

⑫

EUROPEAN PATENT SPECIFICATION

⑳ Application number: **78200023.6**

⑤① Int. Cl³: **B 23 Q 35/10**

㉔ Date of filing: **01.06.78**

⑤④ **Apparatus and tool for simultaneously forming selected circumferential and axial profiles on a workpiece**

③① Priority: **06.06.77 US 803685**

④③ Date of publication of application:
10.01.79 Bulletin 79/01

④⑤ Publication of the grant of the European patent:
23.07.80 Bulletin 80/15

⑧④ Designated Contracting States:
DE FR GB

⑤⑥ References cited:
CH - A - 222 310
DE - B - 2 255 322
DE - C - 912 041
FR - A - 906 842
FR - A - 1 102 712
FR - A - 1 400 646
GB - A - 755 606
NL - C - 87 648
US - A - 2 958 263
US - A - 3 455 206
US - A - 3 803 957

⑦③ Proprietor: **Hardinge Brothers Inc.**
Elmira
New York 14902 (US)

⑦② Inventor: **De Biasse, Richard L.**
8 Rock Ledge Trail
Chatham, New Jersey 07928 (US)

⑦④ Representative: **Barre, Philippe**
77, allée de Brienne
F - 31069 Toulouse Cédex (FR)

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European patent convention).

Apparatus and tool for simultaneously forming selected circumferential and axial profiles on a workpiece

BACKGROUND OF THE INVENTION

Although the pistons used in reciprocating type internal combustion engines are nominally "cylindrical", they have in practice been contoured or profiled to take into account the differential thermal expansion that takes place in normal operating conditions. The head of a piston becomes heated to a significantly higher temperature than the skirts, and there is thus a temperature gradient along the length of the piston which means that the piston "grows" to different extents in different axial parts. Moreover, there are differentials in the growth of the piston at different circumferential locations. Accordingly, it is common to either grind or machine a piston to a selected circumferential profile and a selected axial profile to provide desired profiles after the piston grows due to thermal expansion in operation.

By far the most common way of forming the desired axial and circumferential profiles on pistons is by cam-grinding. Cam-grinding involves the use of a grinding stone which is dressed to an axial profile conforming to the desired axial profile to be put on the piston. The desired circumferential profile is provided by moving the piston toward and away from the grinding stone (or vice versa) in coordination with the rotation of the piston, the piston being translated toward and away from the stone (or vice versa) by a cam having a circumferential profile that matches the desired circumferential profile formed on the piston (hence, the name "cam-grinding"). Cam-grinding is an expensive operation in terms of labor time and tooling costs, and it is difficult to control tolerances because the stone wears at different rates in different places. Good control over tolerances requires frequent dressing of the stone.

A small proportion of the total number of pistons produced are finished to the desired axial and circumferential profiles by machining. Most of the machining techniques involve the use of a master cam having circumferential and axial profiles matching the desired profile to be machined on the piston and rotated in one spindle. The workpiece rotates in another spindle at the same speed, and a cutting tool is guided under the control of the stylus that follows the master cam, either by a direct mechanical linkage between the stylus and the tool or by a hydraulic tracing system that is under the control of the cam. Machine profiling is also expensive, slow, and difficult to control with precision.

A machine of this type is described in the German Patent no. 2.255.322; this equipment is very complex and expensive and require modification of the bed of the machine, not only in length but also in width.

An object of the present invention is to eliminate the deficiencies of the knowned

machines in providing an equipment which can be attached to standard beds, with a minimum of cost, and without having to modify the bed itself.

SUMMARY OF THE INVENTION

There is provided, in accordance with the present invention, apparatus for simultaneously forming selected circumferential and axial profiles on a workpiece, the apparatus being intended primarily for use in a manufacture of pistons but being susceptible of adaptation to any operation in which it is desired to form different, mutually perpendicular contours on an object. The apparatus involves rotating the workpiece about a fixed axis and moving a cutting tool along an axis parallel to that axis of rotation, the movements of the tool toward and away from that axis to form the profiles being controlled by a circumferential cam having a circumferential cam surface matching the desired circumferential profile and a separate axial cam having a axial cam surface conforming to the axial profile to be formed on the workpiece.

More particularly, the apparatus comprises a carrier that is mounted for movement toward and away from the workpiece and carries a cutting element for engagement with the workpiece. The carrier is pushed toward the workpiece by a spring (or an equivalent device, such as a pneumatic piston that exerts a force but yields) to engage the cutting element with the workpiece. A suitable drive moves the carrier along an axis parallel to the axis of rotation of the workpiece. An elongated cam follower bar is mounted on the carrier for movement relative thereto solely along an axis parallel to and spaced from the axis of rotation of the workpiece. A circumferential cam is mounted for rotation conjointly with the workpiece about the axis of rotation thereof, and an axial cam is mounted on the follower bar, which also carries a circumferential cam follower that engages the surface of the circumferential cam. Hence the follower bar tracks the circumferential cam and moves the carrier, and therefore the cutting element, toward and away from the axis of rotation of the workpiece to form the selected circumferential profile on the workpiece. An axial cam follower engages the axial cam and is interposed in series with the circumferential cam follower so that the carrier also tracks the axial cam. Thus the axial profile is superimposed on the circumferential profile.

In the embodiment described in detail below and shown in the drawings, the axial cam is mounted on a holder that in turn is mounted on the carrier for movement relative to the carrier toward and away from the workpiece, and the spring or its equivalent pushes the holder into engagement with the workpiece. In that embodiment the follower bar tracks the circum-

ferential cam, as described above, and the axial cam on the holder causes the holder to track the axial cam relative to the follower bar. Thus the movements of the cutting element are actually a combination of movements originating separately, first, with the circumferential cam follower on the follower bar which transmits the circumferential profile to the follower bar and the carrier and, second, with the axial cam follower which transmits the axial profile from the axial cam to the holder.

In a mechanically and functionally equivalent variation of the arrangement of the embodiment shown in the drawings, the axial follower is interposed between the circumferential follower and the follower bar, and the holder is omitted. In such an arrangement the path of forces generating movements of the cutting element to form the desired profiles originates with the circumferential cam follower which tracks the circumferential cam and moves the axial follower, which in turn works against the axial cam on the follower bar. The follower bar in turn moves the carrier and the cutting tool toward or away from the workpiece. The series relationship between the circumferential and axial cams thus automatically superimposes the axial and circumferential profiles on the movements of the cutting tool, as in the embodiment shown in the drawings.

The apparatus, according to the present invention, may be constructed as a device that can be attached to commercially available, general purpose machine tools, such as lathes or automatic chucks, and the embodiment shown in the drawings is indeed so constructed. On the other hand, the apparatus can be integrated into a machine that is specially designed for profiling pistons.

Another aspect of the invention involves a modification of the apparatus to make it capable of providing different circumferential profiles in different parts of the piston. For example, the piston head may have a circumferential profile different from that of the skirts. The modification of the apparatus involves, in one form, the use of a circumferential cam having two circumferential cam surfaces side by side and means for shifting the circumferential cam follower from one of such cam surfaces to the other in coordination with the movement of the carrier parallel to the axis of rotation of the piston. For example, the absolute position of the follower bar may be shifted by a guide that is moved parallel to the axis of the follower bar relative to the circumferential cam and a gear or other drive for shifting the guide in coordination with movement of the machine carriage. In such an arrangement, the movement of the carriage controls the movement of the follower bar transversely along the circumferential cam to shift the circumferential cam follower from one of the cam surfaces to the other. Essentially, the same apparatus can be used with a circumferential cam that has several

different circumferential cam surfaces or that has a circumferential profile that varies continuously in the axial direction, thus to vary the circumferential profile as some function of the axial movement of the carrier in the course of machining the piston.

Among the preferred features of the apparatus embodying the present invention are the following:

1. the carrier is mounted on needle bearings so that it moves smoothly and precisely;
2. the spring pusher applies a force that is substantially parallel to the axis of movement of the cutting element at a point closely adjacent to such axis of movement, thereby to minimize any tendency for cocking of the holder due to an eccentric pushing force;
3. the circumferential cam follower is mounted on the follower arm for adjustment radially of the circumferential cam so that the diameter of the workpiece can be pre-established very precisely by setting the proper dimensional relationship between the cutting element and circumferential cam follower.

