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3,367,159

GEARED PROFILE-ROLLING HEAD

Filed March 9, 1965

4 Sheets-Sheet 1

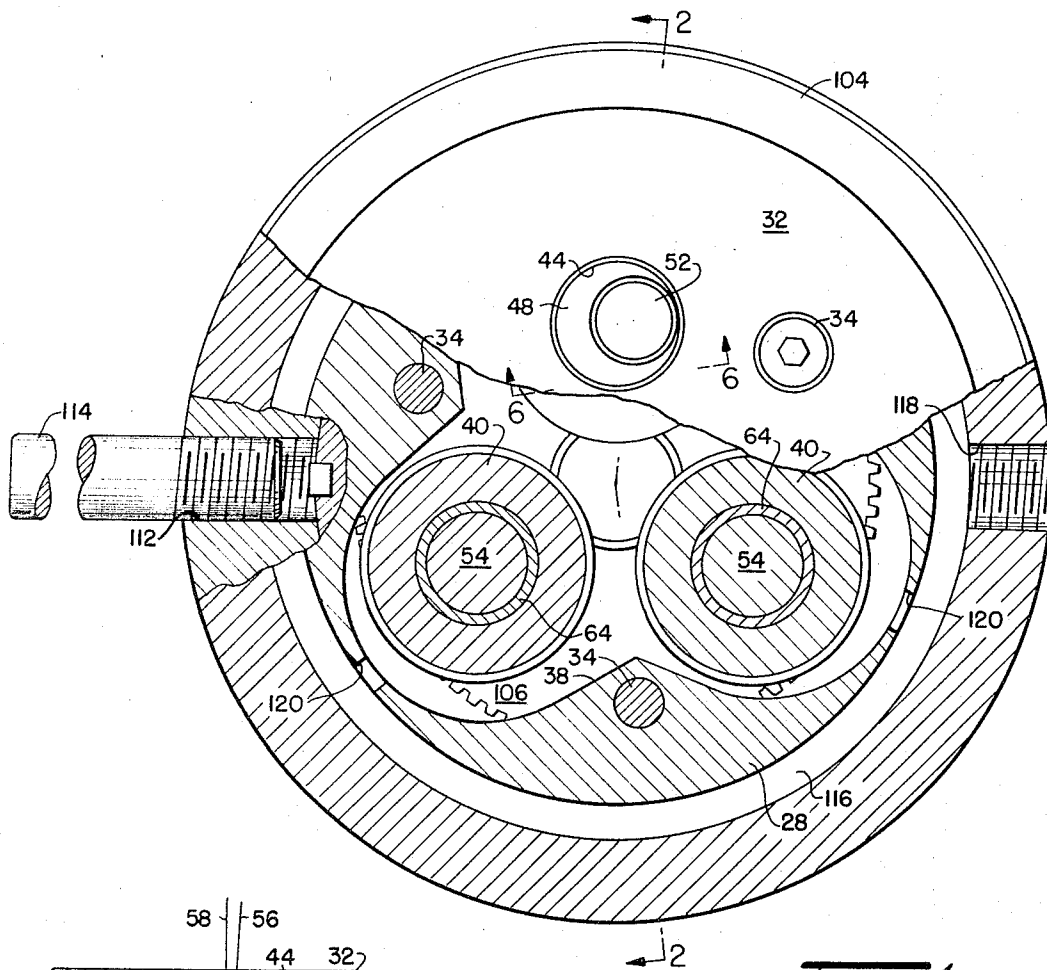


FIG. 1

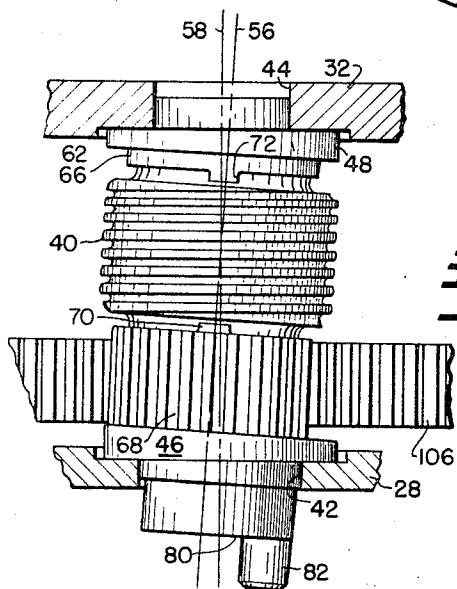


FIG. 6

