

Contact high-precision large stroke thread measuring instrument

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Abstract: Threaded parts are the most widely used mechanical parts in mechanical industry, higher requirements on its detection technology. Thread parameter detection method can more fully reproduce the actual situation of thread according to the facts, in order to thread as a judge on the basis of comprehensive status, ensure the quality of the thread. In this paper, on the basis of detailed analysis of thread measurement device at home and abroad, developed a contact high precision large stroke thread measuring instrument. Measured thread surface profile, the instrument scanning grating with high precision and high precision micro displacement mechanism were recorded in the horizontal and vertical directions of the scanning process numerical changes, the data were analyzed by computer, measured thread to generate two-dimensional contour graphics, calculated to obtain all parameters of the screw to be tested.

Keywords: contact ; scanning ; thread measurement

I. INTRODUCTION

Thread is most widely used mechanical design and manufacturing field parts, precision of screw thread parameters of the detection is a worldwide problem. Universal tool microscope, such as is the use of imaging principle of measuring multiple parameters of the screw thread, but can only measure the external thread, measuring accuracy is affected by the spiral Angle, high surface quality requirement of thread. Laser interferometer to measure thread, the thread surface quality, tooth type Angle, the external environment, the influence of such factors and measuring instrument cost is higher. Contact is thread parameter measurement is an important research direction, a thread can be measured more parameters, high measurement precision, high speed, wide range, can measure the internal thread. The Dutch IAC MSXP series screw thread gauge, expensive, measure the length of the thread is shorter; Xi 'an jiaotong university developed oil pipeline screw thread measuring machine specially designed for field measurement of oil pipeline thread; Beijing university of technology of the pipe joint internal thread measuring device is only for measuring pipe joint internal thread. In view of the imaging method of thread detection and laser detection strict measuring conditions; The contact thread measuring instrument is expensive, with short length of thread and limited factors, such as measuring thread sort, this article introduces a kind of high precision large stroke thread measuring instrument.

II. STRUCTURAL DESIGN OF THE INSTRUMENT

1. Measuring principle

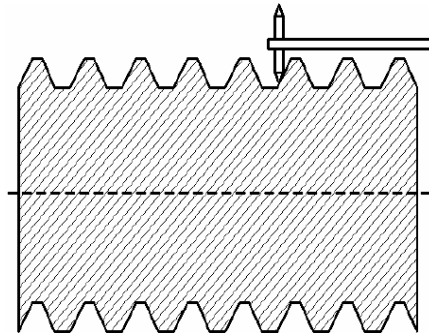
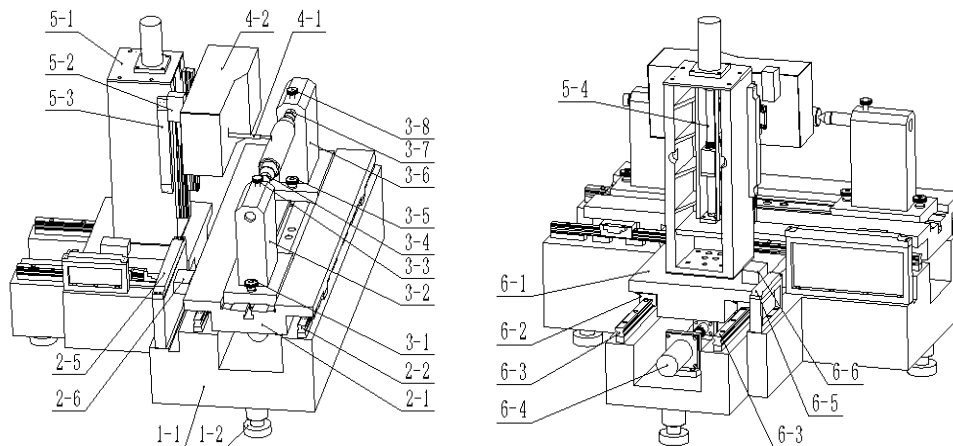