The invention may be better understood by consideration of the following description of an exemplary embodiment, taken in conjunction with the figures of the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

Fig. 1 is a front elevational view of apparatus embodying the invention;

Fig. 1A is a fragmentary front elevational view of the apparatus of Fig. 1 on a larger scale than Fig. 1;

Fig. 2 is a top view partly in full and partly in section of the apparatus, the plane of the section being represented generally by the lines 2—2 of Fig. 1;

Fig. 3 is an end view of the apparatus for Fig. 1 shown partly in section and partly in elevation, as represented by the lines 3—3 of Fig. 1;

Fig. 4 is an end cross-sectional view of a part of the apparatus, the view being taken generally along the lines 4—4 of Fig. 1 and in the direction of the arrows; and

Fig. 5 is a top view in schematic form showing a modification of the apparatus of Figs. 1 to 4 that permits different circumferential profiles to be formed in different portions of the walls of a piston.

DESCRIPTION OF AN EMBODIMENT

The embodiment of the invention shown in Figs. 1 to 5 is an attachment that can be mounted on a commercially available automatic chucker, the chucker being shown schematically in the drawings. The chucker includes a spindle 10, a drive, which is enclosed within a housing 12, for rotating the spindle about a fixed axis, and a thread-chasing head 14 having a key-shaped slot 16 in which any of a variety of accessory tools can be mounted in a selected position. The head 14 is mounted on a bar 18

which is moved axially by a drive (not shown) along an axis parallel to the axis of rotation of the spindle. The speed of such movement can be changed by shifting a transmission in the drive system, and the head 14 and shaft 18 are driven by the drive system in one direction (to the left in Figs. 1 and 2) and returned in the other direction by a spring return. The head 14 and shaft 18 are also coupled to a hydraulic mechanism which automatically lifts them up at the end of a machining operation, disengages the drive, and rapidly returns the chasing head in the other direction to the starting point where it is ready to begin another machining operation on another workpiece.

It will be readily apparent to those skilled in the art that the present invention can be adapted to any sort of machine tool constructed to rotate a workpiece about a fixed axis and to move a tool along an axis parallel to and spaced from the axis of rotation of the workpiece, the latter component of such a machine being referred to herein as a "carriage" and being any mechanically or hydraulically driven device capable of moving a "cutting element," such as a cutting bit or grinding stone or wheel, along a path parallel to the axis of rotation of a workpiece. The apparatus shown in Figs. 1 to 4 and described thus far is not, *per se*, a part of the present invention, but such components (i.e., a device for rotating a workpiece about a fixed axis and a device for moving a cutting element along a path parallel to the axis of rotation of the workpiece) are necessary for the use of the apparatus of the invention. The following description of that apparatus, which, for convenience, will be referred to hereinafter as a compound profiling tool, exemplifies the invention in the context of a commercially available automatic chucker of the type shown schematically in the drawings.

The compound profiling tool 20 comprises a mounting base 22 which, as viewed in front elevation (Figs. 1 and 2), is generally rectangular and which includes at the right end (as viewed from the front) a portion 22a that is generally triangular in cross section and at the left end a portion 22b that is rectangular in cross section. The back face of the portion 22a is inclined to the vertical to match the inclined front face 14a of the chasing head 14. The base 22 is adapted to be mounted on the chasing head 14 by a bar of "T"-shaped cross section 26 (a T-bar) that slides into the matching T-slot 16 on the chasing head 14 and is pulled tightly into engagement with the overhanging flanges of the T-slot 16 by bolts 28. A flange 30 projects from the back face of the base 22 and engages a lateral surface on the chasing head 14, the flange 30 serving to align the tool with respect to the axis of rotation of a workpiece mounted in the machine spindle (the drawings illustrating a piston P mounted in the spindle 10).

The front face of the base 22 is formed with a

wide, shallow vertical slot 32, and a carrier 34, which is mounted in the slot 32 for movement vertically, thereby to move along an axis that lies in a plane perpendicular to the axis of rotation of the piston P. The carrier 34 is mounted on four sets of needle bearings, one set being located in each of four vertical races 36, 37, 38 and 39, two of which (37 and 36) are located in the back face and two of which (38 and 39) are located in oblique side walls (see particularly Fig. 2). The carrier is held and guided in the slot 32 by a fixed-position retainer fastened by screws 42 in the left side of the slot and an adjustable retainer 44 fastened by screws 46 in the right side of the slot. A pair of adjusting screws 48 threaded through bosses 50 on the base 22 work against the adjustable retainer 44 and facilitate adjusting the retainer to provide smooth and precise vertical movement of the carrier relative to the base 22. The top and bottom walls of the carrier 34 receive bearing retainer plates 52 and 54 which are fastened by screws 56 and 58 to the carrier 34. The extent of vertical movement of the carrier 34 in the slot 32 is limited by stop screws 60 installed on the base 22 at the top and bottom of the slot 32 with their heads projecting from the wall of the slot for engagement with the end walls of recesses formed in the back wall of the carrier 34. The stop screws 60 are provided merely to retain the carrier in the slot when the tool 20 is removed from the machine or when it is partly disassembled while on the machine.

It will be recalled from the foregoing that the chasing head 14 is lifted up at the end of each stroke; hence, an adjustable stop 62, consisting of a screw 64 threaded into the top end of the carrier 34 and an adjustable collar 66, is provided to prevent the carrier from shifting downwardly in the slot to a position where the cutting bit will engage the piston on the return stroke after the piston has been machined and the head 14 lifts and returns to the right.

As may best be seen in Fig. 3, the front part of the carrier 34 stands out from the base 22 of the tool, and, as best appears in Figs. 2 and 4, is provided with a horizontal slot 68. The slot 68 receives with a sliding fit a follower bar 70 of T-shaped cross section which is retained in the slot and receives guiding support from a pair of retainer plates 72 and 74 which are fastened by screws 76 and 78 to the carrier 34. The follower bar is thus mounted on the carrier solely for movement relative to the carrier along an axis parallel to the axis of rotation of the piston. An axial cam 80 having a cam surface 82 formed in its upper edge, which surface matches the axial profile to be formed on the piston T, is fastened by screws 84 to the front face of the follower bar 70. The axial cam 80 is precisely positioned, relative to the longitudinal axis of the follower bar 70, by locating pins 86.

The carrier 34 also has a vertical slot 88 which receives with a sliding fit a holder 90. The holder is adopted to receive a chip-type

triangular cutting bit 92 at its lower end, and an axial cam follower roller 94 carried by a bracket 96 is mounted at the upper end of the holder 90 by a pair of screws 98.

The upper end of the holder 90 is engaged by the output plunger 100 of a spring mechanism 102 that is mounted by way of a bracket 104 secured by bolts 106 to the chasing head 14. The spring-driven plunger 100 pushes the holder downwardly, thereby to engage the roller follower 94 with the axial cam surface 82. As will be more apparent from the description below of the mode of operation of the tool, it is the spring mechanism 102 which applies the acting force to the tool to push the cutter 92 against the workpiece, i.e., the piston P, and to keep the followers in tracking engagement with the cams.

The left end of the follower bar 70 carries a follower assembly 108, which includes a follower roller 110 that engages the circumferential cam surface of a circumferential cam 112. The cam surface of the cam 112, which is an annular member suitably attached to a special holder mounted in the machine spindle 10, has a profile that matches the desired profile to be formed on the piston. The follower assembly 108 includes a bracket 112 that is affixed to the follower bar 70 and a movable follower roller carrier 114 that is adjustable vertically with respect to the bracket 112 by an adjusting screw 116 that bears against the lower end of the roller carrier 114 and is locked in position by a set screw 118. The follower assembly 108 is thus adapted for precise adjustment of the roller relative to the axis of movement of the follower bar 70. Accordingly, the position of the tip of the cutting tool 92 can be set precisely with respect to the circumferential cam 112, thus to set up the tool to the precise diameter of the piston. In practice this is done by positioning the various components with the cam followers at predetermined positions, setting a height gauge between the bed of the machine and the cutting bit 92, and then adjusting the circumferential follower 110 using the adjusting screw 116 to position the bit 92 at the known height above the bed for the diameter in question.

