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FINAL REPORT-PART II
ARMA CR 65-02/1
ALLOYS OF IMPROVED ELASTIC PROPERTIES

By

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FEB. 1966

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STRESS Vs STRAIN
 FOR
 BRASS-FREE MACH.
 AND
 AP, Cu, Ni - SINGLE
 CRYSTAL - #4-II
 AMBIENT = +85°F
 5-7-65

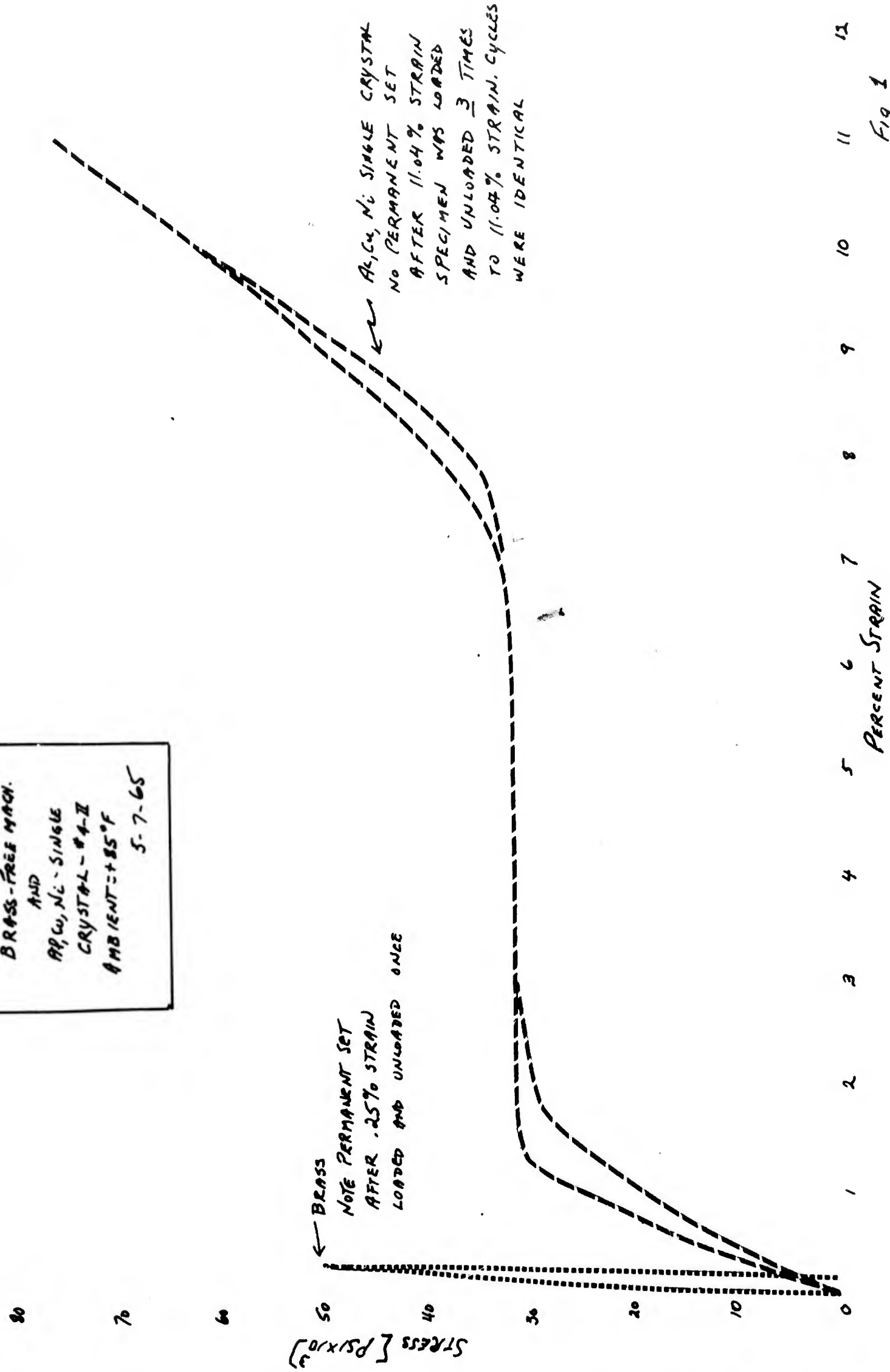
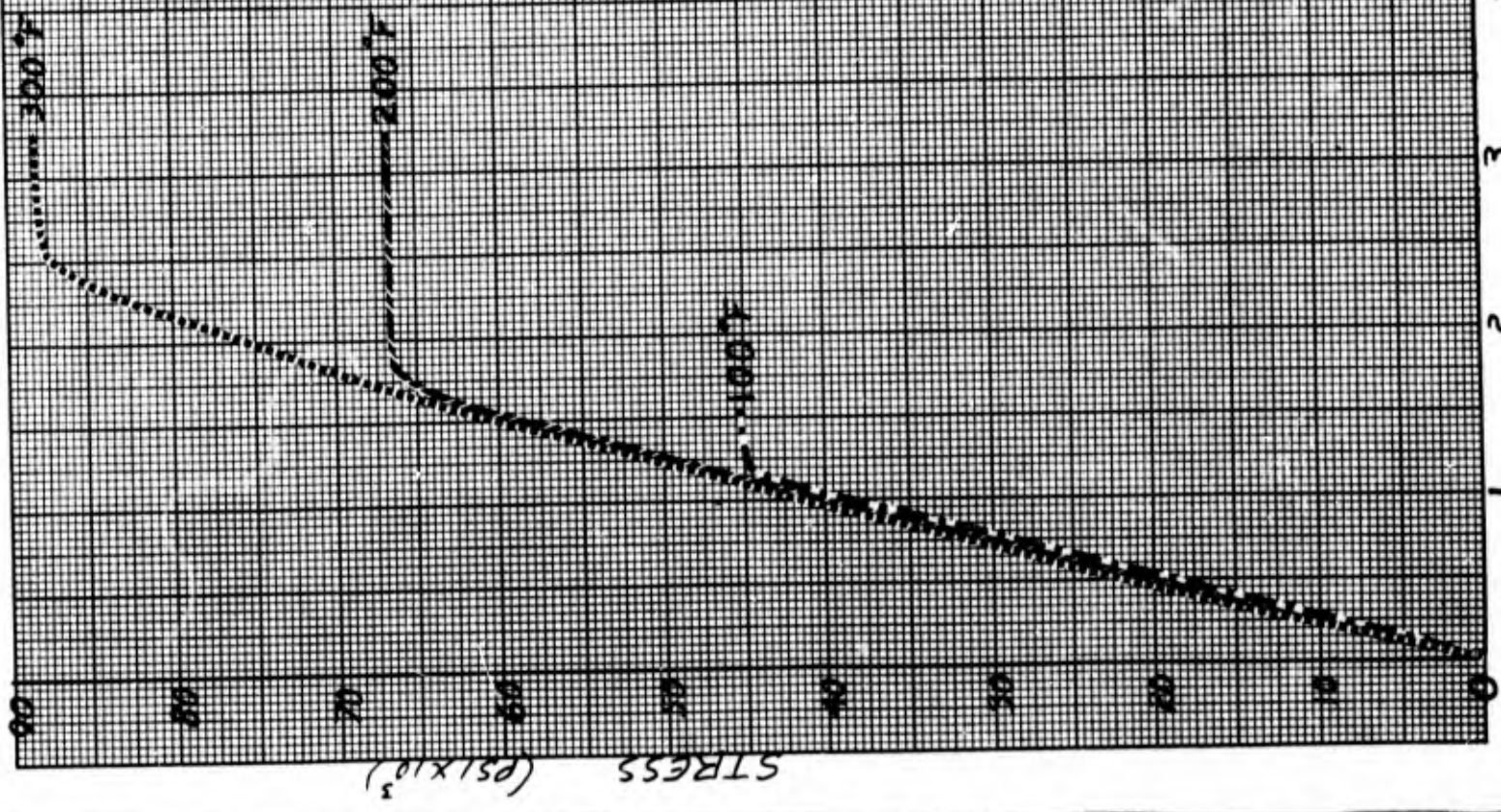


Fig 1

STRESS vs STRAIN
SINGLE CRYSTAL - II
7/2/65



STRAIN (%)

STRESS (PSI x 10³)

STRESS vs STRAIN
SINGLE CRYSTAL - 1A
AMBIENT = 100°
7/11/65

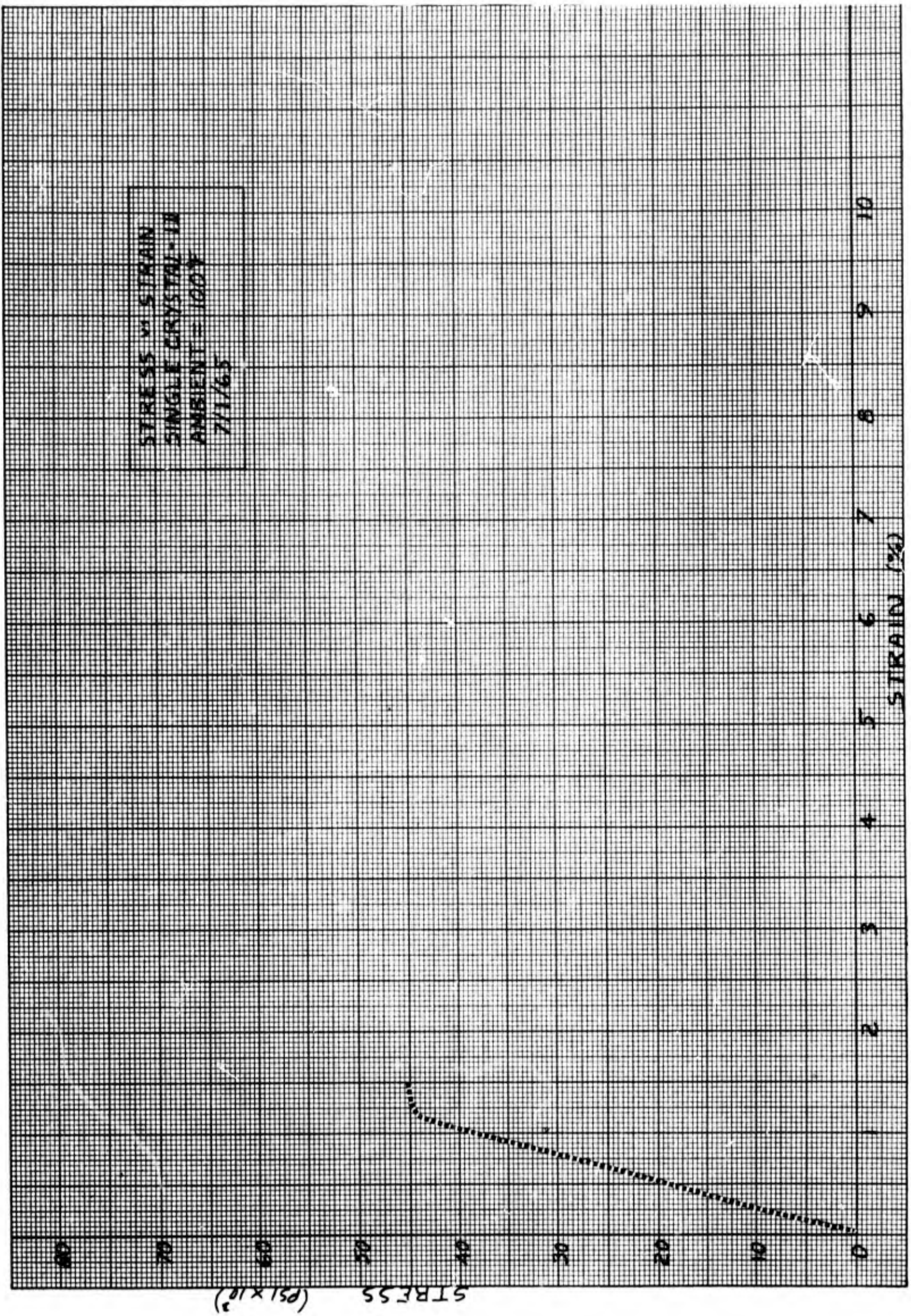


FIG. 3

STRESS vs STRAIN
SINGLE CRYSTAL
AMBIENT = 200°F
7/1/65

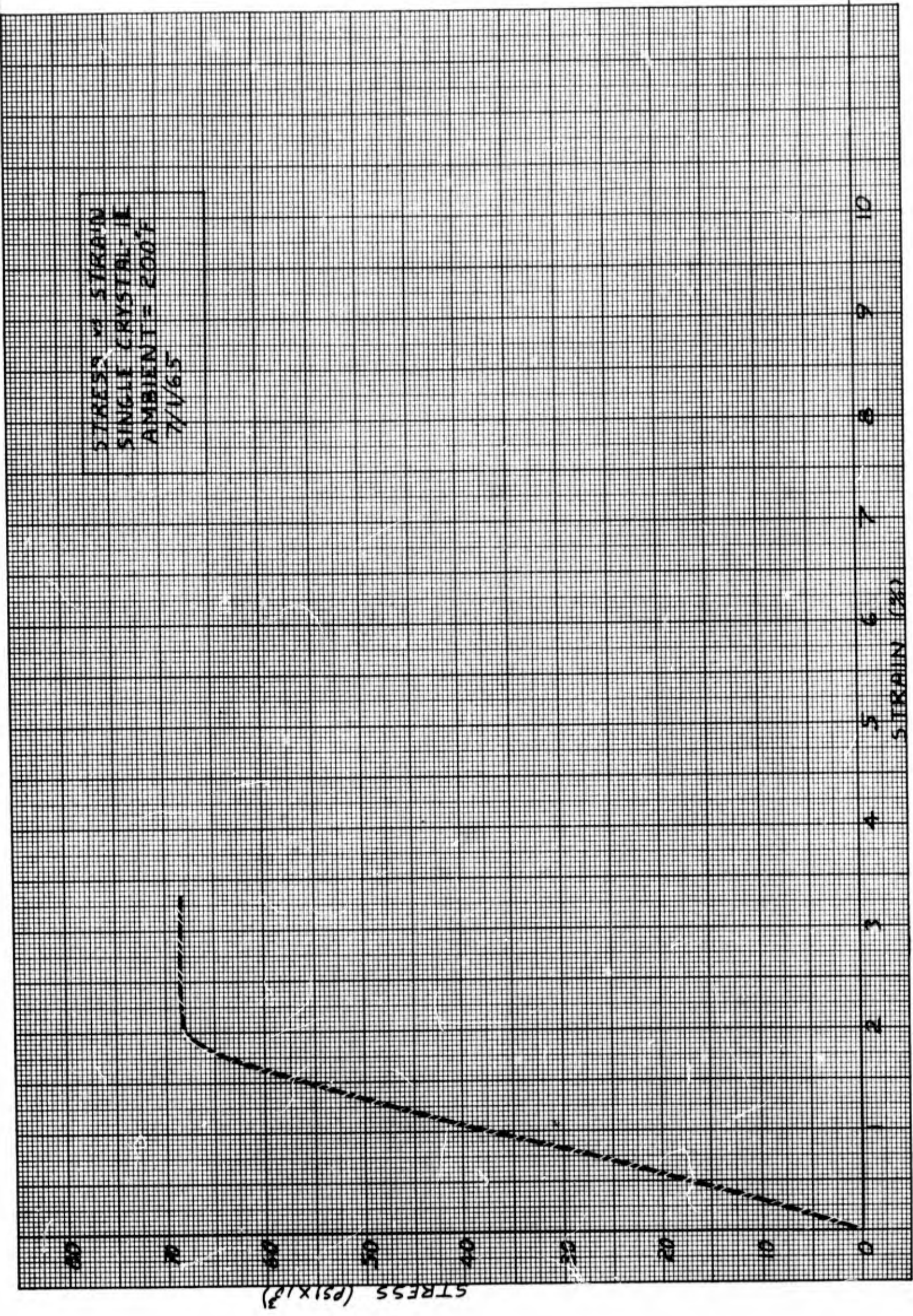
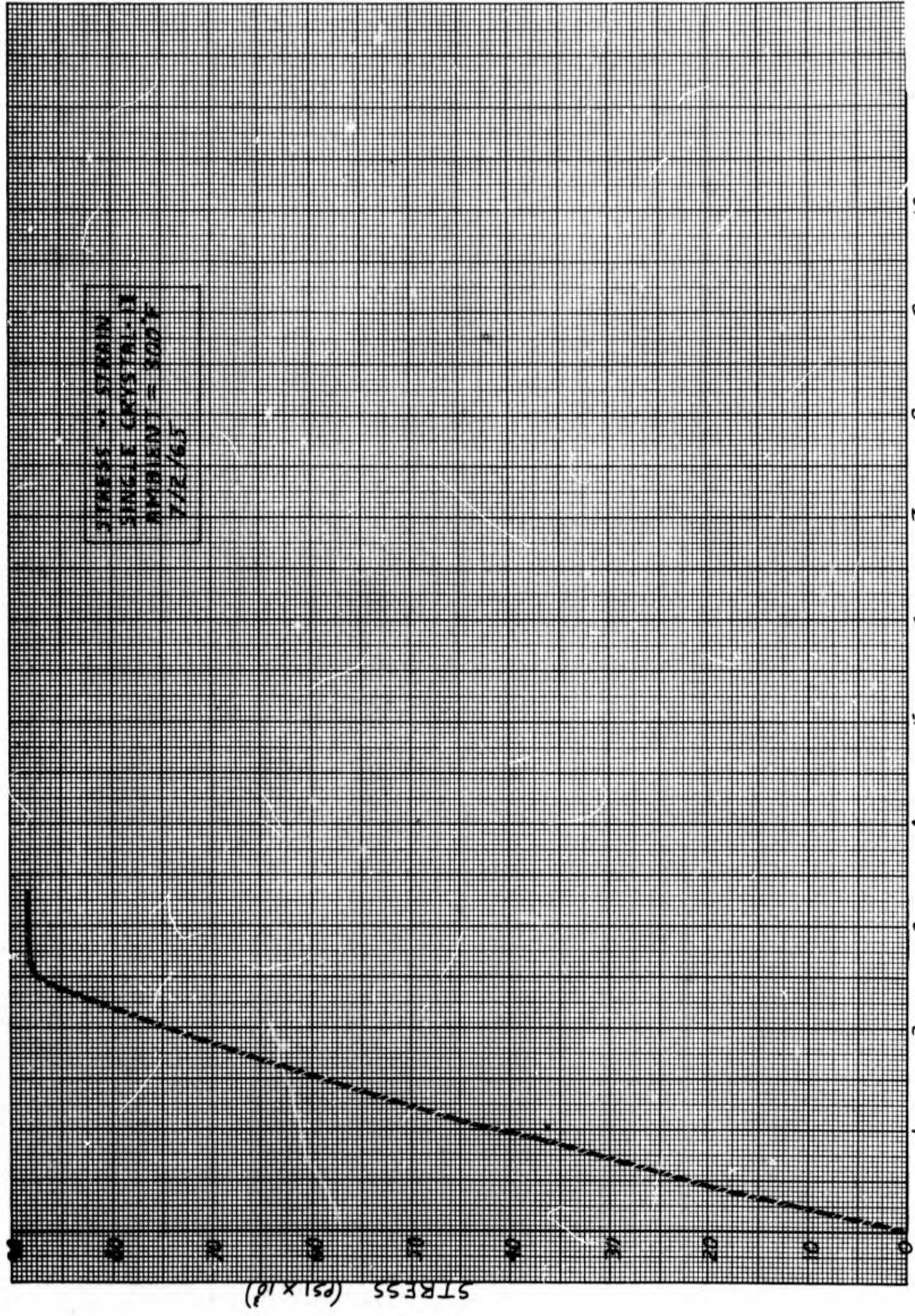


Fig. 4

STRESS - STRAIN
SINGLE CRYSTAL
AMBIENT = 300°K
7/12/65



STRESS (10^8 psi)

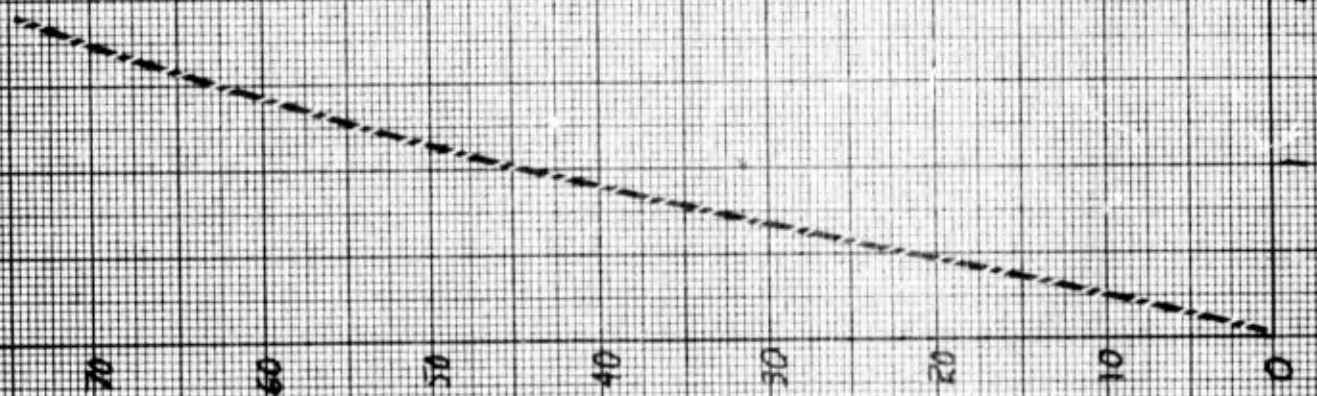
STRAIN (%)

Fig. 6

STRESS vs STRAIN
SINGLE CRYSTAL - III
AMBIENT - 320 °F
7/2/65

STRESS (PSI x 10³)

STRAIN (%)



STRESS vs STRAIN
SINGLE CRYSTAL - II
AMBIENT = 350°F
7/2/65

STRESS (psi x 10²)

STRAIN (%)

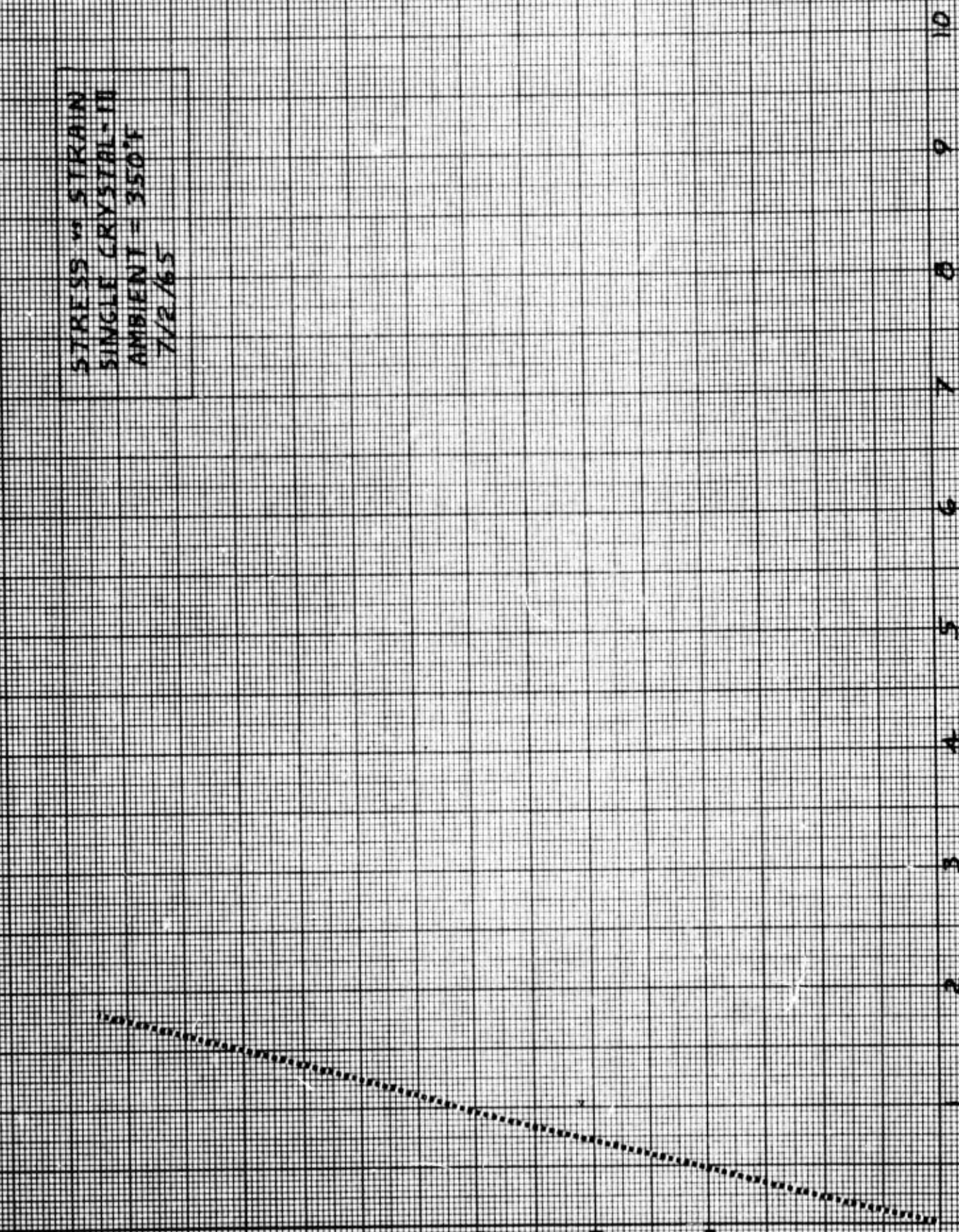


Fig. 7

STRESS vs STRAIN
SINGLE CRYSTAL - IN
AMBIENT - 600° F
7/2/65

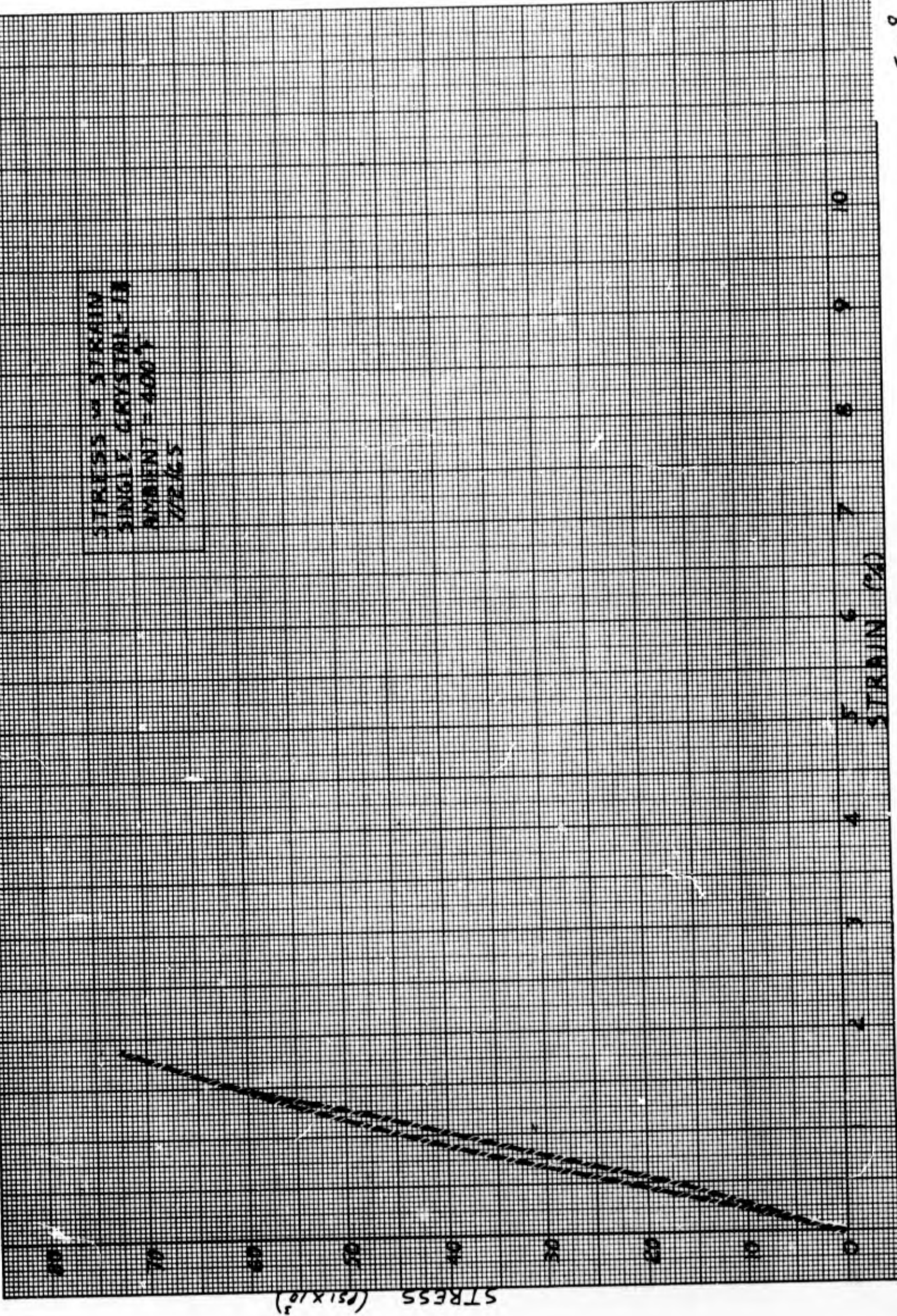


Fig. 8

STRESS vs STRAIN
SINGLE CRYSTAL-III
AMBIENT = 465°F
7/2/65

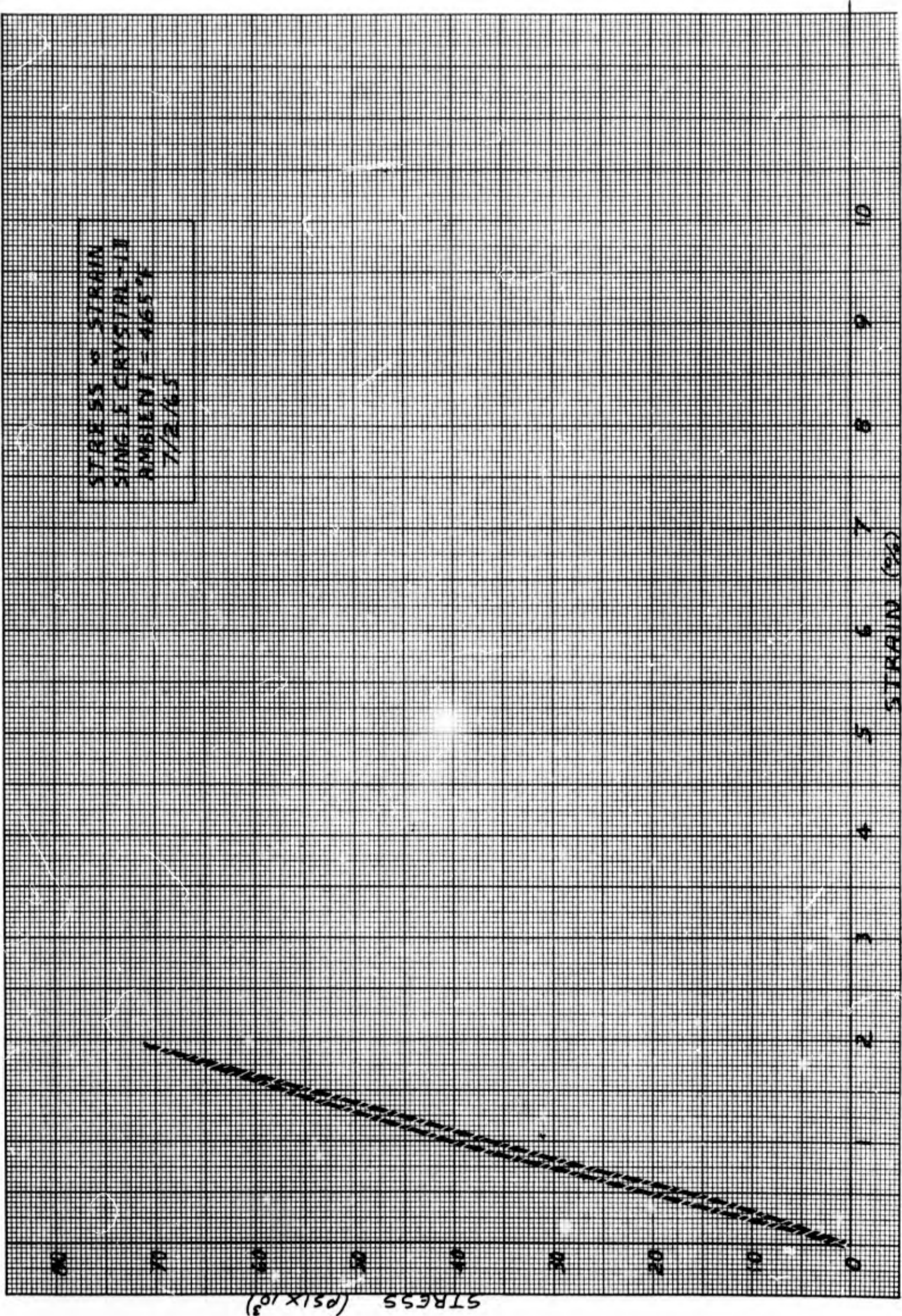
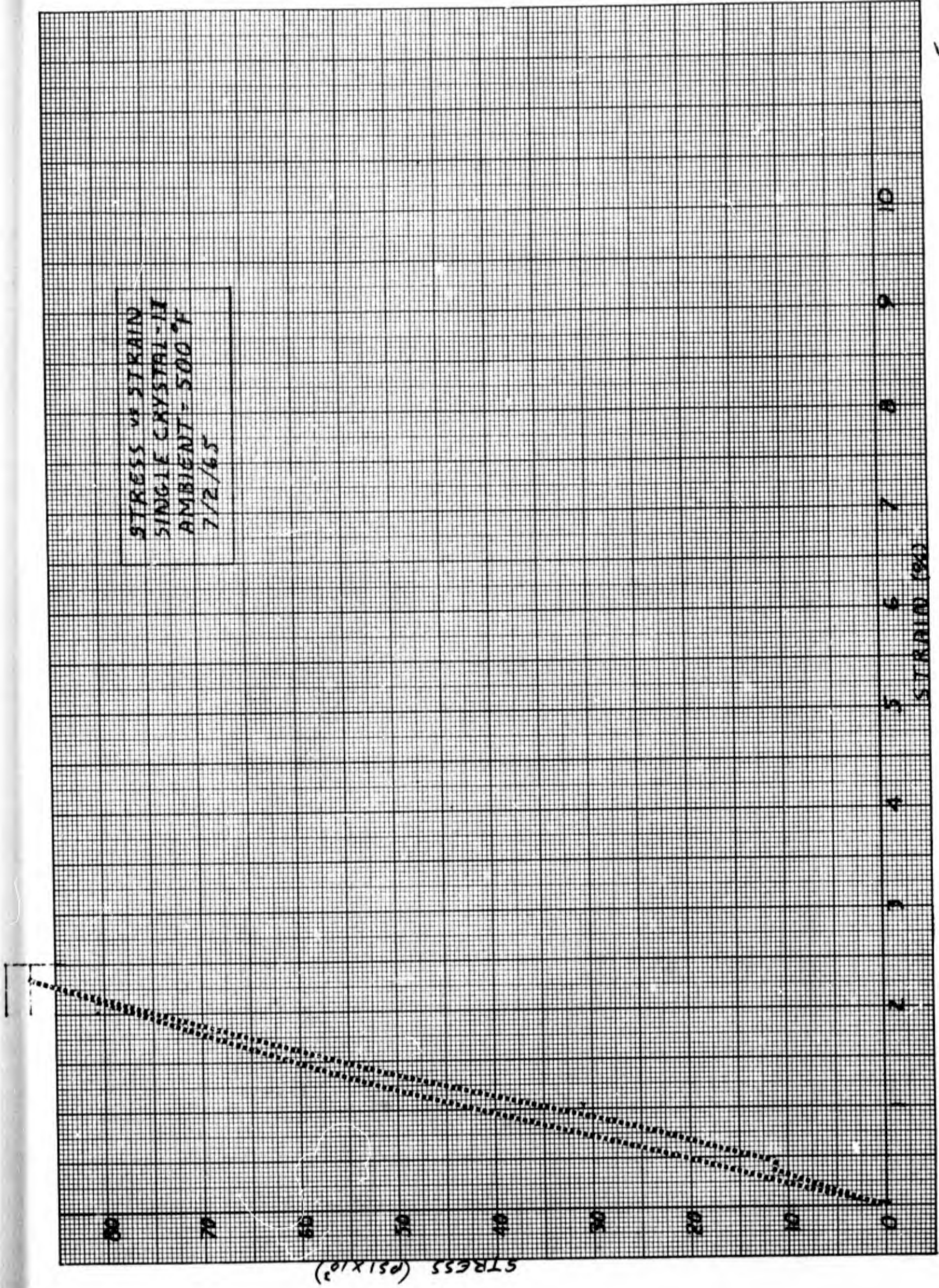


Fig. 10

STRESS vs STRAIN
SINGLE CRYSTAL - II
AMBIENT - 500 °F
7/2/65



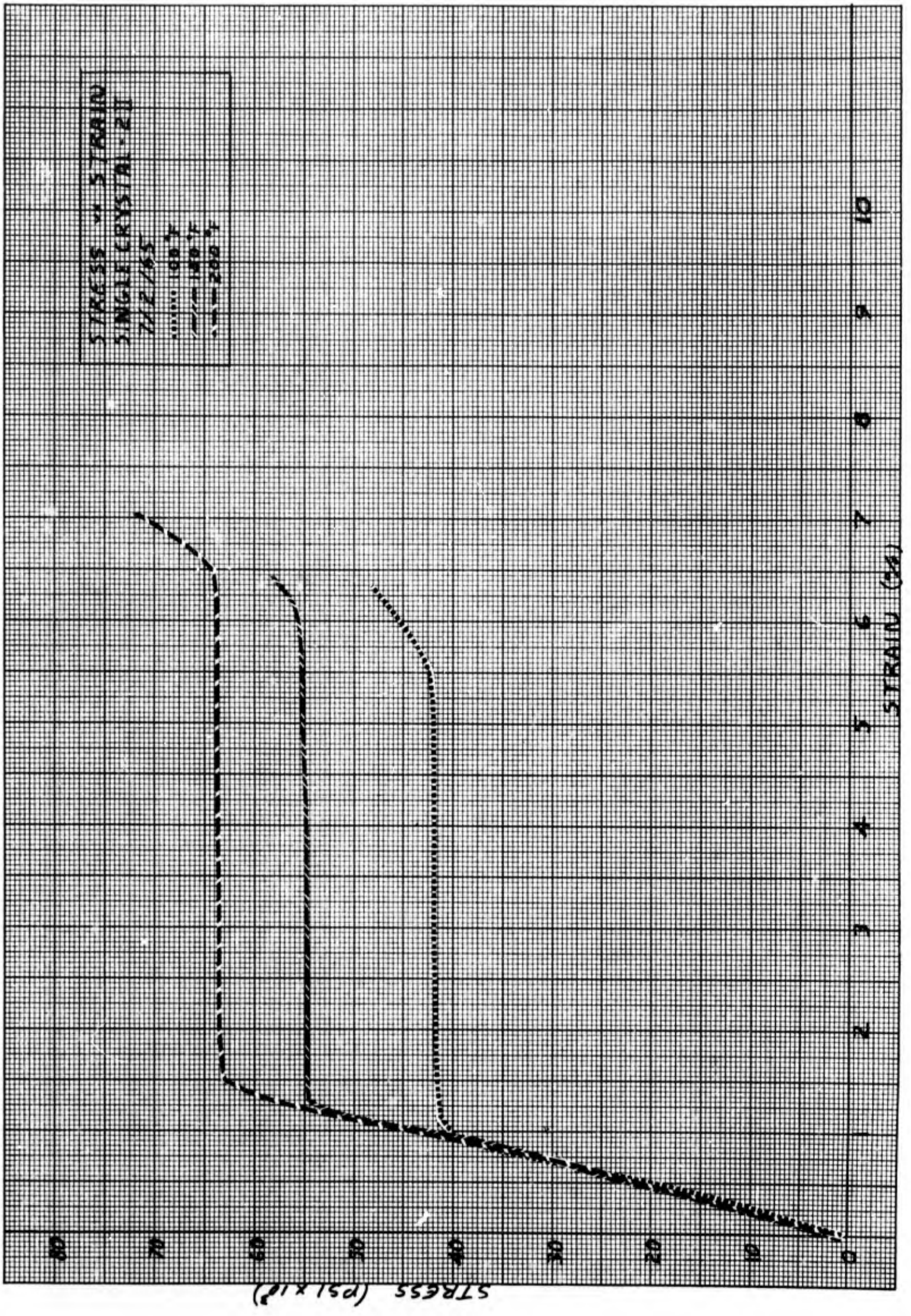
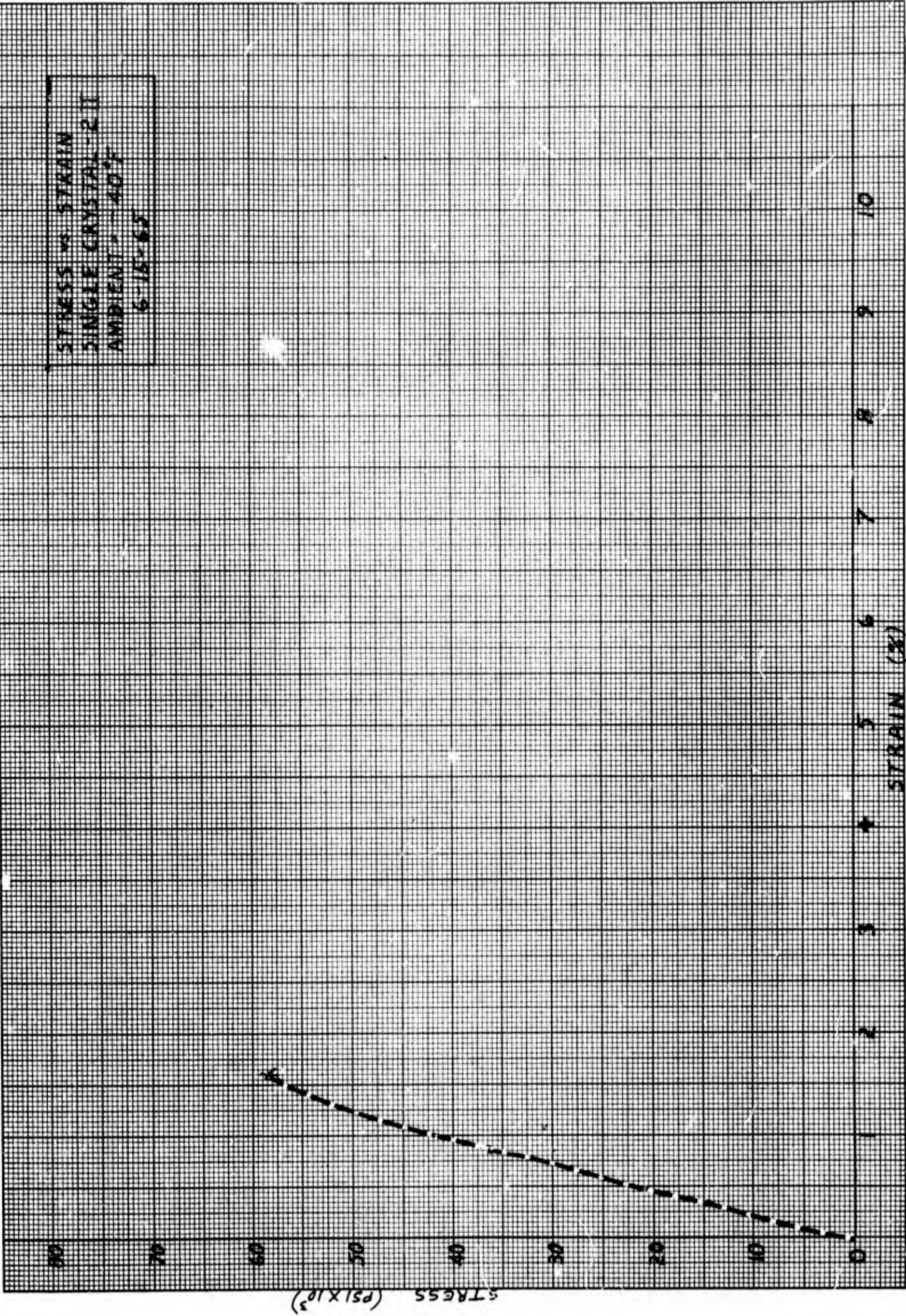


