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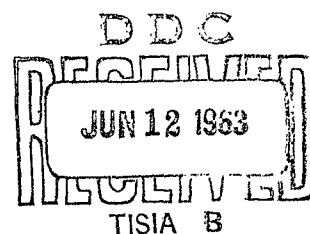
Material - Transparency - Plastic - Plexiglas 55

Static and Fatigue Strength

E. Schiff, J. P. McNelly, W. E. Wise

407 801

30 September 1957



Published and Distributed
under
Contract AF33(657)-8926



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Static and Fatigue Strength

Abstract:

Static tensile and notched tensile, tensile fatigue, crack propagation, edge attachment and shear-out tests were made with biaxially stretched (70% approx.) Plexiglas 55 supplied by the Swedlow Plastics Co., Los Angeles, Calif. The test data resulting from tests at -50, 75 and 195°F are given in tabulations and charts.

Reference: Schiff, E., McNelly, J. P., Wise, W. E.,
"Plexiglass 55 - Physical Properties -
Static and Fatigue Tests," General Dynamics/
Convair Report SL 56-164, San Diego, California,
30 September 1957. (Reference attached).



ANALYSIS

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REPORT NO. 56-164
PLEXIGLAS 55 - PHYSICAL PROPERTIES
STATIC AND FATIGUE TESTS
MODEL F-102A

REFERENCES:

- (a) Federal Specification LP 406 b, "Plastics, Organic: General Specifications, Test Methods", dated 27 September 1951.
- (b) Convair Specification ZM-8-104, "Specification for Canopy and Windshield Materials Development".

OBJECT:

To determine various physical properties of Plexiglas 55, biaxially stretched approximately 70%, for design information purposes and to provide data for the selection of minimum acceptable properties for a procurement specification.

TEST SPECIMENS:

All stretched test specimens were from a single lot of Plexiglas 55 stretched and furnished by Swedlow Plastics Company. After stretching the material, the vendor subjected it to the same heat cycle as a production F-102A canopy panel. Two shrink-back specimens cut from this sheet and shrunk back gave an average stretch percentage of 66.2. As-cast Plexiglas 55 was also furnished by Swedlow Plastics Company.

Specimen configurations were as follows:

Static tensile tests - The 75°F and 194°F specimens were standard tensile coupons in accordance with Reference (a); the -50°F specimens were modified as shown in Figure 1 to cause failure to occur at the center, since they otherwise often failed at the grips.

Static notched tensile tests - These were made as shown in Figures 2 and 3.

Tensile fatigue tests - The specimen shown in Figure 1 was used at 75°F and 194°F; the -50°F specimens were modified as shown in Figure 4, to cause failure at the center.

Crack propagation tests - Standard 2 inch x 6 inch specimens were used, in accordance with Reference (b). See Figure 14.

Edge attachment tests - Convair 8-07142 specimens were made by Swedlow Plastics Company, per Reference (b). See Figure 5.

Shear-out tests - The specimen is shown in Figure 6.

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TEST PROCEDURES:

Static tensile tests - Reference (a) was followed, except that the load rate was changed to .02 inch per minute, to more closely approach the estimated load rate in service. Five specimens were run at each of 3 temperatures: 75°F, 194°F and -50°F.

Static notched tensile tests - The same procedure as for unnotched tensile tests was followed. Ten specimens each of stretched and as-cast Plexiglas 55 were tested at 75°F.

Tensile fatigue tests - A Triplett and Barton fatigue machine was used to load the specimens, at a rate of 15 cycles per minute. Four points were obtained on an S-N curve at 194°F. Five specimens were run at 75°F at 7,000 psi for a minimum of 20,000 cycles, and five were run at -50°F at 10,000 psi for a minimum of 20,000 cycles.

Crack propagation tests - Reference (a) was followed, with load rate adjusted to fail the specimen in 3 to 5 minutes. Five specimens were tested at each of 3 temperatures: 75°F, 194°F and -50°F.

Edge attachment tests - A set of holding fixtures simulating the canopy edge attachment were used. This loaded the specimen eccentrically, similar to the way the actual canopy frame loads the plastic panel. Five specimens were tested at each of 3 temperatures: 75°F, 194°F and -50°F.

Shear-out tests - The specimens were loaded in double shear, using a .186 inch diameter pin. All tests were at 75°F. An attempt was made to cause a shear failure, by varying the edge distance.

RESULTS:

Results of all tests are given in Tables I through V, and failed specimens are shown in Figures 8 through 16. The edge attachment specimens all failed initially by shearing the orlon-acrylic impregnate ledge. The 75°F specimens were reloaded after this failure, until complete tensile failure through the Plexiglas occurred.

The shear-out tests were halted after edge distances as low as 1 d failed to produce a shear failure; all specimens failed in tension. Failing loads were as follows:

<u>Specimen</u>	<u>Edge Distance</u>	<u>Ultimate - Lbs.</u>
257C-1	2 d	1520
257A-1	1.5 d	1225
257A-2	1 d	750

An S-N curve of tensile fatigue data at 194°F is given in Figure 7.

NOTE:

The test data from which this report was prepared are recorded in Structures Test Laboratory Data Book No. 4005, pages 5 through 9.

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TABLE I
STATIC TENSILE TESTS - STRETCHED PLEXIGLAS 55 - (SWEDLOW PLASTICS COMPANY)

SPECIMEN NO.	TEST TEMP. °F.	TEST SPEED IN./MIN.	SPECIMEN		LOAD LBS.	ULTIMATE STRESS P.S.I.	REMARKS
			T. IN.	W. IN.			
257B - 17	76	.02	.357	.751	3180	11900	
257B - 16	75		.357	.750	3200	11950	
459D - 11	75		.359	.745	3130	11720	
459D - 12	75		.361	.745	3135	11650	
459D - 13	75		.356	.745	3195	12060	
459D - 5	194		.352	.745	AV.	11856	
459D - 7	194		.354	.746	1220	4660	
459D - 8	194		.355	.745	1100	4170	
459D - 9	194		.357	.744	1120	4240	
459D - 10	194		.358	.745	1180	4440	
459A - 15	-50		.368	.500	1140	4270	
459A - 17	-50		.356	.500	AV.	4356	
459A - 18	-50		.355	.498	3320	21293	
459A - 19	-50		.355	.500	3300	18581	
459A - 20	-50		.356	.498	3410	19266	
		.02			3430	19313	
					3090	17467	
					AV.	19154	

TABLE II
STATIC NOTCHED TENSILE TESTS - AS-CAST AND STRETCHED PLEXIGLAS 55

MATERIAL	SPECIMEN NO.	TEST TEMP. F.	TEST SPEED IN/MIN.	SPECIMEN		ULTIMATE	
				T. IN.	W. IN.	LOAD LBS.	STRESS P.S.I.
STRETCHED PLEX 55	257A-1	76	.02	.233	.516	600	4990
	2	77		.235	.519	920	7480
	3	77		.237	.517	900	7350
	4	76		.237	.516	960	7850
	5	76		.238	.513	940	7700
	6	75		.238	.523	780	6260
	7	75		.239	.525	1040	8290
	459D-1	75		.228	.509	775	6670
	2	75		.229	.510	1010	8650
	3	76		.230	.508	1075	9200
AS-CAST PLEX 55	ACP55-1	75	.02	.330	.509	Av.	7444
	2	75		.330	.497	1405	2410
	3	75		.331	.506	370	2260
	4	74		.330	.510	330	1970
	5	73		.330	.509	285	1690
	6	73		.333	.504	170	1010
	7	74		.338	.508	230	1370
	8	74		.330	.506	235	1370
	9	73		.331	.508	215	1290
	10	74		.330	.508	205	1220
AS-CAST PLEX 55			.02			200	1190
						Av.	1578

TABLE III

CRACK PROPAGATION TESTS - STRETCHED PLEXIGLAS 55

Specimen No.	Temp. °F	Load Rate lb/min	T in.	X in.	P lbs.	K lb/in.	3/2
257	-1	75	.350	.35	2600	2820	
2			.351	.33	2750	2860	
3			.365	.53	2850	2670	
4			.355	.40	2600	2980	
5			.351	.55	2850	3060	
					AV.	2878	
459C	-6	194	.362	.84	2590	4561	
7			.362	1.00	2370	4951	
8			.363	.83	2650	4617	
9			.368	.62	2840	4013	
10			.371	.64	2780	3981	
					AV.	4425	
459D	-1	-50	.345	.250	1560	1424	
2			.345	.240	1645	1466	
3			.347	.245	1650	1480	
4			.348	.250	1740	1575	
5			.350	.230	1540	1331	
					AV.	1455	

TABLE IV.

