A tool spindle is used to machine or produce elliptical surfaces, in particular elliptical bores. A sleeve is mounted rotatably in a housing, and a shaft which carries the tool is mounted rotatably in the interior of the sleeve, eccentrically with respect to the sleeve axis. The shaft and the sleeve are driven at the same speed, but in opposite directions.
Abstract

A tool spindle is used to machine or produce elliptical surfaces, in particular elliptical bores. A sleeve is mounted rotatably in a housing, and a shaft which carries the tool is mounted rotatably in the interior of the sleeve, eccentrically with respect to the sleeve axis. The shaft and the sleeve are driven at the same speed, but in opposite directions.
Tool Spindle, in particular Boring Spindle

The invention relates to a tool spindle, in particular a boring spindle for boring bores of elliptical cross-section.

Bores normally have a circular cross-section. In certain cases, however, it is desirable to produce bores the cross-section of which deviates from the circular, and specifically bores which have an elliptical cross-section. Bores of this shape have the advantage that with the same cross-section the dimensions in the direction of the short semiaxis are smaller.

The object of the invention is to provide a tool spindle by means of which it is possible to produce elliptical bores of this type. Here, the tool spindle according to the invention serves primarily as a boring spindle. However, it is also possible to use the same tool spindle or one with only slight alterations as, for example, a support for grinding tools or other tools for machining bores of elliptical cross-section.

The tool spindle according to the invention is characterized in that there is mounted in a housing a sleeve which in turn receives a shaft as a tool carrier. The sleeve and the shaft are driven at the same speed but in opposite directions, the axes of rotation of the sleeve and of the shaft running parallel to one another but at a spacing from one another.

With the tool spindle according to the invention, the tool which is carried by the shaft describes an elliptical path, one rotation of the shaft corresponding to one complete elliptical path. The spacing of the axes of the shaft and of the sleeve thereby determines the extent of eccentricity, i.e. the difference between the two semiaxes of the ellipse. Here, the spacing corresponds to half the eccentricity.

The elliptical movement of the tool which is carried by the shaft is effected in that the shaft axis revolves on a circular path,
in particular in the opposite direction to the rotary movement of the shaft itself. Thus, there occurs in fact an addition of the spacing between the two axes mentioned which, after an angular movement of 90°, corresponds to a mutual cancellation. An elliptical movement is thus obtained in which, after an arc of 90°, the long semiaxis and the short semiaxis of the ellipse adjoin one another.

The most significant advantage of the invention consists in the relatively simple construction which produces the elliptical movement.

The two drives, i.e. the drive of the sleeve and the drive of the shaft, can be electrically coupled to one another such that each of the two elements has an electric motor and the two electric motors operate at exactly the same speed, for example through synchronizing devices or other known means. It is thereby merely necessary to select the directions of rotation appropriately.

In another variant of the tool spindle according to the invention, a common mechanical drive is provided for the sleeve and the shaft. A common motor is therefore used to drive both the sleeve and the shaft. Since the sleeve is mounted in the relatively fixed housing, driving this sleeve mechanically does not create any particular problems. However, owing to the eccentric mounting of the shaft in the sleeve, the rotation of the shaft axis has to be taken into account in driving the shaft. This can be effected in a very simple constructional design by driving the shaft by means, for example, of a Cardan shaft which permits the eccentric movements of the shaft carrying the tool. This Cardan shaft extends substantially in the direction of the axes of the shaft or the sleeve.

In the invention, however, an arrangement is preferred in which a gear housing revolves together with the driven sleeve, a gear shaft having two toothed wheels being rotatably mounted in the gear housing, substantially axially parallel to the sleeve and
shaft axes. One toothed wheel of the gear shaft meshes with a stationary central wheel, the axis of which is aligned coaxially with respect to the sleeve axis, while the other toothed wheel of the gear shaft acts on a toothed wheel which is arranged on the shaft serving as a tool carrier and which revolves coaxially together with this toothed wheel.

The arrangement according to the invention has a construction similar to a planetary gear. It fulfils the essential requirements of the invention, which consist in driving the shaft and the sleeve in opposite directions at the same speed and in mounting the shaft eccentrically in the sleeve. Running in opposite directions is obtained by the cooperation of the revolving gear shaft with the central wheel, the direction of rotation of the gear shaft corresponding to the direction of rotation of the sleeve. However, in the action on the toothed wheel on the shaft, this toothed wheel is driven in the opposite direction. By appropriately calculating the number of teeth on the different cooperating toothed wheels, a precise, equivalent countermovement of the shaft with respect to the sleeve can easily be achieved. The proposal according to the invention also solves the problem of driving the shaft mounted eccentrically in the sleeve. With a suitable arrangement, it can easily be achieved that the gear shafts also revolve about the axis of the shaft.

