March 6, 1951 W. S. PRAEG 2,543,985

METHOD AND APPARATUS FOR FINISHING RACK SECTIONS

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FIG.1.

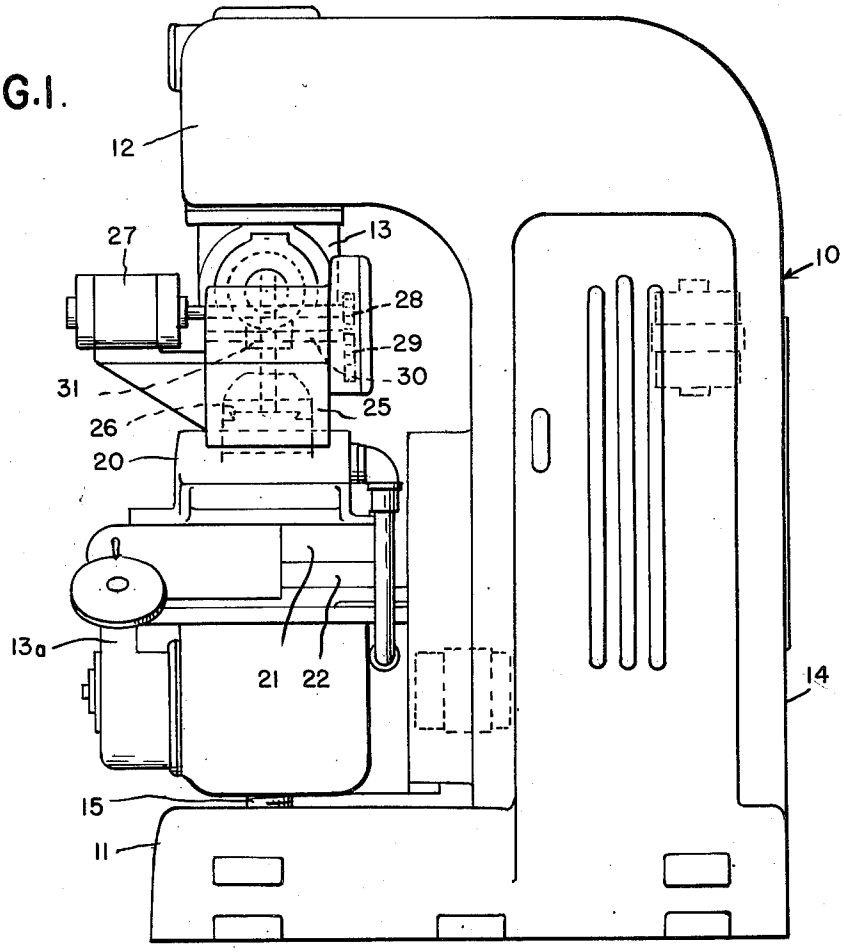


FIG.4.

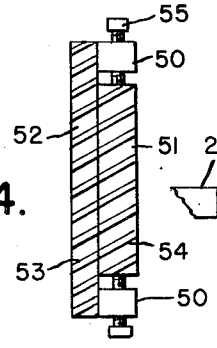
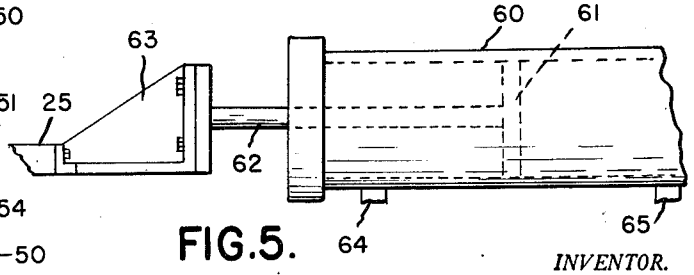


FIG.5.



