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(54) Groove grinding spindle

(57) A wheel spindle 2 to which a grinding wheel 1 is attached, is connected to a driving shaft 5 by bevel gears 6 and 7 and the driving shaft 5 is connected to an output shaft 4 of a motor 3. One end of the drive shaft 5 is axially supported by a needle bearing 8 and the other end is axially supported by angular bearings 9 and 10. The angular bearings 9 and 10 are axially supported by a bearing holder 18, the bearing holder 18 is slidably fitted to a fitting recess 21 and adjusting screws 25 and 26 are attached to a flange 22 of the bearing holder 18. Accordingly, by adjusting the adjusting screws 25 and 26, the drive shaft 5 can be positioned by being moved in the axial direction thereof and, after positioning, the bearing holder 18 is fixed to a spindle main body 12 by a set screw 28.

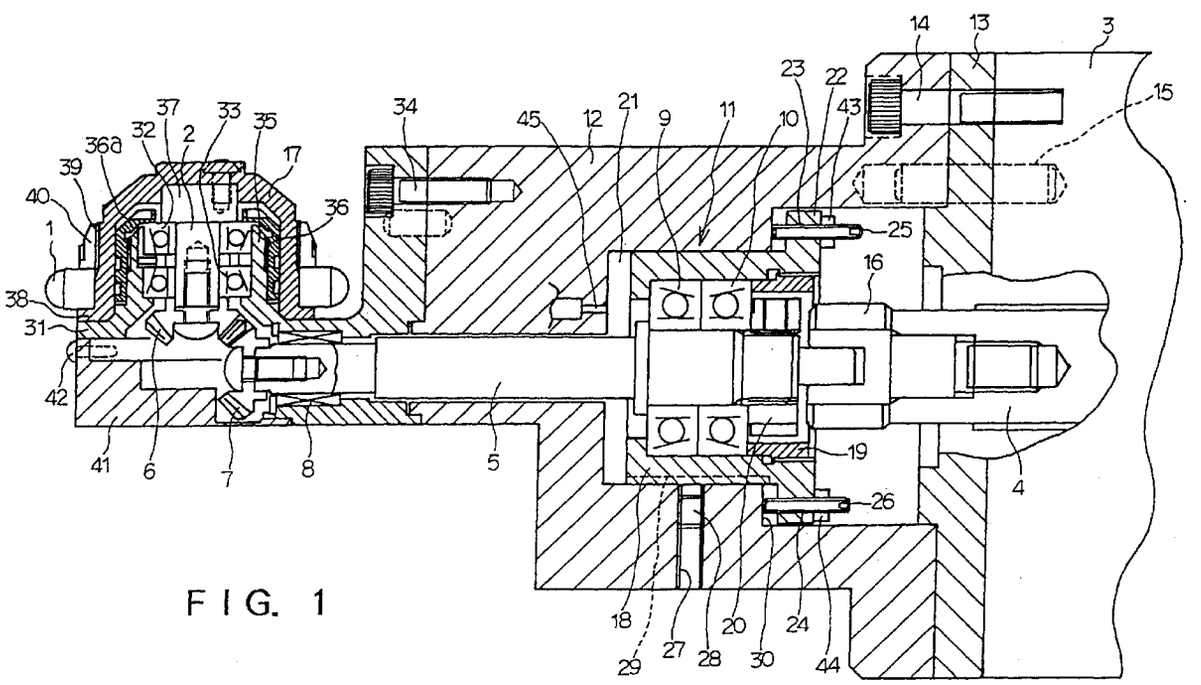

FIG. 1

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Description

The present invention relates to a groove grinding spindle, for example, a groove grinding spindle for grooving an inner peripheral face of a cylindrical hole in a depth direction of the hole.

Conventionally, in performing a working operation for forming a groove at an inner peripheral face of a cylindrical hole along a depth direction of the hole, a groove grinding spindle is used.

