

## Milling Guide for Residual Stress Measurements

### INTRODUCTION

A predominant factor contributing to the structural failure of machine parts, pressure vessels, framed structures, etc., may be the residual “locked-in” stresses that exist in the object prior to its being put into service. These residual stresses are usually introduced during manufacturing, and are caused by processes such as casting, welding, machining, heat treating, molding, etc.

Residual stress cannot be detected or evaluated by conventional surface measurement techniques, since the strain sensor (strain gage, photoelastic coating, etc.) can only respond to strain changes that occur after the sensor is installed.

The most widely used practical technique for measuring residual stresses is the hole-drilling strain gage method described in ASTM Standard E837. With this method, a specially configured electrical resistance strain gage rosette is bonded to the surface of the test object, and a small shallow hole is drilled through the center of the rosette. The local changes in strain due to introduction of the hole are measured, and the relaxed residual stresses are computed from these measurements. Micro-Measurements Tech Note TN-503, *Measurement of Residual Stresses By The Hole-Drilling Strain Gage Method*, presents a detailed discussion of the theory and application of this technique.

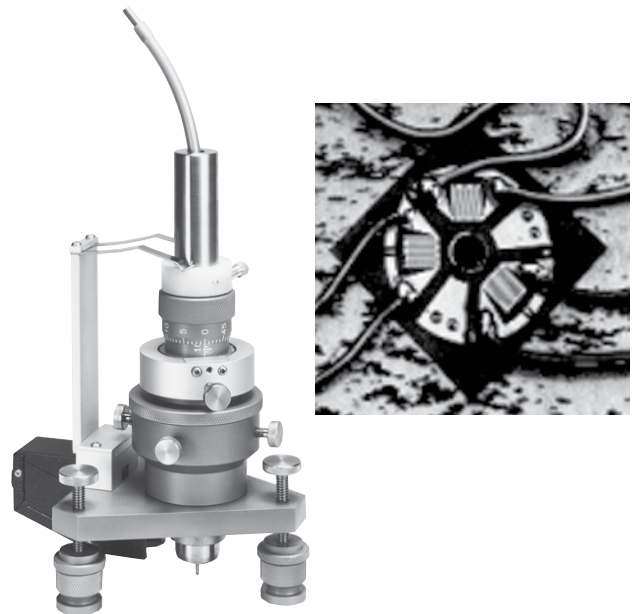
The hole-drilling method is generally considered semi-destructive, since the drilled hole may not noticeably impair the structural integrity of the part being tested. Depending on the type of rosette gage used, the drilled hole is typically 0.062 or 0.125 in (about 1.5 or 3.0 mm), both in diameter and depth. In many instances, the hole can also be plugged, if necessary, to return the part to service after the residual stresses have been determined.

The practicality and accuracy of this method is directly related to the precision with which the hole is drilled through the center of the strain gage rosette. The Micro-Measurements RS-200 milling guide provides a practical means to accomplish this task.

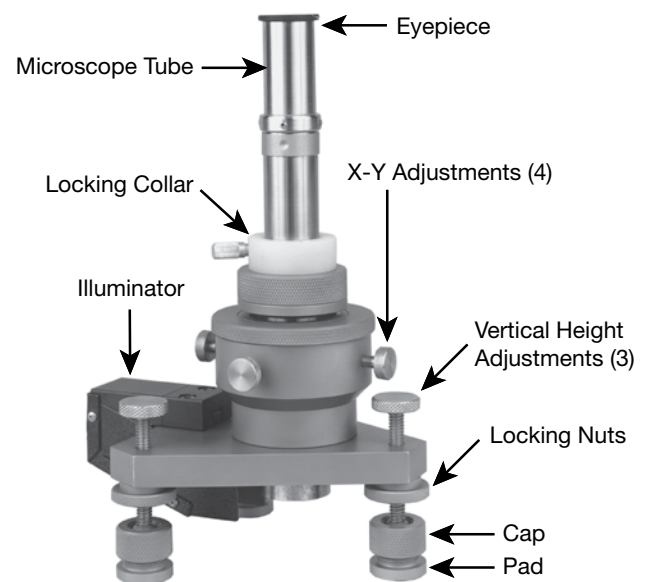
### RS-200 MILLING GUIDE

The RS-200 Milling Guide is a precision fixture for accurate positioning and drilling of a hole through the center of a special strain gage rosette. Principal features and components of the milling guide assembly are shown in the photos herein. When installed on the workpiece, the guide is supported by three leveling screws footed with swivel mounting pads to facilitate attachment to uneven surfaces.

