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MODEL XB-36

REPORT DEVF 275-551

DATE May 5, 1944

Test No. 551

[redacted]

FORT WORTH REPORT NO. FW-FSG 43

TITLE

STRINGER AND SKIN SPLICE TESTS XB-36 OUTER WING, LOWER SURFACE

SUBMITTED UNDER

Development Laboratories

PREPARED BY N. Marsh

GROUP Structures Test

REFERENCE

CHECKED BY G. O. Kenyon

APPROVED BY H. O. Boyvey

C. R. Irvins

NO. OF PAGES 20

NO. OF DIAGRAMS

REVISIONS

| NO | DATE | BY | CHANGE | PAGES AFFECTED |
|---|---|---|---|---|
| | | | | |

336-17

([redacted])

STRINGER AND SKIN SPLICE TESTS XB-36 OUTER WING,

LOWER SURFACE

SUMMARY

| Spec. No. | Specimen Description | Design Load | Ultimate Load | % D. L. |
|---|---|---|---|---|
| 551-1 | P. S. 47015 Inner to Outer Panel Stringer & Skin Tension Splice (Sta. 25) | 164,800# | 168,400# | 102% |
| 551-2 | P. S. 47010 - #1 Typical Skin Splice (Sta. 28) | 131,500# | 131,500# | 100% |
| 551-3 | P. S. 47010 - #2 Same as P. S. 47010 - #1 Except for the addition of twelve Monel Rivets replacing Dural | 131,500# | 147,800# | 112% |
| 551-4 | P. S. 47005 - #1 2" x .125 Z Stringer Spliced to a 2" x .102 Z Stringer | 53,300# | 60,800# | 114% |
| 551-5 | P. S. 47005 - #2 2" x .091 Z Stringer Spliced to a 1½" x .064 Z Stringer | 30,700# | 35,250# | 115% |

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CONSOLIDATED VULTEE AIRCRAFT CORP., FORT WORTH DIV., TEX. (REPORT NO. DEVF 275-551)

STRINGER AND SKIN SPLICE TESTS XB-36 OUTER WING, LOWER SURFACE - FORT WORTH REPORT NO. FW-FSG 41

N. BARSH 5 MAY 44 28PP PHOTOS, DIAGRS, GRAPHS, DRWG

STRUCTURES (7) WINGS - STRUCTURAL TESTS
DESIGN AND DETAILS (2) B-36 - STRUCTURAL TESTS
B-36

UNCLASSIFIED

([redacted])

## REFERENCES

**PHOTOGRAPHS:**

No. 114364 - View Showing Bending of Skin and Doublers at 100% Design Load (Specimen 551-1).

No. 114369 - Front View of Failure (Specimen 551-1).

No. 114367 - Rear View of Failure (Specimen 551-1).

No. 114244 - Front View of Skin Splice (Specimen 551-2) in 200,000# Test Machine.

No. 114245 - Rear View of Skin Splice (Specimen 551-2) in Test Machine.

No. 114246 - Front and Side View of Skin Splice (Specimen 551-2) Showing Failure and Bending of Skin and Doublers.

No. 114243 - Rear View of Skin Splice (Specimen 551-2) Showing Failure of Splice Rivets.

No. 114256 - Front View of Failure of Skin Splice (Specimen 551-3).

No. 114257 - Rear View of Failure of Skin Splice (Specimen 551-3).

No. 114200 - Front View of Stringer Splice (Specimen 551-4) in Test Machine Showing Failure.

No. 114201 - Closeup Showing Front and Side View of Stringer Splice (Specimen 551-4) Failure.

([redacted])

([redacted])

REFERENCES (contd.)

PHOTOGRAPHS: (contd.)

No. 114203 - View Showing Set-Up and Failure of Stringer Splice (Specimen 551-5).

No. 114202 - Side and Front View of Stringer Splice (Specimen 551-5) Showing Failure.