Such a groove grinding spindle is constituted by: an output shaft of a motor, a wheel spindle to which a grinding wheel having a ring-like shape is attached, a belt wheel of the output shaft for transmitting rotation of the output shaft of the motor to the wheel spindle, a belt made to wrap on the belt wheel of the wheel spindle and the like.

However, according to the conventional groove grinding spindle, rotational force of the motor is transmitted to the wheel spindle by utilising the belt wheel and the belt. Accordingly, when the contact between the belt wheel and the belt is small, a drawback arises where frictional force therebetween is decreased, slippage is caused and transmission is not ensured.

Further, the groove grinding spindle is generally used at high speed and accordingly, a drawback arises where wear of the belt is caused in a short period of time. The belt must be exchanged in accordance with the state of wear.

It is conceivable, for resolving the drawbacks, to use gears as a transmission mechanism for transmitting rotational force of the motor to the wheel spindle.

However, when gears are used, the mechanism often becomes structurally difficult for adjusting backlash. Particularly, when initial wear is caused in gears, vibration is generated by backlash which may have significant influence on working accuracy. Therefore, facilitated adjustment of backlash is desired.

Hence, it is an object of the present invention to provide a groove grinding spindle capable of facilitating adjustment of backlash.

According to the present invention there is provided a groove grinding spindle comprising a rotatable wheel spindle to which a grinding wheel having a ring-like shape is attached, a driving shaft connected to an output shaft of a motor, bevel gears for transmitting rotation of the driving shaft to the wheel spindle, a needle bearing for axially supporting one end of the driving shaft, bearings axially supporting the other end of the driving shaft, and backlash adjustment means for adjusting the position of the driving shaft in the axial direction thereof.

Preferably, the backlash adjustment means comprises a bearing holder for supporting the bearings, a moving mechanism for moving the bearing holder in the axial direction of the driving shaft and a fixing member for fixing the bearing holder at one side of the moving mechanism.

Beneficially, the moving mechanism comprises a fitting recess provided in a spindle main body for slidably fitting the bearing holder in the axial direction of the driving shaft, a flange installed at an outer peripheral portion of the bearing holder which does not enter the fitting recess, and adjusting screws which are in mesh with screw holes provided in a thickness direction of the flange. Front ends of the screws are brought into contact with a peripheral edge of an opening portion of the fitting recess.

According to the present invention having such a constitution, in adjusting backlash of the bevel gears, the location of the driving shaft in the axial direction thereof is adjusted and fixed by the adjustment means.

Specifically, with such an arrangement the location of the driving shaft in the axial direction is positioned by adjusting the adjusting screws and after positioning, the location is fixed by a set screw. Therefore, adjustment of backlash can be facilitated.

The preferred embodiment of the invention will now be described in more detail by way of further example only and with reference to the accompanying drawings, in which:-

Fig. 1 is a sectional view of a groove grinding spindle according to an embodiment of the present invention.

As shown in Fig. 1, the groove grinding spindle is provided with a rotatable wheel spindle 2 to which the grinding wheel 1 having a ring-like shape is attached. A driving shaft 5 is connected to an output shaft 4 of a motor 3. Spiral bevel gears 6 and 7 transmit rotation of the driving shaft 5 to the wheel spindle 2. The needle bearing 8 axially supports the driving shaft 5 at the end thereof adjacent the wheel spindle 2 and the angular bearings 9 and 10 axial support the driving shaft 5 at the end thereof adjacent the output shaft 4 of the motor 3.

Further, as shown by Fig. 1, the groove grinding spindle is provided with a backlash adjustment mechanism 11 for positioning and fixing the driving shaft 5 in the axial direction thereof for adjusting backlash of the spiral bevel gears 6 and 7.

According to the groove grinding spindle, the motor 3 is attached to the spindle main body 12 by a bolt 14 via a positioning member 13. Positioning of the motor 3 in respect of the spindle main body 12 is carried out by a positioning pin 15.