EDGE ATTACHMENT STATIC TENSILE TESTS - STRETCHED PLEXIGLAS 55

[illegible]

TABLE V
TENSILE FATIGUE TEST RESULTS - STRETCHED PLEXIGLAS 55

SPECIMEN NO.	TEMP. OF	WIDTH IN.	THICK-NESS IN.	LOAD LBS.	STRESS PSI	FAILURE CYCLES	REMARKS
257 D 30	194	.504	.355	716	3915	182	
29		.501	.354	701	4088	288	AV. 415
28		.500	.354	701	3976	406	
C 25		.494	.356	701	3987	784	
24		.498	.356	621	3499	1796	
26		.501	.357	621	3475	414	AV. 918
29		.496	.356	621	3513	544	
30		.500	.356	619	3438	863	
27		.498	.357	601	3383	2203	AV. 1511
23		.504	.357	611	3402	1469	
28		.501	.357	604	3380	18361	No Failure
21		.499	.357	533	2996	16807	No Failure
19		.502	.357	536	2992	9931	
22		.496	.357	529	2996	624	AV. 4499
17		.498	.359	534	2988	2943	
20		.500	.357	535	3000	55510	No Failure
18		.499	.358	535	2995	16372	No Failure
B 2	75	.500	.356	1246	7001	22017	"
10		.500	.357	1250	7003	24961	"
5		.501	.353	1240	7003	36584	"
8		.501	.357	1250	6992	22835	"
7		.505	.354	1250	6992	22301	"
13	-50	.350	.358	1254	9997	21001	"
14		.348	.358	1250	10036	21115	"
11		.350	.357	1250	10000	24312	"
15		.349	.357	1246	9994	23734	"
9		.351	.357	1252	10005	20494	"

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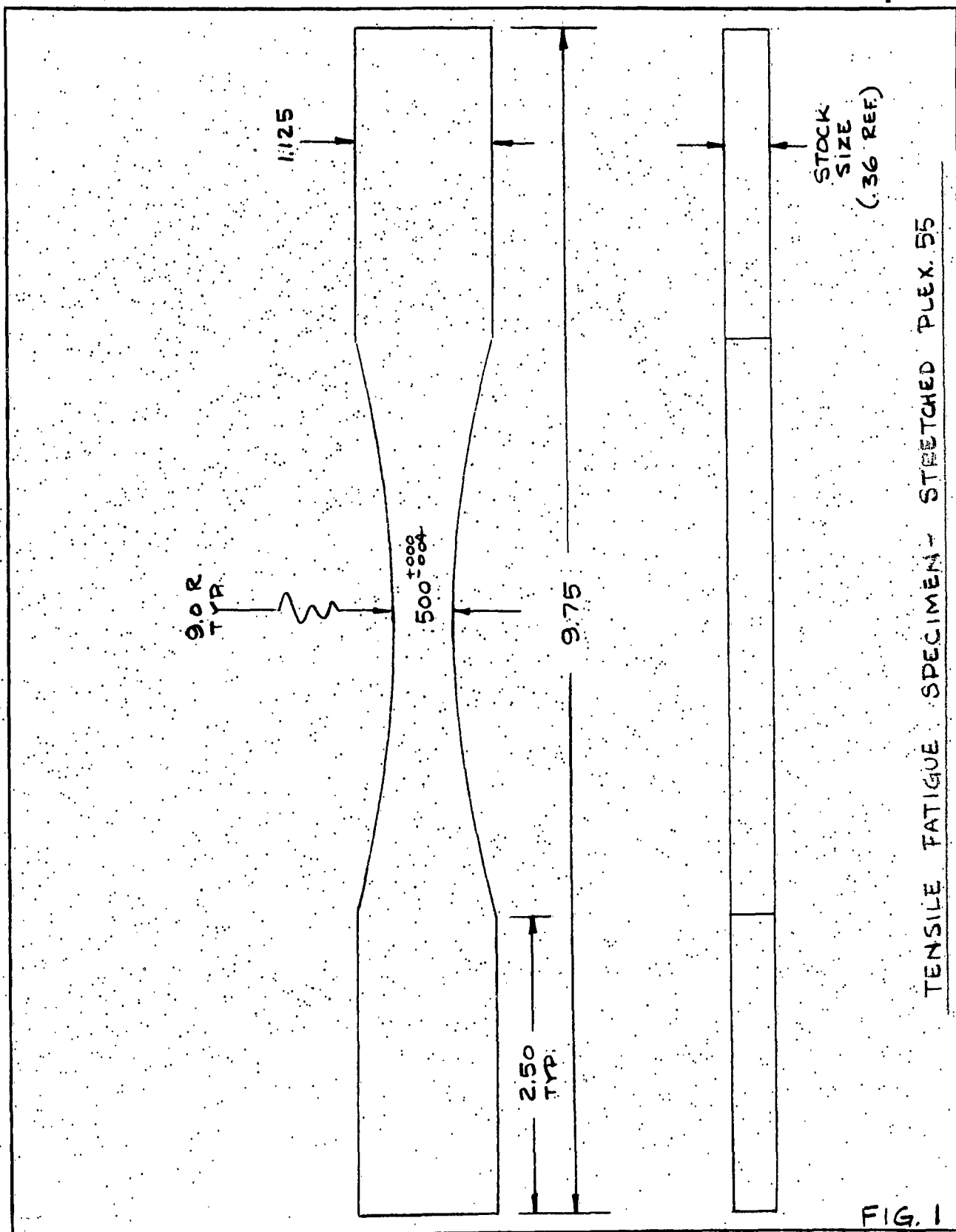
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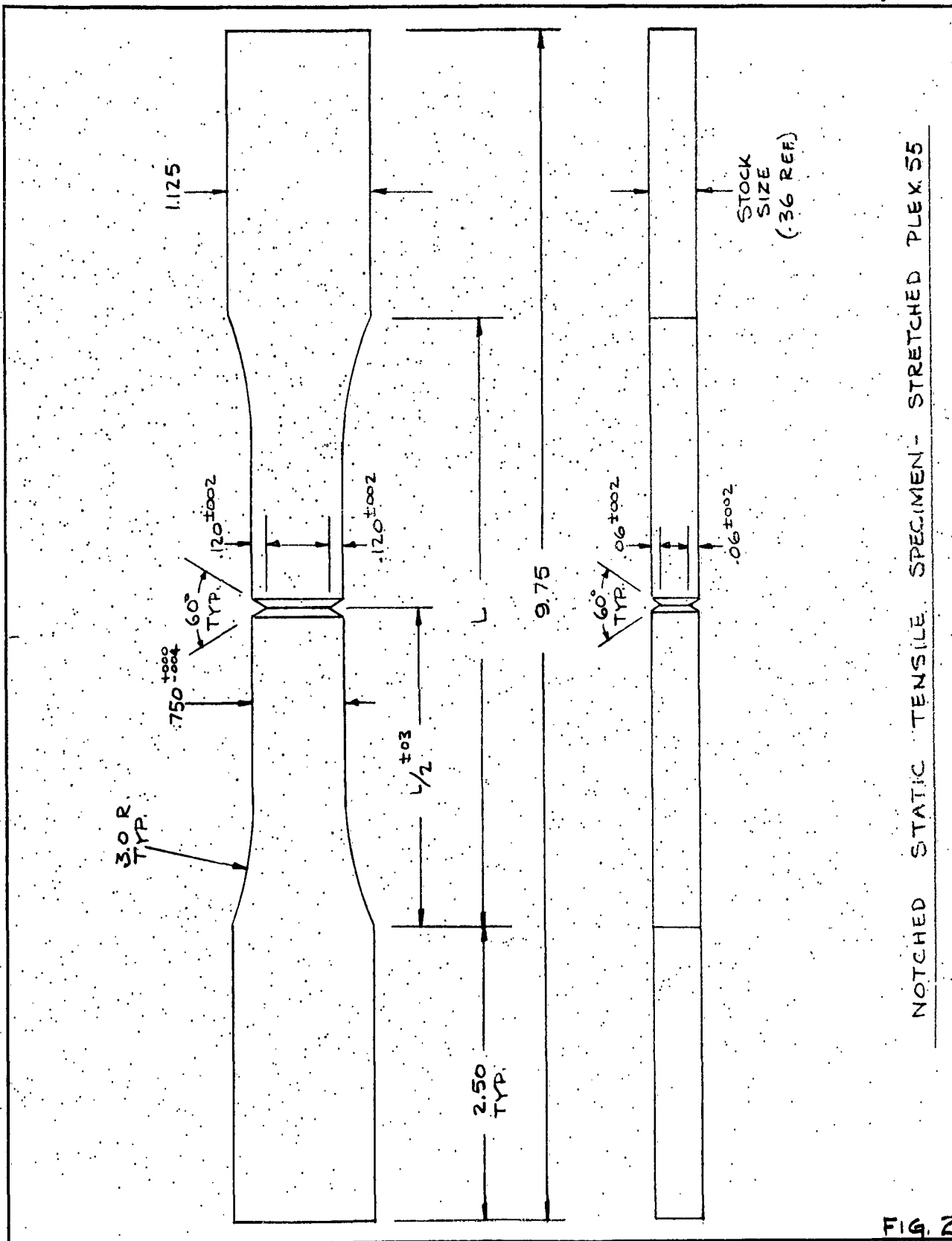
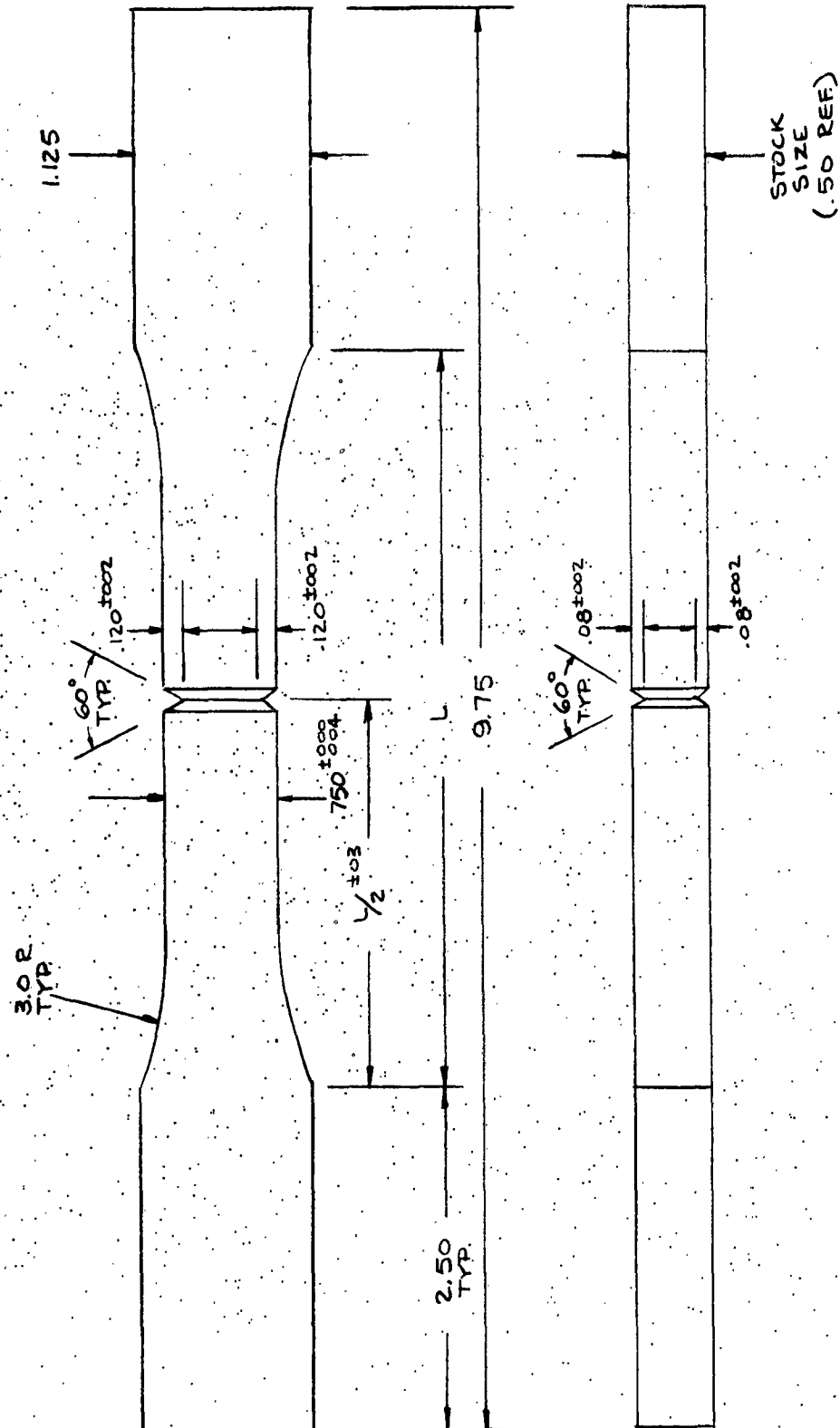


