Analysis and Research on an on-line measuring device for machining accuracy of parts used in NC machine tools

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Abstract: The utility model relates to an on-line detection device for the machining accuracy of parts of a NC machine tool, which comprises a storage flat box, a reciprocating driving mechanism, an on-line detection assembly and a trigger probe. Through the cooperation of the reciprocating driving mechanism and the storage flat box, the on-line detection assembly and the trigger probe can be switched between the storage and detection states. There is no need to disassemble the trigger probe and the cutter shaft of the NC machine tool during the detection, so as to improve the detection efficiency, the time required for the NC machine tool to recover from the detected state to the machining state is shortened.

Key words: Numerical control machine; testing; Machining accuracy

1. Introduction

High level machinery manufacturing is inseparable from high-precision machine tools and machining centers. CNC machine tools are the machining machine of manufacturing industry and an important foundation of the national economy. It provides equipment and means for all departments of the national economy.

Due to the inevitable errors of CNC machine tools, and the increase of errors will be caused by parts aging, mechanical vibration and other reasons, it is necessary to regularly detect the machining accuracy of CNC machine tools, especially when the parts have high requirements for machining accuracy, it is more necessary to shorten the detection cycle to ensure that the parts processed by CNC machine tools meet the requirements.

Generally, the machining accuracy detection device of NC machine tool is mainly the trigger probe replaced on the tool shaft, that is, when the machining accuracy detection is required, the tool on the tool shaft is removed and replaced by manual or automatic tool magazine, and the required tool is installed on the tool shaft after the detection is completed, which not only complicates the operation and reduces the detection efficiency, but also due to the inevitable error in each installation of the trigger probe, It will also increase the detection error.

The purpose of this paper is to provide an on-line detection device for the machining accuracy of parts of NC machine tools, so as to solve the technical problem of reducing the detection efficiency caused by the disassembly and assembly of the trigger probe during and after the machining accuracy detection in the existing technology[1].

2. Technical analysis and research

The utility model relates to an on-line detection device for machining accuracy of parts of a NC machine tool, which comprises a storage flat box, a reciprocating drive mechanism, an on-line detection assembly and a trigger probe. The storage flat box is installed on the side wall on one side of the operation window of the NC machine tool, a storage cavity penetrating one end is opened in the storage flat box, the on-line detection assembly is slidably installed in the storage cavity, and the reciprocating drive mechanism is installed on the storage flat box, The trigger probe is installed on the on-line detection assembly;

The online detection assembly comprises a lifting mechanism, a telescopic rocker arm, a steering mechanism and a pitch adjustment mechanism. The lifting mechanism is slidably arranged in the storage cavity and connected with the reciprocating drive mechanism. The outside of the lifting mechanism is rotationally connected with the tail end of the telescopic rocker arm through the rotating mechanism. The rotating mechanism is rotationally installed at the head end of the telescopic rocker arm, and the trigger probe is movably installed on the steering mechanism through the pitch adjustment mechanism, The rotary guide axis of the steering mechanism is perpendicular to the swing axis of the pitch adjustment mechanism. The rotary mechanism drives the telescopic rocker arm to switch between the horizontal detection state and the storage state aligned with the storage cavity. The trigger probe detects the machining accuracy of the parts processed by the NC machine tool from multiple directions under the adjustment of the

steering mechanism and the pitch adjustment mechanism[2].

The lifting mechanism and the rotating mechanism are slidably installed in the storage cavity through the sliding shell, the outer wall of the sliding shell is fitted with the inner wall of the storage flat box, the reciprocating driving mechanism is connected with the sliding shell, the front of the sliding shell is provided with a vertical groove, and a guide shaft connecting the telescopic rocker arm and the rotating mechanism is installed in the vertical groove.

The reciprocating driving mechanism comprises a rack, a traveling stepping motor and a gear, the rack is arranged on the cavity wall of the storage cavity along the sliding direction of the sliding shell, the outer wall of the sliding shell is provided with a guide groove inserted and matched with the rack, and the traveling stepping motor is embedded and installed on the sliding shell and meshed with the rack.

The rack is provided with a plurality of, and the sliding shell is provided with a plurality of guide grooves and a plurality of progressive motors.

