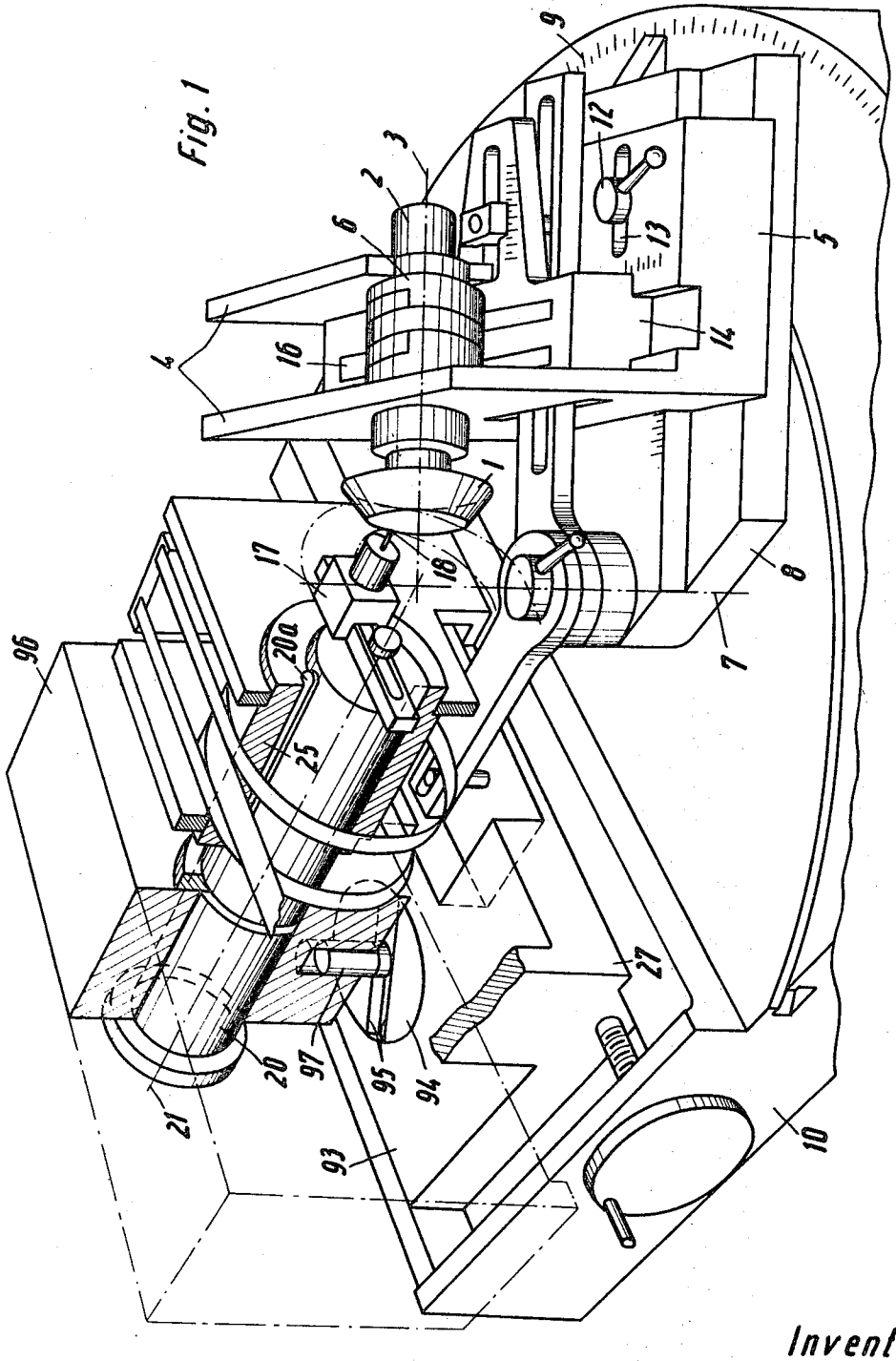
Dec. 15, 1970 K. H. WEBER 3,546,780

APPARATUS FOR CHECKING THE PROFILES OF GEAR TEETH, ESPECIALLY BEVEL GEARS

Filed June 21, 1968 4 Sheets-Sheet 1

Fig. 1



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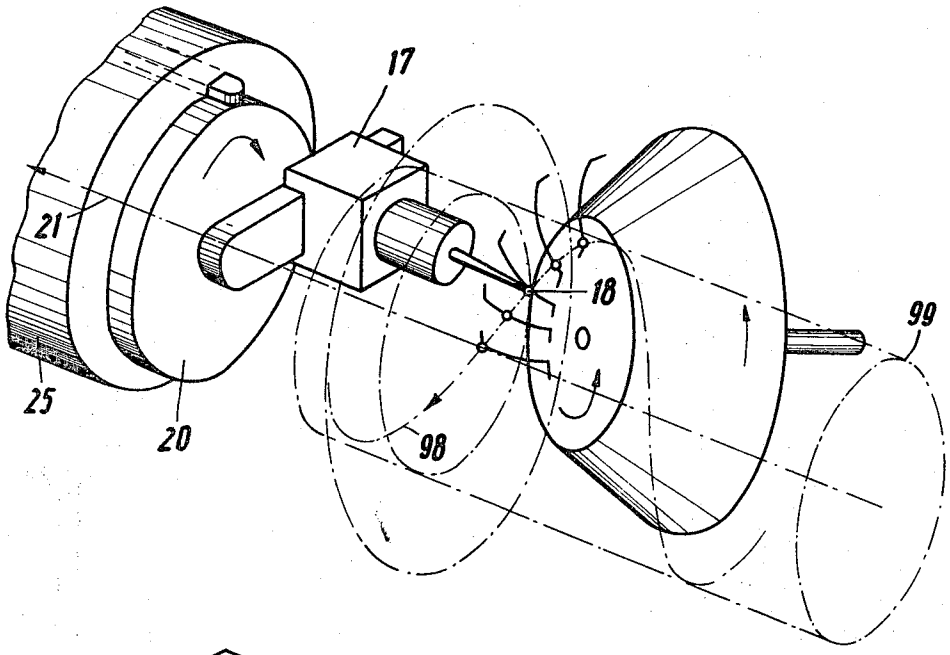