Alignment of the milling guide relative to the strain gage rosette is accomplished by inserting a special-purpose microscope into the guide’s centering journal, and then positioning the guide precisely over the center of the rosette by means of four X-Y adjusting screws. The microscope assembly, consisting of a polished

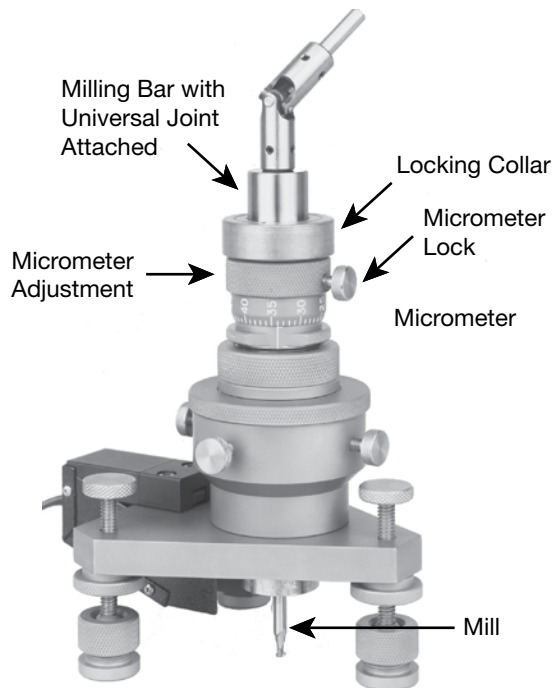


steel housing with eyepiece, reticle, and objective lens, permits alignment to within 0.0015 in (0.038 mm) of the gage center. The microscope is also used to measure the diameter of the hole after it is drilled. An illuminator attaches to the base of the guide to aid in the optical alignment procedure.



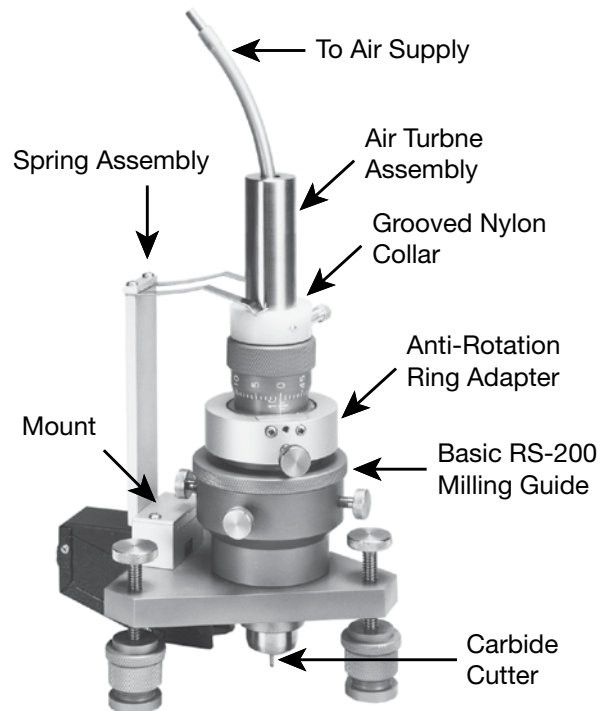
### Milling Guide for Residual Stress Measurements

After alignment, the microscope is removed from the guide, and the milling bar or high-speed air turbine is inserted in its place. The milling bar is used for slow-speed drilling of the hole. Two standard milling cutters are supplied: 0.062 and 0.125 in (1.6 and 3.2 mm) diameter. The milling bar is equipped with a universal joint for flexible connection to a drill motor.



Conventional slow-speed milling may be satisfactory on some mild steels and aluminum alloys. But high-speed drilling is generally the most convenient and practical method for introducing the hole in all test materials. (When residual stresses are to be measured on materials such as stainless steels, nickel-based alloys, etc., ultra high-speed drilling techniques are preferred.) For this purpose, a high-speed air-turbine assembly, along with a supply of tungsten carbide-tipped cutters [ten

each 0.031 in (0.8 mm) diameter and 0.062 in (1.6 mm) diameter], is supplied with the milling guide. A foot pedal control is included for operating the air turbine.



A micrometer depth set attachment, available in English or metric units, is provided with each milling guide assembly. This device is used for incremental drilling when information on the variation of residual-stress-with-depth is desired.

Other items supplied include a plastic template for the proper location of the milling guide foot pads on the test part and a special break-off tool used to remove the foot pads from the part after the test is completed. All components are housed in a sturdy carrying case. The guide is approximately 9 in (230 mm) high, and 4.5 in (114 mm) wide at the base.

A fast-setting-cement kit, used to firmly attach the guide to the test part, is available as an accessory item.



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