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TECHNICAL INFORMATION SERIES

Title Page

AUTHOR N.A. Chapin W.D. Egnor		SUBJECT CLASSIFICATION Welding, Inert Arc		NO. R49GL173 DATE March 2, 1950	
TITLE Welding of Tantalum Tubing					
ABSTRACT Investigations were made in order to determine a method for welding tantalum by using the Inert-Arc Process.					
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GOV. CLASS. None					
CONCLUSIONS Tantalum tubing may be satisfactorily welded by the Inert-Arc process using helium. A flanged joint with a flange height of approximately $1\frac{1}{2}T$ appears to be very suitable to obtain no surface oxidation and complete fusion. The physical properties of a welded sample are approximately those of annealed tantalum.					

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For list of contents—drawings, photos, etc. and for distribution see next page (FN-610-2).

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TESTS MADE BY N. A. Chapin

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COUNTERSIGNED F. E. Crever *F. E. Crever* May 16, 1950

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GENERAL ELECTRIC COMPANY
GENERAL ENGINEERING AND CONSULTING LABORATORY
SCHENECTADY, NEW YORK

WELDING OF TANTALUM TUBING

E&H 130

Prepared by:

N. A. Chapin
N. A. Chapin

March 2, 1950

GENERAL ELECTRIC COMPANY
TECHNICAL INFORMATION SERIES
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INTRODUCTION

EAH-130

Tantalum tubing has for some time been welded by the carbon-arc process under carbon tetrachloride. This method results in rather shallow penetration. The purpose of this investigation was to determine a method for welding this material using the Inert-Arc Process.

CONCLUSIONS

Tantalum tubing may be satisfactorily welded by the Inert-Arc process using helium. A flanged joint with a flange height of approximately $1\frac{1}{2}T$ appears to be very suitable to obtain no surface oxidation and complete fusion. The physical properties of a welded sample are approximately those of annealed tantalum.

PROCEDURE

The material for this investigation was furnished by the Fansteel Metallurgical Corporation. The samples of tubing were flanged as indicated in Drawing K-5146921.

Welding conditions using argon as the shielding gas with DC straight polarity (electrode negative) were first used. Results were quite unsatisfactory with much oxidation and brittleness. Welds made using argon could be broken manually.

It was decided after trials that helium was more suitable as the shielding gas and the remainder of the work was done using helium.

Equipment:

Power Source: WD 3150 DC generator
High frequency starting unit
Electrode Holder - 6WGS20A1
Electrode - .040" tungsten

Fixturing:

The tubing was held in the chuck of a rotating fixture while the electrode was held in a fixed vertical position just off center in the direction of rotation. (See Drawing K 5146736.)

Since tantalum oxidizes readily in air above 300°C, it was found advisable to use a cooling fixture as shown in Photographs 1073 397 and 1073 398. This consisted of split copper cooling blocks around the outside of the tubing located as close as possible to the joint and beveled to provide accessibility for welding. The copper tube inserted within the tantalum tubing was primarily to provide ease of assembly and alignment but also aided in cooling. It is thought that helium gas backing might perform a similar cooling effect.

Welding Conditions:

EAH-130

Tubing with 1/16" flange - Current: 20 amps DCSP (electrode negative)
Welding Speed: 10.5 in./min.

Tubing with flange = 2T - Current: 42 amps DCSP
Welding Speed: 6 in./min.

Tubing with flange = 1½T & T - Current: 32 amps DCSP
Welding Speed: 5.5 in./min.

It is important to note that all welds were made using a transparent nozzle on the electrode holder and a minimum of electrode extension. The minimum electrode extension provided better gas shielding while the transparent nozzle (quartz glass) allowed better visibility.

A "running start" was used, i.e., the rotating fixture was in motion when the arc was initiated by superimposed high frequency.

RESULTS

Surface appearances (both inside and outside) are shown in Photograph 1077 677. With all the joint preparations except the highest flange complete fusion was obtained with a resulting bright, clean undersurface. With the welding conditions used, it appeared that a flange of 1½T was about optimum to obtain a resulting weld with no surface oxidation anywhere on the weld surface. In some cases where the flange was higher, slight surface oxidation was encountered.

One of the welded samples which had been flanged 1½T was subjected to tensile test. The ultimate stress of this was 57,000 psi. This was slightly above the normally quoted tensile strength of annealed tantalum which is 50,000 psi. Photograph 1077 678 shows the tensile specimen after test. Failure was in the heat affected zone immediately adjacent to the weld. There was appreciable necking down of the tube in the areas which had been affected by the heat of welding. The lack of necking at the weld itself was no doubt due to the reinforcement of the weld.

A specimen (flanged 1½T) was also subjected to a hydrostatic test. Photograph 1077 679 shows the hydrostatic test specimen which failed at a pressure of 6650 psi. Note the necking down of the tube indicating that this was not a brittle fracture. Unfortunately in assembling for testing the specimen was bent slightly, thus introducing some stresses other than hydrostatic stresses.

One welded specimen (1½T flange) was leak tested by the mass spectrometer and was found leak-tight.

EAH-130

A photomicrograph of one of the welded specimens ($1\frac{1}{2}$ T flange) is shown in Photograph 1077 680. The weld appears entirely satisfactory. The very slight porosity may have been caused by entrapped helium.

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Laboratory

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GENERAL ELECTRIC

K-5146736

CONT ON SHEET

SH NO.

REV.
NO.

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CONT ON SHEET

SH NO.

TITLE

END VIEW OF TANTALUM TUBE
SHOWING WELDING ELECTRODE

FIRST MADE FOR

REVISIONS

PRINTS TO

MADE BY

ISSUED

APPROVALS

GEN ENGR & CONS LAB DIV

SCHDY

WORKS

K-5146736

CONT ON SHEET

SH NO.

SMALLEST RADIUS
POSSIBLE

EQUAL TO MATERIAL
THICKNESS

SMALLEST RADIUS
POSSIBLE

EQUAL TO 1 1/2 TIMES
MATERIAL THICKNESS

SMALLEST RADIUS
POSSIBLE

EQUAL TO 2 TIMES
MATERIAL THICKNESS

SMALLEST RADIUS
POSSIBLE

1/16"

ALL TUBES ABOVE 1/4" DIA.

THIS DWG. FORMERLY
62998-390

TANTALUM JOINTS

(PROPOSED METHOD OF WELDING)

DRAWN BY *W. L. Schuyler* INSPECTED BY *JAC May 19, 50*

GENERAL ELECTRIC
SCHUYLER WORKS

K-5146921

REVISIONS

PRINTS
TO

G.L.

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1073 397

FIXTURE USED FOR WELDING TANTALUM TUBING. (SHOWN IN SECTION). MATERIAL FOR
FIXTURE-COPPER. G-E SCHENECTADY WORKS LABORATORY.

E990 E326.3

9-29-49

12

1073 398

COMPLETE FIXTURING ASSEMBLY FOR WELDING TANTALUM TUBING. MATERIAL: COPPER G-E
SCHENECTADY WORKS LABORATORY.

E990 E326.3

9-29-49

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1T

1T

1 1/2 T

1 1/2 T

2T

2T

4T

4T

1077 677

VIEW OF WELDED JOINTS SHOWING BOTH INSIDE AND OUTSIDE.

E326.3 M140

1-31-50

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1077 678

SAMPLE OF WELDED TANTALUM TUBING AFTER TENSILE TEST.

E326.3 M140

1-31-50

1077 679

SAMPLE OF WELDED TANTALUM TUBING AFTER HYDROSTATIC TEST.

E326.3 M140

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