Fig. 2

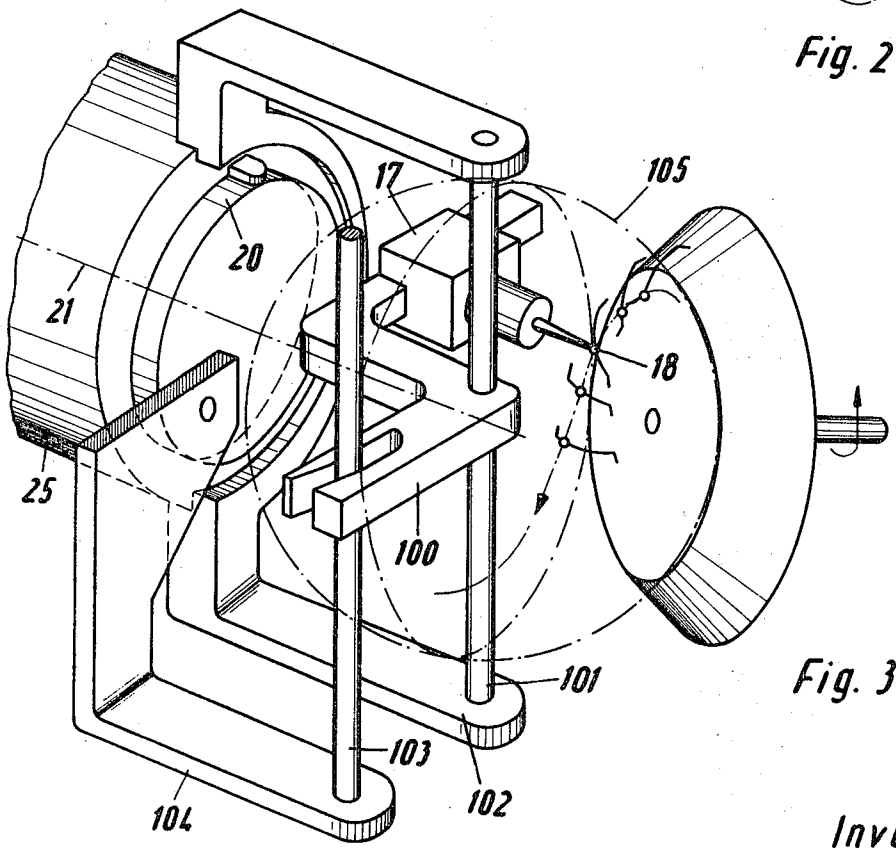

Fig. 3

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APPARATUS FOR CHECKING THE PROFILES OF GEAR TEETH, ESPECIALLY BEVEL GEARS