In the embodiment of Figs. 1 to 4, the follower bar 70 remains stationary in the horizontal direction throughout the operation of the apparatus. It is held in that position by a spring mechanism 118 which consists of a housing 120 secured by screws 122 to the right end of the base 22 and containing a spring 124 which pushes against the right end of the follower bar 70 by means of a drive pin 126 which projects out through an axial slot 128 in the housing 120 and into a groove or hole 130 in the back wall of the follower bar 70. The spring mechanism 118 yieldably pushes the following bar 70 to the left, relative to the base 22 of the tool, against a guide roller 132 that is rotatably mounted on a bracket 134, which is, in turn, bolted to the housing of the automatic chucker

machine, and that bears against the circumferential follower assembly 108.

Figs. 1 to 4 show the tool part way through a profiling operation conducted on a piston P. The operation may be considered to begin when the drive of the chasing head 14 engages and the chasing head starts to move from right to left. At the beginning of the operation the base 22 carrier 34 and holder 90 of the tool are positioned somewhat to the right of the positions shown in the drawings, thus to have the cutting tool 92 positioned a short distance clear to the right of the head end of the piston. The spring mechanism 118, however, holds the follower bar 70 in the position shown with the circumferential follower assembly 108 in engagement with the guide roller 132, thus to retain the circumferential follower 110 in proper tracking position in engagement with the circumferential cam 112.

Upon engagement, the chasing head drive moves the chasing head from right to left, thereby moving the base 22, carrier 34, and holder 90 to the left. The cutting tool 92 is spring-loaded by the spring mechanism 102 downwardly to engage the axial follower 94 with the axial cam 80. The vertical position of the axial cam at any instant is a function of the vertical position of the follower bar 70, which position is under the control of the position of the circumferential cam follower 110. In other words, as the base 22, carrier 34 and holder 90 translate to the left, the vertical position of the cutting tool 92 is under the control of (1) the circumferential cam, by virtue of the vertical movement as a unit of the follower assembly 108 and the follower bar 70, and also (2) the axial cam, by virtue of vertical movement of the holder 90 relative to the carrier as the axial follower 94 tracks the axial cam 80. The holder 90 follows the axial cam 80 by moving relative to the carrier 34, and the holder 90 and carrier 34 both move with the follower bar 70 as the circumferential cam follower 110 tracks the circumferential cam 112. Thus, the axial profile is superimposed on the circumferential profiles as established, respectively, by the axial cam 80 and the circumferential cam 112. Throughout the profiling operation the follower bar 70, and, therefore, the circumferential follower mechanism 108, remain horizontally stationary by virtue of the spring force applied by the spring mechanism 118 between the base 22 (and the chasing head 14) and the follower bar 70. Nonetheless, the spring mechanism 118 is inherently a lost-motion device, the spring 124 being loaded progressively as the chasing head moves to the left.

At the end of the profiling operation the chasing head 14 and the shaft 18 on which it is mounted are lifted hydraulically, thereby disengaging the chasing head drive and enabling the spring return device on the machine to push the chasing head and the base, carrier and holder of the tool rapidly back to the starting

position. When the chasing head 14 lifts up, it lifts with it the base 22, but the carrier 34, and therefor the follower bar 70 and cam follower assembly 108, are driven relatively downwardly by the spring drive 102. The stop assembly 62 on the carrier 34 limits the amount of downward movement of the parts just referred to. Return of the chasing head 14 to the starting position ends a cycle of operation.

The compound profiling tool shown in the drawings and described above is inherently backlash free; the spring mechanism 118 maintains precise tracking of the roller 110 on the cam 112, and the drive spring mechanism 102 always pushes down on the holder, which, in turn, pushes down on the axial cam 80, the follower bar 70, and the circumferential follower assembly 108. The unidirectional force system, which involves springs that always act in one direction, assures precise repeatability from piece to piece; all deflections and movements are ultimately under the influence of the unidirectional drive springs. Inasmuch as the cam surfaces of the tool are, at least in the embodiment shown in Figs. 1 to 4, curved in only one direction, they are very much less expensive than the one-to-one master cams used in previously known apparatus for machining compound profiles on pistons. The tool of the present invention also permits changing separately either the circumferential cam or the axial cam with other cams having different profiles, thus making it very easy to set up the machine to make different pistons.

Fig. 5 of the drawings illustrates a modification of apparatus embodying the present invention, the modification being shown schematically and involving only the replacement of the fixed guide roller 132 which holds the circumferential follower assembly in tracking position on the circumferential cam and the substitution of different circumferential and axial cams for the ones depicted in Figs. 1 to 4 of the drawings.

More particularly, instead of having the circumferential follower assembly 108 and the follower bar 70 remain axially stationary throughout the profiling operation, a mechanism 200 for moving the follower bar is substituted for the fixed guide 132. The mechanism comprises a spring-loaded plunger 202 which engages the follower head 14 (or it can engage the base 22 of the profiling tool) and has a rack gear 204 located adjacent one end. The rack gear drives a larger pinion gear 206 which, in turn, drives a smaller pinion gear 208, the two pinion gears constituting a reducer gear train. A second spring-loaded plunger 210 having a rack gear 212 meshing with the smaller pinion gear 208 carries a guide roller 214 which engages the circumferential follower assembly 108.

The device 200 shown in Fig. 5 is used in conjunction with a circumferential cam 216 which has two or more circumferential cam sur-

faces in different adjacent bands, each such surface being shaped to match a selected circumferential profile to be formed in a selected axial part of the piston. The cam 216 may, alternatively, have a surface formed with a profile that varies along its axial extent, thus to vary continuously the circumferential profile along the axial extent of the piston. The operation of the modified structure of Fig. 5 is very similar to that of the embodiment shown in Figs. 1 to 4, the only difference being that the guide 214 moves to the left in a proportion established by the gear ratio in the mechanism 200 in response to the movement of the chasing head in the course of the profiling operation. During the first part of the operating cycle the circumferential profile of the right part of the cam 216 (as viewed in Fig. 5) is formed on the head end of the piston, and for the remainder of the cycle, the circumferential profile of the left portion of the circumferential cam 216 is formed on the piston. The transition between the two profiles can occur at a ring groove.

It will be apparent to those skilled in the art that numerous variations and modifications of the compound profiling tool shown in the drawings can be made without departing from the spirit and scope of the invention. One such modification involving relocation of the axial cam and cam follower so that they are located between the circumferential cam follower and the follower bar has been described in the section entitled "Summary of the Invention" hereof. Another modification is the elimination of the spring mechanism 118 which holds the circumferential follower assembly 108 and the follower bar assembly 70 in the desired position in tracking relation to the circumferential cam 112 or the modified assembly shown in Fig. 5 and the substitution therefor of a vertical guide assembly associated with the circumferential follower. For example, such an assembly may involve a pair of guide rollers substituted for the rollers 132 or 214, one such guide roller being located on either side of the follower assembly 108 to hold it in the desired fixed or movable position axially (with respect to the follower bar 70) while permitting it to track the cam radially relative to the axis of rotation of the piston.

Claims

1. Apparatus for simultaneously forming a selected circumferential profile and a selected axial profile on a workpiece (P) mounted for rotation about a fixed axis, comprising a carrier (34) mounted for movement toward and away from the workpiece and carrying a cutting element (92) for engagement with the workpiece; means (102) for yieldably pushing the carrier toward the workpiece to engage the cutting element therewith for work thereon; means (18) for moving the carrier along an axis parallel to the axis of rotation of the workpiece; a circumferential cam (112) mounted for rotation con-

jointly with the workpiece about the axis of rotation of the workpiece and having a circumferential cam surface matching the circumferential profile to be formed on the workpiece; an axial cam (80) having an axial cam surface matching the axial profile to be formed on the workpiece; a circumferential cam follower (110) engaging the circumferential cam surface; and an axial cam follower (94) engaging the axial cam surface and interposed in series with the circumferential cam follower between the axial cam and the cutting element such that the cutting element tracks the axial cam and the axial profile is superimposed on the circumferential profile in the movement of the cutting tool parallel to the workpiece thereby to form the axial profile on the workpiece simultaneously with the circumferential profile, the said apparatus being characterised in that:

(a) the apparatus includes an elongated cam follower bar (70) mounted on the carrier (34) for movement relative thereto solely along an axis parallel to and spaced from the axis of rotation of the workpiece,

(b) the axial cam is mounted on the follower bar (70),

(c) the circumferential cam follower (110) is interposed between the circumferential cam (112) and the follower bar (70),

(d) the follower bar (70) has means (124, 134) for controlling its end movement along its axis relative to the circumferential cam (112).