The telescopic rocker arm comprises a sleeve connecting the rotating mechanism, a hollow connecting rod sliding and mating with the sleeve, and a telescopic driving component for driving the hollow connecting rod to expand and contract along the sleeve. The length from the tail end of the hollow connecting rod in the sleeve to the trigger probe is less than the length of the sleeve, so that the trigger probe can be protected in the sleeve.

The telescopic drive assembly is a telescopic stepping motor and a lead screw, the central hole for installing the lead screw is opened at the axis of the hollow connecting rod, and the nut of the lead screw is connected with the hollow connecting rod.

The trigger probe is installed on the pitch adjustment mechanism through the plug-in end, and the trigger probe is electrically connected with the plug-in end.

The interior of the sleeve is a cylindrical cavity, the shape of the plug-in end is adapted to the internal contour of the sleeve, the inner wall of the open end of the sleeve is sliding and sealed with the side wall of the plug-in end, a plurality of guide holes through both ends are arranged in the wall of the plug-in end, and the intersection of the axes of the plurality of guide holes is located at the head of the reset trigger probe, so that the plug-in end is in the process of receiving the sleeve, The gas in the sleeve overflows from a plurality of guide holes to form an air flow for cleaning the head of the trigger probe.

A plurality of axially distributed annular grooves are arranged on the inner wall of the open end of the sleeve, a sealing ring is installed in the annular groove, and the side wall of the plug-in end is slidably sealed and matched with the inner wall of the sleeve through the sealing ring.

A baffle is installed on the outside of the telescopic rocker arm relative to the guide shaft, and the size of the baffle is larger than the size of the storage cavity[3].

3. Example given to illustrate

The utility model relates to an on-line detection device for machining accuracy of parts of a NC machine tool, which comprises a storage flat box 1, a reciprocating drive mechanism 2, an on-line detection assembly 3 and a trigger probe 4. The storage flat box 1 is installed on the side wall on one side of the operation window of the NC machine tool, a storage cavity 101 penetrating one end is opened in the storage flat box 1, the on-line detection assembly 3 is slidably installed in the storage cavity 101, and the reciprocating drive mechanism 2 is installed on the storage flat box 1, The trigger probe 4 is installed on the on-line detection assembly 3

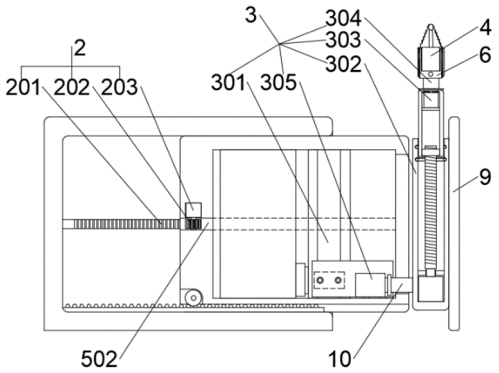

Fig. 1 Overall structure diagram

1 - storage of flat box; 2 - reciprocating drive mechanism; 3 - online detection assembly; 4 - trigger probe; 5 - sliding shell; 6 - plug end; 7 - annular groove; 8 - sealing ring; 9 - baffle; 10 - guide shaft;101 - storage chamber;201 rack; 202 - traveling stepping motor; 203 - gear;
301 - lifting mechanism; 302 - telescopic rocker arm; 303 steering mechanism; 304 - pitch adjustment mechanism; 305 - rotating mechanism;3021 sleeve; 3022 hollow connecting rod; 3023 telescopic stepping motor; 3024 lead screw;501 - vertical groove; 502 - guide groove; 601 - diversion hole.

The online detection assembly 3 includes a lifting mechanism 301, a telescopic rocker arm 302, a steering mechanism 303 and a pitch adjustment mechanism 304. The lifting mechanism 301 is slidably arranged in the storage cavity 101 and connected with the reciprocating drive mechanism 2. The outside of the lifting mechanism 301 is rotationally connected with the tail end of the telescopic rocker arm 302 through the rotating mechanism 305, and the steering mechanism 303 is rotationally installed at the head end of the telescopic rocker arm 302, The trigger probe 4 is movably installed on the steering mechanism 303 through the pitch adjustment mechanism 304. The rotation guide axis of the steering mechanism 303 is perpendicular to the swing axis of the pitch adjustment mechanism 304. The rotation mechanism 305 drives the telescopic rocker arm 302 to switch between the horizontal detection state and the storage state aligned with the storage cavity 101, The trigger probe 4 detects the machining accuracy of the parts processed by the NC machine tool from multiple directions under the

adjustment of the steering mechanism 303 and the pitch adjustment mechanism 304.