The output shaft 4 of the motor 3 is connected to the driving shaft 5, which extends in the longitudinal direction of the spindle main body 12, via a coupling 16. The driving shaft 5 is rotatably supported by the angular bearings 9 and 10 at the end thereof adjacent the output shaft 4 of the motor 3. The end of the shaft 5 adjacent the bevel gear 7 is rotatably supported by the needle bearing 8. Shaft 5 is housed in the spindle main body 12. The needle bearing 8 is supported by a wheel spindle support frame 31, mentioned later.

The spiral bevel gear 7 is attached to the front end portion of the driving shaft 5 and is in mesh with a spiral bevel gear 6. The bevel gear 6 is attached to the lower

end side of the wheel spindle 2. A grindstone holder 17 is fixed to wheel spindle 2. The spiral bevel gears 6 and 7 are covered by a cover 41 attached to the wheel spindle support frame 31 by a bolt 42. The space incorporating the driving shaft 5 is hermetically sealed from outside of the spindle main body 12 as illustrated.

The grinding wheel 1 is rotated by rotationally driving the driving shaft 5 by the motor 3. Drive force is transmitted to the wheel spindle 2 with a 90° change of direction being effected by the spiral bevel gears 6 and 7. The surface of the grinding wheel 1 is constituted to be supplied with grinding fluid.

Next, an explanation will be given of the backlash adjustment mechanism 11.

The backlash adjustment mechanism 11 comprises a bearing holder 18 for incorporating the angular bearing 9 and 10, a fitting recess 21 for fitting slidably the bearing holder 18 and adjusting screws 25 and 26 for positioning to adjust the location of the bearing holder 18 and the like.

That is, as shown by Fig. 1, the angular bearings 9 and 10 are incorporated in the cylindrical bearing holder 18, both ends of which are opened. The respective outer rings of the angular bearings 9 and 10 are fixed to the bearing holder 18 by an outer ring nut 19 and the respective inner rings are fixed to the driving shaft 5 by an inner ring nut 20.

As shown by Fig. 1, the outer periphery of the bearing holder 18 is fitted slidably to the cylindrical fitting recess 21 provided in the spindle main body 12. A flange 22 is provided at an outer periphery of the bearing holder 18 on a rear end side thereof. The flange 22 is larger than the fitting recess 21.

Screw holes 23 and 24 are provided in the thickness direction of the flange 22 at positions in the flange 22 opposed to each other. The adjusting screws 25 and 26, for adjustably positioning the driving shaft 5 in the axial direction thereof, are in mesh with the respective screw holes 23 and 24. The respective front ends of the respective adjusting screws 25 and 26 are brought into contact with a flat peripheral edge 30 adjacent the opening of the fitting recess 21. Nuts 43 and 44 on the rear end sides of the screws are brought into contact with the flange 22.

As shown by Fig. 1, a screw hole 27 extends from a peripheral face of the spindle main body on the bottom thereof towards the fitting recess 21. A set screw 28 is in mesh with the screw hole 27 and the front end of the set screw 28 is brought into contact with a flattened outer peripheral face 29 of the bearing holder 28 as shown in Fig. 1.

The distal end of a nozzle 45 for supplying lubricant to the annular bearing 9 and 10 opens into the bottom of the fitting recess.

The wheel spindle 2 is supported by two bearings 32 and 33 fixed to the wheel spindle support frame 31. The wheel spindle support frame 31 is fixed to the front end side of the spindle main body 12 by a bolt 34.

A boss 35 projects upwardly from a portion of the wheel spindle support frame 31 where the bearing 32 and 33 are supported. The boss 35 has a substantially cylindrical shape and a male screw thread 36 is formed on the outer peripheral face thereof. A bearing retainer 36a, which has a cup shape, surrounds the outer periphery of the boss 35 and is screwed to the male screw portion 36, thus locking the bearing 32 in place.

