Waveguide Inspection Techniques

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Because of the demonstrated contribution of certain waveguide internal flaws to system noise and high transmitter back power, an improved inspection is being performed on S-band waveguide using a new precision borescope.

I. Introduction

Discussions with JPL Quality Assurance have led to the procurement of a precision borescope for the detailed internal inspection of S-band waveguide. It is expected that improved inspection of waveguide stock will eliminate failures of finished waveguide assemblies which have been traced to certain internal surface flaws.

II. Description of Precision Borescope

The borescope consists of a power-driven carriage, on which the component to be inspected can be positioned, and a control head. The control head includes the controls for linear positioning of the work piece and the illumination of the borescope probe. The probe located at the end of the support column is angularly positioned manually (Figs. 1 and 2). A polaroid photograph of the borescope's field of view can be made with integral photographic equipment. Magnification can be continuously varied from 7½ to 40 times. Figure 3 shows an inspector operating the borescope while inspecting S-band copper waveguide stock. The calibration provided on the support tube and the angular position indicator enable accurate location of internal flaws.

III. Results of Initial Use of Borescope

Approximately 20 meters of S-band copper waveguide stock has been inspected prior to being used for the fabrication of water-cooled S-band high-power waveguide assemblies. The waveguide stock was cleaned by a nonetching chemical process in order to eliminate dirt and allow close inspection of the internal surface. Two categories of mechanical flaws which have caused waveguide arcing in the past were detected. These mechanical flaws are the swaging of loose metal into the internal wall of the waveguide during the extrusion process (Fig. 4) and voids or spaces which break through the internal waveguide surface. In addition, surface ripples and various deposits and chemical discolorizations were detected. These additional defects have not been identified with respect to the failure of waveguide components. The inspection has prevented defective portions of the wave-

guide stock from being included in finished waveguide assemblies.

IV. Future Plans

All waveguide stock which is to be incorporated into high-power S-band waveguide for use in the DSN will be inspected with the borescope. Waveguide stock containing flaws will be eliminated or identified to prevent these flaws being included in finished high-power S-band waveguide assemblies. In addition, a program of evaluation will be carried out to identify all types of internal variations with respect to waveguide component performance.

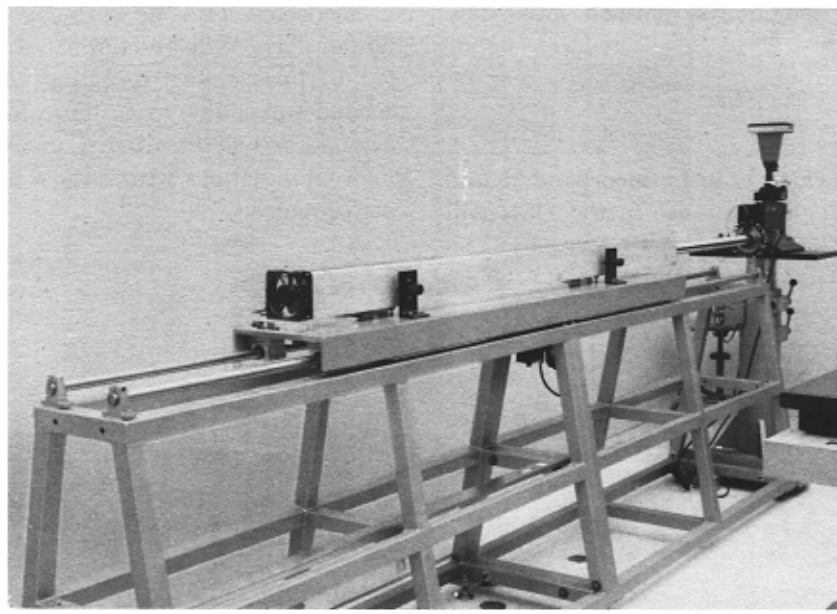

Fig. 1. Precision borescope showing carriage, waveguide to be inspected, and control head

