

INDEXING MECHANISM

BACKGROUND OF THE INVENTION

Field of the Invention

5 The present invention relates to an indexing mechanism for indexing the rotary table of a machine tool or the like.

Description of the Related Art

10 In prior art indexing mechanisms of this kind disclosed in, for instance, JP-B No. 4-36823 and JP-U No. 6-39864, the output rotation of a drive motor is transmitted through a precision worm-and-wheel mechanism to an indexing shaft to turn a rotary table mounted on the indexing shaft to a desired indexed position, and the rotary table is locked
15 at the indexed position by a locking device having a control mechanism including a locking cylinder actuator and a solenoid valve.

 These prior art indexing mechanisms need the precision worm-and-wheel mechanism and must be provided with the
20 locking device to lock the rotary table at the indexed position. Such prior art indexing mechanisms are costly and large, and requires a large space which is unavailable on small machine tools.

SUMMARY OF THE INVENTION

25 Accordingly, it is an object of the present invention to provide an inexpensive indexing mechanism having a small, simple construction and capable of precision indexing.

 According to the present invention, an indexing
30 mechanism comprises a base block, an indexing shaft supported for rotation on the base block, a reversible servomotor having an output shaft connected to the indexing shaft, a ratchet wheel provided in its circumference with indexing teeth at angular intervals and fixedly mounted on
35 the indexing shaft, and a holding member supported on the base block so as to engage the tooth of the ratchet wheel to restrain the ratchet wheel from reverse rotation.

The holding member has a base end and a working tip, the holding member is supported movably at the base end so as to swing between a working position where the working tip engages the tooth of the ratchet wheel and an idle position where the working tip is disengaged from the tooth of the ratchet wheel, and the holding member is biased toward the working position.

The indexing shaft is supported for rotation on the base block, and a rotary table or the like for supporting a workpiece is fixed directly or through a rotating shaft to one end of the indexing shaft. Preferably, the drive shaft of the reversible servomotor mounted on the base block is connected to the shaft of a worm engaged with a worm wheel. The ratchet wheel provided in its circumference with the indexing teeth at angular intervals is fixed to the indexing shaft. Usually, the indexing teeth are arranged at equal angular intervals. However, the number of the indexing teeth is optional and the indexing teeth need not necessarily be arranged at equal angular intervals. The holding member for preventing the reverse rotation of the ratchet wheel is supported on the base block so as to engage the tooth of the ratchet wheel. The holding member may be supported pivotally so as to swing between the working position and the idle position. Preferably, the holding member is biased toward the working position. The holding member may be a holding pawl pivotally supported at one end thereof on the base block or a holding block capable of moving between a working position and an idle position. The servomotor turns the indexing shaft in the normal direction to a position slightly beyond a desired indexed position, and then turns the indexing shaft in the reverse direction so that one of the indexing teeth engage the holding member to index the indexing shaft. The servomotor is kept energized after the indexing shaft has been indexed to the desired indexed position to keep the indexing tooth in contact with the holding member.

Since the indexing shaft is turned by the servomotor in the normal direction to a position beyond a specified indexed position and then the same is turned in the reverse direction to bring the indexing tooth of the ratchet wheel
5 into contact with the holding member for indexing, the indexing shaft can accurately be indexed even if a rotation transmitting mechanism for transmitting the rotation of the drive shaft of the servomotor to the indexing shaft is not very accurate and hence machining and assembling can easily
10 be accomplished. Since the servomotor is kept energized to hold the indexing shaft at the indexed position, the indexing mechanism need not be provided with any locking mechanism, such as a locking cylinder actuator, for locking the index shaft in place, can be manufactured at reduced
15 costs and has a simple, small construction. The holding member biased toward the working position is very simple and small in construction and is capable of accurately positioning the indexing tooth, so that precision indexing can be achieved.

20 A preferred embodiment of the present invention will be understood from the following detailed description made with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a longitudinal sectional view of an indexing
25 mechanism in a preferred embodiment according to the present invention;

Fig. 2 is a partly omitted side view of the indexing mechanism of Fig. 1, taken from the right in Fig. 1;

Fig. 3 is a sectional view taken on line A-A in Fig.
30 1; and

Fig. 4 is an enlarged sectional view taken on line B-B in Fig. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Figs. 1 and 3, an indexing mechanism 1 in
35 a preferred embodiment according to the present invention has a base block 2 having the shape of a rectangular box. An indexing shaft 4 is disposed in and supported for

rotation about a horizontal axis in a bearing 5 on the base block 2. A rotary table 3 for supporting a workpiece is detachably attached to the outer end of the indexing shaft 4. As shown in Fig. 1, a worm wheel 7 and a ratchet wheel 8 are put contiguously on the inner end of the indexing shaft 4. The worm wheel 7, the ratchet wheel 8 and the indexing shaft 4 are joined together with a positioning pin 11 and bolts 12. In this embodiment, the ratchet wheel 8 is provided in its outer circumference with four indexing teeth 13 at equal angular intervals of 90° as clearly shown in Fig. 2. Each tooth 13 has a radial working surface 13a and a tangential pawl positioning surface 13b. Recesses 8a are formed in the ratchet wheel 8 to improve machining accuracy when forming the pawl positioning surfaces 13b.