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METHOD AND APPARATUS FOR FINISHING RACK SECTIONS

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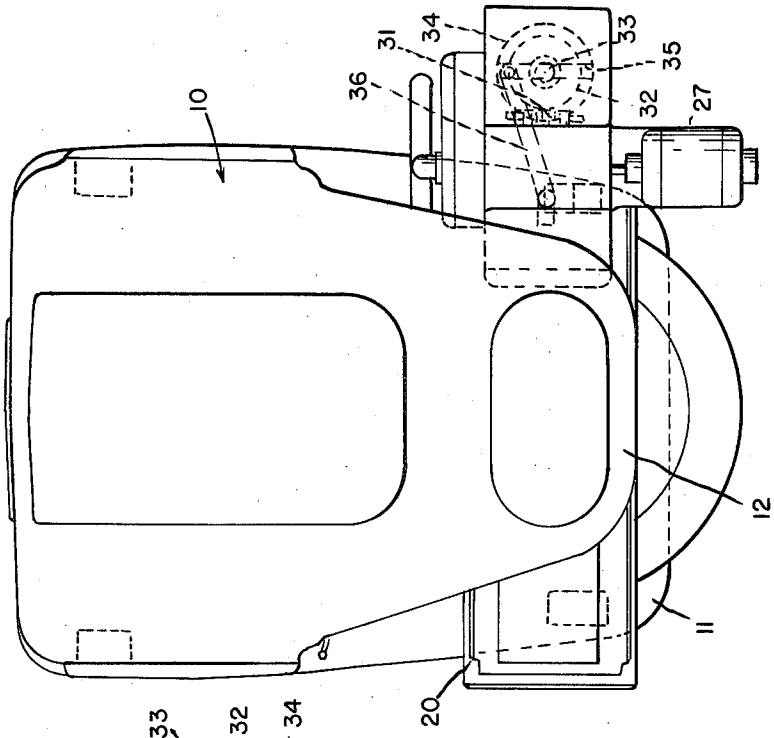

FIG. 3.

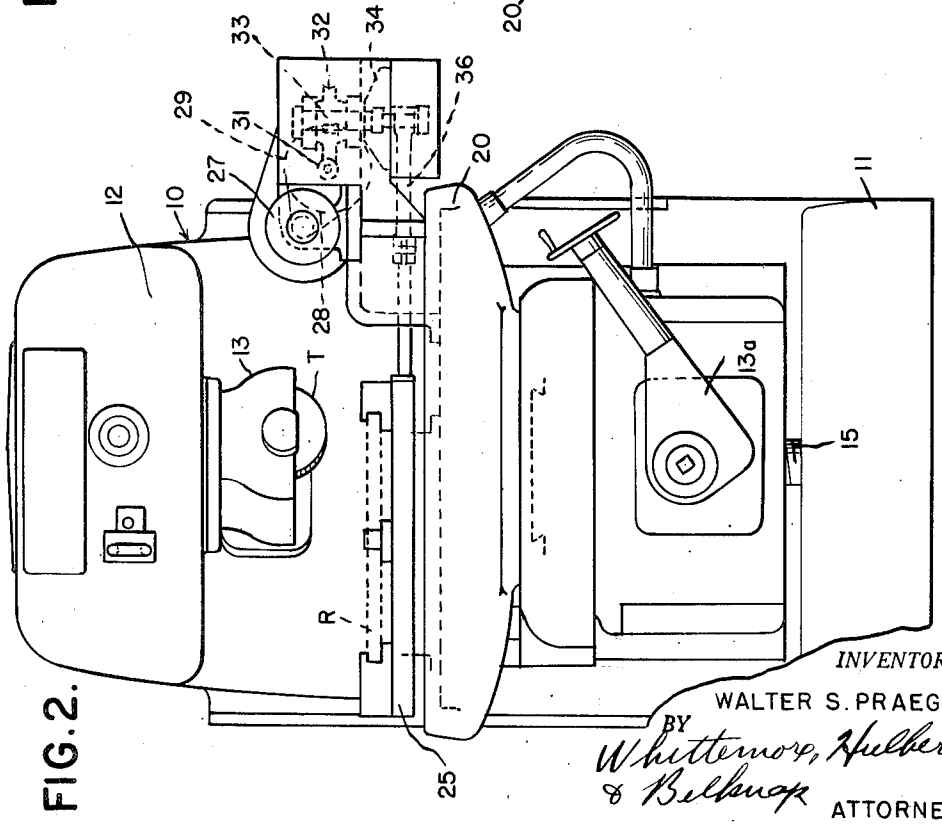

FIG. 2.

