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**GENERAL DYNAMICS**

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Report No. 8926-148

Material - Nickel Base Alloy - R-235  
(Haynes Stellite Co.)

Spot and Fusion Weld Fatigue Characteristics

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Abstract:

The fatigue of 10 per cent cold worked and aged (1500°F) Haynes Stellite Co., R-235 nickel base alloy spot weld lap and fusion weld butt joints was determined at room temperature and 1500°F with a 4/9 test ultimate strength maximum fatigue load. Spot welds were tested in thickness combinations of 0.020" to 0.020", 0.020" to 0.040" and 0.040" to 0.063", and fusion weld thickness combinations were 0.016" to 0.016", 0.040" to 0.040" and 0.063" to 0.063". Fatigue life data are given.

Reference: Lindeneau, G. D., Schiff, E., Wise, W. E., "R-235 Nickel Base Alloy, Spot and Fusion Weld Fatigue Tests, Room Temperature and 1500°F," General Dynamics/Convair Report SL 59-083, San Diego, California, 20 July 1959. (Reference attached).

ACCESS NO.

Title: MATERIAL - NICKEL BASE ALLOY - R235 (HAYNES STELLITE CO.). SPOT AND FUSION WELD FATIGUE CHARACTERISTICS.

Authors: Lindeneau, G. D., Schiff, E., Wise, W. E.

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9 pages, 2 tables, 4 figures, 1 reference.



ANALYSIS  
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A DIVISION OF THE GENERAL ELECTRIC CORPORATION  
SAN DIEGO

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INTRODUCTION:

Some tests were reported (Reference 1) on the static strength at room and elevated temperatures of spot and fusion welded lap and butt joints. This test was initiated to obtain preliminary fatigue data on R 235 material under these conditions.

OBJECT:

To determine the fatigue life of R 235 material spotweld lap joints and fusion welded butt joints at room temperature and 1500°F with a 4/9 test ultimate maximum fatigue load.

CONCLUSIONS:

The fatigue lives of spot and fusion welded R 235 material are presented in Tables I and II.

TEST SPECIMENS:

The specimens were manufactured from R 235 nickel base alloy material.

The spotweld thickness combinations were .020 to .020, .020 to .040, and .040 to .063. The fusion weld thicknesses were .016 to .016, .040 to .040, and .063 to .063.

The spotwelded lap joints and fusion welded butt joints are shown in Figures 1 and 2 respectively. The specimen manufacturing control was the same as for the specimens reported in Reference 1 but were not made at the same time.

TEST PROCEDURE:

The specimens were tested at 4/9 static ultimate test load or stress and a minimum to maximum ratio (R) = +.30 at 1800 cycles per minute in a Sonntag SF-1U fatigue machine. The static ultimate load or stress was obtained from Reference 1.

The tests were run at room temperature and 1500°F. The 1500°F temperature was obtained in a Heavy Duty Electric Company clam shell oven Type #MK-2010-S, with Minneapolis Honeywell Brown indicator control. The high temperature set up is shown in Figures 3 and 4.

TEST RESULTS:

The test results are listed in Tables I and II.

It is to be noted that the .020 - .040 spotweld combination had a comparatively low 1500°F strength as compared to the room temperature strength. This might explain the long fatigue life of this combination at 1500°F. It is also to be noted

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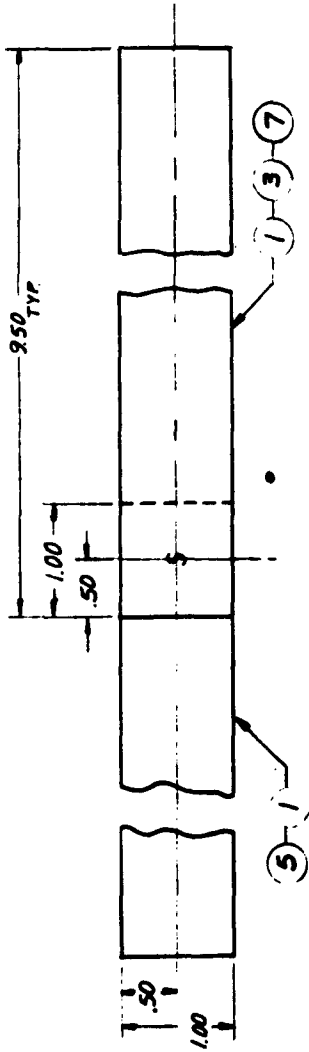
TEST RESULTS: (Continued)

