

[54] **APPARATUS FOR FINISHING GLOBOID WORMS**

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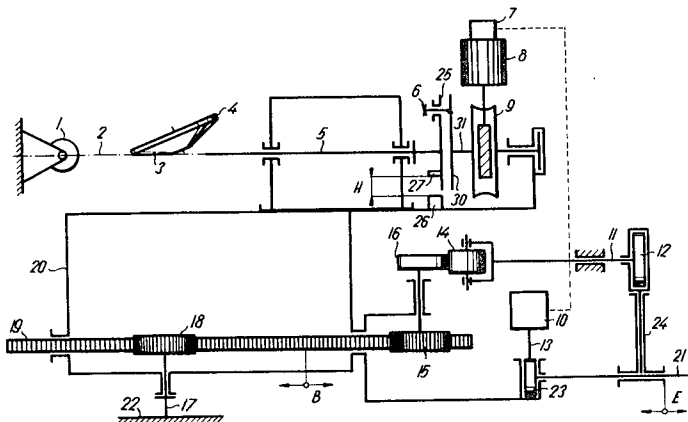
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[57] **ABSTRACT**

Apparatus for finishing globoid worm gears wherein the angular position of the shaft of a disk-shaped tool for finishing a globoid worm is adjusted according to changes of the lead of the globoid helix by mounting the disk-shaped tool on a pivotably supported base, the angular position of which is determined in dependence on the working process as it proceeds. Means are included for adjusting simultaneously in dependence on the position of said base the position of the shaft of the disk-shaped tool with respect to the worked globoid worm, the latter adjustment being carried out by way of a selsyn coupling.

6 Claims, 4 Drawing Figures



APPARATUS FOR FINISHING GLOBOID WORMS

BACKGROUND OF THE INVENTION

This invention relates to an arrangement for the control of the angular position of the shaft of a disk-shaped tool for finishing a globoid worm according to changes of the corresponding globoid helix.

In the manufacture of globoid gear systems the worm and worm wheel are generally roughly formed with their globoid helix tooth configuration. It is thereafter necessary to finish the worm or worm wheel by grinding the tooth flanks to remove burrs, imperfections, and to generally insure perfect engagement of the moving parts. In general such apparatus for finishing the worm includes means for mounting and rotating the worm, a disk-shaped grinding tool, and means for both rotating and linearly translating the disk and worm relative to each other, so that the globoid helix of the worm is properly formed. A power coupling is used to control the angular position of the shaft of the disk with respect to the generating gear which coupling generally requires control elements of a rugged design. This rugged design is difficult to achieve because the control element also requires a high degree of sensitivity to the generating lines and generating gear to conform to the parameters of the globoid helix. The known control systems fail in one or the other of the above mentioned aspects.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a rugged arrangement for the control of the angular position of the shaft of a disk-shaped tool for finishing a globoid worm, which will maintain a high-degree sensitivity.

It is another object of this invention to provide an arrangement of this kind, which permits easy adjustment over the whole range of manufactured globoid worms.

Bearing these and other objects in mind an arrangement of this kind is provided comprising a base pivoted simultaneously with the worked globoid worm in dependence on the transmission ratio of the globoid worm gear system for which it is made. A sliding rack is provided on the body of the base, said sliding rack engaging with a fixed toothed wheel, generating thus in the course of rotation of said base a relative sliding movement between the rack and the body of the base. Means are provided for transmitting the sliding movement to adjust the position of a programming cam, which is in engagement with means for adjusting the position of a sliding mechanism, which in turn transmits its movement to a selsyn transmitter. A selsyn receiver is actuated by the transmitter controlling driving means for adjusting the angular position of the disk-shaped tool with respect to the surface of the globoid worm.

An advantage of the arrangement according to this invention is the powerless transmission between individual control elements and thus a substantial increase of the sensitivity of the control and operating mechanisms, obtaining higher degrees of accuracy of the manufactured globoid worm gear. An equally important advantage is the possibility of application of the control system for the whole range of parameters of the manufactured globoid worms by using a single control cam, the profile of which includes the entire program for all control mechanisms as a whole.

DESCRIPTION OF THE DRAWING

The attached drawing illustrates an exemplary embodiment of the object of this invention, where FIG. 1 is a schematical elevation of the control arrangement for the adjustment of the angular position of the shaft of the disk-shaped tool, FIG. 2 the corresponding top view of the bottom part, FIG. 3 a top view of the upper part and FIG. 4 a side view on the adjusting disk.