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Fig. 4a

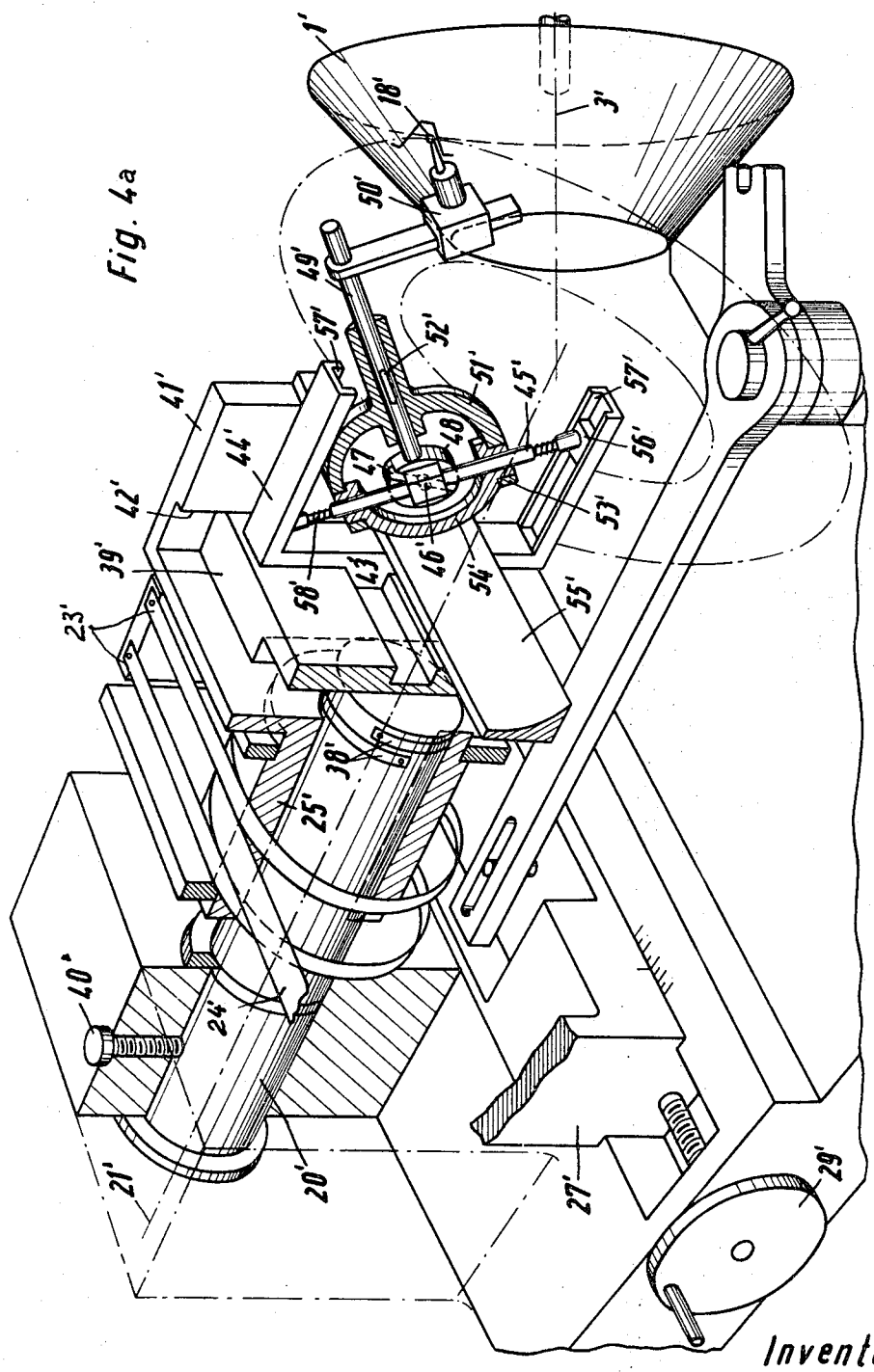