2. Apparatus according to claim 1 and wherein the carrier includes a holder that is mounted thereon for movement relative thereto solely in a direction toward and away from said workpiece, said cutting element being mounted on said holder, said holder carrying said axial cam follower, and said means pushing the carrier toward said workpiece engaging said holder to push said follower bar and said carrier toward said workpiece.

3. A tool for use in a machine which has means for rotating a workpiece (P) about an axis and a carriage 14 for moving a tool along a path parallel to that axis, the tool being adapted to cut simultaneously in a workpiece placed in the machine at least one selected circumferential profile and at least one selected longitudinal profile and comprising a carrier for a cutting element (92) having a base part (22) adapted to be affixed to the tool moving means of the machine and a movable (34) part mounted on the base part for movement toward and away from the workpiece along an axis lying in a plane substantially perpendicular to the axis of rotation of the workpiece; a circumferential cam (112) having a circumferential cam surface shaped to match the selected circumferential profile to be formed on the workpiece and being adapted to be connected to said means for rotating the workpiece for rotation conjointly with the workpiece about the axis of rotation thereof; a cam follower (110) to engage the circumferential cam surface; a longitudinal cam (80) having a

cam surface matching the selected longitudinal profile to be formed on the workpiece and oriented relative to the axis of the workpiece to match the selected longitudinal profile to be formed thereon; a holder (90) mounted on the movable part of the carrier for movement on a plane perpendicular to the axis of rotation of the workpiece and adapted to receive the cutting element; a cam follower (94) positioned to engage the longitudinal cam surface; and means (100) engaging the holder for yieldably pushing the holder toward the workpiece and for thereby maintaining the cam follower thereon in tracking engagement with the longitudinal cam and the cam follower in tracking engagement with the circumferential cam, the said tool being characterised in that:

(a) a follower bar (70) is mounted in a guideway on the movable part of the carrier (34) along a longitudinal axis relative to the carrier (34), parallel to and spaced from the axis of rotation of the workpiece.

(b) the circumferential cam follower (110) is mounted on the follower bar (70),

(c) the follower bar (70) has means for controlling its movement along the longitudinal axis relative to the circumferential cam (112) while permitting the follower bar to move transversely of said axis and parallel to the direction of movement of the movable part of the carrier and thereby track the circumferential cam,

(d) the longitudinal cam (80) is mounted on the follower bar (70),

(e) the holder (90) is mounted in a guideway and moves along an axis,

(f) the longitudinal cam follower (94) is positioned in the holder (90).

4. A tool according to claim 3 wherein the means for controlling the axial movement of the follower bar includes a guide located in a fixed position relative to the circumferential cam and spring means acting between the base part of the carrier and the follower bar for yieldably pushing the follower bar into engagement with the guide while the carrier moves with the machine carriage and relative to the follower bar.

5. A tool according to claim 3 wherein the profile of the circumferential cam is different in different circumferential bands thereof, thus to provide different circumferential profiles on the workpiece in different longitudinal parts thereof in correspondence to the circumferential cam profiles, and wherein the means for controlling movement of the follower bar includes a guide mounted for movement parallel to the axis of the follower bar relative to the circumferential cam, means responsive to movement of the machine carriage for moving the guide along said parallel axis thus to change the track of the circumferential follower on the circumferential cam surface from one such band to another, and spring means acting between the base part of the carrier and the follower bar for yieldably pushing the follower bar into engagement with

the guide while the carrier moves with the machine carriage and relative to the follower bar.

6. A tool according to claim 3 wherein the movable part of the carrier is mounted on the base part by needle bearings so that it moves smoothly and precisely in response to the circumferential cam follower.

7. A tool according to claim 3 wherein the means for pushing the holder toward the work-piece is a spring pusher disposed closely adjacent to and acting substantially parallel to the axis of movement of the cutter on the holder thus to minimize a tendency for cocking of the holder due to the pushing force.

8. A tool according to claim 3 wherein the circumferential cam follower is mounted on the follower arm for adjustment radially of the circumferential follower such that the diameter of the workpiece can be pre-established by setting the proper dimensional relation between the cutting element and the circumferential cam follower.

Revendications

1. Dispositif pour former simultanément sur une pièce P un choix de profils circulaires et axiaux, cette pièce étant montée pour tourner autour d'un axe fixe, comprenant un support (34) assemblé pour effectuer un mouvement en direction et en provenance de la pièce et possédant un élément coupant (92) pour le contact avec la pièce; des moyens (102) pour pousser en douceur le support vers la pièce afin de faire entrer celle-ci en contact avec l'élément coupant sus-mentionné; des moyens (18) pour déplacer le support le long d'un axe parallèle à l'axe de rotation de la pièce; une came circulaire (112) montée pour pivoter conjointement à la pièce autour de l'axe de rotation de la pièce et ayant une surface de came circulaire s'adaptant au profil circulaire devant être formé sur la pièce; une came axiale (80) ayant une surface de came axiale s'adaptant au profil axial devant être formé sur la pièce; un plateau de came circulaire (110) en contact avec la surface de came circulaire; et un plateau de came axiale (94) en contact avec la surface de came axiale et interposé en série avec le plateau de came circulaire entre la came axiale et l'élément coupant, afin que l'élément coupant suive la came axiale et que le profil axial soit superposé au profil circulaire dans le mouvement de l'élément coupant parallèle à la pièce, afin de former par conséquent le profil axial sur la pièce en même temps que le profil circulaire, ledit dispositif étant caractérisé en ce que:

a) le dispositif comprend un plateau de came allongé (70) monté sur le support (34) pour accorder son mouvement sur celui de ce dernier, et uniquement le long d'un axe parallèle, et espacé, à l'axe de rotation de la pièce,

b) la came axiale est montée sur le plateau mobile (70),

c) le plateau de came circulaire (110) est interposé entre la came circulaire (112) et le plateau mobile (70),

d) le plateau mobile (70) a des moyens (124, 134), de contrôler le mouvement de son extrémité le long de son axe par rapport à la came circulaire (112).

2. Dispositif selon la revendication 1, caractérisé en ce que le support comporte un bras de soutien qui y est assemblé pour accorder son mouvement sur celui de ce dernier uniquement en direction et en provenance de ladite pièce, ledit élément coupant étant monté sur ledit bras de soutien, ledit bras de soutien portant ledit plateau de came axiale, et ledit moyen poussant ledit support vers ladite pièce en contact avec ledit bras de soutien pour pousser ledit plateau mobile et ledit support vers ladite pièce.

3. Outil destiné à être utilisé dans une machine pourvu de moyens pour faire pivoter une pièce P sur un axe et un chariot 14 pour déplacer un outil le long d'un chemin parallèle à cet axe, l'outil étant conçu pour couper simultanément sur une pièce placée dans la machine au moins un profil circulaire choisi et au moins un profil longitudinal choisi, et qui comprend un support pour un élément coupant (92) ayant une partie base (22) conçue pour être attachée au dispositif de déplacement d'outil de la machine et une partie mobile (34) montée sur la partie base pour permettre un mouvement en direction et en provenance de la pièce le long d'un axe sur un plan perpendiculaire à l'axe de rotation de la pièce; une came circulaire (112) ayant une surface de came circulaire dont la forme s'adapte au profil circulaire choisi devant être formé sur la pièce et qui est conçue pour être reliée audit moyen destiné à faire pivoter la pièce pour rotation conjointe avec la pièce autour de l'axe de rotation de celle-ci; un plateau de came (110) en contact avec la surface de came circulaire; une came longitudinale (80) ayant une surface de came s'accordant avec le profil longitudinal choisi devant être formé sur la pièce et orientée par rapport à l'axe de la pièce pour s'accorder avec le profil longitudinal choisi devant être formé sur cette pièce; un bras de soutien (90) monté sur la partie mobile du support pour mouvement sur un plan perpendiculaire à l'axe de rotation de la pièce et conçu pour recevoir l'élément coupant; un plateau de came (94) placé pour être en contact avec la surface de came longitudinale; et un moyen (100) en contact avec le bras de soutien pour pousser ce bras en douceur vers la pièce et pour maintenir par conséquent le plateau de came en alignement de contact avec la came longitudinale et le plateau de came en alignement de contact avec la came circulaire, ledit outil étant caractérisé en ce que:

a) un plateau mobile (70) est monté en coulisse sur la partie mobile du support (34) le long d'un axe longitudinal par rapport au support (34), parallèle, et espacé, à l'axe de

rotation de la pièce.