An upper end portion 37 of the wheel spindle 2 is fixed to the grindstone holder 17. The holder 17 has a cup shape and surrounds the outer periphery of the bearing holder 36a with a small gap therebetween. Portions of the outer peripheral face of the bearing holder 36a and the inner peripheral face of the grindstone holder 17 constitute a labyrinth seal.

The grinding wheel 1 has a ring-like shape with an inner diameter substantially equal to an outer diameter of the grindstone holder 17 and is thus fitted to the outer periphery of the grindstone holder 17. The vertical outer periphery of grinding wheel 1 has a substantially semicircular shape. The lower side of the grinding wheel 1 is retained by a flange 38 formed on the lower end of the grindstone holder 17. A male screw thread 39 is formed on the outer periphery of the grindstone holder 17. The grinding wheel 1 is held in position by a grindstone fixing nut 40 screwed to the male screw 39. Incidentally, the height of fixing the grinding wheel 1 is substantially half of the height of the spindle main body 12 (even if not shown as such in figure 1).

The width and the height of the spindle main body 12 are substantially equal to the diameter and the height of the grindstone holder 17. Thus, when the groove grinding spindle is inserted into a cylindrical hole in the grinding operation, the spindle main body 12 is prevented from being brought into contact with the inner peripheral face of the hole.

Next, an explanation will be given of the operation of the embodiment constituted as described above.

When the motor 3 is driven, the driving force of the motor 3 is transmitted to the wheel spindle 2 via the coupling 16, the driving shaft 5, the spiral bevel gear 7 and the spiral bevel gear 6 by which the grinding wheel 1 is rotated. When the grinding wheel is rotated, grinding fluid is supplied to the surface of the grinding wheel 1.

Further, in forming a groove in a cylindrical hole (not illustrated), the peripheral face of a left side or a right side of the rotating grinding wheel 1 is cut into the inner peripheral face of the cylindrical hole and the groove grinding spindle is advanced by a predetermined distance in the depth direction of the cylindrical hole thereby forming a groove.

Next, an explanation will be given of adjusting backlash of the spiral bevel gear 7 and the spiral bevel gear 6 according to the embodiment.

In this case, the motor 3 is removed from the spindle main body 12 by loosening the bolt 14 and the cover 41 attached to the wheel spindle support frame 31 is removed by loosening the bolt 42.

Next, the respective nuts 43 and 44 in mesh with the adjusting screws 25 and 26 are retracted and loosened. Thereafter, the adjusting screws 25 and 26 are retracted by which a gap is provided between the adjusting screws 25 and 26 and the peripheral edge 30 of the opening of the fitting recess 21. The set screw 28 is loosened. The driving shaft 5 is advanced by pushing the bearing holder 18 forward and the spiral bevel gear 7 is thus brought back into firm contact with the spiral bevel gear 6.

Thereafter, the adjusting screws 25 and 26 are rotated and advanced. The front ends of the adjusting screws 25 and 26 are brought into contact with the peripheral edge 30 and the rotation is continued further, by which the bearing holder 18 is moved to the right (given the position shown in Fig. 1). Thereby, the location of the driving shaft 5 in the axial direction is retrogressed such that the mesh state (play) of the spiral bevel gear 7 with the spiral bevel gear 6 is brought into a desired state. The driving shaft 5 can be advanced and retrogressed in such a way since the bevel gear end of the driving shaft 5 is axially supported by the needle bearing 8.

When the driving shaft 5 has been positioned in such a manner, the position of the bearing holder 18 is fixed to the spindle main body 12 by the set screw 28.

The backlash of the spiral bevel gear 6 and the spiral bevel gear 7 is adjusted in accordance with the above-described procedure and accordingly, the adjustment is facilitated.