Fig. 11

STRESS vs STRAIN
SINGLE CRYSTAL - 211
AMBIENT - 40°F
6-18-65



STRESS VS STRAIN
SINGLE CRYSTAL - 20
ANNEAL - 1000°
CANTILE

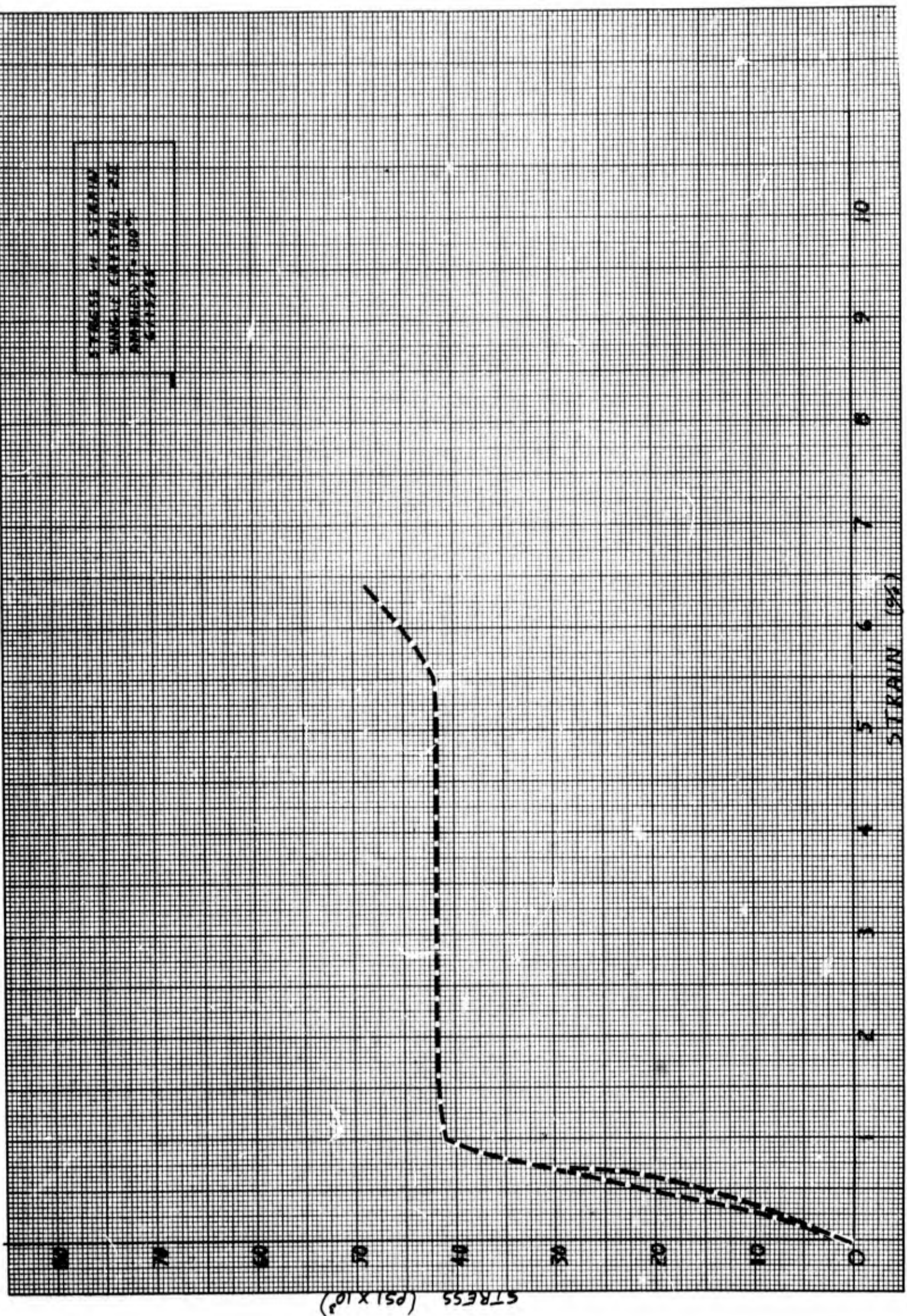
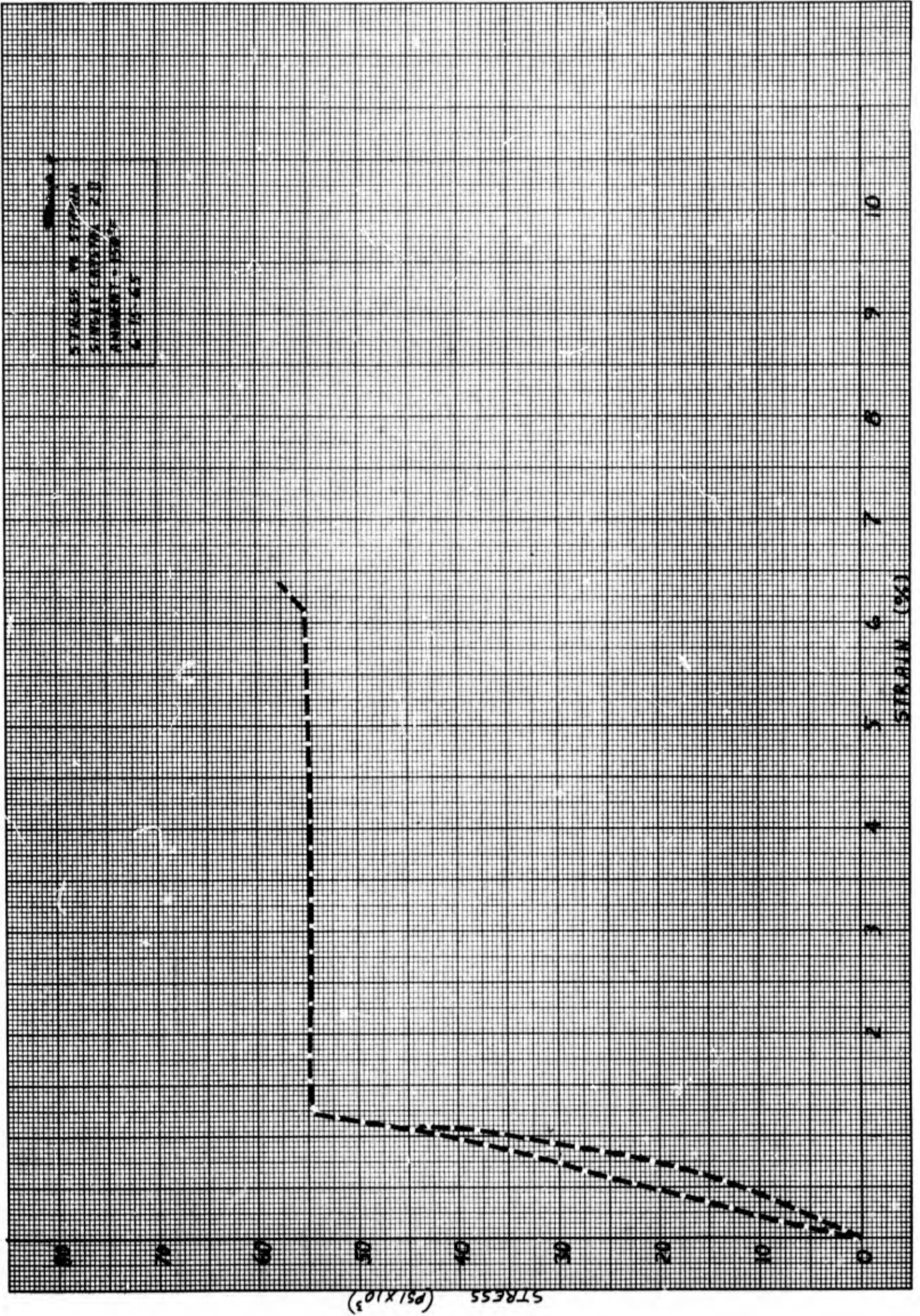


Fig. 13

Fig. 14



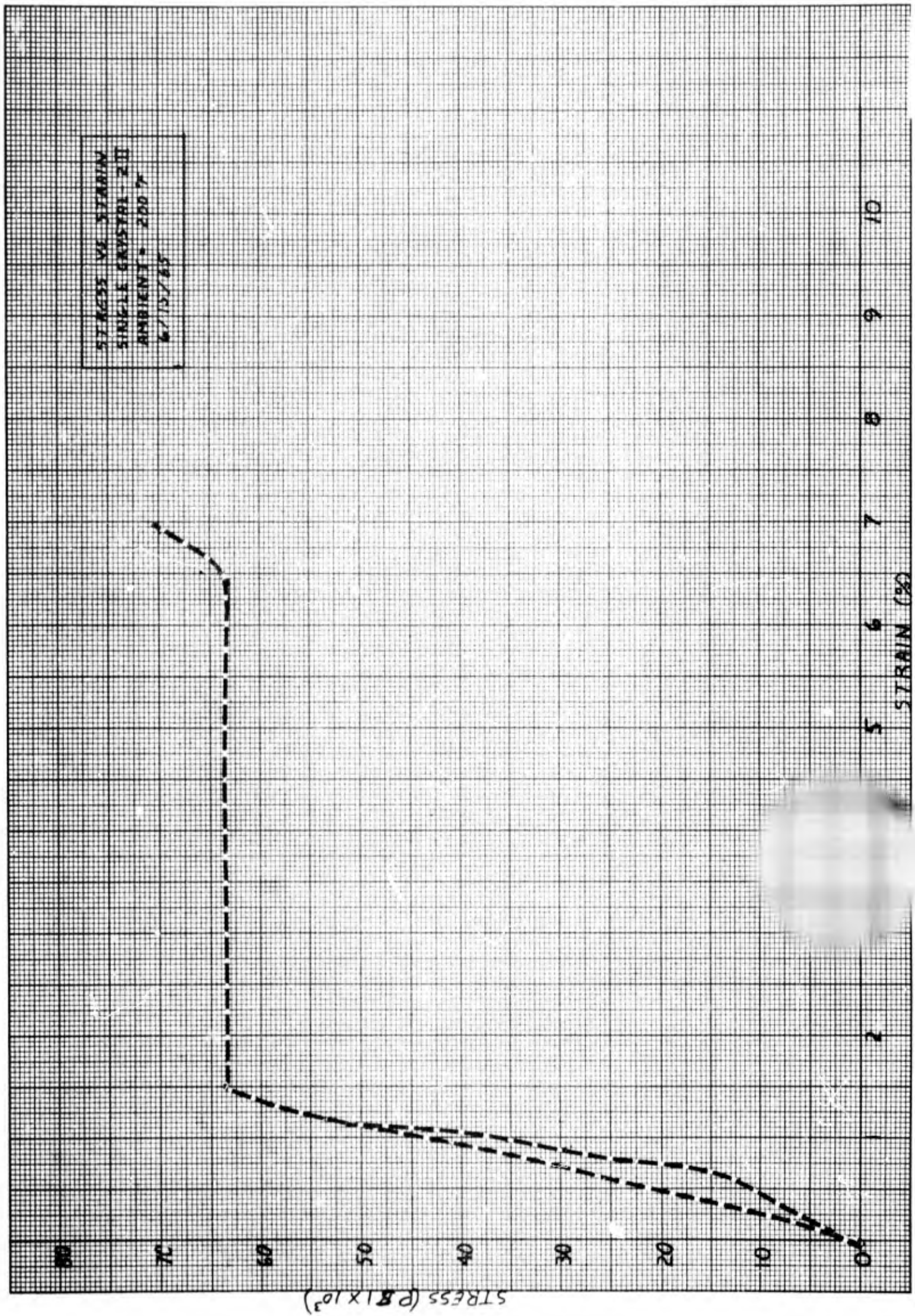


Fig. 15

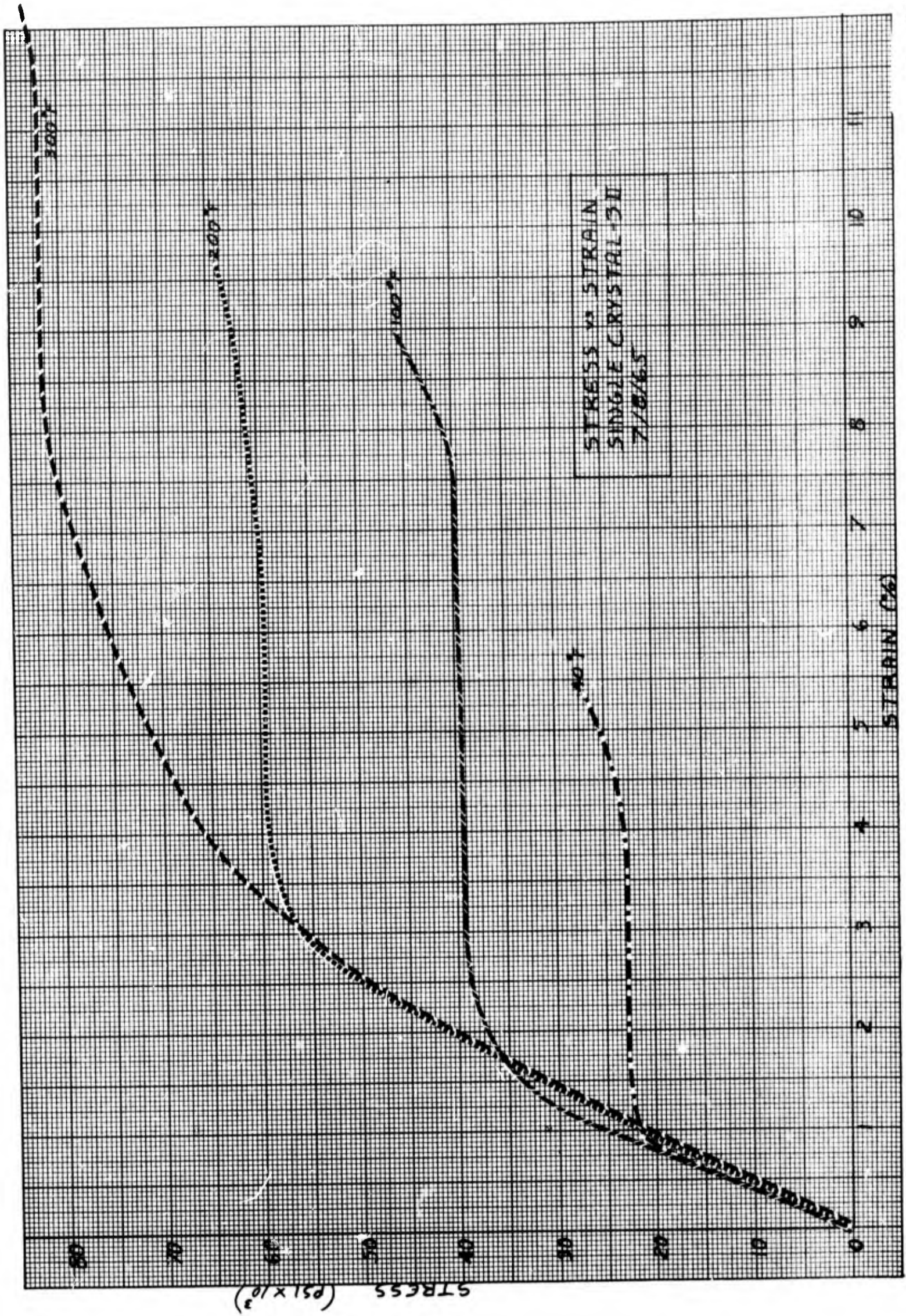
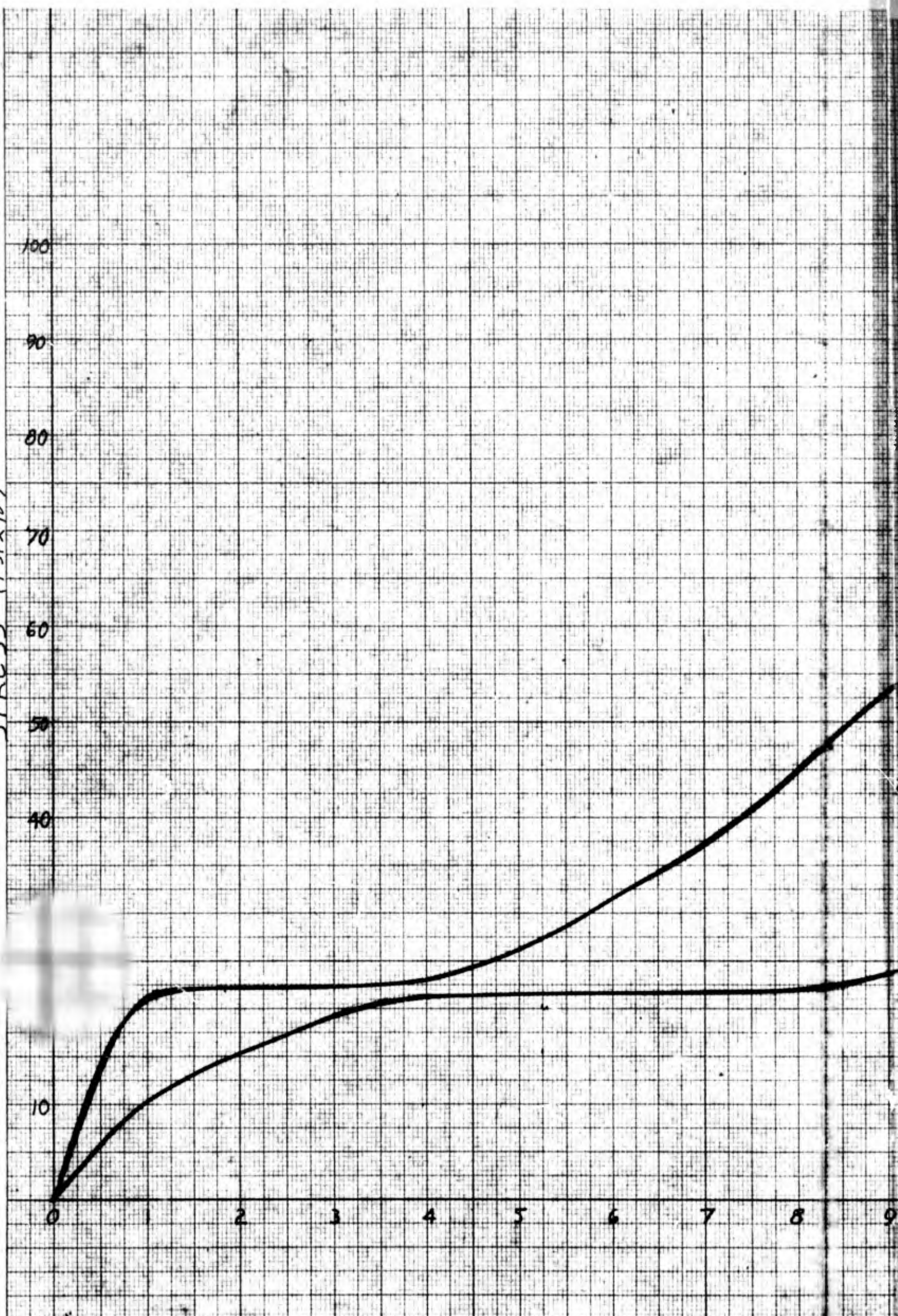
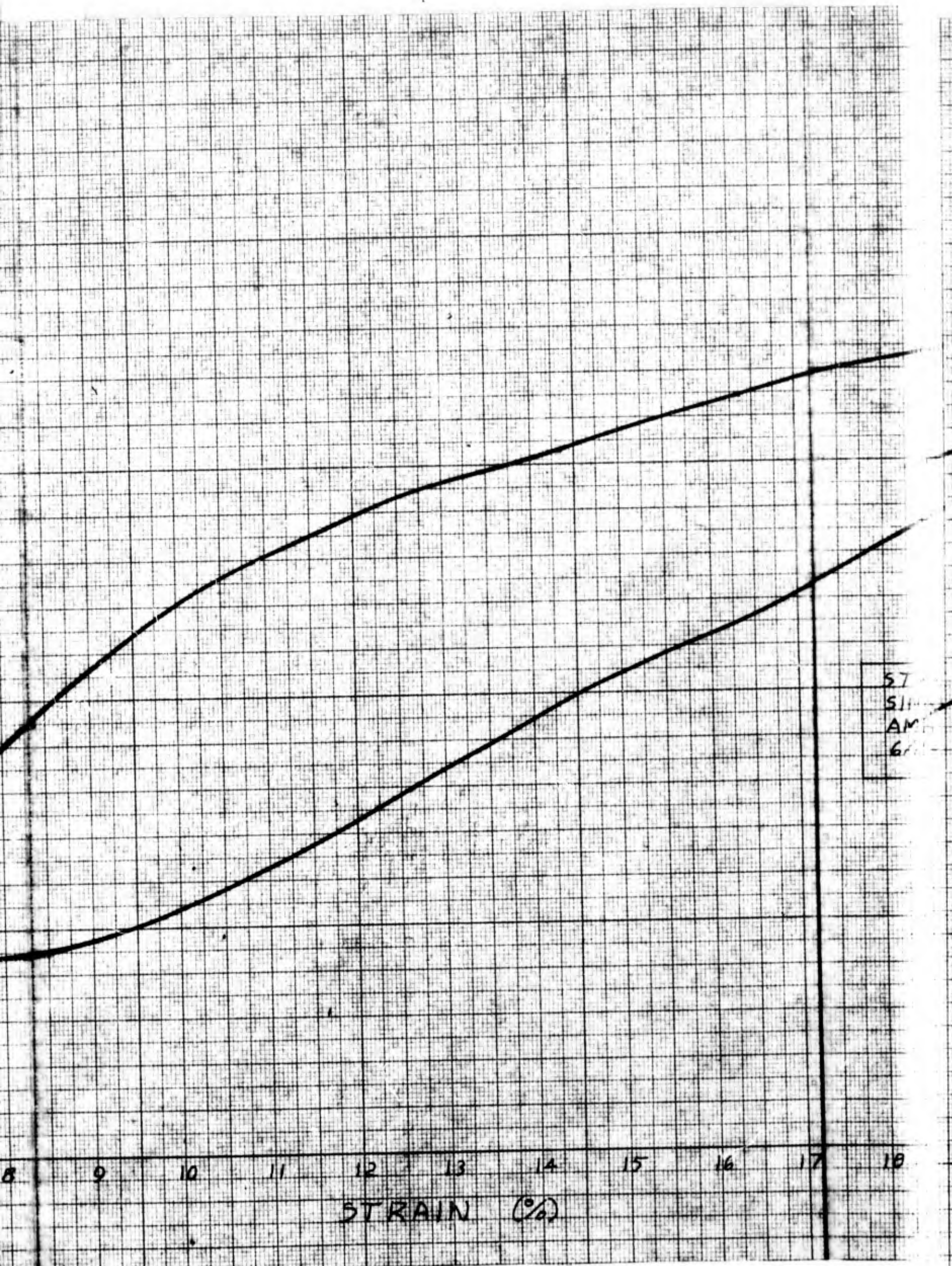
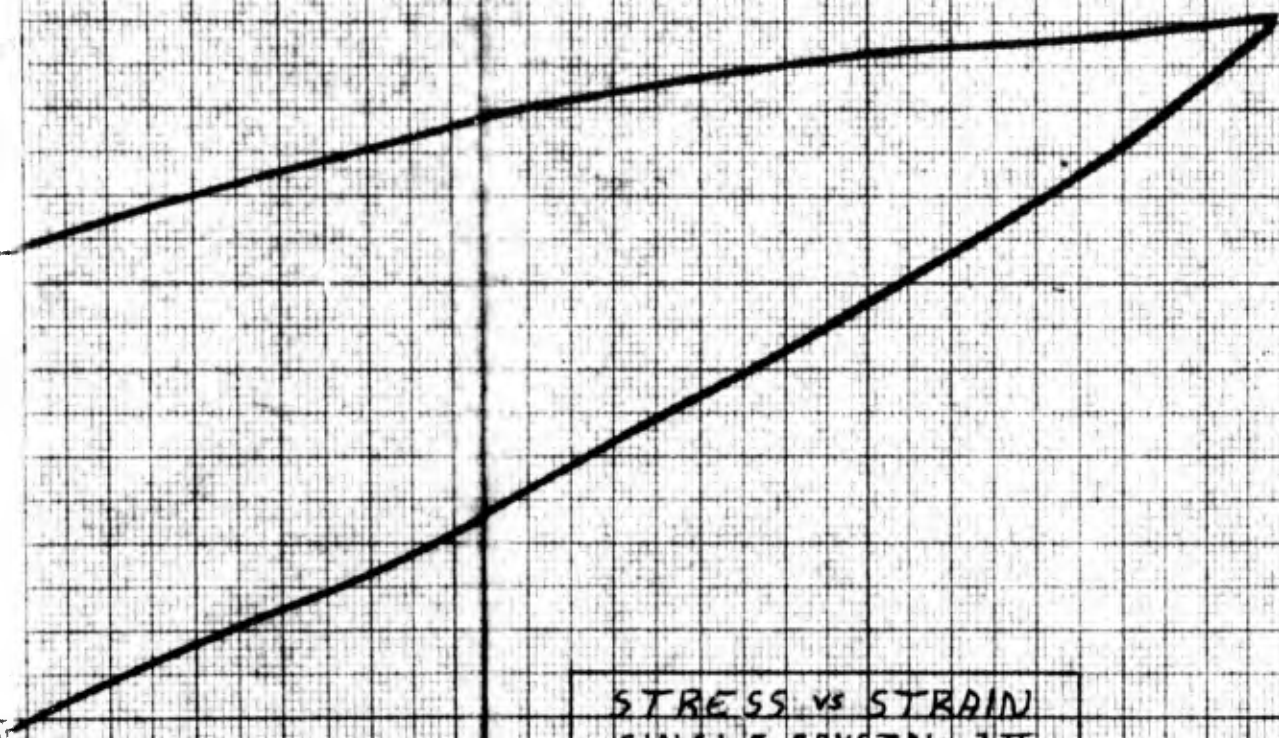


Fig. 16

STRESS ($\text{psi} \times 10^3$)



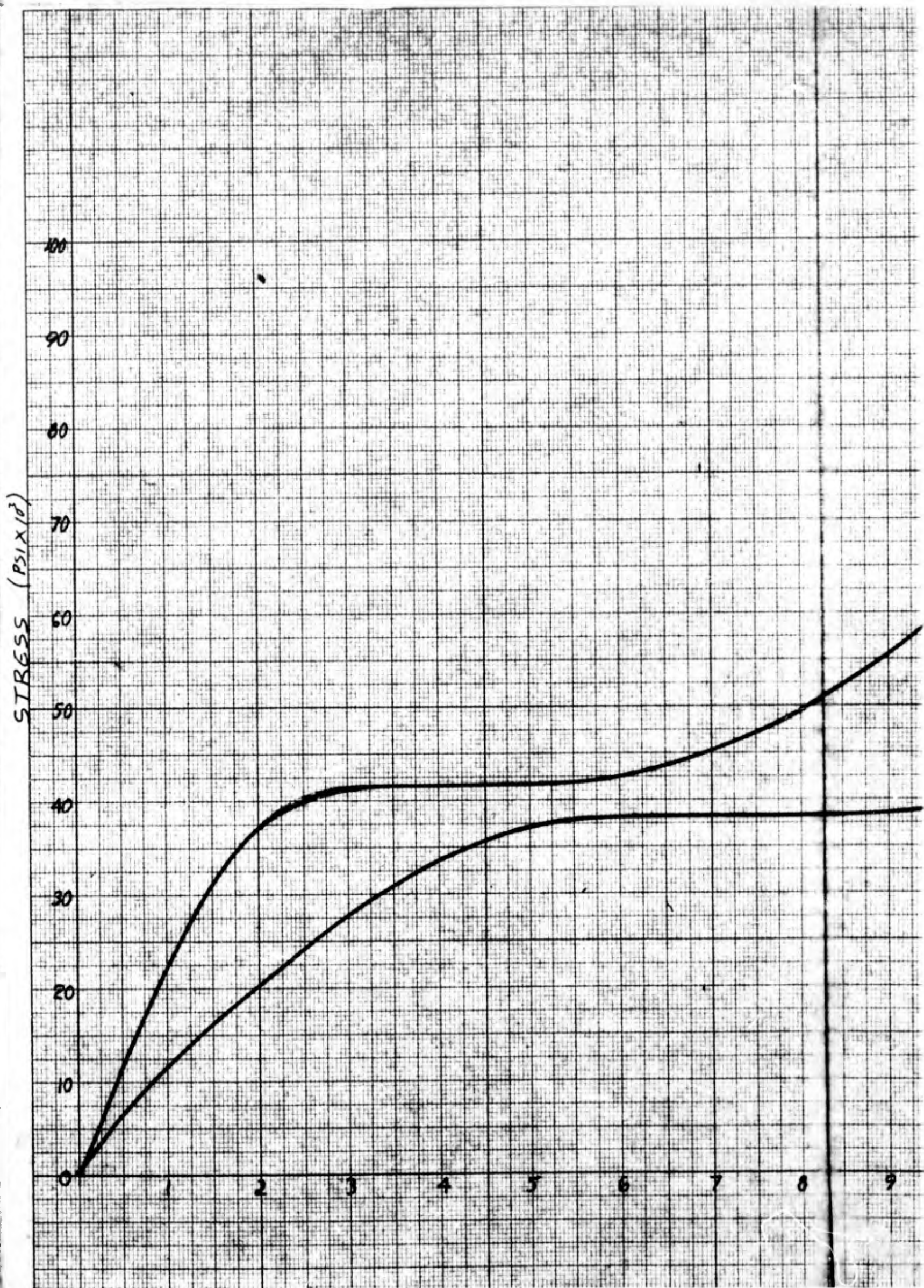


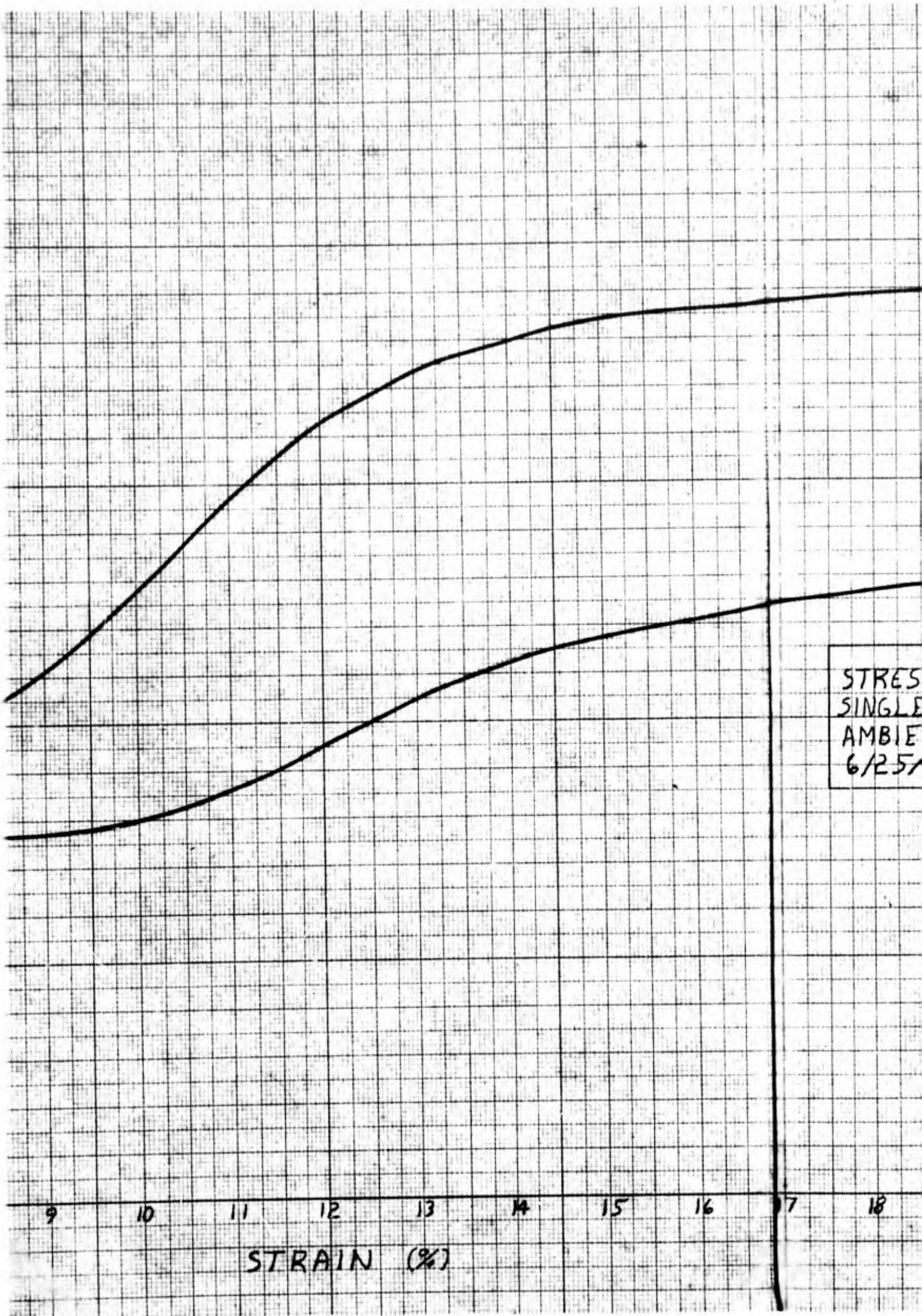


STRESS vs STRAIN
SINGLE CRYSTAL-3II
AMBIENT = 40°F
6/24/65

15 16 17 18 19 20 21 22 23 24

FIG 17





STRES
SINGLE
AMBIE
6/25

STRAIN (%)

B

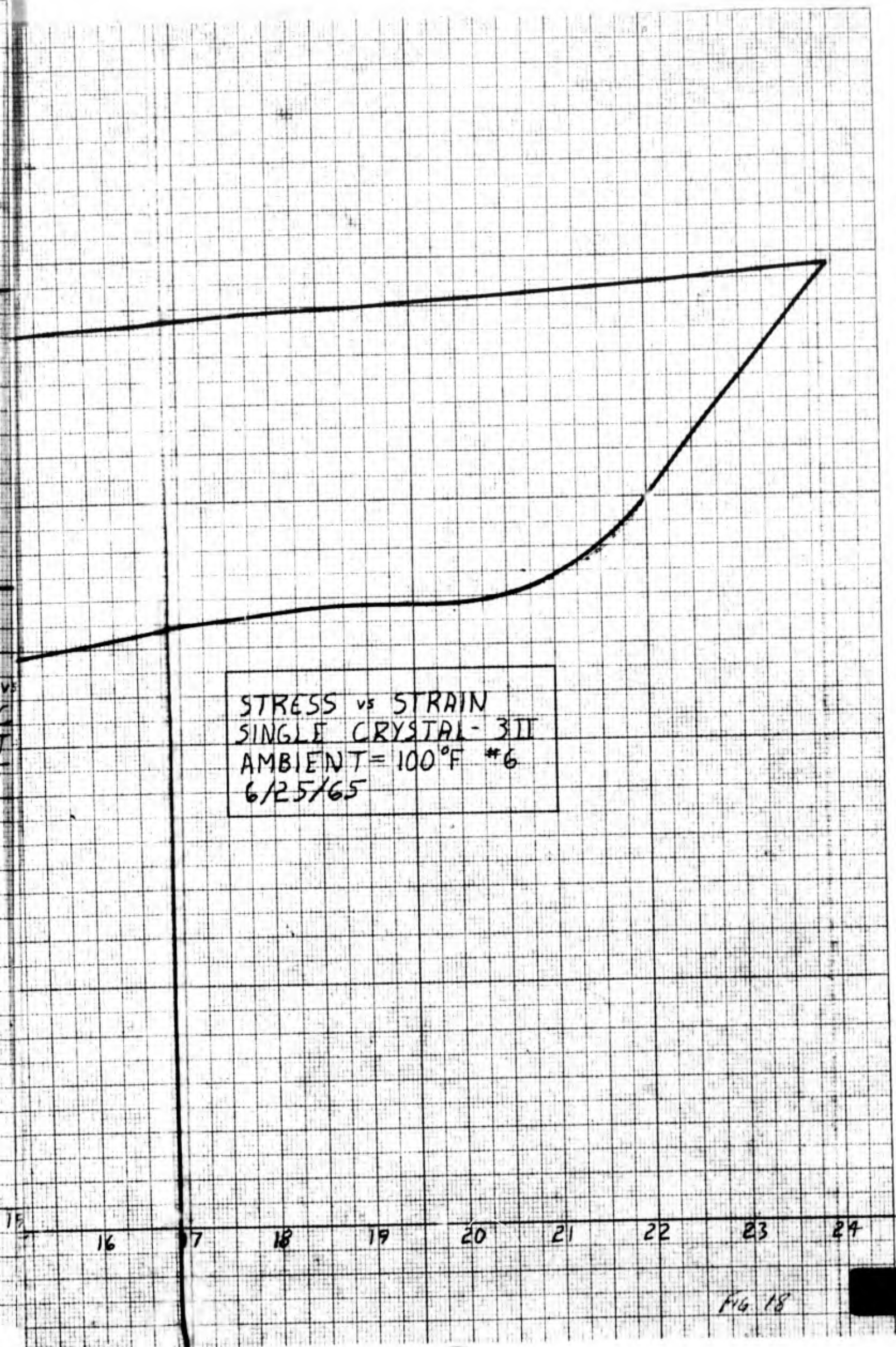
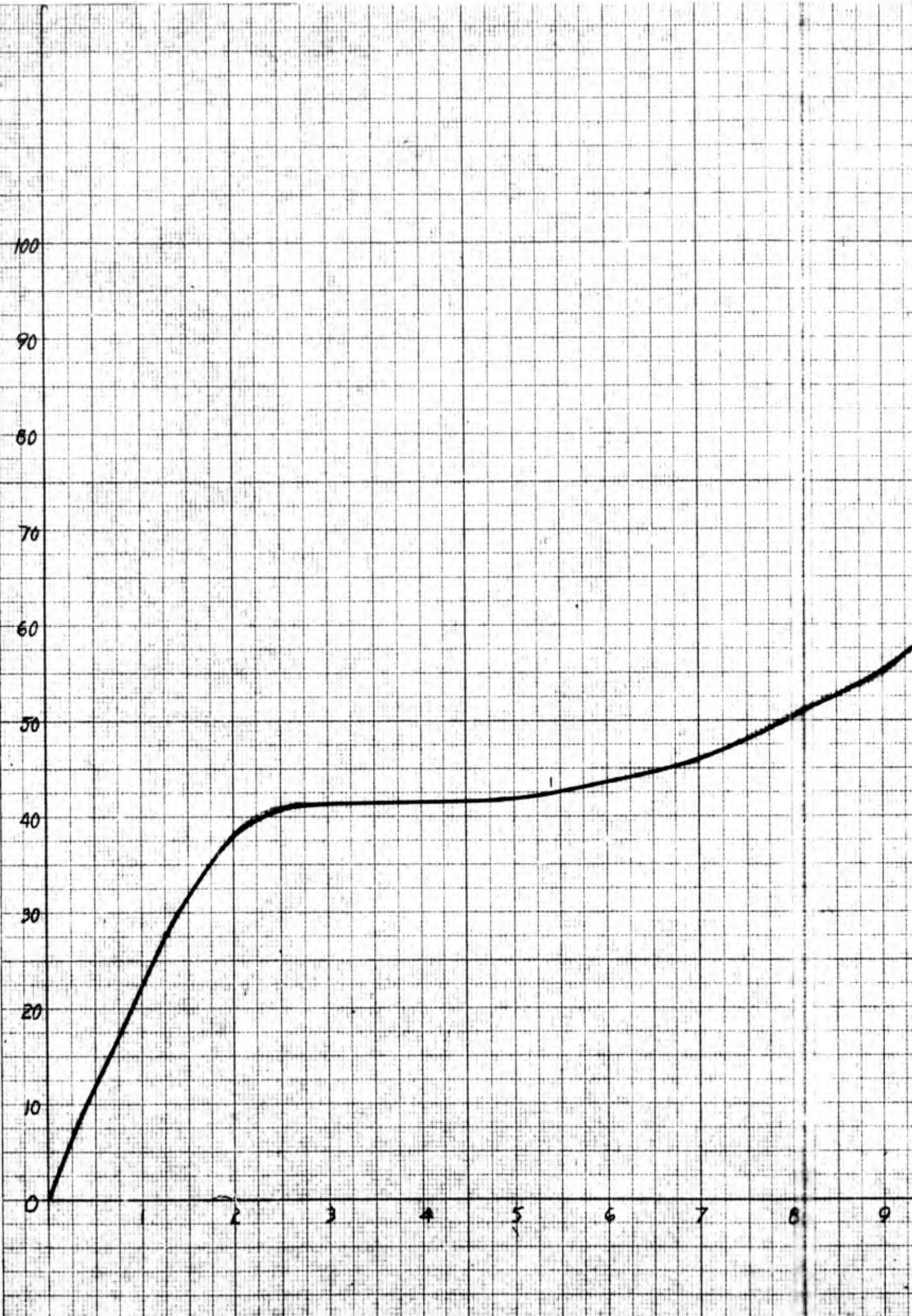
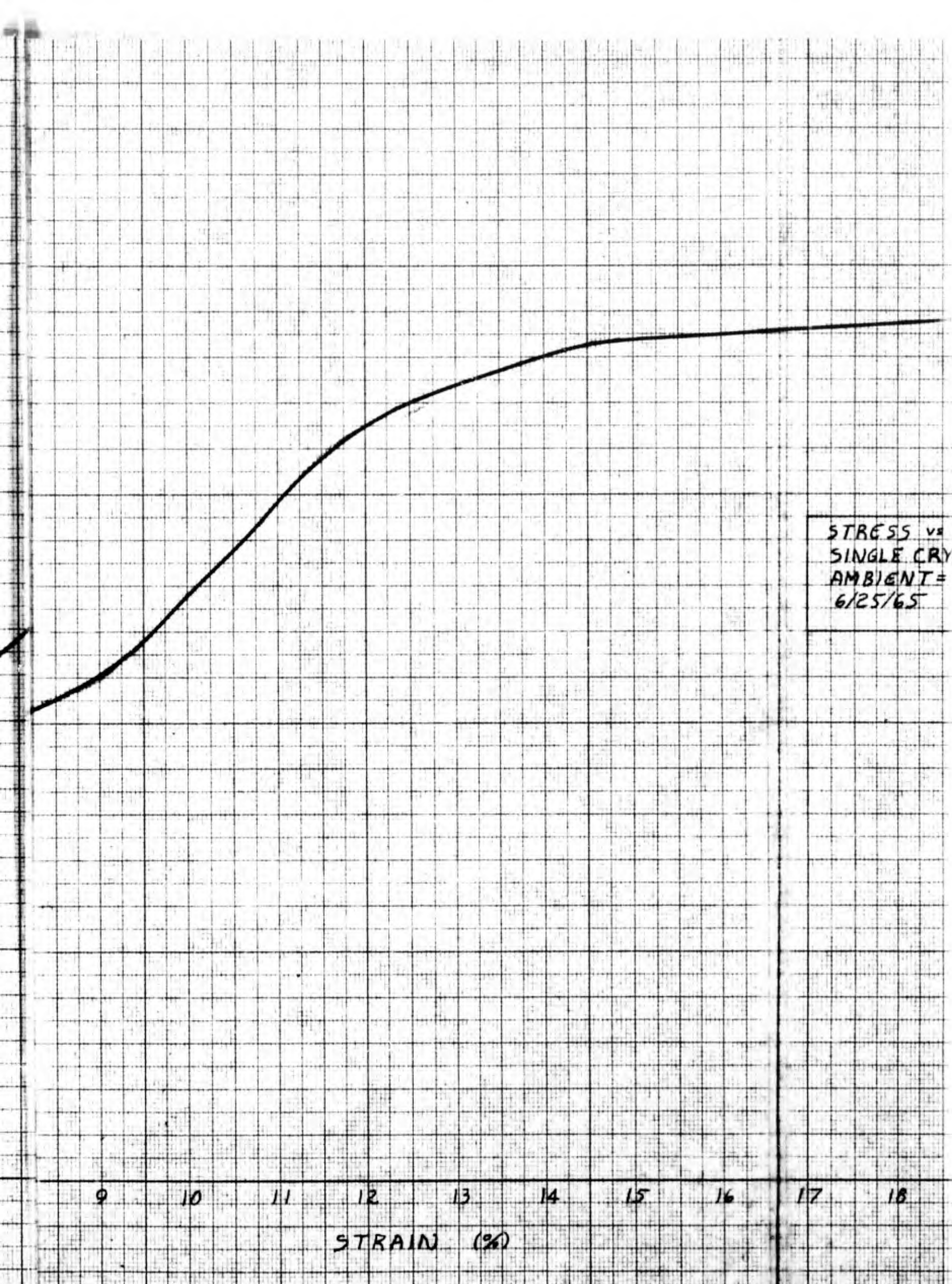