A rotating shaft 15 is supported for rotation in bearings 16 and 17 on the base block 2 under the indexing shaft 4 with its axis extending perpendicularly to that of the indexing shaft 4. A worm 18 is fixedly mounted on the rotating shaft 15 and in engagement with the worm wheel 7. A reversible servomotor 21 is attached to the base block 2. One end of the rotating shaft 15 and the drive shaft 21a of the servomotor 21 are coupled with a shaft coupling 22. The drive shaft 21a of the servomotor 21 is able to rotate in opposite directions, i.e., the normal direction and the reverse direction. The drive shaft 21a rotates in the normal direction to rotate the indexing shaft 4 through the worm 18 and the worm wheel 7 in the normal direction and vice versa.

A bracket 23 is fitted in a hole 2a formed in the upper wall of the base block 2 and fastened to the upper wall with bolts 24. A pivot shaft 25 is supported on an inner projection 23a of the bracket 23. A holding pawl 26, i.e., a holding member, is supported at its base end on the pivot shaft 25, as shown in Fig. 4, so as to be moved between a working position where the holding pawl 26 engages the indexing tooth 13 and an idle position where the holding pawl 26 is disengaged from the indexing tooth 13. The

holding pawl 26 is biased toward the working position, i.e., clockwise as viewed in Fig. 2, through a ball 28 by a spring 27 held on the bracket 23. A projection 26a formed on the base end of the holding pawl 26 comes into
5 contact with the bracket 23 to limit the turning of the holding pawl 26 beyond the working position and to hold the holding pawl 26 at the working position. When the holding pawl 26 is held at the working position, the tip of the holding pawl 26 engages the radial working surface 13a of
10 the indexing tooth 13 to prevent the reverse rotation, i.e., counterclockwise rotation as viewed in Fig. 2, of the ratchet wheel 8. When the indexing shaft 4 is rotated in the normal direction, the outer circumference of the ratchet wheel 8 pushes the holding pawl 26 outside the path
15 of the indexing teeth 13 to the idle position. Shims 30 of an optional thickness are placed detachably between the base block 2 and the bracket 23 to enable the fine adjustment of the angular position of the indexing tooth 13 where the holding pawl 26 engages the indexing tooth 13,
20 i.e., a stopping position of the indexing shaft 4.

The servomotor 21 is controlled by a controller 32 shown in Fig. 2, to turn the rotary table 3 for indexing. When indexing the rotary table 3, the drive shaft 21a of the servomotor 21 is rotated stepwise in the normal
25 direction through an angle slightly greater than the angular interval of 90° between the adjacent indexing teeth 13, the drive shaft 21 is turned in the reverse direction to bring the indexing tooth 13 of the ratchet wheel 8 into engagement with the tip of the holding pawl 26. In this
30 state, a current is supplied continuously to the servomotor 21 to hold the indexing tooth 13 in engagement with the holding pawl 26.

The operation of the indexing mechanism 1 will be described below. The indexing mechanism is set in an
35 initial state. When an indexing signal representing an indexing instruction is given by a controller of an NC machine tool, such as a machining center, not shown, to the

controller 32 of the indexing mechanism 1, the drive shaft 21a of the servomotor 21 rotates in the normal direction through an angle specified by the indexing signal to rotate the rotating shaft 15. Consequently, the indexing shaft 4 is turned in the normal direction through the worm 18 and the worm wheel 7 through an angle slightly greater than 90° so that the indexing tooth 13 is turned to a position slightly beyond an indexed position where the indexing tooth 13 engages the tip of the holding pawl 13. When the indexing shaft 4 is thus turned in the normal direction, the outer circumference of the ratchet wheel 8 comes into contact with the side surface of the holding pawl 26 and pushes the holding pawl 26 so that the tip of the holding pawl 26 is moved temporarily outside the path of the indexing teeth 13.

After the indexing shaft 4 has been turned through the angle slightly greater than 90°, the holding pawl 26 is returned to the working position by the spring 27. Then, the drive shaft 21a of the servomotor 21 is turned in the reverse direction by a signal from the controller 32, to turn the rotating shaft 15 in the reverse direction. Consequently, the radial working surface 13a of the indexing tooth 13 of the ratchet wheel 8 comes into contact with the tip of the holding pawl 26, whereby the reverse rotation of the indexing shaft 4 is stopped. In this state, the tip of the holding pawl 26 rests on the tangential pawl positioning surface 13b of the indexing tooth 13, so that the holding pawl 26 is positioned in a high accuracy at the working position. The servomotor 21 is kept energized by the controller 32 to urge the drive shaft 21a in the reverse direction after the indexing tooth 13 has been brought into contact with the holding pawl 26 to keep the indexing tooth 13 pressed against the holding pawl 26, whereby the indexing shaft 4 is held at the desired indexed position.