As has been explained, according to the embodiment, the wheel spindle end of the driving shaft 5 is axially supported by the needle bearing 8. The motor end of the driving shaft 5 is axially supported by the angular bearings 9 and 10 and the angular bearings 9 and 10 are supported by the bearing holder 18. The driving shaft 5 is positioned by adjusting the adjusting screws 25 and 26 and, after positioning, the bearing holder 18 is fixed to the spindle main body 12 by the set screw 28. Therefore, the adjustment of the backlash of the spiral bevel gears 6 and 7 can be facilitated.

The output shaft 4 of the motor 3 and the wheel spindle 2 are connected by the driving shaft 5 and the spiral bevel gears 6 and 7. Therefore, there is provided an advantage in that when some distance is needed between the output shaft 4 and the wheel spindle 2, the distance can easily be dealt with by using a longer driving shaft 5 and housing 12.

Although according to the above-described embodiment, the drive force of the motor 3 is transmitted to the wheel spindle 2 by bringing the spiral bevel gears 6 and 7 in mesh with each other, the drive force may be transmitted by other gears.

For example, a worm wheel can be attached to the wheel spindle 2 in place of the spiral bevel gear 6 and a worm attached to the front end of the driving shaft 5 in place of the spiral bevel gear 7. The drive force of the motor 3 may be transmitted to the wheel spindle 2 by arranging to move the driving shaft 5 and the like and bringing the worm and the worm wheel in mesh with each other. Further, the drive force of the motor 3 may be transmitted to the wheel spindle 2 by attaching screw gears respectively to the wheel spindle 2 and the driving shaft 5 in place of the spiral bevel gears 6 and 7 and bringing them in mesh with each other.

According to the above-described embodiment, the screw holes 23 and 24 are provided in the thickness direction of the flange 22 and the screws 25 and 26 are in mesh with the respective screw holes 23 and 24 for adjusting the position of the driving shaft 5 in the axial direction. However, the movement of the driving shaft 5 in the axial direction may alternatively be carried out as follows.

That is, a male screw can be formed on the outer peripheral face of the bearing holder 18 adjacent the motor 3 whereas a female screw in mesh with the male screw can be formed on the inner peripheral face of the fitting recess 21. The driving shaft 5 may thus be constituted to be able to move in the axial direction by rotating the screw holder 18.

As has been explained, according to the present invention, adjustment means for positioning and fixing the position of the driving shaft in the axial direction is provided and therefore the adjustment of backlash can be facilitated.

The aforegoing description has been given by way of example only and it will be appreciated by a person skilled in the art that modifications can be made without departing from the scope of the present invention.

Claims

1. A groove grinding spindle comprising:

a rotatable wheel spindle (2) to which a grinding wheel (1) having a ring-like shape is attached;
a driving shaft (5) to which an output shaft (4) of a motor (3) is connected;
bevel gears (6, 7) for transmitting rotation of the driving shaft (5) to the wheel spindle (2);
a needle bearing (8) for axially supporting one end of the driving shaft (5);
a bearing (9, 10) for axially supporting the other end of driving shaft (5); and
backlash adjustment means (18-28) for adjusting the position of the driving shaft (5) in the axial direction thereof.

2. The groove grinding spindle according to claim 1, wherein the backlash adjustment means comprises:

a bearing holder (18) for supporting the bearing;
a moving mechanism (25, 26) for moving the

bearing holder (18) in the axial direction of the driving shaft (5); and
a fixing member (28) for fixing the bearing holder (18) at one side of fixing the moving mechanism (25, 26).

3. The groove grinding spindle according to claim 2, wherein the moving mechanism (25, 26) comprises:

a fitting recess (21) provided in a spindle main body (12) for slidably fitting the bearing holder (18) in the axial direction of the driving shaft (5);
a flange (22) installed at an outer peripheral portion of the bearing holder (18) which does not enter the fitting recess (21); and
adjusting screws (25, 26) which are in mesh with screw holes (23, 24) installed in a thickness direction of the flange (22) and front ends of which are brought into contact with a peripheral edge (30) of an opening of the fitting recess (21).