FIG. 2

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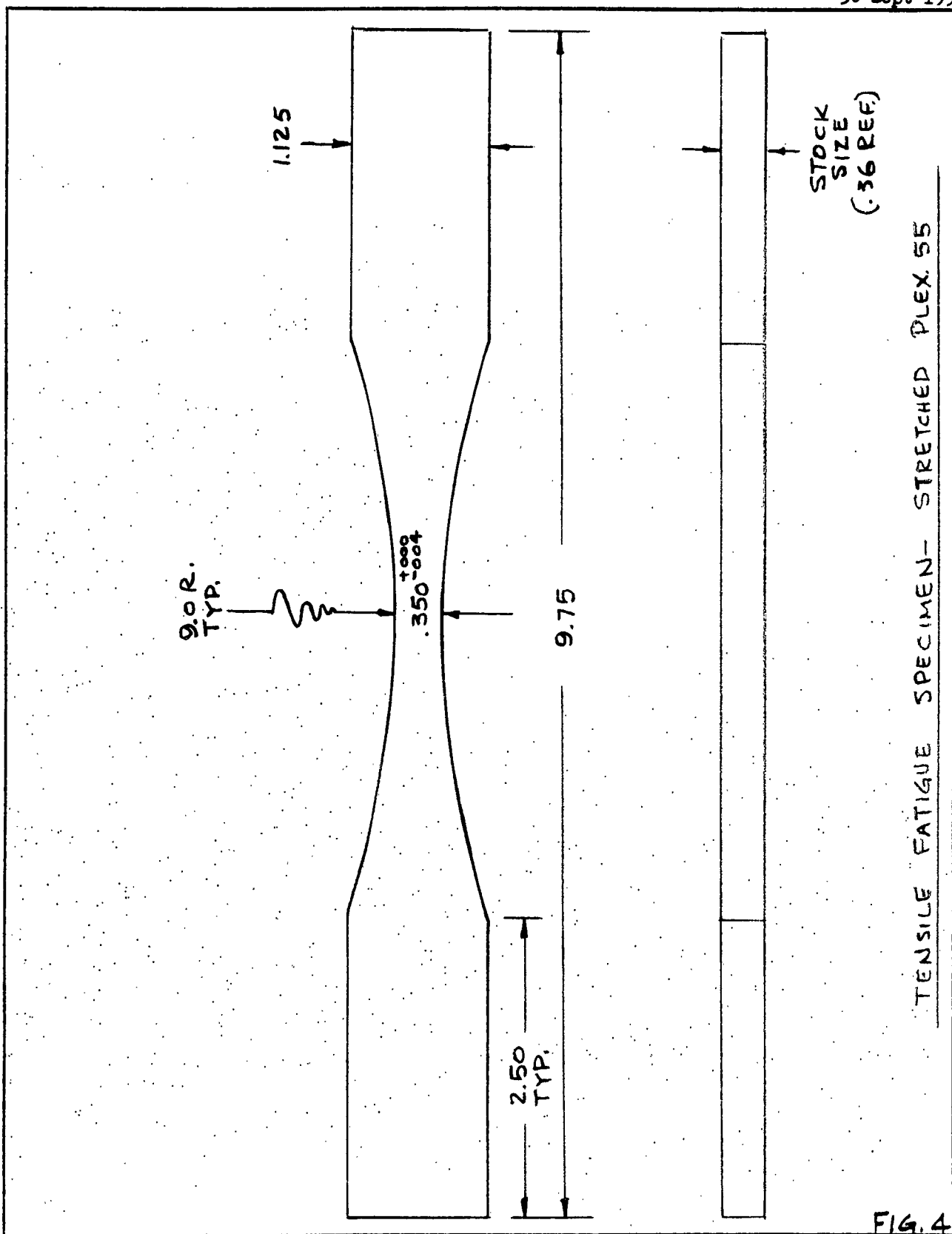
NOTCHED STATIC TENSILE SPECIMEN- AS-CAST PLEX. 55