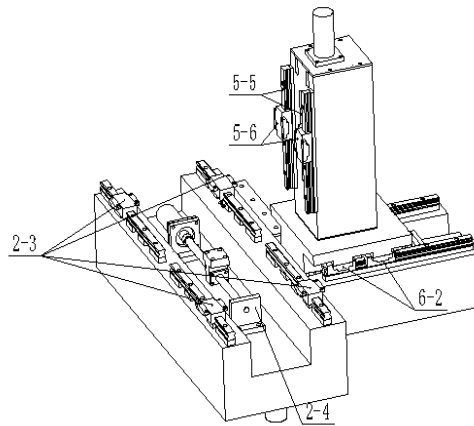
Fig. 1 contact thread measuring principle diagram

Making uniform motion drive system drives the workbench, needle with the thread contour surface of ups and downs do up and down. Needle movement and the movement of the workbench signals by the rod is passed to the electronic device, electronic device to enlarge the signal and transformation, through processing and calculation of the software system, finally be measured on the surface of the screw thread 2 d contour graphics, further in calculating the parameters of screw thread. Contact relative to non-contact measurement is reliable in operation is simple, intuitive, and the advantages of stable performance, strong commonality, is currently the best thread measurement method.

2. Mechanical device

High-precision large stroke thread measuring instrument includes base parts, fixture components, X workbench parts, Y workbench parts, column parts and micro displacement components, as shown in Fig. 2.





1-1 base ; 1-2 adjustable support leg ;2-1 X workbench; 2-2 X direction guide rail; 2-3 X direction guide rail slider; 2-4 X direction transmission system;2-5 X direction grating ruler; 2-6 X direction moving grating; 3-1 thimble rack locking bolt and nut; 3-2、 3-6 thimble rack;3-3、 3-8 the top locking bolts; 3-4、 3-7 tops; 4-1 needle; 4-2 micro displacement box;5-1 column;5-2 column parts (Z direction) grating ruler;5-3 column parts (Z direction) moving grating;5-4 column parts (Z direction) transmission system; 5-5 column parts (Z direction) guide rail; 5-6 column parts (Z direction) guide rail slider; 6-1 Y workbench; 6-2 Y direction guide rail slider; 6-3 Y direction guide rail; 6-4 Y direction transmission system;6-5 Y direction grating ruler;6-6 Y direction moving grating.

Fig. 2 high-precision large stroke thread measuring instrument structure schematic diagram

X direction transmission system fixed base, drive X workbench along the X direction guide rail movement; X direction guide rail and X direction grating ruler are installed on the base, the X direction moving grating and the X direction guide rail slider are installed on the X workbench. When X workbench with base in relative motion, grating ruler component to measure the displacement of X workbench and feedback to the control system. The column is installed on the Y workbench, column parts (Z direction) transmission system installed inside the column. Column parts (Z direction) transmission system drive Micro displacement box and the movement is perpendicular to X workbench; column parts (Z direction) grating ruler and column parts (Z direction) guide rail are installed on the column, column parts (Z direction) moving grating and column parts (Z direction) guide rail slider are installed on the micro displacement box. When micro displacement box and column of relative movement occurs, grating ruler component to measure micro displacement box of displacement and feedback to the control system; When the needle is scanned by the screw thread, the surface of the workpiece is measured with a tiny upper and lower displacement movement. The micro displacement is fed to the control system with the feedback of the micro displacement. Y direction transmission system fixed base, drive Y workbench along the Y direction guide rail movement; Y direction guide rail and Y direction grating ruler are installed on the base, the Y direction moving grating and the Y direction guide rail slider are installed on the Y workbench. When Y workbench with base in relative motion, grating ruler component to measure the displacement of Y workbench and feedback to the control system. Adjustable support leg mounted at base bottom surface. Thimble rack is installed on the X workbench, thimble rack locking bolt and nut and tops are respectively arranged on the thimble rack, thimble rack locking bolt and nut connecting X workbench and thimble rack for the thimble rack lock on the X workbench.

3. working process

Top fixture clamps screw thread workpiece. Through thread axis parts and perpendicular to the surface of the X workbench as the measuring plane. The movement of Y workbench makes the measuring needle fast

locating the relative position of the upper and lower profile surfaces of the measured screw workpiece. The T type needle is scanned in the upper and lower profile surfaces of the measured plane. Superposition of two values which the displacement of the micro displacement components and the displacement of the micro displacement of the needle as the thread profile radial coordinate values under test. Displacement of X workbench as thread surface profile axial coordinate values on the corresponding points. Each contour point of the scan is corresponding to a two-dimensional coordinate value. To deal with the data obtained, get measured on the surface of the screw thread two-dimensional contour graphics, calculation for each thread profile parameter values.