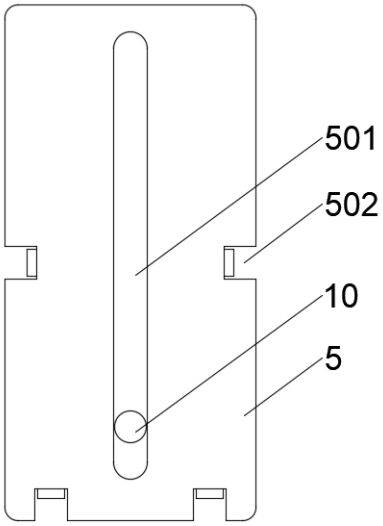

Fig. 2 Structural diagram of sliding shell

The baffle plate 11 is connected with the The function of the reciprocating driving mechanism 2 is to adjust the position of the trigger probe 4 in the horizontal length direction when the telescopic rocker arm 302 is in the detection state, and when the telescopic rocker arm 302 is in the storage state, the reciprocating driving mechanism 2 drives the online detection assembly 3 into the storage cavity 101 as a whole, so as to facilitate the cleaning and protection of the online detection assembly 3 and the trigger probe 4, so as to maintain the repeated detection accuracy of the online detection device, And avoid the negative impact of the exposed on-line detection assembly 3 on the operation of the NC machine tool, and control the trigger probe 4 through the on-line detection assembly 3 that can be stored to regularly detect the machining accuracy of the parts to be tested processed by the NC machine tool, and avoid installing the trigger probe 4 on the cutter shaft of the NC machine tool and driving the trigger probe 4 through the cutter shaft to detect the parts to be tested, There are disadvantages that the detection efficiency and the machining efficiency of NC machine tool are affected due to the disassembly and assembly of trigger probe 4, and the detection error is increased due to the installation error of trigger probe 4.

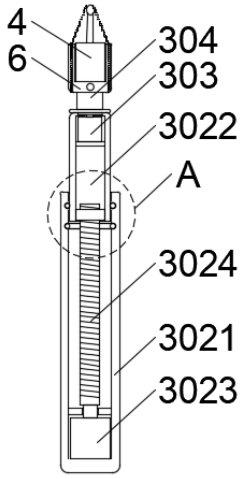

Fig. 3 Structural diagram of telescopic rocker arm

Among them, the function of the lifting mechanism 301 is to adjust the height of the trigger probe 4, the function of the telescopic rocker arm 302 is to adjust the distance between the trigger probe 4 and the surface of the part to be measured on the NC machine tool, so that the trigger probe 4 moves on the surface of multiple directions of the part to be measured and contacts the surface of the part to be measured for detection, and the function of the pitch adjustment mechanism 304 is to adjust the angle of the trigger probe 4 relative to the axis of the telescopic rocker arm 302, for example, The trigger probe 4, which is originally on the same straight line as the telescopic rocker arm 302, rotates 90 ° under the driving trend of the rocker arm, and detects the upper surface of the part to be measured under the adjustment of the lifting mechanism 301 and the telescopic rocker arm 302. The function of the steering mechanism 303 is to drive the trigger probe 4 to rotate, so that the trigger probe 4 can adjust the angle to any direction under the adjustment of the steering mechanism 303 and the pitch adjustment mechanism 304, To adapt to the detection of parts to be tested with complex geometric structure.

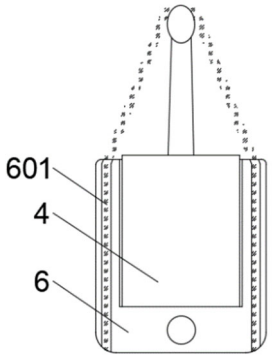

Fig. 4 Structural diagram of plug-in terminal

The device switches the on-line detection assembly 3 and the trigger probe 4 between the storage and detection states through the cooperation of the reciprocating drive mechanism 2 and the storage flat box 1. The lifting mechanism 301, the telescopic rocker arm 302, the

steering mechanism 303 and the pitch adjustment mechanism 304 of the on-line detection assembly 3 cooperate with each other to realize the detection of the surface of the parts to be measured by the trigger probe 4 in multiple directions, There is no need to disassemble the trigger probe 4 and the cutter shaft of the NC machine tool during detection, which improves the detection efficiency, shortens the time required for the NC machine tool to recover from the detected to the processing state, and avoids the disadvantage of increasing the detection error due to the installation error of the trigger probe 4 every time. The on-line detection assembly 3 and the trigger probe 4 can be stored in the storage flat box 1 without disturbing the operation of the NC machine tool.