that 4/9 ultimate load on the 1500°F fusion test is near the endurance for the material since all three .016 specimens failed at 229,000 to 423,000 at 41,050 psi and the .063 specimens exceeded 2,082,000 cycles at 39,600 psi. The .040 material again had a low strength at 1500°F.

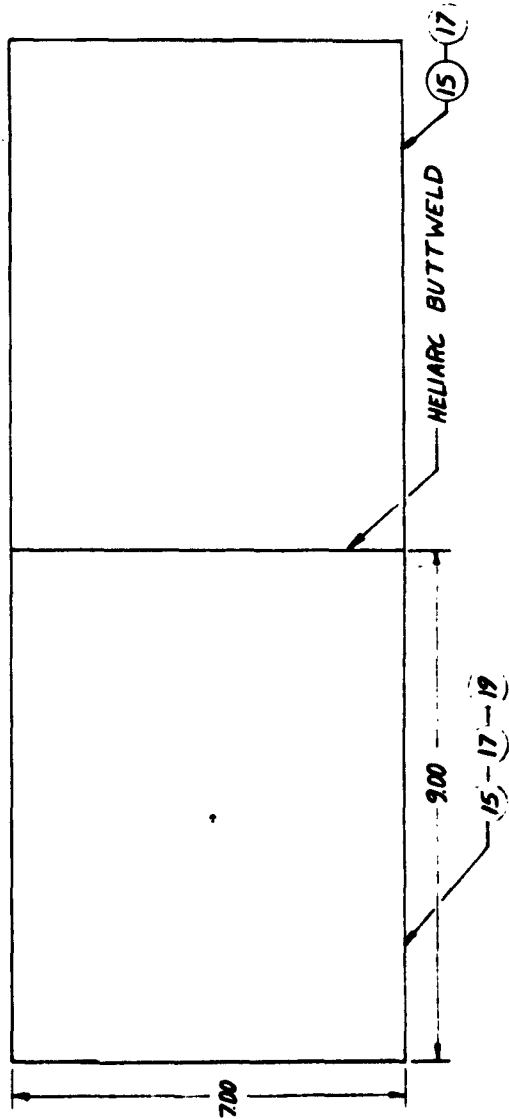
NOTE:

The data from which this report was prepared are recorded in Structures Test Laboratory Data Book No. 343, pages 125-125.