b) le plateau de came circulaire (110) est monté sur le plateau mobile (70),

c) le plateau mobile (70) a des moyens de contrôler son mouvement le long de l'axe longitudinal par rapport à la came circulaire (112) tout en permettant au plateau mobile de se déplacer transversalement audit axe et parallèlement à la direction du mouvement de la partie mobile du support et par conséquent de suivre la came circulaire,

d) la came longitudinale (80) est montée sur le plateau mobile (70),

e) le bras de soutien (90) est monté en coulisse et se déplace le long d'un axe,

f) le plateau de came longitudinale (94) est placé dans le bras de soutien (90).

4. Outil selon la revendication 3, caractérisé en ce que le moyen de contrôle du mouvement axial du plateau mobile comprend un guide placé en position fixe par rapport à la came circulaire et un moyen ressort agissant entre la partie base du support et le plateau mobile pour pousser celui-ci en douceur en contact avec le guide tandis que le support se déplace avec la chariot de la machine et par rapport au plateau mobile.

5. Outil selon la revendication 3, caractérisé en ce que le profil de la came circulaire est différent en différentes portions circulaires de la came, afin de fournir à la pièce différents profils circulaires en différents points de sa partie longitudinale par rapport aux profils de came circulaire, et en ce que le moyen de contrôle du mouvement du plateau mobile comporte un guide monté pour effectuer un mouvement parallèle à l'axe du plateau mobile par rapport à la came circulaire, moyen réagissant au mouvement du chariot de la machine pour mouvoir le guide le long dudit axe parallèle pour changer par conséquent la piste du plateau circulaire sur la surface de came circulaire d'une de ces bandes sur une autre, et un moyen ressort agissant entre la partie base du support et le plateau mobile pour pousser en douceur le plateau mobile en contact avec le guide tandis que le support se déplace avec le chariot de la machine et par rapport au plateau mobile.

6. Outil selon la revendication 3, caractérisé en ce que la partie mobile du support est montée sur la partie base au moyen de roulements à aiguille de sorte qu'il se déplace doucement et avec précision par rapport au plateau de came circulaire.

7. Outil selon la revendication 3, caractérisé en ce que le moyen destiné à pousser le bras de soutien vers la pièce est un poussoir à ressort placé très près et agissant parallèlement à l'axe de mouvement de l'élément coupant sur le bras de soutien pour minimiser par conséquent une tendance du bras de soutien à se dresser sous la force de la poussée.

8. Outil selon la revendication 3, caractérisé en ce que le plateau de came circulaire est monté sur le plateau mobile pour réglage

radialement au plateau circulaire afin que le diamètre de la pièce puisse être pré-établi en fixant le rapport dimensionnel correct entre l'élément coupant et le plateau de came circulaire.

Patentansprüche

1. Gerät zur gleichzeitigen Herstellung eines gewählten Umrissprofils und eines gewählten Axialprofils auf einem Werkstück (P), welches drehbar an eine fixe Achse gebaut ist, bestehend aus einer Halterung (34), die für eine Bewegung von und zum Werkstück vorgesehen ist, und ein Schneideelement (92) zum Einschneiden in das Werkstück trägt; eine Vorrichtung (102), die den Halter leicht gegen das Werkstück schiebt und das Schneideelement mit ihm in Verbindung bringt, welches dann in das Werkstück einschneidet; eine Vorrichtung (18), die die Halterung an einer zur Drehachse parallelen Achse entlang schiebt; eine Umrissnocke (112), die für die Drehbewegung zusammen mit dem Werkstück an die Drehachse des Werkstücks montiert ist und eine zum Umrissprofil, das vom Werkstück hergestellt werden soll, passende Oberfläche hat; eine Axialnocke (80) mit einer zum Axialprofil, das auf dem Werkstück hergestellt werden soll, passende Oberfläche; ein Umrissnockenstößel (110), der auf der Umrissnockenoberfläche eingreift; ein Axialnockenstößel (94), der auf der Axialnockenoberfläche ansetzt, und abwechselnd mit dem Umrissnockenstößel zwischen die Axialnocke und das Schneideelement geschoben wird, so dass das Schneideelement die Axialnocke nachführt—und dies in der Bewegung des schneidenden Werkzeugs parallel zum Werkstück, so dass dadurch das Axialprofil sowie das Umrissprofil gleichzeitig auf dem Werkstück gebildet werden, das genannte Gerät wird dadurch gekennzeichnet, dass:

a) das Gerät eine Längsnockenstößelstange (70) besitzt, welche auf die Halterung (34) montiert ist für die Ausübung einer dazu relativen Bewegung, die ausschliesslich entlang einer zur Drehachse parallelen Achse des Werkstücks sowie von der Drehachse entfernt stattfindet,

b) die Axialnocke auf die Nockenstößelstange (70) montiert ist,

c) der Umrissnockenstößel (110) zwischen die Umrissnocke (112) und die Nockenstößelstange geschoben ist (70),

d) die Nockenstößelstange (70) Vorrichtungen (124, 134) hat zur Kontrolle der Endbewegung entlang einer zur Umrissnocke (112) relativen Achse.

2. Gerät nach Anspruch 1, dadurch gekennzeichnet, dass die Halterung einen auf sie montierten Halter besitzt, der für die zur Halterung relative Bewegung sorgt, welche ausschliesslich von und zum genannten Werkstück ausgeführt wird, das genannte Schneideelement ist auf die genannte Halterung montiert, die genannte

Halterung trägt den genannten Axialnockenstößel, die genannte Schiebevorrichtung, die die Halterung zum genannten Werkstück schiebt und auf die genannte Halterung eingreift, damit die genannte Nockenstößelstange und der genannte Halter zum genannten Werkstück geschoben werden.

3. Das Werkzeug, welches in der Maschine bearbeitet wird, ist ausgestattet mit einer Drehvorrichtung für ein Werkstück (P) um eine Achse und einem Fuhrschlitten (14), der das Werkzeug parallel zu dieser Achse auf einer Bahn transportieren kann, das Werkzeug ist so angepasst, dass es gleichzeitig in ein in die Maschine gelegtes Werkstück mindestens ein gewähltes Umrissprofil und mindestens ein gewähltes Längsprofil schneiden kann, und besitzt eine Halterung für ein Schneideelement (92) mit einem Sockel (22), der so konstruiert ist, dass das Schneideelement auf die das Werkzeug bewegende Vorrichtung fixiert werden kann, sowie ein bewegliches Teil, das auf den Sockel montiert ist für eine Bewegung von und zum Werkstück entlang einer Achse, die in einer weitgehend rechtwinkligen Ebene zur Rotationsachse des Werkstücks liegt; eine Umrissnocke (122) hat eine Umrissnockenoberfläche, die passend zum gewählten Umrissprofil geformt ist, das auf dem Werkstück hergestellt werden soll, und ist so gebaut, dass es mit der genannten Drehvorrichtung verbunden werden kann, zur Rotation zusammen mit dem Werkstück um dessen eigene Drehachse; ein Nockenstößel (110) für die Verbindung mit der Umrissnockenoberfläche; eine Längsnocke (80) mit einer zum gewählten Längsprofil passenden Oberfläche, welches auf dem Werkstück hergestellt werden soll und relativ zu dessen Achse orientiert ist, damit es zum auf dem Werkstück herzustellenden gewählten Längsprofil passt; ein Halter (90), der auf den beweglichen Teil der Halterung montiert ist zur Ausführung einer Bewegung auf einer zur Drehachse des Werkstücks rechtwinkligen Ebene und das Schneideelement aufnimmt; ein Nockenstößel (94) liegt derart, dass er mit der Oberfläche der Längsnocke in Verbindung steht; und eine mit dem Halter verbundene Vorrichtung (100), die den Halter leicht gegen das Werkstück schiebt und dadurch den Nockenstößel darauf hält, während er ihn mit der Längsnocke nachführt und der Nockenstößel die Umrissnocke nachführt, das genannte Werkzeug ist dadurch gekennzeichnet, dass:

