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DETERMINATION OF THE MEASUREMENT ERROR OF FLAT PARALLEL LENGTH STANDARDS AND MICROMETER

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Annotation: This article studies the accuracy of flat parallel length standards and the micrometer used in length measurements. The methods for determining the indication error of a micrometer, as well as the analysis of systematic and random errors in measurement, are discussed. In addition, practical recommendations are given to improve the reliability of measurement processes and reduce errors. The paper is aimed at improving the quality of measurement technologies in the fields of mechanical engineering and metrology.

Keywords: metrology, length measurement, flat parallel gauge blocks, Johanson blocks, micrometer, accuracy, error, calibration.

Introduction

Measurement techniques play an important role in mechanical engineering, instrumentation, construction, optics, and many other industries. The accuracy of technical measurements determines the quality of manufactured parts and the reliability of products. Measuring length with high precision is one of the most important metrological processes. Among measurement instruments, flat parallel length standards (Johanson gauge blocks) and micrometers are widely used as the main length standards.

This article analyzes the structure and applications of flat parallel gauge blocks, as well as the methods for determining micrometer indication errors.

1. Units of Length Measurement and Their Accuracy

Length is one of the fundamental physical quantities in metrology, and its international unit is the meter (m). The accuracy of the meter is based on international standards and forms the foundation of the entire measurement system.

To ensure accuracy, the following calibration chain is established: national standard → secondary standards → working measurement instruments.

Flat parallel gauge blocks serve as the main tools for transferring length units to other instruments.

2. Flat Parallel Length Standards (Johanson Gauge Blocks)

Flat parallel length standards are rectangular metal or ceramic blocks with two flat, polished, and parallel surfaces and a precisely defined length. They are usually made of steel, carbide, or ceramic materials. Each block's working surface is polished to a high degree of precision. Two or more blocks can be joined together using the wringing method.

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This phenomenon occurs due to molecular attraction forces and the difference in air pressure between the surfaces.
The accuracy of flat parallel gauge blocks reaches 0.05–0.1 micrometers, and they are classified into grades such as 00, 0, 1, and 2.

3. Micrometer and Its Working Principle

A micrometer is a mechanical length-measuring instrument that operates on a screw mechanism. Using a screw pair, it converts linear displacement into angular measurement, enabling the high-precision measurement of part dimensions.
The main parts of a micrometer include the frame, measuring faces, spindle screw, thimble mechanism, and vernier scale. The typical accuracy of a micrometer is 0.01 mm, although some modified versions reach 0.001 mm accuracy.

4. Determining the Indication Error of a Micrometer

To ensure the accuracy and correct functioning of a micrometer, calibration or verification is required.
During this process, flat parallel gauge blocks are used as reference standards. The procedure for testing a micrometer includes cleaning the instrument, checking the zero position, and measuring with gauge blocks of different lengths.
The indication error is determined by the formula:
\Delta = L_m – L_h
Where:
Δ — measurement error,
L_m — micrometer reading,
L_h — true value of the gauge block length.
Errors may be systematic (caused by screw imperfections or zero error) or random (caused by operator pressure, vibration, etc.).
The permissible indication error generally should not exceed ±2 µm.

5. Methods for Ensuring Accuracy and Reducing Errors

To ensure measurement accuracy, the following recommendations should be observed:
Keep the instrument and gauge blocks at the same temperature;
Avoid applying excessive pressure to the screw mechanism;
Keep the measuring surfaces clean;
Calibrate the instrument regularly;
Use statistical analysis of measurement results to determine average errors.

Conclusion

High-precision length measurement plays a vital role in mechanical engineering and metrology. Flat parallel gauge blocks serve as the fundamental source of length standards and are the main tools for verifying micrometers and other instruments.
Determining and maintaining the indication error of micrometers within permissible limits increases the reliability of measurement results and improves the overall accuracy of manufacturing processes.

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