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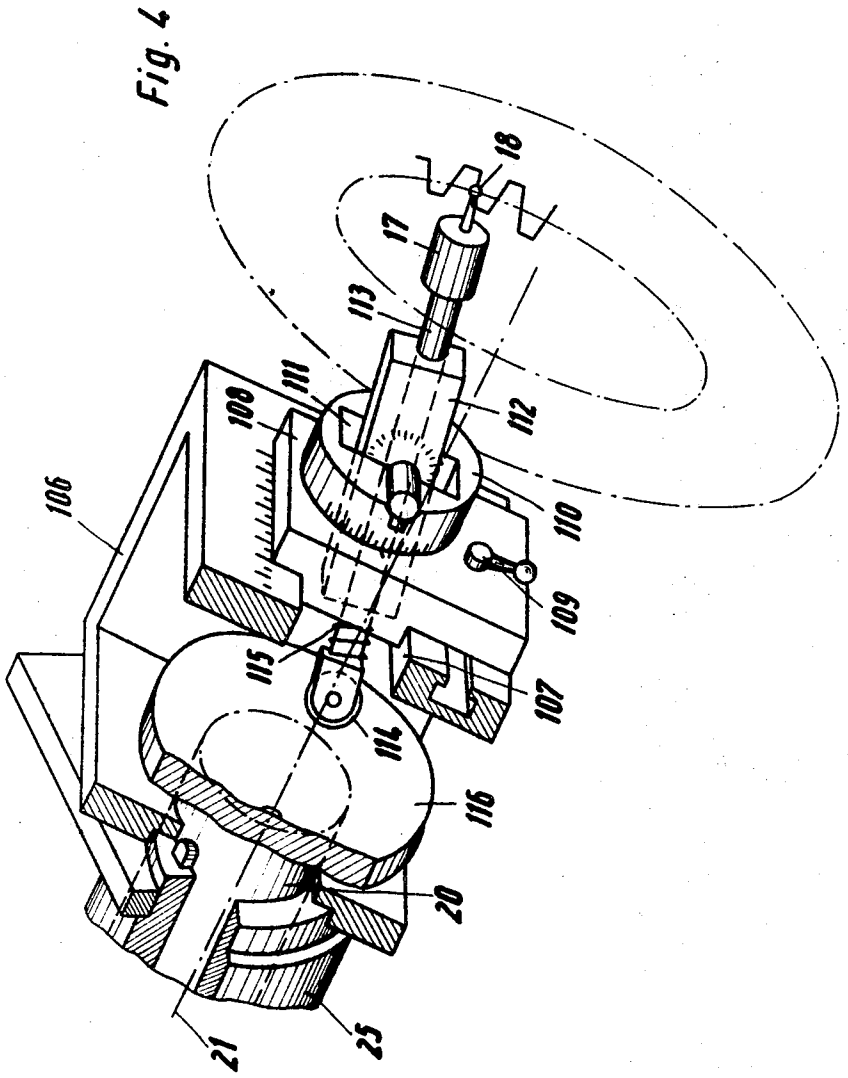
Fig. 4