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Fig. 3

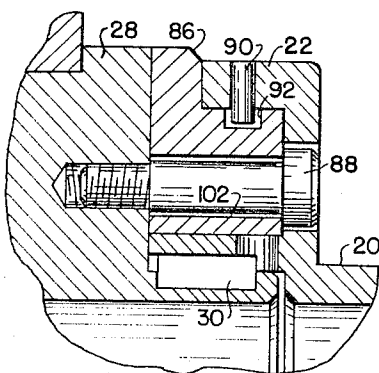
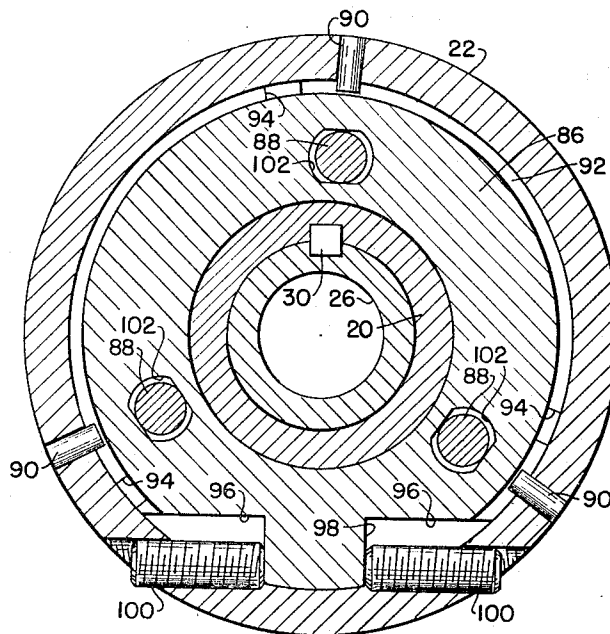


Fig. 5

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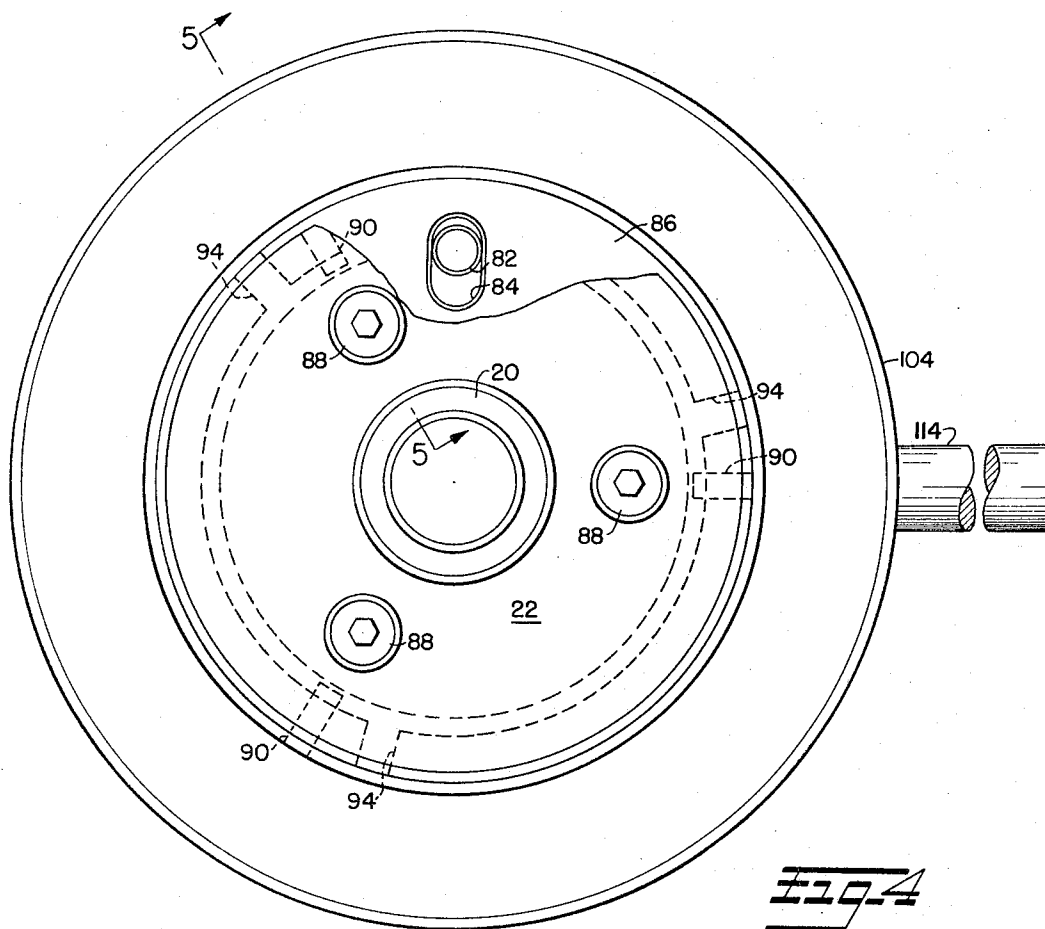