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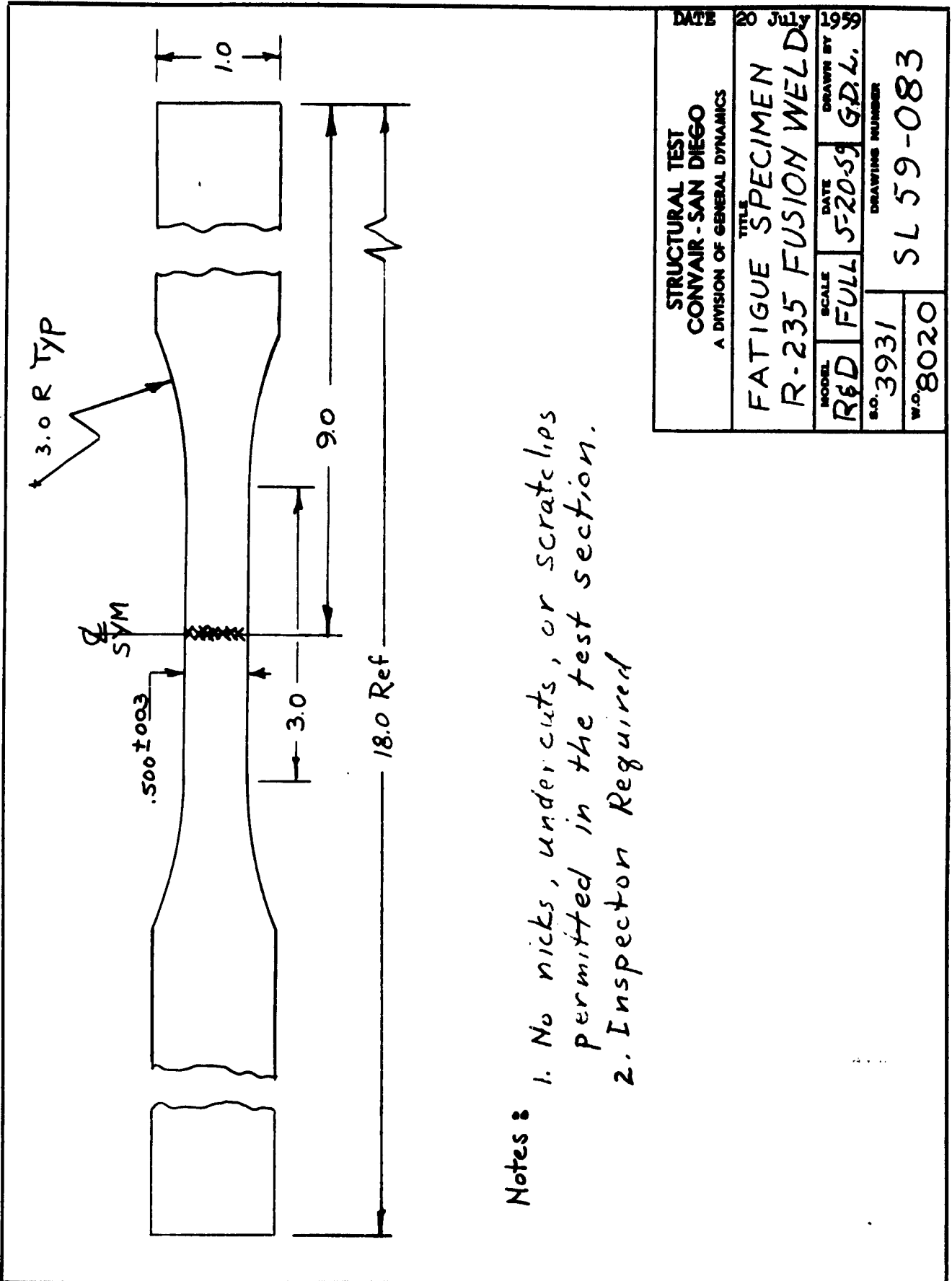
SPOTWELD SPECIMEN  
 FULL SCALE



BUTTWELD SPECIMEN  
 HALF SCALE

25	1	ASSY~2(17)
23	1	ASSY~2(17)
21	1	ASSY~2(15)
19	1	.0631X19 R235
17	2	.0401X19 R235
15	2	.0617X19 R235
13	8	ASSY~1(15)/ASSY
11	6	ASSY~1(15)/ASSY
9	6	ASSY~2(15)/ASSY
7	8	.0631X19.50 R235
5	8	.0401X19.50 R235
3	6	.0401X19.50 R235
1	10	.0201X19.50 R235
USE		SIZE AND DESCRIPTION
		OF MATERIAL
STRUCTURAL TEST		
CONVAR - SAN DIEGO		
A DIVISION OF GENERAL DYNAMICS		
TITLE		
ELEV. TEMP.		
FATIGUE TESTS		
MODEL	SCALE	DATE
GEN	NOTED	11-11-58
S.S.		D. LOVE
		DRAWING NUMBER
		58-399-A

FIGURE 1



- Notes:
1. No nicks, undercuts, or scratches permitted in the test section.
  2. Inspector Required

