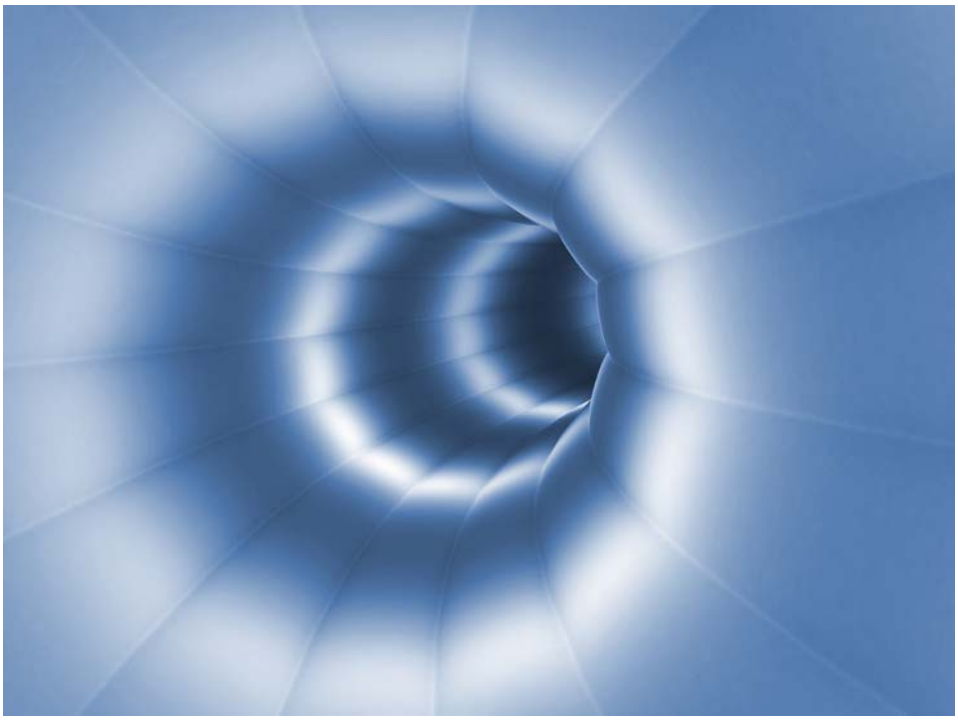
White Paper

CAMERA PROBES FIND SHARPER FOCUS BY SWITCHING TO PRECISION ELECTROFORMED METAL HOUSING



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CAMERA PROBES FIND SHARPER FOCUS BY SWITCHING TO PRECISION ELECTROFORMED METAL HOUSING

By switching from a machined camera retainer to a precision electroformed component, a manufacturer of imaging equipment has improved the accuracy and repeatability of the camera's focus. The new component is made by Servometer® of Cedar Grove, NJ. Because the electroformed retainer holds higher tolerances, it has facilitated the continuing miniaturization of industrial imaging instruments.

The instruments include video probe borescopes for industrial applications such as aircraft engines and underground pipe inspection. A miniature digital camera housed in the probe's tip generates an image so that inspectors get a real-time look at inaccessible components and surfaces. The camera is packed into the tip assembly along with other sensors and fiber optic light bundles. The market demanded smaller probes. Camera retainer sizes had decreased from 0.48 inch to 0.24 inch (12.2 mm to 6.1 mm) in diameter.

Because it permits miniaturization to the 0.20 inch (5.1 mm) range, the electroformed component has been adopted exclusively for borescope products made by this manufacturer.

Tolerance Is Critical

The miniature camera housing is a cylindrical component about .50 inch (12.7 mm) long and .196 inch (0.5 mm) in diameter. Its purpose is to retain the camera in a permanently focused position and to shield it from electrical interference and environmental conditions such as moisture for lifetime use. The material thickness of the housing wall and the housing diameter are critical factors in assuring the proper focus of the camera.

Tolerance is critical because of the way the probe is assembled. A lens is epoxy bonded to the end of the probe. Then the miniature camera is placed in the retainer. Before the assembly is fixed in place, its position must be manually adjusted while the lens is aimed at a target and focused. A technician visually measures its resolution in line pairs per millimeter. If the camera is too loose inside the retainer, its direction will stray from the required axis. The image will be in focus at one end of the target and out of focus at the other. Maintaining

the tight tolerance of the retainer prevents divergence from the axis, assuring proper focus and repeatability from one unit to the next.

There is continuing market pressure to reduce the overall diameter of the probe and specifically, of the camera bundle within the probe. When the bundle diameter is greater than 0.250 inch (6.35 mm), the housing of the camera bundle may be a machined 303SS part with a wall thickness of 0.003 inch, +/- 0.001 inch (0.0762mm, +/- 0.0254 mm). However, with a smaller-diameter camera, this tolerance is too wide for machining tolerances to handle.

For the new camera to fit snugly into the retainer, tolerances needed to be tightened. The wall thickness had to be 0.002 inch, +/- 0.0005 inch (0.0508 mm, +/- 0.0127 mm). Both accuracy and shape factors ruled out stamping as a potential production method.

Electroforming A Precision Retainer

The solution for the retainer problem was precision electroforming. Servometer produces the smaller retainer by creating an aluminum mandrel in the desired shape and electrodepositing a thin layer of nickel onto its surface. The company then chemically dissolves the aluminum, leaving the retainer as a thin shell of tough nickel. The electroform process can maintain the required tolerance with parts as small as .030 inch (.76 mm) in diameter.

From concept to finish, Servometer was able to create prototype retainers in about two weeks. These were tested internally to meet the requirements of the customer's ISO and USP Class 6 Certifications. The retainers passed their field trials with flying colors. The electroformed retainer has since become the standard housing for digital cameras less than 0.25 inches (6.35 mm) in diameter.

Benefits

The manufacturing process for the video probes is now somewhat simpler than it used to be. Instead of trying to adjust the direction of the miniature camera before it is fixed in place and then tested, the technicians can reliably focus and then glue the cameras in place. The repeatable manufacturing process results in a more reliable product. Although the cost per component is slightly higher for using electroforms, these benefits more than make up the difference.

There are two other benefits related to the tightened tolerance. Technicians spend less time inspecting, testing and adjusting the cameras in their retainers. The number of rejected retainer components had dropped off significantly as well.

The new electroformed retainers withstand service conditions without a problem. They must pass an impact test and operate within a temperature range of –25ºC to +125ºC (-13° F to +257° F). Also, they prevent damage to the camera from moisture and process chemicals. Since the switch to the new components, there have been no field failures.

Servometer's electroformed components have provided alternatives for other miniature parts. The electroform manufacturing process is especially useful in situations calling for high precision, short runs, and quick turnaround. Electroforming is an attractive alternative where shape factor limitations or excessive die charges would limit the use of stamping. Electroforms can be made in unusual shapes and extremely close tolerances. They combine light weight with ruggedness in thin-wall applications. Manufacturing engineers see this process as an important addition to their range of fabrication alternatives.

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