FIG. 3

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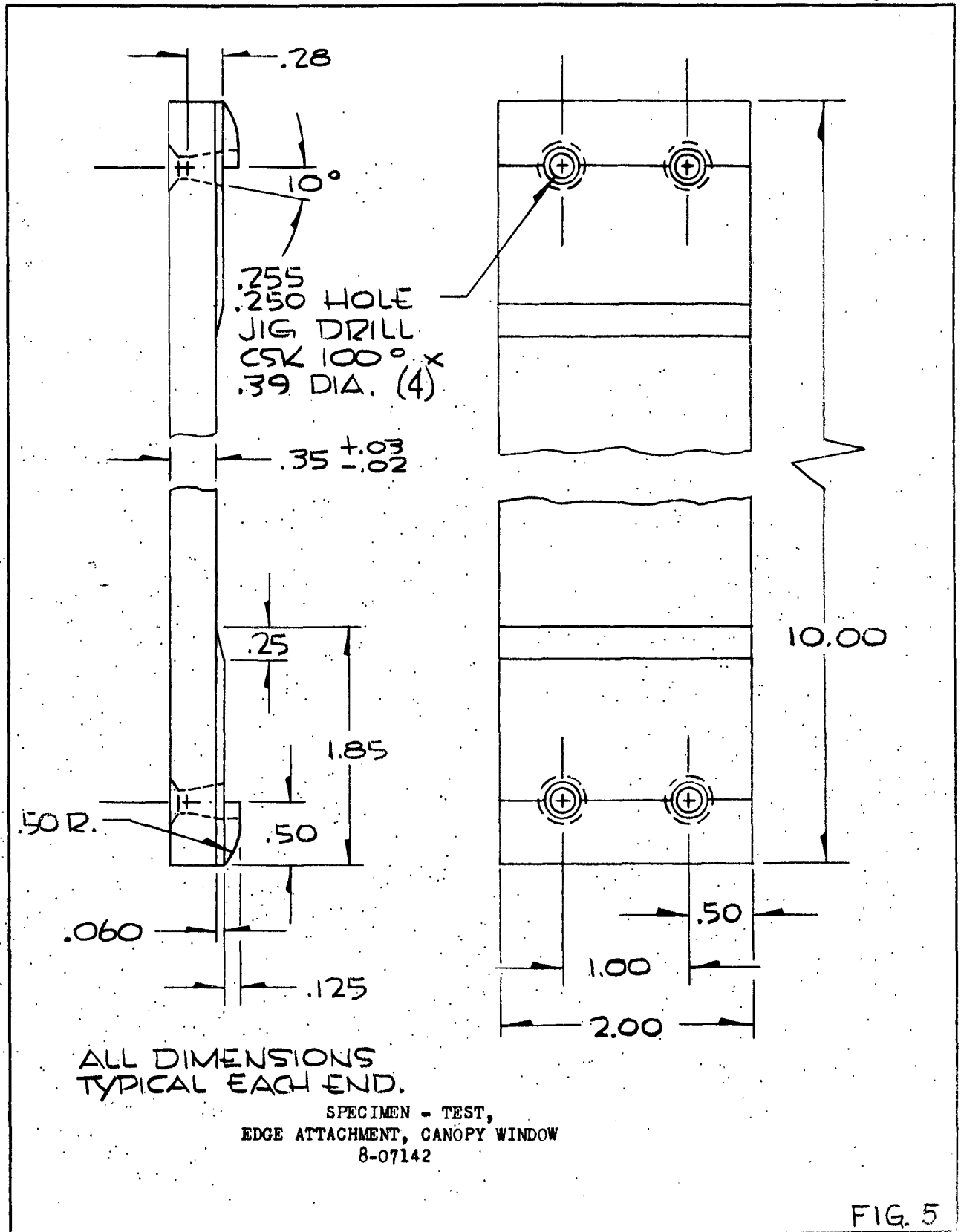
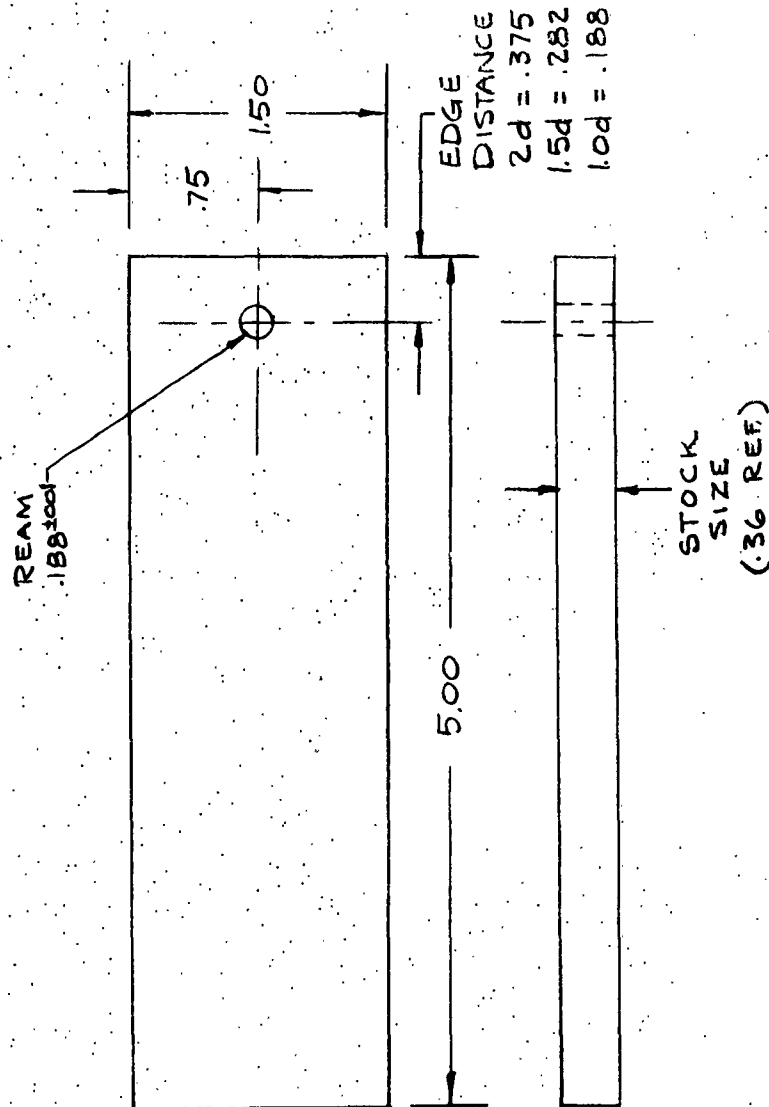


FIG. 5

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SHEAR-OUT SPECIMEN - STRETCHED PLEXIGLAS 55

