded on the rod and mounted on the frame for rotary and axial movement, means for turning the nut element to propel the rod and move the tool carriage into a predetermined position relative to the work spindle, and means for moving the nut element axially to propel the rod with a tool carriage feed movement.

22. In a machine of the class described, a stationary main frame, a movable tool carriage on the frame, a work spindle on the frame adapted to support a work piece, a threaded push and pull rod connected to the tool carriage for moving it, a nut element threaded on the rod and mounted on the frame for rotary and axial movement, a stop on the frame, a stop associated with the nut element for stopping its rotary movement in a predetermined position, means for turning the nut element to bring the stops into engagement and to propel the rod and move the tool carriage into a predetermined position relative to the work spindle, means for moving the nut element axially with the stops in engagement to propel the rod with a tool carriage feed movement relative to the work spindle.

23. In a machine of the class described, a stationary main frame, a movable tool carriage on the frame, a work spindle on the frame adapted to support a work piece, a threaded push and pull rod connected to the tool carriage for moving it, a nut element threaded on the rod and mounted on the frame for rotary and axial movement, a stop on the frame, a stop associated with the nut element for stopping its rotary movement in a predetermined position, means for turning the nut element to bring the stops into engagement and to propel the rod and move the tool carriage into a predetermined position relative to the work spindle, means for moving the nut element axially with the stops in engagement to propel the rod with a tool carriage feed movement relative to the work spindle, and means for automatically limiting the amount of said feed movement to a predetermined amount.

24. In a machine of the class described, a stationary main frame, a tool carriage movable on the frame, a work spindle on the frame adapted to support a work piece, a threaded push and pull rod connected with the tool carriage for moving it, a nut element threaded on the rod and mounted on the frame for rotary and axial movement, means for turning the nut element to propel the rod and move the tool carriage into a predetermined position relative to the work spindle, means for moving the nut element axially to propel the rod with a tool carriage feed movement, said last means including a cam and a cam follower mechanism one of which is mounted on the frame and the other associated with the nut element.

25. In a machine of the class described, a stationary main frame, a tool carriage movable on the frame, a work carriage movable on the frame and adapted to support a work piece, a threaded push and pull rod connected to the tool carriage for moving it, a nut element threaded on the rod, and mounted on the frame for rotary and axial movement, means for turning the nut element to propel the rod to move the tool carriage into a predetermined position relative to the work carriage, and means for moving the nut element axially to propel the rod with a tool carriage feed movement, said means being connected to and operable by movement of the work carriage.

26. In a machine of the class described, a stationary main frame, a tool carriage movable on the frame, a work carriage movable on the frame and adapted to support a work piece, a threaded push and pull rod connected to the tool carriage for moving it, a nut element threaded on the rod, and mounted on the frame for rotary and axial movement, means for turning the nut element to propel the rod to move the tool carriage into a predetermined position relative to the work carriage, and means for moving the nut element axially to propel the rod with a tool carriage feed movement, including a cam and cam follower mechanism connected to and operable by the movement of the work carriage.

27. In a machine of the class described, a stationary main frame, a tool carriage movable on the frame, a work carriage movable on the frame and adapted to support a work piece, a threaded push and pull rod connected to the tool carriage for moving it, a nut element threaded on the rod, and mounted on the frame for rotary and axial movement, means for turning the nut element to propel the rod to move the tool carriage into a predetermined position relative to the work carriage, and means for moving the nut element axially to propel the rod with a tool carriage feed movement, said means including a cam and cam follower, one of which cam members is mounted on the main frame and the other of which is associated with the nut element, and connections between the latter cam member and the work carriage for moving the cam member.

28. In a machine of the class described, a stationary main frame, a tool carriage movable on the frame, a work carriage movable on the frame and adapted to support a work piece, a threaded push and pull rod connected

to the tool carriage for moving it, a nut element threaded on the rod, and mounted on the frame for rotary and axial movement, means for turning the nut element to propel the rod to move the tool carriage into a predetermined position relative to the work carriage, and means for moving the nut element axially to propel the rod with a tool carriage feed movement, said means including a cam and cam follower, one of which cam members is on the main frame, and the other of which is rotatably mounted on the nut element, and connections between the latter cam member and the work carriage for moving the cam member.

29. In a machine of the class described, a stationary main frame, a tool carriage movable on the frame, a work carriage movable on the frame and adapted to support a work piece, a threaded push and pull rod connected to the tool carriage for moving it, a nut element threaded on the rod, and mounted on the frame for rotary and axial movement, means for turning the nut element to propel the rod to move the tool carriage into a predetermined position relative to the work carriage, and means for moving the nut element axially to propel the rod with a tool carriage feed movement, said means including a cam on the main frame, an annular cam follower surrounding the nut element and rotatable thereon on the axis thereof, gear teeth on the came follower and a rack on the work carriage engaging the gear teeth for rotating the cam follower.

In testimony whereof, I have hereunto signed my name.

EDWARD A. BAYTON.