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METHOD AND APPARATUS FOR FINISHING RACK SECTIONS

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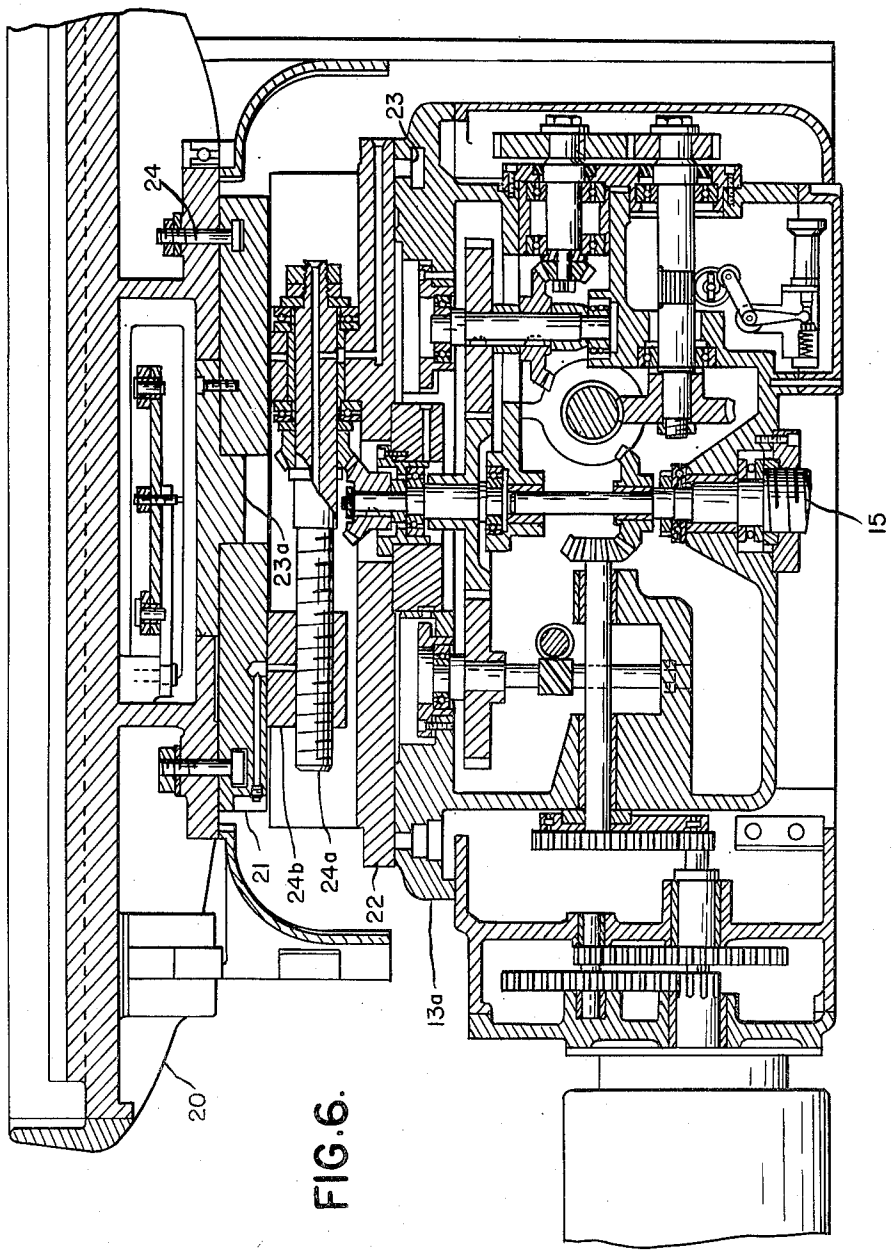

FIG. 6.

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METHOD AND APPARATUS FOR FINISHING RACK SECTIONS

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6 Claims. (Cl. 90—1.6)

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The present invention relates to method and apparatus for finishing rack sections.

It is an object of the present invention to provide a method and apparatus for finishing the teeth of a rack section by reciprocating the rack longitudinally in mesh with a gear-like tool, the plane of which extends at an angle of less than 30° to the direction of reciprocation.

