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Crack Propagation Tests on 2024-T3 Unstiffened Aluminium Alloy Panels of Various Length-Width Ratios

by

T. J. Carter

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CRACK PROPAGATION TESTS ON 2024-T3 UNSTIFFENED ALUMINIUM ALLOY PANELS OF VARIOUS LENGTH-WIDTH RATIOS

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T. J. Carter

SUMMARY

Panels of 2024-T3 clad material of one width and of four length-width ratios were tested under constant amplitude fatigue loads in tension. Variations were observed in the rate of crack growth with change of length-width ratio. The variations are greatest at the highest stress level tested. The results for panels of small length-width ratio were influenced by the proximity of the end attachments to the test section. Information obtained from static longitudinal strain measurements was generally in accord with the results of the crack growth tests.

It is recommended that tests performed to assess fatigue crack growth characteristics of materials in unstiffened panels, should be made with a length-width ratio about 2 : 1.

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* Replaces R.A.E. Tech. Report 66366 - A.R.C. 28966.

CONTENTS

ILLUSTRATIONS

ILLUSTRATIONS (Contd)

1 INTRODUCTION

Design data on fatigue crack growth in sheet material have been collected from many independent sources. The data have been obtained from tests on panels of various lengths, widths, thicknesses and length-width ratios. The use of panels of such varied geometry may have introduoed scatter into the data. This paper presents the results of an investigation of the effect of panel length-width ratio at constant panel width and thickness in clad aluminium alloy material to specification 2024-T3. The tests were made on unstiffened panels of 0.080 inch thick material with central notches. Length-width ratios of 1 : 1, 2 : 1, 3 : 1 and 4 : 1 were used, the width being 10 inches in all cases. The tests were made with constant amplitude fluctuating tension. Three alternating stress levels were investigated, the ratio of alternating stress amplitude to mean stress remaining constant. The test results indicate that the length-width ratio of the panel may have a significant effect on the rate of growth of fatigue cracks which are subjected to otherwise nominally identical conditions, and it is suggested that a length-width ratio of 2 : 1 might be standardised for material assessment tests.

A limited investigation of the strain distribution in the vicinity of a crack showed that the magnitude of the strains varied as length-width ratio was changed, in a manner corresponding to that of the observed crack growth rates,

2 SPECIMENS

Specimens of four length-width ratios, 1 : 1, 2 : 1, 3 : 1 and 4 : 1 were tested*. These ratios were chosen to cover the range normally used to obtain crack growth data. All specimens, as shown in Fig.1, were 10 inches wide and 0.080 inch thick, being made from 2024-T3 material with central notches 0.5 inch long. The geometry of the notch is shown in Fig.1 being left as finished by a saw, in order to initiate cracks as quickly as possible. To achieve accurate axiality of load, all bolt holes at the ends ware drilled through a jig.

The ends of the specimens were clomped by $\frac{3}{8}$ inch diameter high tensile steel bolts, between $\frac{3}{8}$ inch thick mild steel plates. The bolts were tightened with a torque of 30 lb/ft.

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*For convenience these are referred to as 1 : 1 panels, 2 : 1 panels, etc. in the subsequent text.

The material was supplied in 8 ft x 4 ft sheets and twelve panels were cut from each sheet, comprising three set s of the four different length-width ratios. In all cases the loading axis was parallel to the direction of rolling.

The nominal chemical composition and static strength properties of the material are given in Table 1.

3 LOADING CONDITIONS

The tests were made in an Avery Schenck Long base 20 ton machine and the stresses applied to the panels were a constant amplitude sinusoidal stress of amplitude S_a superimposed upon a mean stress of magnitude 1.25 Sa. The three values of S_a used were 4000 lb/in^2, 6000 lb/in^2 and 8000 lb/in^2. The repeatability of a given stress level from specimen to specimen was ±2%. Having set the stress level, the machine control system permitted a variation of stress level with time of about ±3%.

Tests were made at each value of S_a on three nominally identical specimens, at each of the four length-width ratios. The twelve panels used at any one value of S_a were taken from one sheet of material so that any sheet-to-sheet variation in material properties would not invalidate the conclusions drawn on length-width ratio effect.

It was found during preliminary tests that panels of ratios 3 : 1 and 4 : 1 vibrated in a direction perpendicular to the plane of the panel. The vibration was prevented by applying slight clamping pressure along the two free edges of the panel with felt pads on lengths of light steel angle section.

4 CRACK MEASUREMENT

A photographic method was employed and a side view of the arrangement is shown in Fig.2. The method relied upon the fact that the surface of the sheet, having a smooth finish, formed a mirror on which the crack appeared as a dark line. Transparent plastic sheets with scales along their edges were placed along each side of the crack so that the length could be recorded.

A counter of cycles was arranged to appear in the photograph. Thus each frame of film recorded the number of cycles and associated crack length. In order to obtain adequate accuracy of resolution it was necessary to use very fine grain microfilm and a very short exposure from an electronic flash unit to minimise the effects of motion. About 15-20 photographs were taken in each test at approximately equal increments of crack length. Typical curves of variation of crack length with cycles of stress are shown in Figs.3, 4 and 5.

5 RESULTS OF CRACK GROWTH TESTS

The data from the tests were analysed by a digital computer using a modification of the method of Rooke, Gunn, Ballett and Bradshaw[1]. For each test the analysis produced a table of crack growth rates associated with particular crack lengths. There was some scatter in the crack growth rates produced in the three nominally identical tests at each stress level and panel ratio. The geometric means of the rates at particular crack lengths were used to plot a curve of mean crack growth rate against crack length. Fig.6 shows curves of this type for four panel ratios at a stress level of 5000 ±4000 lb/in^2. Figs.7 and 8 show the results at stress levels of 7500 ±6000 lb/in^2 and 10000 ±8000 lb/in^2 respectively.

The graphs on Figs.9,10 and 11 show the variation of crack growth rate with change of length-width ratio for various crack lengths. In general the crack growth rate is highest at length-width ratio 1 : 1 falling through ratio 2 : 1 to a minimum between 2 : 1 and 3 : 1 and rising again to 4 : 1. This variation is most marked at the highest stress level (10000 ±8000 lb/in^2 - Fig.11) where, taken as an average for all crack lengths, the minimum value is about 60% of the value at ratio 1 : 1. At stress level 7500 ±6000 lb/in^2 - Fig.10, for crack lengths from 1.2 inches to 4.8 inches inclusive, the variation is less marked, the minimum value being on average about 70% of the value at ratio 1 : 1. At crack length 0.8 inch at this stress level scatter in crack growth rate prevents the assessment of a general trend. At the lowest stress level, 5000 ±4000 lb/in2 - Fig.9, for crack lengths up to and including 3.2 inches, the minimum crack growth rate is on average about 75% of the value at ratio 1 : 1. Above a crack length of 3.2 inches at this stress level any general trend is difficult to find because of scatter in crack growth rates.

6 STRAIN MEASUREMENT TESTS

Measurements were made of static longitudinal strain at the centre of cracked and uncracked panels to see if the trend in the variation of crack growth rate with change of length-width ratio could be associated with a trend in the variation of strain.

Strain gauges were positioned on 1 : 1 and 4 : 1 uncracked panels as shown in Fig.12(a). Measurements were made of the increments of strain caused by an increment of applied stress from 1000 lb/in^2 to 11000 lb/in^2. The results are shown in Fig.13 and it is seen that the distribution of strain at the uncracked test section is less uniform on the short panel, which over the middle 30% of the width, has a strain 7% higher than the mean strain. It could be inferred that conditions would be more severe on the 1 : 1 panel at least in the early stages of crack growth. The proximity of the end fittings to the centre of the panel will affect the relationship between the magnitudes of the longitudinal strains and the transverse strains induced by Poisson's Ratio effects. This may account for the fact that the average longitudinal strain is generally lower at the test section in the 1 : 1 panel than in the 4 : 1 panel under the same axial loads.

To determine the effect of panel ratio on the strain distribution near the tip of a crack a second series of strain measurements was made on a cracked panel, which was progressively shortened from ratio 4 : 1 to ratio 1 : 1. The gauge positions are shown in Fig.12(b), and again measurements were made of increments of strain at these points caused by an increment of applied stress from 1000 lb/in^2 to 11000 lb/in^2. The results are shown in Figs.14, 15 and 16. It is seen in Fig.14 that at the test section, the strain in the 1 : 1 panel is higher than that in any of the others, and the strain in the 4 : 1 panel is higher than that in the 3 : 1. Figs.15 and 16 also show that over most of the panel width the strains at the other measurement sections are highest in a panel of ratio 1 : 1. It may be assumed that the strain measurements in the longitudinal direction alone give a general indication of the local stress conditions in the panel. The crack propagation rates under the test conditions which obtain in this work have been found to be dependent on the third, or somewhat higher, power of stress and therefore the comparatively small variations in strain could account for the observed variations in crack propagation.

7 SUMMARY OF RESULTS

In view of the variations which have been found in crack growth rate with panel ratio, and the supporting evidence from the strain measurements, it is considered that an effect of panel length-width ratio could contribute to variations in measured crack growth rates in panels of varying geometries. There is clearly a need for standardisation of the geometry of test panels used to obtain design data. Panels of length-width ratio as low as 1 : 1 are undesirable because the distribution of strain at the test section is affected by the constraint caused by the end plates. Similarly panels of high length-width ratio are undesirable because panel resonance may complicate testing. It is therefore recommended that a panel length-width ratio of about 2 : 1 should be chosen.

8 CONCLUSIONS

Panels with four different length-width ratios have been tested at three stress levels, in nne material at nne thickness and width.

At the highest stress level tested (10000 ±8000 lb/in^2) crackgrowth rate was fastest in panels of length-width ratio 1 : 1 falling to a minimum for a ratio between 2 : 1 and 3 : 1 and rising a little for ratio 4 : 1. The minimum is about 60% of the value measured at ratio 1 : 1. At the middle and lowest stress levels tested a similar but weaker trend is shown.

The results of the crack growth tests are confirmed by an investigation of static longitudinal strain at the test section of cracked and uncrccked panels.

It is recommended that material assessment tests in crack propagation should be done with a panel length-width ratio of Gout 2 : 1.