III. ELECTRICAL DESIGN OF THE INSTRUMENT

The electrical system is the important part of high-precision large stroke thread measuring instrument, which mainly includes the control circuit, the measurement circuit and the computer. Computer collection of three coordinate direction of the grating measuring signal, through the control circuit control the movement of X/Y workbench, micro displacement box and measuring needle, the resulting closed loop control system can effectively complete the whole measurement process.

1. control circuit

In the process of the control, circuit is mainly used for the measurement or adjustment in mobile positioning and mobile displacement variation to X, Y and Z three directions. In three directions of movement control, Computer send out mobile instruction, according to the needs of user, the analog power is obtained by A/D conversion. The computer controls the transmission system in all directions to drive the X/Y workbench and the micro displacement box to move along the guide rail of the respective direction, the change of displacement is collected by the grating ruler in every direction, and the data is processed by real-time feedback to computer. The computer sends out the stop instruction to reach the predetermined mobile displacement, and the transmission system stops the action of the direction., as shown in Fig. 3.

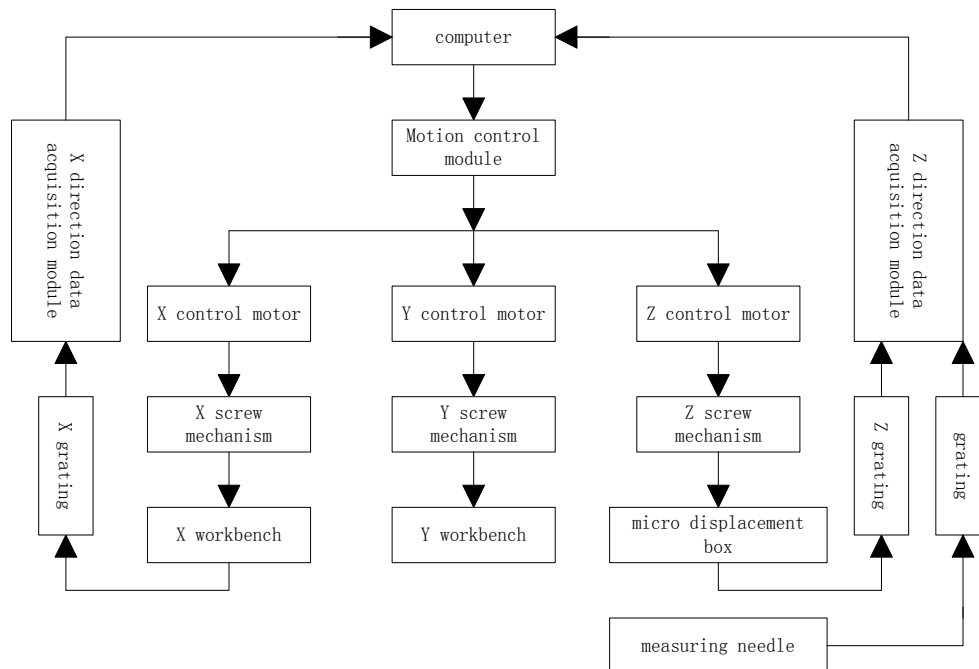


Fig. 3 high-precision large stroke thread measuring instrument control system block diagram

2. Measurement circuit

X/Y workbench, the micro displacement components was driven mobile transmission system in all

directions. They have in each direction displacement variation through their direction of the grating for data collection, the subdivision circuit breakdown them into the computer through the I/O interface, after data conversion and processing, the displacement variation of the direction is obtained. X, Y, Z directions of the mobile is accompanied by a grating measuring signals, each signal processing principle and circuit of all the way. as shown in Fig. 4.