Fig. 18

STRESS (PSI x 10³)





STRESS vs
SINGLE CRY
AMBIENT =
6/25/65

9 10 11 12 13 14 15 16 17 18

STRAIN (%)

STRESS vs STRAIN
SINGLE CRYSTAL-3II
AMBIENT = 100°F #7
6/25/65

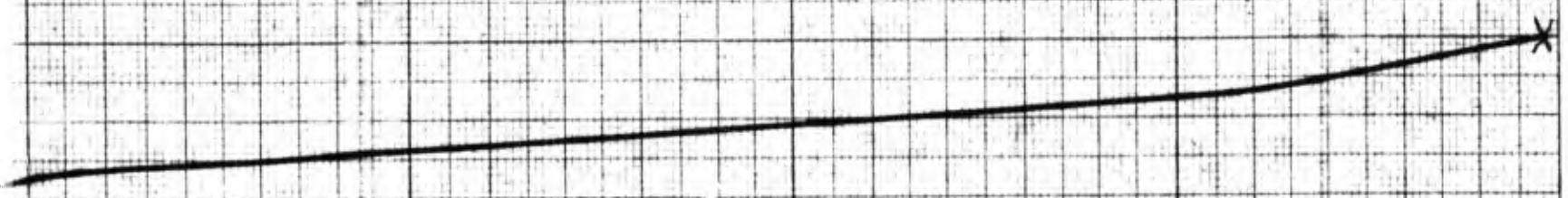
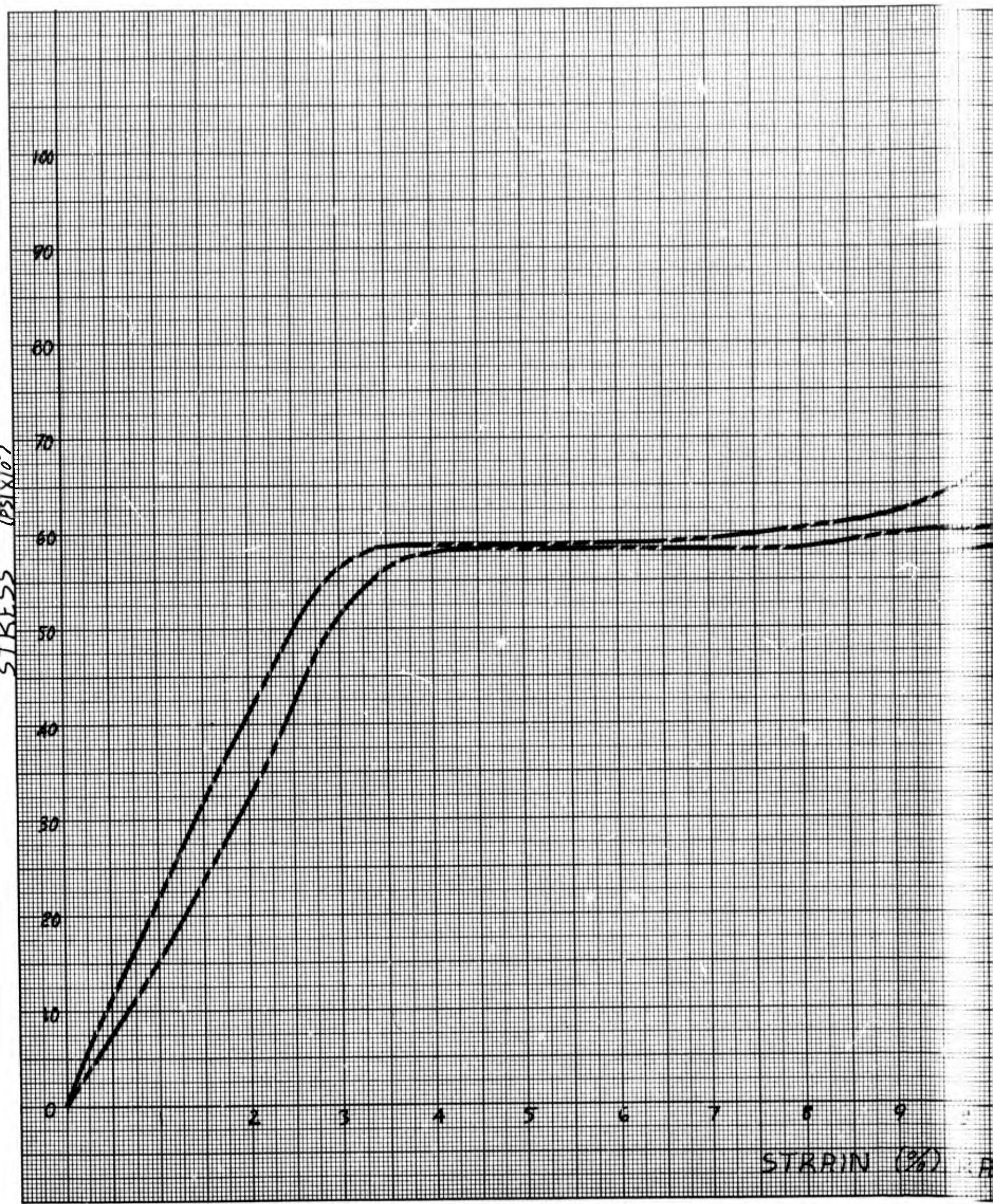
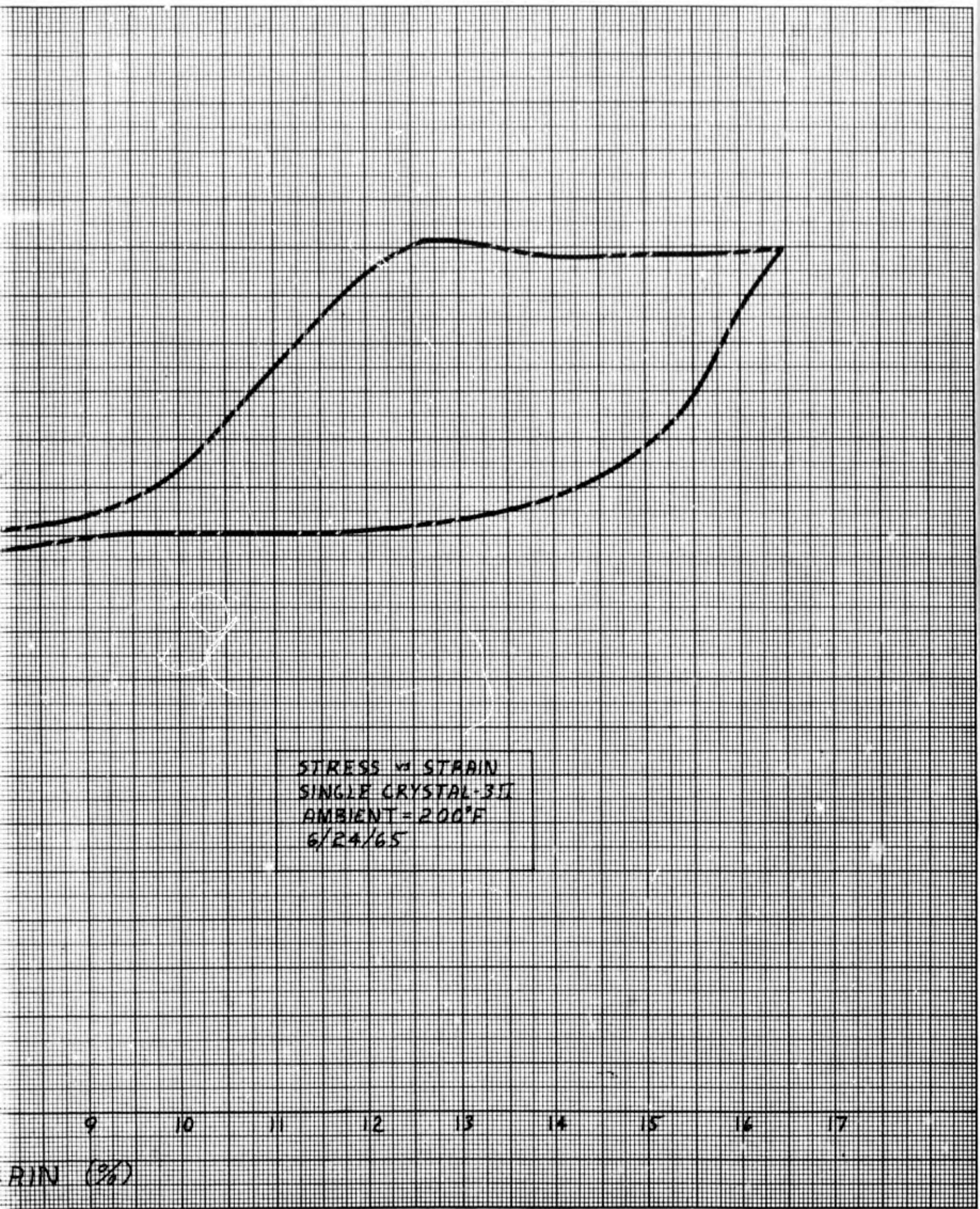


Fig. 19

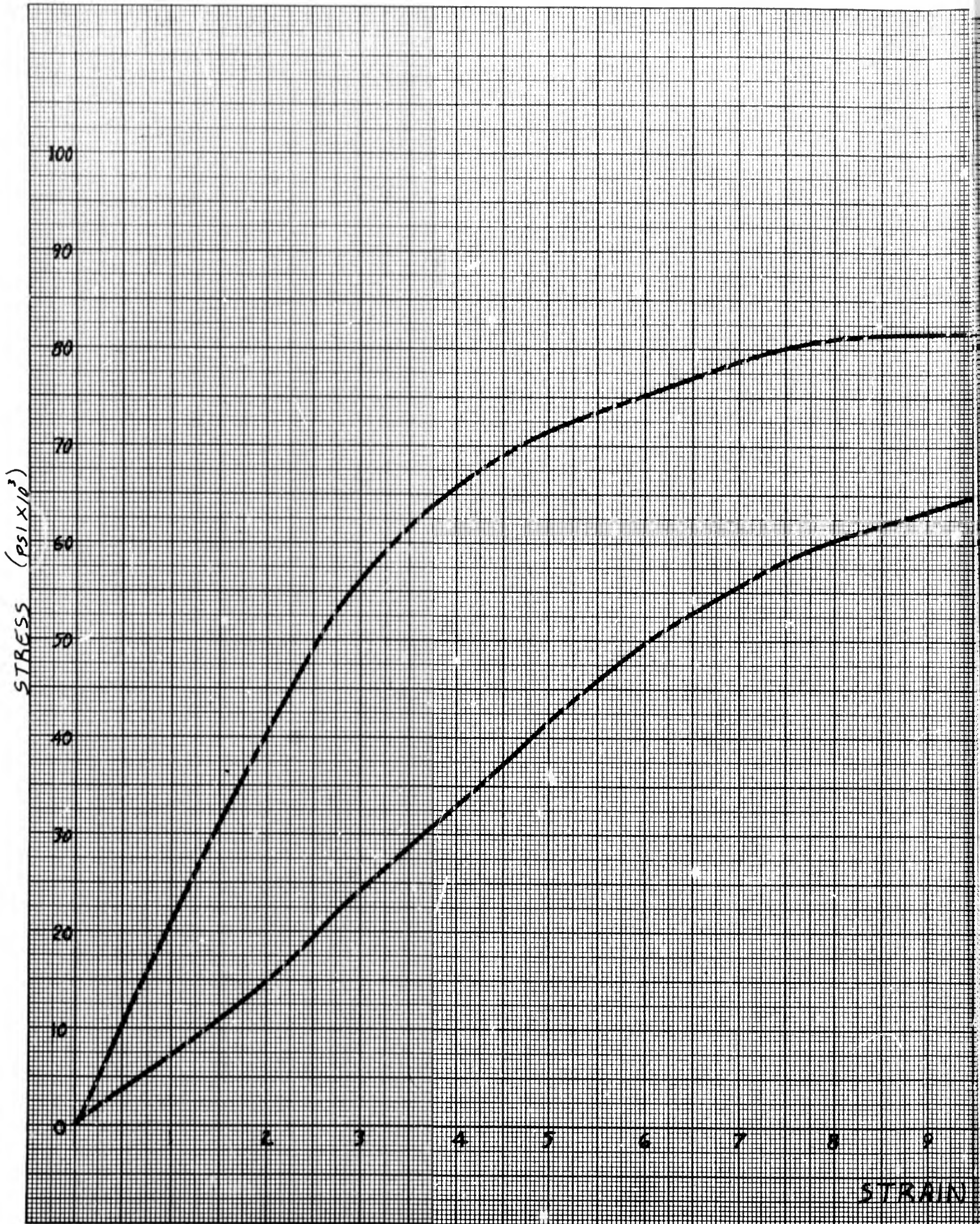


A

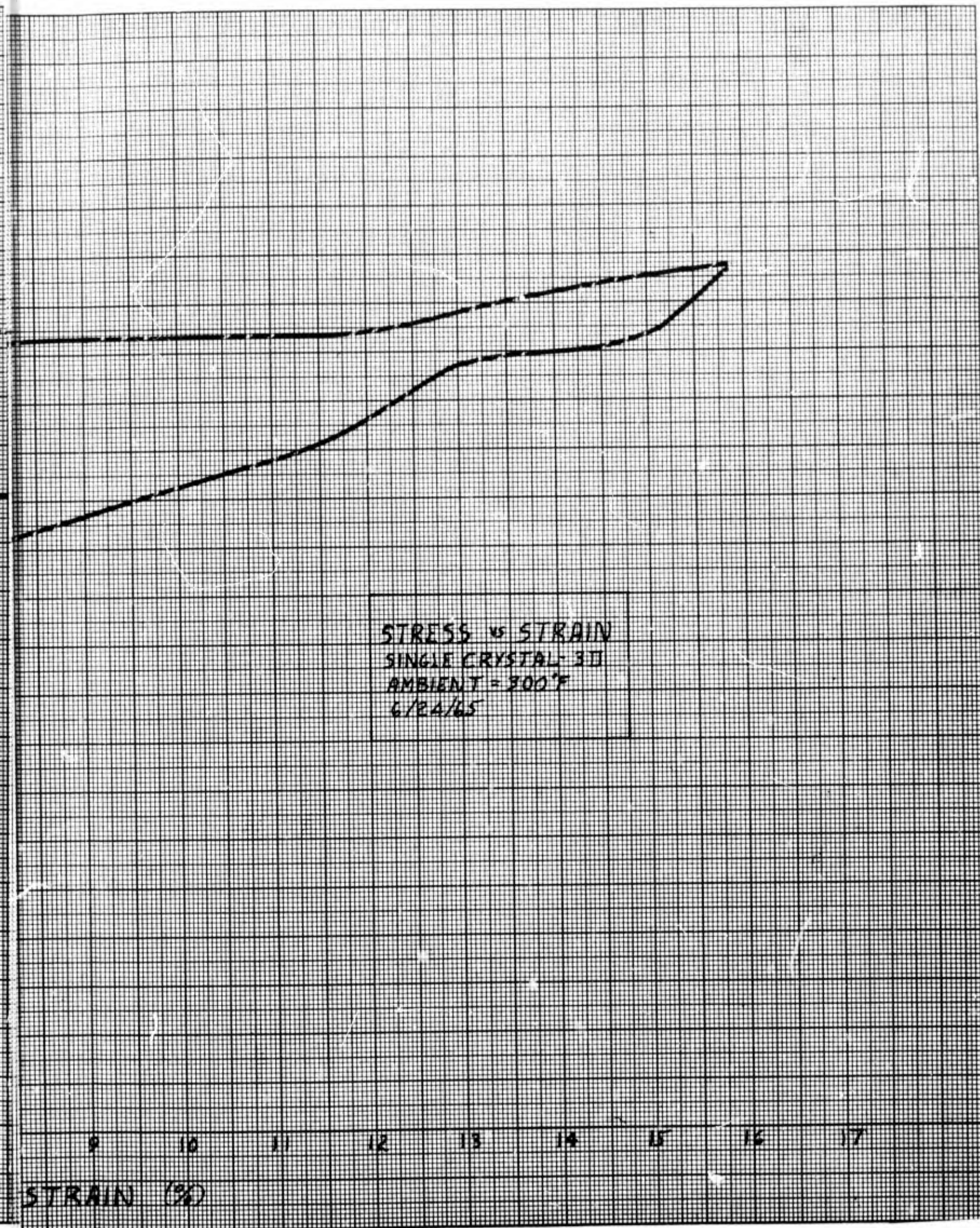


B

Fig. 20

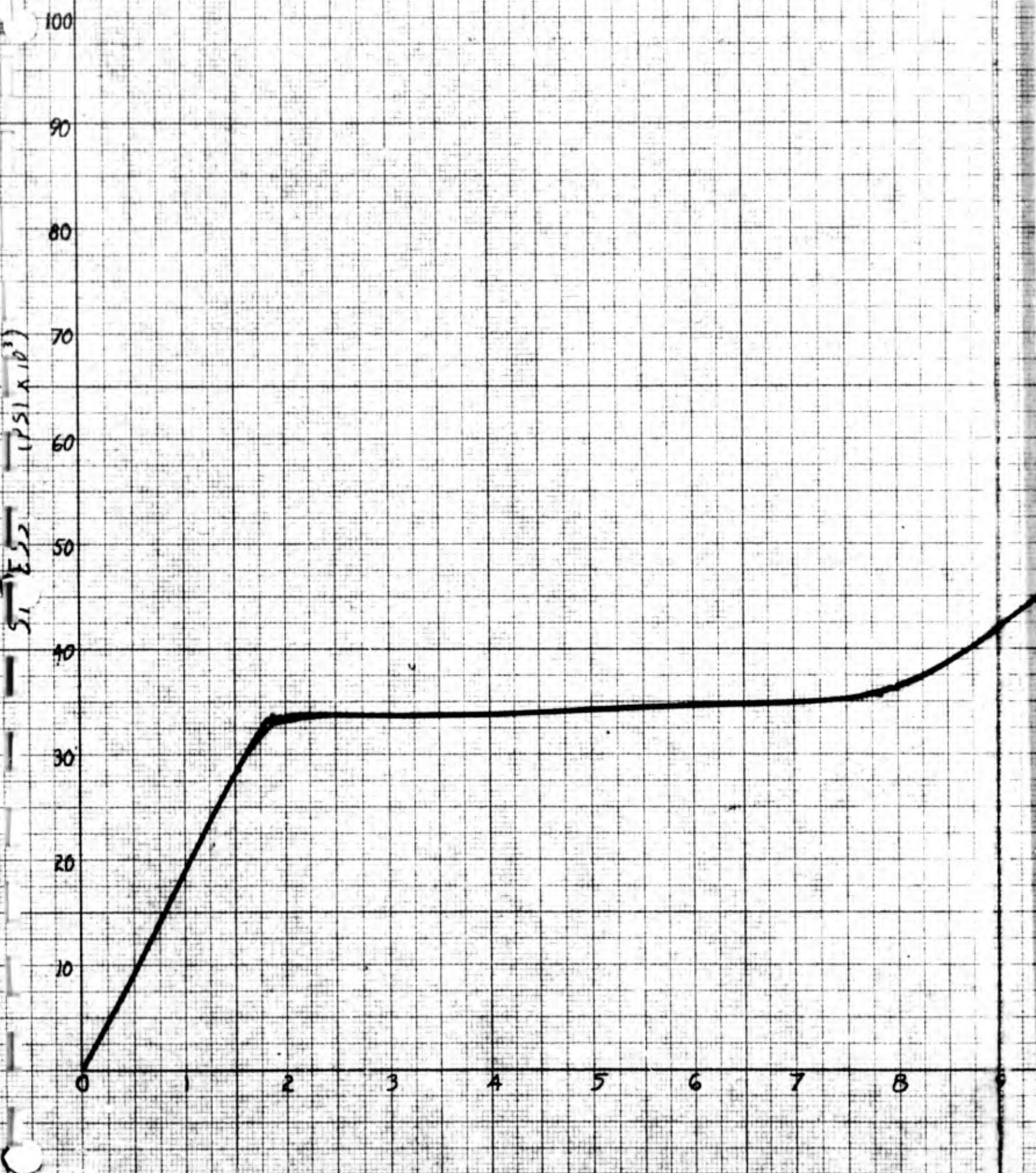


A



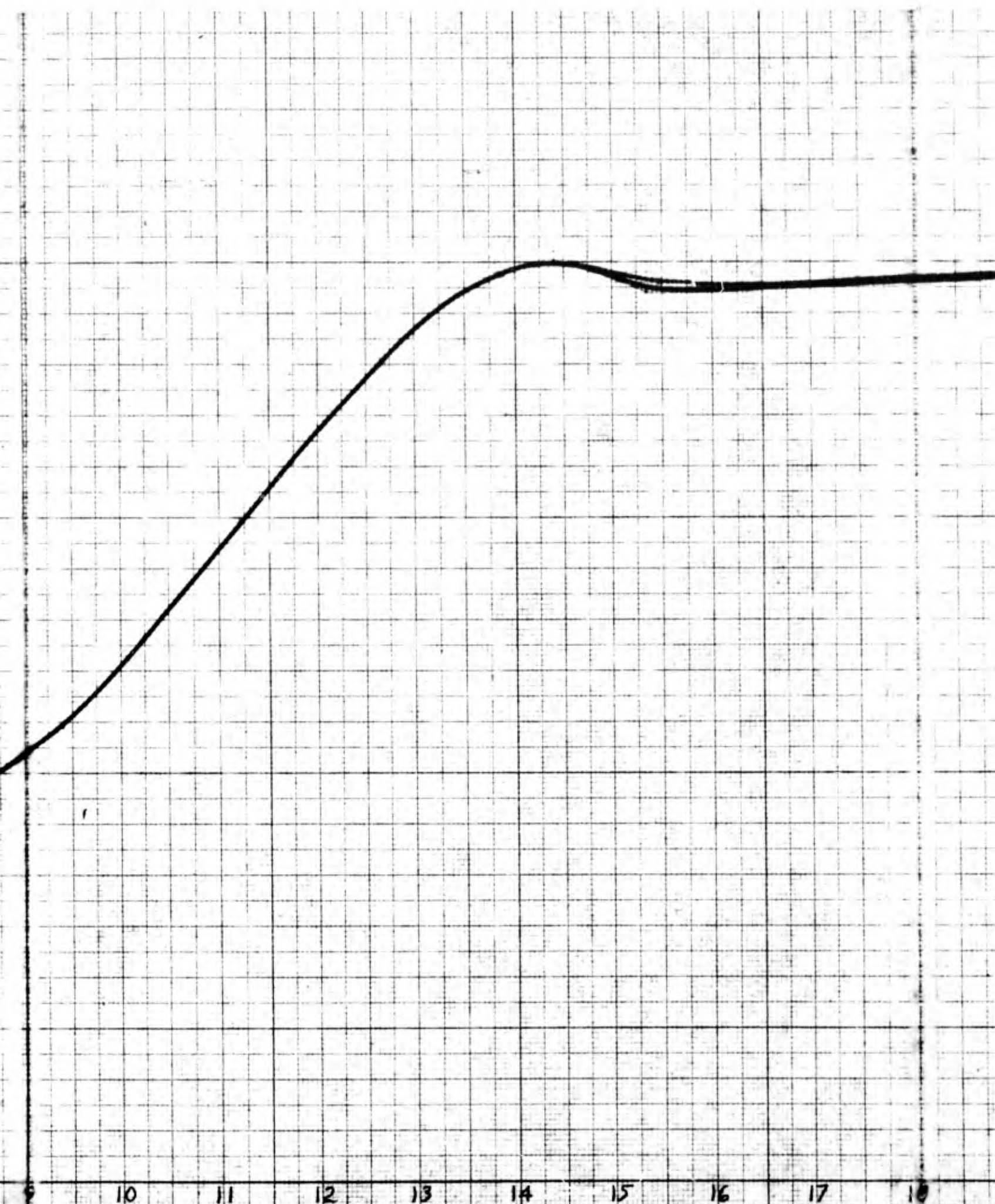
B

Fig. 21



A

KEUFFEL & ESSER CO.
MADE IN U.S.A.



S. TRAI

B

K+E STANDARD © CROSS SECTION
MILLIMETER

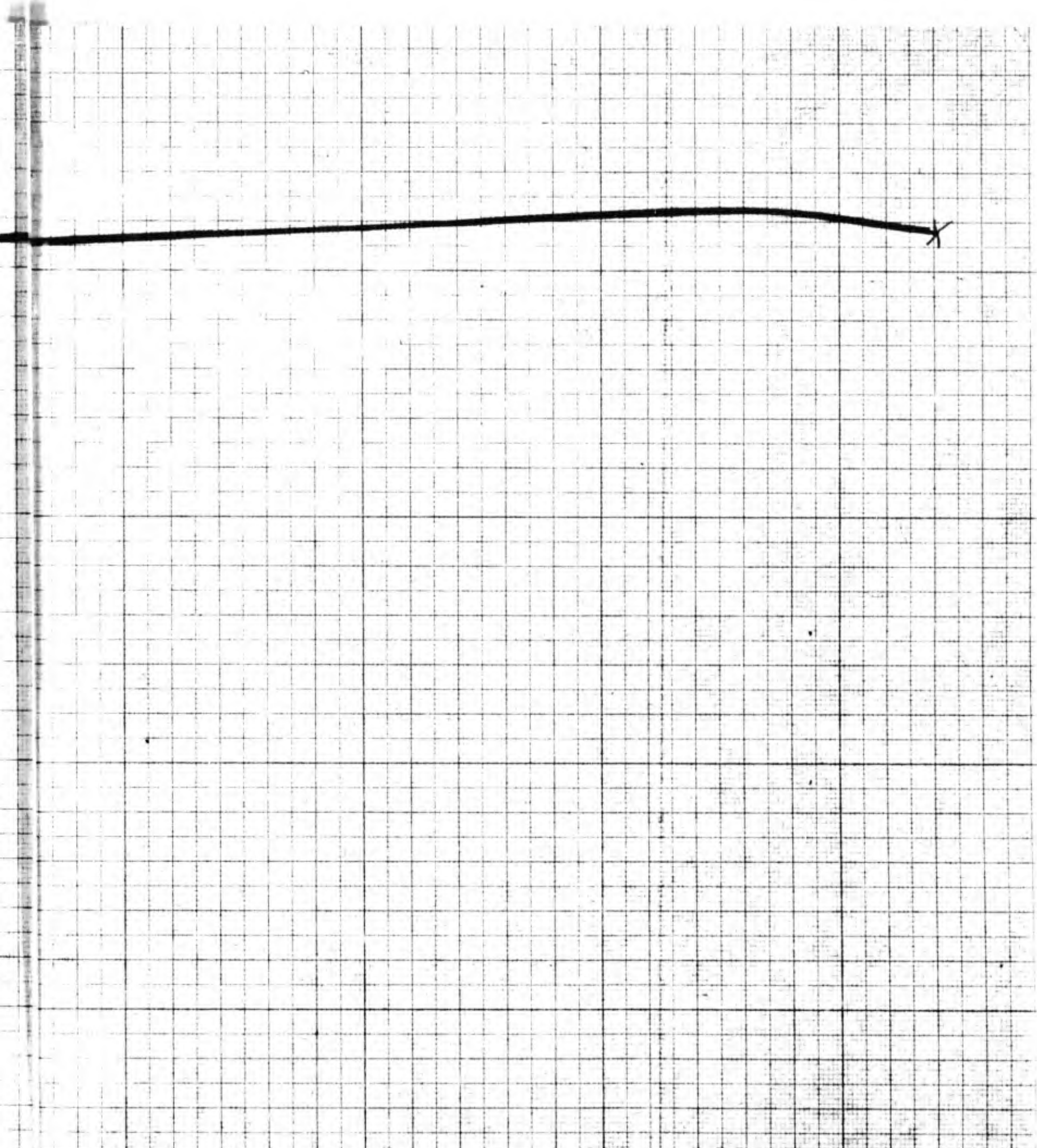


STRESS vs STRAIN
SINGLE CRYSTAL-3III
AMBIENT = 85°F
6/18/65

19 20 21 22 23 24 25 26 27 28

RAIN (%)

C



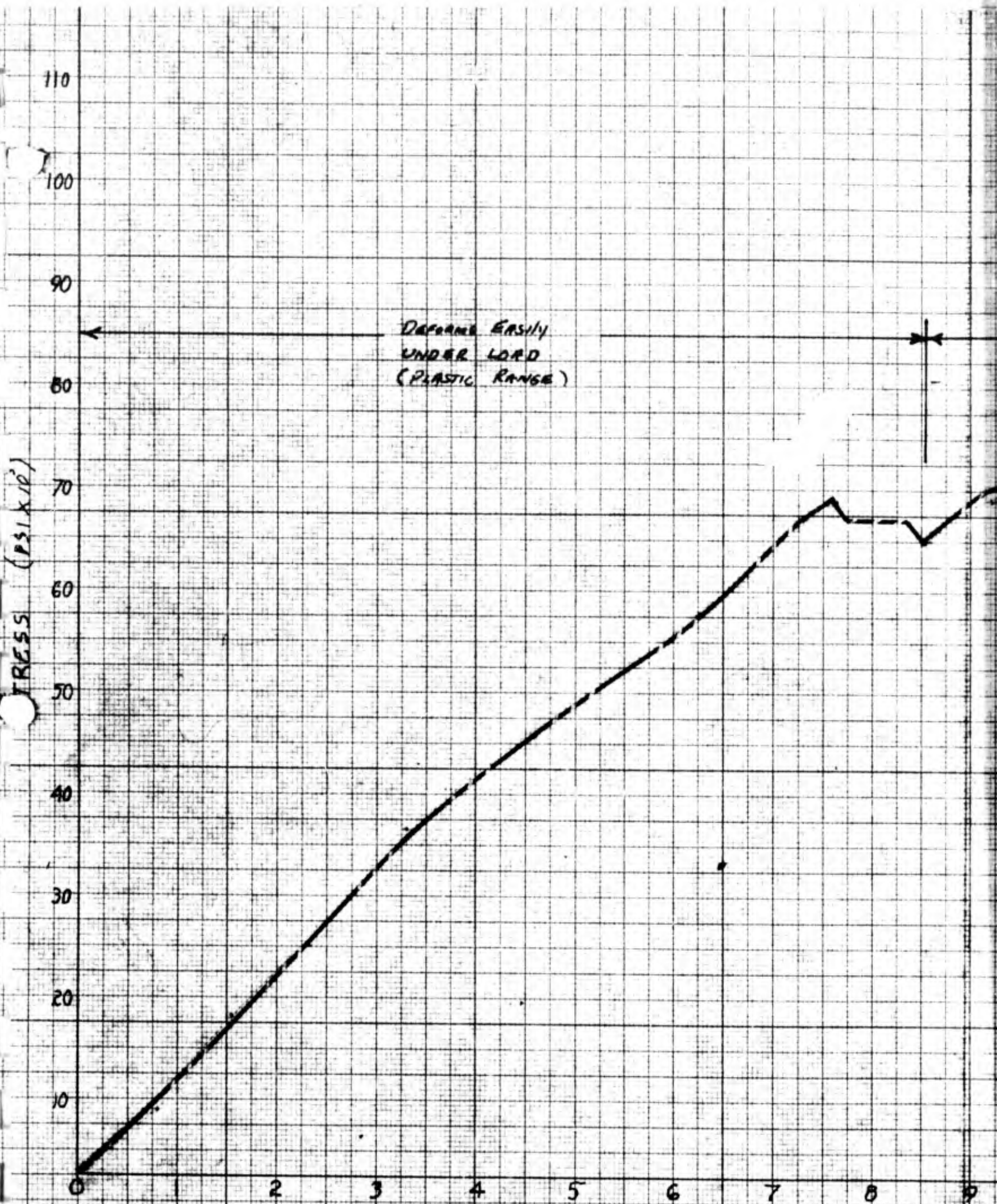
29 30 31 32 33 34 35 36 37 38



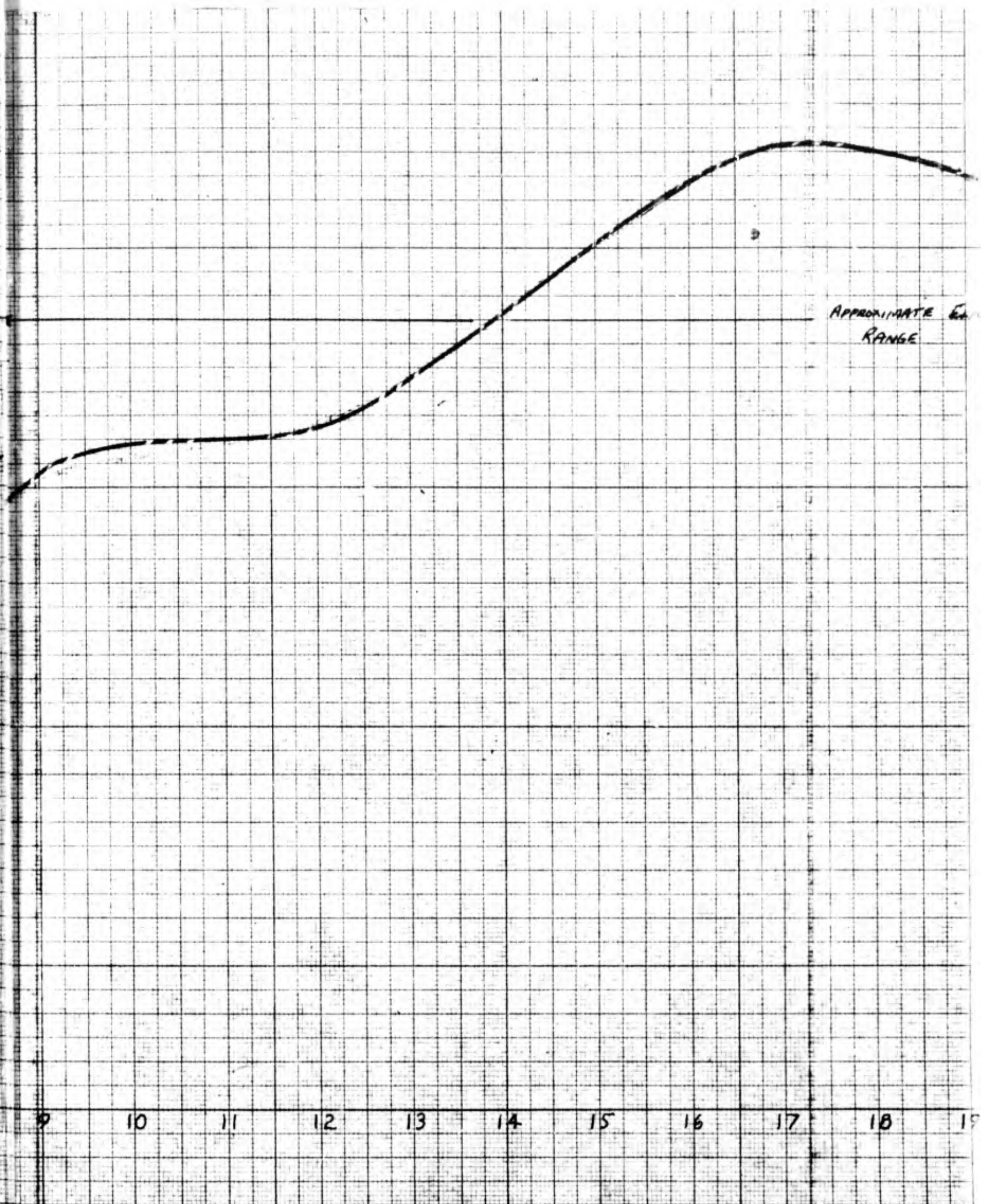
FIG. 21

D

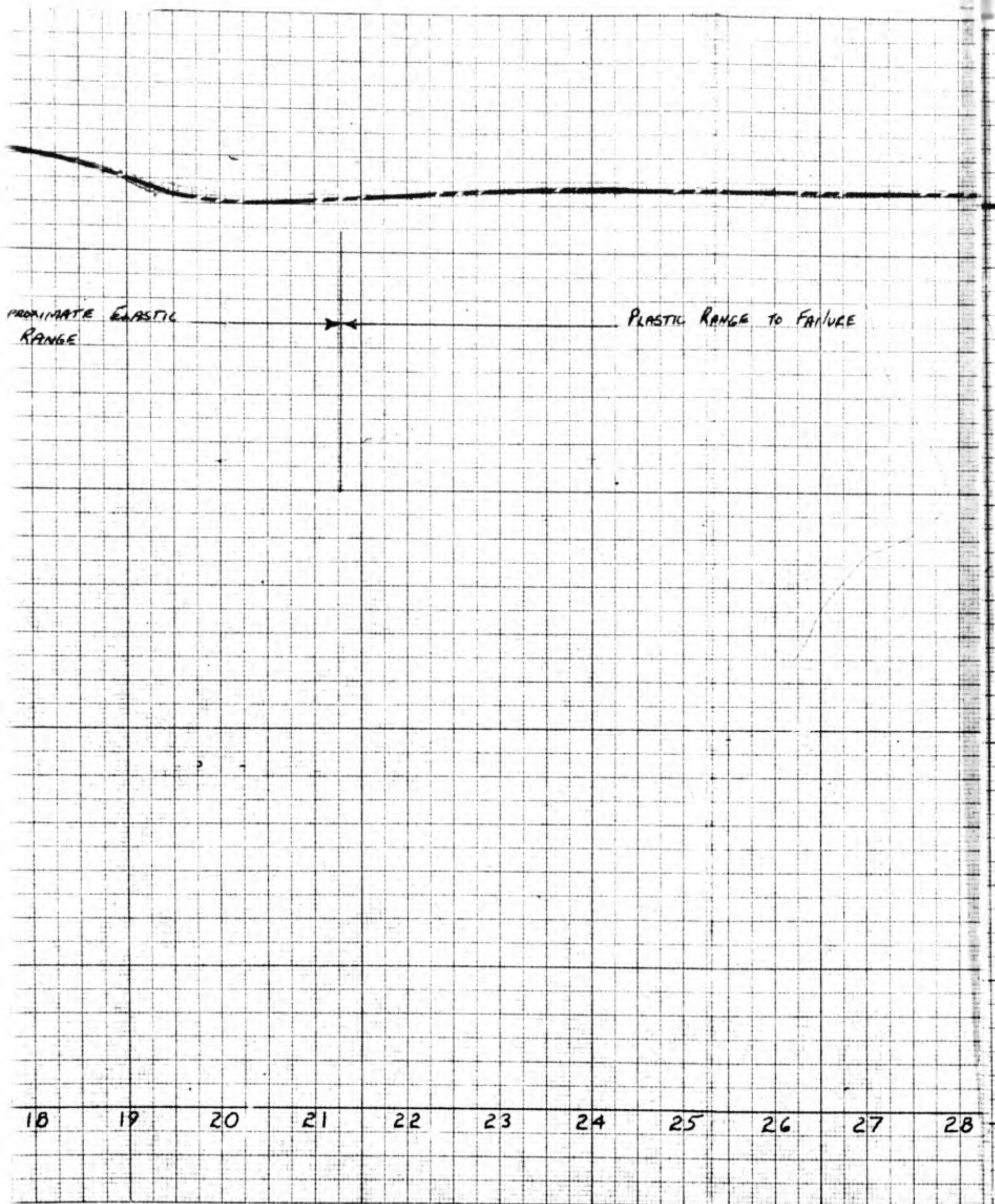
K+Σ STANDARD CROSS SECTION
MILLIMETER



A



B



C

STRESS vs STRAIN
SINGLE CRYSTAL-3I
AMBIENT = -290°F
6/21/65

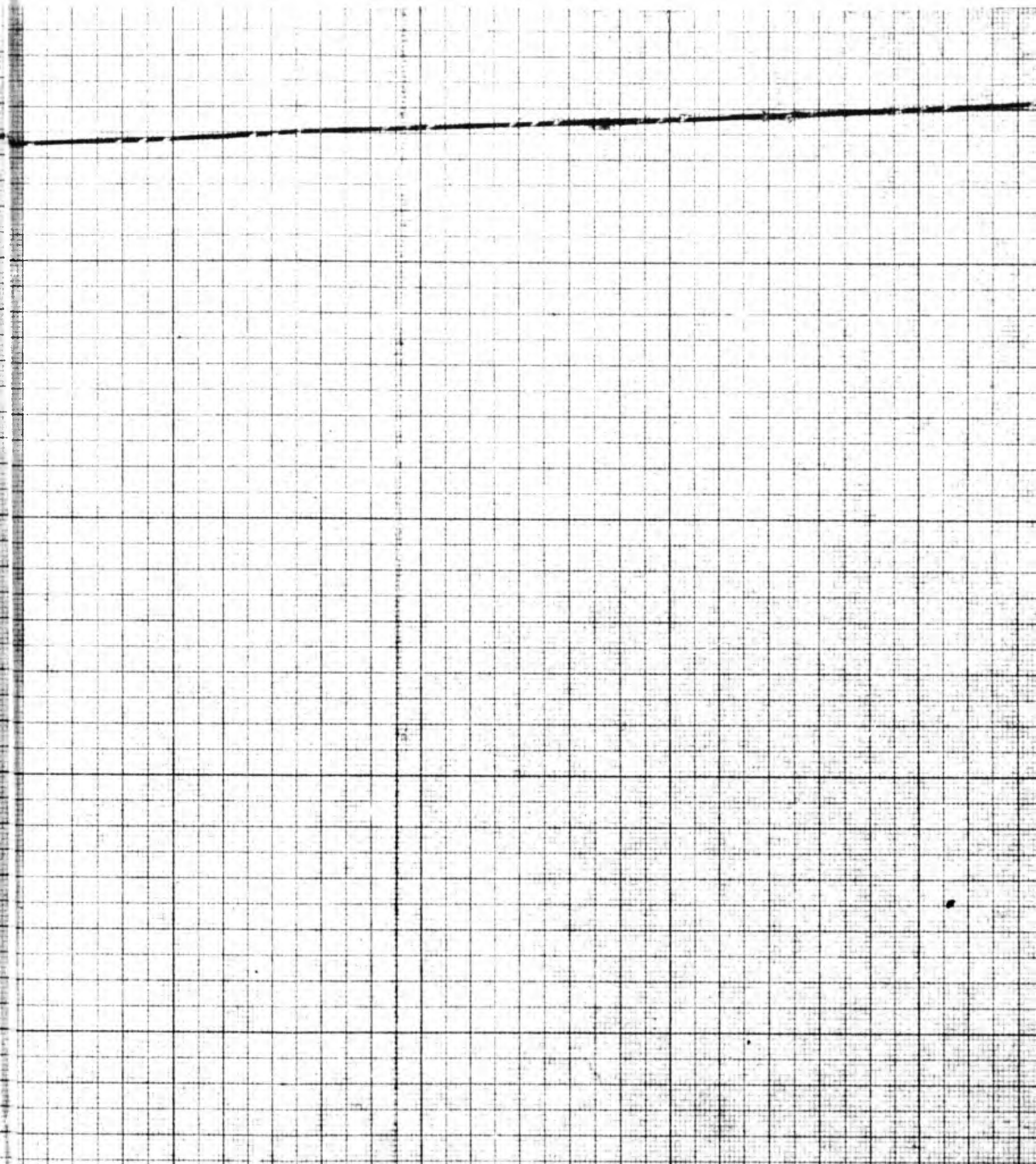
7 28 29 30 31 32 33 34 35 36 37

STRAIN (%)