Fig. 4

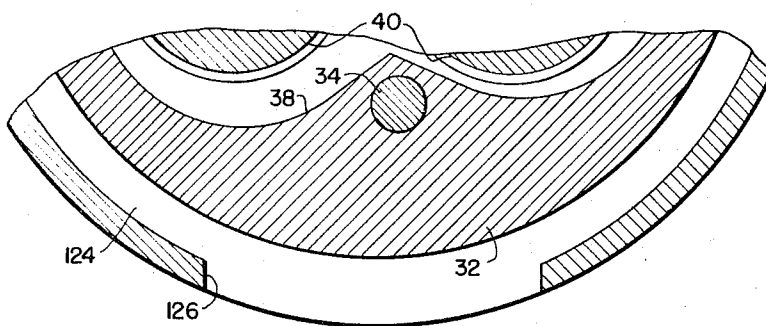


Fig. 1

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ABSTRACT OF THE DISCLOSURE

Tool for rolling threads, splines or like formations on a workpiece, said tool having a plurality of dies carried by a rotatable head. The head includes a stationary part connected to drive each of the dies upon rotation of the head. The dies are arranged to produce axial feed of the workpiece without substantial rotation of the workpiece.

This invention relates to profile rolling and more particularly to heads having rotating rolling dies for generating screw threads, splines and the like in workpieces by the cold-rolling method.

In many instances thread and spline rolling operations have been performed with rolling dies to which a driving force has been applied independently of the workpiece. The alternate mode of operation, practiced where it is not feasible to apply power to the individual rolling dies, is to amount cylindrical rolling dies for free rotation in a tool, then positively rotate the tool while holding the workpiece stationary or drive the workpiece while holding the tool stationary.

In this operation, therefore, the rolling dies are rotated solely by their frictional contact with the workpiece.

Such operation has the considerable disadvantage of imposing a torque on the workpiece while the profile is being rolled. This in turn requires a chuck or grip mechanism for holding the workpiece, induces a certain amount of torsional distortion in the workpiece and requires an axial portion of the workpiece to be reserved for gripping space. Accordingly, it is not possible, for example, to roll a continuous thread on a long bar without opening and closing the grips a number of times.

The principle of positively driven rolls, which obviates the above disadvantages, has heretofore been employable on such machines as single-purpose thread rolling machines, and has not been applicable to tools such as thread and spline rolling heads employed on automatic screw machines and the like. A need exists, therefore, for a device having rotatively driven rolling dies for application to such multi-purpose machines.