It is a further object of the present invention to provide method and apparatus for finishing the teeth of a rack section in which relative longitudinal reciprocation of the rack is carried to a point at which a rotary gear-like cutter passes out of mesh with the end of the rack.

It is a further object of the present invention to provide method and apparatus for finishing the teeth of a rack section characterized by a substantially constant relative speed of reciprocation between the rack and tool throughout at least the major portion of the reciprocatory stroke.

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

Figure 1 is a side elevation of the improved machine for finishing rack sections;

Figure 2 is a front elevation of the machine shown in Figure 1;

Figure 3 is a plan view of the machine shown in Figure 1;

Figure 4 is a fragmentary view illustrating the use of a tool guiding fixture in conjunction with the rack to be shaved;

Figure 5 is a fragmentary view illustrating the use of a piston and cylinder as the driving means for the rack shaving machine;

Figure 6 is a fragmentary vertical section showing the details of the table adjusting and traversing mechanism.

In accordance with the present invention, the teeth of a rack section are finished by engagement with the teeth of a rotary finishing tool.

The rotary finishing tool is in the form of a gear and it may operate as a shaving cutter, in which case the flanks of its teeth are provided with narrow grooves providing intermediate lands having sharp cutting corners occupying the tooth surfaces. On the other hand, the finishing tool may be in the form of a lap, in which case it is formed of cast iron or equivalent material and its finishing action is obtained through the use of an abrasive introduced between the meshing teeth of the rotary tool and the rack.

Referring now to Figures 1 to 3, the machine comprises a main frame 10 including a forwardly

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extending base 11 and a forwardly extending overhanging portion 12 to which is secured a tool support 13. The tool support 13 is angularly adjustable about a vertical axis to set up the desired degree of angularity between the axis of the tool and the direction of traverse of the rack section to be shaved. The machine includes a vertically adjustable knee 13a which is slidable in vertical ways provided at the front of the column 14, an adjustable feed screw indicated at 15 being provided to effect vertical adjustment of the knee. Mounted at the top of the knee is a table 20 and between the table 20 and the knee 13a are a pair of plates 21 and 22 which are angularly adjustable as a unit about a vertical axis and which have cooperating rectilinear ways provided therebetween. The plate 21 is slidable along the ways relative to the plate 22 and the table 20 is adapted to move in translation with the upper plate 21.

The foregoing structure is well illustrated in Figure 6. In this structure it will be observed that the lower plate 22 is rotatable about a vertical axis on the knee which is provided with circular T-slots indicated at 23 so that the plate 22 may be locked in angularly adjusted position. The plates 21 and 22, which as previously stated are provided with interfitting longitudinally extending ways, are rotatable as a unit. In order to maintain the table 20 in position without disturbing its orientation the table is provided with a pilot 23a received in a corresponding circular opening in the top of the plate 21, and is provided with bolt means indicated generally at 24 for locking the table in position after adjustment of the plates 21 and 22. Relative adjustment between the plates 21 and 22 along their interfitting ways is accomplished by means of a feed screw 24a mounted on the lower plate 22 and cooperating with a feed nut 24b depending from the upper plate 21. Carried by the table 20 is a rack supporting fixture or slide indicated at 25 in which a rack R to be shaved is positioned. The slide 25 is mounted for reciprocation in suitable ways 26. Means are provided for effecting a relatively rapid back and forth traverse of the slide 25 and this means comprises a motor 27 carried by and extending forwardly from the table 20. The motor 27 drives a pulley 28 which in turn drives a second pulley 29 secured to a shaft 30 carrying a worm 31. The worm 31, as best seen in Figure 2, engages a worm wheel 32 keyed or otherwise secured to a shaft 33. The shaft 33 in turn is provided with a disk crank 34 having a transverse slot 35 formed therein in which one

end of a link 36 is adjustable. By adjusting the end of the link at different distances from the center of the crank 34, the travel of the slide 25 will be adjusted, as is readily apparent.