The invention specifically proposes that two gear shafts each having a pair of toothed wheels be mounted in the gear housing, the centre vertical on the connection line between the two gear shaft axes intersecting the axes of the sleeve and of the shaft. Such an arrangement fulfils all the necessary geometric conditions.

It is also possible for the axes of the gear shafts to be arranged to be offset by 180° with respect to the sleeve axis, so that substantially only turning moments, and no other forces are to be transmitted.
In one proven embodiment of the invention, the revolving gear housing is provided with a neck-like extension which receives the mounting for the shaft of the stationary central wheel, this central wheel shaft being fixed at its end opposite the central wheel. It is favourable for this fixing to be adjustable. The alignment of the semi-axes of the desired ellipse can be determined in this way. It is therefore not strictly necessary to arrange the workpiece such that the ellipse to be produced has the desired alignment with respect to the workpiece. It is also possible to appropriately align the tool spindle alone.

It is favourable for a drive plate to be set on the neck-like extension. The rotary movement is transmitted to the sleeve, and thence to the shaft by way of this drive plate.

According to a further feature of the invention, the housing is constructed in two parts. A first tubular part is associated with the tool and preferably receives the mountings for the sleeve and the shaft. A second housing-type part encloses the revolving gear housing.

The invention is described above with respect to a tool spindle in which the tool, carried by the shaft is preferably intended to produce or to machine a bore.

However, the inventive idea can also be used specifically to produce an elliptical external contour. To this end, the invention proposes a tool for producing and machining surfaces of elliptical cross-section, which tool is characterized in that there is provided a central supporting body on which there revolves a sleeve which serves as a supporting mounting for a revolving tool carrier, the sleeve and the tool carrier being driven at the same speed but in opposite directions, and the axes of rotation of the sleeve and of the tool carrier running parallel to one another but at a spacing from one another. Thus, a tool carrier which revolves on a comparatively large diameter and describes elliptical paths is obtained, so that a tool of
this type can also be used for example for elliptical external contours or indeed internal contours of large dimensions.

The invention will now be described in greater detail, by way of illustration only, with reference to the accompanying drawings, in which

Fig. 1 shows a sectional view of a tool spindle according to the invention,

Fig. 2, Fig. 3 and Fig. 4 show respectively the front, the central and the rear parts of the tool spindle of Fig. 1, on a larger scale, and

Fig. 5 shows a schematic view of a revolving gear housing forming part of the tool spindle of Fig. 1.

In the tool spindle shown, an outer housing 1 which comprises the parts 31 and 32. These two parts are connected fixedly to one another, for example by means of screws 22. The part 32 is part of a larger housing by means of which the tool spindle according to the invention is connected to a machine tool.

The part 31 has an approximately tubular construction and substantially receives a sleeve 2, while the part 32 encloses a revolving gear housing 7.

The sleeve 2 is held in the housing 1 by radial bearings 23,24 and by axial bearings 25. The sleeve axis is designated 12.

The revolving gear housing 7 is mounted on the sleeve 2 by means of screws 27. This gear housing is closed by means of a neck-like extension 18. Two gear shafts 4,5 are freely rotatably mounted in the revolving gear housing 7. Each of the gear shafts 4,5 has a pair of toothed wheels 8,9, which are rigidly mounted on the gear shafts 4,5 respectively.
Each toothed wheel 8 of the gear shafts 4,5 meshes with a central wheel 6 which is supported in a mounting 19 in the neck-like extension 18. This mounting 19 substantially comprises two roller bearings 28,29. The axis 16 of the central wheel 6 runs coaxially with respect to the sleeve axis 12. The end 30 of the shaft 26 of the central wheel 6 is fixed non-rotatably to the part 32 of the housing 1. However, this fixing can be released if required, in order to rotate the alignment of the semiaxes of the ellipse to be produced about the axes 12,13.

The axis 13 is the axis of the shaft 3 which runs in the interior of the sleeve 2, eccentric to the axis 12.

It will be noted that in the diagrammatical illustrations of Figs. 1 to 4 both the gear shafts 4,5 and the eccentric offsetting of the shaft 13 with respect to the shaft 12 are shown in the plane of the drawing. However, Fig. 5 shows clearly that this only serves the purpose of illustration. In a practical embodiment, the plane to which the axes 12,13 belong and the plane to which the axes of the two gear shafts 4,5 belong intersect at right angles.

The neck-like extension 18 is in turn additionally supported by way of a bearing 33 in the housing part 32.

While the sleeve 2 is arranged in a bore 34 in the housing 1, the shaft 3 is accommodated in a bore 35 in the sleeve 2. The axis 13 is associated with this bore 35. The elements for mounting the shaft 3 in the sleeve 2 are designated 36 to 39. The bearings 36,38,39 are radial bearings, and the bearing 37 takes up the axial forces.