D

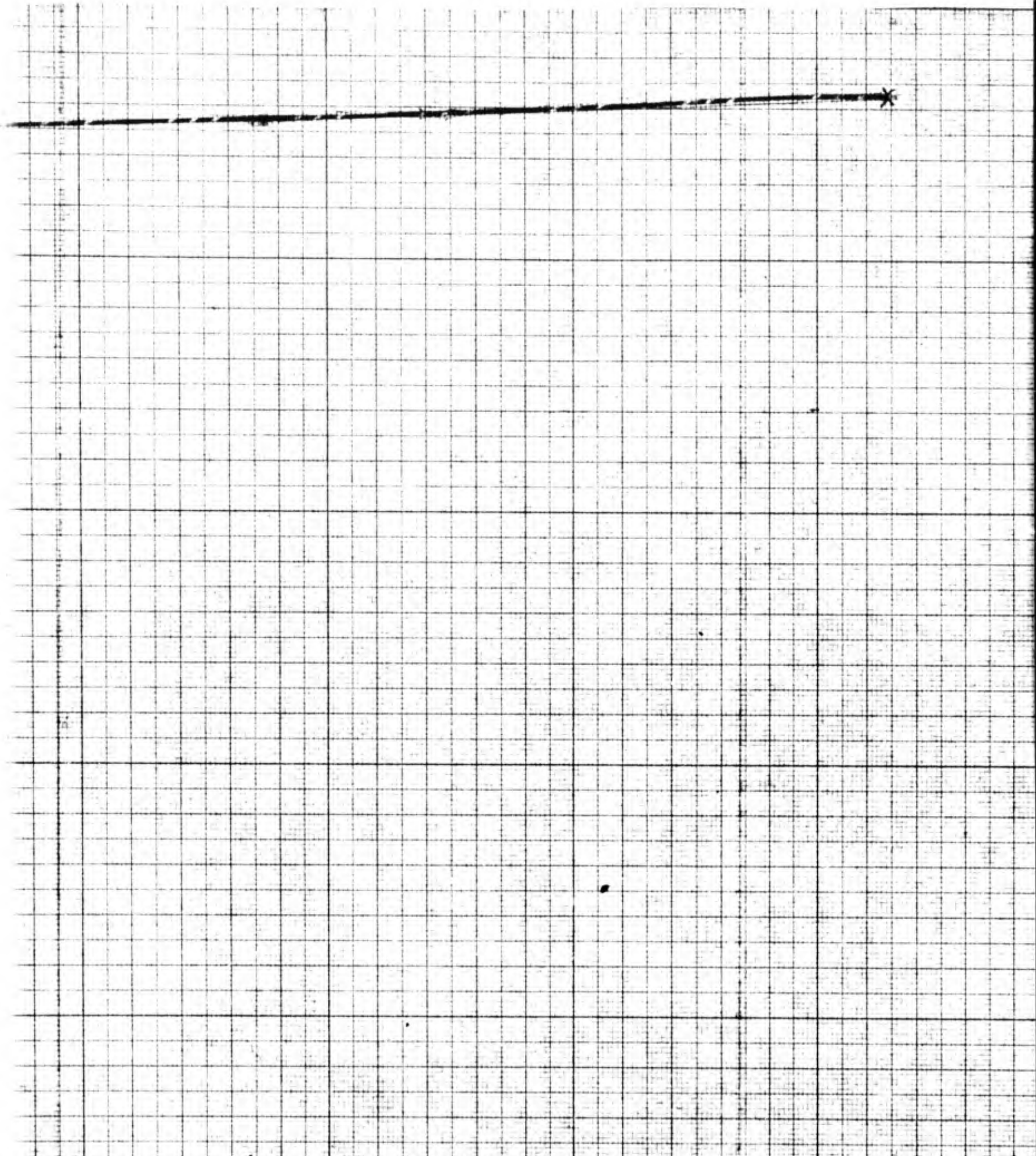
37 38 39 40 41 42 43 44 45 46

E



5 46 47 48 49 50 51 52 53 54 55

F



49 50 51 52 53 54 55 56 57 58

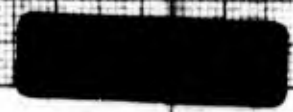
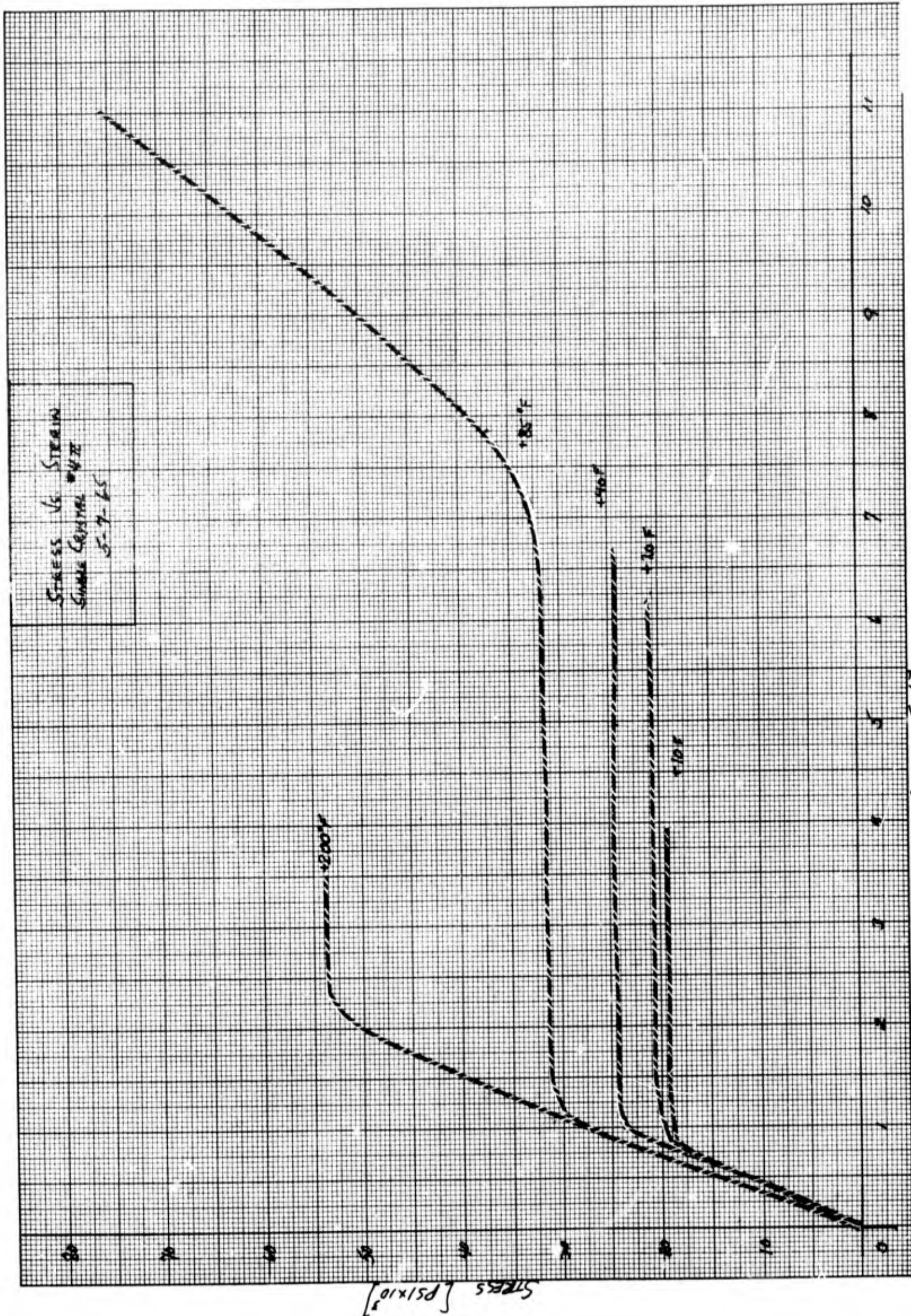


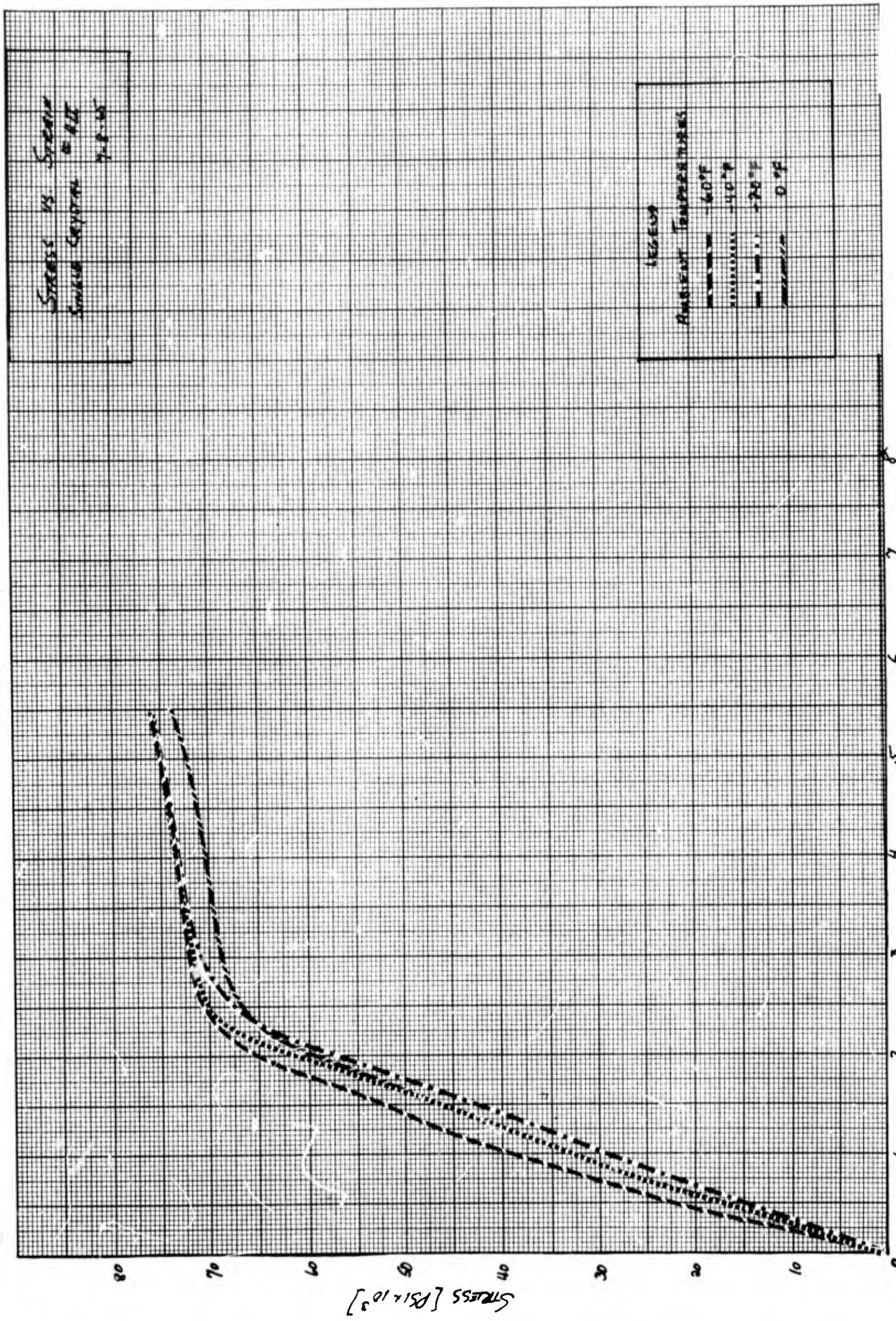
Fig. 2B

G



STRAIN [%]

Fig. 24



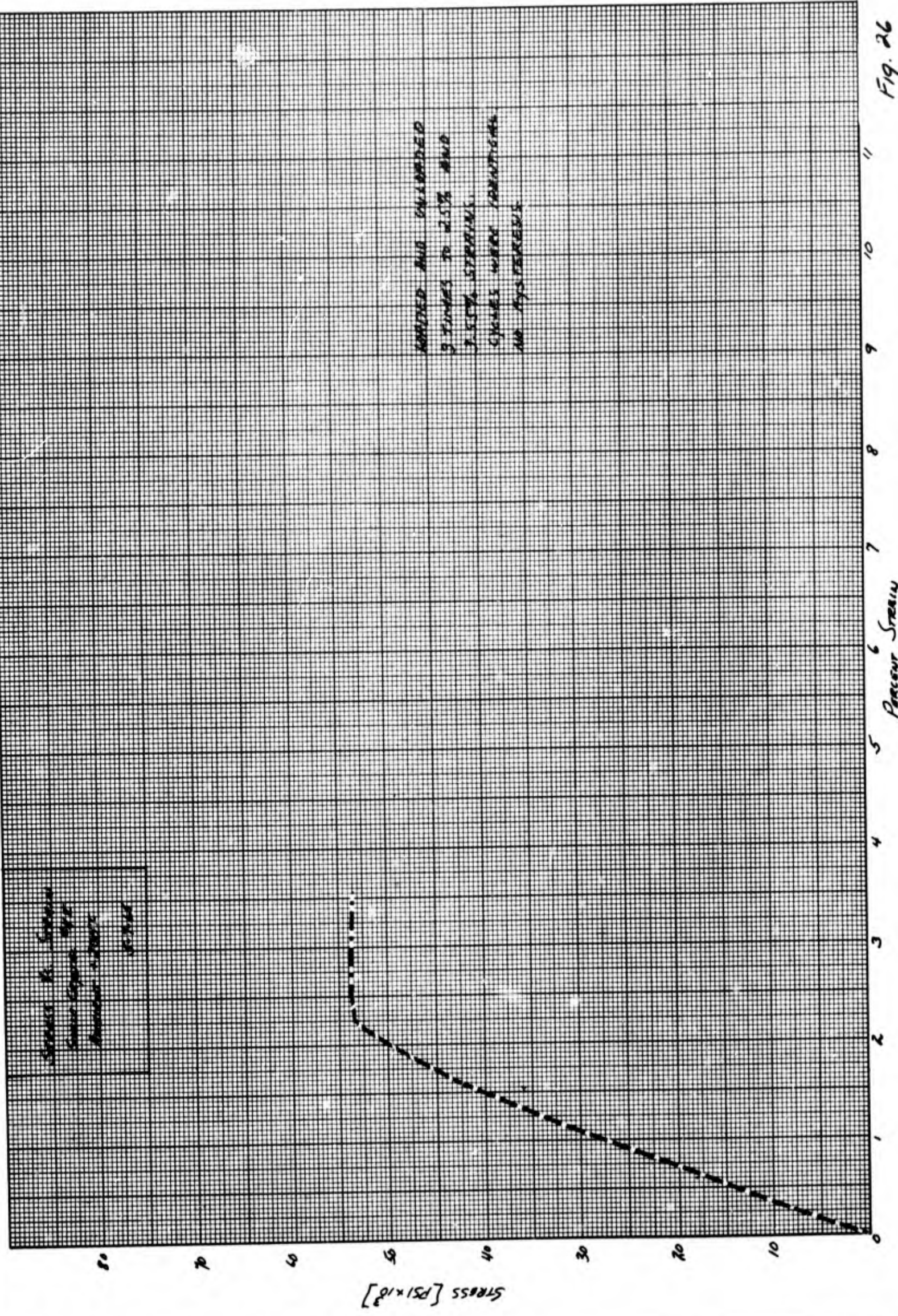


Fig. 26

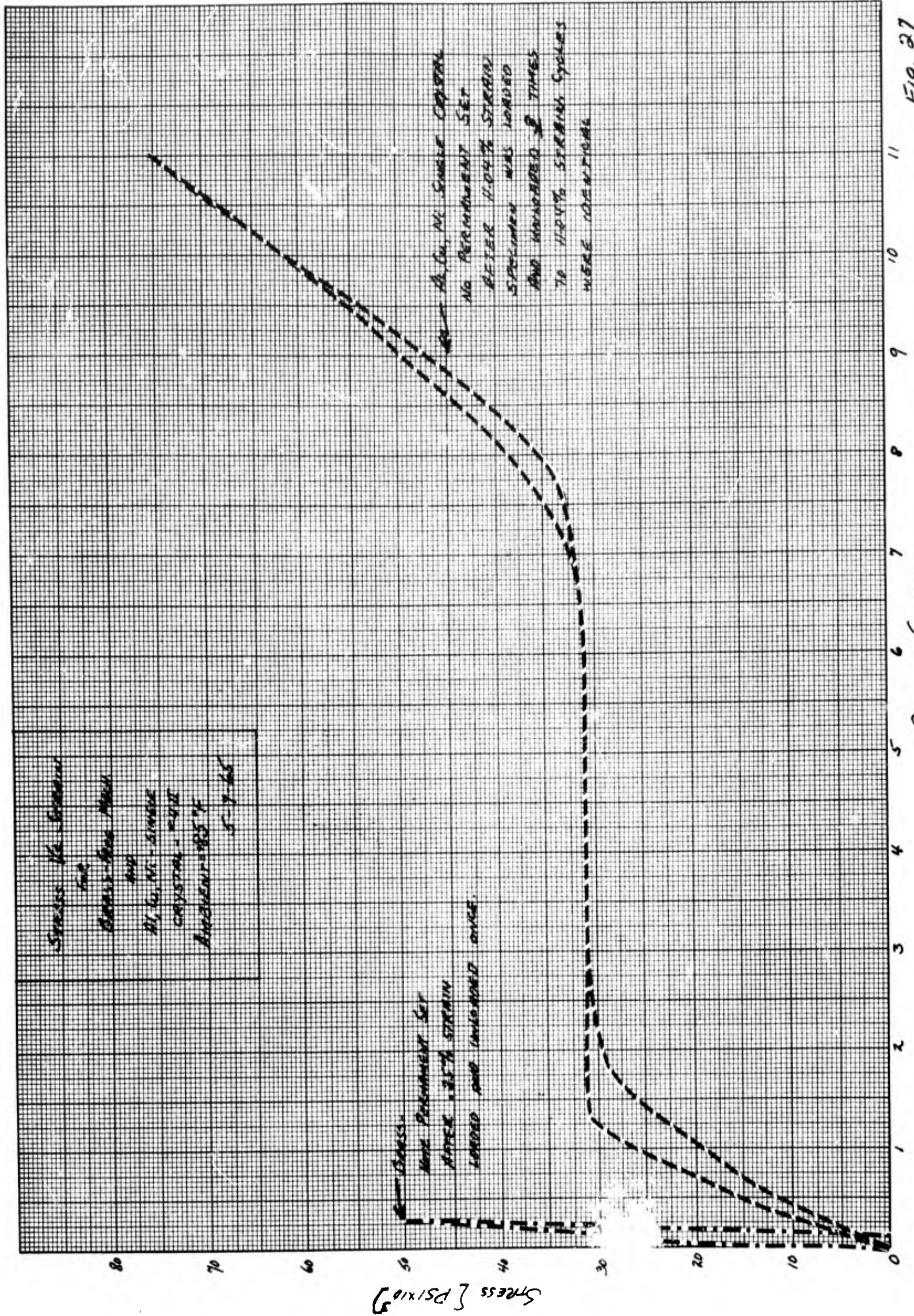


Fig. 27

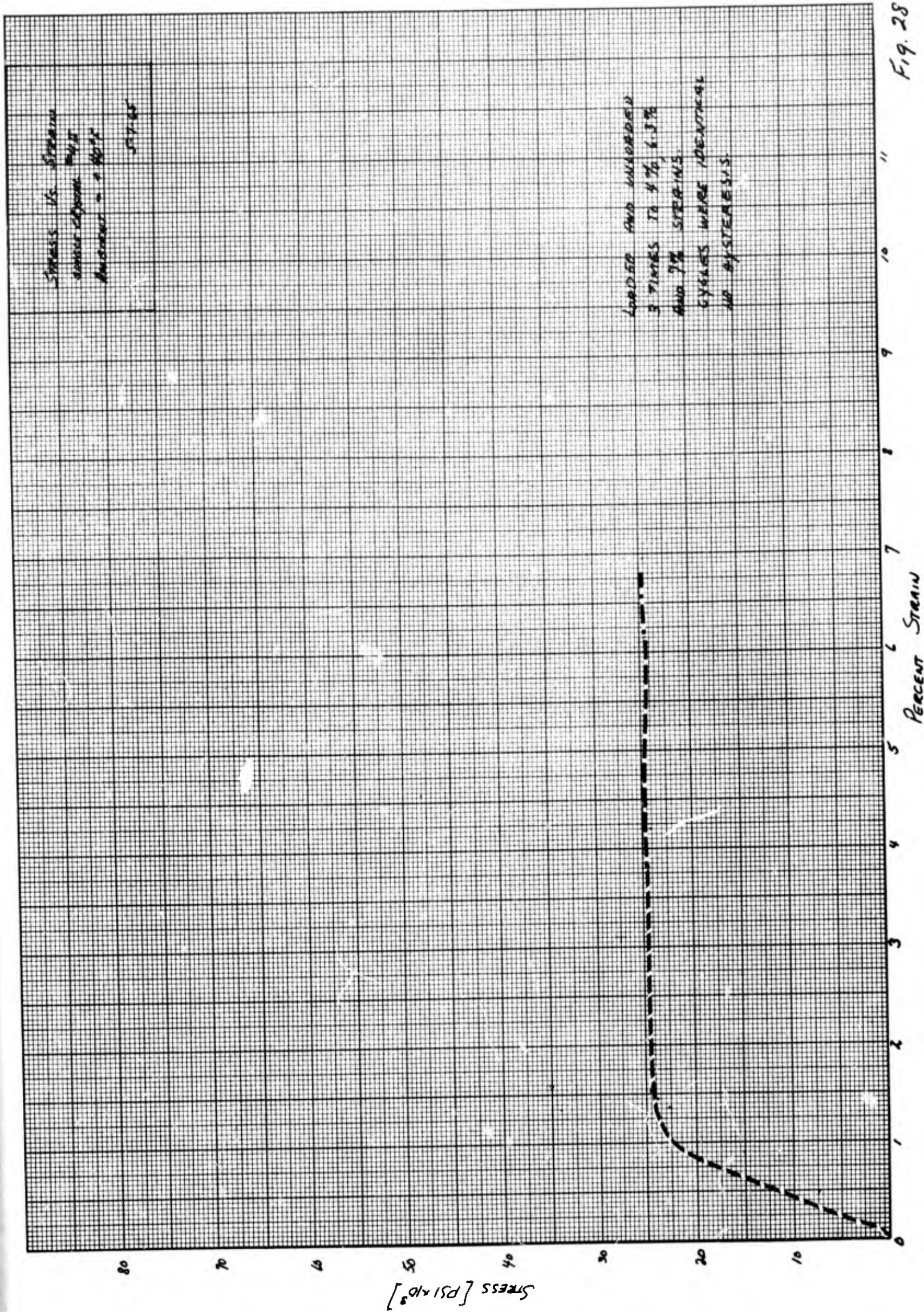


Fig. 28

STRESS vs. STRAIN
 Single Crystal
 Aluminum - 404F
 Machine Grip
 6-7-65

LOADED AND UNLOADED
 3 TIMES FROM 1.5% TO
 6.8% STRAINS.
 CYCLES WERE IDENTICAL
 IN HYSTERESIS.

80
70
60
50
40
30
20
10
0

STRESS [PSI x 10³]

PERCENT STRAIN

0 1 2 3 4 5 6 7 8 9 10 11

Fig. 29



STRESS VS STRAIN

303 STAINLESS STEEL
Diameter = 0.250 in

5-7-65

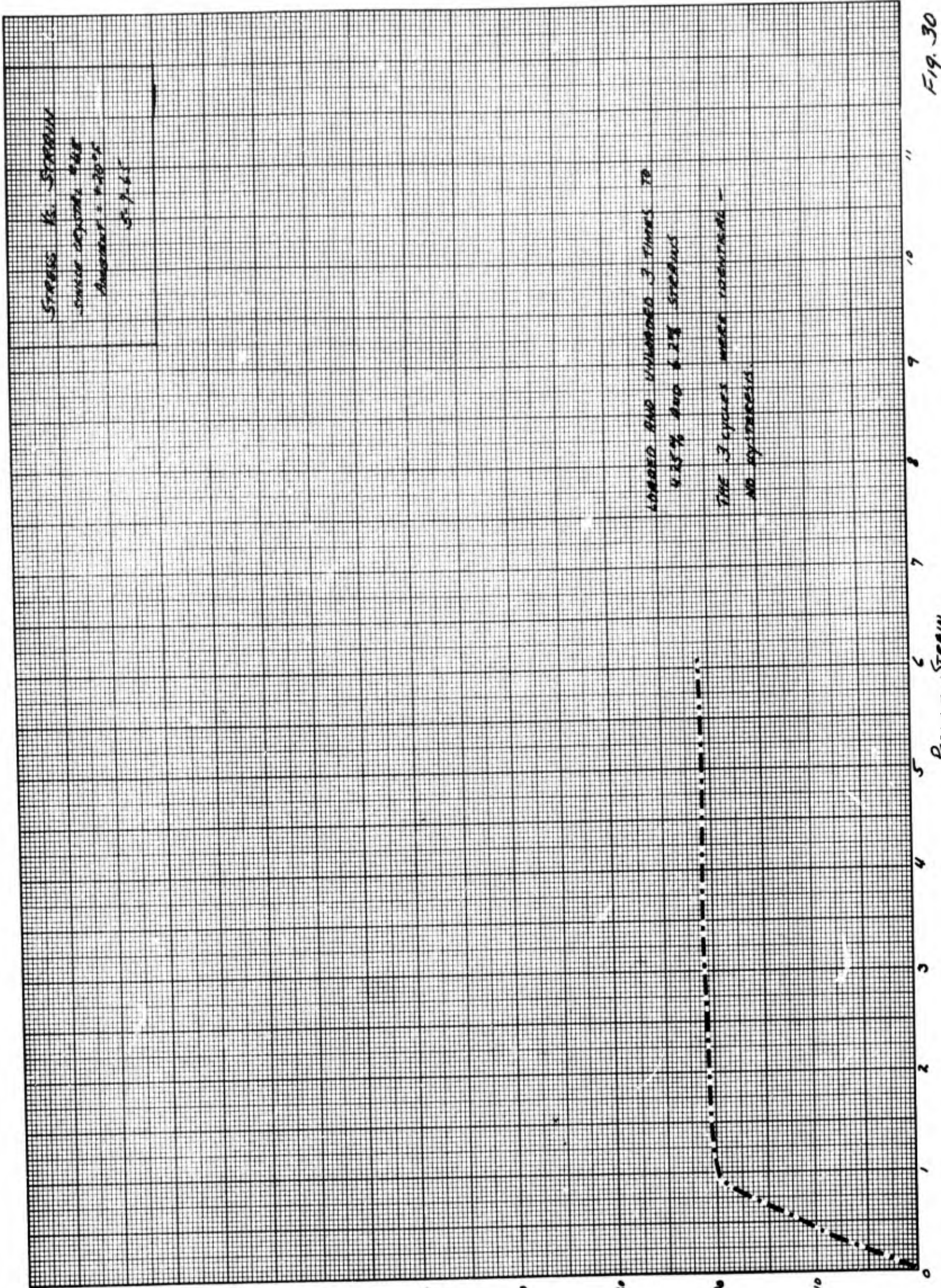
LOADED BAR UNLOADED 3 TIMES TO
4.25% AND 2% STRAINS

THE 3 CYCLES WERE IDENTICAL -
NO STRESS.

Stress [$PSI \times 10^3$]

PERCENT STRAIN

FIG. 30



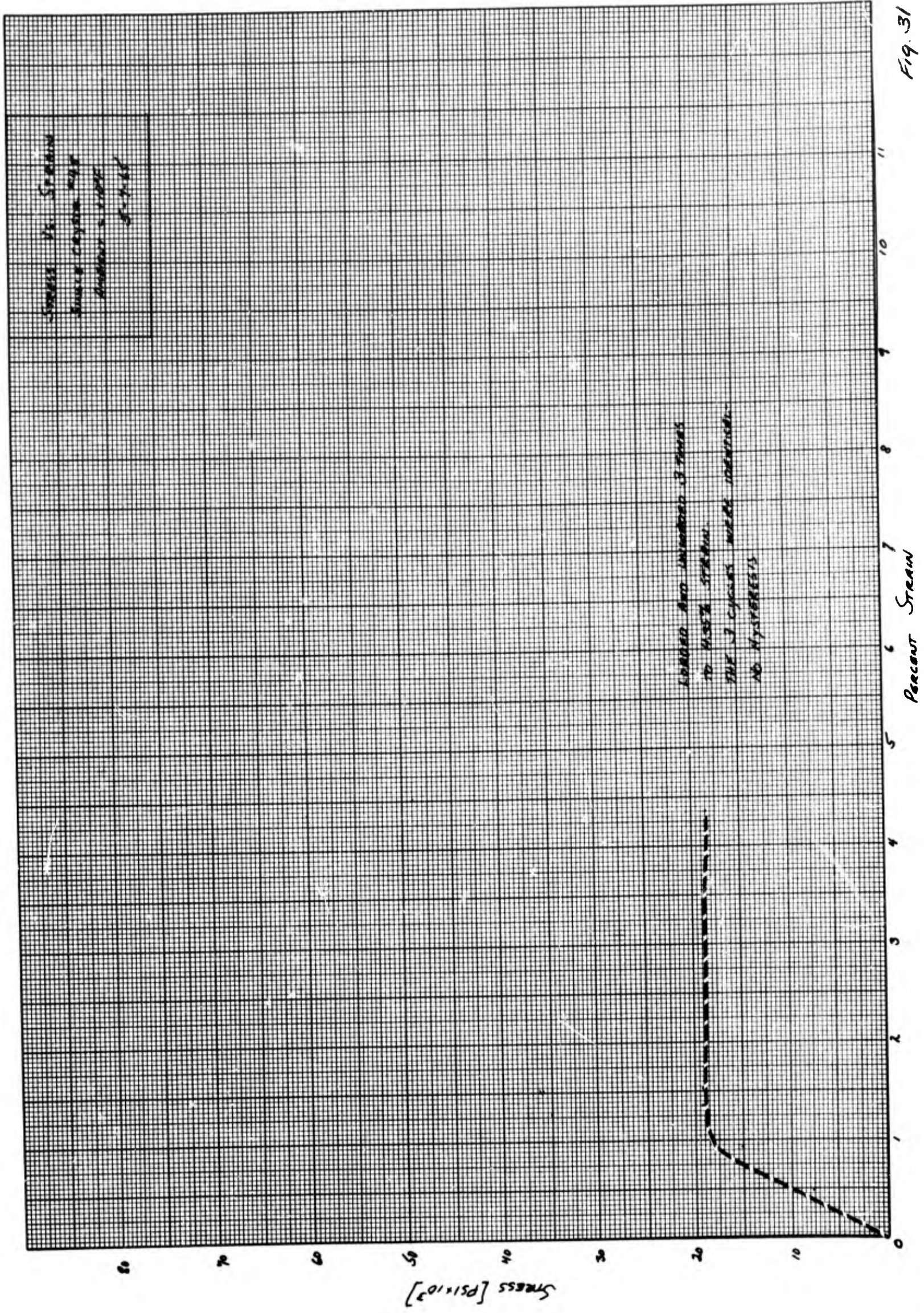


Fig. 31

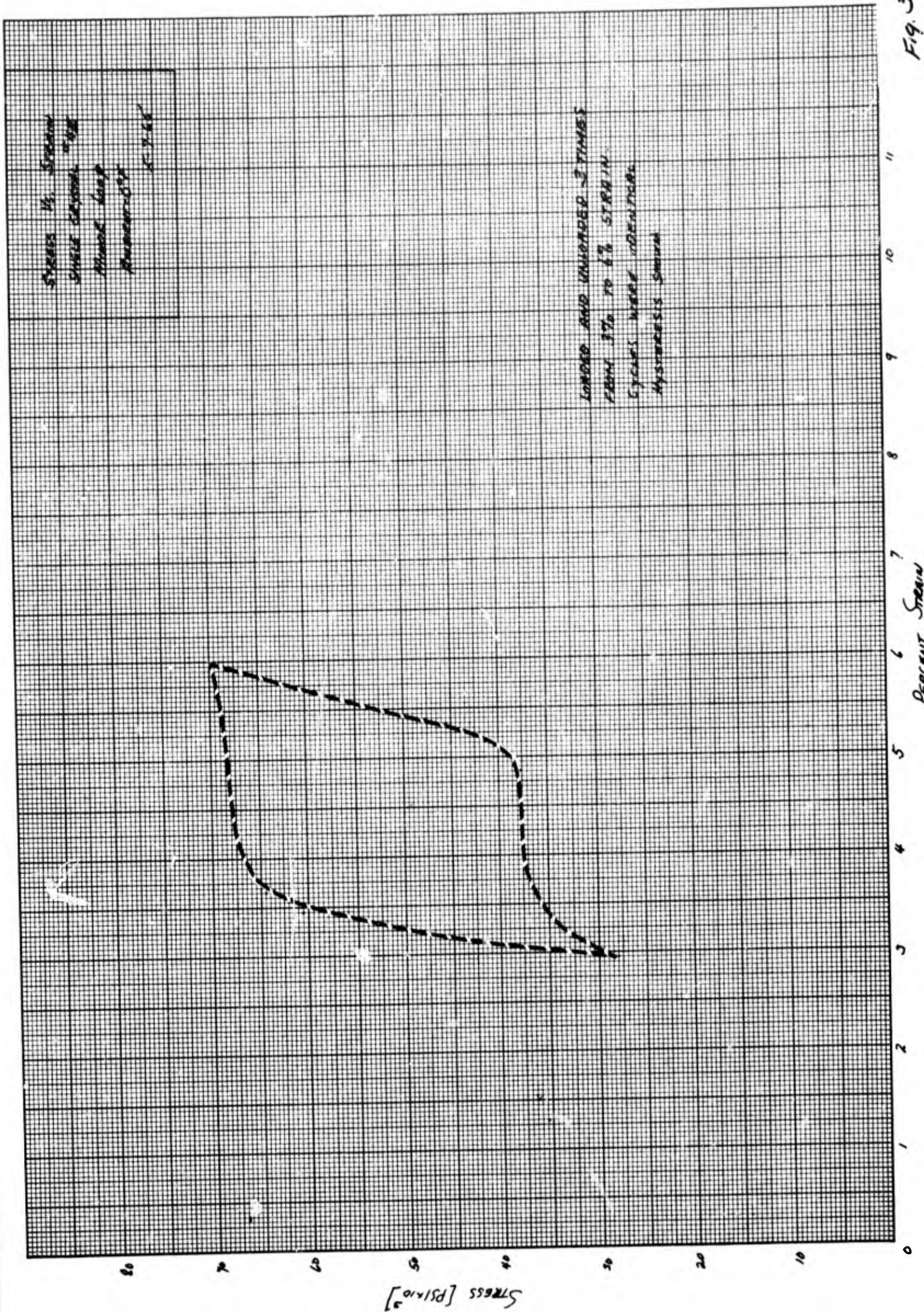
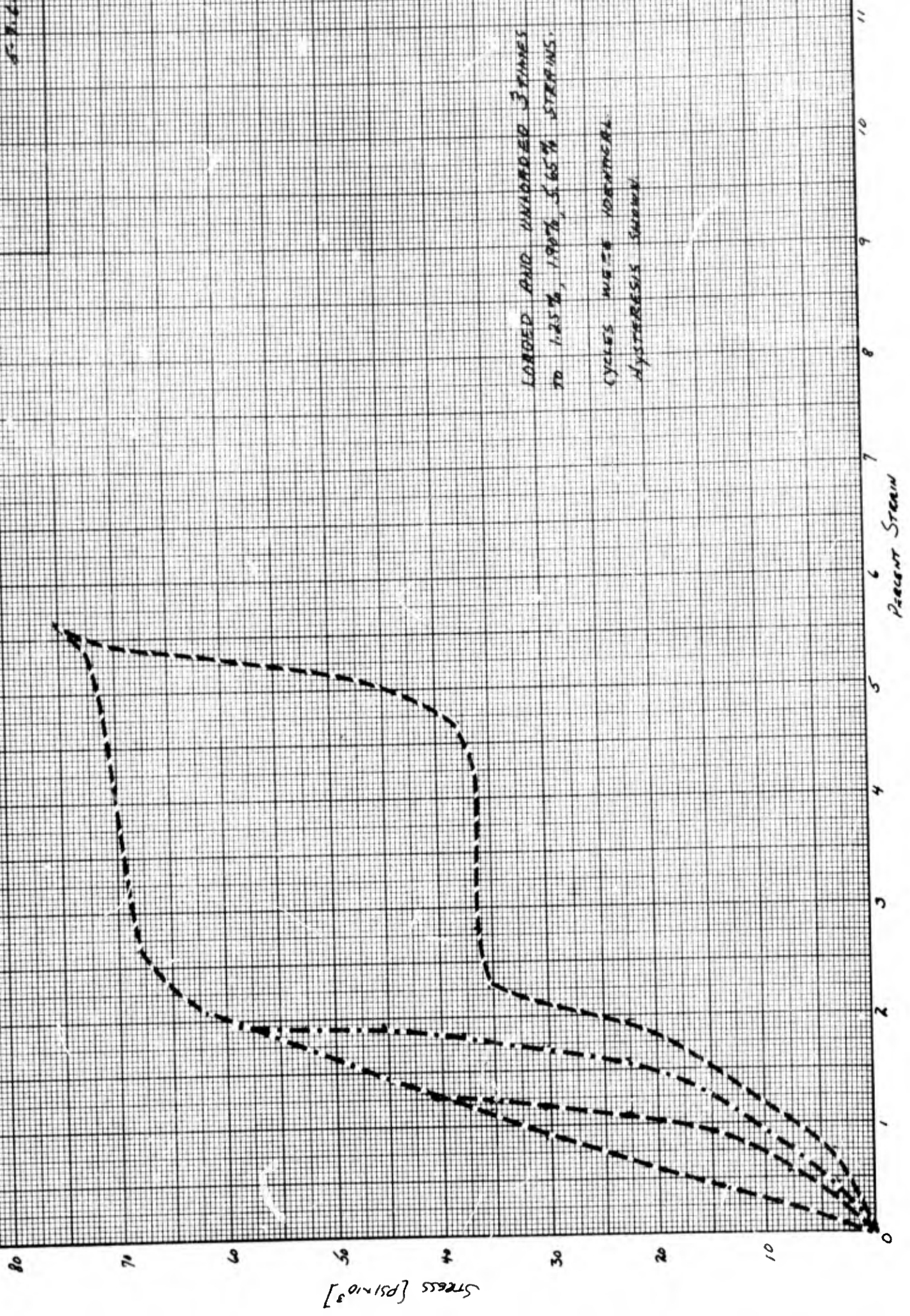