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3,546,780

APPARATUS FOR CHECKING THE PROFILES OF GEAR TEETH, ESPECIALLY BEVEL GEARS

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Claims priority, application Germany, Aug. 4, 1967, K 63,026
Int. Cl. G01b 5/20
U.S. Cl. 33—179.5 3 Claims

ABSTRACT OF THE DISCLOSURE

Gear checking apparatus having a base member in which a first shaft for supporting a gear is supported on a carriage mounted on the base member for movement transverse to the axis of the first shaft with simultaneous rotation of the shaft in the carriage. The carriage is adjustable in the direction of the shaft axis and also angularly relative to an axis vertical to the axis of the first shaft.

A second carriage on the base member has a second shaft rotatable therein. The second carriage is adjustable on the base member transversely to the axis of said second shaft with simultaneous rotation of said second shaft. A feeler adjustably carried by said second shaft engages the gear on said first shaft. A lever interconnects the carriages for simultaneous transverse movement thereof.

The second shaft is arranged for axial movement in said second carriage.

The present invention relates to an apparatus for checking the profiles of gear teeth, especially bevel gears.

Such apparatus generally includes a support for the gear to be checked and a support for a feeler and a base common to the supports; the supports are adjustable angularly about an axis vertical to the base, each support comprising a carriage. A lever pivoted on the aforementioned axis interconnects the carriages for simultaneous movement. Movements of the carriage pertaining to the gear support causes rotation of the gear to be checked that is mounted thereon. Movement of the carriage pertaining to the support for the feeler causes rotation of the feeler. The supports are adjustable relatively to accommodate for different types and sizes of gears and the feeler is adjustable on its support during rotation of the gear being checked and the feeler, the feeler follows the profile of a tooth of the gear. The present invention concerns an improvement in apparatus of the abovementioned type according to which the rolling cylinder associated with the feeling device is supported by a stationary shaft. This shaft may according to a specific embodiment of the said apparatus support a further rolling transmission from which is derived an additional movement. The purpose of this additional movement is a movement of the feeler in the direction of the height of the teeth.

It is an object of the present invention to provide additional means to bring about the said additional movement according to the present invention, the transverse carriage associated with the stationary shaft is connected to adjustable inclined guiding means which impart onto the shaft bearing and thereby also onto the shaft with the feeler device connected thereto an axial movement which is adjustable as to its magnitude. A device of this type is characterized by a particular simplicity.

The invention is illustrated by way of example in the accompanying drawings, in which:

FIG. 1 is an isometric view showing an apparatus according to the invention with a device for axially displacing the feeler head.

FIG. 2 shows the measuring of the profile with a measuring feeler displaceable in axial direction.

FIG. 3 shows an arrangement for a feeler head for producing a movement of the measuring feeler on a ball surface about the tip of the partial cone.

FIG. 4 shows an arrangement for a feeler head, the measuring feeler of which moves on the profile of the normal cut of the replacement tooth.

FIG. 4*a* is an isometric view of an apparatus as one example in which the feeler mechanism likewise carries out a turning movement in conformity with the reference gearing while the feeler head is additionally displaced in the direction of the height of the teeth.

Similar to the apparatus disclosed in assignee's above identified copending application, the rolling cylinder **6** is supported by a carriage **5** which, in its turn, is guided on a rotatable base **8**, while the rolling cylinder **25** associated with the feeler device **17** is mounted on a stationary shaft **20**. A circular disc **94** provided with inclined guiding means **95** is rotatably and arrestably arranged in the broadened table surface **93**. The inclined guiding means **95** may be adjustable parallel or inclined at will with regard to the direction of movement of the transverse carriage **27**. A stud or pivot **97** inserted in the shaft bearing **96** engages the inclined guiding means. If the inclined guiding means is in inclined position and the transverse carriage **27** is displaced, a displacement of the shaft bearing and of the shaft **20** in the direction of its axis will result. The shaft **20** is coupled to the rolling cylinder **25** for rotation therewith by means of a key **20***a*. In this way it is possible to impart to the radial adjustable feeler device **17** connected to shaft **20** the desired additional movement in the direction of the height of the tooth when the feeler device **20** exerts a rolling movement.