In operation the rack R is mounted so that its longitudinal axis extends horizontally transversely of the machine and parallel to the direction of reciprocation of the slide 25. The adjustable cutter head 13 is set with the tool axis at an angle to the direction of traverse of the slide and with the teeth of a finishing tool disposed so as to mesh with the teeth of the rack R. At this time back and forth traverse of the slide 25 is initiated and due to the angular relationship between the direction of traverse and the axis of the gear-like tool, a cross sliding action between the surfaces of the teeth of the rack R and the teeth of the tool T results. Thus if the tool is in the form of a gear shaving cutter provided with cutting edges extending generally up and down the surfaces of its teeth, these cutting edges will be effective to shave the teeth of the rack section.

In the event that the width of the rack section is greater than the effective width of the tool T, it may be desirable to effect the shaving of the rack section in steps and to accomplish this the plates 21 and 22 may be angularly adjusted until the direction of the ways therebetween is from the front to the back of the machine. Thus the upper plate 21 together with the table 20 and the rack supporting fixture or slide 25 may be adjusted forwardly or rearwardly with respect to the machine to bring different portions of the rack beneath the cutting tool T.

The operation is carried out at substantial speeds. In a typical operation, a tool having a diameter of nine inches, a diametral pitch of twelve, the teeth being of 20° pressure angle and 17° helix angle, was employed with a spur rack having a length of about four and one-half inches. The slide 25 was reciprocated through a four and five-eighths inch stroke at a rate of eighty-seven strokes per minute. In carrying out the operation the knee was vertically adjusted until the tool, which in this case was a shaving cutter, was in tight mesh therewith and was thereafter fed upwardly intermittently by increments of .001 inch until total up-feed had amounted to .010 inch. This up-feed was timed with the operating cycle so that it took place at the end of a stroke. This operation machined the teeth of the rack from end to end of the rack, producing a desirable surface finish thereon and a very satisfactory involute profile.

In the apparatus as thus far described the relative reciprocation between the rack and tool necessarily includes stoppage and reversal while the teeth of the tool are in contact with the end teeth of the rack. This condition is not fatal to the satisfactory finishing of rack teeth but in some cases it is desirable to provide for a more uniform result, in which case a holding and guiding fixture as illustrated in Figure 4 may be employed. In this figure the work supporting means may include a pair of fixed blocks 50 between which the rack section 51 is mounted, the blocks 50 being short enough so as to avoid interference with a rotary finishing tool as it passes out of mesh with the rack 51 at either end of the stroke. Extending between the blocks 50 is a tool guide 52 having teeth 53 similar to the tooth 54 of the rack 51. Adjusting screws 55 or equivalent means are provided in association with the blocks 50 for adjusting the rack 51 longitudinally so as to place the teeth 53 and 54 in endwise alignment. A

rotary cutter is then placed in mesh with the angular relationship previously described so that it contacts the teeth 54 of the rack from end to end and also contacts the teeth 53 of the guide for a distance sufficient to insure proper cooperation therewith. With this structure the slide may be operated for a longer stroke so as to cause the teeth of the rotary tool to come completely out of mesh with the teeth of the rack, it being maintained in proper meshing relation therewith by remaining in engagement with the teeth 53 of the guide beyond the ends of the rack 51. By employing this construction a substantially uniform relative speed of reciprocation between the tool and rack will be maintained so long as the tool remains in mesh with the rack. Stoppage and reversal of the parts takes place when the rotary tool is in mesh only with the guiding means beyond the ends of the rack.

Referring now to Figure 5, another embodiment of the invention is illustrated which is in all respects similar to that shown in Figures 1 to 3 with the exception that the motive means for reciprocating the work supporting fixture 25 in this case takes the form of a cylinder 60 in which is reciprocatable a piston 61 having a piston rod 62 connected through a bracket 63 with one end of the rack supporting slide 25. Suitable inlet and outlet connections to the cylinder 60 are illustrated at 64 and 65. Conventional valve means are provided for effecting back and forth reciprocation of the piston 61 and this means may control both the length of stroke as well as the speed of reciprocation. This type of reciprocating means has the advantage that the speed of traverse in each direction of reciprocation may be constant substantially throughout the entire stroke and stoppage and reversal may take place abruptly.