FIGURE 2

CONVAIR 80-2813



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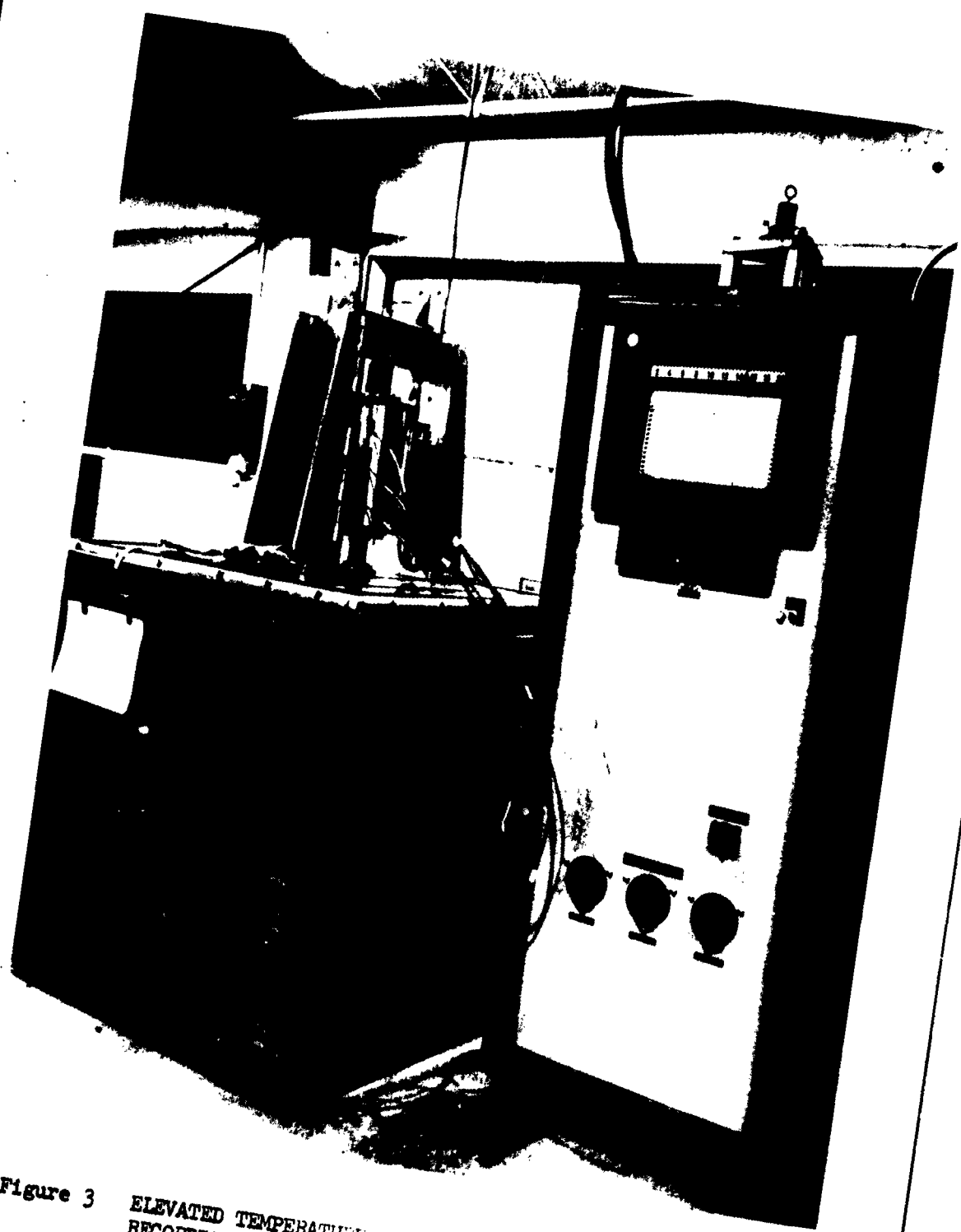