Table 1

Nominal chemical composition and static strength properties of 2024-T3 material

Element	Core		Cladding
	min. %	max. %	max. %
Copper	3.8	4.9	0.10
Magnesium	1.2	1.8	
Manganese	0.30	0.9	0.50
Iron		0.50	
Silicon		0.50	0.70
Chmmium		0.10	
Zinc		0.25	0.10
Others, each		0.05	0.05
Others, total		0.15	0.15
Aluminium		Remainder	99.30

Mechanical properties

Tensile strength minimum	62000 lb/in^2
Yield strength (0.2%)	40000 lb/in^2
Elongation in 2 inches	15%

Table 2

Results of fatigue crack growth tests at stress 5000 ±4000 lb/in²

Panel ratio 1 : 1

Specimen 1		Specimen 2		Specimen 3	
Cycles	Crack length	Cycles	Crack length	Cycles	Crack length
24 200	0.55	43 500	0.70	31 200	0.63
58 000	0.74	95 900	1.18	86 000	1.01
119 900	1.19	120 300	1.51	123 900	1.42
151 700	1.55	141 300	1.91	168 300	2.15
177 200	2.01	158 400	2.31	190 200	2.72
204 700	2.80	169 a00	2.66	200 100	3.10
215 500	3.34	178 400	3.02	208 800	3.55
221 100	3.66	189900	3.54	21.5 700	4.13
225 800	4.01	202 900	4.71	218 800	4.51
230 000	4.50	205 500	5.28	220 loo	4.72
232 400	5.04	206 400	5.70	221 000	4.89
234 200	5.48	207 200	6.13	222 000	5.36
235 100	5.88	207 400	6.38	224 000	5.77
235 400	6.08			224 700	6.22
				224 900	6.52

Panel ratio 2 : 1

Specimen 4		Specimen 5		Specimen 6	
Cycles	Crack length	Cycles	Crack length	Cycles	Crack length
29 000	0.52	19 300	0.57	38 100	0.56
59 900	0.73	59 100	0.78	68 800	0.7-1
122 600	1.20	74 500	0.89	146 500	1.08
155 600	1.49	119 800	1.26	193 700	1.47
189 600	2.08	157 200	1.72	224 200	1.82
205 600	2.31	198 900	2.55	250 600	2.31
221 300	2.81	205 600	2.78	262 200	2.66
232 700	3.21	220 900	3.32	273 100	3.06
240 000	3.59	224 300	3.49	285 500	3.86
245 200	3.96	231 100	4.00	291 900	4.70
250 600	4.52	235 100	4.44	292 800	4.95
252 700	4.99	237 300	4.77	294 400	5.56
254 500	5.42	238 600	5.03		5.77
255 400	6.26	239 700	5.38	294 000	6.15
255 500	7.60	240 500	5.67	295 100	5.51
		240 900	5.91		
		241 200	6.26		

Table 2 (contd)

Panel ratio 3 : 1

Specimen 7		Specimen 8		Specimen 9	
Cycles	Crack length	Cycles	Crack length	Cycles	Crack length
25 300	0.56	40 600	0.60	22 000	0.54
47 800	0.68	118 300	0.96	63 900	0.74
116 800	1.07	196 000	1.56	114 400	1.09
177 200	1.70	218 200	1.88	172 100	1.59
196 700	2.05	239 400	2.23	192 700	1.89
213 800	2.43	251 800	2.55	222 000	2.45
231 500	2.84	271 900	2.98	235 100	2.77
245 300	3.33	283 700	3.35	242 800	3.05
251 900	3.67	292 700	3.69	251 900	3.40
255 100	3.88	301 900	4.12	259 700	3.78
259 900	4.32	307 100	4.55	266 800	4.21
263 300	5.20	314 400	5.35	278 100	5.50
266 400	5.52	316 300	5.69	279 800	6.05
267 100	5.94	317 400	6.00	279 900	6.20
267 300	6.10	317 800	6.18		
267 400	6.66	318 100	6.61		

Panel ratio 4 : 1

Specimen 10		Specimen 11		Specimen 12	
Cycles	Crack length	Cycles	Crack length	Cycles	Crack length
26 800	0.55	37 400	0.55	19 700	0.52
27 600	0.55	81 000	0.76	42 400	0.66
70 000	0.76	161 500	1.16	79 500	0.79
134 900	1.07	218 000	1.72	108 400	0.83
176 200	1.44	249 300	2.31	164 500	1.43
216 500	2.03	264 500	2.79	188 900	1.81
238 900	2.54	275 500	3.23	206 800	2.19
249 000	2.86	281 500	3.59	228 900	2.92
256 800	3.19	285 400	3.82	239 000	3.42
262 800	3.51	289 900	4.24	245 900	3.86
267 000	3.79	292 700	4.65	250 800	4.35
273 700	4.33	295 100	5.14	254 400	4.76
277 200	4.71	295 800	5.41	255 900	5.00
279 900	5.15	296 400	5.65	257 500	5.33
281 200	5.57	296 700	5.85	258 800	5.69
281 900	6.12	297 000	6.10	259 500	5.34
282 100	6.45	297 100	6.11	259 800	6.20
				260 100	6.70

Table

Results of fatigue crack growth tests at stress, 7500 ±6000 lb/in^2

Panel ratio 1 : 1

Specimen 13		Specimen 14		Specimen 15	
Cycles	Crack length	Cycles	Crack length	Cycles	Crack length
5610	0.60	10810	0.65	12070	0.67
14980	0.73	25480	0.87	20230	0.90
25500	0.86	34350	1.08	20530	0.90
32880	1.01	39420	1.22	28830	0.98
41530	1.23	42610	1.40	36540	1.20
52770	1.85	45960	1.55	42790	1.44
57610	2.41	46940	1.62	47590	1.75
59450	2.71	49930	1.82	49050	1.83
60760	3.24	53080	2.20	50410	2.03
61550	3.72	5354-Q	2.28	52800	2.37
61900	4.02	52240	2.61	54510	2.76
62200	4.42	56310	2.94	5504-Q	2.97
62420	4.73	57240	3.29	55930	3.34
62580	5.14	57550	3.49	56470	3.54
		57970	3.82	56900	3.94
		58410	4.21	57250	4.30
		58640	4.49	57000	4.64
		58860	4.97	57620	4.86
		58940	5.90	57720	5.20

Panel ratio 2 : 1

Specimen 16		Specimen 17		Specimen 18	
Cycles	Crack length	Cycles	Crack length	Cycles	Crack length
12540	0.65	4690	0.60		
23040	0.73	5250	0.63		
33740	0.89	10260	0.72		
55900	1.19	14130	0.75		
61700	1.36				
63030	1.55				
68490	1.68				
73060	2.04				
75880	2.38				
76870	2.51				
77890	2.73				
78510	2.85				
79130	3.01				
79990	3.29				
80320	3.43				
80770	3.66				
81090	3.87				
81330	4.28				
82130	5.11				
82280	5.65				

Table 3 (Contd)

Panel ratio j : 1

Specimen 19		Specimen 20		Specimen 21	
Cycles	Crack length	Cycles	Crack length	Cycles	Crack length
4960	0.60	'12210	0.68	9240	0.61
8490	0.63	17620	0.74	12170	0.70
12330	0.68	29880	0.93	12510	0.70
16250	0.72	39920	1.18	17070	0.75
33620	1.06	40120	1.15	22040	0.60
46150	-1.36	46430	1.37	26220	0.90
51960	-1.56	46640	1.37	33700	'1.02
57300	-1.79	55940	1.60	42530	1.23
62400	2.22	62090	2.28	47410	1.37
68230	3.06	64410	2.61	61250	2.08
69960	3.52	64900	2.71	64470	2.35
70740	3.76	65850	2.88	67610	2.76
71290	4.03	66990	3.20	68910	3.02
71800	4.52	67420	3.35	70660	3.53
72010	4.62	68010	3.61	71570	3.97
72180	5.37	68580	3.95	71780	4.16
		68930	4.23	72070	4.45
		69200	4.50	72280	4.72
		69460	4.87	72520	5.23
		69610	5.20	72650	6.02
		69770	6.31		

Panel ratio 4 : 1

Specimen 22		Specimen 23		Specimen 24	
Cycles	Crack length	Cycles	Crack length	Cycles	Crack length
9290	0.61	13650	0.67	8290	0.59
19420	0.71	18990	0.78	16410	0.71
37730	1.01	25140	0.88	24630	0.80
48650	1.34	25360	0.89	27500	0.82
55790	1.66	30400	0.95	44280	1.03
58940	1.82	40940	1.17	60890	1.55
61510	1.99	51190	1.65	62730	1.65
65090	2.30	57600	2.30	64390	1.75
66040	2.42	59460	2.52	68910	2.17
66880	2.56	60110	2.80	70830	2.41
69660	3.01	61060	3.13	72780	2.77
70190	3.15	61540	3.34	74160	3.23
70640	3.29	61970	3.56	75160	3.71
71630	3.70	62370	3.83	75480	3.91
72090	3.97	62640	4.11	75660	4.06
72640	4.45	62380	4.44	75800	4.20
72820	4.63	63030	4.61	76060	4.50
73040	4.90	63140	4.94	76260	4.85
73160	5.36	63240	5.39	76420	5.35
				76510	6.43

Table 4

Results of fatique crack growth tests at stress 10000±8000 lb/in^2.

Panel ratio 1 : 1

Specimen 25		Specimen 26		Specimen 27	
Cycles	Crack length	Cycles	Crack length	Cycles	Crack length
2260	0.58	5360	0.57	2520	0.58
2590	0.60	5990	0.59	5470	0.64
5070	0.64	7030	0.63	9890	0.78
8800	0.78	7240	0.64	12100	0.90
9100	0.79	7630	0.65	15770	1.15
12550	0.95	8770	0.70	17070	1.31
18930	2.34	9980	0.72	17980	1.44
19240	2.58	11160	0.78	18410	1.53
19490	2.86	13520	0.90	18680	1.60
19730	3.23	16770	1.13	20500	2.33
19890	3.54	19050	1.42	20850	2.62
20050	4.09	20540	7.78	21000	2.77
		21670	2.27	21140	2.93
		22410	2.83	21270	3.13
		23000	6.05	21540	3.62
				21670	4.14
				21790	5.80

Panel ratio 2 : 1

Specimen 28		Specimen 29		Specimen 30	
Cycles	Crack length	Cycles	Crack length	Cycles	Crack length
4760	0.64	6970	0.67	6510	0.66
5970	0.67	11720	0.80	9120	0.71
7930	0.71	18520	1.14	13830	0.95
12330	0.83	20520	1.32	14140	0.97
18720	1.18	23700	1.74	15700	1.07
20950	1.40	25100	2.07	17790	1.25
23000	1.69	25540	2.23	19830	1.54
24650	2.19	26500	2.68	21560	1.91
25620	2.56	26650	2.80	21970	2.02
25840	2.84	26950	3.06	23050	2.47
26000	2.95	27080	3.19	23900	3.11
26120	3.09	27220	3.38	24080	3.35
26240	3.25	27350	3.59	2424-o	3.63
26370	3.45	27W0	3.81	24380	3.95
26490	3.62	27610	4.11	24490	4.50
26610	3.95	27740	4.72		
26740	4.32				

Table 4 (Contd)

Panel ratio 3 : 1

Specimen 31		Specimen 32		Specimen 33	
Cycles	Crack length	Cycles	Crack length	Cycles	Crack length
6930	0.65	9370	0.68	9150	0.64
10190	0.71	23220	1.10	22440	1.04
25290	1.17	27780	1.51	26180	1.34
29230	1.65	30350	1.94	31000	2.26
29520	1.71	32040	2.55	31660	2.57
29770	1.77	32160	2.56	31810	2.66
30020	1.82	32280	2.60	31940	2.77
30280	1.87	32510	2.77	32060	2.85
30520	1.92	32630	2.90	32180	2.92
30780	2.00	32750	3.00	32310	3.03
32450	2.66	32870	3.15	32440	3.15
32570	2.74	33000	3.37	37560	3.28
32690	2.82	33120	3.52	32680	3.47
32810	2.93	33240	3.88	32810	3.63
33050	3.15	33360	4.09	33110	4.37
33410	3.62	33480	4.54		
33650	4.14				
33780	4.87				