a) eine Nockenstößelstange (70) auf einer Führungsbahn auf den beweglichen Teil der Halterung (34) entlang einer zu dieser Halterung (34) relativen Längsachse parallel zu und entfernt von der Drehachse des Werkstücks montiert ist,

b) der Umrissnockenstößel (110) auf die Nockenstößelstange (70) montiert ist,

c) die Nockenstößelstange eine Vorrichtung hat zur Kontrolle ihrer Bewegung entlang der zur Umrissnocke (112) relativen Längsachse,

während es möglich ist, die Nockenstößelstange transversal zur genannten Achse und parallel zur Laufrichtung des beweglichen Teils der Halterung zu bewegen und dadurch die Umrissnocke nachzuführen,

d) die Längsnocke (80) auf die Nockenstößelstange montiert ist,

e) der Halter (90) auf einer Führungsbahn liegt und sich entlang der Achse bewegt,

f) der Längsnockenstößel (94) im Halter (90) liegt.

4. Werkzeug nach Anspruch 3, dadurch gekennzeichnet, dass die Vorrichtung zur Kontrolle der Axialbewegung der Nockenstößelstange eine feststehende Gleitbahn einschliesst relativ zur Umrissnocke, sowie eine Federvorrichtung, die zwischen dem Fussteil der Halterung und der Nockenstößelstange einen leichten Druck auf die Nockenstößelstange ausübt, um sie mit der Gleitbahn in Verbindung zu bringen, während die Halterung sich mit dem Maschinenfuhrschlitten und relativ zur Nockenstößelstange bewegt.

5. Werkzeug nach Anspruch 3, dadurch gekennzeichnet, dass das Profil der Umrissnocke in Verschiedenen Umrissbandbreiten unterschiedlich ist, so dass verschiedene Umrissprofile auf dem Werkstück in seinen verschiedenen Längsteilen gemäss den Umrissnockenprofilen gewonnen werden, und dass die Laufkontrollenvorrichtung der Nockenstößelstange eine Gleitbahn einschliesst, die eine zur Achse der Nockenstößelstange relativ zur Umrissnocke parallele Bewegung ausführt, die Vorrichtung ist für die Bewegung des Maschinenfuhrschlittens verantwortlich, der die Gleitbahn entlang der genannten parallelen Achse bewegt, so dass die Führungsbahn des Umrissnockenstößels auf der Umrissnockenoberfläche von einem solchen Band zum anderen wechselt, und eine Federvorrichtung, die zwischen dem Fussteil der Halterung und der Nockenstößelstange einem leichten Druck auf die Nockenstößelstange ausübt, so dass diese mit der Gleitbahn in Verbindung kommt, während die Halterung sich mit dem Maschinenschlitten relativ zur Nockenstößelstange bewegt.

6. Werkzeug nach Anspruch 3, dadurch gekennzeichnet, dass der bewegliche Teil der Halterung auf Nadellagern auf den Fussteil montiert ist, damit er sich sanft und präzise entsprechend dem Umrissnockenstößel gleichzeitig mit demselben bewegt.

7. Werkzeug nach Anspruch 3, dadurch gekennzeichnet, dass die Vorrichtung, die den Halter zum Werkstück schiebt, aus einem Federschieber besteht, der nahe an der Bewegungsachse des Schneiders auf dem Halter anliegt und weitgehend parallel zu dieser Achse arbeitet, so dass die Spannungstendenz des Halters durch die Schubkraft verkleinert wird.

8. Werkzeug nach Anspruch 3, dadurch gekennzeichnet, dass der Umrissnockenstößel zwecks seiner Radialeinstellung auf den

Nockenstößelarm montiert ist, so dass der Durchmesser des Werkstücks vorher festgestellt werden kann, indem das werkstückeigene

Größenverhältnis zwischen das Scheideelement und den Umrissnockenstößel gesetzt wird.

5

10

15

20

25

30

35

40

45

50

55

60

65

11

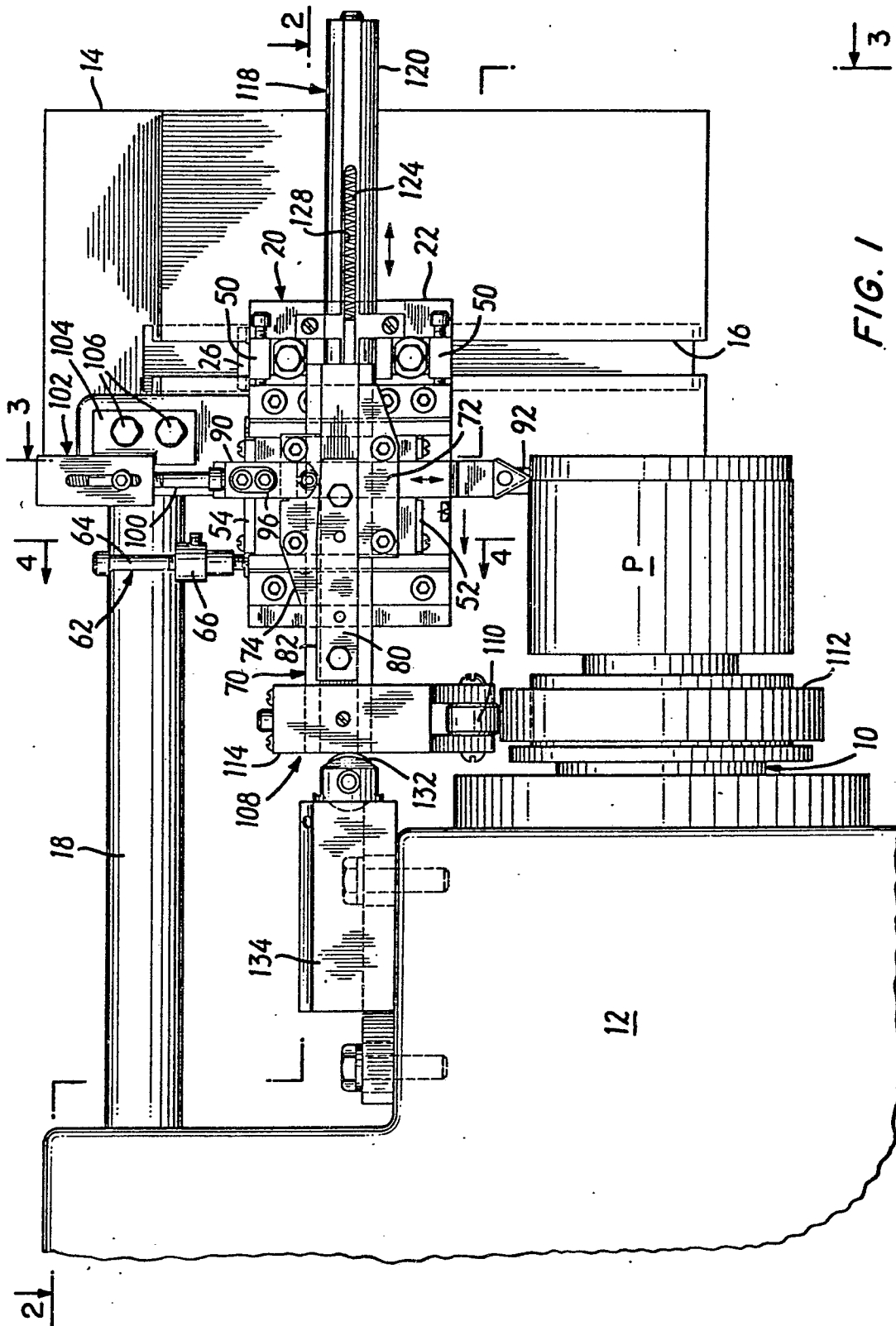
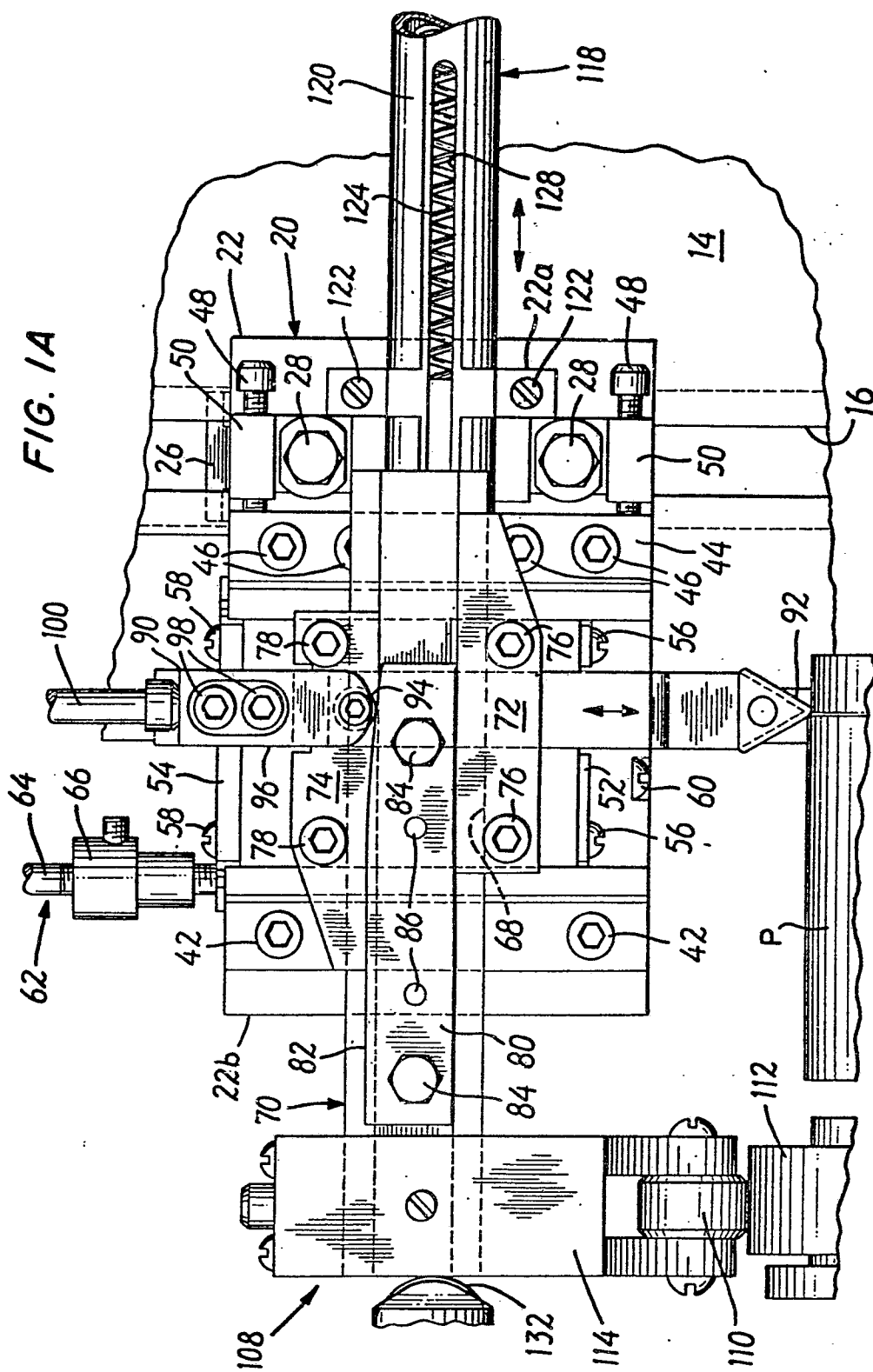