Figure 3 ELEVATED TEMPERATURE TEST SETUP SHOWING THE BROWN CONTROLLER-RECORDER AND SF-1U FATIGUE MACHINE

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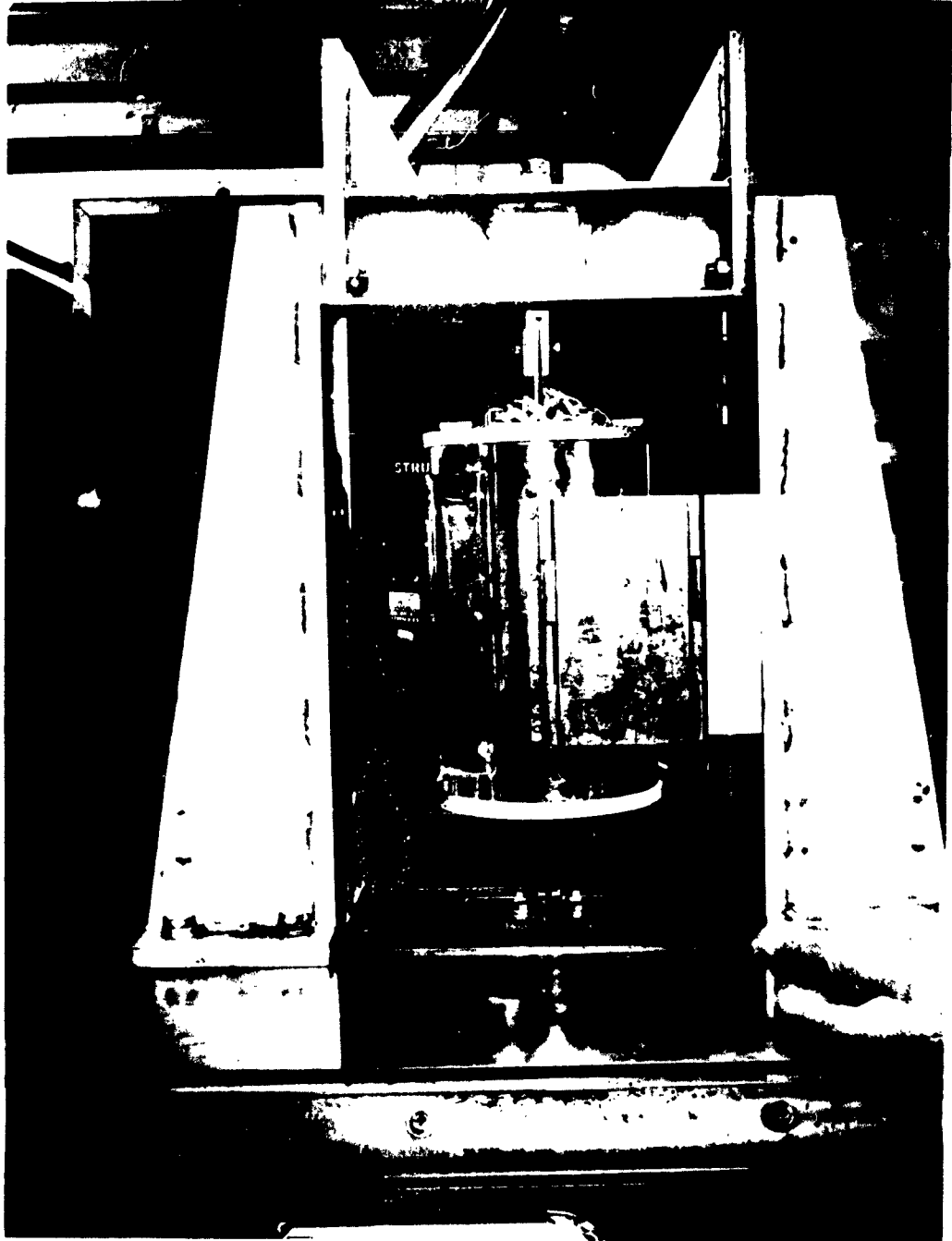