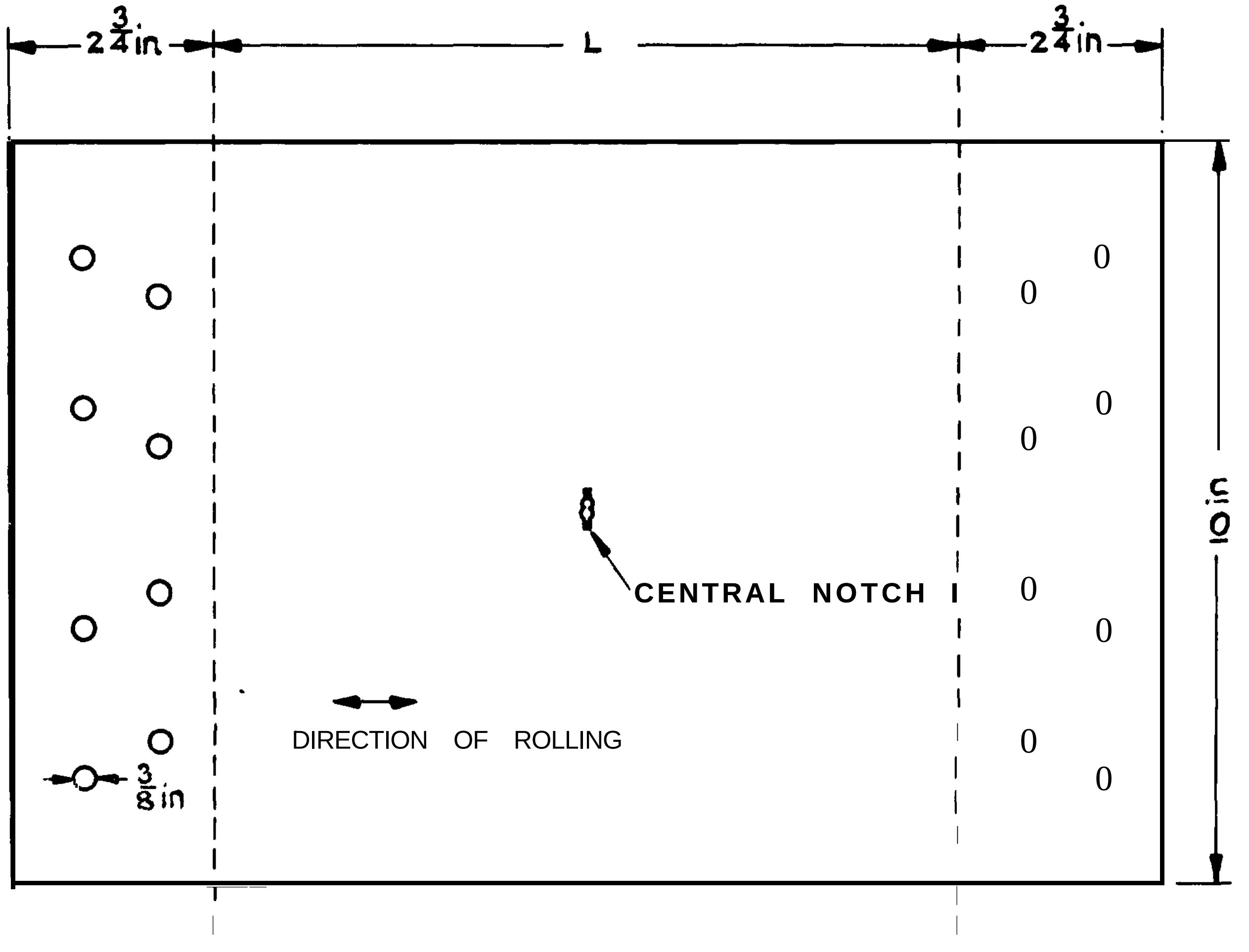
Panel ratio 4 : 1

Specimen 34		Specimen 35		Specimen 36	
Cycles	Crack length	Cycles	Crack length	Cycles	Crack length
8420	0.72	6860	0.61	4140	0.64
14110	0.92	7030	0.63	7040	0.70
19740	1.39	9010	0.68	11030	0.87
23780	2.97	14240	0.89	14790	1.06
23910	3.10	17070	1.04	18260	1.43
24030	3.32	19090	1.20	20560	1.87
24470	3.59	20810	1.41	21700	2.27
24300	3.93	22460	1.64	21990	2.40
24430	4.44	23860	1.98	22410	2.66
		24960	2.36	22800	2.94
		25290	2.57	22990	3.22
		25590	2.79	23120	3.38
		25840	2.98	23270	3.59
		26070	3.34	23500	4.19
		26320	3.32		
		26430	4.20		
		26520	4.38		

REFERENCE

No.	Author	Title, etc.
1	D.P. Rooke N.J.F. Gunn J.T. Ballett F.J. Bradshaw	Crack propagation in fatigue. Some experiments with DTD 5070A aluminium alloy sheet. R.A.E. Technical Report No.64025