The profile-rolling head of this invention fills this need by providing a relatively small, simple and compact device having rolling dies that are driven positively with respect to the workpiece. Consequently, the workpiece can be fed to the rolling dies with support means only and without gripping. Thus, threads can be rolled on any length of blank rod that can conveniently be supported, without damage to the workpiece by grip indentations and without applying any torsional force to the workpiece. Such a device is particularly advantageous in rolling splines and other toothed members requiring accurate tooth spacing around the circumference of the part (circular pitch).

The profile-rolling tool or head of the present invention is adapted to be mounted on a rotating spindle of an automatic screw machine, for example, and to be driven thereby. The substantially cylindrical rolling dies

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are mounted on shafts in the head and are provided with driving gears which mesh with a surrounding internal gear. By holding the internal gear stationary by means of any convenient stationary part of the machine to which the head is applied, the gears on the rolling die shafts and the rolling dies may be driven in the direction of rotation opposite to that of the machine spindle on which the head is mounted. As will appear from the detailed description, the rolling dies will rotate much faster than the surrounding internal gear, yielding the significant added advantage that the machine spindle need be driven at only a fraction of the speed required for driving those rolling heads in which the rolling dies are rotated by their contact with the workpiece.

Accordingly it is an object of this invention to provide a profile-rolling tool for use on rotating spindle, multi-purpose machines and having positively driven rolling dies for relieving the workpiece of torsional forces.

Another object of the invention is to provide a head for rolling threads, splines and the like, for application to a rotating machine spindle and having cylindrical rolling dies operated by a common driving gear held stationary while the head rotates.

A further object is the provision of a rolling head as described above in which the axes of the rolling dies are inclined with respect to the head axis to induce axial movement of the workpiece during the rolling operation.

A still further object of the invention is to provide a head as described above in which the rolling dies are journaled upon eccentric shafts for the purpose of effecting a fine adjustment of the rolling diameter.

A further object is the provision of a rolling head as described above having means for delivering coolant directly to the rolling dies.

Further objects and advantages of the invention will be apparent from the following detailed description of an embodiment of the invention and from the accompanying drawings, wherein:

FIGURE 1 is a front view of a thread rolling head embodying the invention, partially in section along line 1-1 of FIGURE 2;

FIGURE 2 is a longitudinal section taken along line 2-2 of FIGURE 1;

FIGURE 3 is a transverse section taken along line 3-3 of FIGURE 2;

FIGURE 4 is a rear view of the head, partially in section along line 4-4 of FIGURE 2;

FIGURE 5 is a fragmentary section taken along lines 5-5 of FIGURE 4;

FIGURE 6 is a fragmentary section taken along line 6-6 of FIGURE 1; and

FIGURE 7 is a fragmentary section taken along line 7-7 of FIGURE 2.

As best shown in FIGURE 2 the head comprises a hollow shank 20 for supporting all other parts of the head and by means of which the head may be mounted in the operative end of a rotating machine spindle as is well understood in the art. The forward end of shank 20 is formed integrally with a flange portion 22 and has a forwardly facing, cylindrical, central recess 24 to receive a mating cylindrical projection 26 formed as a part of a head body 28. The projecting portion 26 centers the head body in the recess 24 of the shank 20. A key 30 (FIGURES 3 and 5) drivingly connects the head body 28 and the shank 20.

A front cap 32 having a central bore 33 for workpiece

entry is secured to the forward part of the head body 28 by cap screws 34. The head body 28 is formed with a deep three-lobed, forwardly facing recess 36. A matching, rearwardly facing recess 38 is machined in the front cap 32. The chamber formed by the combined recesses 36 and 38 houses the thread rolling dies 40, which are three in number in the present embodiment, and the die driving mechanism to be described later.