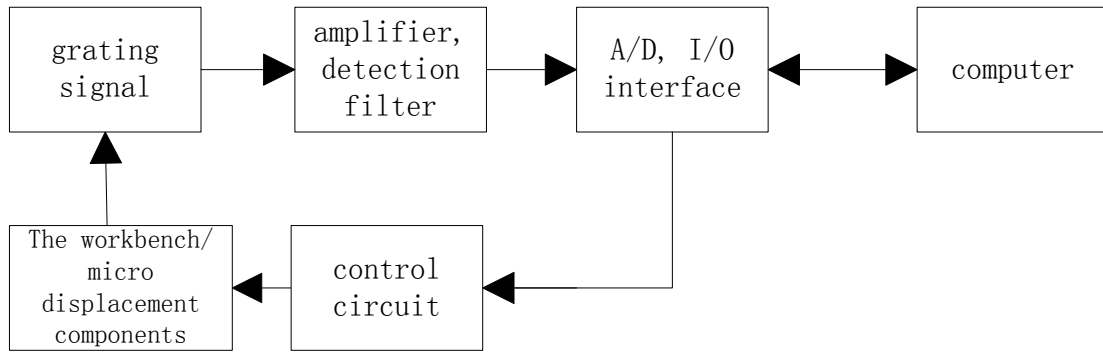


Fig. 4 high-precision large stroke thread measuring instrument flow diagram

Needle and thread being measured workpiece surface contact, the X workbench is driven by the transmission system, the needle is moved along the surface of the screw workpiece at a constant speed, Measured by the needle on the surface of the peak valley make fluctuation displacement, Each direction grating obtains the displacement signal, which causes the AC carrier wave to change. This change after amplification, demodulation, filtering circuit, then converted into digital signal and stored in the computer system memory. The original contour information is digitally filtered by the computer, the surface profile of the screw is separated and its parameters are calculated.

2.1 amplifying circuit

The grating converts optical signal into light current by the photoelectric conversion circuit, and the change of the displacement is proportional to the change of the current. Usually the output signal of the grating is small, so it is necessary to amplify the sensor signal. The principle is shown in Fig. 5.

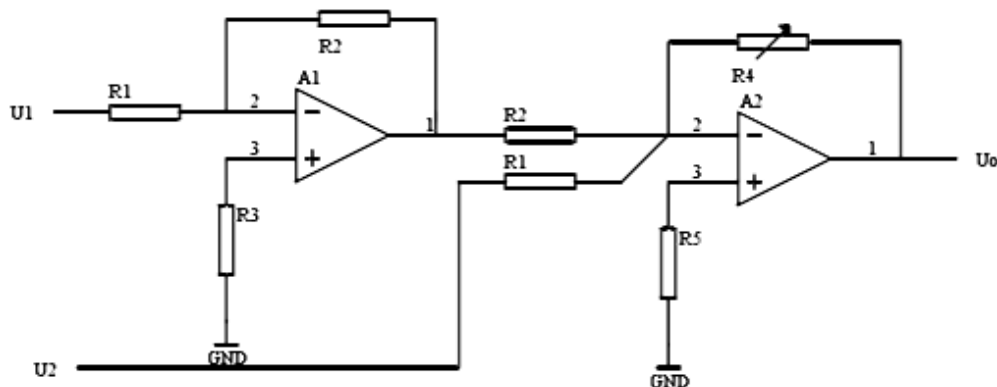


Fig. 5 amplifying circuit

2.2 switch phase-sensitive detection circuit

Detection circuit is demodulating the output signal of the amplifier, in order to obtain consistent with threaded workpiece contour graph of graded DC signal. In order to make the detection circuit has the ability of identifying the signal phase and frequency selective, it need to adopt the phase-sensitive detection circuit. From the structure of the circuit, phase sensitive detection circuit is mainly characterized in that, in addition to the demodulation of AM signal, provide a reference signal. The reference signal can be used to identify the phase and

frequency of the input signal. The reference signal shall have the same frequency as the amplitude modulation signal of the desired demodulation, and the carrier signal can be used as the reference signal to meet the condition. This instrument adopts the switch square-wave multiplication phase sensitive detector, because this kind of detector conforms to the trend of miniaturization and integration of the circuit. Its working principle is shown in Fig. 6.