FIG. 1



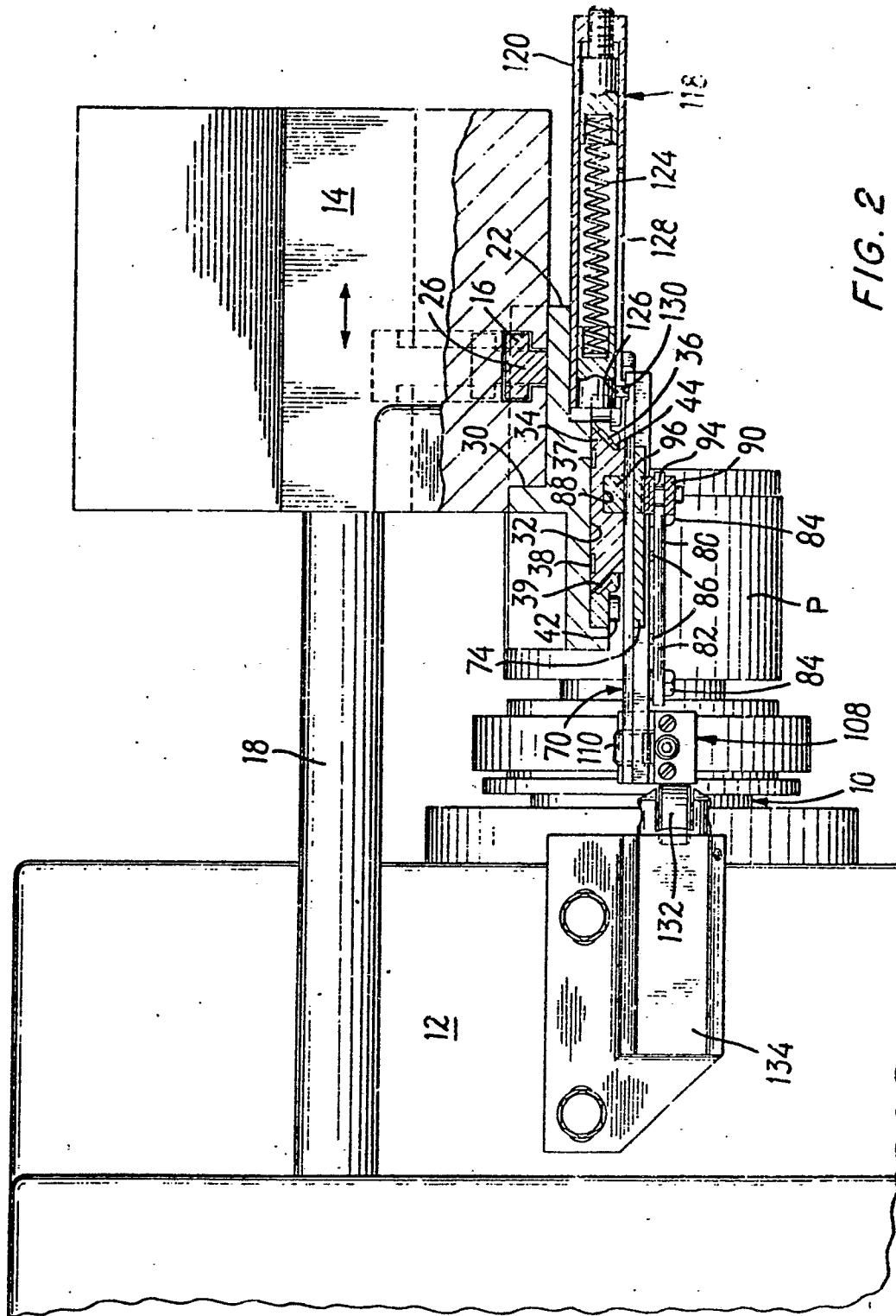


FIG. 2

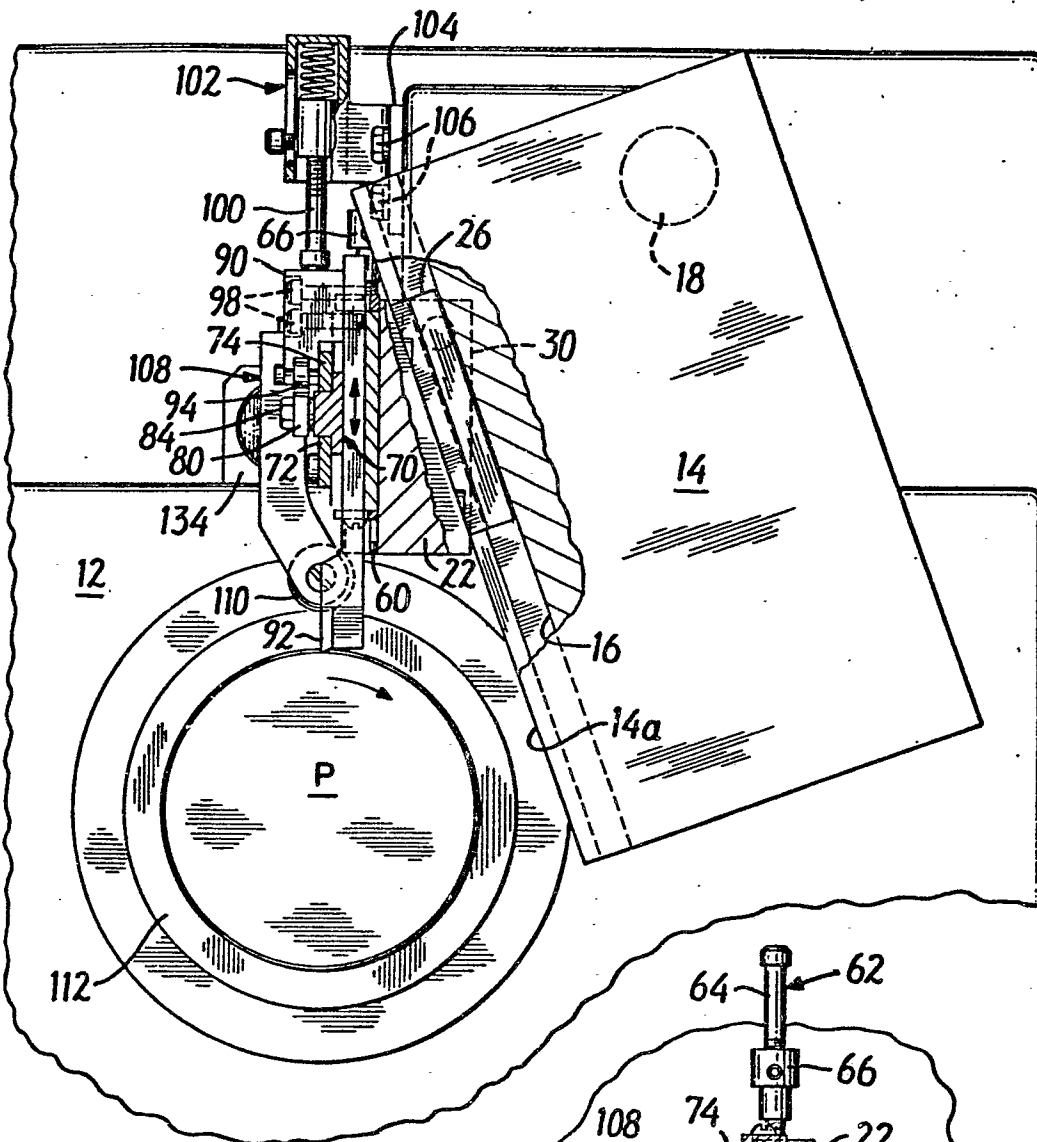