The manner of mounting the thread rolling dies is best shown in FIGURES 2 and 6. There it will be seen that, for each thread rolling die 40, a circular opening 42 is provided in the head body 28 in alignment with a similar opening 44 in the front cap 32. Thrust bushings 46 and 48, respectively, are mounted in the openings 42 and 44 and have aligned openings to receive the opposite ends, respectively, of a die shaft 50 having an enlarged central portion 54 which is slightly eccentric with respect to the shaft end portion. The bushings 46 and 48 have flange portions abutting the shoulders formed by the enlarged central portion 54.

When the shaft 50 is rotated within the bushings 46, 48 the axis of the rolling die and therefore its operative surface is displaced radially with respect to the axis of the head because of the eccentricity of the shaft portion 54.

The central portion of the shaft is surrounded by a sleeve bearing 64 upon which are journaled, in order from front to rear, a thrust washer 66, the rolling die 40 and a helical gear 68. As shown in FIGURE 6, both ends of the rolling die 40 have transverse keyways 70 and 72 for drivingly engaging mating keys formed integrally on the adjacent end faces of gear 68 and washer 66, respectively. Since the purpose of this keyed connection is solely to establish a driving connection between the rolling die 40 and the gear 68, keyways are provided on both sides of rolling die 40 to enable the die to be reversed end for end after one end has become worn in use. Accordingly, the purpose of the washer 66 is to prevent the unused keyway 72 from damaging the front bushing 48.

It is well known that, for a rolling die to induce axial movement in the workpiece during rolling, the axis of the rolling die must be inclined with respect to that of the workpiece. In accordance with this principle, the axis 56 of the die shaft portion 54 and consequently of the rolling die 40 is inclined with respect to the axis 58 of the workpiece and rolling head in the plane of FIGURE 6. When screw threads are being rolled, the extent of this inclination may equal the lead angle of the workpiece, the result of which is that the ridges and grooves on the rolling die are annular and without lead. Inasmuch as the openings 42 and 44 in the head body 28 and front cap 32 for the bushings 46 and 48, respectively, are parallel to the axis 58 of the head, the above-mentioned inclination of the die axis 58 requires that the openings in bushings 46 and 48, in which the shaft ends are journaled shall be inclined with respect to the external peripheral surfaces of the bushings. By replacing the bushings 46 and 48 with others having differently inclined bores, the head can be adapted to roll a thread having a different helix angle. It will be noted that the thrust surfaces of the bushing flanges, respectively, are perpendicular to the inclined bores to present plane wear surfaces to the adjacent gear 68 and washer 66.

Each die shaft 50 has a cylindrical rearward projection 78 concentric with the rear shaft bearing portion. A crank 80, keyed to projection 78 has a rearwardly projecting, cylindrical portion 82 (FIGURES 2 and 4) engaging the sides of an elongated slot 84 of an adjusting ring 86. The adjusting ring 86 is mounted in an annular recess of rectangular cross section in the flange portion 22 of the shank 20, and has a portion extending to the outer periphery of the head between the flange portion 22 and the rear surfaces of the head body 28. A plurality of screws 88 (FIGURES 4 and 5), threaded into the rear of the head body 28, secure the adjusting ring 86 in posi-

tion axially. A plurality of pins 90 (FIGURES 3 and 4) are embedded in radial holes in the flange portion 22 of the shank 20 and project inwardly into a groove 92 of rectangular cross-section, formed in the circumference of the adjusting ring 86 inside the flange portion 22, to prevent axial movement between the shank 20 and the remainder of the head. Axially directed slots 94 communicate with the groove 92 and the rear face of the adjusting ring 86 to permit assembly and disassembly of the shank 20.

As shown in FIGURE 3, opposed slots 96 are milled in the adjusting ring 86 to leave a land 98 having opposed parallel walls for engagement by a pair of tangentially directed screws 100 threaded in the flange 22 of shank 20. In operation, the screws 100 are maintained in engagement with the opposite sides of land 98 to prevent relative movement of the adjusting ring 86 relative to the shank 20. Loosening one screw 100 and tightening the other changes the relative relative positions of adjusting ring 86 and the shank 20, with a size adjusting effect to be explained further below. It will be noted that the holes 102 provided in the adjusting ring 86 for the screws 88 are elongated to permit such relative rotation (FIGURE 3).