DESCRIPTION OF PREFERRED EMBODIMENT

As seen in the drawings a workpiece such as a worm 1 is mounted on a frame fixed to the machine for rotation about its

central axis. Engaging with the flanks of the teeth of the worm 1 is a grinding disk 4 having a face lying along an axis 3 lying in a plane 2 which passes through the central axis of the worm 1 so that the face of the disk 4 is tangent to the tooth flank. Mounted on the machine frame is a rotating base board 20 which is interconnected with the worm 1 by conventional transmission so that both move in dependence upon the transmission ratio of a globoid helical generating worm gear. The worm 1 is rotated exactly as it would in use and as if it engages a worm wheel, which in fact is represented by the grinding disk 4. The distance between the axis of the workpiece worm 1 and the axis 17 of the base is maintained equal to the theoretical distance between worm and worm wheel.

A central toothed wheel 18 is mounted on an axle 17 firmly connected with the machine frame 22. A rack 19, is slidably mounted within the underside of the body 20 of a pivotable base mounted to rotate around the axle 17. The rack 19 meshes with the central pinion toothed wheel 18. A second pinion toothed wheel 15 having the same number of teeth as wheel 18 is rotatably supported by the body of the base 20 also meshes with said rack 19 and a cam 16 is fixed on the shaft supporting the toothed wheel 15. The profile of the cam 16 includes the entire control program of all attached mechanisms and is designed so that a correct resulting deviation of the disk 4 around a generating line 3 is achieved via interconnection with the base 20, as the work progresses and the finishing proceeds. A sliding lever system is provided for engagement with the cam 16, composed of a bar 11 terminating at one end with a roller 14 contacting the cam 16 and with a bolt 12 at the other end for transmission of the movement to a sleeve 24 of the sliding system. A sliding rod 21 is mounted within the sleeve, said sliding rod 21 being pivotable around a bolt 23 (see also FIG. 2) firmly connected with the shaft 13 of a control selsyn transmitter 10. The control selsyn 10 is electrically coupled with a selsyn receiver 7 controlling an electric motor 8 transmitting its motion to a worm wheel 9, the output shaft 31 of which is coupled by an adjustable coupling with the shaft 5 supporting the grinding disk 4. This adjustable coupling is composed of a disk 30 fixed on the output shaft 31 of the worm gear 9. The disk 30 is provided with screwbolts 6 which engage into an annular groove formed in another disk 25 fixed to the shaft 5. An interconnection of both shafts 31 and 5 is achieved by tightening the nuts of the screwbolts 6. The disk 25 is furthermore provided with a bolt 27 adapted to cooperate with a rest 26 on the body 20. By inserting gauge templates H between the bolt 27 and the rest 26 the angular starting position of the grinding disk 1 can be adjusted. The other extremity of the shaft 5 is designed as a supporting bearing means for the shaft of the disk-shaped tool 4. The supporting means include an electric motor 28 driving by means of a V-belt transmission 29 the shaft of the disk-shaped grinding tool 4.

As seen in FIG. 3, the angular starting position of the grinding disk 4 with respect to the generating line 3 coincident with the axis of the output shaft 5 of the worm wheel 9, lies in the axial plane 2 of the worm 1 which is to be worked on or finished. This is determined by the value H of the previously mentioned gauge. The axial plane 2 is a plane defined by the axis of the worm 1 and by a radial line passing through the axis of the worm wheel 9 and perpendicular to the axis of the worm. The control elements described above function to adjust the angle to follow the helix, however, if the angular position of the working tool or grinding disk is to remain constant, the whole arrangement for the adjustment of its angular position is put out of operation.

In operation the working tool 4 is first adjusted with respect to the axis of the gear so that the active surface of the grinding disk is on the generating line of the manufactured gear and that the grinding disk touches the globoid helix of the worm in a point where the generating line crosses the pitch circle, whereby the radial line of pitch circle in this point is perpendicular to the axis of the worm. In the described manner first the right flank of the helical surface of the worm is worked and subsequently the left flank.

The described arrangement executing the method according to this invention operates so that (see FIG. 2) a longitudinal movement B of the rack 19 is generated in the course of turning the body 20 of the rotatable board around its rotation axis coincident with the axis of the axle 17 of the central toothed wheel 18 indicated in FIG. 2 by the letter A. The rack 19 is thus caused to hob around the central toothed wheel 18.