After the indexing shaft 4 has thus been indexed, workpiece mounted on the rotary table 3 is machined by a

machining center or the like. Since the rotation of the indexing shaft 4 is prevented by the servomotor 21, the rotary table 3 is held stationary even if machining forces are exerted on the rotary table 3. When the next indexing instruction is provided after the completion of a machining cycle, the indexing shaft 4 is turned again through an angle slightly greater than 90° and is indexed at the next indexed position. Thus, the indexing mechanism 1 is able to index the indexing shaft 4 sequentially at four angular positions spaced an angular interval of 90° apart by controlling the rotation of the drive shaft 21a of the servomotor 21 to turn the indexing shaft 4 in the aforesaid mode. The indexing shaft 4 can be turned through 180° or 270° in one indexing cycle by properly controlling the rotation of the drive shaft 21a of the servomotor 21.

The present invention is not limited in its application to the preferred embodiment specifically described herein and may be embodied in various forms. For example, the indexing mechanism may be of a vertical type having an index shaft that rotates about a vertical axis, the indexing mechanism may be provided with a ratchet wheel provided with a plurality of indexing teeth arranged at equal angular intervals other than 90°, such as 30°, 45°, 60° or 120°, to index the indexing shaft at a plurality of indexed positions other than the four indexed positions, and the indexing teeth may be formed at equal angular intervals only in a section of the circumference of the ratchet wheel.

The indexing mechanism of the present invention is applicable to indexing a workpiece on machine tools other than machining centers and to indexing objects for purposes other than machining purposes.

While the presently preferred embodiment of the present invention has been shown and described, it is to be understood that this disclosure is for the purpose of illustration and that various changes and modifications may be made without departing from the scope of the invention

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as set forth in the appended claims.



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Claims:

1. An indexing mechanism comprising:

a base block (2);

an indexing shaft (4) supported for rotation on the base block (2);

a ratchet wheel (8) provided in its circumference with a plurality of indexing teeth (13) arranged at angular intervals, and fixedly and coaxially mounted on the indexing shaft (4); and

a transmission gear mechanism (7, 15, 18) connected to the indexing shaft (4); characterized by:

a holding member (26) supported on the base block (2) for movement between a working position where a tip of the holding member engages the indexing tooth (13) of the ratchet wheel (8) and an idle position where the tip thereof is disengaged from the teeth (13) of the ratchet wheel (8);

a reversible servomotor (21) coupled with the transmission gear mechanism (7, 15, 18) to rotate the indexing shaft (4) and the ratchet wheel (8); and

a controller (32) for controlling the reversible servomotor (21) so as to turn the indexing shaft (4) in a normal direction so that a desired one of the indexing teeth (13) of the ratchet wheel (8) is turned beyond a desired indexed position where the desired tooth (13) engages the tip of the holding member (26) and then to turn the indexing shaft (4) in a reverse direction to bring the desired indexing tooth (13) into engagement with the tip of the holding member (26) for indexing.

2. The indexing mechanism according to claim 1, further comprising means (27) for biasing the holding member (26) toward the working position.

3. The indexing mechanism according to claim 2, wherein said biasing means is a spring (27).



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4. The indexing mechanism according to claim 1, wherein each of the indexing teeth (13) of the ratchet wheel (8) has a holding member positioning surface (13b) which positions the holding member (26) accurately at the working position.

5. The indexing mechanism according to claim 4, wherein said holding member positioning surface (13b) is provided adjacent to each of said indexing teeth (13).

6. The indexing mechanism according to claim 5, wherein said holding member positioning surface (13b) extends tangentially of the ratchet wheel (8).

7. The indexing mechanism according to claim 4, wherein said holding member is a holding pawl (26) pivotally mounted for turning movement between said working position and the idle position.

8. The indexing mechanism according to claim 1, wherein in the working position said tip of each of the holding member (26) includes a surface extending substantially radially of the ratchet wheel (8) and each of said indexing teeth (13) also includes a surface extending substantially radially of the ratchet wheel (8).

9. The indexing mechanism according to claim 1, further comprising a worm wheel (7) fixedly mounted on said indexing shaft (4), and a worm (18) engaging said worm wheel (7) and coupled to said reversible servomotor (21), said worm wheel and worm constituting said transmission gear mechanism.

10. The indexing mechanism according to claim 1, wherein said controller (32) includes means for maintaining said servomotor (21) operating in said reverse direction after



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the desired indexing tooth (13) has been brought into engagement with the tip of the holding member (26).

11. The indexing mechanism according to claim 1, further comprising a bracket (23) adjustably fixed to said base block (2) with an exchangeable shim (30) interposed therebetween, said bracket supporting said holding member (26) for movement between the working position and the idle position whereby the holding member can be adjusted in position by changing the shim (30).