Fig. 32

STRESS VS STRAIN
50000 CARBON STEEL
RATCHET = 0.2
S-7.65

LOADED AND UNLOADED 3 TIMES
TO 1.25%, 1.90%, 5.65% STRAINS.
CYCLES WERE IDENTICAL
HYSTERESIS SHOWN



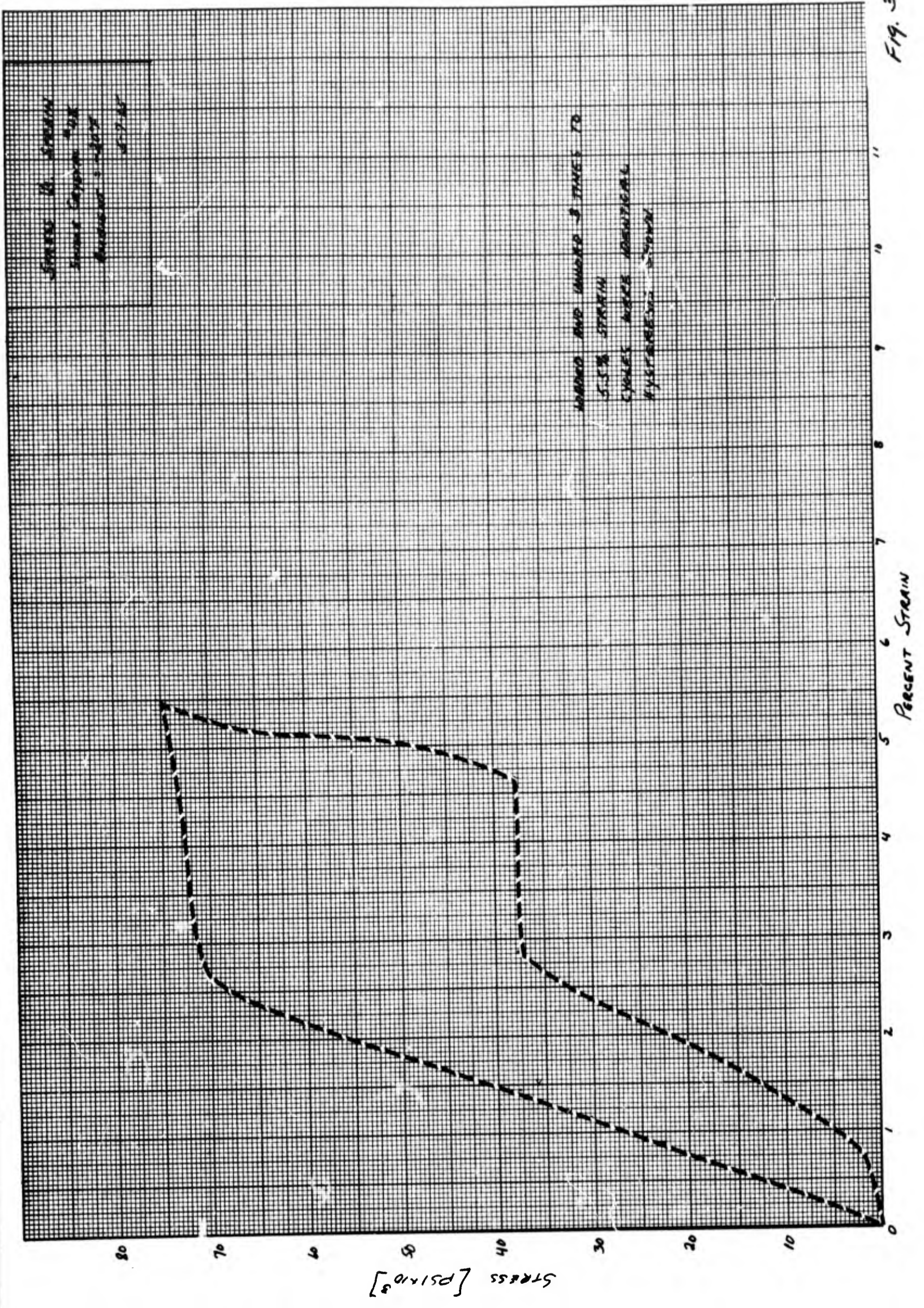
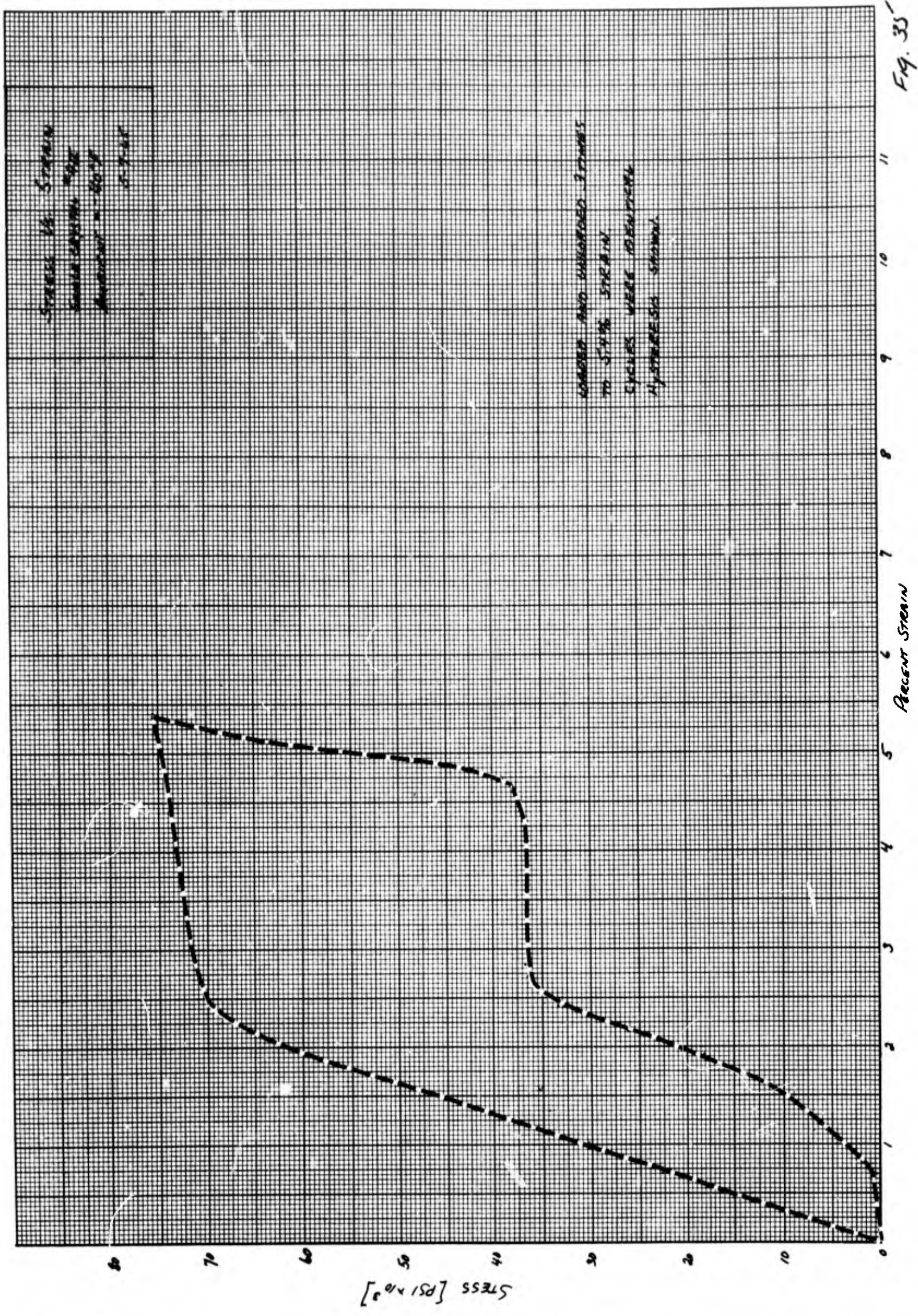
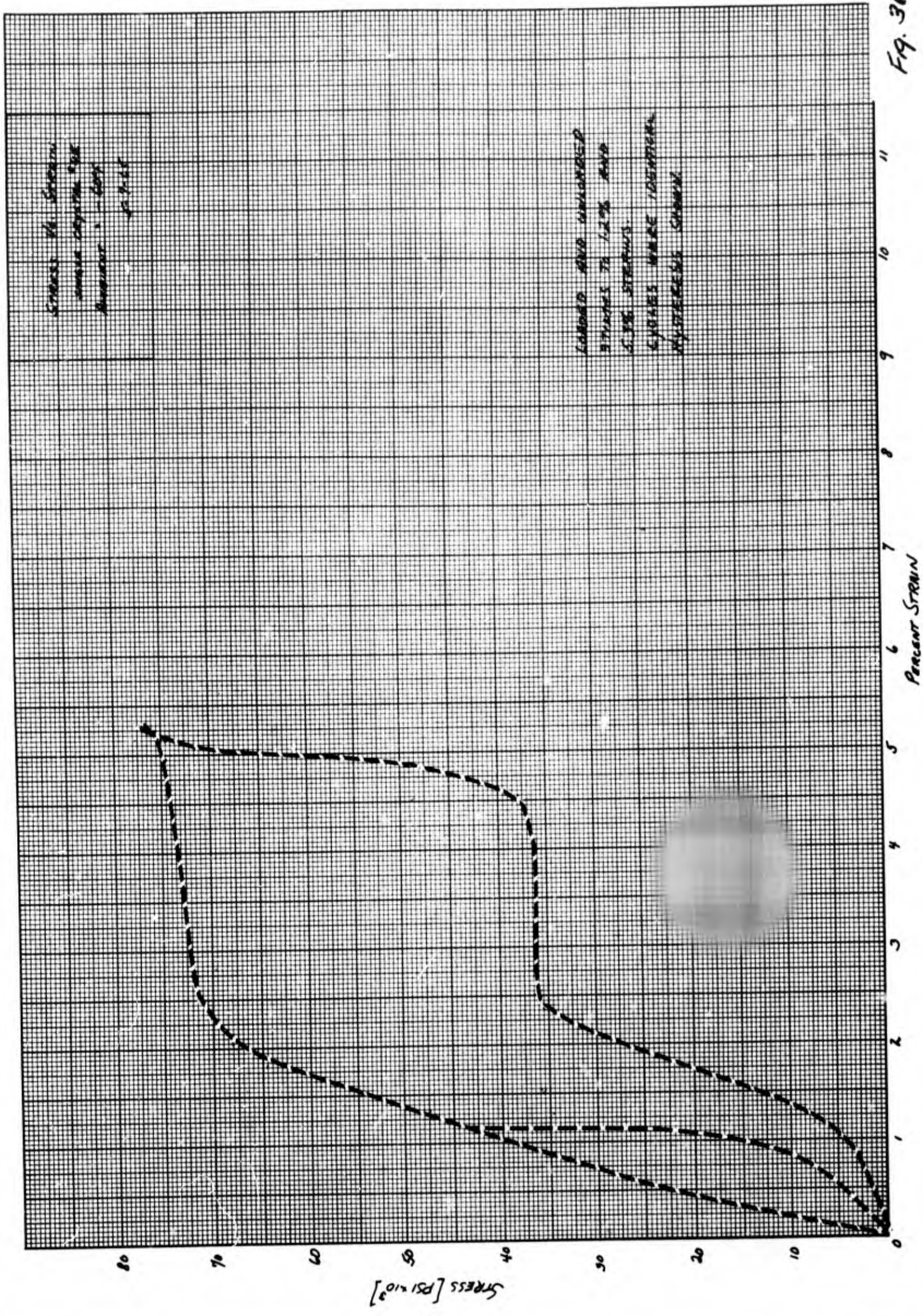


Fig. 34



STRESS vs. STRAIN
SINGLE CRYSTAL POLY
METHACRYLATE
G.P.L.E.

LOADED AND UNLOADED
STRAINS TO 1.2% AND
5.1% STRAINS.
CYCLES WERE IDENTICAL
HYSTERESIS SHOWN.



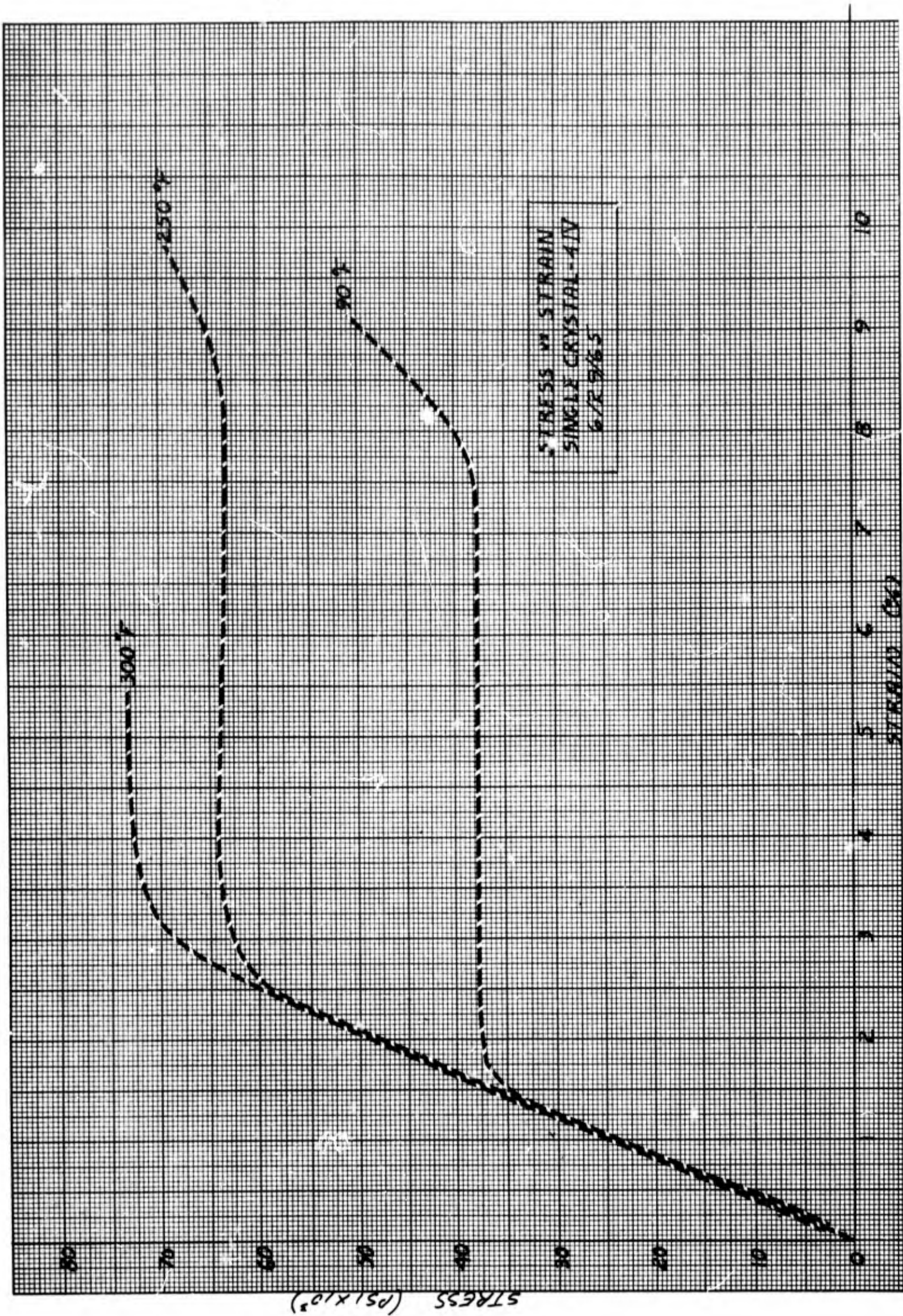
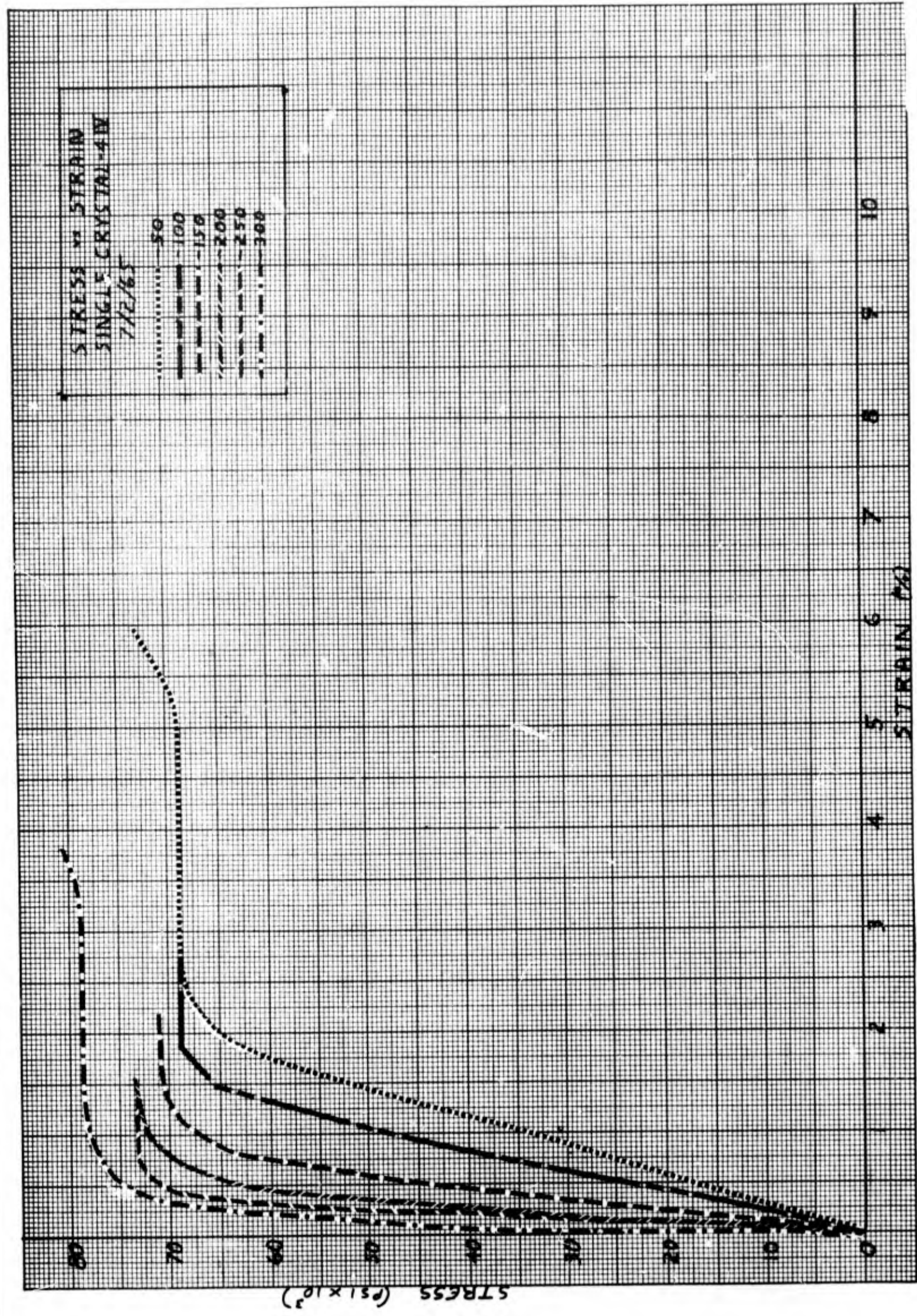
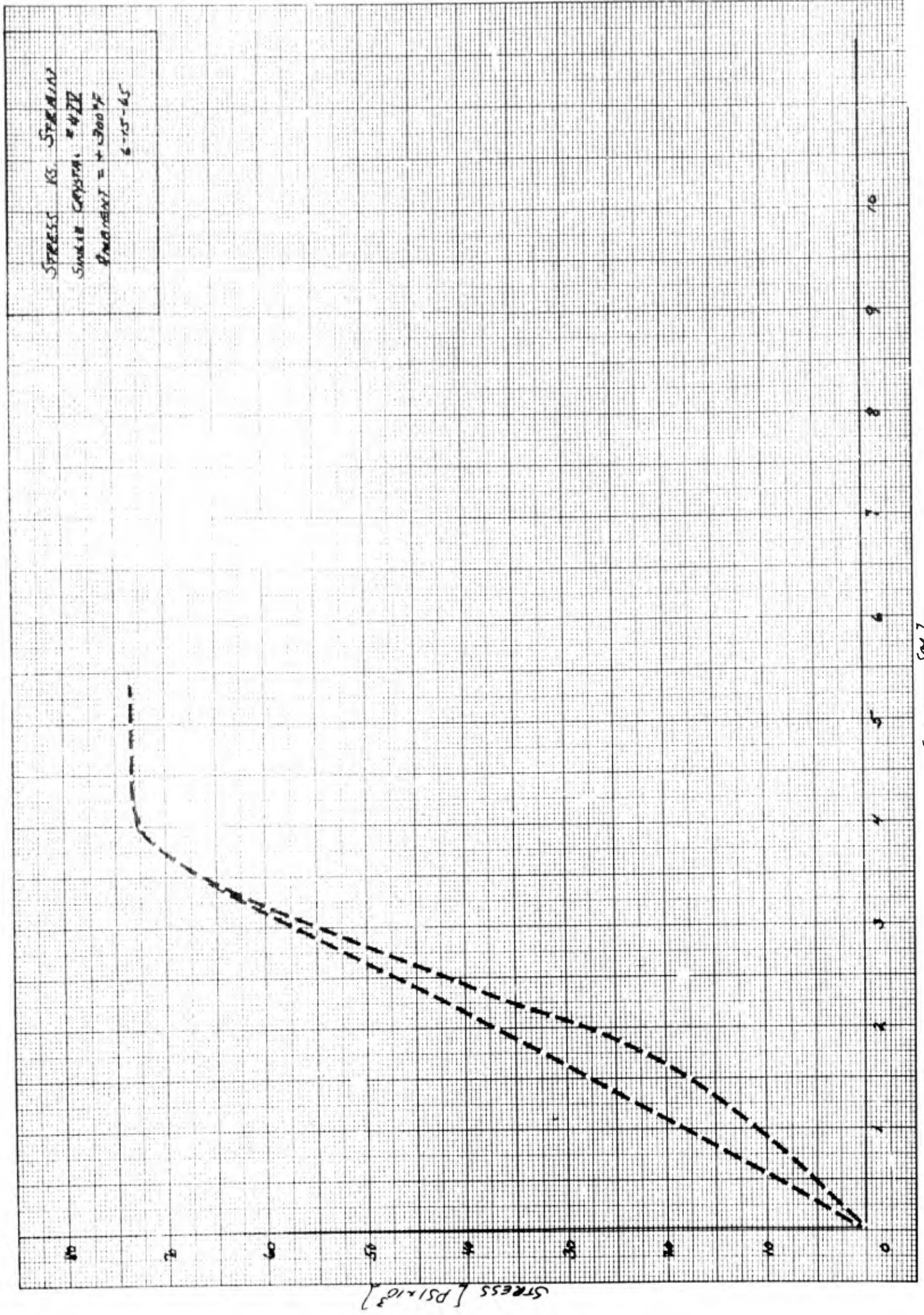


Fig. 91



STRAIN [%]



STRESS VS. STRAIN
 SAMPLE DESIGN # 422
 DIMENSION = 1.300" x 0.150"
 6-15-65

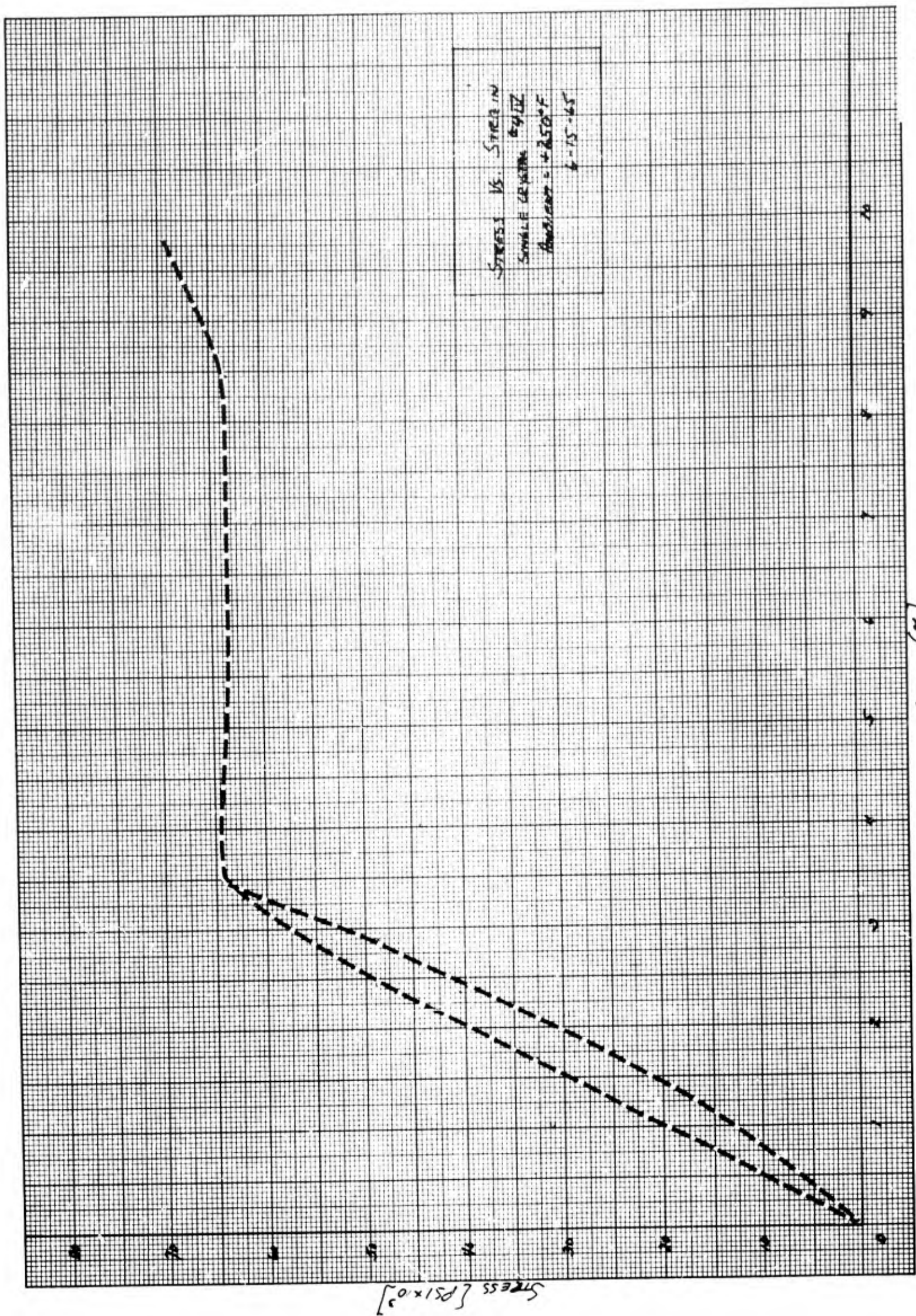


Fig 40

STRAIN [%]

Stress [PSI x 10³]

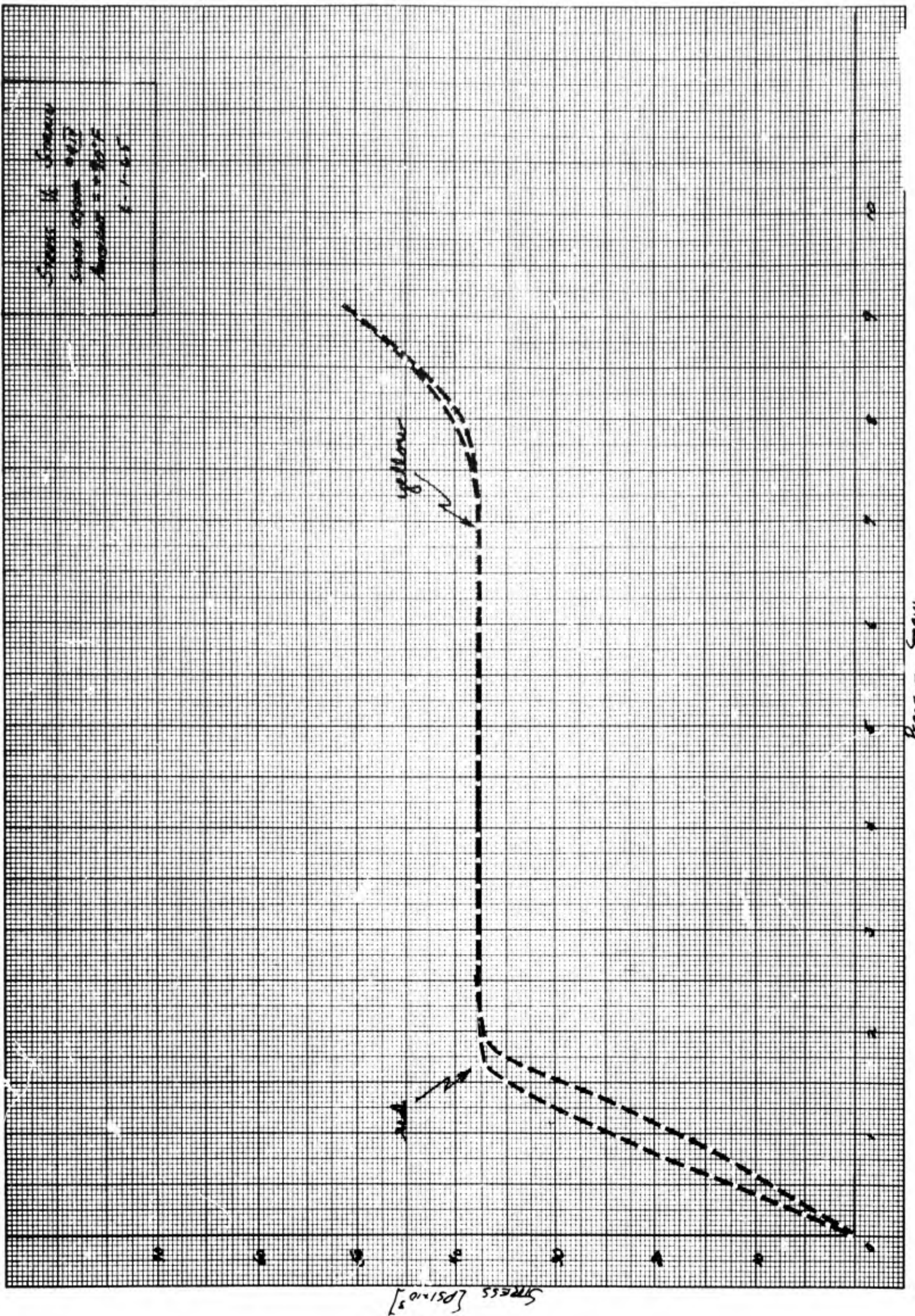


Fig. 41

Percent Strain

STRESS vs. STRAIN
Series: CEMENT # 417
Modulus: 3005
6-1-65

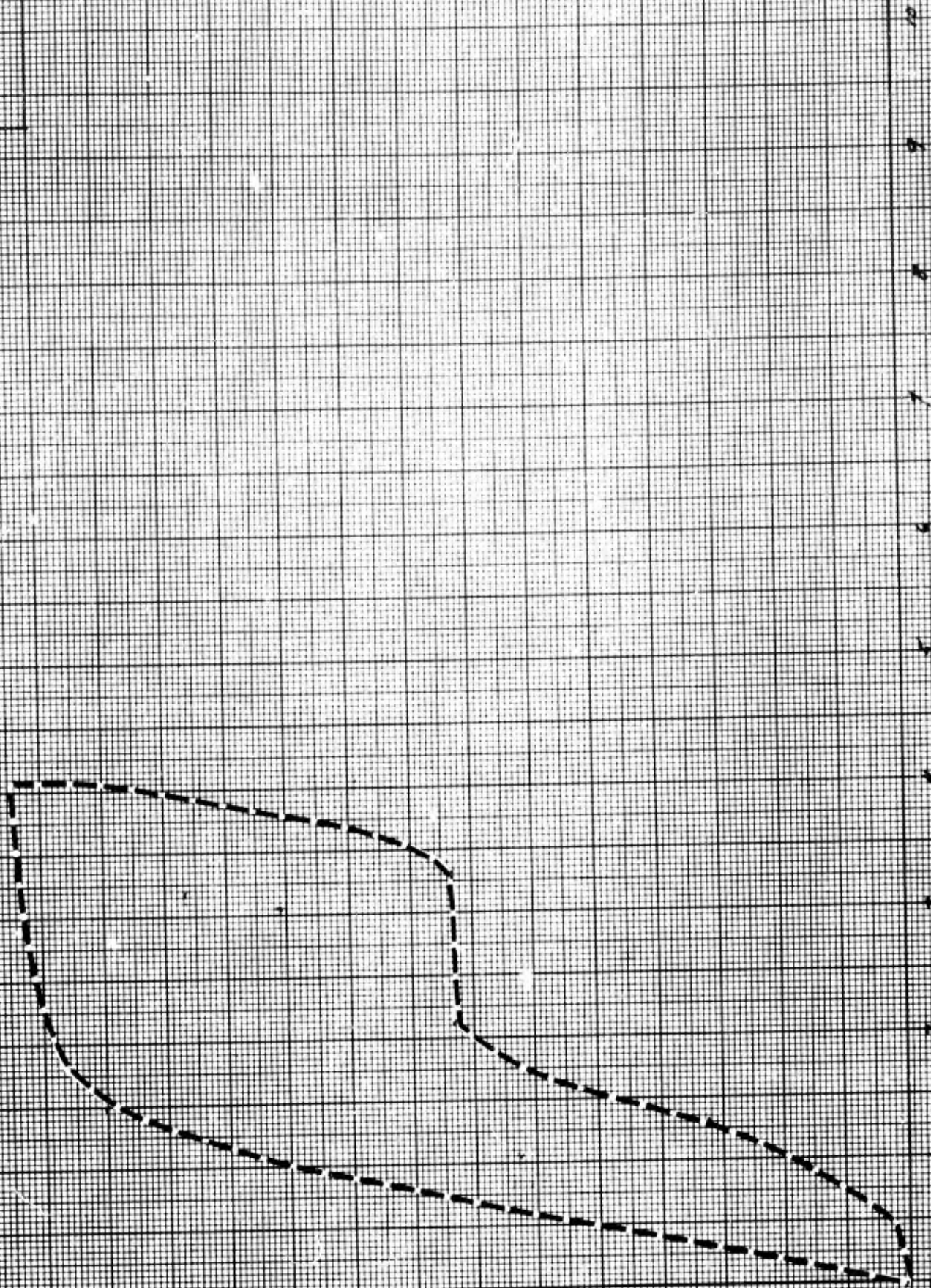
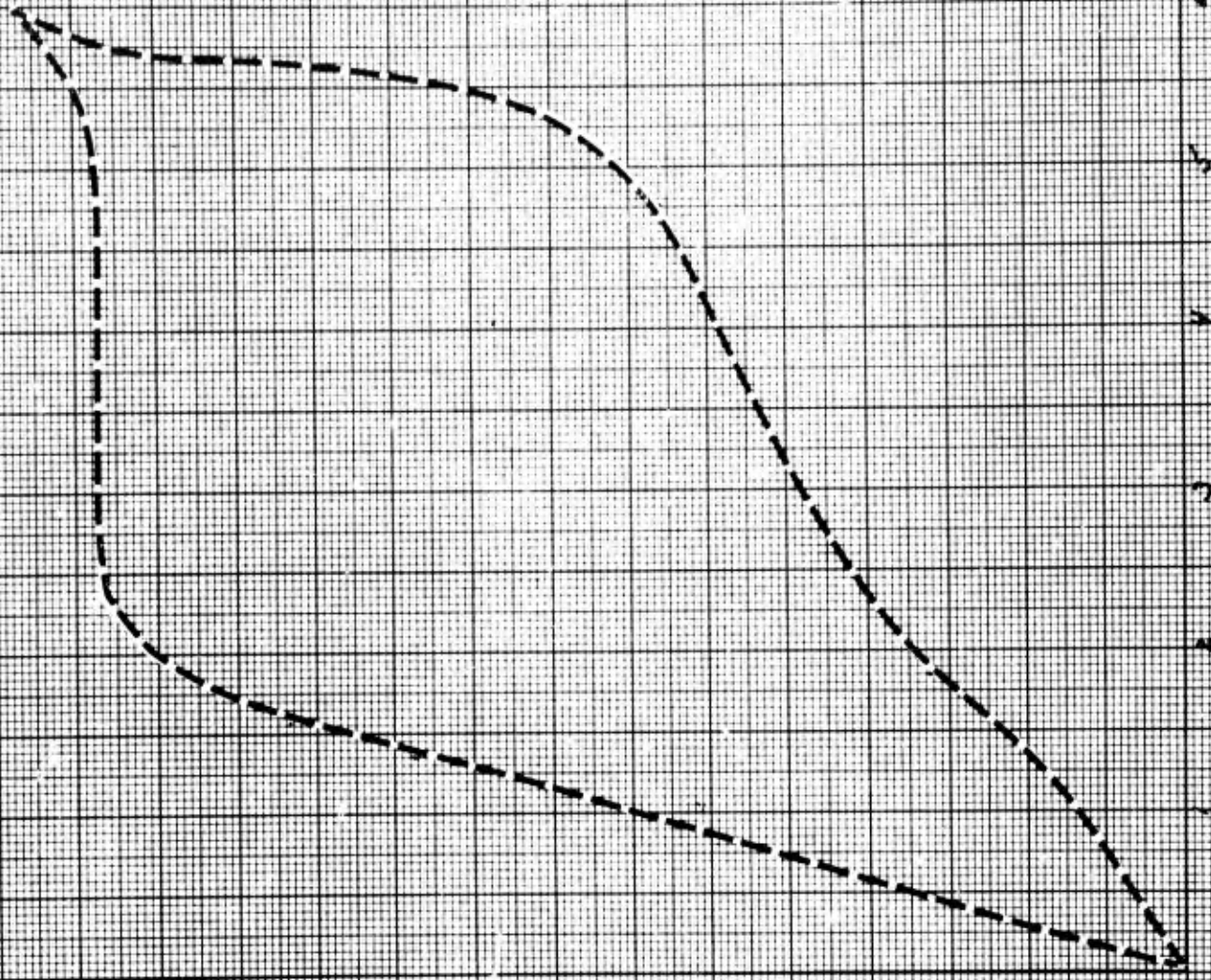


Fig. 42

PERCENT STRAIN

STRESS [PSI x 10³]

Stress vs. Strain
Sample: Carbon Steel
Batch: 1000
Date: 6-15-65



Strain [%]

STRESS vs. STRAIN
SINCE DEFORMATION IS ELASTIC
REVERSIBLE - 100%
5-27-65

STRESS [PSI x 10³]

PERCENT STRAIN

Fig. 44



Stress vs. Strain
Small Strain
Elastic
E = 1000
6.15 x 10¹¹

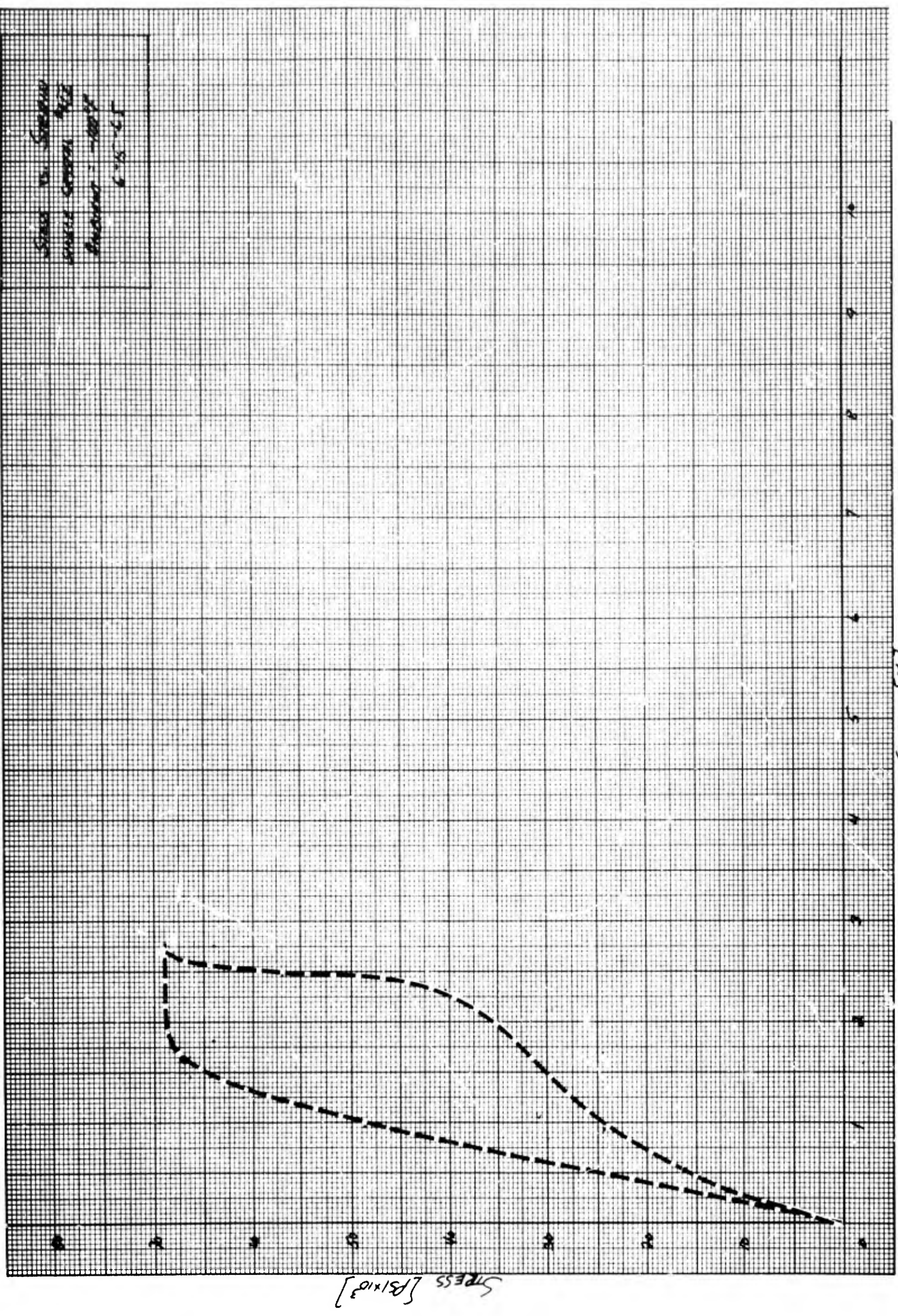
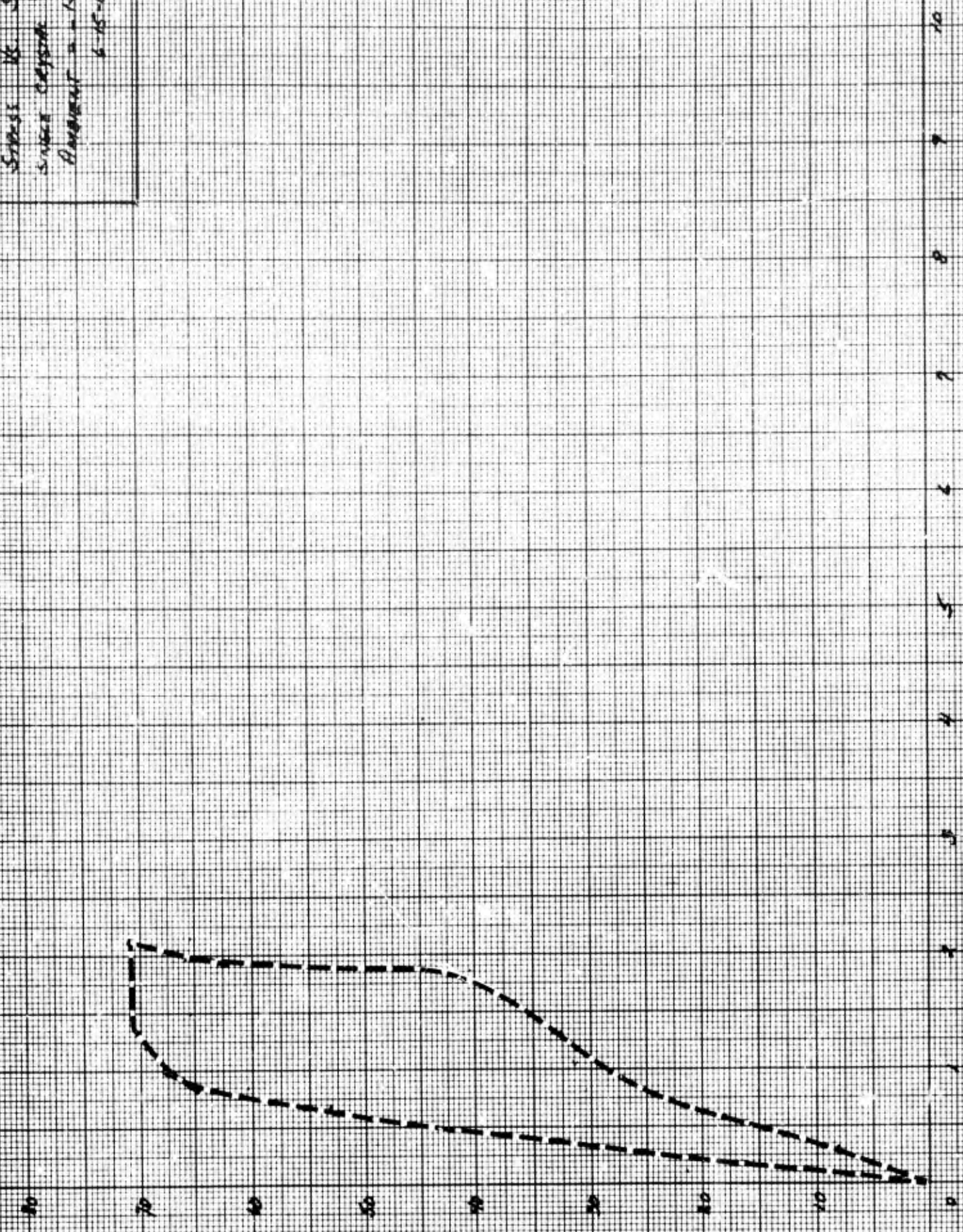