A drive ring 104 surrounds the front cap 32 and a part of the head body 28, and has mounted in its interior an internal ring gear 106 which surrounds and meshes simultaneously with all of the gears 68 mounted on the rolling die shafts 50. When a change is made to a different angle of inclination of the rolling die shaft 50, gears 68 are exchanged for others of different helix for proper engagement with the ring gear 106. Space for the internal gear 106 is provided by a groove 108 in the forward portion of head body 28 and the gear is retained in position by the front cap 32. Keys 110 (FIGURE 2) prevent relative rotation between the internal gear 106 and drive ring 104. A radially directed threaded hole 112 (FIGURE 1) is provided in the drive ring 104 to receive the threaded end of a rod 114 which projects a substantial distance outwardly from the circumference of the ring.

An annular groove 116 of rectangular cross-section is formed in the interior of the drive ring 104 to receive coolant through the threaded hole 118 which may be connected by piping not shown, to a convenient source of coolant. The coolant flows from the groove 116 through openings 120 in the front cap 32 directly onto the profiled surfaces of the rolling dies 40. After flowing around the rolling dies, the coolant leaves through the openings 122, equal in number to the thread rolling dies and formed in the front cap 32 forwardly of the openings 120, into an annular groove 124 in the interior of the drive ring 104 forwardly of the groove 116. The outer wall of groove 124 is removed at the bottom thereof as at 126 (FIGURE 7) to permit the coolant to flow out of the head and into the bed of the machine on which the head is being used.

The head is adapted for precise adjustment within narrow limits. Accommodation of the head to different sizes of screw threads or splines is effected by altering the diameter of the rolling dies, that is, by providing rolling dies having a diameter that is accommodated to the nominal size of the workpiece. The precise adjustment is effected by moving the tangential screws 100 in either direction depending upon whether an increase or decrease in the rolling diameter is desired, thus rotating the adjusting ring 86 relative to the shank 20 and therefore relative to the head body 28 to which the shank is keyed. Rotation of adjusting ring 86 causes the elongated openings 84 to rock the crank levers 80 by means of their projections 82 and thus to rotate the roll shafts 50 a small amount. As explained above, rotation of the roll shafts will cause the rolling dies to be moved radially toward or away from the axis of the head. This adjustment is limited in extent because the gears 64 participate in this radial move-

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ment and therefore change their condition of engagement with the internal gear 106.

In operation, the rolling head is mounted on a machine tool by affixing the shank 20 in the conventional manner to the rotatable spindle of a suitable machine tool. The rotative motion of the spindle is imparted to the shank 20, adjusting ring 86, head body 28 and front cap 32. The drive ring 104, however, is held stationary by arranging for the rod 114 to be in contact with any convenient stationary portion of the machine. Consequently, while the axes of the rolling dies rotate with the spindle, the gear 106 is held stationary and its engagement with the gears 68 cause the latter to rotate in a direction opposite to the spindle rotation and at a much faster speed. The keyed connections at 70 between gears 68 and dies 40 therefore drive the latter to roll profiles on workpieces without imparting torque thereto. Since the drive ring 104 is stationary during the rolling operation, the coolant is discharged downwardly through the opening 126 instead of being thrown off tangentially as is usually the case with rotating heads.

The head does not open and close at the completion of an individual rolling operation but is particularly adapted to roll profiles continuously on relatively long workpieces that pass rearwardly through the shank of the head and the spindle of the machine as they are completed.

As described above the rolling dies are provided with a thread profile in the form of annular grooves without helix. The inclination of the roll axes at the lead angle of the thread being rolled aligns the annular grooves of the rolling dies with the helix being formed on the workpiece. The magnitude of this inclination of the roll axes is determined by the desired rate of axial movement of the workpiece, as is well understood in the art. If helical teeth are to be rolled whose helix angle is quite different from the angle of inclination of the rolling die axis required for proper axial feed, the required angle of inclination of the rolling die axis is first established and the angle of inclination of the teeth on the die relative to the axis thereof results from the combination of the work helix angle and the angle of inclination of the die axes. Thus, if an angle of inclination of the rolling die axes of 3 degrees is required for proper axial feed of the work and if the helix angle of the work is 30 degrees, the teeth on the rolling die will have a helix angle of either 33° or 27°, to align the die teeth with the work teeth.