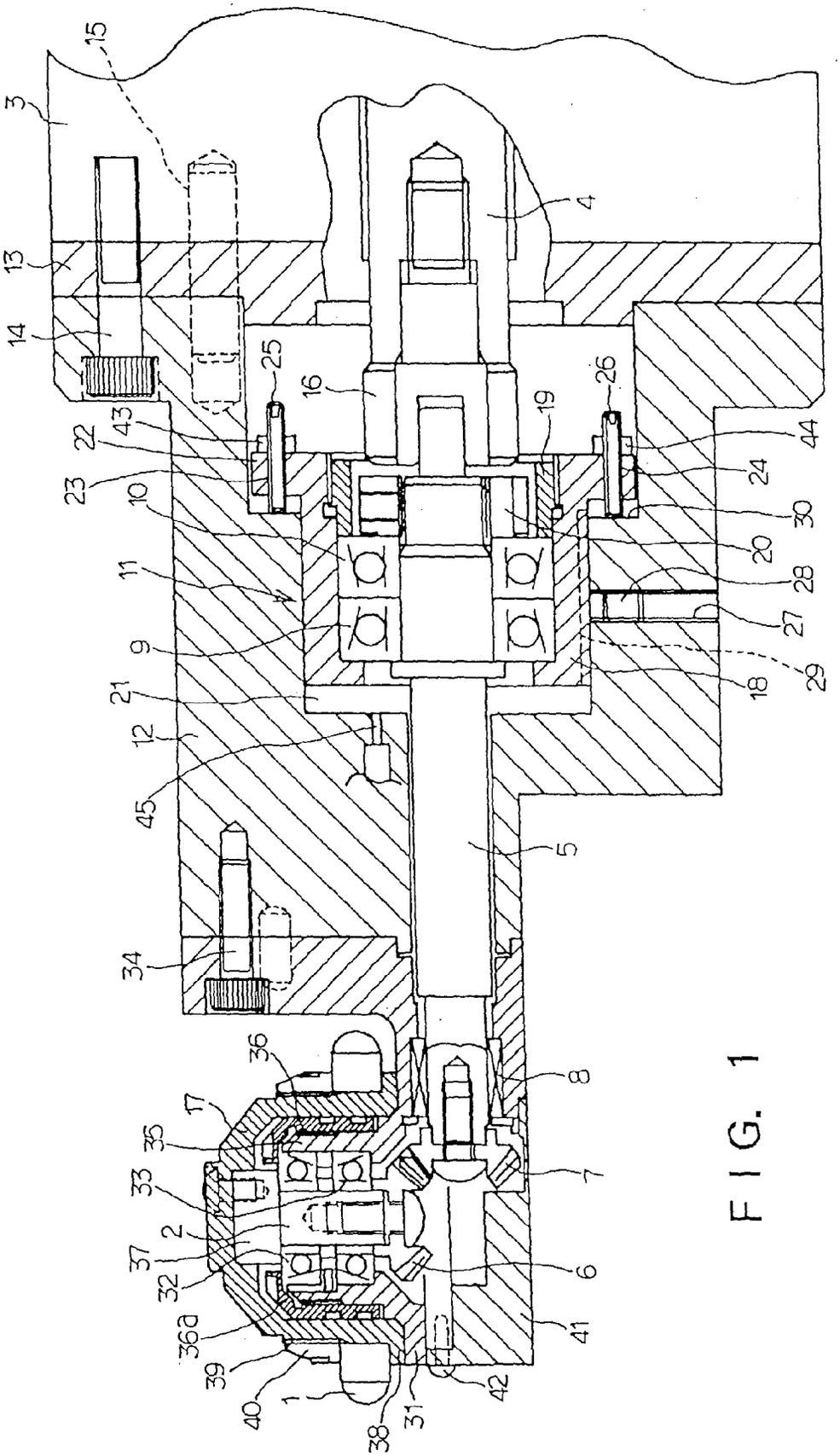
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FIG. 1