FIG. 6

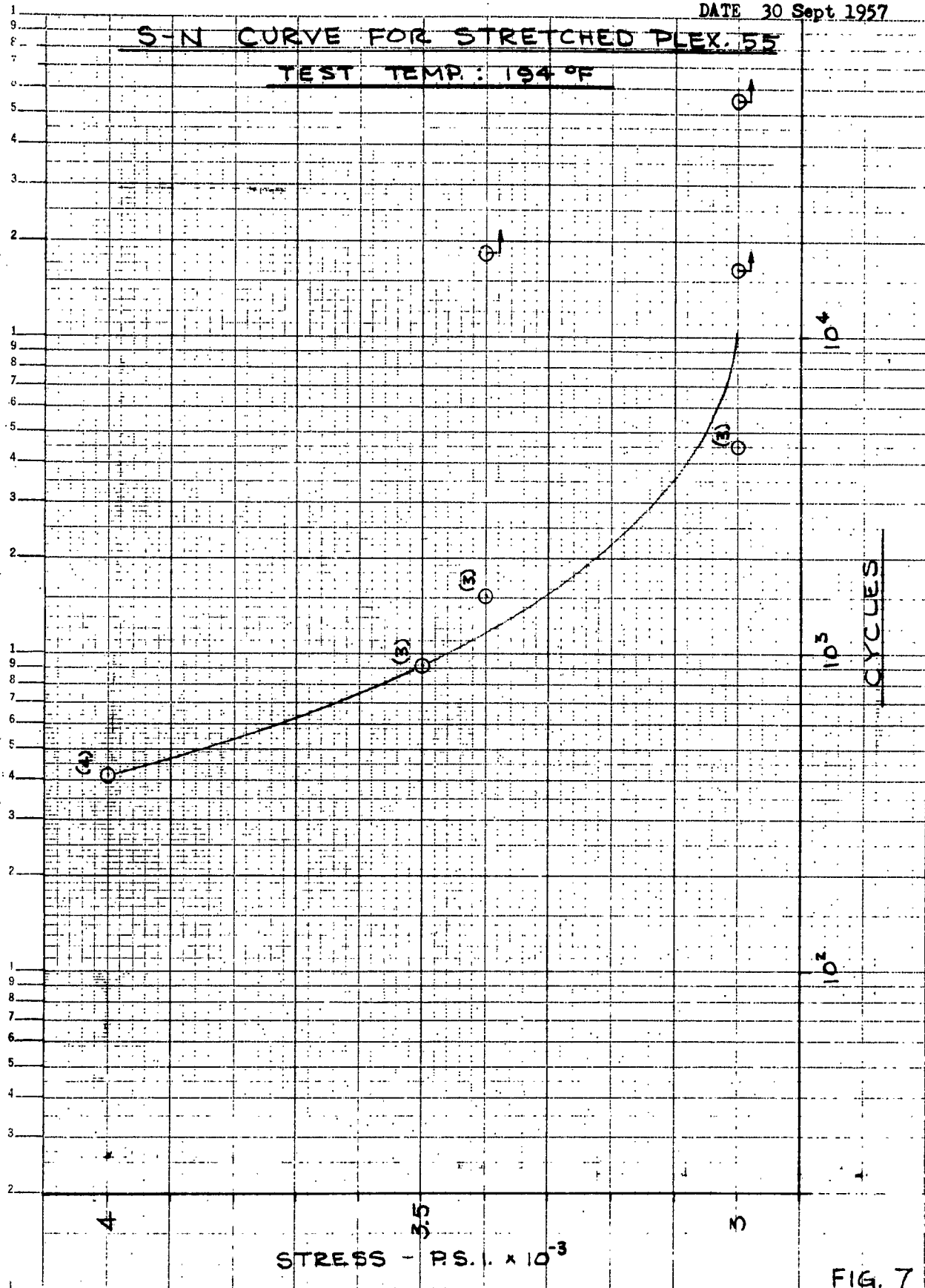


FIG. 7

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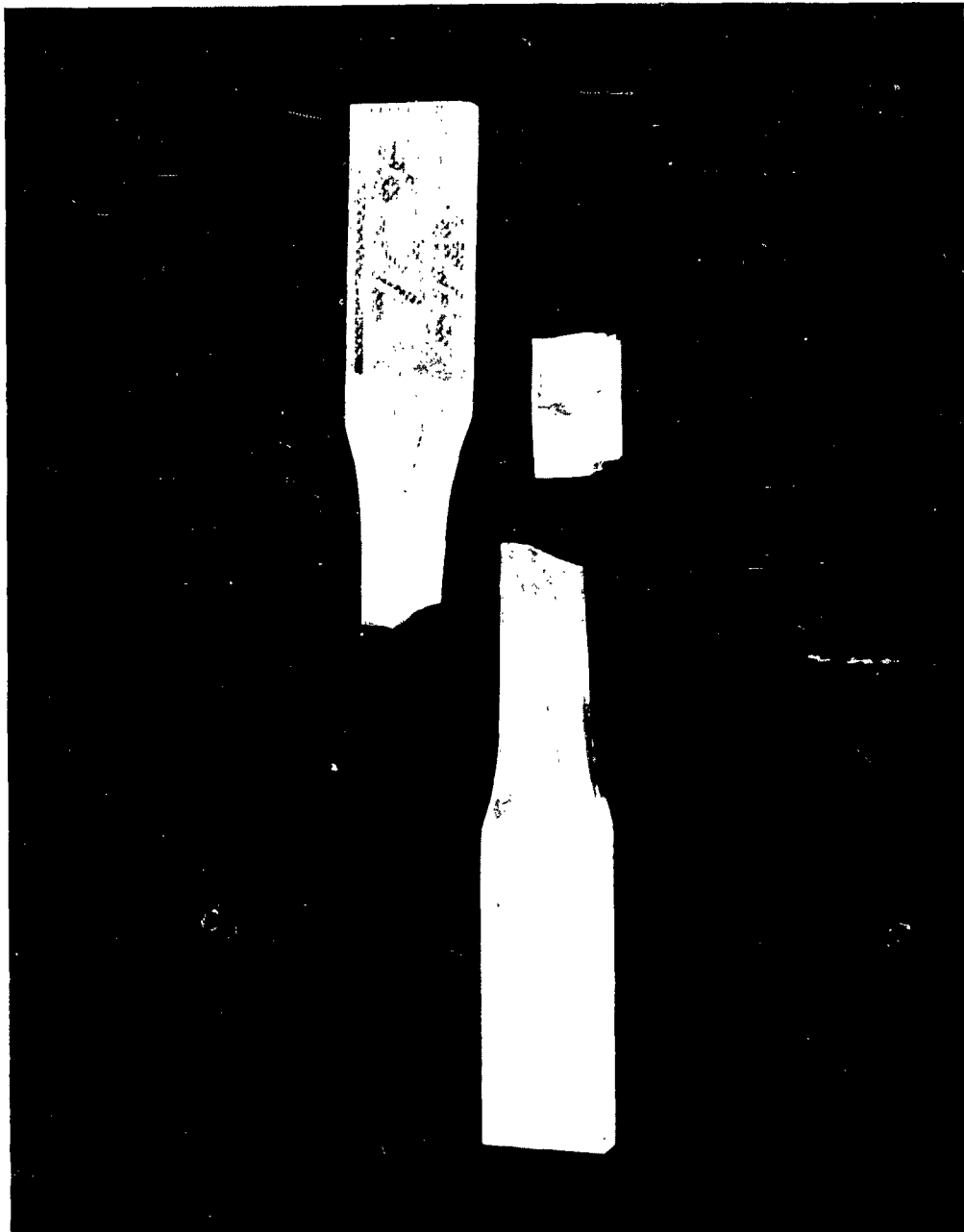


Figure 8 STATIC TENSILE FAILURE 75°F

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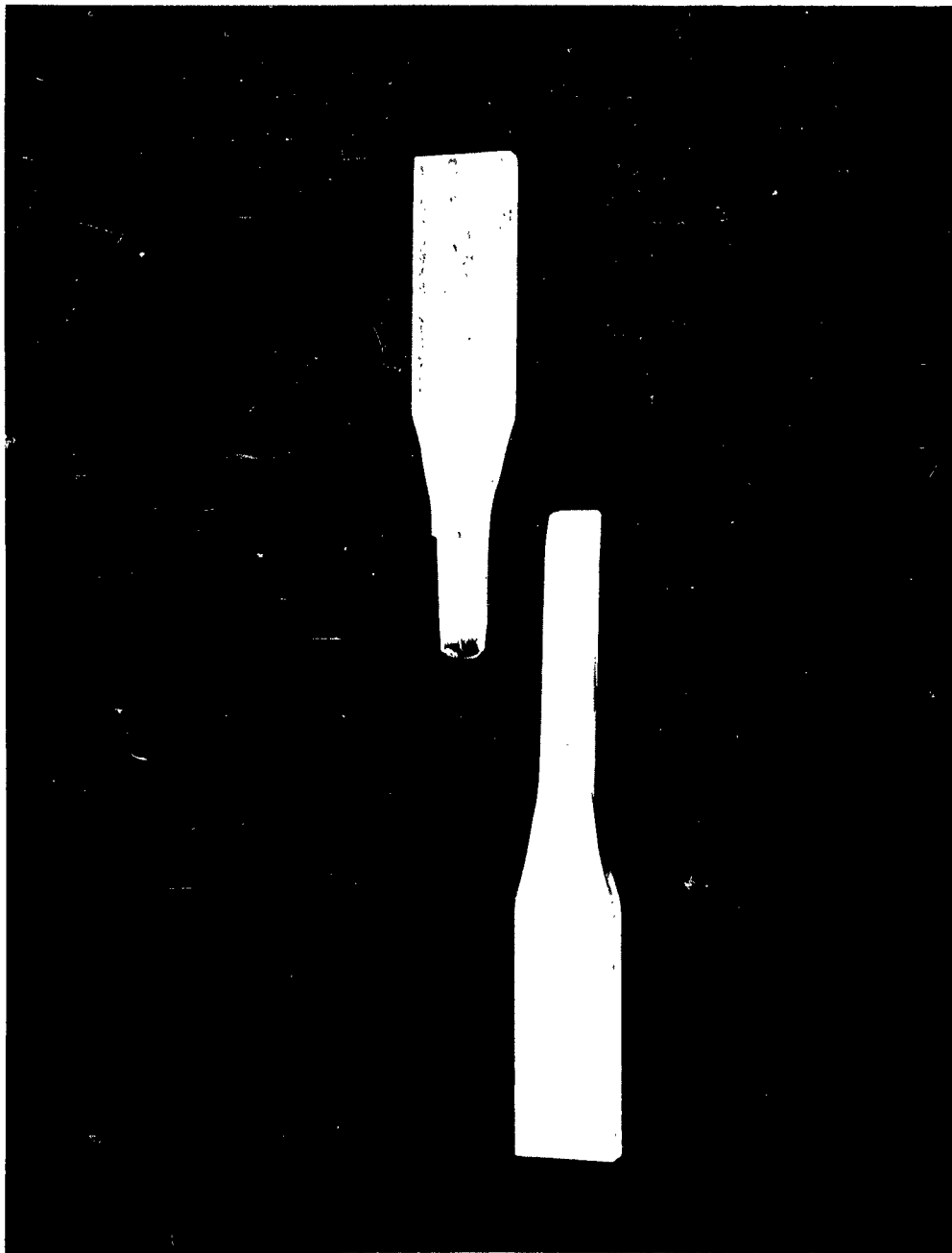