As shown in FIG. 2, the measuring dome or peek **18** of the feeler moves along a helical line **98** of a cylinder **99** for the radius of which it has been adjusted and which cylinder is circumscribed around the axis **21**. This is due to the rotation of the rolling cylinder **25** brought about the rolling bands during the displacement of the transverse carriage **27** and due to the rotation of the shaft **20** and is, furthermore, due to the simultaneous displacement in the direction of its axis as caused by the pivot or stud **97**. This helical line, when the cylinder is developed into a plane, corresponds to a straight line and with a corresponding angular adjustment of the inclined guiding means **95** corresponds to the engaging line of the plane appropriate gearing of the bevel gearing (Tredgold's approximation). According to the transmission ratio adjusted by the roller band and lever transmission in conformity with the rolling of the workpiece on the reference gearing, the measuring dome of the feeler always contacts the profile or flank of the workpiece at points pertaining to the common engaging line of the supplementary gearing and records the deviation of the shape of the flanks of the workpiece to be checked from the rated shape.

With the arrangement according to FIG. 3 which represents an alternative solution to that of FIG. 2, the measuring dome **18** does not move on the surface of a cylinder but on a ball surface circumscribed by the common partial cone tip of the workpiece to be tested and reference gearing. The feeler device **17** is radially adjustably mounted on an arm of a two-arm lever **100**. This lever is connected to a shaft **101** which is rotatably journalled in a yoke bearing body **102**, which, in its turn, is connected to the rolling cylinder **25**. The second yoke-shaped arm of lever **100** extends a bolt **103** which in its turn is connected in an angle piece screwed fast onto shaft **20**.

The operation is as follows: While the work to be tested and the rolling cylinder **25** rotate at their transmission ratio, the shaft **20** rotating with the rolling cylinder will

be axially displaced in conformity with a correspondingly adjusted inclined guiding means **95**. The rod **103** brings about a rotation of lever **100** with the feeling device about the shaft **101** which rotates together with the rolling cylinder. The measuring dome **18** therefor, moves on the surface of the ball **105** for the radius of which it has been adjusted and upon said ball **105** moves along a curve which very much resembles the spacial engaging line of the bevel gear ring, inasmuch as rotations by small angles are involved.

With the spiral cone gears, due to manufacturing conditions, the straight line flank profile is obtained in normal section of the reference gearing. Therefore, it is expedient to adjust the measuring feeler for the normal cut of the reference gearing.

FIG. 4 shows an arrangement which permits this adjustment. A supporting frame **106** is connected to the rolling cylinder **25** while the front side of said frame which faces the workpiece to be checked is provided with a guiding path **107**. In this guiding path there is guided a carriage **108** which is radially adjustable and arrestable by means of a screw **109**. On the said carriage **108** there is mounted a cylindrical disc **110** which has a rectangular window **111**, said disc **110** being rotatably adjustable and being arrestable by any convenient means not shown. Within said window there is pivotally journalled a bearing body **112** which is pivotable about its axis which is perpendicular to the axis **21**. In said bearing body **112** there is axially adjustable and nonrotatably guided a rod **113** which has its front end carrying the feeler device **17** with the measuring dome **18** whereas the other end of said rod **113** carries a roller **114** journalled therein. A spring **115** presses the rod **113** against a plane abutment surface **116** at the front end of shaft **20**. By rotation of the cylinder disc **110** in conformity with the inclined or spiral angle of the respective tooth and when pivoting the bearing body **117** toward the normal angle of engagement, the displacement of the rod **113** with the measuring feeler in the direction of the straight flank profile as brought about by the axial movement of the shaft **20** may be adjusted in the normal cut of the reference gearing. The radius by which the measurement is to be effected is adjusted by the carriage **108**. The diameter of the engaging surface **116** must be so great that the roller **114** will still engage the same by all occurring adjustments.