SPECIMEN



THICKNESS O-080 in

L = IO in, 20 IN., 30 in AND 40 in

NOTCH

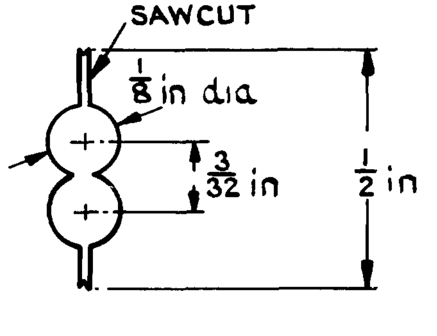


FIG. I SPECIMEN AND NOTCH

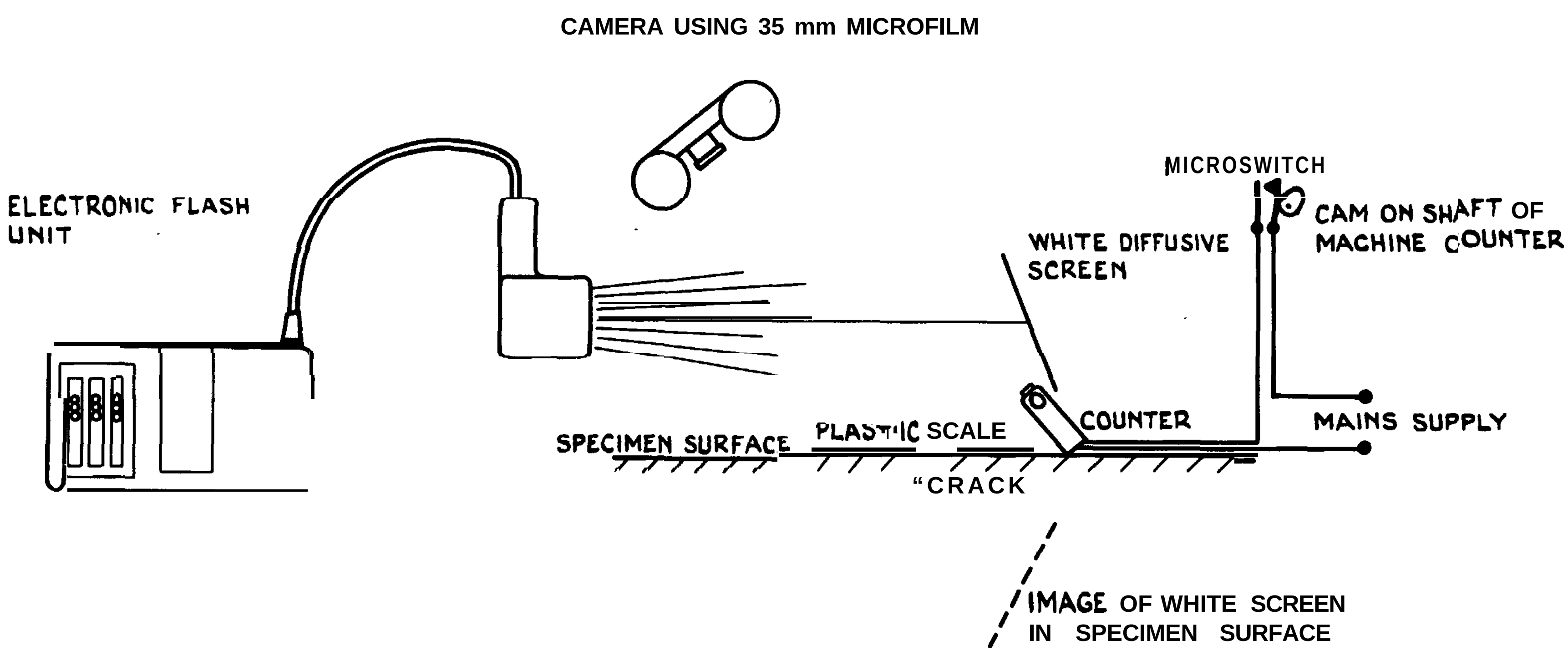


FIG. 2 SIDE VIEW OF APPARATUS AND SPECIMEN

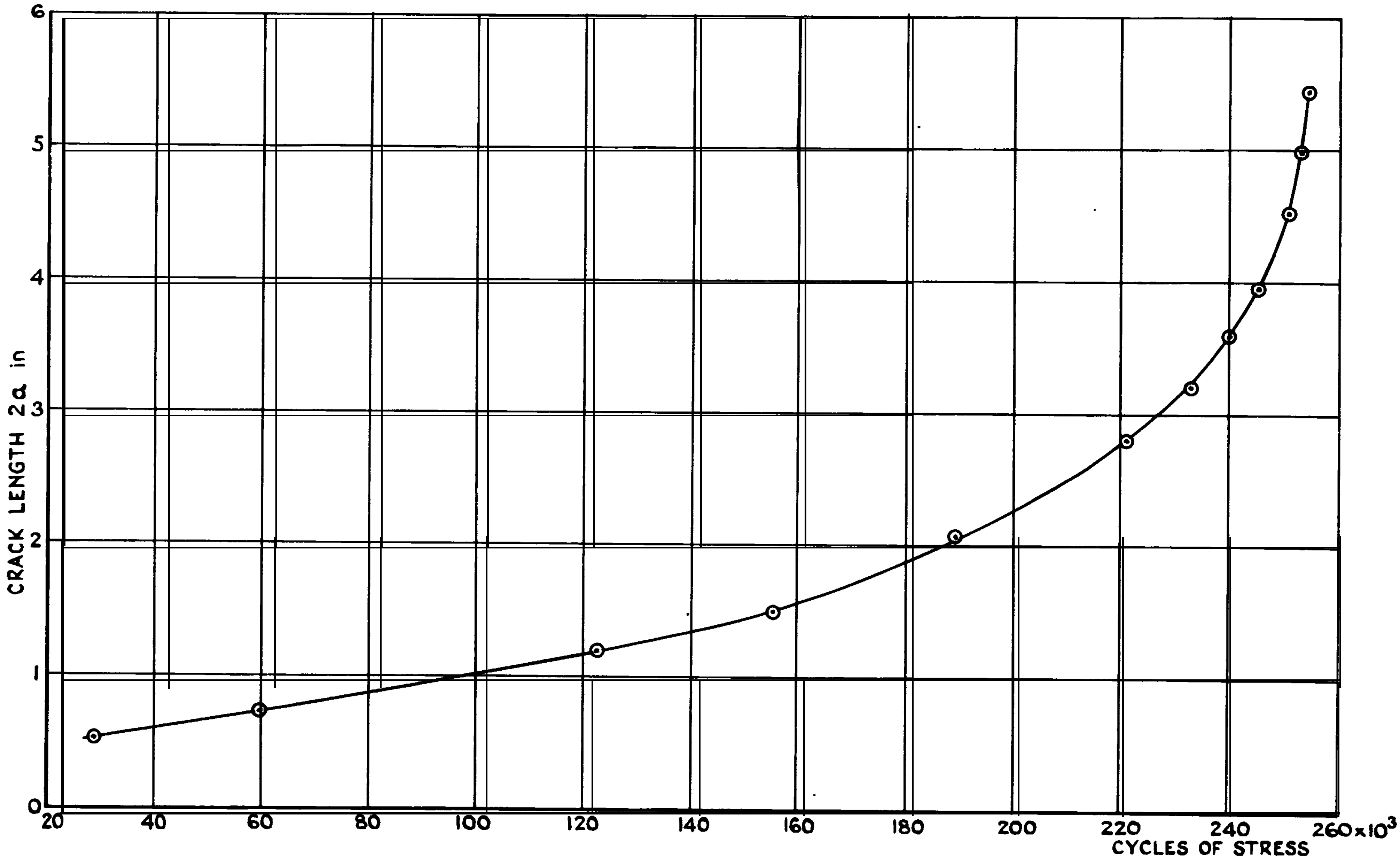


FIG. 3 TYPICAL CURVE OF CRACK LENGTH WITH CYCLES OF STRESS.
STRESS LEVEL 5000 ± 4000 lb/in²

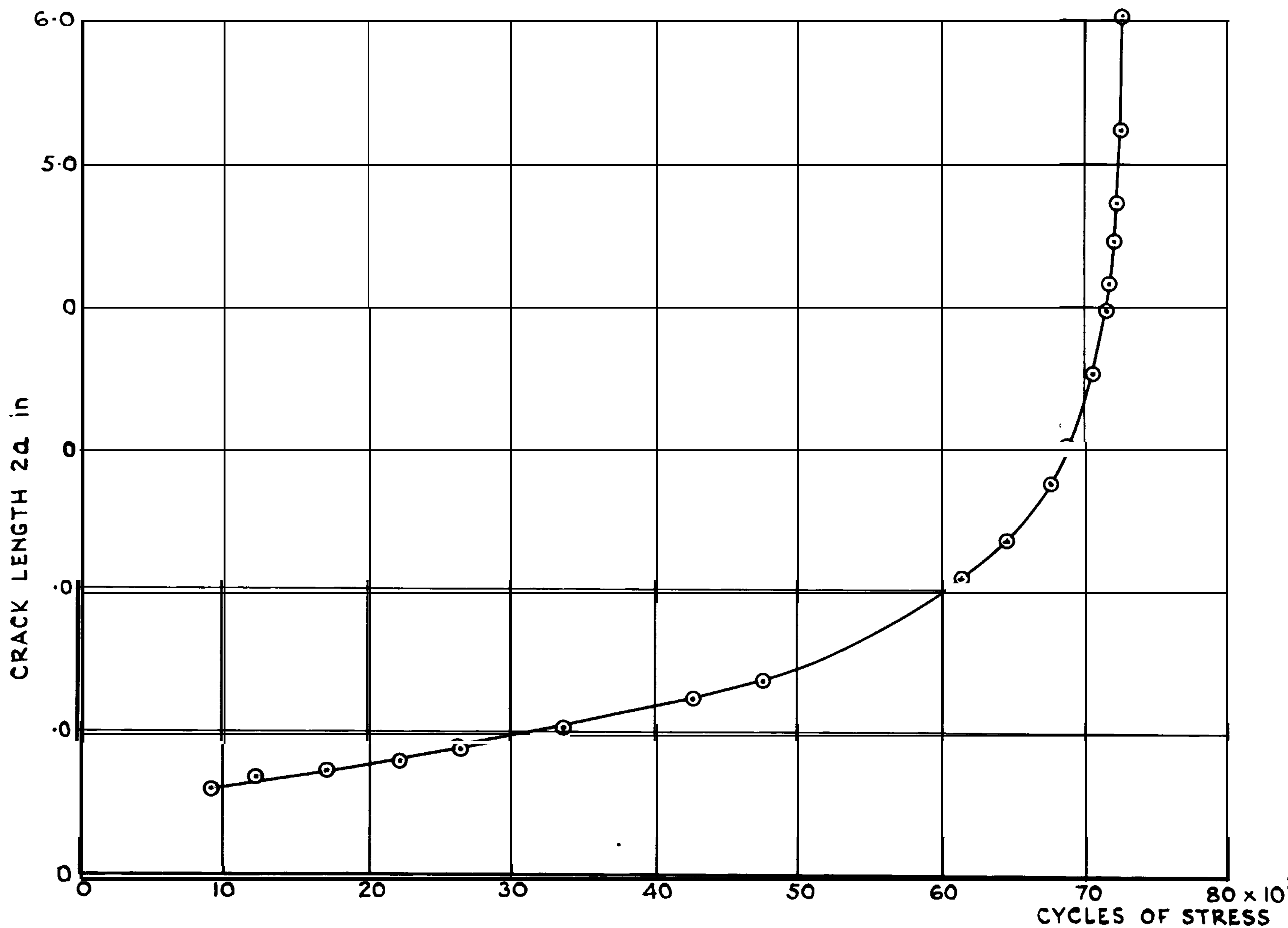


FIG. 4 TYPICAL CURVE OF CRACK LENGTH WITH CYCLES OF STRESS.
STRESS LEVEL 7500 ± 6000 lb/in²

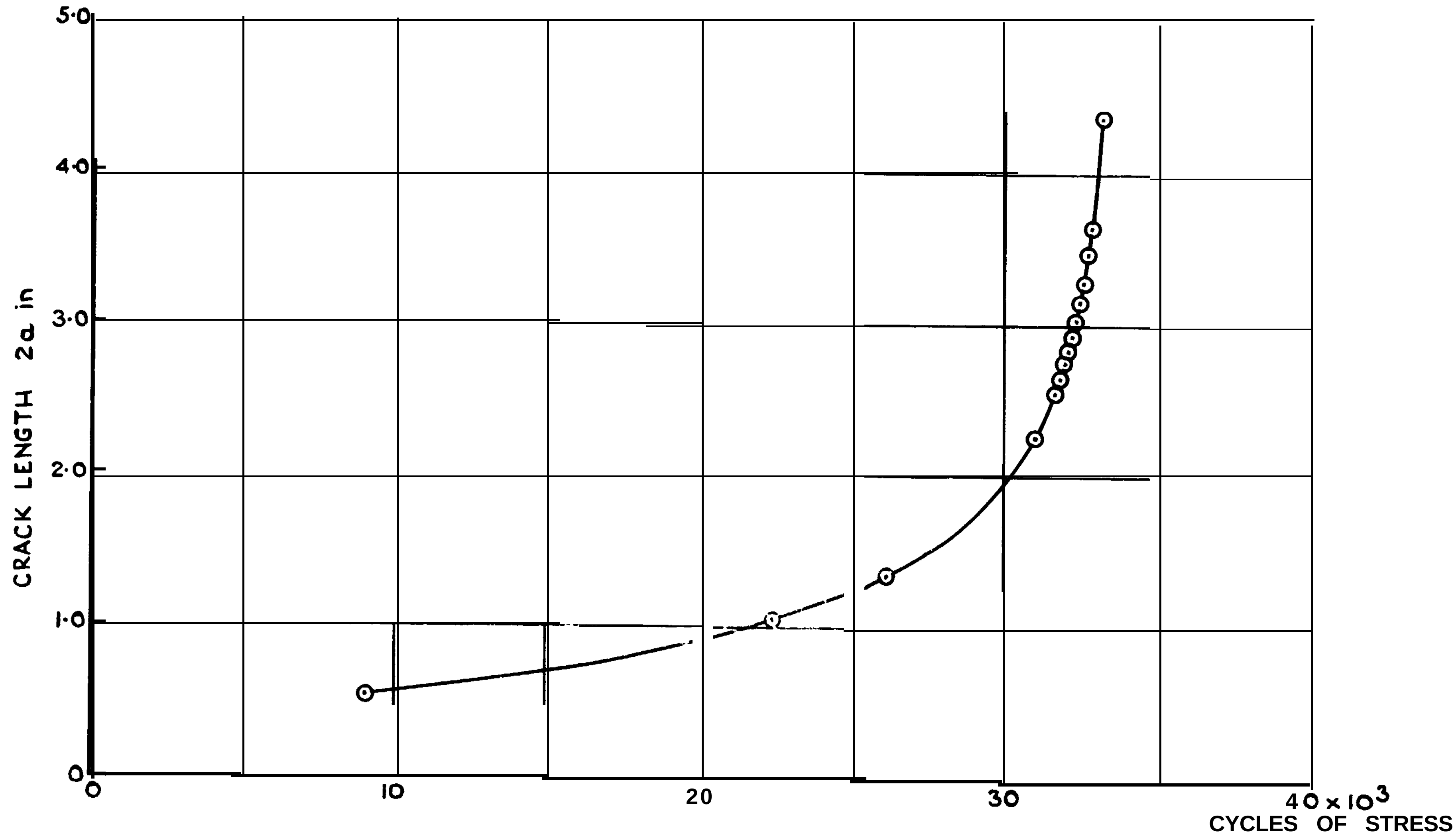


FIG. 5 TYPICAL CURVE OF CRACK LENGTH WITH CYCLES OF STRESS.