Fig. 45

STRAIN [%]

STRESS [PSI x 10³]

Stress vs. Strain
Sintered Cellulose #410
Amalgam # - 1500F
6-15-65

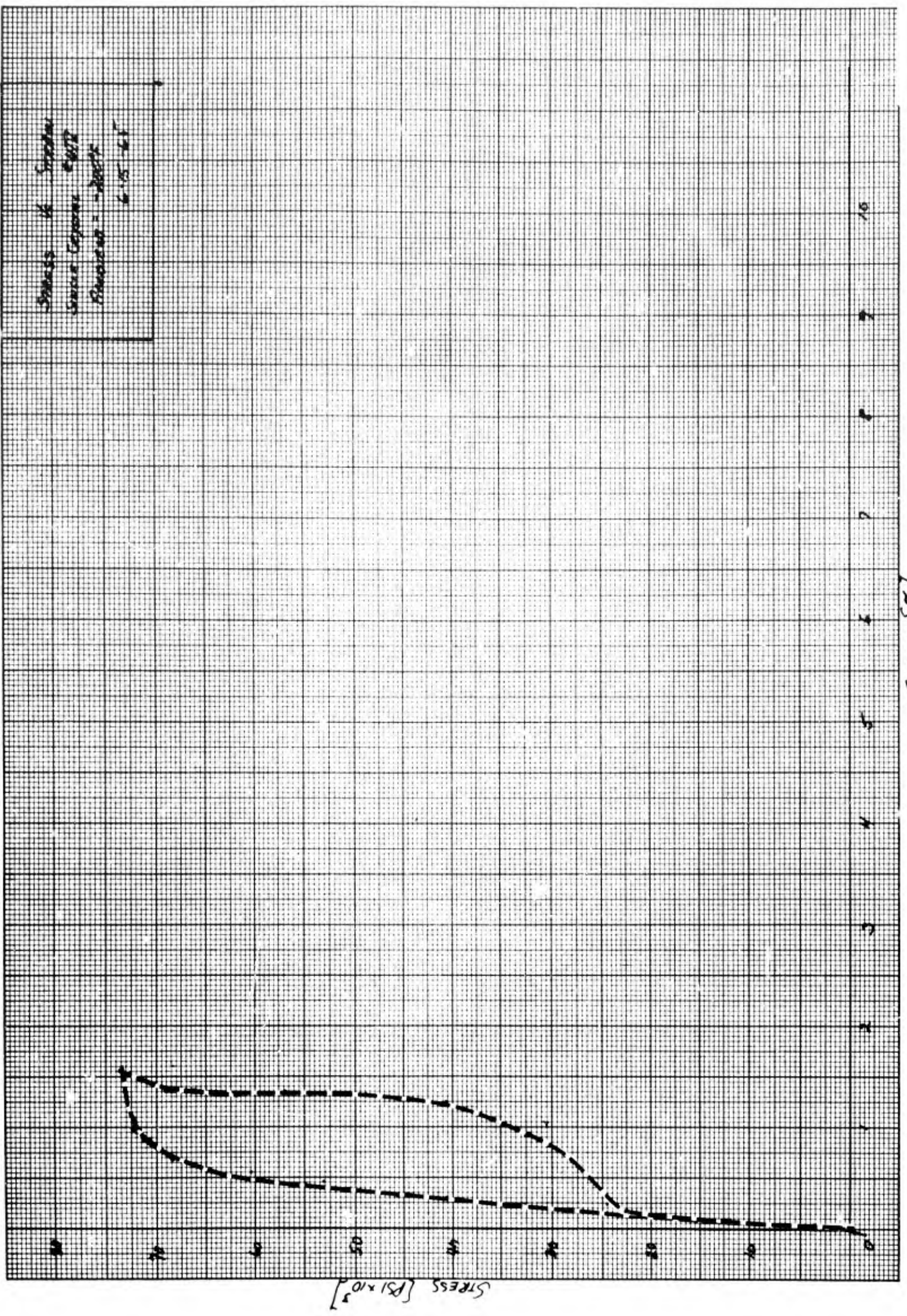


STRAIN [%]

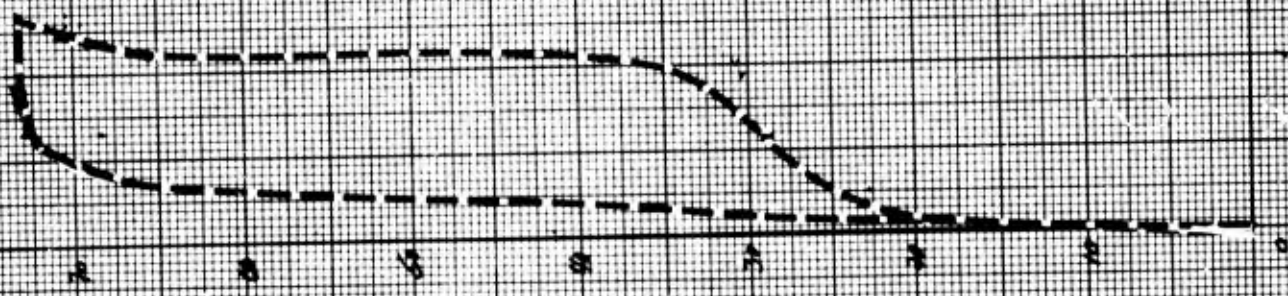
STRESS [PSI x 10³]

F-19.46

Fig 47

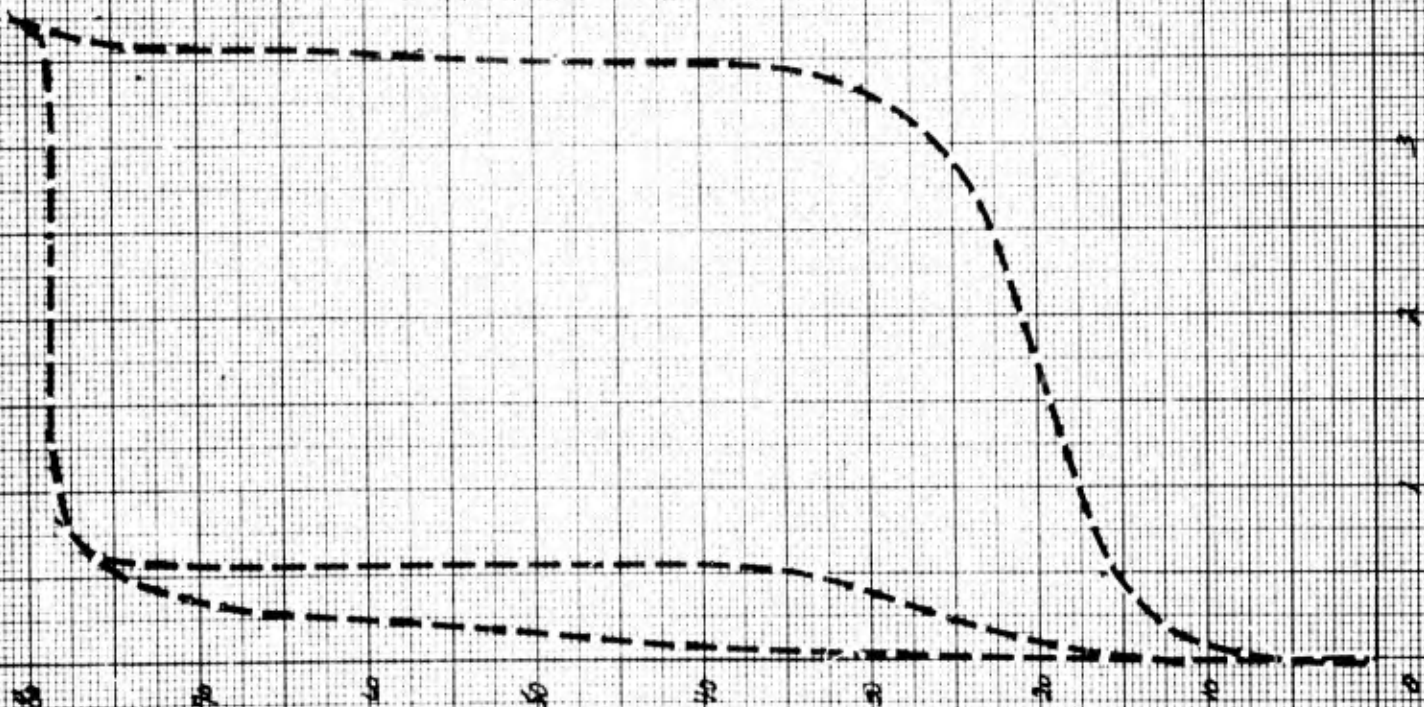


Stress vs. Strain
Small Strain - 412
Proportionality - 75000
E = 1.5 x 10⁵



F.9.48

STRESS vs STRAIN
SINGLE CRYSTAL
ANALYSIS = 3000F
6-15-65



STRAIN [%]

FIG. 49

STRESS VS. STRAIN
 SINGLE CRYSTAL
 7-8-65

LEGEND
 ANCIENT TEMPERATURES
 +40°F
 - - - - - +90°F
 - · - · - +145°F
 · · · · · +200°F

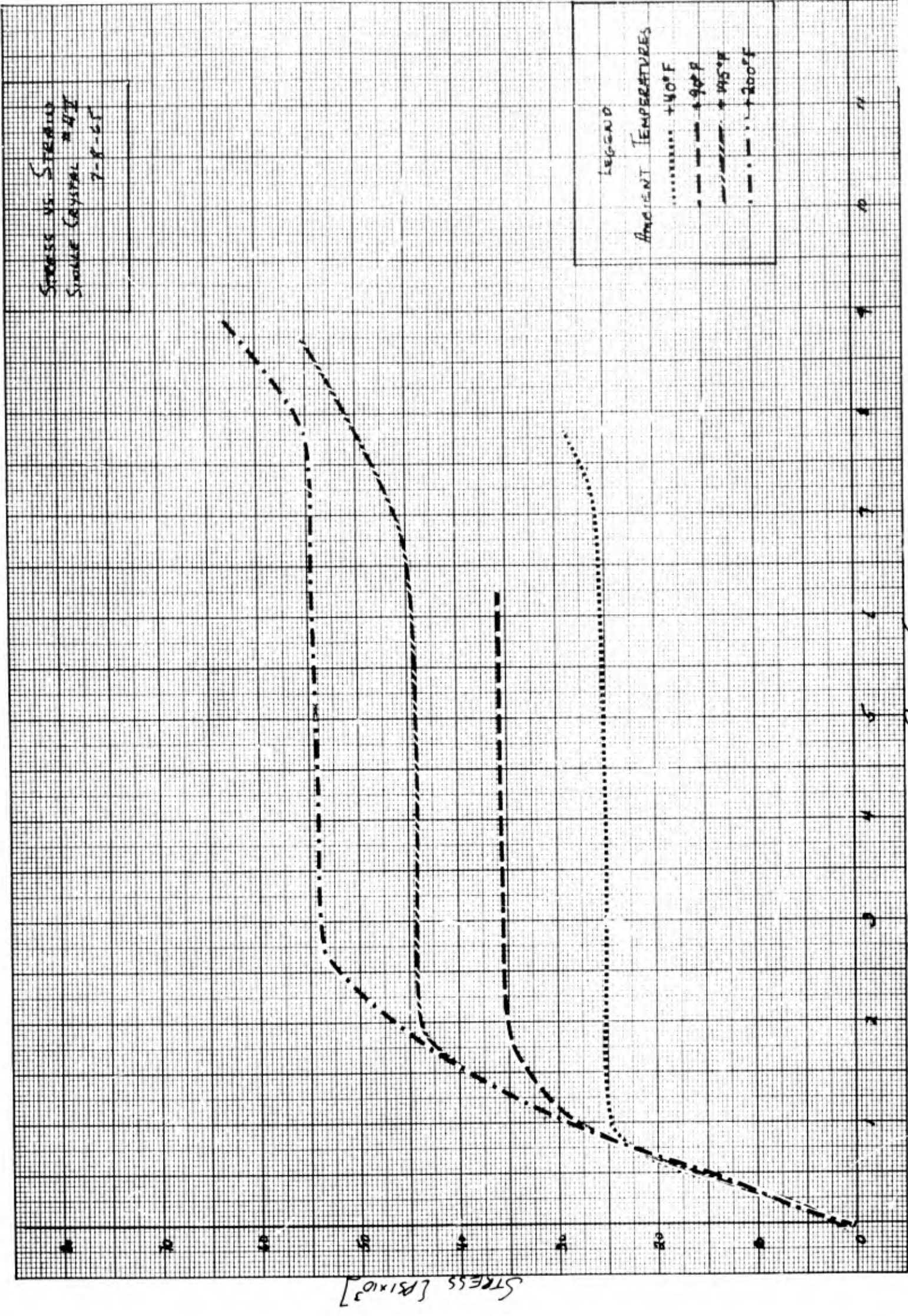


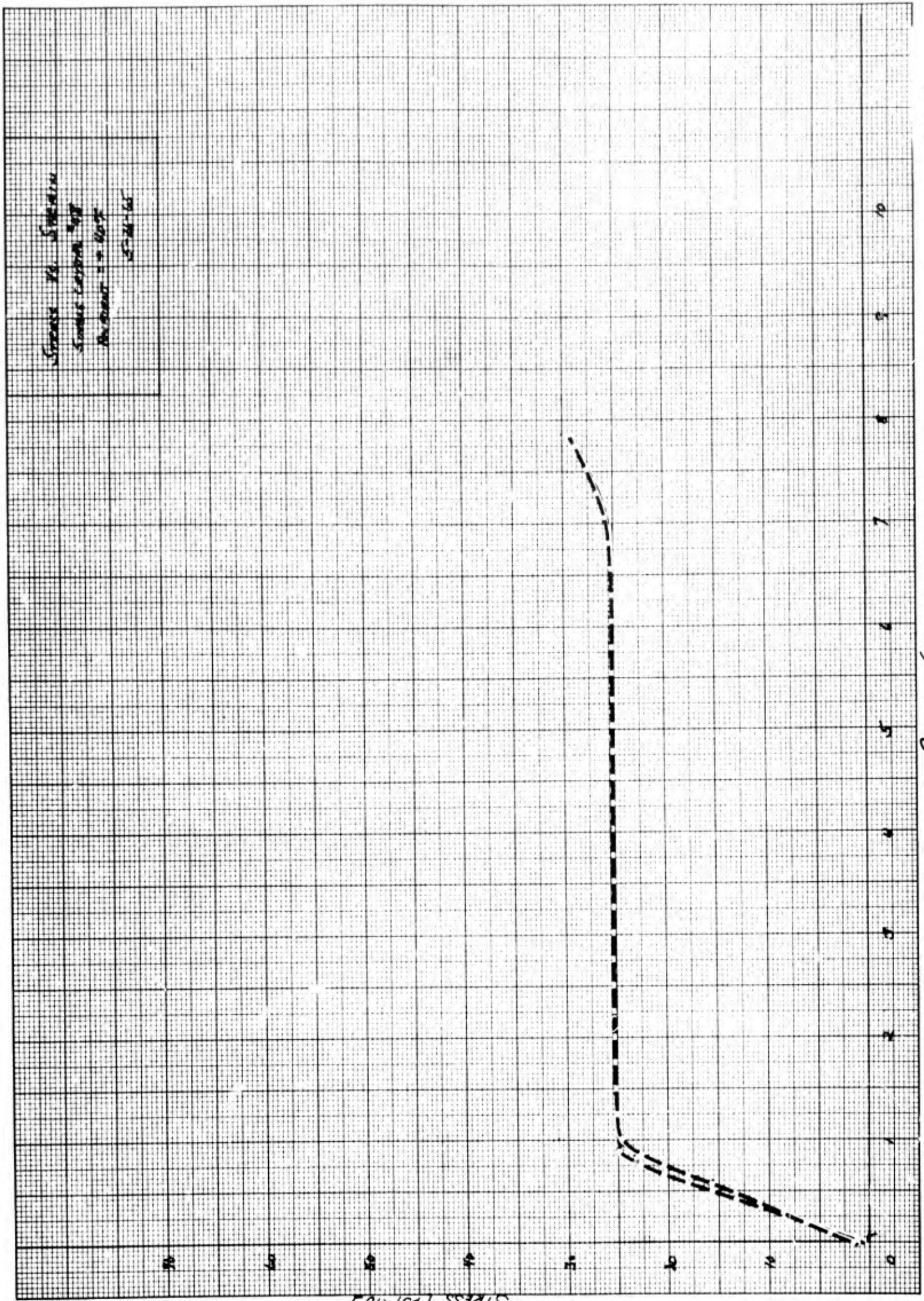
Fig. 50

STRESS vs. STRAIN
 SAMPLE C-10000-1008
 REDUCED TO 40°F
 15-21-65

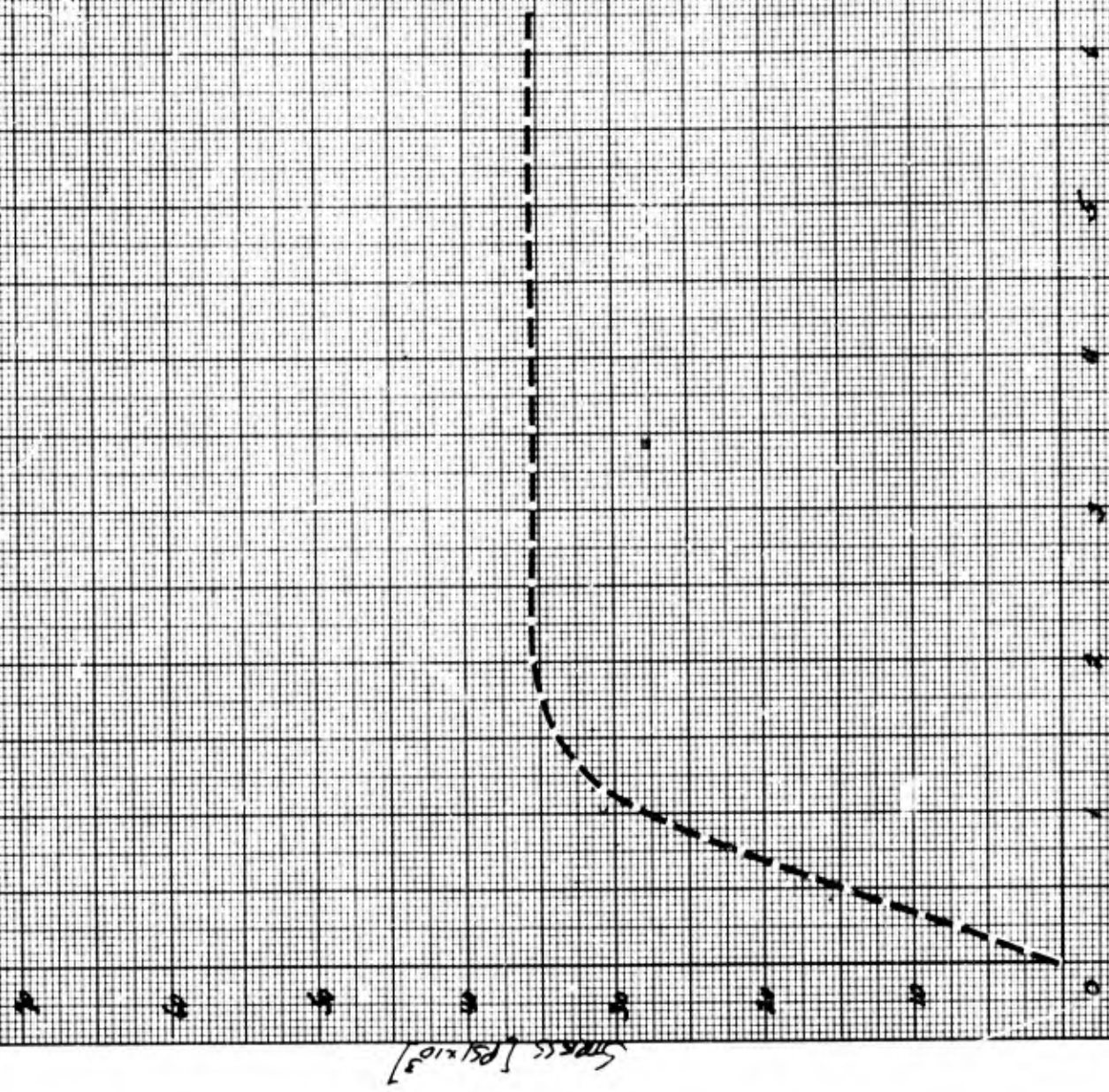
STRESS [PSI x 10³]

PERCENT STRAIN

Fig 51

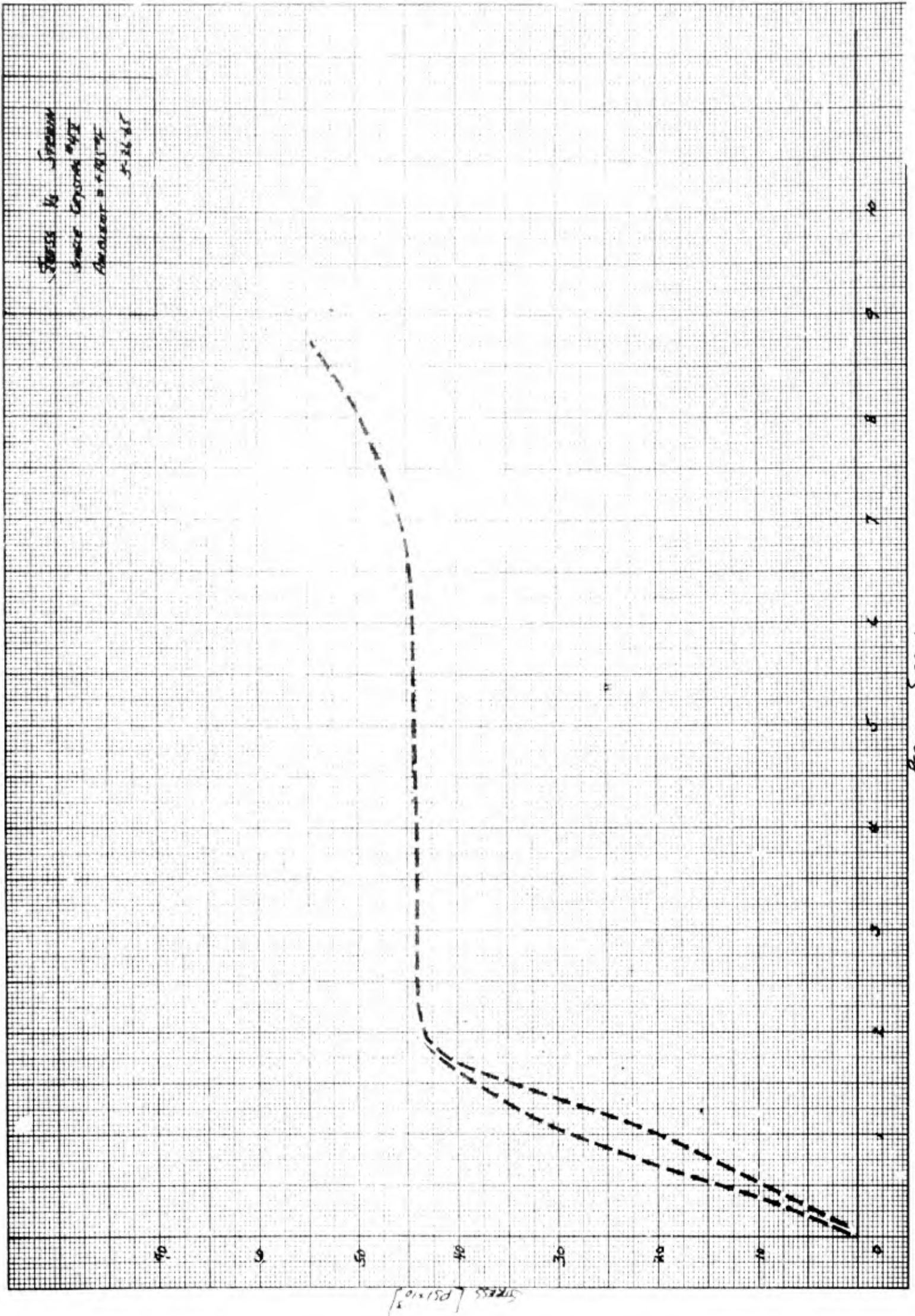


Stress $\frac{1}{2}$ Strain
 Average diameter = 0.125"
 Diameter = 0.125"
 57-100 - 65



PERCENT STRAIN

Stress vs Strain
 Sample Designation #412
 Area under curve = 49.17 in²
 5-26-65

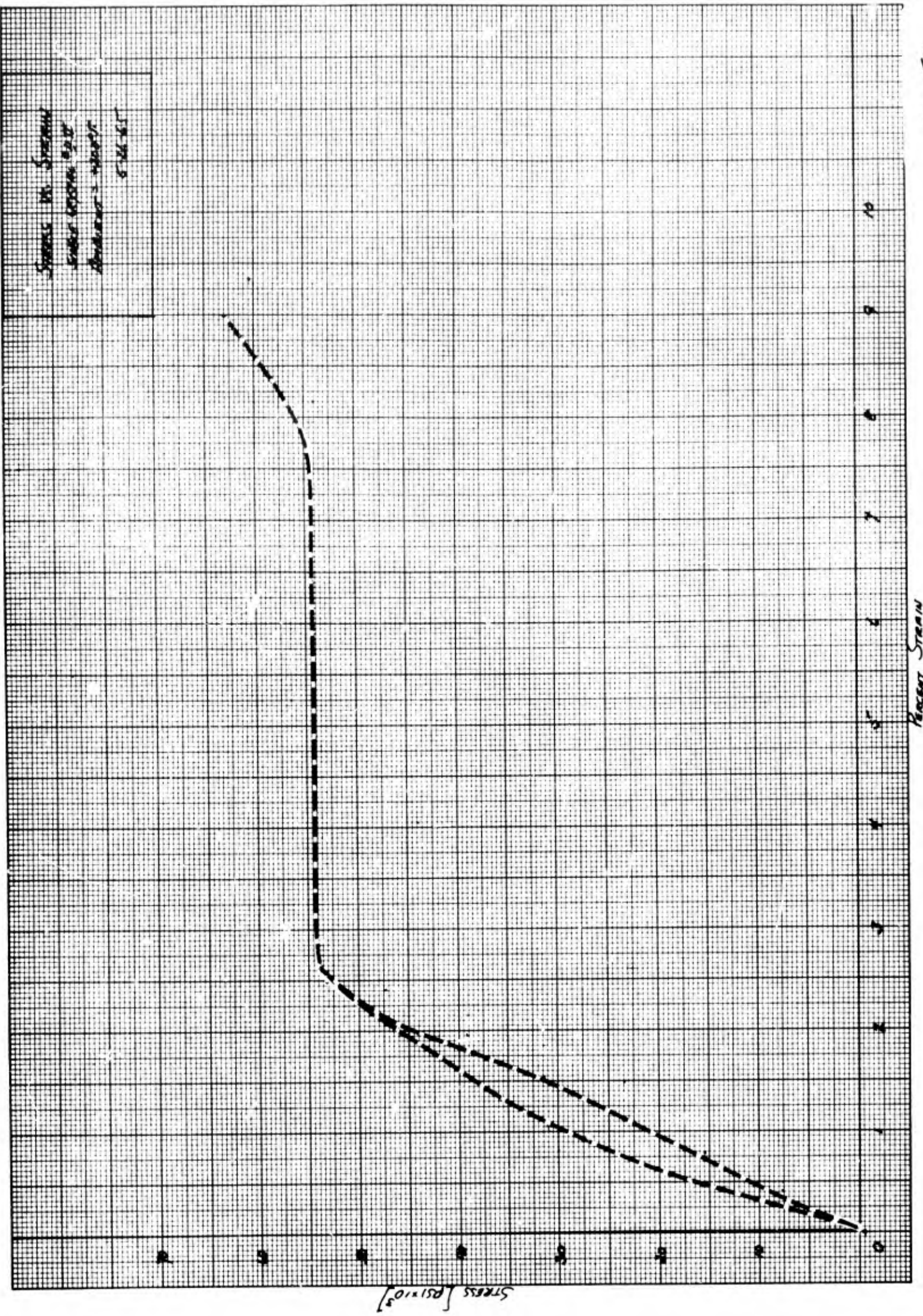


1-19 53

PERCENT STRAIN

STRESS [PSI x 10³]

STRESS VS STRAIN
SHEET METAL
ALUMINUM - 2024-T3
5-26-65



PERCENT STRAIN

STRESS [PSI x 10⁵]

STRESS VS STRAIN
POLYETHYLENE
SPECIMEN # 20015
MS = 1500 PSI
4-1-65

LOADED AND UNLOADED
3 TIMES TO 4.25% STRAIN.
CYCLES WERE IDENTICAL.
HYSTERESIS SHOWN

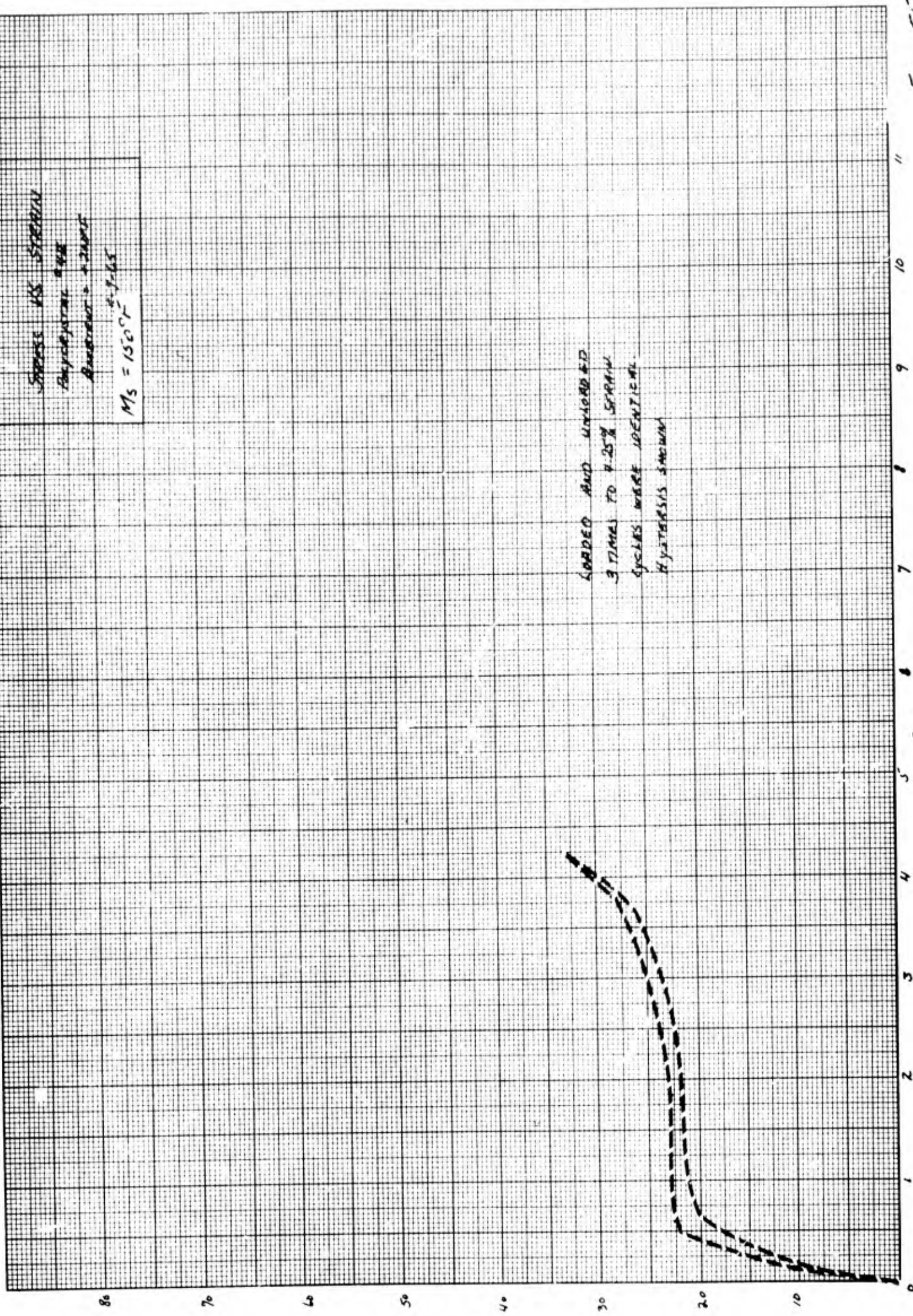


Fig. 55

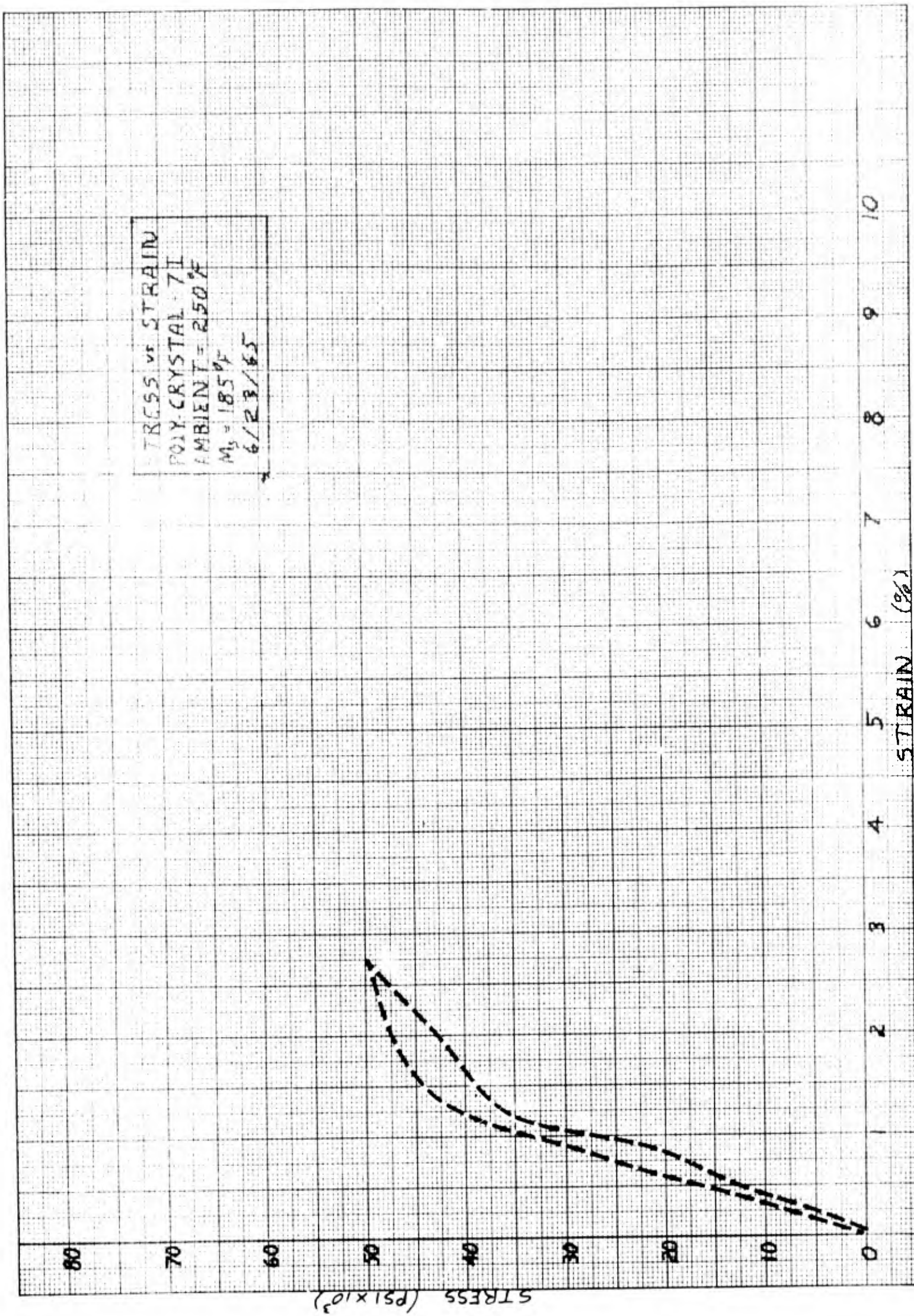
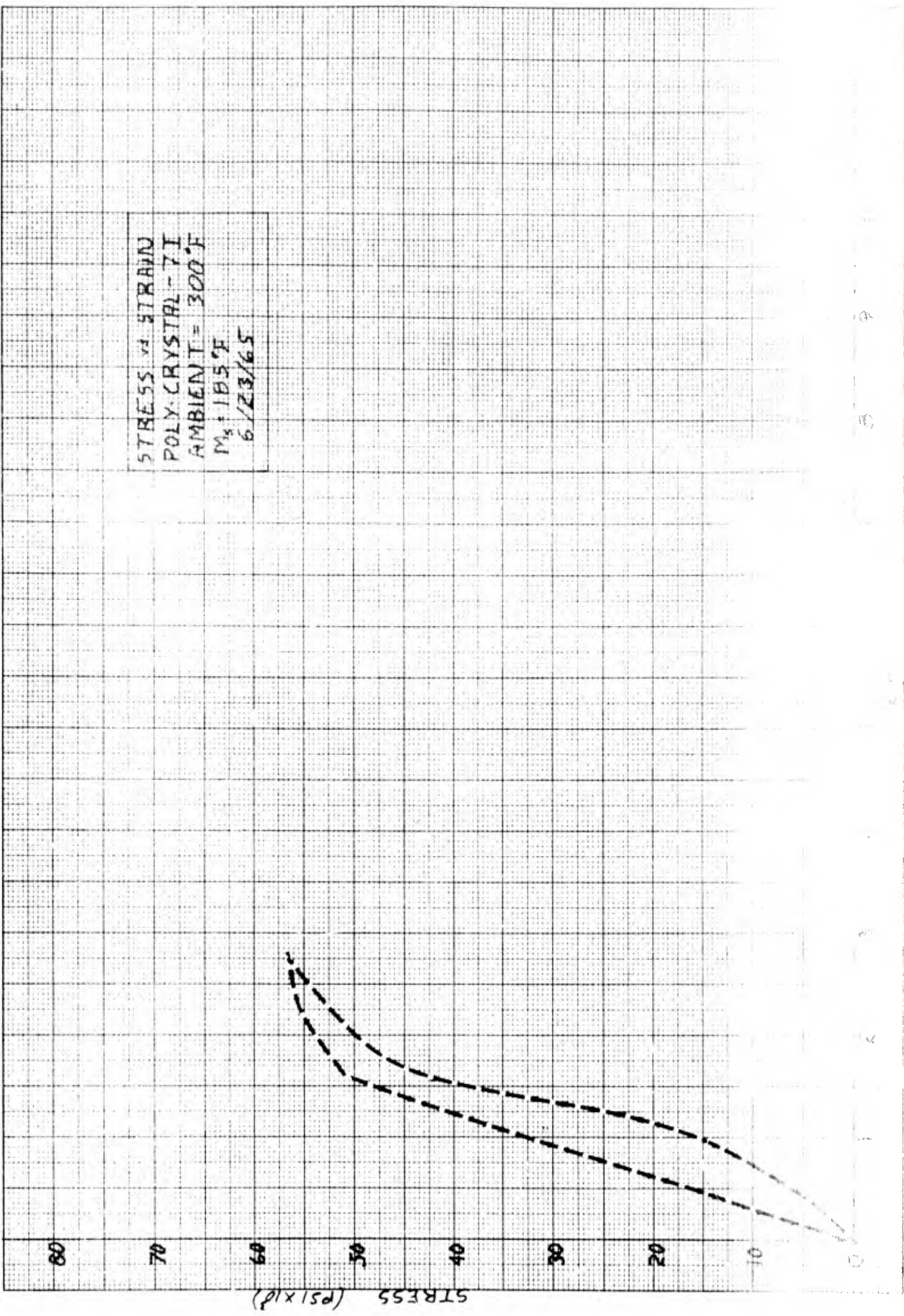


Fig. 56

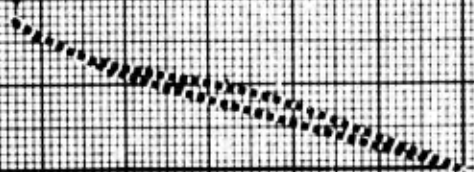
STRESS vs STRAIN
POLY-CRYSTAL - 7I
AMBIENT = 300°F
M_s = 185°F
6/23/65



