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7.1 Boroscopes


Applications: Visual inspection of small, narrow or otherwise inaccessible areas in turbines, piping, engines, tanks, heating, ventilation, and air conditioning (HVAC) systems, boilers, pumps, valves, etc.

Types: Units can be permanently mounted on bench top or can be portable; units can have battery-operated self-contained illuminators or rechargeable shoulder-pack illuminators; the probe itself can be rigid, flexible, gooseneck sheathed, or provided with a viewing end tip that can flex up to 120°.

Diameters: From 0.118 to 2.75 in. (3 to 75 mm)

Lengths: For rigid designs, from 3 in. to 150 ft. (76 mm to 45 m); for flexible designs, up to 96 in. (2.4 m)

Resolution: Can identify flaws as small as 0.0005 in. (0.013 mm)

Field of View (FOV): From 20 to 120°

Costs: A portable fiberscope costs about $1500, a fiber-optic illuminator shoulder-pack costs about $800, and an articulating tip fiberscope costs about $3000. Units designed for an industrial environment can cost $10,000 or more.

Partial List of Suppliers: Aims Ndt (www.aims.nl)
Borescopes (www.boroscopes.com)
Cole-Parmer Instrument Co. (www.coleparmer.com)
Edmund Scientific Co. (www.edsci.com)
ITI Instrument Technology Inc. (www.scopes.com)
Karl Storz Endoscopy America Inc. (www.careers.ksea.com)
Lenox Instrument Co. (www.thomasregister.com/ole/lenoxinstrument)
Machida America Inc. (www.machidascope.com)
Mitsubishi Cable America Inc. (www.mcausa.com)
Olympus Co. (www.olympus.com)
Schott Fiber Optics (www.techexpo.com/firms/schottfi)
Titan Instruments (www.titanspecialties.com)
Titan Tool Supply Co. (www.titantoolsupply.com)
UXR (www.uxr.com)
Visual Inspection Technologies Inc. (www.waterdrop.com/visual)

INTRODUCTION

Boroscopes (also spelled borescopes) are visual inspection tools providing high image quality. They were originally designed for inspecting gun barrels, but currently have many applications in modern technology. They are used to inspect remote or limited access locations, such as drill holes, vessels and chambers, chemical reactors, heat exchangers, process lines, and much more. Illuminated boroscopes and fiberscopes provide bright, sharp images for visual observations and are camera-adaptable for permanent record keeping. They enable critical internal inspections with speed, safety,
7.1 Boroscopes

and certainty in the field or on the factory floor. Table 7.1a gives a partial list of applications that speed testing, inspection, and quality control.

### Table 7.1a

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<thead>
<tr>
<th>Aviation</th>
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<tr>
<td>• drill pipe</td>
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</table>

**Flexible Illuminated Fiberscopes**

The flexible illuminated boroscope or fiberscope (Figure 7.1c) allows for inspection of the most difficult-to-reach spots. The semirigid gooseneck sheathing can be bent through multiple angles to clear almost any obstruction. There are two separate bundles inside the scope. The image bundle contains thousands of fibers precisely arranged at each end so that each fiber is in the same position at both ends of the bends.

The illuminating halo bundle, or the light guide bundle, carries light from an external light source to illuminate the viewing area. The fibers in these bundles are drawn from high-quality optical glass and are coated or clad with another glass which has a lower refractive index. The outer layer prevents light that enters the tube from escaping or passing through the sides to another fiber. The fibers are drawn small enough to be flexible and very rugged. These flexible fiberscopes can withstand repeated bending and flexing.

A fixed-focus objective lens is used to image the object onto the end of the bundle. The image is transmitted through the image bundle to the other end of the fiberscope, where an adjustable eyepiece magnifies the image for viewing. The unit can be used for straight-through viewing or 90° viewing by attaching the right angle tip to the objective lens.

The eyepiece can be adjusted for the individual operator’s eye requirements. Like the rigid boroscope, it can be used with camera, video recorder, and TV monitor. Working lengths of up to 96 in. (2.4 m) are available.

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Chamberscopes offer greater magnification than conventional rigid boroscopes. They include high-intensity lighting and variable direction of view, and also allow examination of areas in large cavities at a distance up to 36 in. (0.9 m), particularly within vessels and engines.

Periscopes allow examination of hazardous processes or dangerous areas. They are designed for extreme radiation, high pressure or temperature, or underwater applications.

Vacuum and high-pressure boroscopes allow observations and recordings of images inside vacuum chambers and inside vessels under high pressures and temperatures. They allow documentation with photographic or video cameras.

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