Figure 9 STATIC TENSILE FAILURE 194°F

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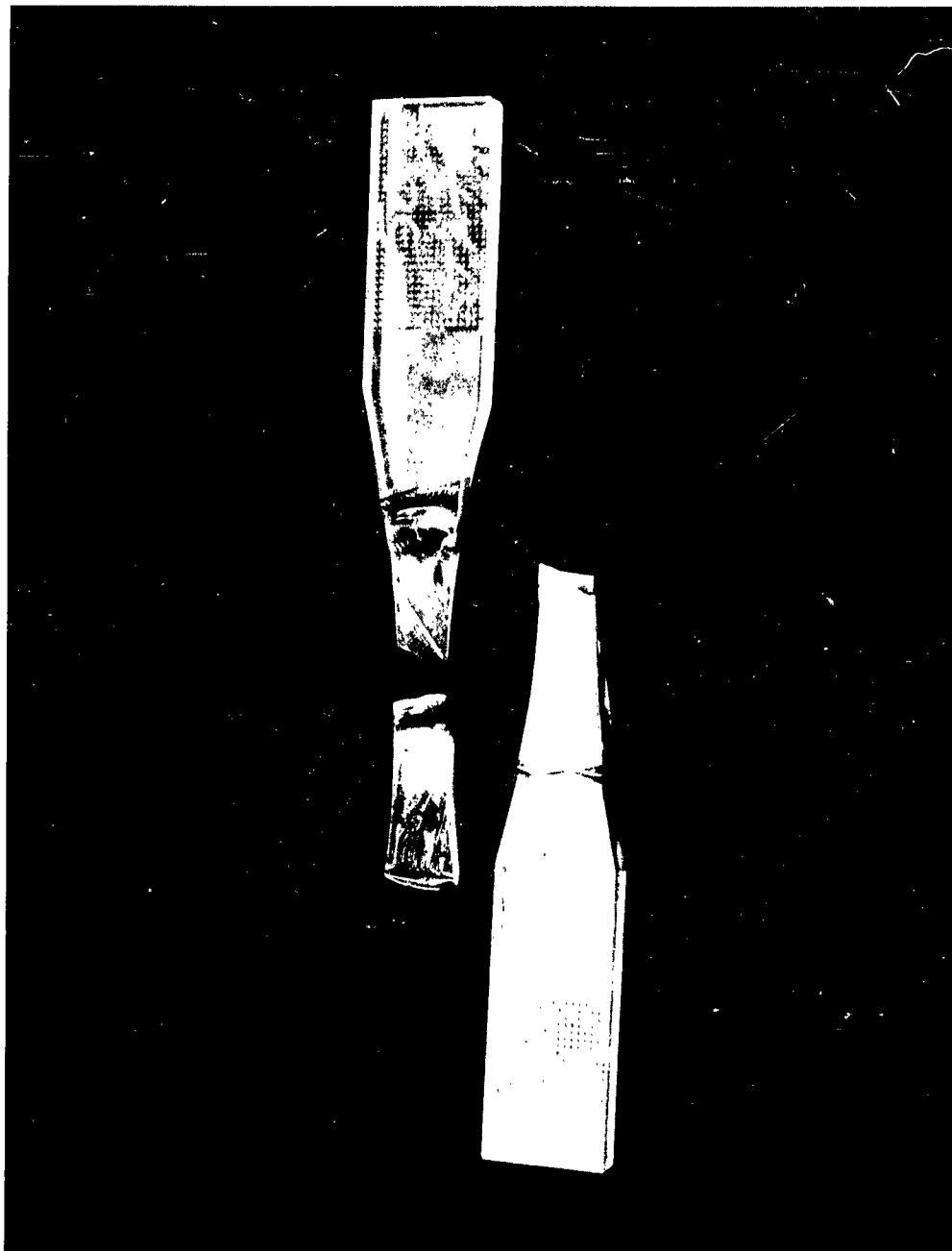


Figure 10 STATIC TENSILE FAILURE -50°F

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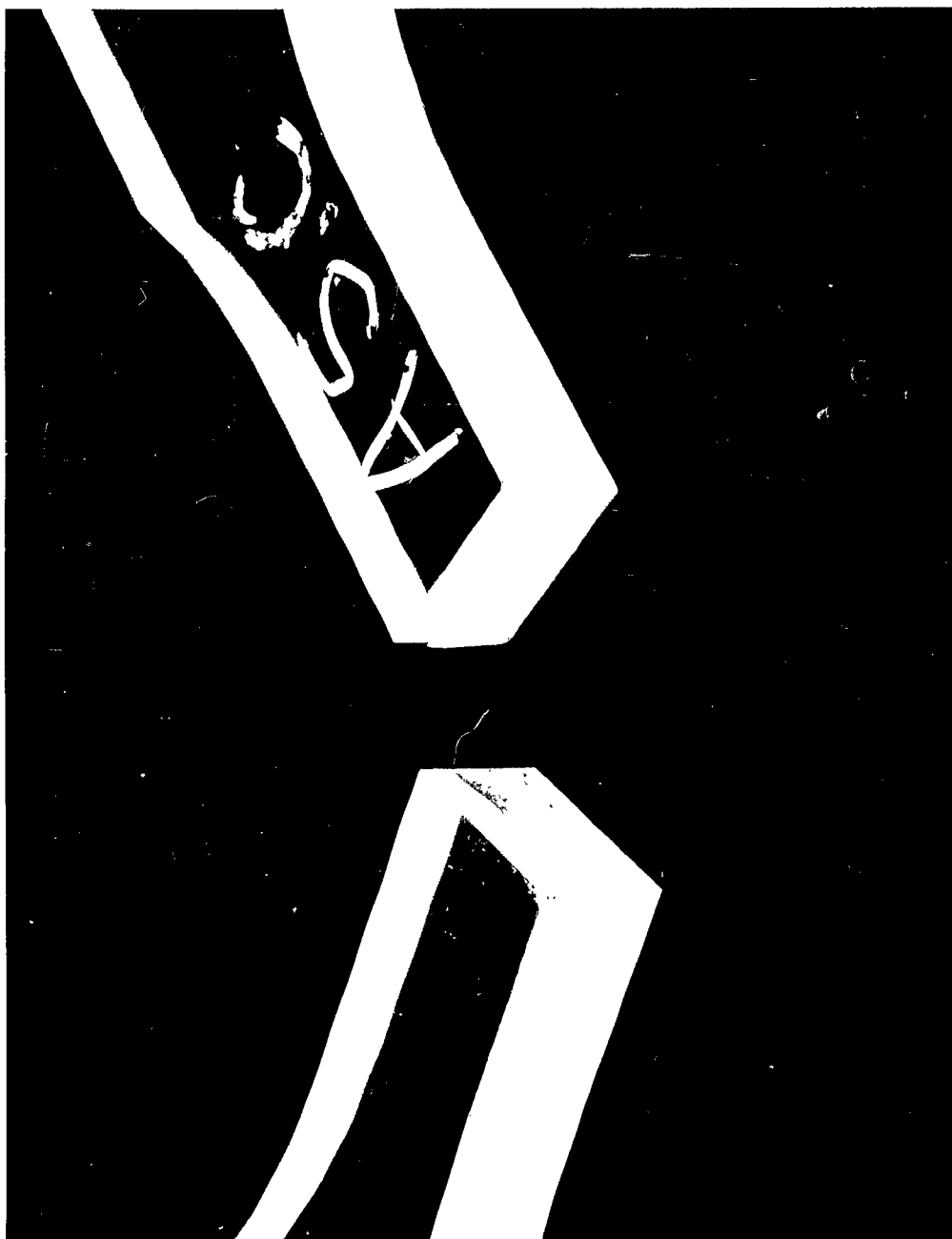