STRESS LEVEL 10000 ± 8000 lb/in²

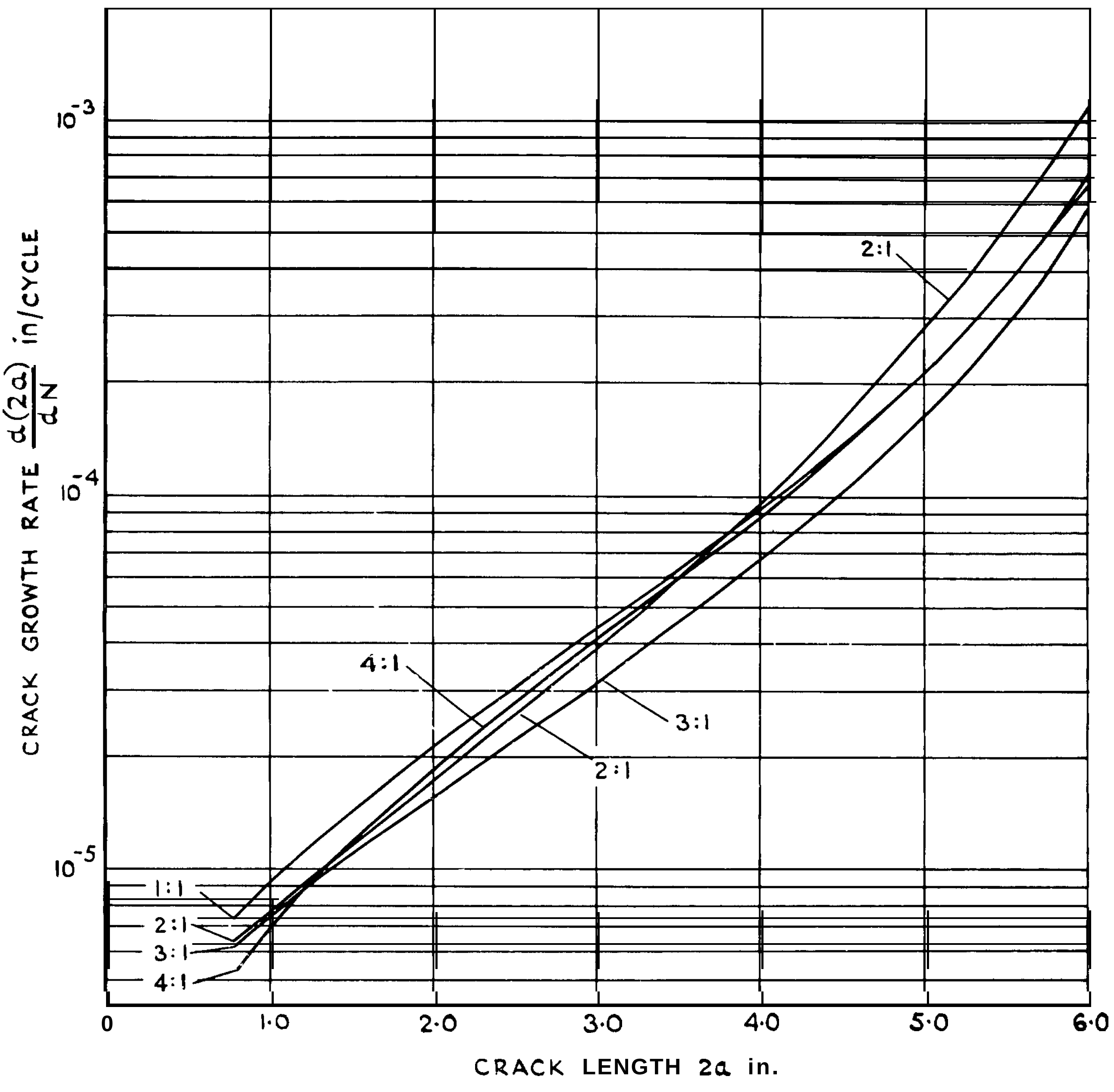


FIG. 6 VARIATION OF FATIGUE CRACK GROWTH RATE WITH CRACK LENGTH IN PANELS OF DIFFERENT LENGTH/WIDTH RATIOS AT A STRESS LEVEL OF 5000 ± 4000 lb/in*

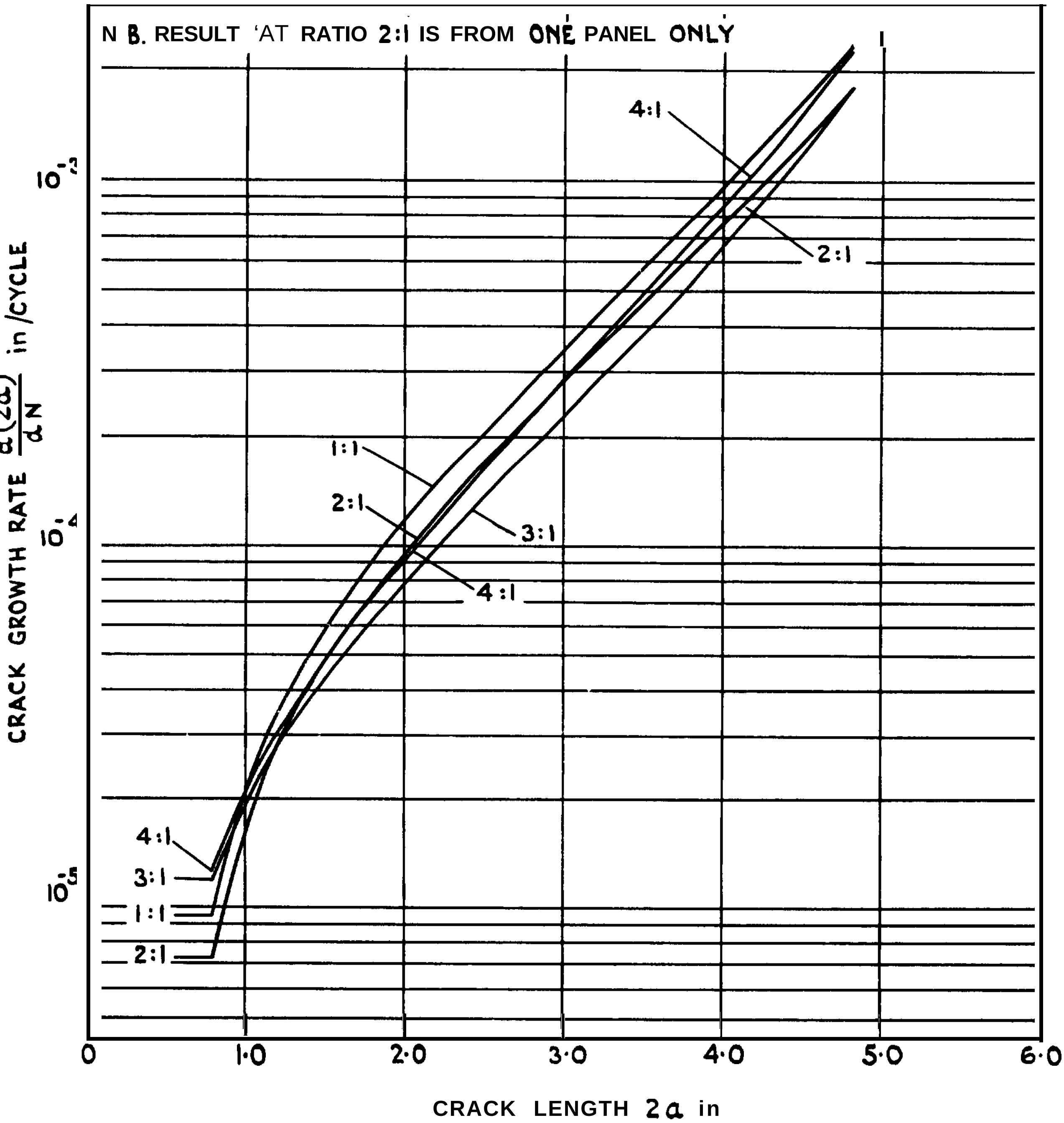


FIG. 7 VARIATION OF FATIGUE CRACK GROWTH RATE WITH CRACK LENGTH IN PANELS OF DIFFERENT LENGTH/WIDTH RATIOS AT A STRESS LEVEL OF 7500 ± 6000 lb/in^2

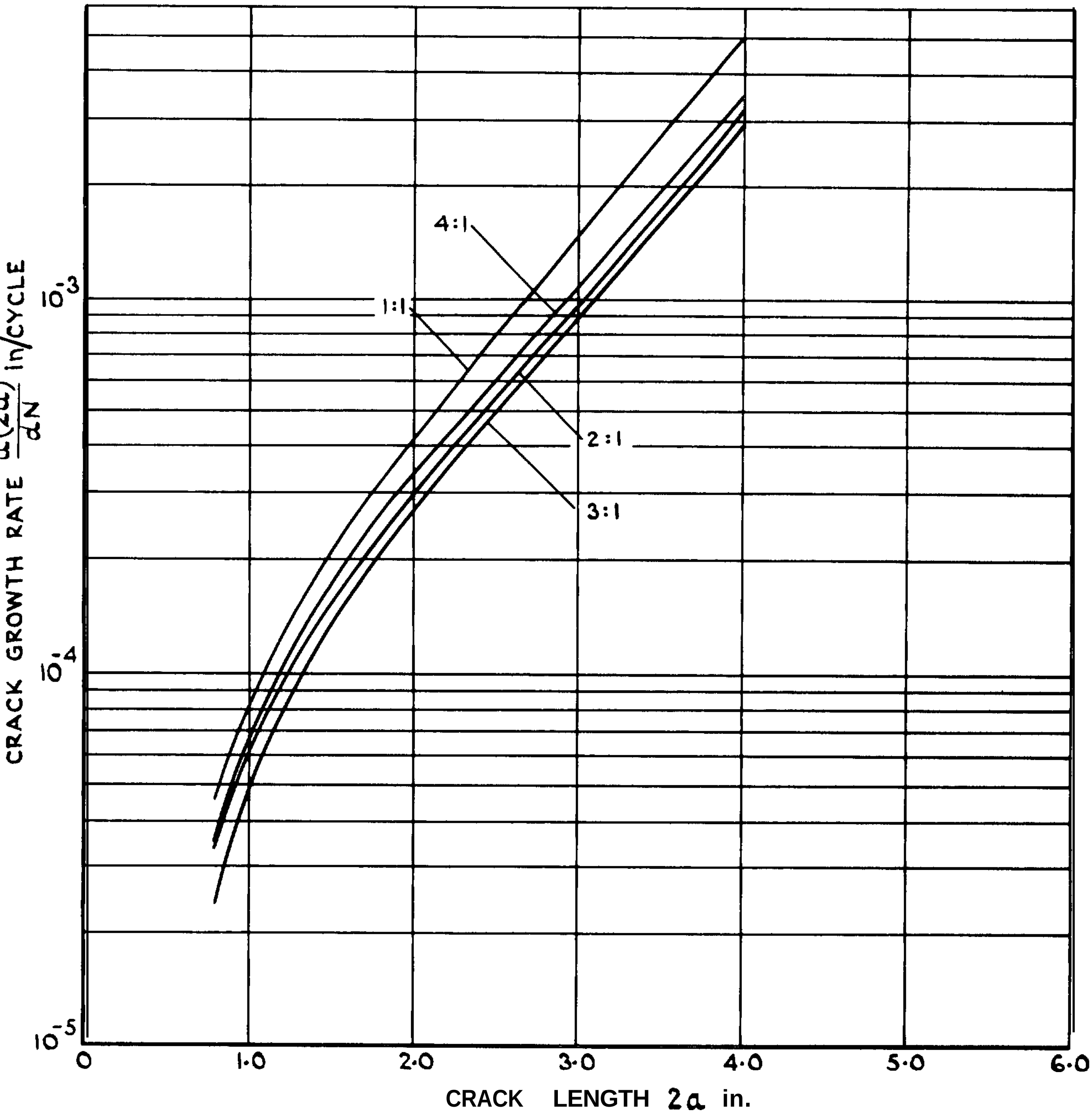


FIG 8 VARIATION OF FATIGUE CRACK GROWTH RATE WITH CRACK LENGTH IN PANELS OF DIFFERENT LENGTH/WIDTH RATIOS AT A STRESS LEVEL OF 10000 ± 8000 lb/in^2