The adjustability between the plates 21 and 22, as above described, provides a second function in addition to its use in providing adjustment when a relatively wide rack section is to be finished. Thus, for example, if a rack section whose length exceeds the length of stroke of the machine is to be shaved, plates 21 and 22 may be adjusted as a unit about a vertical axis until the direction of the intermediate ways extends parallel to the direction of reciprocation of the rack section. Thereafter the upper plate 21 may be adjusted laterally of the machine so as to shave different longitudinal sections of the rack. The above described arrangement also permits shaving a rack section which is not only of greater length than the length of stroke of the machine but also a rack section which is of greater width than the effective width of the cutter. In this case, by way of example, the shaving action cutter may be applied to four different areas of the rack section, these areas being located at the corners of the rack section and preferably overlapping so as to provide for a smooth uniform finishing operation.

The drawings and the foregoing specification constitute a description of the improved method and apparatus for finishing rack sections in such full, clear, concise and exact terms as to enable any person skilled in the art to practice the invention, the scope of which is indicated by the appended claims.

What I claim as my invention is:

1. The method of finishing the teeth of a rack section which comprises providing a rack with toothed guide means extending beyond the ends of said rack, the teeth of said means being in

endwise alignment with the teeth of said rack, providing a rotary gear-like tool in position to mesh with the teeth of both said rack and said guide means, and rapidly reciprocating said rack and guide means as a unit longitudinally of said rack between limiting positions in which said tool has passed out of mesh with said rack but remains in mesh with said guide means.

2. The method of finishing the teeth of a rack section which comprises providing a rack with toothed guide means extending beyond the ends of said rack, the teeth of said means being in endwise alignment with the teeth of said rack, providing a rotary gear-like tool in position to mesh with the teeth of both said rack and said guide means, and rapidly reciprocating said rack and guide means as a unit longitudinally of said rack between limiting positions in which said tool has passed out of mesh with said rack but remains in mesh with said guide means, said reciprocation being at a substantially uniform rate while the tool remains in mesh with the teeth of said rack.

3. A rack finishing machine comprising a frame, a tool support including means for mounting a gear-like tool for rotation about its axis, means for angularly adjusting said support about an axis perpendicular to the axis of rotation of the tool, a ram reciprocably mounted on said frame for movement in a plane parallel to the axis of rotation of tool and perpendicular to the axis of adjustment of said tool support, means on said ram for mounting a rack section in meshed engagement with said tool, said rack mounting means including toothed guide means extending beyond the ends of a rack carried thereby, its teeth being in endwise alignment with the teeth of a rack carried thereby, said guide means remaining in meshed contact with said tool at the ends of stroke when said tool has passed out of mesh with said rack, and means for effecting repeated back and forth reciprocation of said ram.

4. A rack finishing machine comprising a frame, a tool support including means for mounting a gear-like tool for rotation about its axis, means for angularly adjusting said support about an axis perpendicular to the axis of rotation of the tool, a ram reciprocably mounted on said frame for movement in a plane parallel to the axis of rotation of tool and perpendicular to the axis of adjustment of said tool support, means on said ram for mounting a rack section in meshed engagement with said tool, said rack mounting means including toothed guide means extending beyond the ends of a rack carried thereby, its teeth being in endwise alignment with the teeth of a rack carried thereby, said guide means remaining in meshed contact with said tool at the ends of stroke when said tool has passed out of mesh with said rack, and means for effecting repeated back and forth reciprocation of said ram, said last means being effective to produce substantially constant speed of said ram while said tool remains in engagement with said rack.

5. A machine for finishing a rack comprising a frame, a tool support on said frame including means for mounting a gear-like tool for rotation about its axis, a work support on said frame for supporting a work piece in the form of a toothed rack having rack teeth conjugate to the teeth of the tool, toothed guide means on said work support having toothed portions extending beyond the ends of the work piece, the teeth of said guide means being disposed to form longitudinal extensions beyond the ends of the work piece, means for effecting angular adjustment between said tool support and work support about an axis perpendicular to the plane of the work piece, and means for effecting relative rapid back and forth traverse between said work support and tool support in a direction having a major component parallel to the longitudinal axis of the work piece for a distance such that the tool comes out of mesh with the work piece at both ends of the traverse strokes but remains in mesh with said guide means.

6. A machine as defined in claim 5 in which means are provided independent of the means for effecting angular adjustment between the work support and tool support for effecting an adjustment of the direction of relative traverse between the work support and tool support with respect to the longitudinal axis of the work piece.

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