The body 20 of the rotating base 20 and the worked worm 1 obtain a rotating movement in dependence on the transmission ratio of the respective worm gear. The movement of the rack 19 is transmitted to the toothed wheel 15 fixed to the cam 16, the profile of which is chosen so as to cover the whole range of manufactured globoid gears. The cam 16 reacts on the roller 14 supported by the sliding bar 11, which is thus shifted in direction D. This movement is transmitted by means of the bolt 12 to the sleeve 24 of the sliding rod 21, causing a reciprocating movement E of the sleeve 24 along the sliding rod 21 in the direction E whereby the distance between the bolt 12 and the bolt 23 of the sliding rod 21 changes in dependence on the program of the cam 16 resulting in changes in the distance indicated by their coordinates G and F. The guiding of the sleeve 24 transmits the reciprocating movement E to the sliding rod 21 and generates an angular movement K of the sliding rod 21 changing the angle J of the position of the sliding rod 21. The change of the angle J causes the turning of the bolt 23 of the sliding rod 21 and thus also of the shaft 13 of the control selsyn transmitter 10 generating an electric impulse which is transmitted to the selsyn 7 controlling the electric motor 8, FIG. 1. As seen in FIG. 3 the torque of the electric motor 8 is transmitted via the worm wheel gear 9 to the output shaft 5 by means of the coupling composed of disk 30 and 25. Deviation of the shaft of the disk-grinding tool is thus obtained.

The output shaft 5 is firmly connected with the adjusting disk 25 the position of which is adjusted prior to the start of working by the limiting gauges H. Thus the starting angular position of the shaft of the disk-shaped tool 4 around its generating line 3 is adjusted, which generating line 3 is within the axial plane 2 of the workpiece worm 1. In the course of this adjustment the screwbolts 6 pass freely through the annular groove 32 of the disk 25. After the correct adjustment both disks 25 and 30 are firmly connected by nuts on the screwbolts 6, securing a direct transmission of required changes of the angular position of the shaft of the disk-grinding tool 4 from the selsyn drive 7 to the shaft of the tool 4. The drive of the disk-shaped tool 4 in any angular position is secured by the electric motor 28. The body 20 of the rotatable base supporting the disk-grinding tool 4 and the workpiece worm 1 are rotated in dependence on the transmission ratio of the worm gear.

From the foregoing it will be seen that there has been provided a simple mechanism for adjusting the angular position of a rotating grinding disk with respect to the teeth of a rotating

workpiece such as a worm, the axes of which being angular to each other. By mounting the grinding disk on a pivotal base coupled with the worm workpiece the position may be determined by the changes in the angle between a radial line to the pitch circle of the vertical globoid gear system, perpendicular to the axis of the workpiece worm and between a radial line of the pitch circle passing through a point of the globoid helix corresponding to the point or place of working of the worm.

I claim:

1. Apparatus for finishing the worms of globoid worm gears comprising means for supporting a workpiece for rotation about its central axis, a grinding disk mounted about a central shaft and adapted to rotate in engagement with said workpiece, motive means for angularly positioning said disk relative to said workpiece, and control mechanism for adjusting the angular position comprising a pivotal base mounted about a fixed axle, means coupling the rotating workpiece and the pivotal base at speeds dependent upon the transmission ratio of the finished globoid worm gear, means responsive to the movement of said pivotal base for producing an electrical signal and means responsive to said electrical signal for activating said motive means to adjust the angular position of said grinding disk.

2. The apparatus according to claim 1 wherein said control mechanism includes a rack slidably mounted on said base, a first pinion mounted on said fixed axle and engaging said rack, a second pinion spaced from said first pinion and engaging said rack, a cam secured to said second pinion for conjoint movement therewith, a lever having a cam follower at one end engaging said cam and means located at the other end for actuating a selsyn transmitter, a selsyn transmitter and a selsyn receiver actuated by said transmitter, and means for transmitting a signal from said receiver to said motive means to operate the same.

3. The apparatus according to claim 2 wherein said motive means includes a clutch located between said selsyn receiver and said grinding disk, said clutch including means for angularly adjusting one part with respect to another.

4. The apparatus according to claim 3 including means for presetting the adjustment of said clutch prior to the start of operation.

5. The apparatus according to claim 3, wherein said cam comprises a disk cam having a contoured profile corresponding to the full program of the globoid helix of said worm.

6. The apparatus according to claim 5, wherein the profile of the cam is determined by the continuous changes of the angle between a radial line of the pitch circle of the globoid gear which is perpendicular to the axis of the worm and between a radial line of the pitch circle passing through a point of the globoid helix corresponding to the worked place of the globoid worm.

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