The shaft 3 has a holding element 40 which carries the cutting tool 20. The workpiece is designated 44. At the end remote from the tool 20, the toothed wheel 11 is rigidly connected to the shaft. This toothed wheel 11 meshes with the two toothed wheels 9 of the gear shafts 4,5.
A drive plate 21 is provided for driving the sleeve 2. This drive plate 21 can, for example, be a toothed belt plate for the toothed belt 41. However, other known means, such as toothed wheels, V-belts or the like can also be used for driving the sleeve 2.

In the embodiment shown, driving of the shaft 3 is derived from driving of the sleeve 2. The toothed wheels 8 which revolve together with the sleeve 2 mesh with the central wheel 6, rotate about the associated axes 14,15 and at the same time revolve together with the sleeve in the same direction, and also the toothed wheels 8,9 on the gear shafts 4,5 have the same direction of rotation as the sleeve 2, since they roll against the central wheel 6. However, when the toothed wheels 9 cooperate with the toothed wheel 11, a counter-directed rotary movement occurs for the toothed wheel 11, so that the shaft 3 rotates in the opposite direction.

Fig. 5 shows an enlarged illustration of a schematic view of the interior of the revolving gear housing, the various toothed wheels being shown only by broken circles or rolling circles.

The rolling points between the central wheel 6 and the toothed wheels 8 are designated 42 and the rolling points between the toothed wheels 9 and the toothed wheel 11 on the shaft 3 are designated 43.

In the embodiment shown, the axes 14 and 15 are opposed with respect to the axis 12 of the sleeve 2 by 180°. The shaft axis 13 is offset by a specific amount with respect to the sleeve axis 12. When the gear shaft axes 14 and 15 revolve, the toothed wheels 8 cooperate with the central wheel 6 and the toothed wheels 9 cooperate with the toothed wheel 11 of the shaft 3. The centre vertical 10 on the connection line 17 between the axes 14 and 15 intersects the axes 12 and 13.
1. Tool spindle comprising
   a housing;
   a sleeve rotatably mounted in said housing;
   a rotatable shaft received within said sleeve and acting as
   a tool carrier; and
   drive means adapted to rotate said sleeve and said shaft at
   equal speeds but in opposite directions;
   wherein the axes of rotation of said sleeve and said shaft
   are parallel and spaced apart.

2. Tool spindle according to Claim 1, wherein there are
   provided separate drive means for said sleeve and said shaft,
   said separate drive means being electrically coupled.

3. Tool spindle according to Claim 1, wherein said drive means
   comprises a common mechanical drive for said sleeve and said
   shaft.

4. Tool spindle according to Claim 1, further comprising
   a gear housing rotatable with said sleeve;
   a gear shaft rotatably mounted within said gear housing
   substantially axially parallel to the axes of said sleeve and
   said shaft;
   first and second toothed wheels provided on said gear shaft;
   a further toothed wheel provided on said shaft which serves
   as a tool carrier and revolving coaxially therewith; and
   a stationary central wheel, the axis of which is coaxial
   with the axis of said shaft;
   wherein said first toothed wheel meshes with said central
   wheel, and said second toothed wheel meshes with said further
   toothed wheel.

5. Tool spindle according to Claim 1, further comprising
   a gear housing;
   first and second gear shafts mounted in said gear housing;
first and second pairs of toothed wheels mounted on said first and second gear shafts respectively;
wherein the centre vertical on the connection line between the axes of said first and second gear shafts intersects the axes of said sleeve and said shaft.

6. Tool spindle according to Claim 5, wherein the axes of said first and second gear shafts are arranged to be offset by 180° with respect to the axis of said sleeve.

7. Tool spindle according to Claim 4, wherein said gear housing has a neck-like extension which receives a mounting for a central wheel shaft carrying at a first end thereof said stationary central wheel, said central wheel shaft being fixed at its end opposite to said central wheel.

8. Tool spindle according to Claim 4, wherein said gear housing has a neck-like extension on which a drive plate is set.

9. Tool spindle according to Claim 4, wherein said housing comprises a first, tubular, part facing a tool mounted, in use, on said spindle, and a second, housing-like, part enclosing said gear housing.

10. Tool spindle according to Claim 1, which is a boring spindle for boring holes of elliptical cross-section.

11. Tool for producing or machining surfaces of elliptical cross-section, comprising a central support; a sleeve rotatably mounted on said central support; a tool carrier rotatably mounted on said sleeve; and drive means adapted to rotate said sleeve and said tool carrier at equal speeds but in opposite directions;
wherein said sleeve serves as a supporting mounting for said tool carrier, and the axes of rotation of said sleeve and said tool carrier are parallel and spaced apart.