Figure 4 ELEVATED TEMPERATURE TEST SETUP SHOWING THE HEAVY DUTY  
ELECTRIC COMPANY CLAM SHELL OVEN

**TABLE I**  
**SPOTWELDED R235 LAP JOINTS**  
**FATIGUE TEST RESULTS**

SPEC NO.	MATERIAL THICKNESS	TEST TEMP.	STATIC ULT. #/SPOT AVERAGE #	MAX. FAT. LOAD #/SPOT	LOAD RATIO	CYCLES TO FAILURE	REMARKS
1	.020"-.020"	ROOM	672 LBS.	298.6	+30	263,000	FAILED SPOT
2	" "	" "	" "	" "	" "	226,000	NUGGET TORN OUT
3	" "	" "	" "	" "	" "	381,000	" "
1	.020"-.020"	1500°F	424 LBS.	188.4	+30	4,000	NUGGET TORN OUT
2	" "	" "	" "	" "	" "	16,000	" "
3	" "	" "	" "	" "	" "	111,000	" "
1	.020"-.040"	ROOM	857 LBS.	381.0	+30	347,000	NUGGET TORN OUT-.020
2	" "	" "	" "	" "	" "	334,000	" "
3	" "	" "	" "	" "	" "	244,000	" "
1	.020"-.040"	1500°F	395 LBS.	175.6	+30	2,020,000	NO FAILURE-TEST STOPPED
2	" "	" "	" "	" "	" "	2,094,000	" "
3	" "	" "	" "	" "	" "	2,348,000	" "
1	.040"-.063"	ROOM	2552 LBS.	1134.0	+30	36,000	FAILED SPOT
2	" "	" "	" "	" "	" "	27,000	" "
3	" "	" "	" "	" "	" "	43,000	" "
1	.040"-.063"	1500°F	1441 LBS.	640.0	+30	1,000	FAILED .040 SHEET
2	" "	" "	" "	" "	" "	3,000	" "
3	" "	" "	" "	" "	" "	4,000	" "

**TABLE II**  
**FUSION WELDED R235 BUTT JOINTS**  
**FATIGUE TEST RESULTS**

SPEC NO.	MAT'L. THICK.	TEST TEMP.	STATIC ULT. PSI- AVG *	FAT. TEST STRESS-PSI	STRESS RATIO	CYCLES TO FAILURE	REMARKS
13	.016"	ROOM	114,800	51,000	+30	3,100,000	NO FAILURE
14	"	"	"	"	"	175,000	SHEET NEAR WELD
15	.016"	1500°F	93,300	41,050	+30	229,000	SHEET NEAR WELD
16	"	"	"	"	"	423,000	"
17	"	"	"	"	"	326,000	"
1	.040"	ROOM	120,200	53,400	+30	7,175,000	NO FAILURE
2	"	"	"	"	"	2,241,000	"
3	"	"	"	"	"	2,557,000	"
4	.040"	1500°F	47,300	21,020	+30	2,351,000	NO FAILURE
5	"	"	"	"	"	2,229,000	"
6	"	"	"	"	"	2,668,000	"
7	.063"	ROOM	115,000**	51,112	+30	9,491,000	NO FAILURE
8	"	"	"	"	"	2,531,000	"
9	"	"	"	"	"	2,523,000	"
10	.063"	1500°F	89,000**	39,600	+30	2,154,000	NO FAILURE
11	"	"	"	"	"	2,082,000	"
12	"	"	"	"	"	2,927,000	FAILED THRU WELD

\* CONVAIR REPORT MP-58-233  
 \*\* DATA OBTAINED FROM SPECIMENS MADE WITH THE FATIGUE SPECIMENS.

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REFERENCE

1. G. J. Langford, "Element Tests of Alloys for 1500°F Service", Convair San Diego Report No. MP58-233 dated 12 January 1959.