Figure 11 STATIC NOTCHED TENSILE FAILURE - AS-CAST PLEXIGLAS 55

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Figure 12 STATIC NOTCHED TENSILE FAILURE - STRETCHED PLEXIGLAS 55

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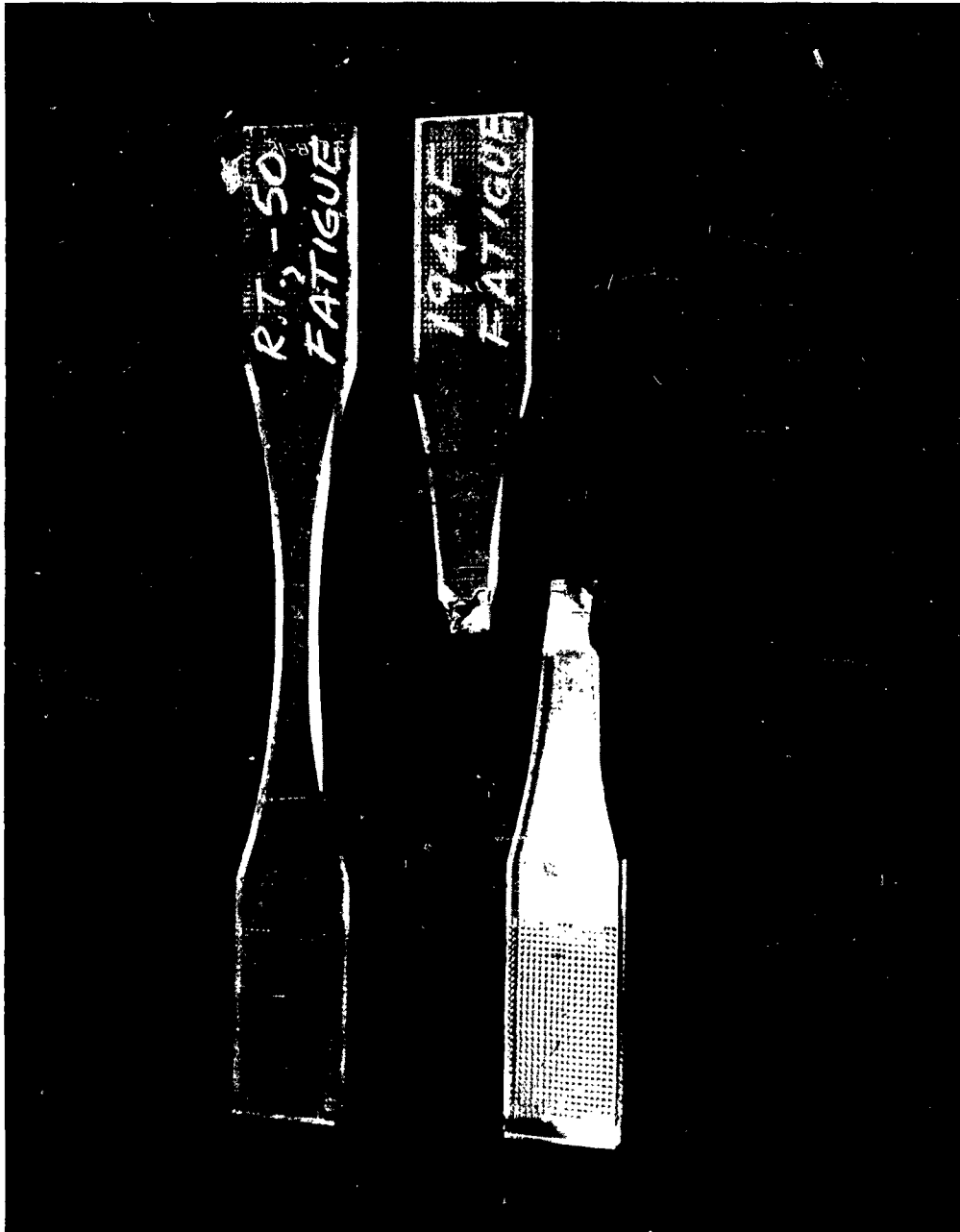


Figure 13 TENSILE FATIGUE SPECIMENS - STRETCHED PLEXIGLAS 55

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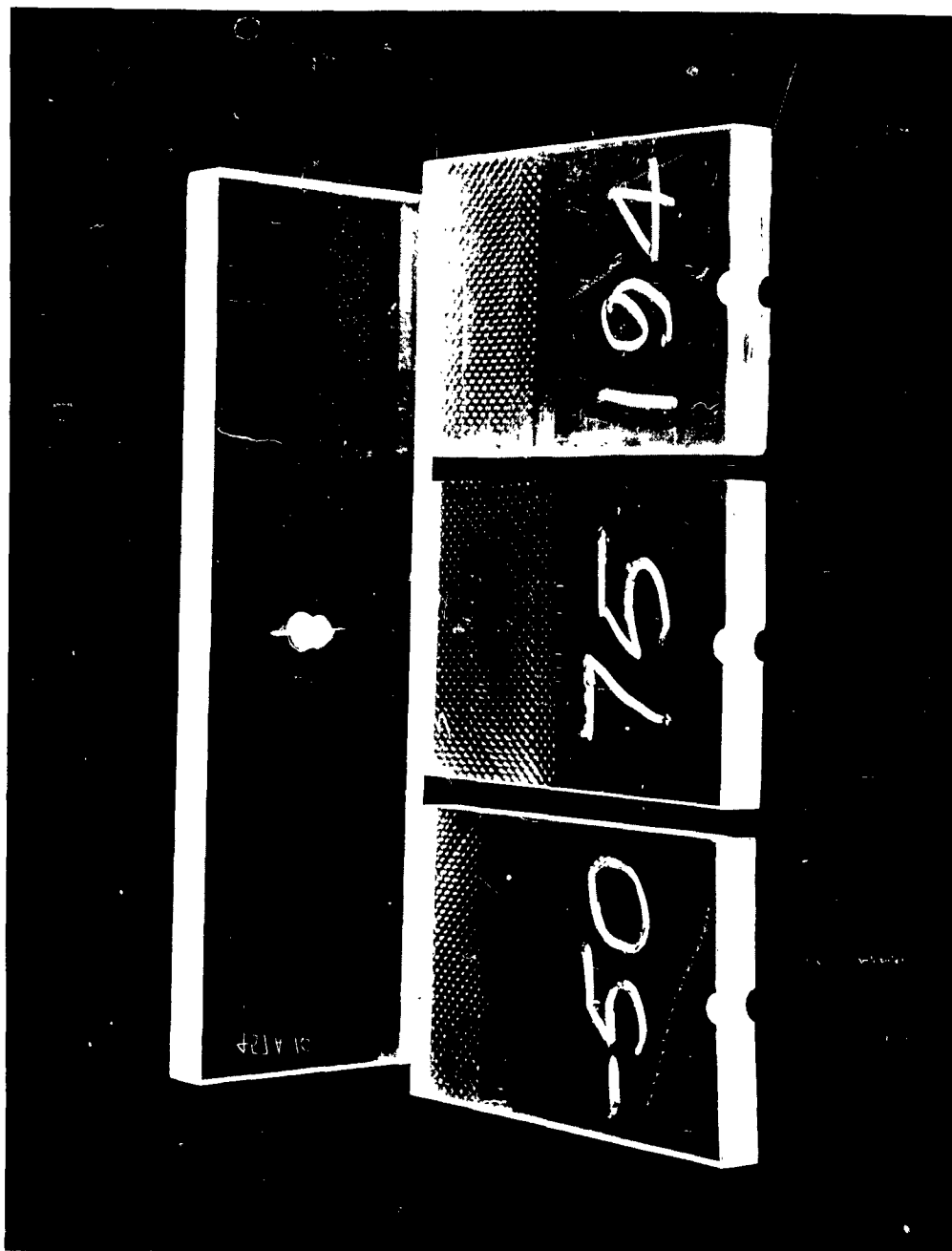