FIG. 3

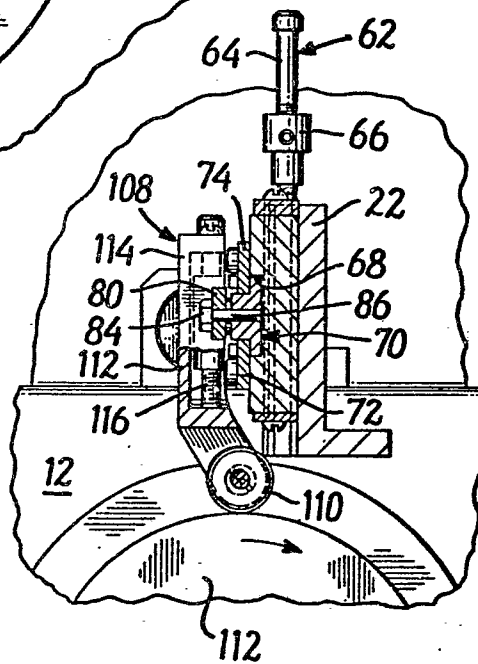


FIG. 4

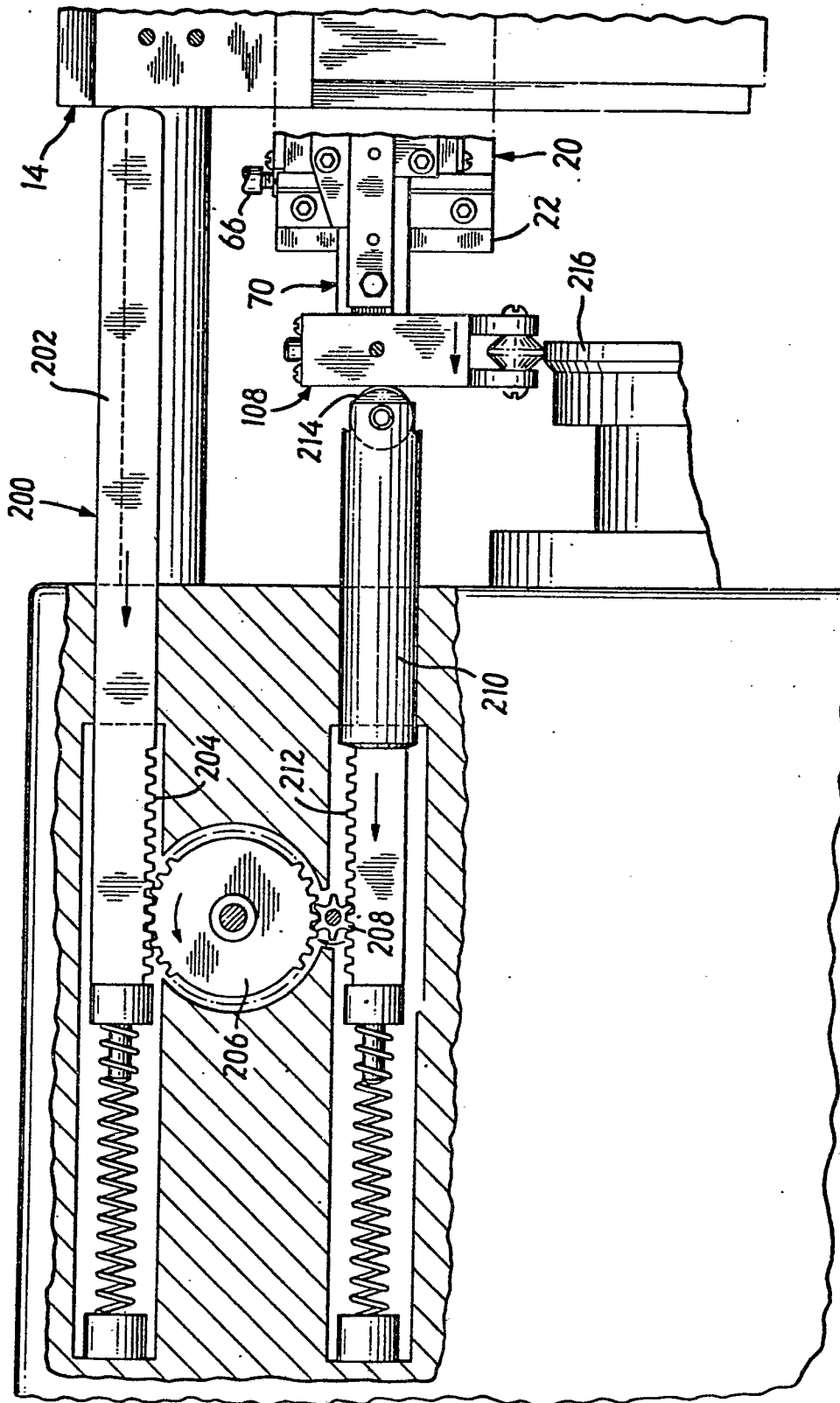


FIG. 5