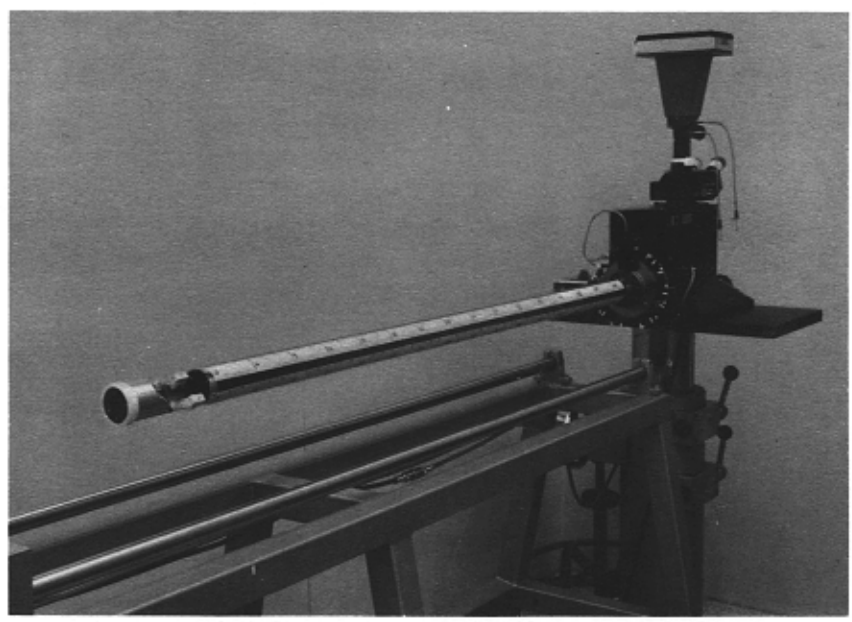

Fig. 2. Control head showing probe (at left), calibrated tube and angular position indicator, and camera

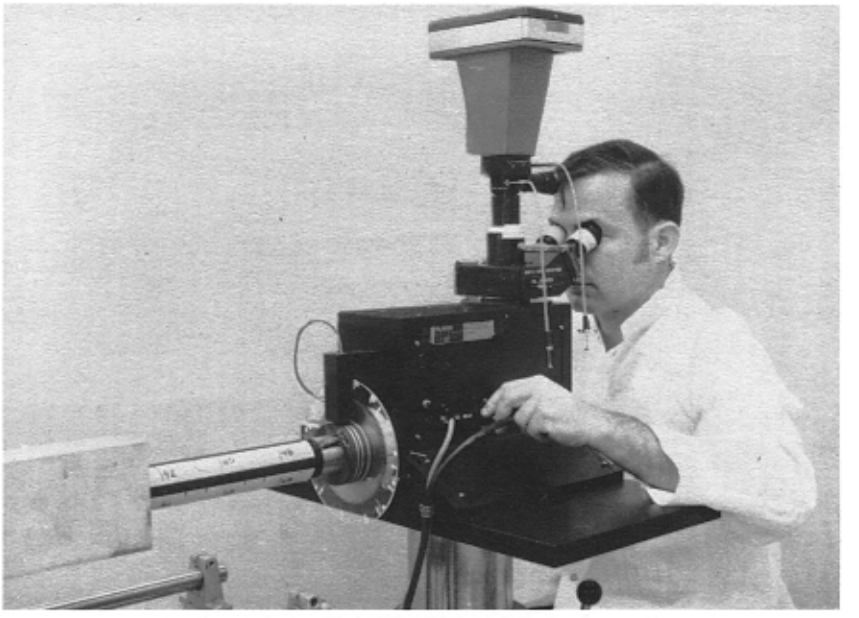

Fig. 3. Operation of precision borescope

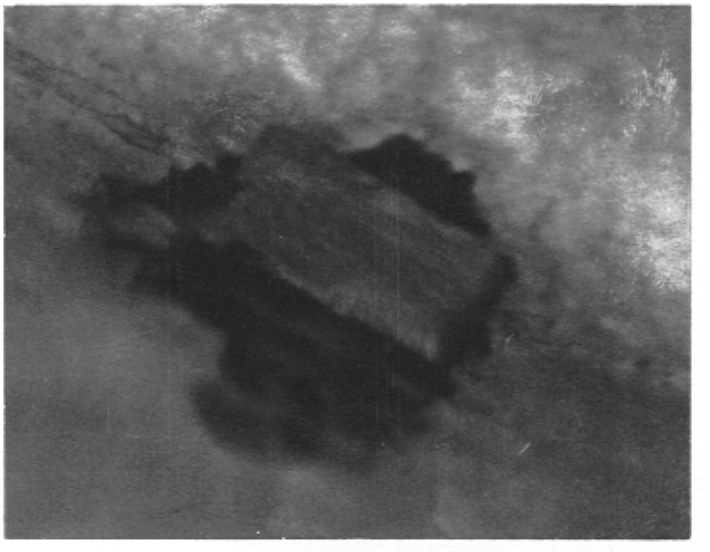

Fig. 4. Mechanical flaw (swaging of loose material into internal surface)