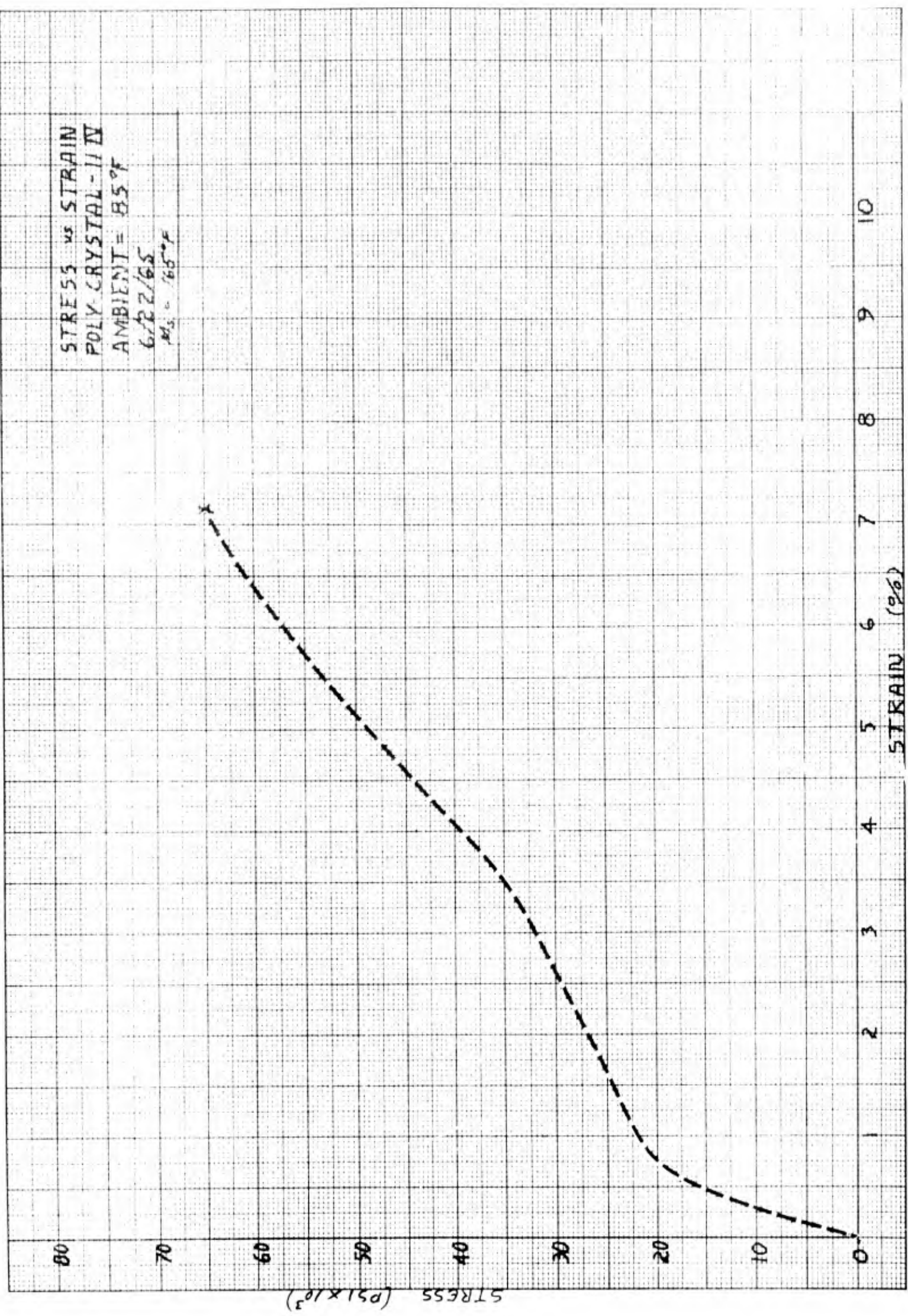
STRESS vs. STRAIN
POLYCRYSTALLINE #11
AMBIENT = 150°F
M₂ = 16700
7-10-65

STRESS [PSI x 10³]

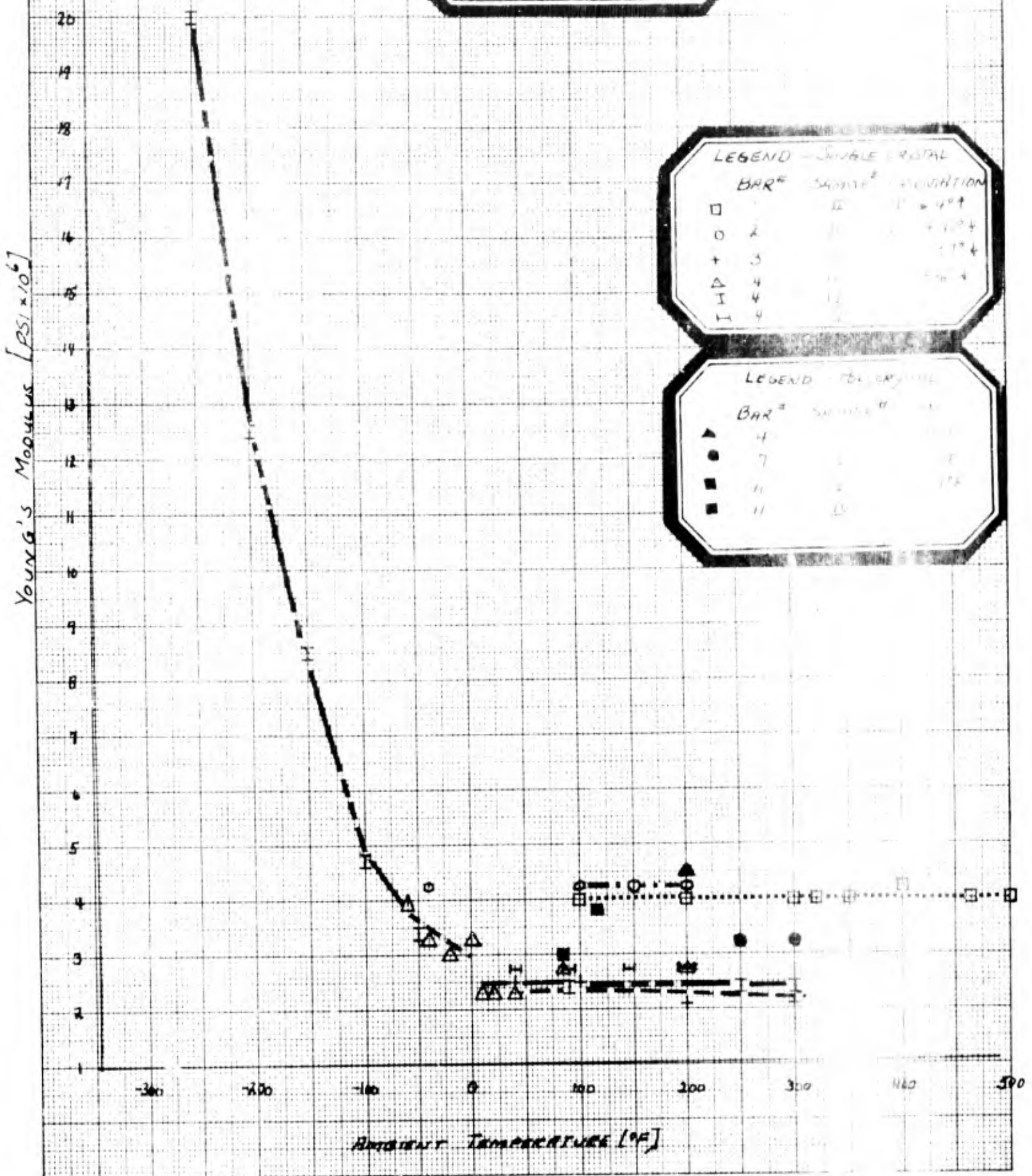
PERCENT STRAIN



STRESS vs STRAIN
POLY-CRYSTAL-III
AMBIENT = 85°F
6/22/65
MS. 165°F



YOUNG'S MODULUS
 VS
 AMBIENT TEMPERATURE
 FOR
 SINGLE AND POLYCRYSTAL
 MATERIAL



LEGEND - SINGLE CRYSTAL

BAR #	SAMPLE #	ORIENTATION
□	1	110°
○	2	110°
+	3	110°
△	4	110°
I	4	110°
I	4	110°

LEGEND - POLYCRYSTAL

BAR #	SAMPLE #	ORIENTATION
▲	4	110°
●	7	110°
■	11	110°
■	11	110°

FIG. 60

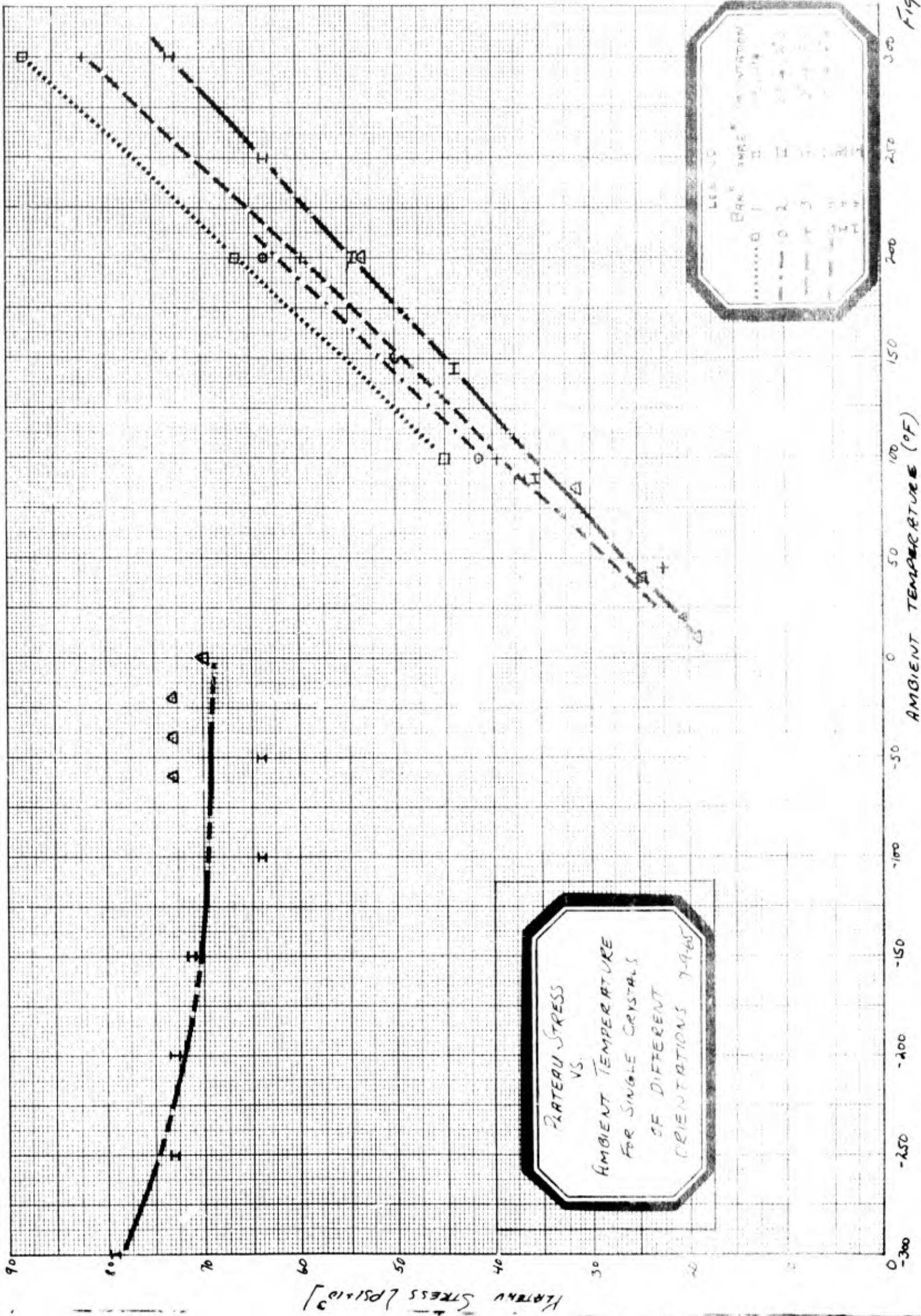


Fig. 61

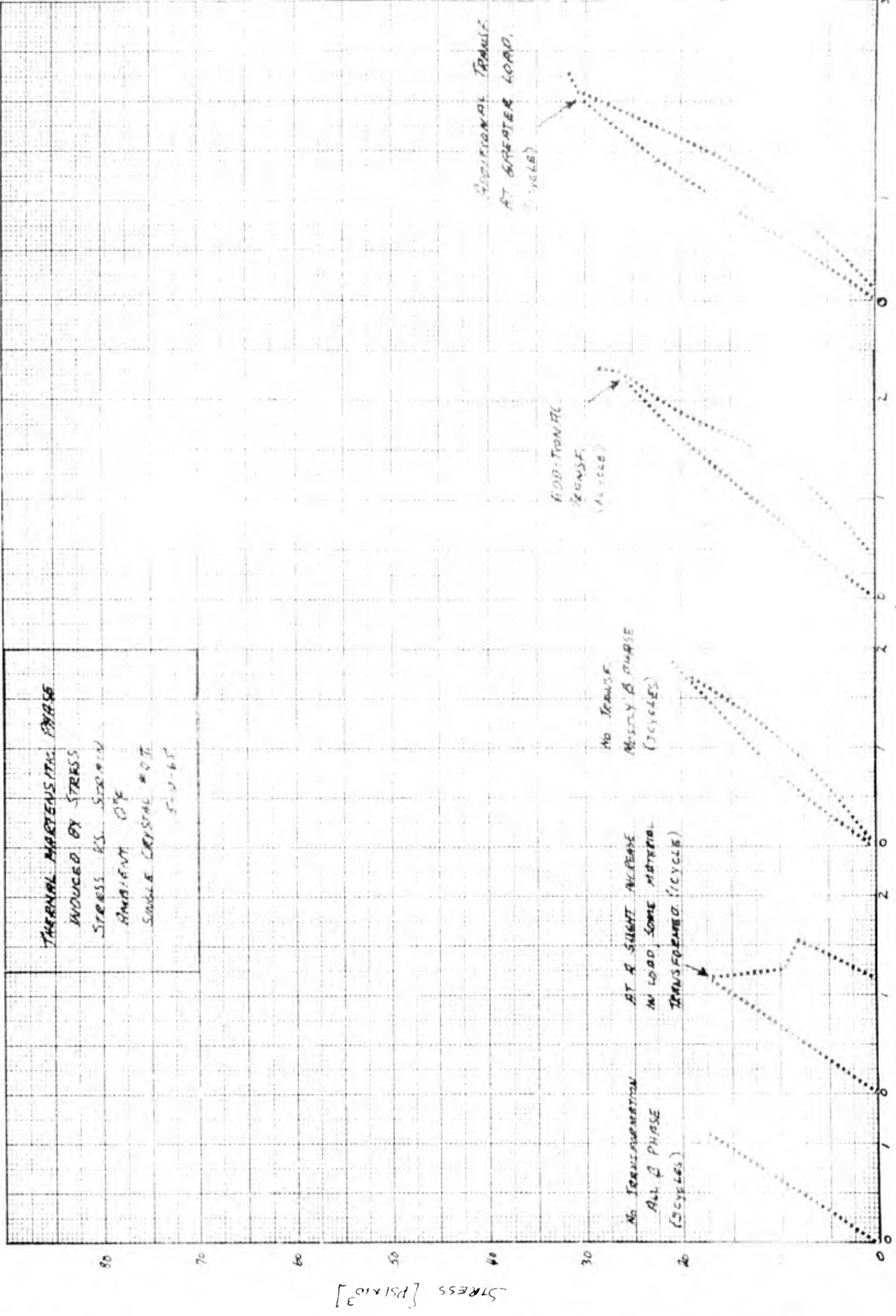


FIG. 62A

TEMPERATURE HISTORICAL PHASE
 INDICATED BY STRESS -
 CONTINUED

[continued]

TEMPERATURE HISTORICAL PHASE
 INDICATED BY STRESS

TEMPERATURE HISTORICAL PHASE
 INDICATED BY STRESS

NO TRANSFORMATION
 (7 CYCLES)

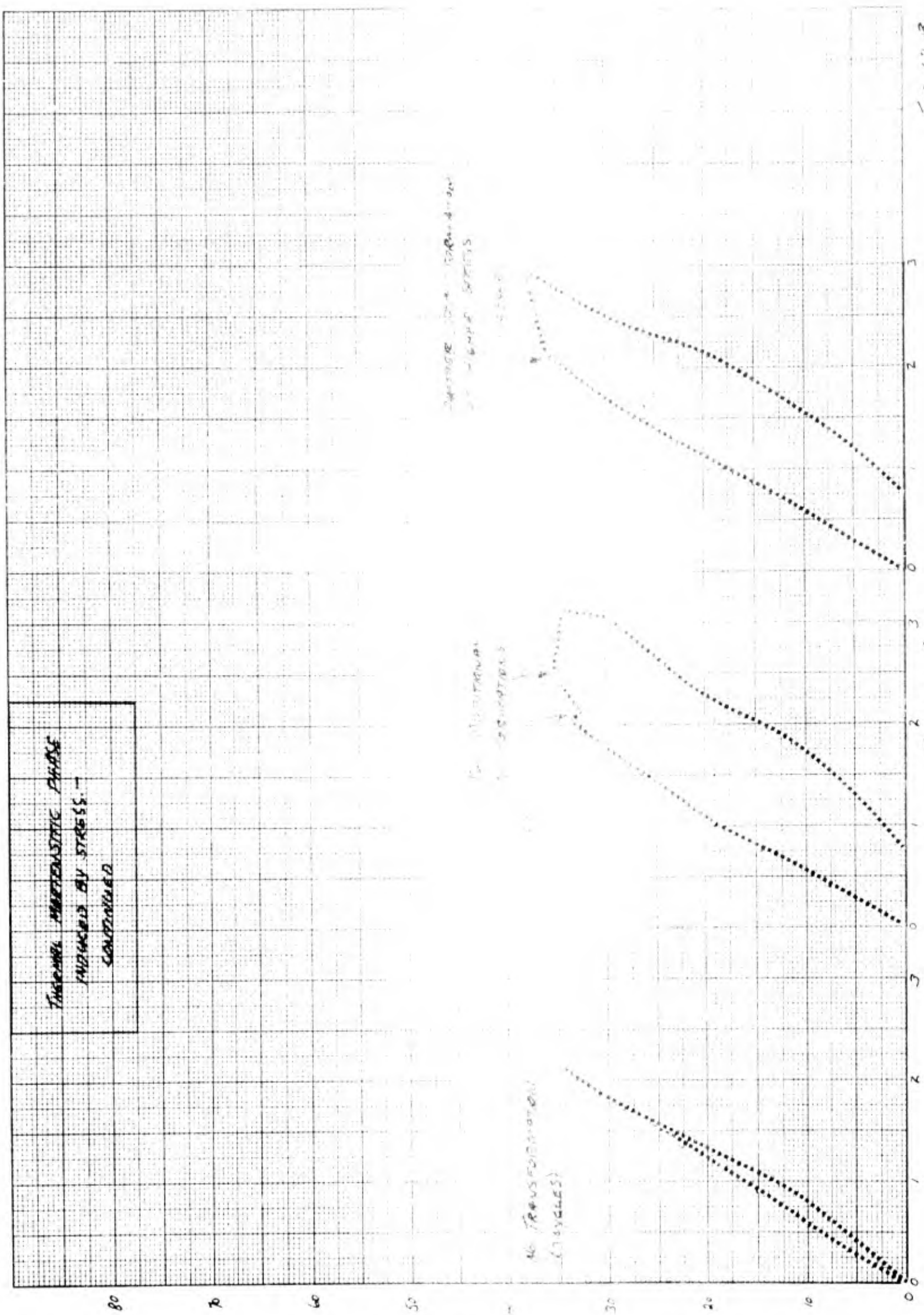


Fig. 62 B

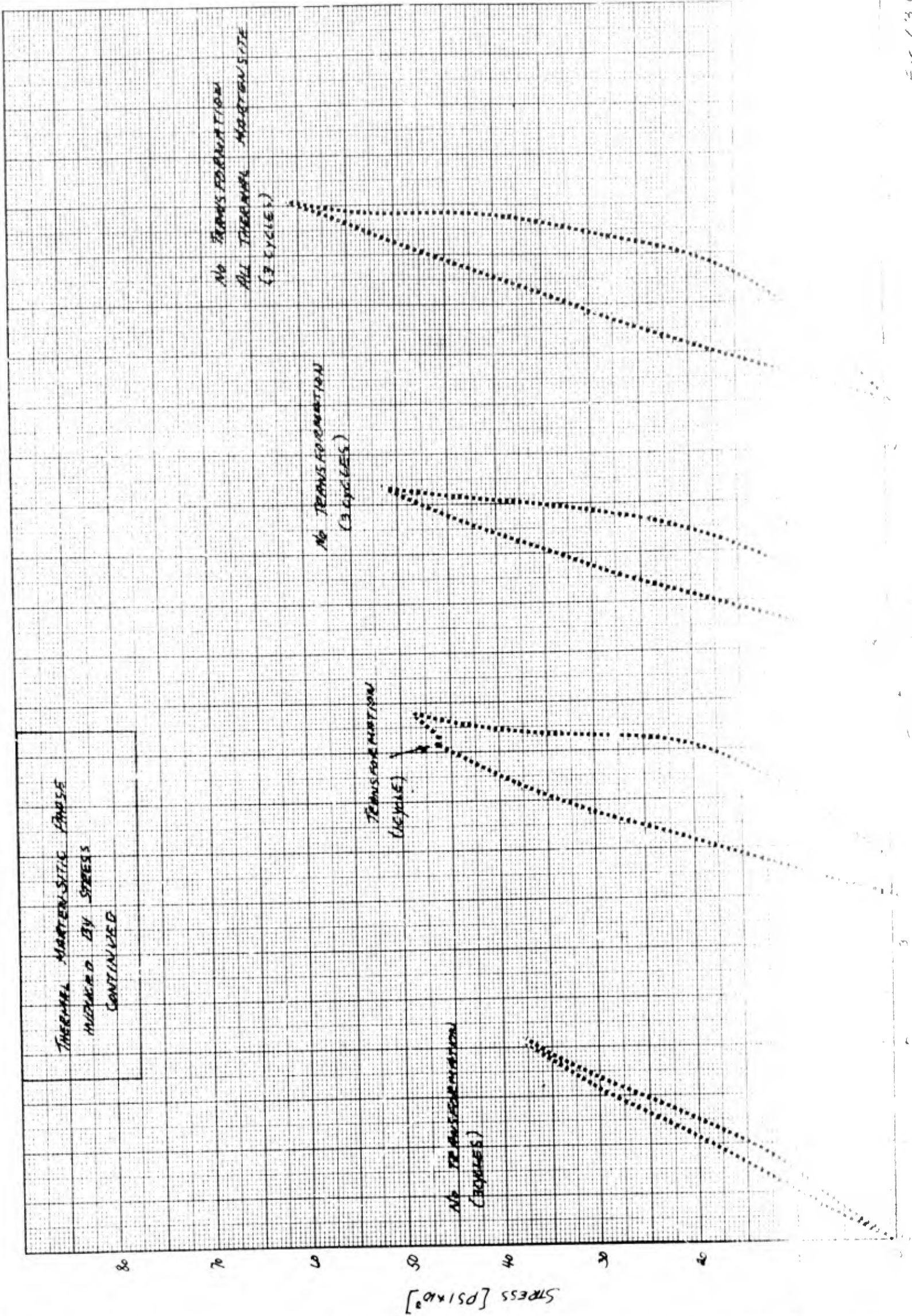


FIG 63 C

PERCENT STRAIN

HYSTERESIS Vs. STREAM
 AT VARIOUS TEMPERATURES
 USING CENTRA SPECIMENS
 BELOW 0°F - MARTEGALSTE
 ABOVE 0°F - BETA
 9-16-45

Stream Rate = 8 1/2 ft/minute



340
 330
 320
 310
 300
 290
 280
 270
 260
 250
 240
 230
 220
 210
 200
 190
 180
 170
 160

A

19.5 L IN 16

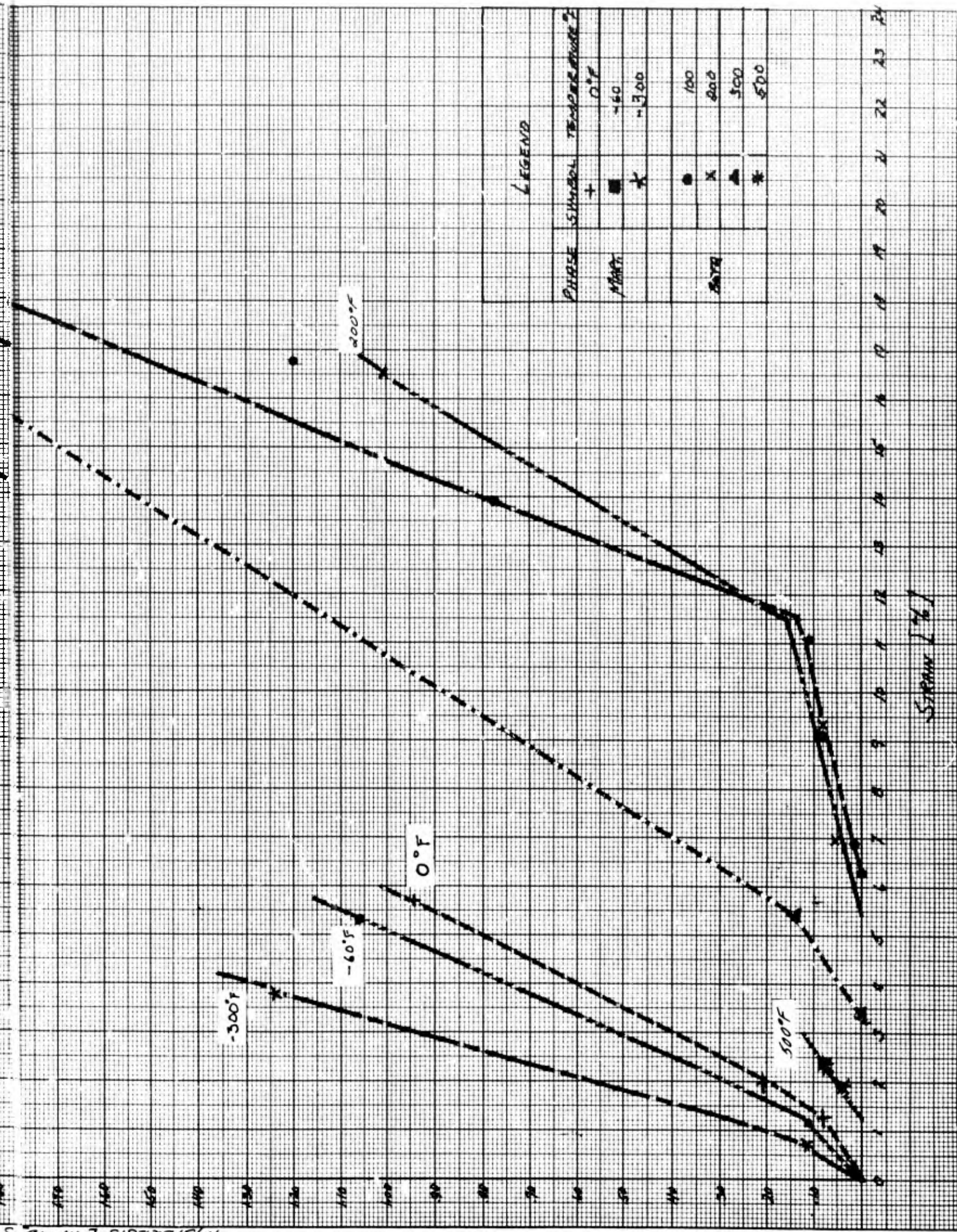
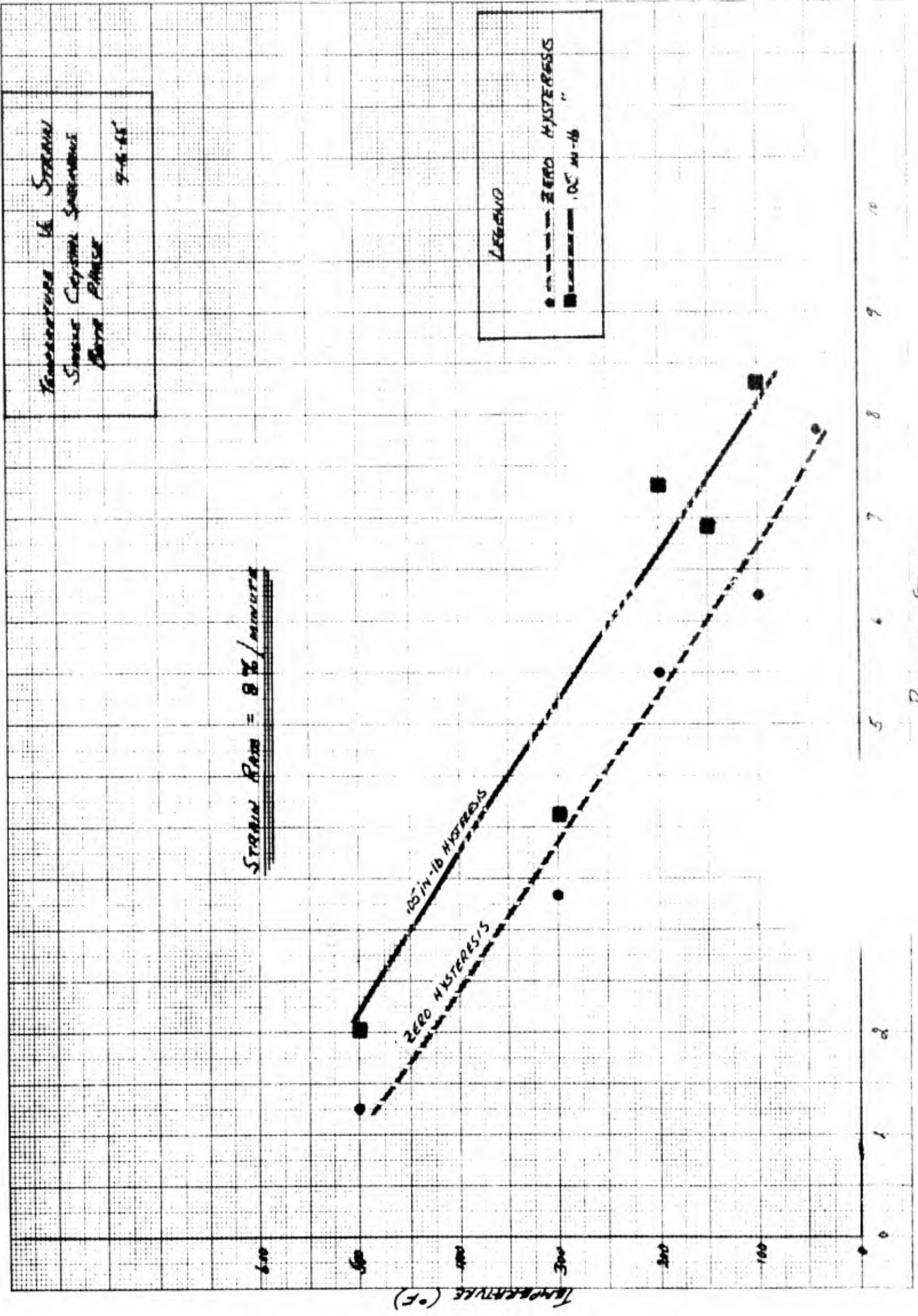


Fig. 63

Hysteresis L in-lb.s

B



PERCENT STRAIN

FIG. 64

STRESS VS. STRAIN
 SINGLE CRYSTAL #312
 AMBIENT = 100°F
 EFFECT OF 1 POUND
 WEIGHT ON SPECIMEN
 FOR APPROXIMATELY
 15 HOURS.

7-8-45

LOADED AND UNLOADED
 SIX TIMES TO ABOUT 8%
 STRAIN AFTER 1 POUND
 WEIGHT (UNLOADED) FOR 15
 HOURS

LOADED AND UNLOADED
 SIX TIMES TO 9% STRAIN.
 CURVE REPRODUCED
 EACH RUN.

Stress (psi) x 10³

STRAIN (%)

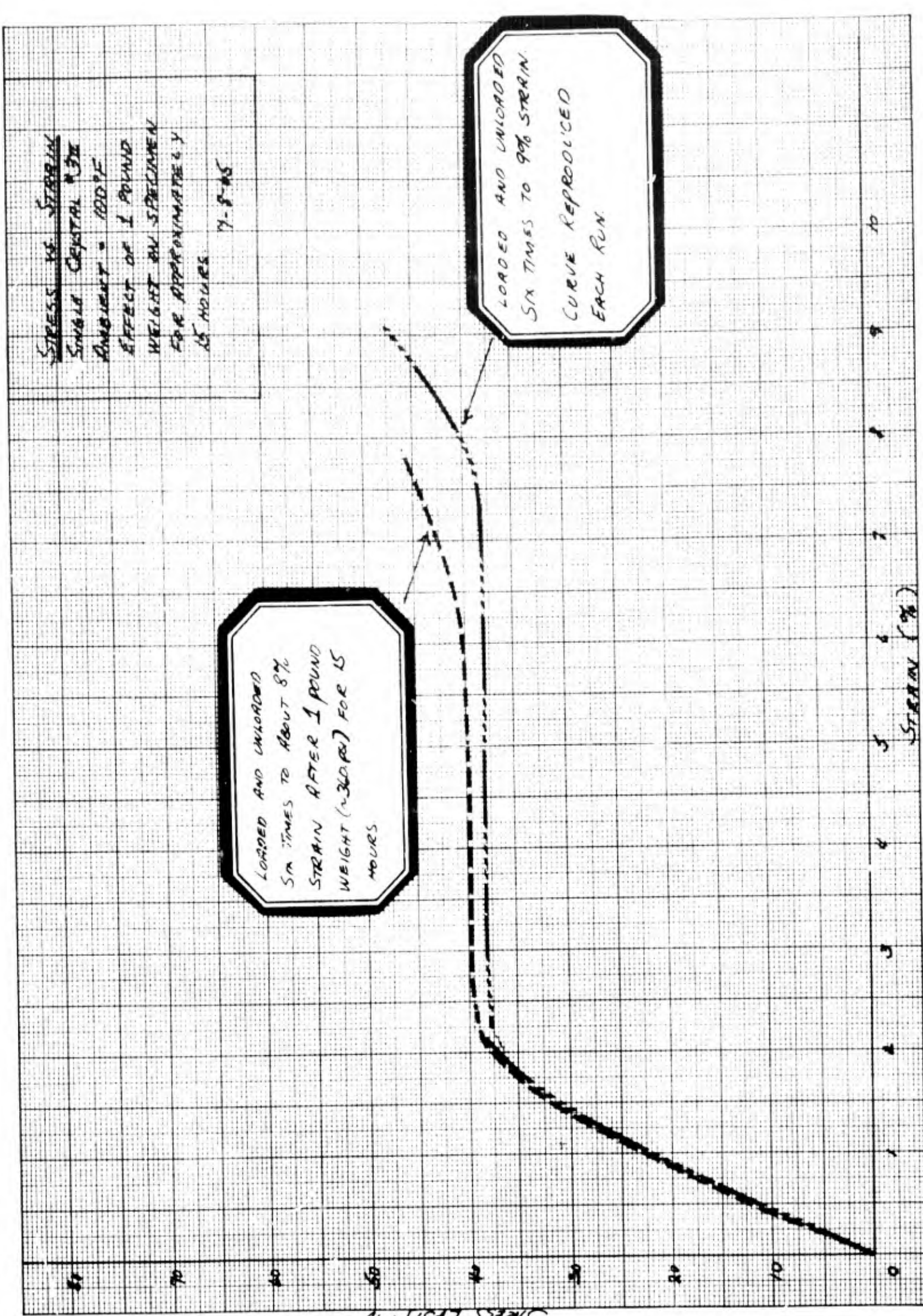
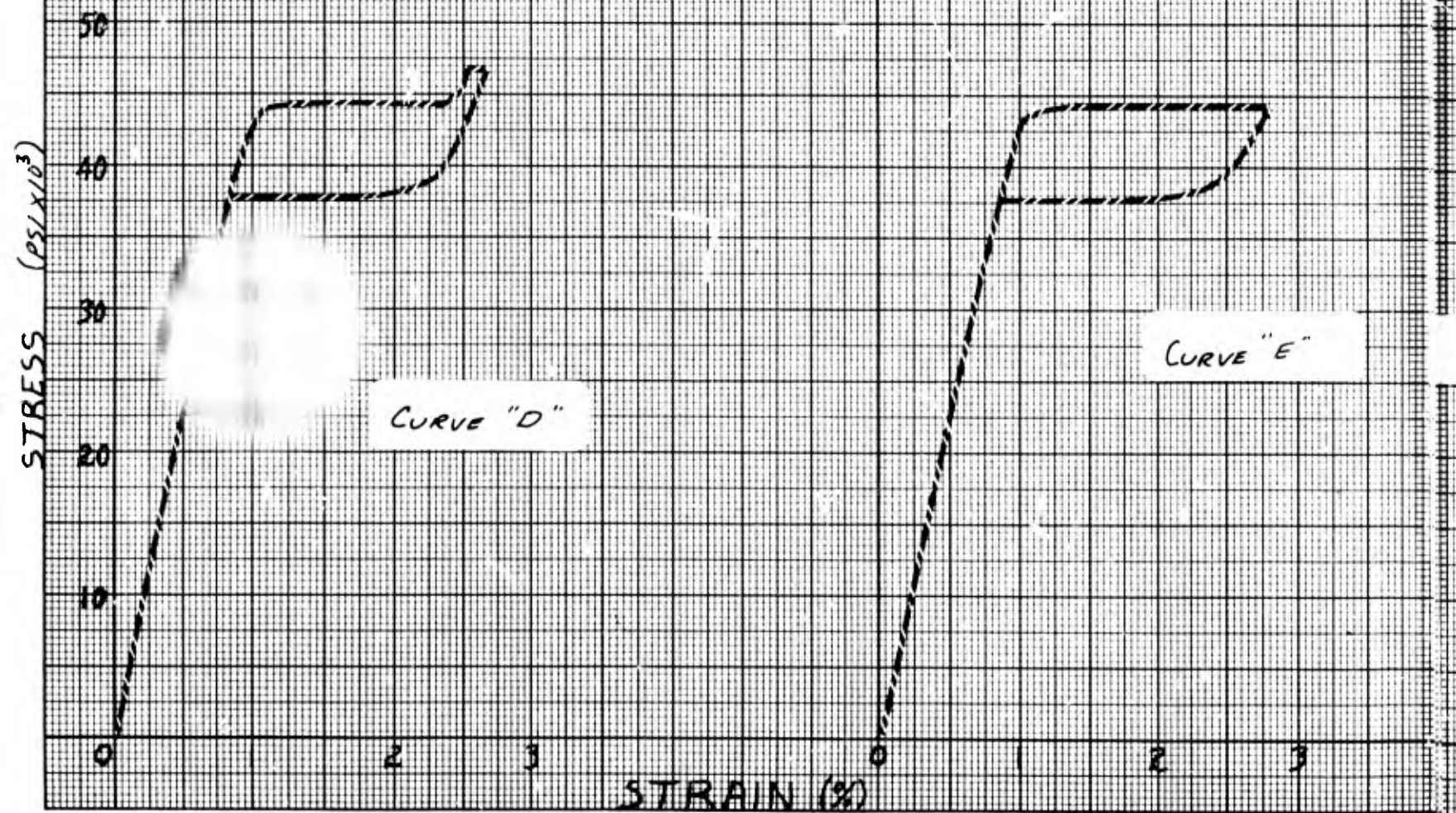
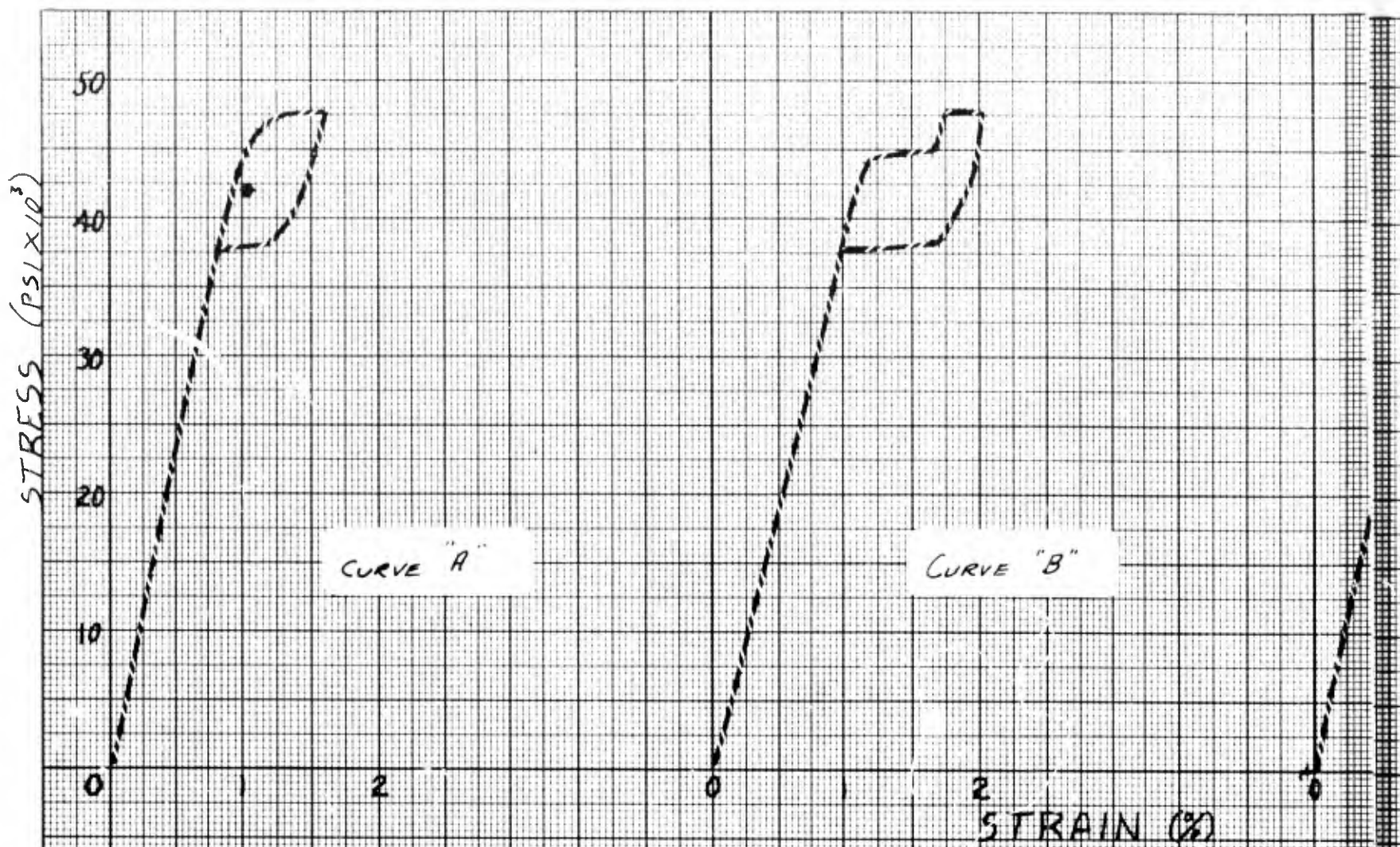
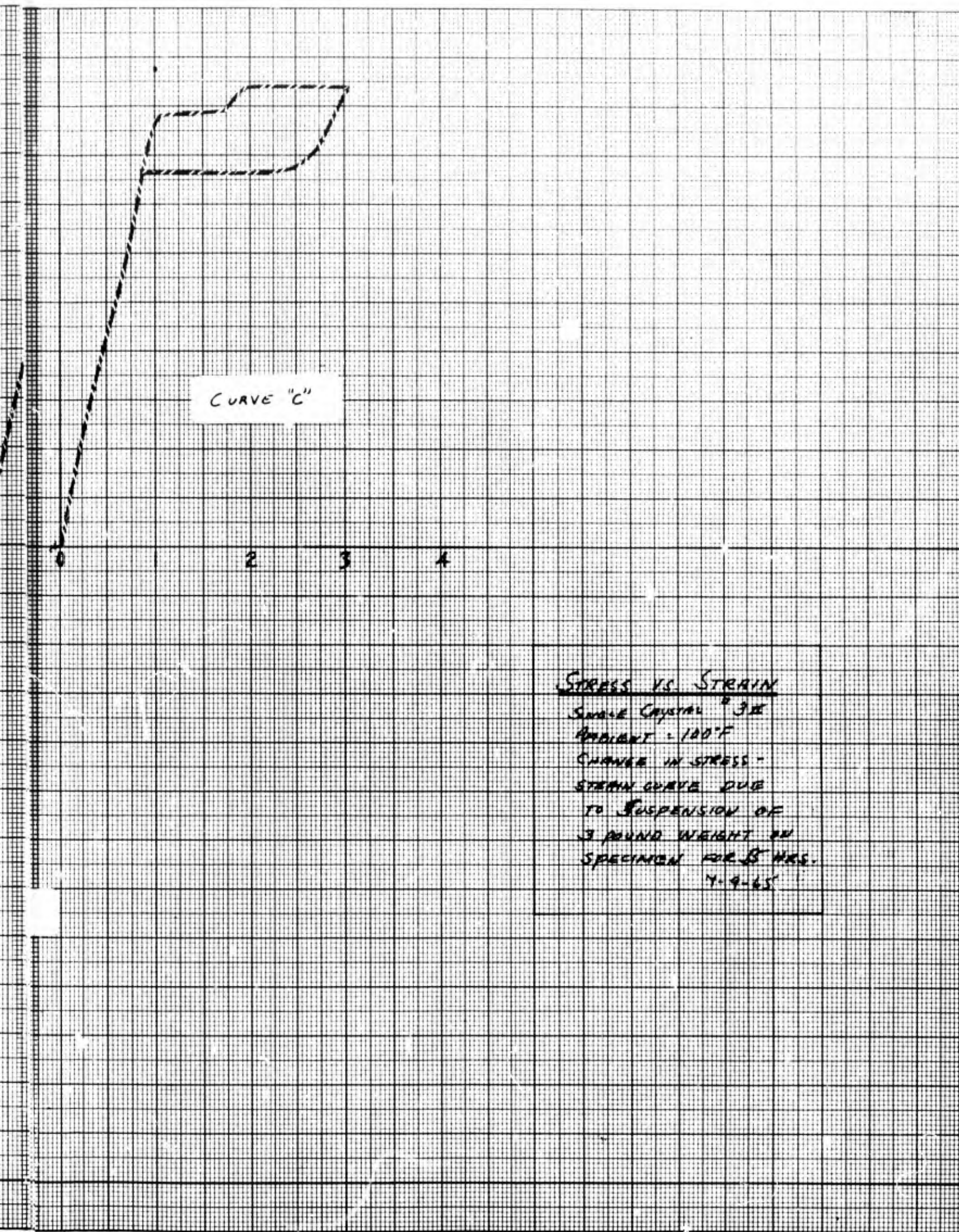