It is, of course, to be understood that the present invention is not limited to the specific embodiments referred to above. Thus, for instance, the inclined guiding means for producing the axial supplemental movement may, contrary to the examples referred to above, act directly upon the shaft rather than upon the shaft bearing.

It is considerably more favorable to employ a point-shaped feeler and to move the same during the measuring operation additionally in the direction of the height of the tooth so that in its path it will act like a measuring edge. Such operation is possible with the design according to FIG. *4a*.

Fundamentally, the device according to FIG. *4a* corresponds to that of FIG. 4 in copending U.S. application Ser. No. 738,986, Seybold, filed concurrently herewith on June 21, 1968 and belonging to the assignee of the present invention. The arrangement of FIG. *4a* comprises the shaft **20'** associated with the feeler mechanism, in addition to the described roller transmission **23'–25'** cooperating with the transverse carriage **27'**, additionally equipped with a further roller transmission, namely, shaft **20'**, roller bands **38'** and carriage **39'**. Shaft **20'** is, by means of a set screw **40'** secured against rotation, whereas the roller cylinder **25'** is freely rotatable on the shaft **20'**. Fixedly connected to the roller cylinder is an angle member **41'** with machined-in guiding groove **42'** for the carriage **39'**. This carriage **39'** has connected thereto the ends of the roller bands **38'**. The carriage **39'** supports a substantially U-shaped member **44'** which is radially adjustable in the guiding groove **43'**. Between the legs of U-shaped

member **44'** there is rotatably journalled a shaft **45'**. Shaft **45'** is adjustable, inclined by the meshing angle of the workpiece to be checked with regard to a plane perpendicular to the axis **21'**. Shaft **45'** has its central portion provided with a stud or pin **46'** which is guided in a groove **47'** of a cylindrical disc **48'**. Connected to disc **48'** is a rod **49'** with the feeler **50'**, said rod **49'** being guided in the neck of a rocker **51'** and is secured by a key **52'** against rotation. The inclined position of groove **47'** is adjustable in conformity with the respective prevailing conditions. The rocker **51'** is journalled in bearings **53'** on a base member **54'** which is adjustably connected on a guiding body **55'** by nonillustrated means. The said guiding body **55'** is connected to the legs of the angle member **41'**.

The ends of the shaft **45'** are journalled in ball cups of sliding shoes **56'** which are adapted to be displaced in guiding grooves **57'** in the legs of the member **44'**. Shaft **45'** consists of three telescopically interengaging members which are pressed apart by springs **58'**. When pivoting the rocker **51'** about the axis of the stud **46'**, the slide shoes **56'** slide in the guiding grooves **57'**, and the sections of the shaft **45'** move into or out of each other. In the adjusted pivoting positions about the axes of members **46'** and **53'**, the rocker is adapted to be clamped fast by any convenient means not shown in FIG. *4a*.

OPERATION OF THE DEVICE ACCORDING TO FIG. *4a*

The operation of the device of FIG. *4a* is as follows:

The U-shaped member **44'** arranged on the carriage **39'** is radially adjusted with regard to the axis **21'** in such a manner that the feeler dome **18'** rakes the profile of the workpiece to be checked at the predetermined distance from its pitch cone tip when by turning the hand crank **29'** the imaginary reference gearing and the workpiece to be checked roll upon each other. So far, the movements correspond to those of the device according to FIG. 1 of the aforementioned copending application. According to FIG. *4a* there is an additional movement of the feeler head in the direction of the height of the tooth. If, namely, the angle member **41'** together with the roller cylinder **25'** turns about the axis **21'** and the carriage **39'** follows this movement, said carriage **39'** simultaneously moves in groove **42'** due to the rolling on the stationarily held shaft **20'** as forced by the roller bands **38'**. The member **44'** is thus moved along. Shaft **45'**, stud **46'** and inclined guiding means **47'** bring about an axial displacement of the rod **49'** and thereby the desired additional movement of the feeling device **50'** with the feeler dome **18'** in the direction of the height of the tooth.