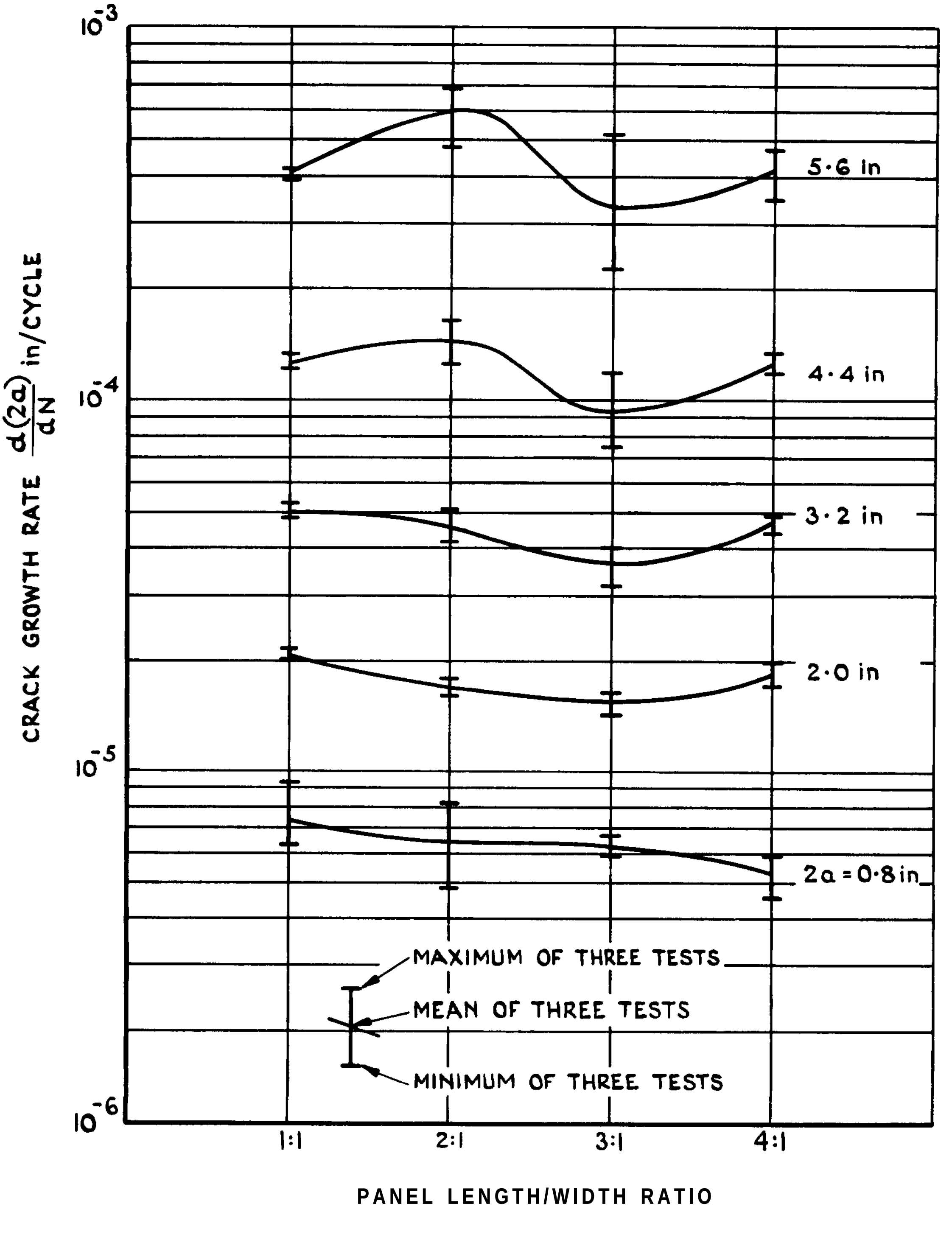


FIG. 9 VARIATION OF CRACK GROWTH RATE WITH PANEL LENGTH/WIDTH RATIO AT PARTICULAR CRACK LENGTHS. STRESS LEVEL 5000 ± 4000 lb/in^2

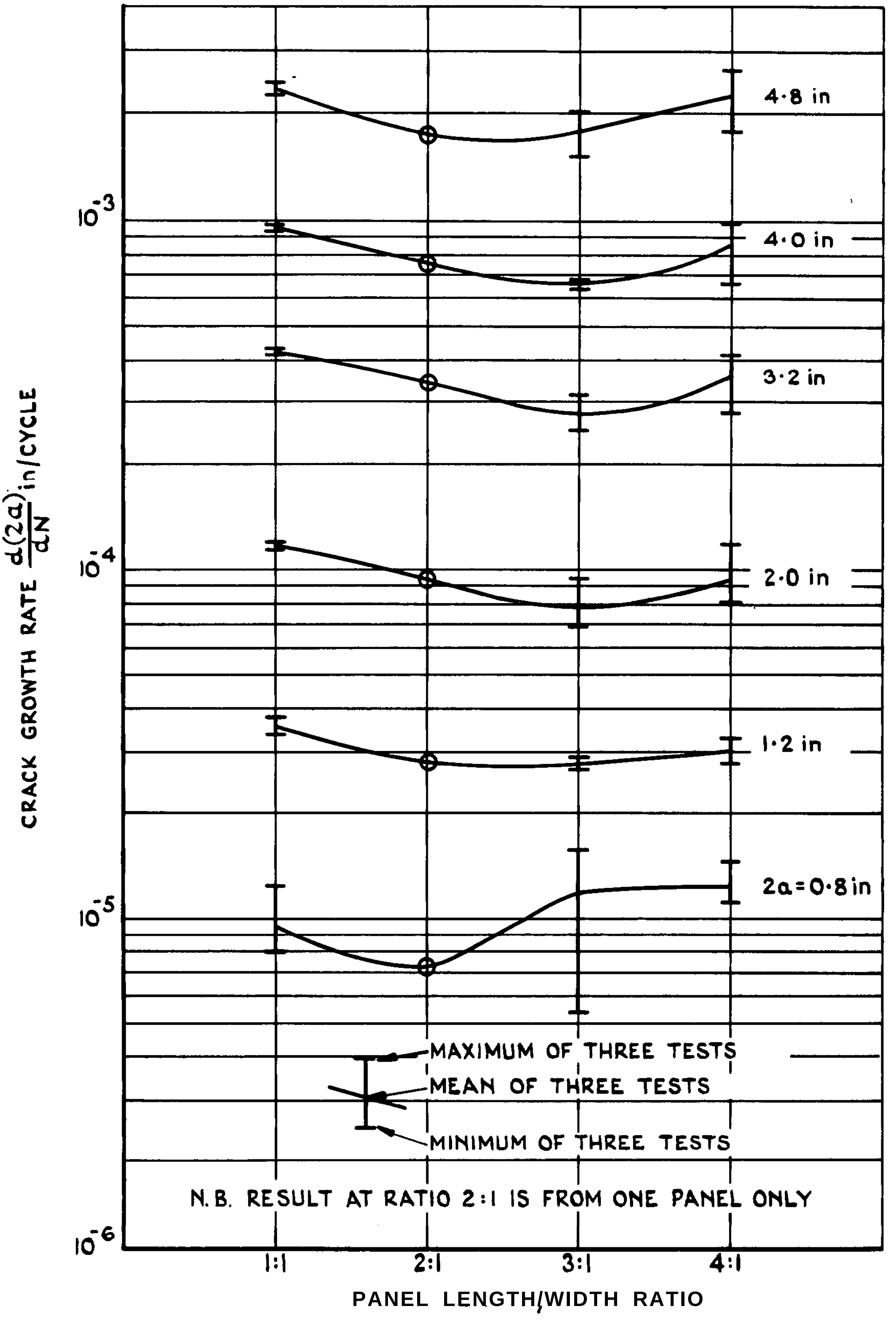


FIG. 10 VARIATION OF
CRACK GROWTH RATE WITH
PANEL LENGTH/WIDTH RATIO AT PARTICULAR
CRACK LENGTHS. STRESS LEVEL 7500 ± 6000 lb/in²

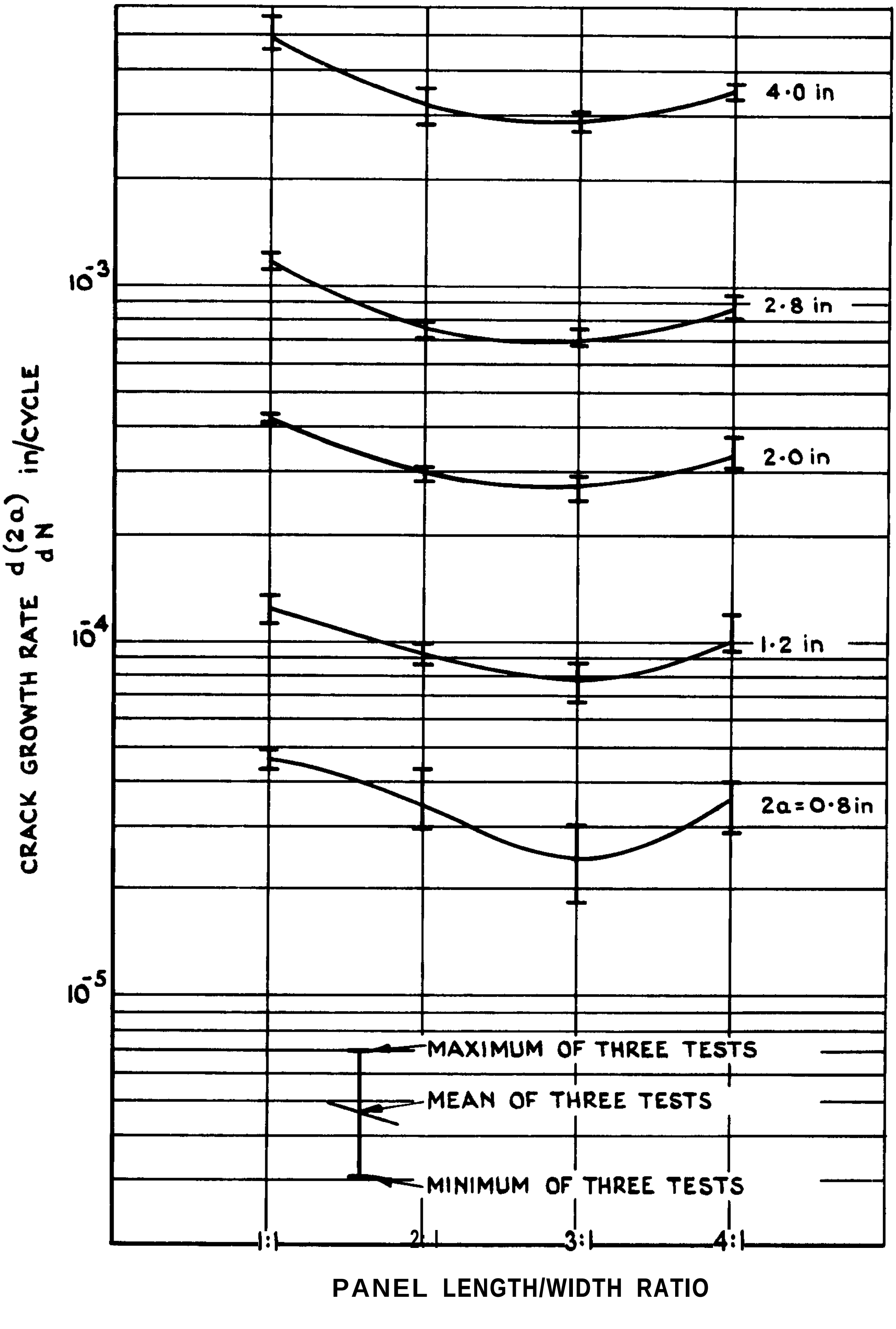


FIG. II VARIATION OF CRACK GROWTH RATE WITH PANEL LENGTH/WIDTH RATIO AT PARTICULAR CRACK LENGTHS. STRESS LEVEL 10000 ± 8000 lb/in*