In the above implementation process, it is further optimized that the lifting mechanism 301 and the rotating mechanism 305 are slidably installed in the storage cavity 101 through the sliding shell 5, the outer wall of the sliding shell 5 is fitted with the inner wall of the storage flat box 1, the reciprocating driving mechanism 2 is connected with the sliding shell 5, and the setting of the sliding hole shell is conducive to improving the stability and positioning accuracy of the reciprocating movement of the lifting mechanism 301. In addition, the front of the sliding shell 5 is provided with a vertical groove 501, A guide shaft 10 connecting the telescopic rocker arm 302 and the rotating mechanism 305 is installed in the vertical groove 501.

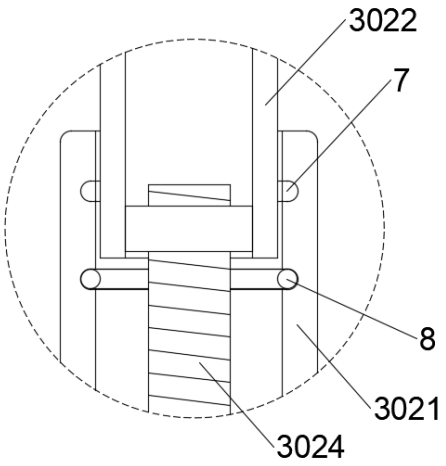

Fig. 5 Structural diagram of part a in Fig3

The reciprocating driving mechanism 2 includes a rack 201, a traveling stepping motor 202 and a gear 203. The rack 201 is arranged on the cavity wall of the storage cavity 101 along the sliding direction of the sliding housing 5. The outer wall of the sliding housing 5 is provided with a guide groove 502 inserted and matched with the rack 201. The traveling stepping motor 202 is embedded and installed on the sliding housing 5 and engaged with the rack 201.

The arrangement of the guide groove 502 enables the sliding housing 5 to move stably along the rack 201, and the rack 201 arranged on the side of the storage cavity 101 or on the ground cooperates with the travel stepping motor 202 arranged at the corresponding position on the sliding housing 5 to form a distributed structure of the reciprocating drive mechanism 2. While realizing the reciprocating drive function of the reciprocating drive mechanism 2, the disadvantage of increasing the length of the storage flat box 1 caused by the setting of the reciprocating drive mechanism 2 is avoided, In order to facilitate the good combination of on-line detection device and NC machine tool.

Moreover, in order to improve the stability of the reciprocating motion of the sliding housing 5, a plurality of racks 201 are arranged on the sliding housing 5, and a plurality of guide grooves 502 and a plurality of progressive motors 202 are arranged on the sliding housing 5. For example, racks 201 are arranged on both sides of the bottom cavity wall of the storage cavity 101 and on both sides of the cavity wall of the storage cavity 101, and the racks 201 on both sides of the bottom stably support the sliding housing 5, The two racks 201 on the side can support the upper half of the sliding housing 5. When the front half of the sliding housing 5 extends out of the storage cavity 101, the two racks 201 on the side can inhibit the rear half of the sliding housing 5 from tilting upward.

The telescopic rocker arm 302 includes a sleeve 3021 connecting the rotating mechanism 305, a hollow connecting rod 3022 sliding and mating with the sleeve 3021, and a telescopic driving component for driving the hollow connecting rod 3022 to expand and contract along the sleeve 3021. The length from the tail end of the hollow connecting rod 3022 in the sleeve 3021 to the trigger probe 4 is less than the length of the sleeve 3021, so that the trigger probe 4 can be protected in the sleeve 3021. The steering mechanism 303 and the reset pitch adjustment mechanism 304 meet the conditions of being included in the sleeve 3021. It is possible to adjust the structure of the steering mechanism 303 and the pitch adjustment mechanism 304, increase the internal cross-sectional area of the sleeve 3021 or change the internal shape of the sleeve 3021.

