MASTER

SINGLE-TRANSDUCER DIFFERENTIAL
MEASURING DEVICE (U)

L. G. Whitten

RELEASED FOR ANNOUNCEMENT
IN NUCLEAR SCIENCE ABSTRACTS

UNION CARBIDE CORPORATION
NUCLEAR DIVISION
OAK RIDGE Y-12 PLANT

operated for the ATOMIC ENERGY COMMISSION under U. S. GOVERNMENT Contract W-7405 eng 26

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Oak Ridge, Tennessee

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ABSTRACT

A review of current practice showed that to keep abreast of present-day machine-tool capabilities, the precision of on-the-machine gaging should be improved by at least an order of magnitude. A simple, easily operated, portable, on-the-machine measuring device utilizing a single-transducer measuring system was designed, built, and tested. Its performance demonstrated an improvement in precision over current practice by one to two orders of magnitude.

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INTRODUCTION

The increasing use of tape-controlled machines has created a disparity between machining and measurement technology. While industry has been building machines to move more and more accurately and in smaller increments, practice in part measurement has failed to keep pace. Handheld inside-diameter and outside-diameter micrometers are simply no longer adequate to gage parts that are being produced on machines having twenty-five-microinch incremental movements or less.

A single-transducer differential measuring device was proposed that could be mastered with gage blocks, carried to the machine, and be used by hand to determine part size. A precision of better than the machine's least readout was the goal to be realized. Since machines with tool-path accuracy in the order of fifty microinches are commonplace today, it was deemed appropriate to aim at measuring part diameters with an accuracy of twenty-five microinches or better.

SUMMARY

A single-transducer differential measuring device has been built and tested for checking critical dimensions of a part while the part is still on the machine.

DESCRIPTION

The normal arrangement for measuring diameters with gaging cartridges is to pick up one end of a diameter, rotate the stylus, move a measured amount, and then read the deviation at the other end. Alternatively, opposed matched gaging cartridges could be used with the gaging cartridge output being fed as input to matched amplifiers. The differential signal of the amplifiers would then either analog or digitally display the difference from the nominal dimension.

Both of these methods have disadvantages. In the first method, the traversing of a known distance requires a device such as a measuring machine and obviously is not portable and could not be used on the machine. The disadvantage of the second method is that two gage cartridges and two matched amplifiers are required to obtain the desired results.

Figure 1 shows schematically the single-transducer differential measuring device which was developed to perform all of the functions of the second method, while requiring only one cartridge and one amplifier. The device consists of two parallel-reed "feeler" supports. Attached to one parallel-reed subassembly is a linear differential-transformer coil. Attached to the other parallel-reed subassembly is the armature for this coil. Movement of the coil feeler, the armature feeler, and/or both feelers, results in a proportional movement of the coil with respect to the core. This gives a differential measurement of the feeler displacement to a single amplifier.

Figure 1. THE SINGLE-TRANSDUCER DIFFERENTIAL MEASURING DEVICE.

Later models of this device have made use of different probe assemblies such as precisely located balls for gaging a known distance down from the surface of the part. The device can be made either shorter or longer simply by decreasing or increasing the length of the frame and the corresponding transfer rod.

Another modification, shown in Figure 2, depicts an arrangement using a plain adjustable bar and a standard electronic gage cartridge.

Figure 2. MODIFIED SINGLE-TRANSDUCER DIFFERENTIAL MEASURING DEVICE.

Advantages of the parallel-reed arrangement are:

1. Hysteresis is kept to a minimum, thereby reducing zero shift.
2. There are no bearings to clog, stick, or cause friction.
3. Gaging pressure can be reduced to zero by the proper placement of the subassemblies.

This arrangement is adaptable to the measurement of outside diameters, inside diameters, length, and heights. Variations in the measurement of heights may be achieved by substituting: (1) the body of a mechanical indicator in the described core position and the mechanical actuating shaft of the indicator in the armature position; (2) capacitance plates at the core and armature positions; (3) strain gages or strain wire couples between the core and armature positions, and (4) optical interference equipment between the core and armature positions.

In addition to the dimensional measurements, the device is adaptable to the calibration of force (load cell), and to the measurement of strain, differential velocity and acceleration, and displacements.

The described device has been used successfully to measure parts produced on a tape-controlled turning machine.