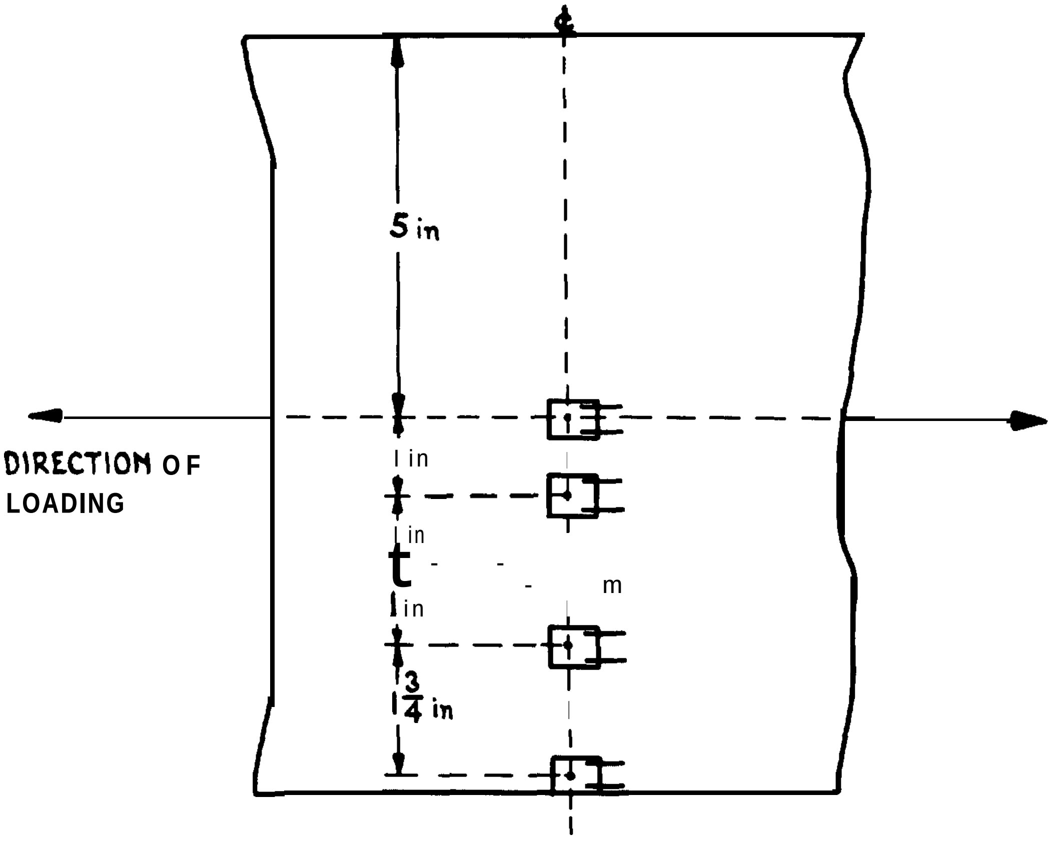


FIG. 12a POSITIONS OF STRAIN GAUGES
ON THE UNCRACKED PANEL

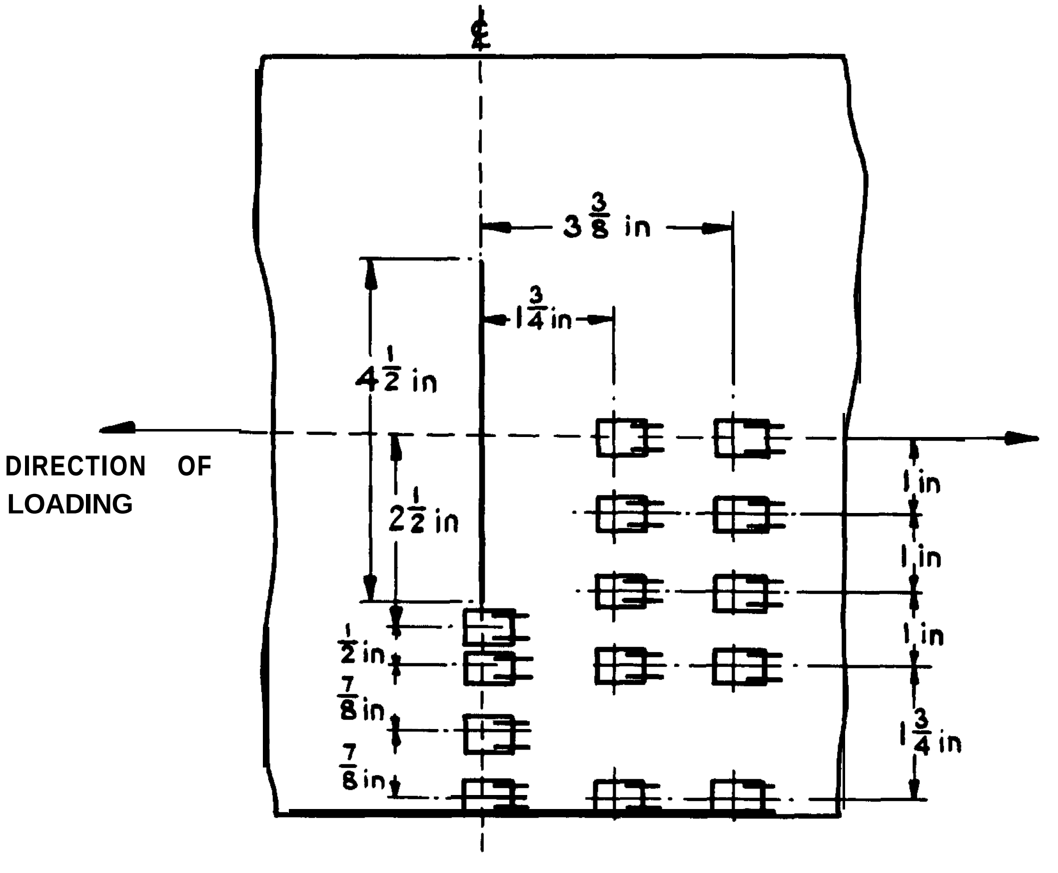


FIG. 12b POSITIONS OF THE STRAIN GAUGES
ON THE CRACKED PANEL

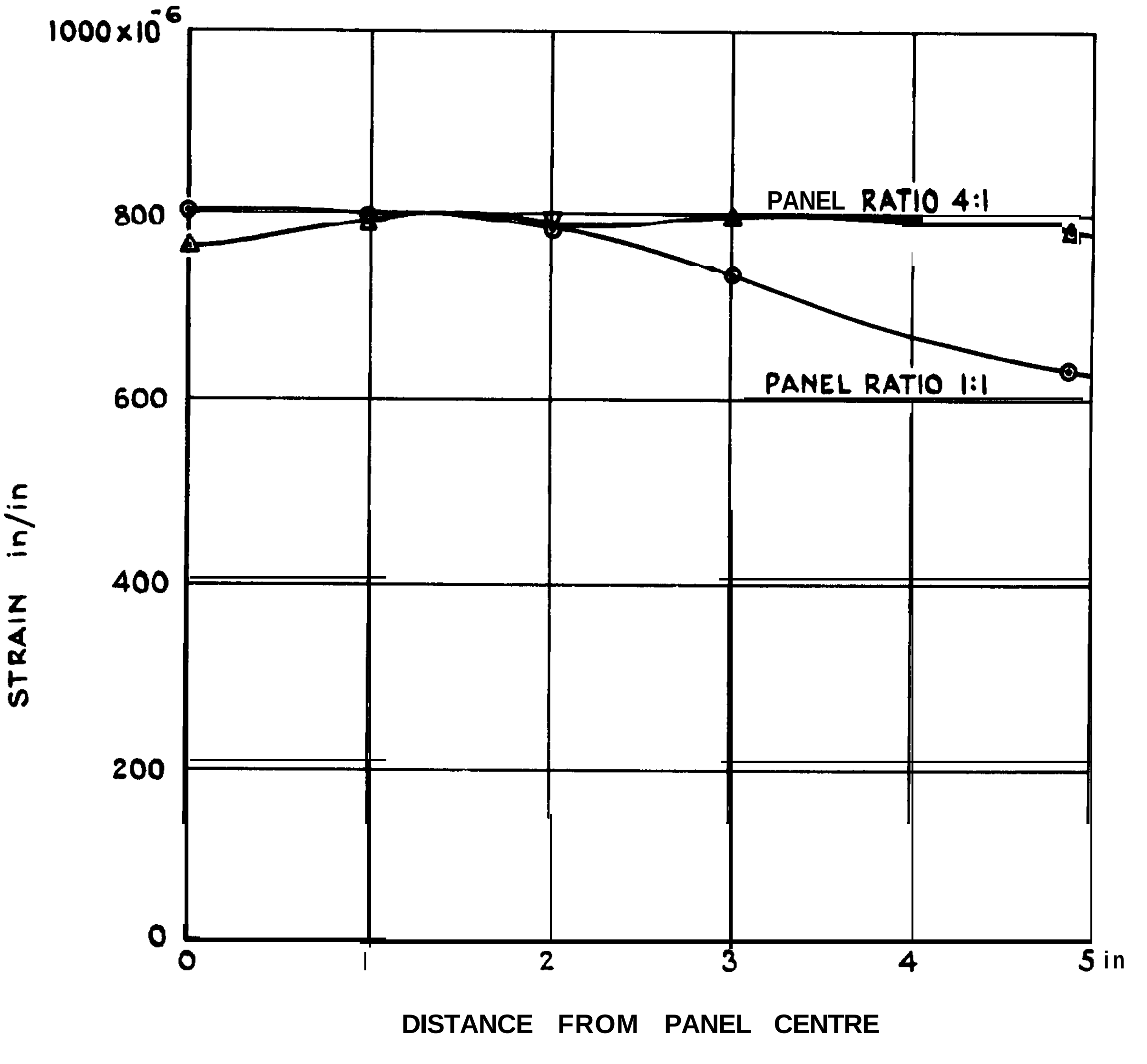


FIG. 13 DISTRIBUTION OF STRAIN ACROSS THE CENTRE OF UNCRACKED PANELS OF RATIOS 1:1 AND 4:1

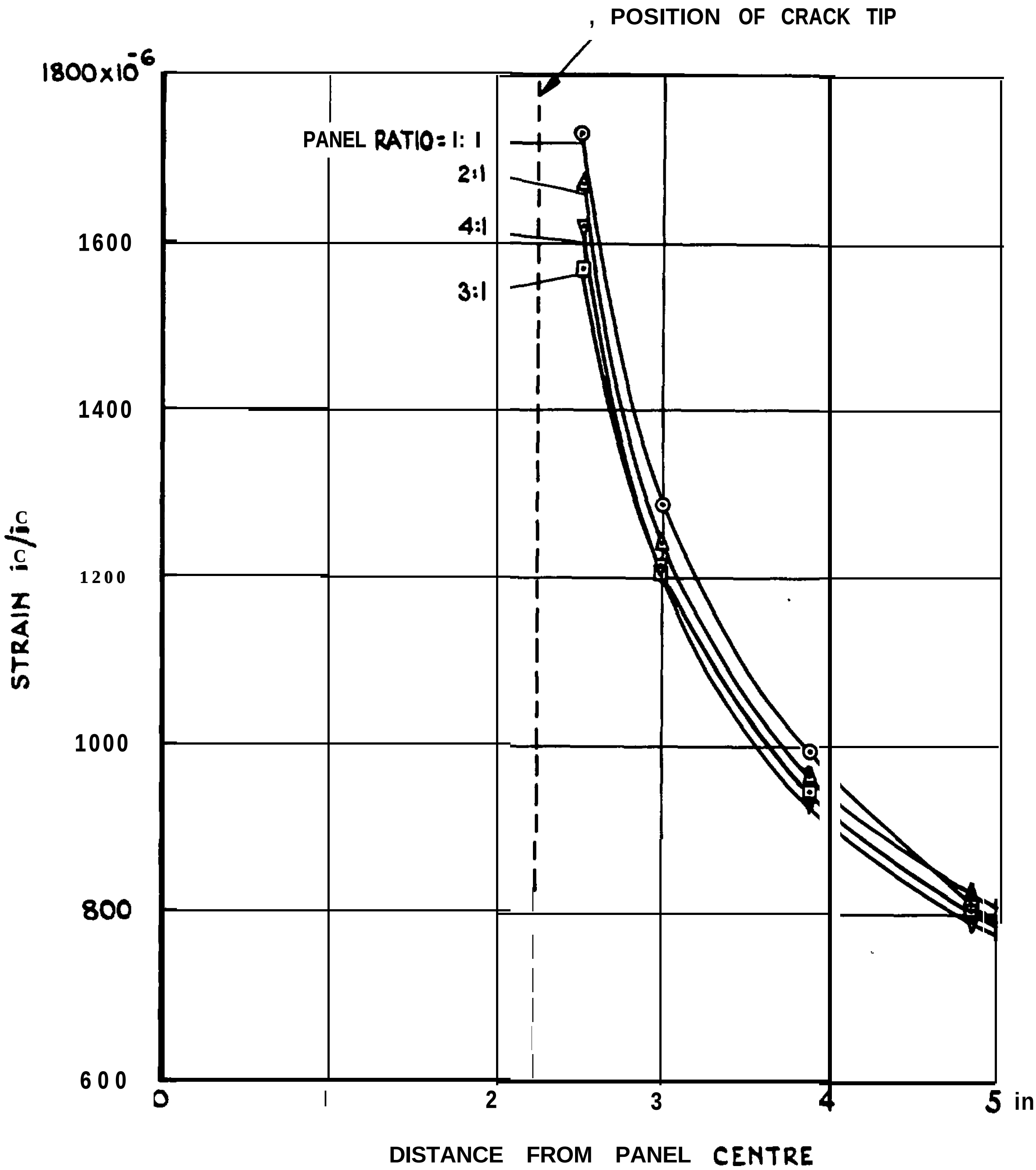


FIG. 14 DISTRIBUTION OF STRAIN ACROSS THE CENTRE OF CRACKED PANELS OF RATIOS 1:1, 2:1, 3:1 AND 4:1

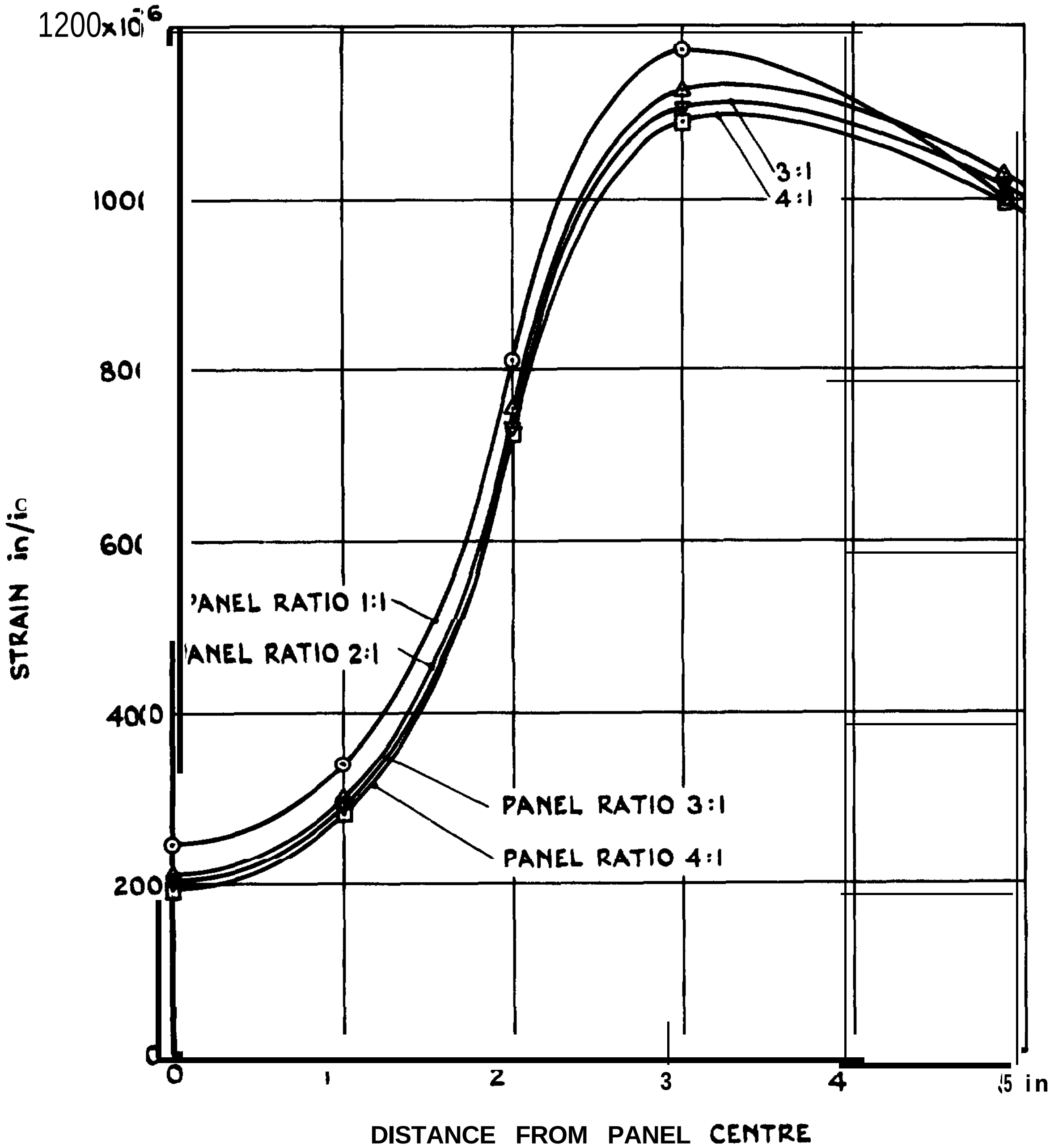


FIG. 15 DISTRIBUTION OF STRAIN ACROSS A PANEL WITH A 4·5 in. CRACK, ON A LINE $1\frac{3}{4}$ in. FROM THE CRACK

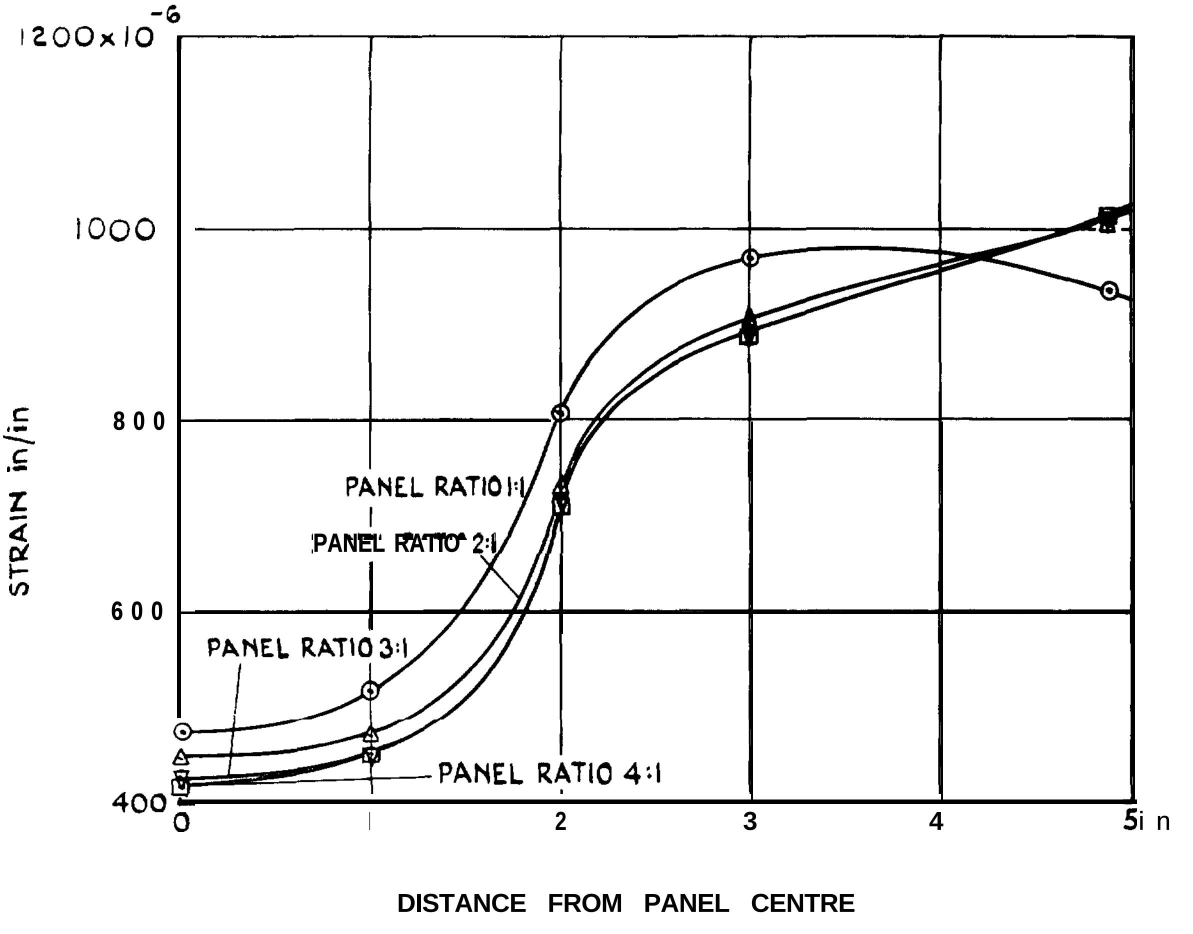


FIG. 16 DISTRIBUTION OF STRAIN ACROSS A PANEL WITH A 4·5 in. CRACK ON A LINE $3\frac{3}{8}$ in. FROM THE CRACK

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A.R.C. C.P. No.952
November 1966

Carter, T.J.

CRACK PROPAGATION TESTS ON 2024-T3 UNSTIFFENED ALUMINIUM ALLOY PANELS OF VARIOUS LENGTH-WIDTH RATIOS

629.13.012.1 :
629.13.012.31 :
539.388.1 :
539.219.2 :
620.178.3 :
669.715-415

Panels of 2024-T3 clad material of one width and of four length-width ratios were tested under constant amplitude fatigue loads in tension. Variations were observed in the rate of crack growth with change of length-width ratio. The variations are greatest at the highest stress level tested. The results for panels of small length-width ratio were influenced by the proximity of the end attachments to the test section. Information obtained from static longitudinal strain measurements was generally in accord with the results of the crack growth tests.

(Over)

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