Fig. 65

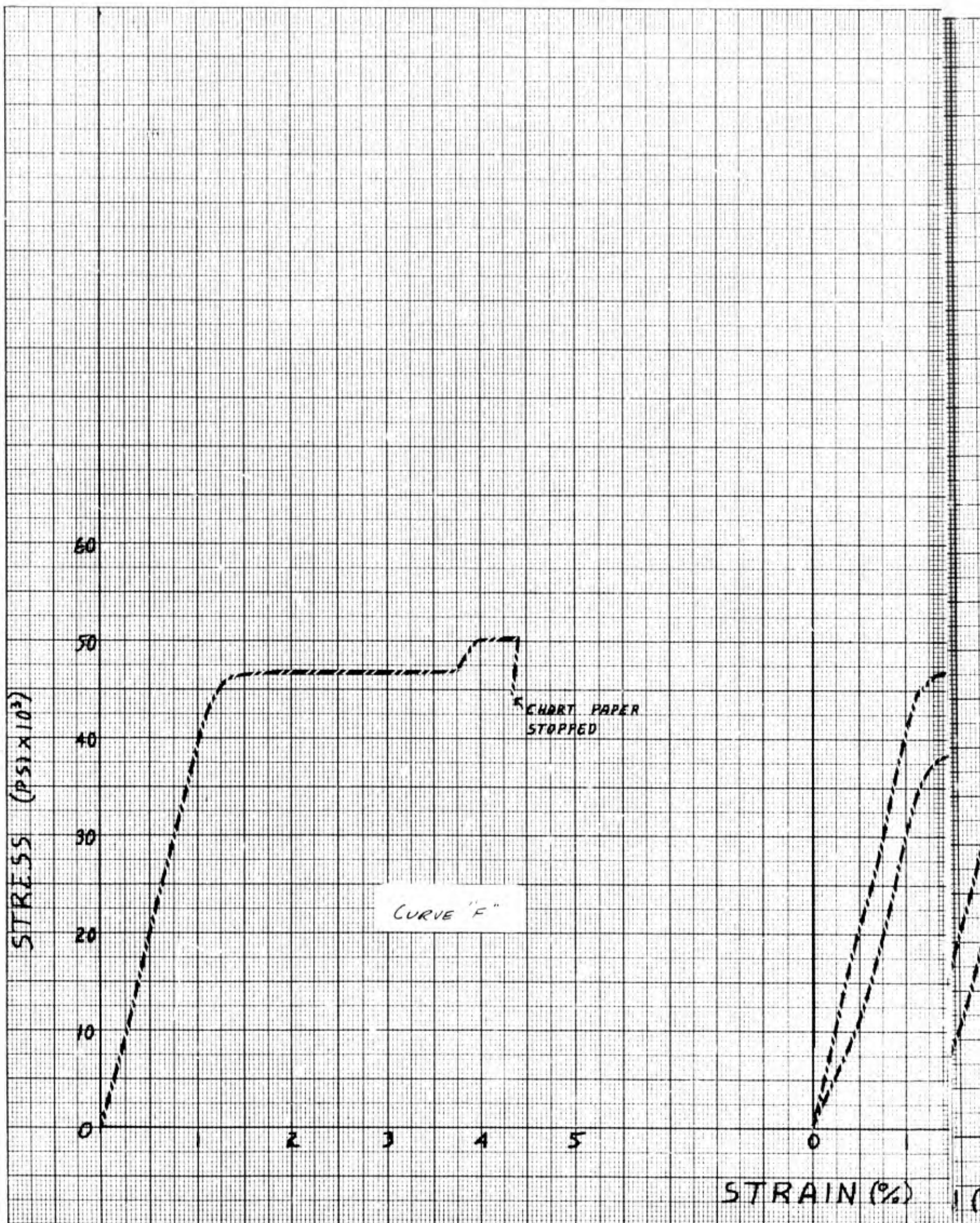


A



B

FIG. 66



A

STRESS VS. STRAIN

SINGLE CRYSTAL #32

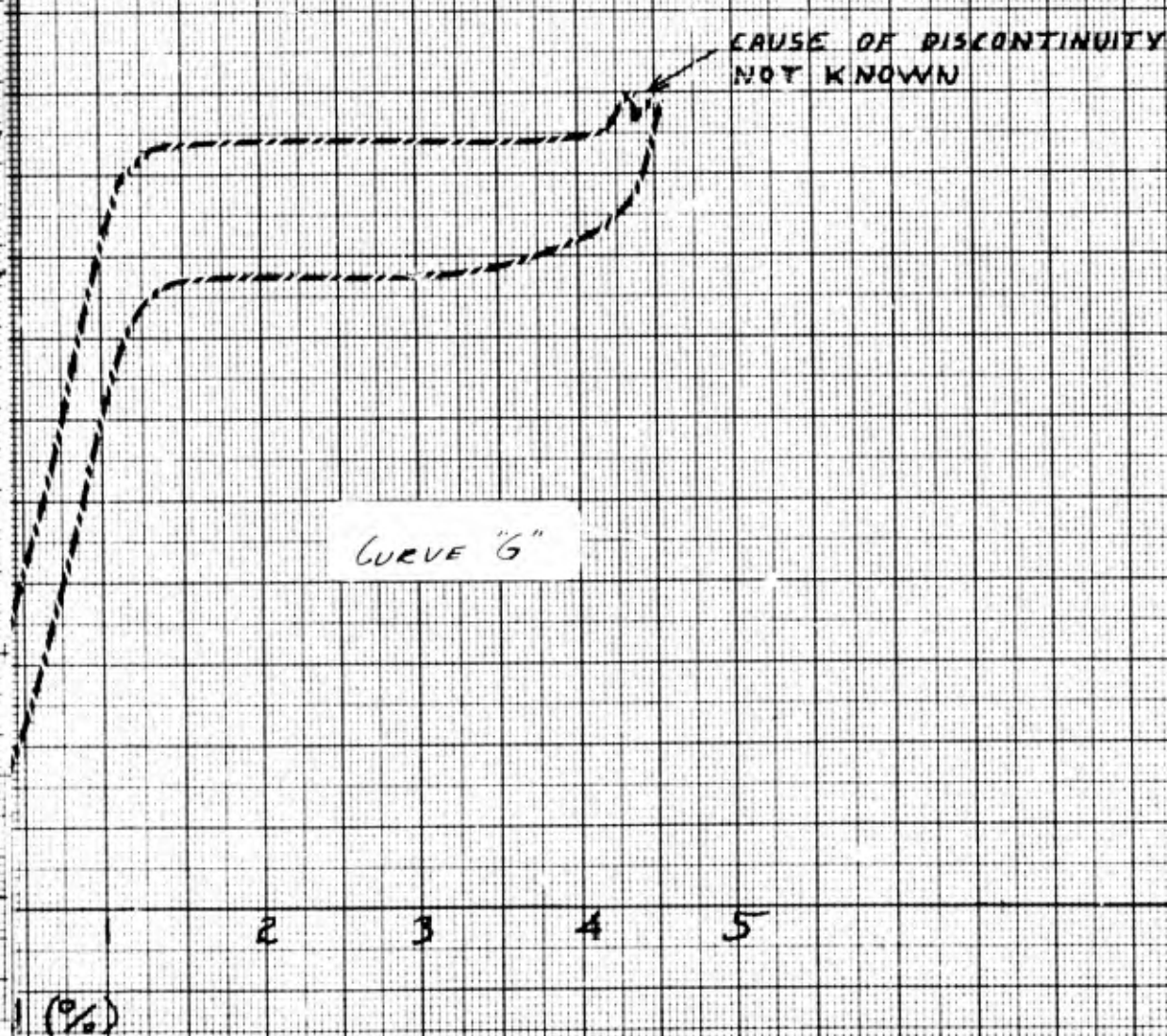
AMBIENT = 100°F

EFFECT OF 13610

WEIGHT ON SPECIMEN

FOR 30 MINUTES

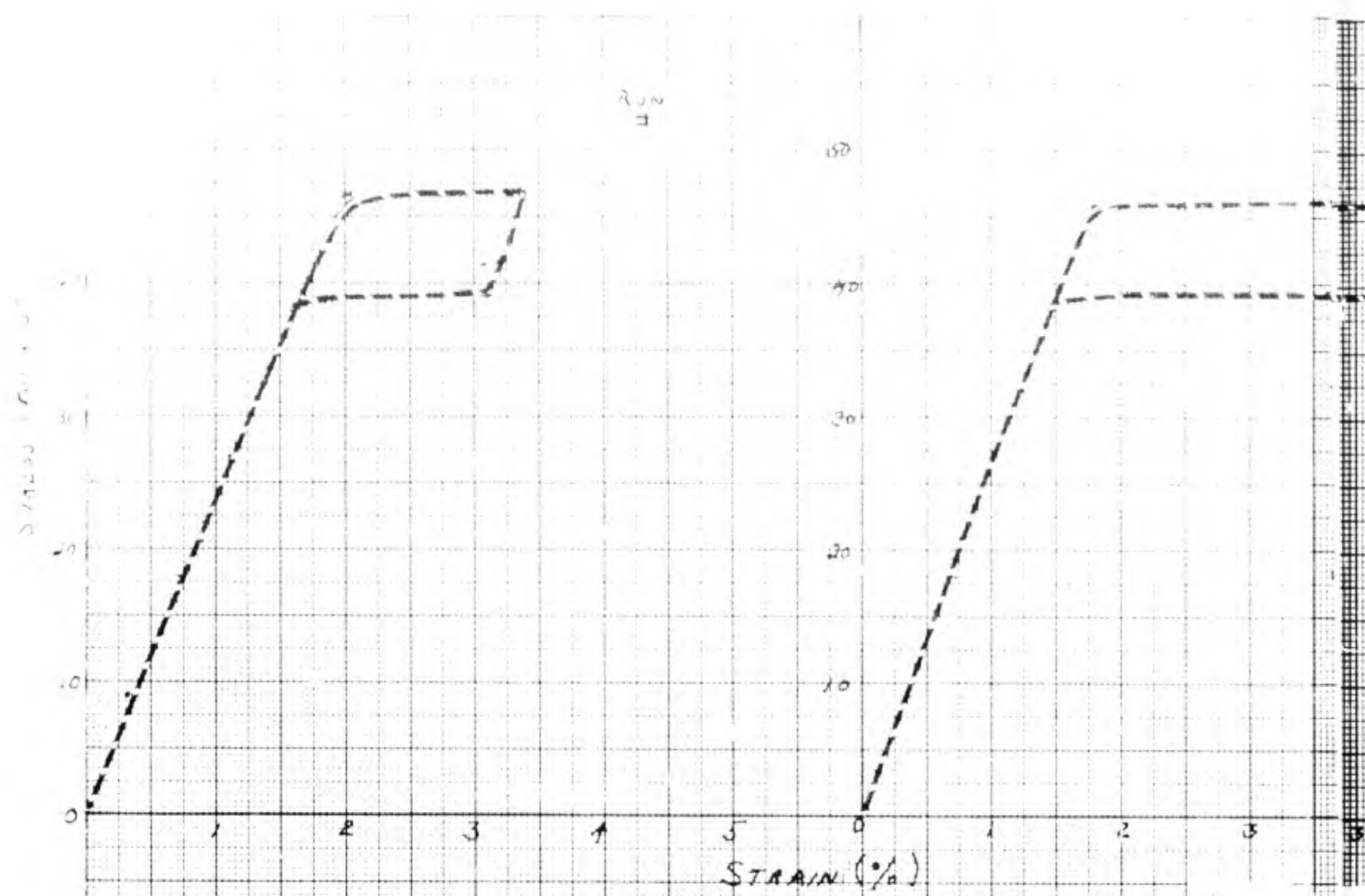
7-9-65



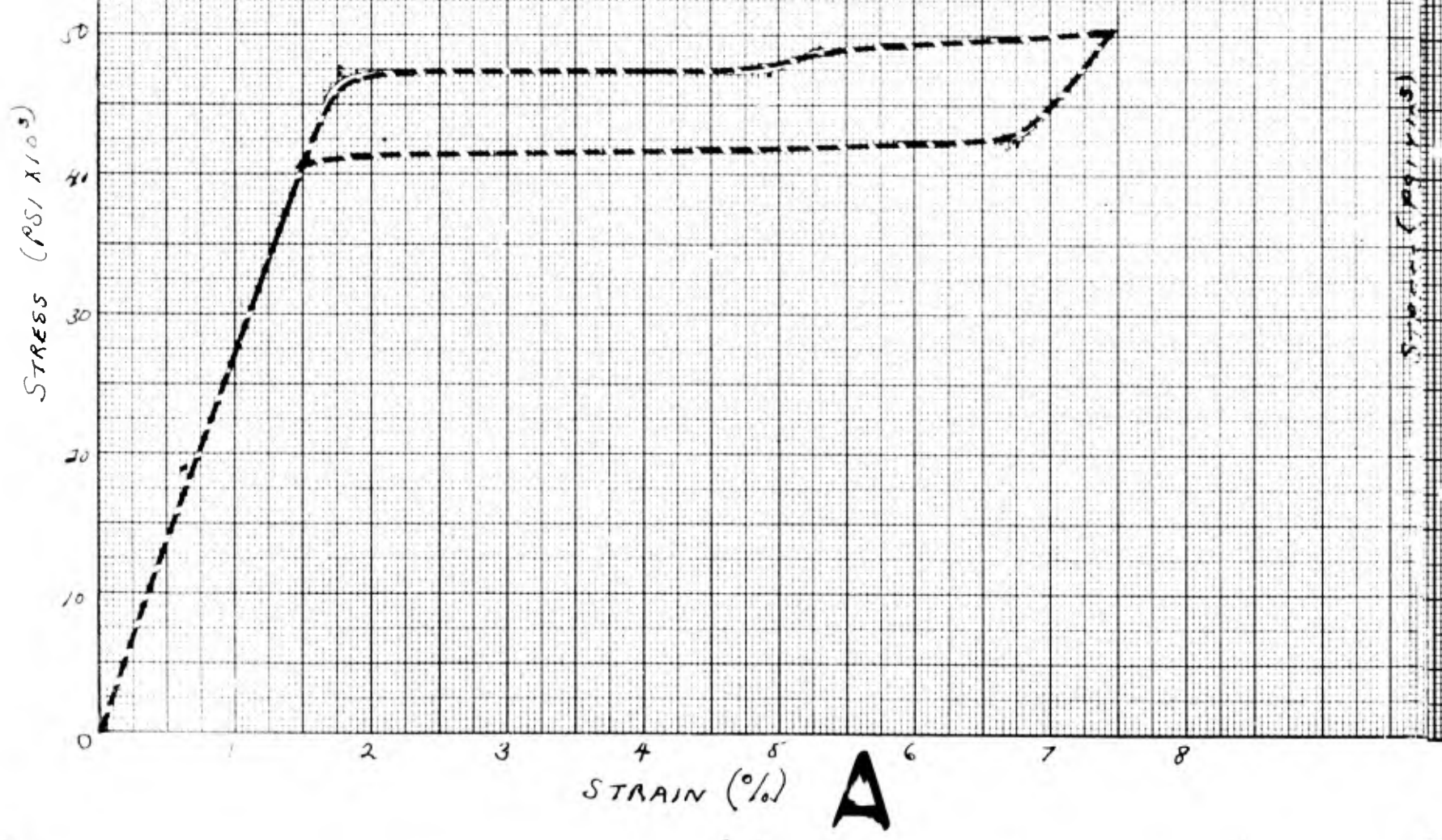
B

F967

Run 3



2
3
4



A

CURVES OF
STRESS VS STRAIN
FOR
SINGLE CRYSTAL AL N. CU
ALLOY
AT 100°F

RUNS
2+3

STRESS IS (PSI X 10⁹) AREA OF ALLOY =
STRAIN IS (%) $2.78 \times 10^{-3} \text{ IN}^2$

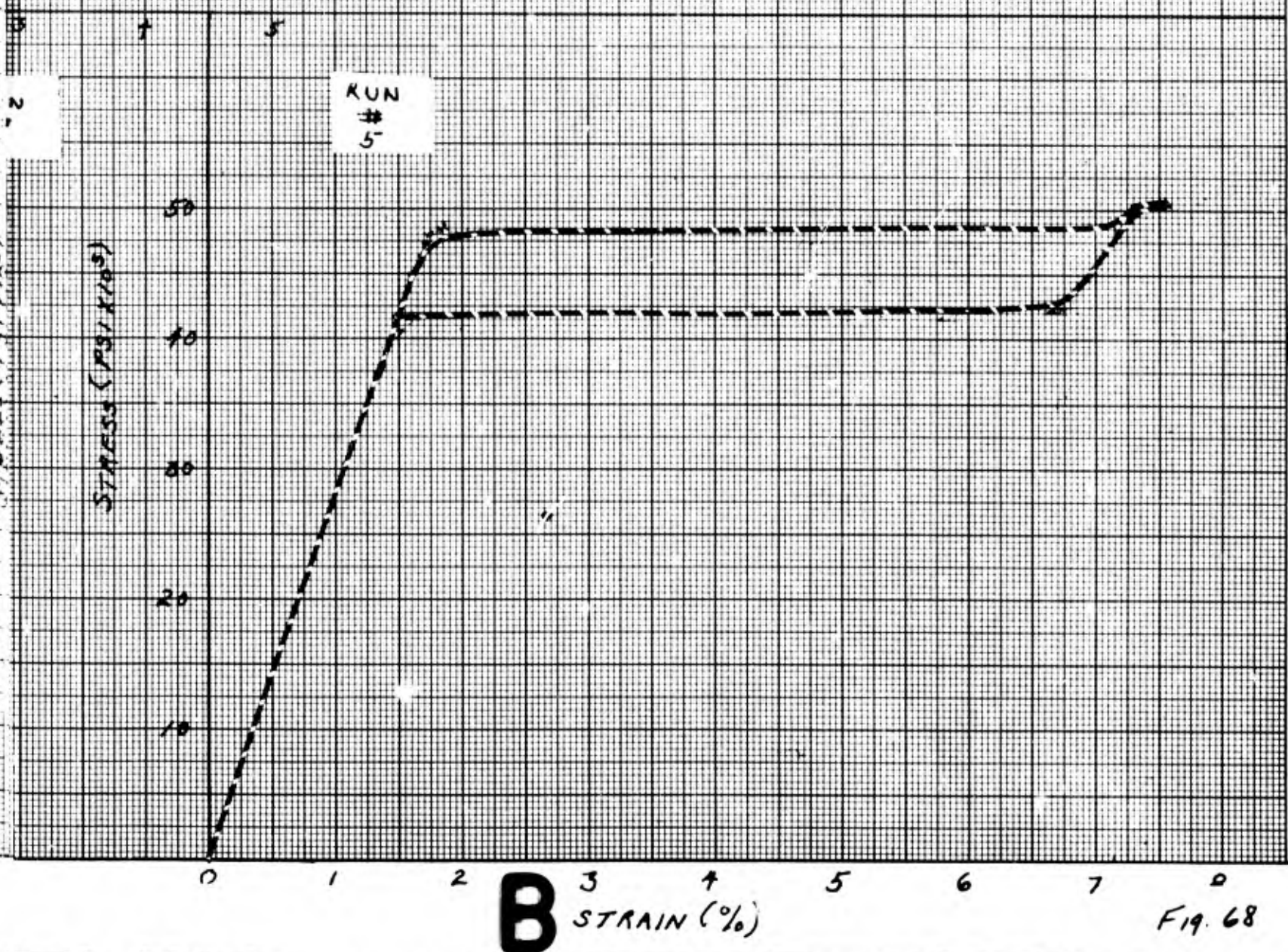
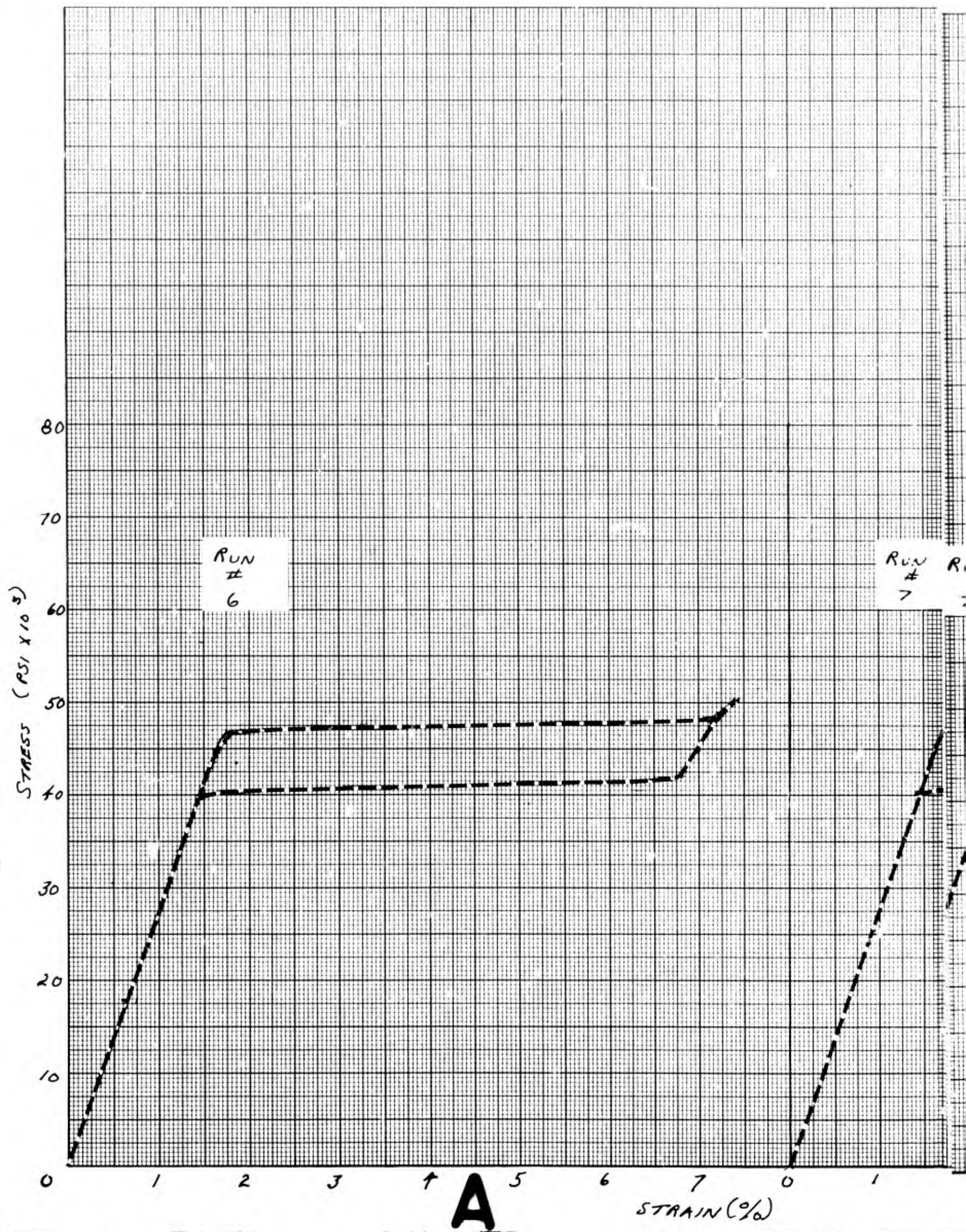


Fig. 68



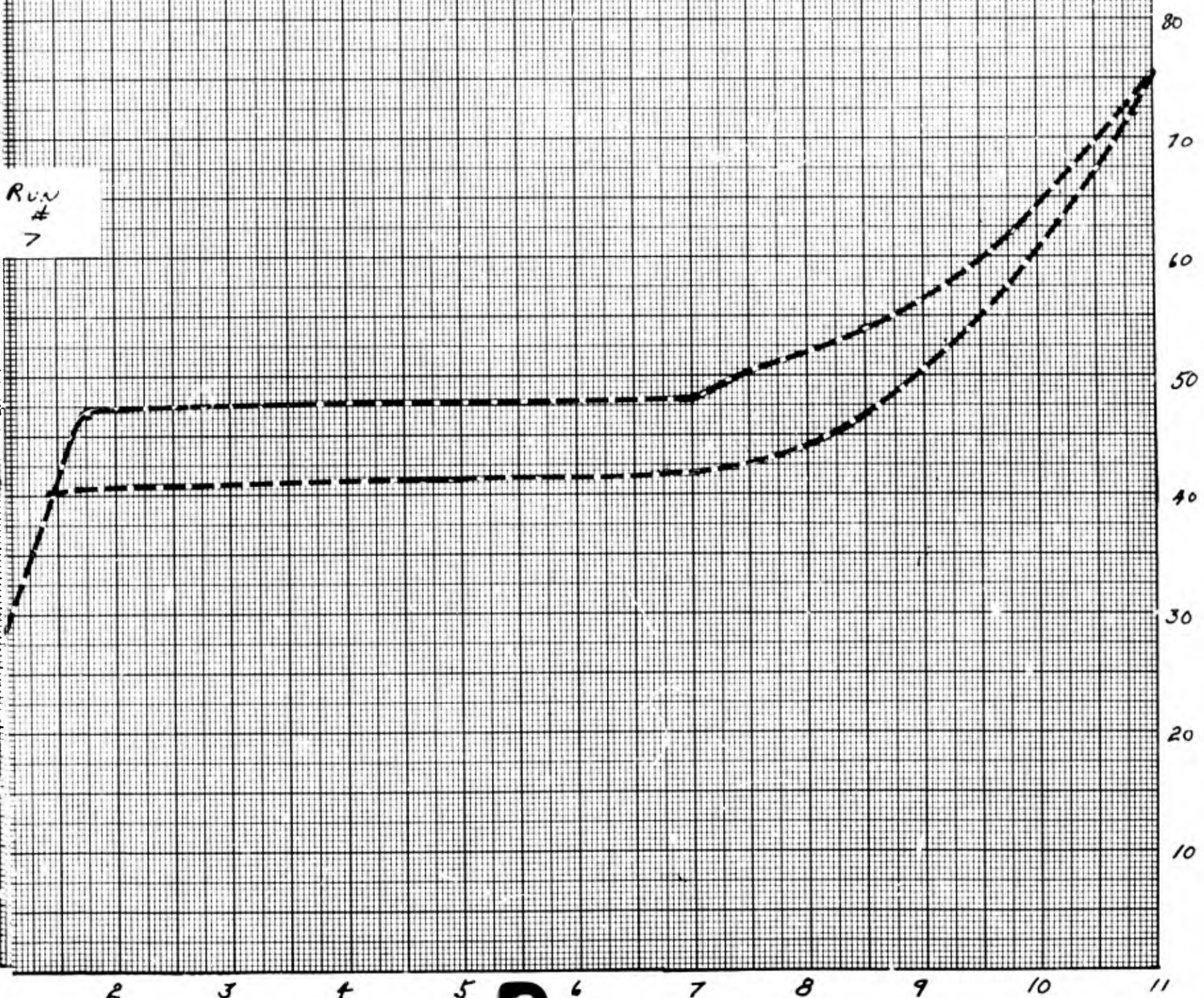
C.A.L. 10/10/62

GRAPH OF
STRESS VS STRAIN
FOR
SINGLE CRYSTAL Al-Ni-Cu
ALLOY
AT 100°F

STRESS IS (PSI/10³)
STRAIN IS (%)

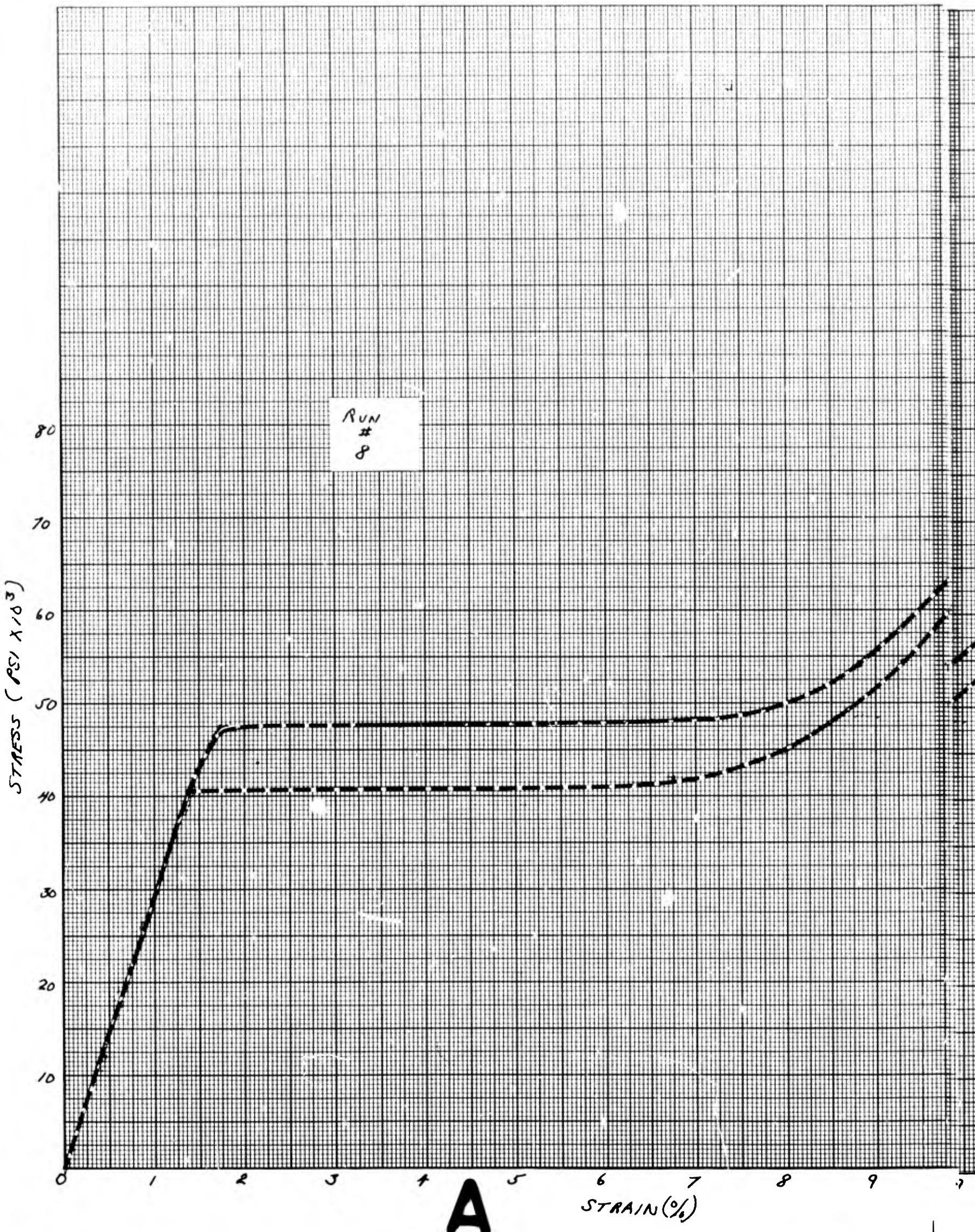
AREA OF
ALLOY
3.72 x 10⁻³ IN²

Run #
7



B

FIG. 69



PAL 10/22/75

CURVES OF

STRESS VS STRAIN
FOR
SINGLE CRYSTAL Al-Ni-Cu
ALLOY
AT 100° F

STRESS IN (PSI) (10⁸)
STRAIN IN (%)

AREA OF
ALLOY
 $2.78 \times 10^{-5} \text{ IN}^2$



10 11 12 13

B

Fig. 70

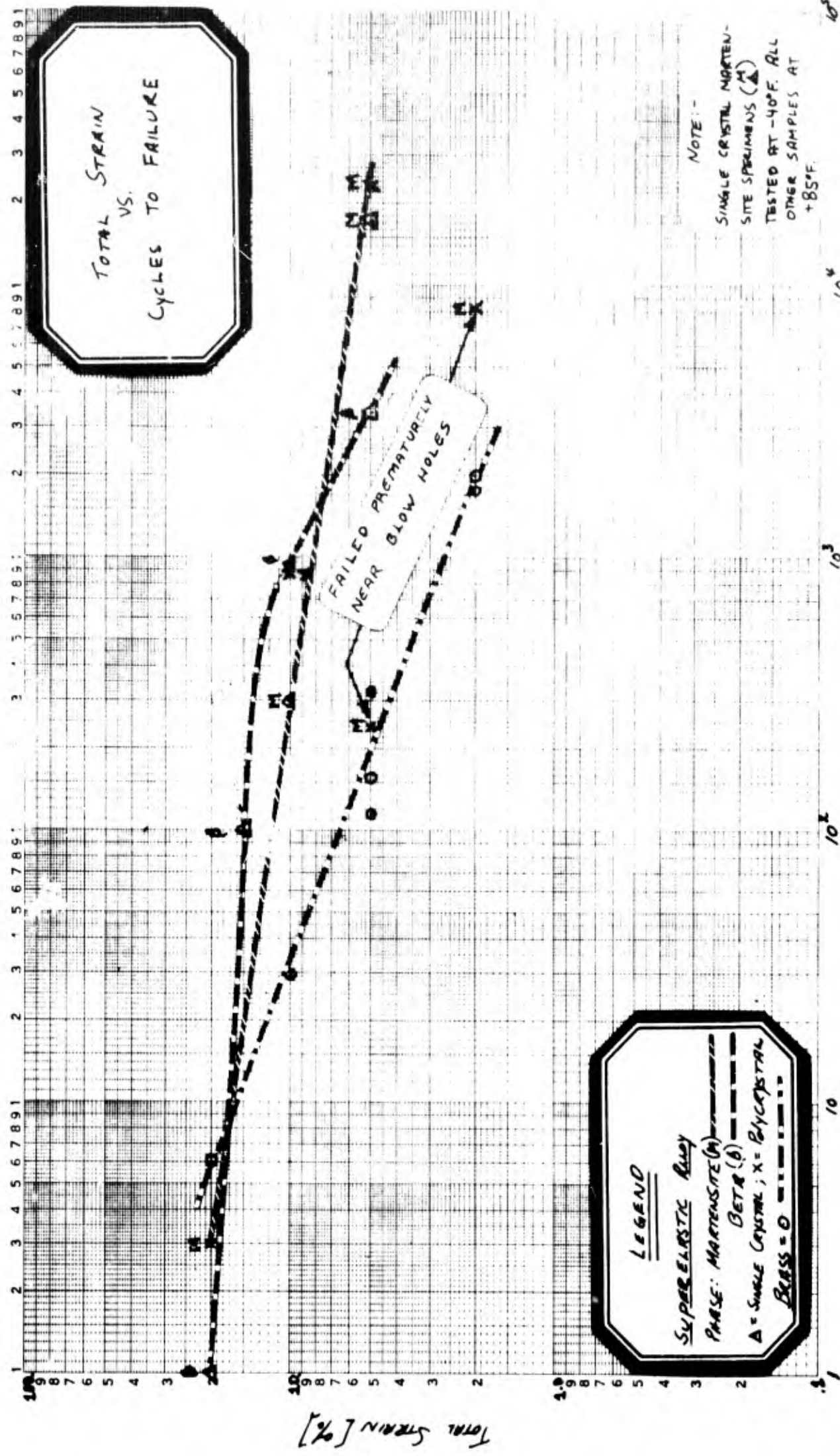
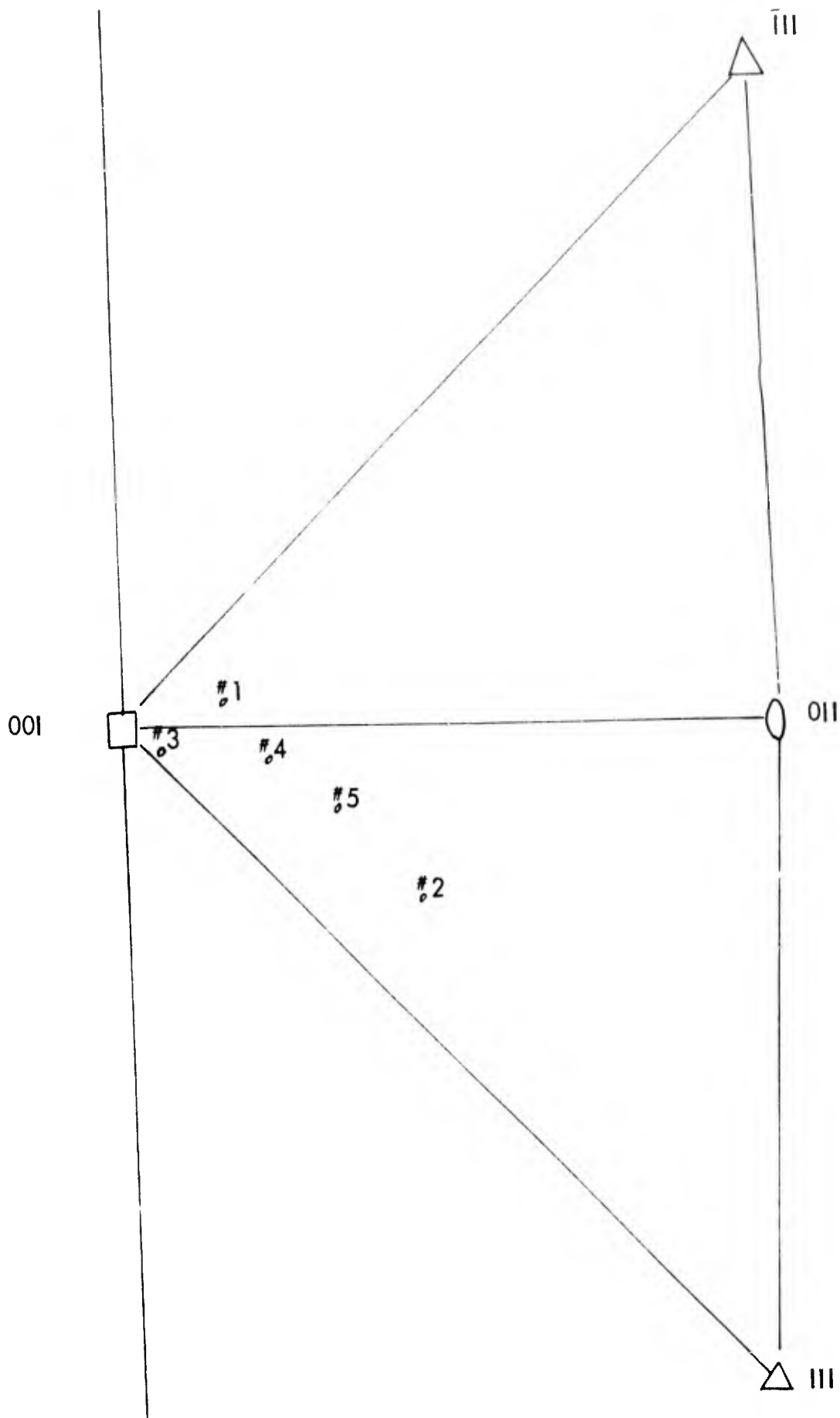


Fig. 71

TENSILE AXIS ORIENTATIONS



- #1 $9^\circ \rightarrow 4^\circ \uparrow$
- #2 $21^\circ \rightarrow 32^\circ \downarrow$
- #3 $2^\circ \rightarrow 37^\circ \downarrow$
- #4 $10^\circ \rightarrow 16^\circ \downarrow$
- #5 $16^\circ \rightarrow 22^\circ \downarrow$

Fig. 72