Due to the tiltability of the rocker **51'** about two axes arranged perpendicularly to each other, the rod **49'** can, within certain limits, be adjusted in conformity with any desired direction relative to axis **21'**. In this way it will be possible to move the feeler in conformity with the rectilinear profile of the tangential sections of the flanks of the reference gearing bevel gears with straight or inclined teeth and also in conformity with the rectilinear profile of the normal section of the reference gearing of bevel gears with spiral teeth. Inasmuch as the measuring feeler which moves along a straight path in both instances represents a profile of the reference gearing, the transmission ratio for the turning movements of the reference gearing and of the workpiece to be checked, i.e., of the rolling cylinder **25'** and the spindle upon which the workpiece is tested as shown in the aforementioned copending application is to be adjusted in conformity with the pitch cone angle of the workpiece **1'** to be checked.

If desired, in view of the adjusting possibilities, the rod **49'** carrying the measuring feeler may also be adjusted in the direction of the rectilinear normal profile section of a non-roller spur bevel gear with spiral teeth. In order then to check the flank profile of the teeth of a gear associated with said spur bevel gear, it is necessary to adjust

the transmission ratio of the rolling cylinder 25' and the receiving spindle upon which the workpiece is tested as shown in the aforementioned co-pending application in conformity with the teeth ratio of the workpiece to be checked to the spur bevel gear while the angle of the axes 3' and 21' must equal the axis angle of the transmission.

What is claimed is:

1. In an apparatus for checking the profiles of gear teeth, especially bevel gear teeth: a base member, a first support member mounted on said base member for pivotal movement thereon about a first axis perpendicular to the base member, a second support member mounted on said first support member for movement thereon radial to said first axis, a third support member mounted on said second support member for movement thereon transverse to the direction of movement of said second support member, a first shaft rotatable in said second support member, means for rotating said first shaft in response to movement of said third support member on said second support member, a fourth support member on the opposite side of said first axis from said first support member and supported on said base member for movement therein in a direction at right angles to a radius from said first axis, a fifth support member adjacent said fourth support member and moveable radially of said first axis, a second shaft rotatable but nonaxially moveable in said fifth support member, a cylindrical portion nonrotatably but axially moveably carried by said second shaft and rotatably but nonaxially moveably mounted in said fourth support member, means responsive to movement of said fourth support member on said base to rotate said cylindrical portion and said second shaft, the line of intersection of the planes perpendicular to said base member and containing the axes of said first and second shafts being coaxial with said first axis, a lever pivoted on said first axis and having one arm engaging said third support member and another arm engaging said fourth support member for simultaneous movement of said third and fourth support members, means for mounting a gear on the end of said first shaft adjacent said first axis, a feeler, means for mounting said feeler on one of said second shaft and cylindrical portion adjacent said first axis for engaging the teeth of said gear, and means for adjusting said fifth support member together with said second shaft means radially of said first axis.

2. An apparatus according to claim 1 which includes a yoke connected to said cylindrical portion, a third shaft in the yoke having its axis intersecting the axis of said second shaft, a two arm lever rotatable on said third shaft, said feeler being mounted on one arm of said two arm lever, the other arm of said two arm lever being fork shaped, a bracket fixed to said second shaft, and a rod fixed to said bracket and engaging said fork shaped arm of said two arm lever.

3. An apparatus according to claim 1 which includes an abutment disc on the end of said second shaft, a bracket connected to said cylindrical portion, a first member slidable on said bracket perpendicular to the axis of said second shaft, a second member angularly adjustable on said first member, a push rod extending through said first and second members and having one end engaging said abutment member, spring means urging said push rod toward said abutment member, a pivotal connection between said push rod and said second member, and said feeler being mounted on the end of said push rod opposite said one end thereof.

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