The telescopic drive assembly is any device or component with reciprocating drive function, which is conducive to the air pump and the piston installed on the hollow connecting rod 3022, that is, the piston drives the hollow connecting rod 3022 to telescopic action by adjusting the air pressure in the sleeve 3021 through the air pump, but the accuracy is affected by ambient temperature, piston aging, etc. Therefore, the telescopic drive assembly preferably adopts the telescopic stepping motor 3023 and the lead screw 3024. The central hole for installing the lead screw 3024 is opened at the axis of the hollow connecting rod 3022, and the nut of the lead screw 3024 is connected with the hollow connecting rod 3022, or compared with the matching mode of the telescopic stepping motor 3023 and the lead screw 3024

The trigger probe 4 is installed on the pitch adjustment mechanism 304 through the plug-in end 6. The trigger probe 4 is electrically connected with the plug-in end 6 to facilitate the disassembly and assembly of the trigger probe 4.

In addition, the interior of the sleeve 3021 is a cylindrical cavity, the shape of the plug-in end 6 is adapted to the internal contour of the sleeve 3021, and at least the inner wall of the open end of the sleeve 3021 is sliding and

sealed with the side wall of the plug-in end 6. A plurality of guide holes 601 penetrating both ends are arranged in the wall of the plug-in end 6, and the intersection of the axes of the plurality of guide holes 601 is located at the head of the reset trigger probe 4, so that the plug-in end 6 can be inserted into the sleeve 3021, The gas in the sleeve 3021 overflows from a plurality of guide holes 601 to form an air flow for cleaning the head of the trigger probe 4, so that the trigger probe 4 can clean the head by air injection after each detection, so as to avoid the debris on the surface of the part to be tested sticking to the head of the trigger probe 4 and affecting the accuracy of repeated detection of the trigger probe 4.

The inner wall of the open end of the sleeve 3021 is provided with a plurality of axially distributed annular grooves 7, in which a sealing ring 8 is installed. The side wall of the plug-in end 6 and the inner wall of the sleeve 3021 are slidably sealed and matched through the sealing ring 8. Compared with setting the sealing ring 8 on the side of the plug-in end 6, setting the sealing ring 8 on the inner wall of the sleeve 3021 is conducive to keeping the sealing ring 8 clean.

In addition, a baffle 9 is installed on the outside of the telescopic rocker arm 302 relative to the guide shaft 10, and the size of the baffle 9 is larger than the size of the storage cavity 101, so that when the telescopic rocker arm 302 is collected into the storage cavity 101, the baffle 9 on the outside can close the storage cavity 101, so as to further prevent the on-line detection assembly 3 and the trigger probe 4 from being polluted by dust, water vapor and oil in the environment, The service life and detection accuracy of the on-line detection device are negatively affected[4].

4. Conclusion

The device switches the on-line detection assembly and the trigger probe between the storage and detection states through the cooperation of the reciprocating drive mechanism and the storage flat box, while the lifting mechanism, telescopic rocker arm, steering mechanism and pitch adjustment mechanism of the on-line detection assembly cooperate with each other to realize the detection of the trigger probe from the surface of the parts to be measured in multiple directions, without disassembling the trigger probe and the cutter shaft of the NC machine tool during the detection, While improving the detection efficiency, the time required for the NC machine tool to recover from the detected state to the machining state is shortened.

The labels in the article figure are shown as follows:

1 - storage of flat box; 2 - reciprocating drive mechanism; 3 - online detection assembly; 4 - trigger probe; 5 - sliding shell; 6 - plug end; 7 - annular groove; 8 - sealing ring; 9 - baffle; 10 - guide shaft;101 - storage chamber;201 rack; 202 - traveling stepping motor; 203 - gear;

301 - lifting mechanism; 302 - telescopic rocker arm; 303 steering mechanism; 304 - pitch adjustment mechanism; 305 - rotating mechanism;3021 sleeve; 3022 hollow connecting rod; 3023 telescopic stepping motor; 3024 lead screw;501 - vertical groove; 502 - guide groove; 601 - diversion hole.

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