PROBE FLIES INSIDE JET ENGINE TO PERFORM INSPECTION

Tiny video camera, light, and air jet enter otherwise-inaccessible areas

Lyle H. McCarty, Western Editor

Costa Mesa, CA—What you don't know can hurt you, especially if it happens to be the incipient failure of an aircraft structural member or a critical jet-engine component. That's why engines and airframes are carefully inspected at specified intervals to detect cracks or other evidence of potential trouble.

Inspectors often want to know the condition of parts hidden deep in a jet engine's complex geometry—the turbine blades, or the inner surfaces of the combustion chambers, for example. Of course, it's desirable to do this without removing the engine from the aircraft. You'd especially like to avoid disassembly and rebuilding of the engine, with its associated high costs. To gain a peek at these jet engine innards, both rigid and flexible borescopes have been devised, the latter using fiber optics to transmit the image. All exhibit certain shortcomings, such as limited image resolution, imprecise positioning of the viewing head, or inability to traverse the tortuous path that often must be followed.

Knowing this, engineers have designed and developed a flying borescope that can quickly and easily be guided into the vitals of an engine. It can perform painstakingly detailed inspections in a fraction of the time required when using other devices—if the others can do the job at all.

Geoff Taylor and his colleagues at Identechs say the COBRA RPB-2010 Borescope System consists of a lens, a Charge Coupled Device (CCD), a light source with optical fiber light transmitters, a four-cable multidirectional control, and an air jet that permits the whole thing to fly. Controls and a color video processor with monitor are included.

The miniature CCD TV camera located at the tip of the probe is a mere 3/8 inch in diameter and 3/4 inch long, yet it contains over 30,000 pixels that produce a surprisingly sharp image. Surrounding the camera in an annular pattern

Ability of the probe to fly is demonstrated here; thrust of air jet holds end of probe suspended in position shown.

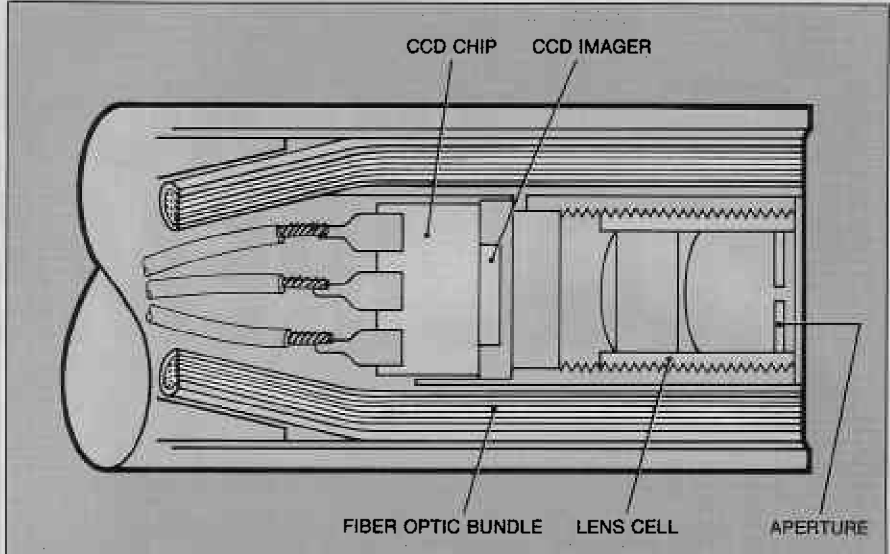
Geoff Taylor pilots flying borescope through inspection of jet engine. Note probe entering compressor section, controls in Taylor's hands, and monitor at right. Air jet's thrust suspends probe.

are the optical fibers that illuminate the field of view.

White light from the light source, a Xenon arc lamp, passes through an IR filter and a focusing lens, and then sequentially through red, green, and blue filters on a color wheel. Filter phasing is synchronized by a stepper motor controlled by the video processor. Images produced by the CCD are stored in the processor, then displayed simultaneously to create color viewing.

Pressurized air from a compressor or other source travels through the probe's 15-ft length, then is reversed and ported through a jet located just to the rear of the camera. The exiting air supplies the thrust needed to make the probe fly. Directional control is provided by a four-cable arrangement that permits the end of the cable to be bent in any desired direction, directing the movement of the probe.

Digital signals generated by the CCD are transmitted to the computer-integrated video analyzer that provides real time viewing. This step allows the operator to pilot the probe throughout the engine, and gain access to the areas to be inspected. Propelled by its air jet, the probe is very responsive to the operator's control input. Its responsiveness makes possible thorough and methodical coverage of all surfaces to be viewed.



View shows lens, CCD chip, optic lighting.

These four individuals designed the flying borescope; left to right, Dr. Irwin Ginsburg, Geoff Taylor, John Carlson, Hamid Saghatchi. (*Design News* photo)

The computer and its software do all the things a computer does with digital input—zoom, enhance and magnify the image, and store and transmit the data. An inspector in the field can set up a telephone link with an engineer at the manufacturer's facility; they can jointly view and discuss problem areas, and collectively resolve any questions.

Primary use of this equipment has been to periodically inspect for cracks in the liners of the nine combustion chambers on Pratt and Whitney JT8D jet engines. Only two of the chambers can be entered directly. Access to the remaining seven chambers is via small-diameter interconnecting ducts linking one chamber to the next. This inspection formerly was a tedious nine-hour task, with operators taking turns peering down the eyepiece of a standard borescope, and attempting to wiggle the unwilling probe into position. With the COBRA, the inspection is completed in less than 2 hours (the unit can literally fly through all nine combustion chambers in 40 seconds!).

Another effective use of the flying borescope was demonstrated during a recent structural inspection of the Space Shuttle Columbia. A 100% inspection with conventional gear meant removal of cryogenic tanks, freon systems, insulating blankets, and many electrical boxes. It required hundreds of hours of work. Instead, NASA inspectors directed the flying borescope probe behind the insulating blankets, around electrical boxes and other equipment, and easily completed the inspection without removing any components. Additional details . . . Contact Identechs, 3183 Redhill Ave., Costa Mesa, CA 92626, 714-540-6364. □

Tip of 1/2-inch-dia probe contains CCD TV camera and fiber optics for lighting.

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