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SUBJECT: Non-Destructive Tests on 2 $\frac{1}{2}$ " Titanium
Pipe And Housing for Centrifugal Pump

TO: R. M. Warner

FROM: J. P. Hammond and T. M. Kegley

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Introduction

Approximately 9 feet of 2½ inch I.D. schedule 40, MST Grade 3, commercially pure titanium pipe were received for evaluation of soundness and surface quality. This particular material had been stocked some time earlier and had been considered off-grade from the standpoint of concentricity requirements and surface quality at the time of purchase. Subsequent to receiving the pipe, a housing for a 5 gpm canned-rotor centrifugal pump, which had been fabricated from this material, was received for examination.

The pipe was tested using immersed ultrasound and radiography, followed by a metallographic examination. The fabricated pump housing was visually inspected and subjected to a radiographic examination.

Results

The pipe was revealed to be of seamless construction and sound structure. However, the bore surface was of low quality. Copious surface defects elongated in the longitudinal direction were found on the bore surface. The more prominent of these no doubt were produced at the time of extrusion, possibly from protrusion or foreign matter on the mandrel.

On the basis of the radiographic test, the bore defects were estimated to be 3 to 18 mils deep and average ¾ inch in length. Immersed ultrasound revealed a number of defects judged to be greater than 9 mils in depth. Cursory metallographic examination revealed these defects to be even shallower.

Except for certain of the welds on the water jacket, radiographic examination revealed the fabricated pump housing to be sound and largely free of surface defects. The only surface defects found were those associated with the narrow stretch of bore in the rear of the housing where machining was not carried out. It is understood, however, that this area would not be greatly stressed. The moderate amount of porosity in the jacket welds would be tolerable as these too would not be stressed to any appreciable extent. The plug in the rear end of the housing proved to be soundly welded.

Metallographic examination of the pipe revealed a perfectly sound microstructure. Except for a slight semblance of the original dendritic structure, not completely removed through hot working, the structure is typical for this material (Fig. 1a). Figure 1b shows one of the bore defects which had been partially closed during rolling.

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Conclusions and Recommendations

On the basis of the tests conducted, the pump housing is of sound material and acceptable constructure. It is understood, however, that the component will be proof-tested by hydrostatic methods.

The 9 feet of remaining $2\frac{1}{2}$ inch schedule 40, MST Grade 3, titanium pipe is of sound internal structure but possesses inferior I.D. surface quality. It is recommended that it not be employed for highly stressed components unless the surface is machined to free defects and the resulting component radiographed for soundness. Other appropriate tests on the completed component, such as hydrostatic testing, would be highly recommended since it is entirely possible that machining could cover up some of the defects.

The depths of the defects reported herein are only approximate. It is suggested that a request be made at the time of any future fabrication, should quantitative values on depth be required.

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Fig. 1. Microstructure of 2 1/2" Sch. 40, MST Gr. 3 Titanium Pipe.
(a) Internal structure showing alpha plus slight residual beta, 500X. (b) Bore defect partially closed during rolling, 250X.

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