Straight splines, i.e., splines parallel to the axis of the workpiece, can also be rolled by making use of the above system. Thus, if 3 degrees is determined to be the proper angle of inclination of the rolling die axes, the teeth are formed on each rolling die at 3 degrees from the axis thereof and the rolling dies are inclined so as to bring the die teeth parallel to the workpiece axis. The method of this invention is particularly advantageous in the generation of such straight splines since the throughfeed procedure results in better continuity of engagement between the rolling dies and workpiece than is available without relative axial movement therebetween during the rolling operation.

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

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

1. A profile-rolling head comprising a shank member, a head body assembly supported by and driven rotatively by said shank member, a plurality of die shafts mounted

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in said head body assembly, each of said die shafts being inclined with respect to the axis of said head body assembly, a profile rolling die journaled upon each of said die shafts for rotation independently thereof, drive means adapted to be held stationary during rotation of said head body assembly, and means drivably connecting said drive means and said dies whereby said rolling dies are positively driven during rotation of said head body assembly.

2. A profile-rolling head comprising a head body assembly, means for operatively connecting said head body assembly to a machine tool spindle, a plurality of die shafts mounted in said head body assembly, the axes of said die shafts being revolved about the axis of said head body assembly when said head body assembly is rotatively driven, a profile-rolling die journaled for free rotation upon each of said die shafts, and means for positively driving said rolling dies in the direction opposite to the direction of rotation of said head body assembly.

3. The profile-rolling head of claim 2 wherein each of said die shafts has end bearing portions and a central portion for supporting said dies, said central portion being eccentric with respect to said bearing portions, whereby, upon rotation of said die shafts, said central portions are displaced with respect to the axis of said head body assembly.

4. The profile-rolling head of claim 3 together with means for adjustably rotating said die shafts simultaneously, and means for holding said die shafts in such rotatively adjusted position.

5. A profile-rolling head comprising a shank member, a head body concentric with and supported by said shank member, for unitary rotation therewith, a front cap secured to said head body, said head body and said front cap having a plurality of journal means aligned in pairs, a die shaft mounted in each of said pairs of journal means, profile rolling dies mounted on said die shafts, gears mounted on said die shafts, said gears having a driving connection with said dies, a drive ring surrounding said head body and front cap, an internal gear mounted within said drive ring, having a driving connection therewith and meshing with said gears on said die shafts, said drive ring being capable of relative rotation with respect to said head body and front cap whereby said profile-rolling dies are driven rotatively upon rotation of said head body.

6. The profile-rolling head of claim 5 wherein each of said die shafts is mounted at an inclination with respect to the axis of said head body, said gears on said drive shafts having helical teeth to mesh with the spur teeth of said internal gear.

7. The profile-rolling head of claim 6, wherein said journal means comprises replaceable bushings whose replacement is capable of altering the angle of inclination of said die shafts.

8. The profile-rolling head of claim 5, including passages in said drive ring and front cap for conveying coolant to and from the operative surfaces of said rolling dies.

9. A profile rolling head comprising a head body, a shank member rigid with said body adapted for connection to a rotating drive member, a plurality of profile rolling dies, means mounting said dies equidistantly from the axis of said head and at an inclination with respect to the axis of said head, said dies being bodily moved around the axis of said head upon rotation of said head, and said mounting means permitting rotation of said dies about their individual axes, drive means carried by said head adapted to be held stationary during rotation of said head, and means drivably connecting said drive means and said dies whereby said rolling dies are positively driven during rotation of said head body.

10. The combination according to claim 9 wherein said drive means comprises an internal ring gear and said drivably connecting means comprises pinion gears mesh-

ing with said ring gear and each pinion gear being drivingly connected to one of said dies.

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