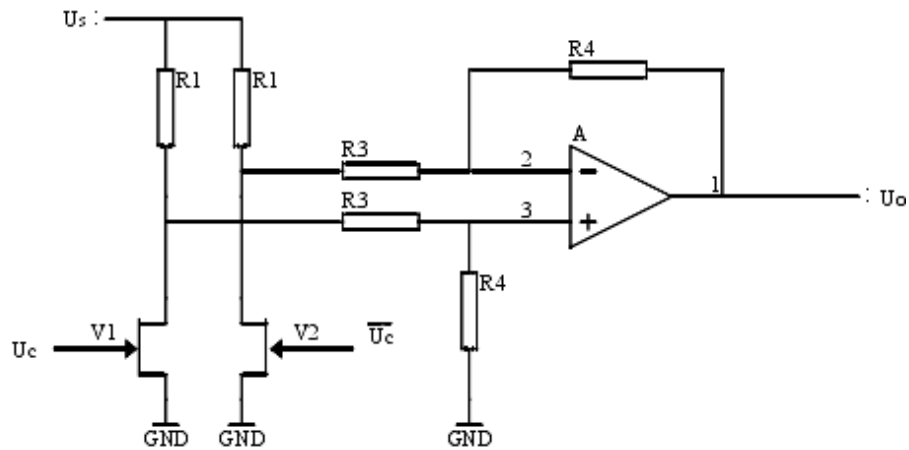


Fig. 6 switch phase-sensitive detection circuit

2.3 active low-pass filter circuit

The signal obtained from the grating in the measurement system often contains noise and many signals unrelated to the measurement. the original measured signal which through transmission, amplification, transformation, operation, and various other process, will be mixed with various forms of noise. They affect measurement accuracy. These general random noise is very strong, it is difficult to directly separated from the time domain, but limited to its mechanism, the noise power is limited, and distributed in the frequency domain according to certain rules. Minimum standards of beard needle tip radius of 2 microns, so rough distance is less than 2 microns signals are not of the thread surface contour. X workbench to 1 mm/s speed of movement, needle reflects to no greater than 500 Hz frequency for vertical movement, higher than the frequency of the signal component is not a thread surface outline signal, but is caused by noise interference signals and electrical components. Therefore, the filter should be used to filter the signal above this frequency. In this instrument, the design of active low pass filter is shown in Fig. 7.

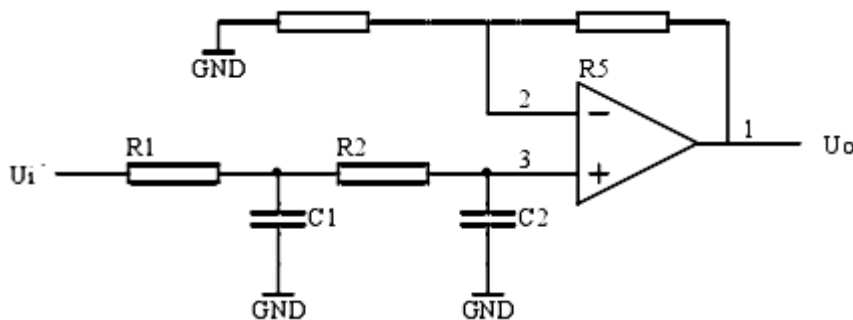


Fig. 7 active low-pass filter circuit

3. Data collection

The instrument choose AC1059 multi-function data collection card 12 bit A/D board. AC1059 has 16 channel analog input (single side); Input programmable amplifier $G = 1, 2, 5, 10$ times; Board a 16-bit timer can automatically control the sampling speed $10 \mu s - 65 ms/s$ time, $1 \mu s$ clock benchmark; Multiple working modes; Software startup; External trigger start timer; External trigger switch (BURST mode); A/D's end judgment; Query

software or hardware interrupt; 24 programmable digital I/O (8255); 12 bit D/A converter and 16 bit counter (8253) can be applied to digital pulse counting or frequency measurement. According to Nyquist theorem, determine the sampling points. Determine the sampling frequency by setting the timer on the A/D board. For example: the sampling length is 0.8 mm, sampling points are 1600 points. Due to the driver box at the rate of 1 mm/s, so the sampling frequency is 2000 Hz, the sampling interval is 500 μ s.

IV. CONCLUSION

In this paper, contact high-precision large stroke thread measuring instrument is studied. Feed direction of the micro displacement measuring needle parts is perpendicular to the direction of needle scanning thread workpiece in the instrument, which increase the size of the measured screw workpiece type, so that the application of the instrument range increases. The mechanical parts of the instrument structure is relatively simple, the equipment cost is low. The study of the instrument is significant progress and application value.

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