Figure 14 CRACK PROPAGATION SPECIMENS - STRETCHED PLEXIGLAS 55

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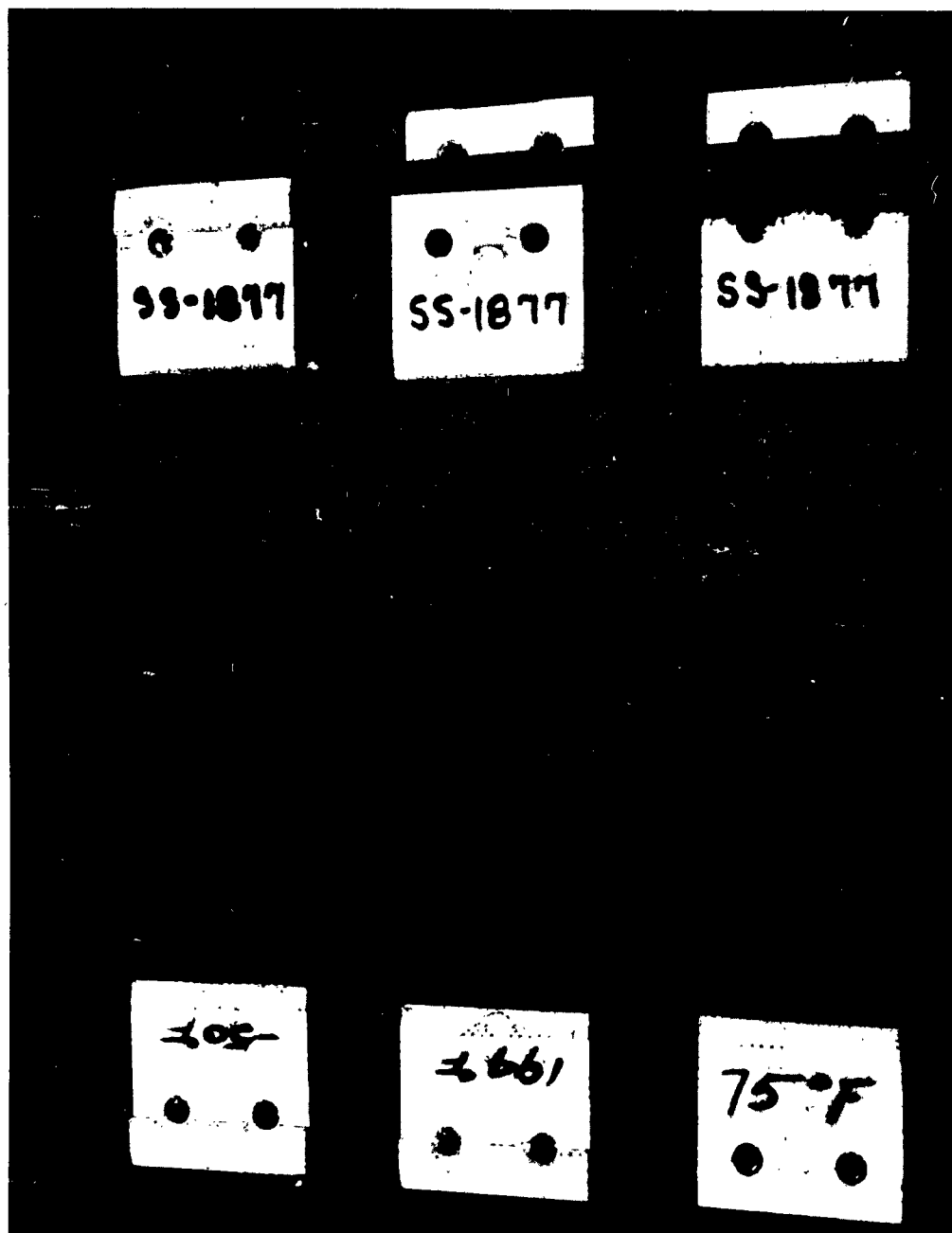


Figure 15 EDGE ATTACHMENT SPECIMENS - STRETCHED PLEXIGLAS 55

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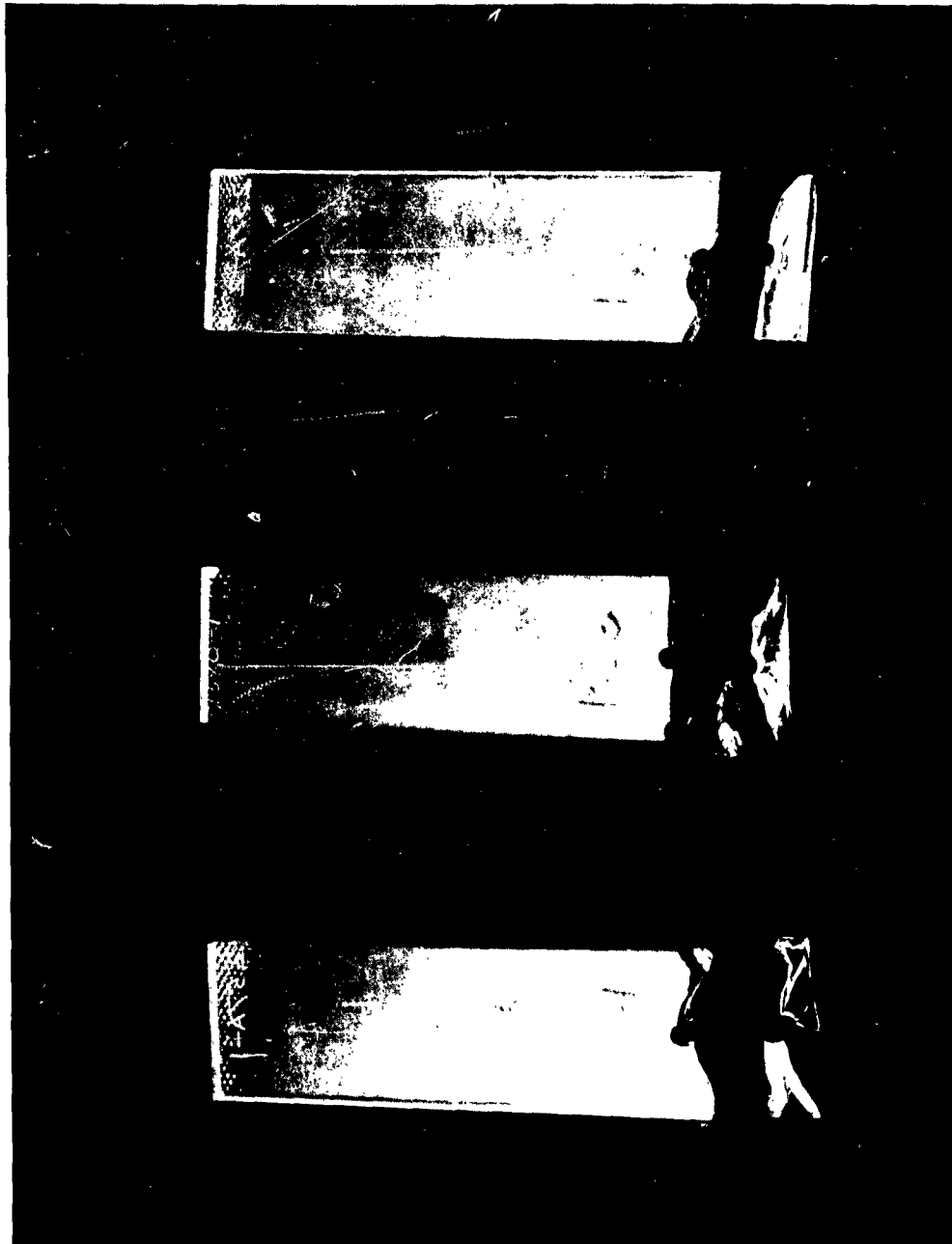


Figure 16 SHEAR-OUT SPECIMENS - STRETCHED PLEXIGLAS 55