REFERENCES ONLY:

Specimen Project Slips - No. 47015
No. 47010
No. 47005

Test Project Slips - No. 44213
No. 44215

([redacted])

(redacted)

RESULTS:

| Specimen | Design Load | Ultimate Load | Failure at % D. L. | Description of Failure |
|---|---|---|---|---|
| 551-1 | 164,800 | 168,400 | 102% | Specimen failed in tension at splice (See Photo. #114369, Page 18, and #114367, Page 19 ). |
| 551-2 | 131,500 | 131,500 | 100% | One of the Zee section stringers failed in tension at splice (See Photo.# 114246, Page 22), and splice rivets failed in shear (See Photo. # 114243, Page 23). Ultimate load maintained for approximately two minutes before failure. |
| 551-3 | 131,500 | 147,800 | 112% | (See Sketch, Page 9 ) In this specimen stringers and skin failed in tension (See Photo. #114256, Page 24, and #114257, Page 25). |
| 551-4 | 53,300 | 60,800 | 114% | The stringer failed in tension at splice. The skin failed in tension at section where holes were drilled simulating the effect of a rib (See Photo. #114200, Page 26, and Photo. #114201, Page 27). |
| 551-5 | 30,700 | 35,200 | 115% | Skin and stringer failed in tension at stringer splice (See Photo. #114203, Page 28, and Photo. #114202, Page 29). Note that failure of skin did not occur at the section where holes were drilled so as to simulate effect of rib. |

For distribution of stress at various strain gage locations for the different specimens, see Curves, Pages 11, 12, 13, 14, 15 and 16.

Strain gage data is available in test files.

(redacted)

( [redacted] )

DISCUSSION:

It is believed that Specimen 551-2 failed in the following manner:

At high loads a definite "rocking" motion of the splice rivets permitted the skin to slip. This condition, while relieving the skin, allowed an increasing amount of the load to pass to the stringer. Ultimate failure, however, was caused by a complete transfer of load to the stringer, following a shear failure of the splice rivets.

Specimen 551-3 was able to accept a greater load than Specimen 551-2 because of the increased number of monel rivets at the splice. By replacing twelve (12) of the 1/4 in. diameter 17ST rivets with 1/4 in. diameter monel rivets, the slipping effect of the skin was retarded, thus enabling the skin to carry more load than it did in Specimen 551-2. In this Specimen, failure of the skin was accompanied (followed) by the tension failure of the skin, the monel rivets holding though severely deformed.

Specimen 551-1, which was similar in construction to Specimens 551-2 and 551-3, failed in a manner similar to Specimen 551-3. In this Specimen, 1/4 in. monel rivets were used almost exclusively. Rocking action and deformation of the skin splice rivets was also noted in this Specimen, although it was not as prominent as it was in Specimens 551-2 and 551-3.

Eccentric loading of the skin and doublers at the splice was noted in Specimens 551-1, 551-2 and 551-3. Strain gages #1, 4 and 7 on doublers read compression during the entire loading. (See Photographs No. 114364, Page 17, and No. 114246, Page 22.)

Bending action was also noted in the stringers of all specimens, as can be seen by comparing the stresses at the extreme fibres and legs of the Zee sections (See Curves, Pages 11 to 16, inclusive).

( [redacted] )

([redacted])

PROCEDURE:

Seventeen strain gages were located at different points (See Sketch, Page 8 ) on Specimens 551-1, 551-2 and 551-3. Strain gage readings were taken at a number of load increments up to 100% design load, after which the specimens were loaded to failure.

Strain gage readings were also taken for the twelve gages on Specimens 551-4 and 551-5 (See Sketch, Page 10 ) for a number of load increments up to 100% design load. After reaching 100% design load, holes were drilled in a line across the Specimen's skin so as to simulate actual conditions on the wing where the ribs framed into the skin. The Specimens were then loaded to failure.

Design load was calculated on the basis of 50,000 psi over the minimum gross cross-sectional area of the Specimen.

CONCLUSION:

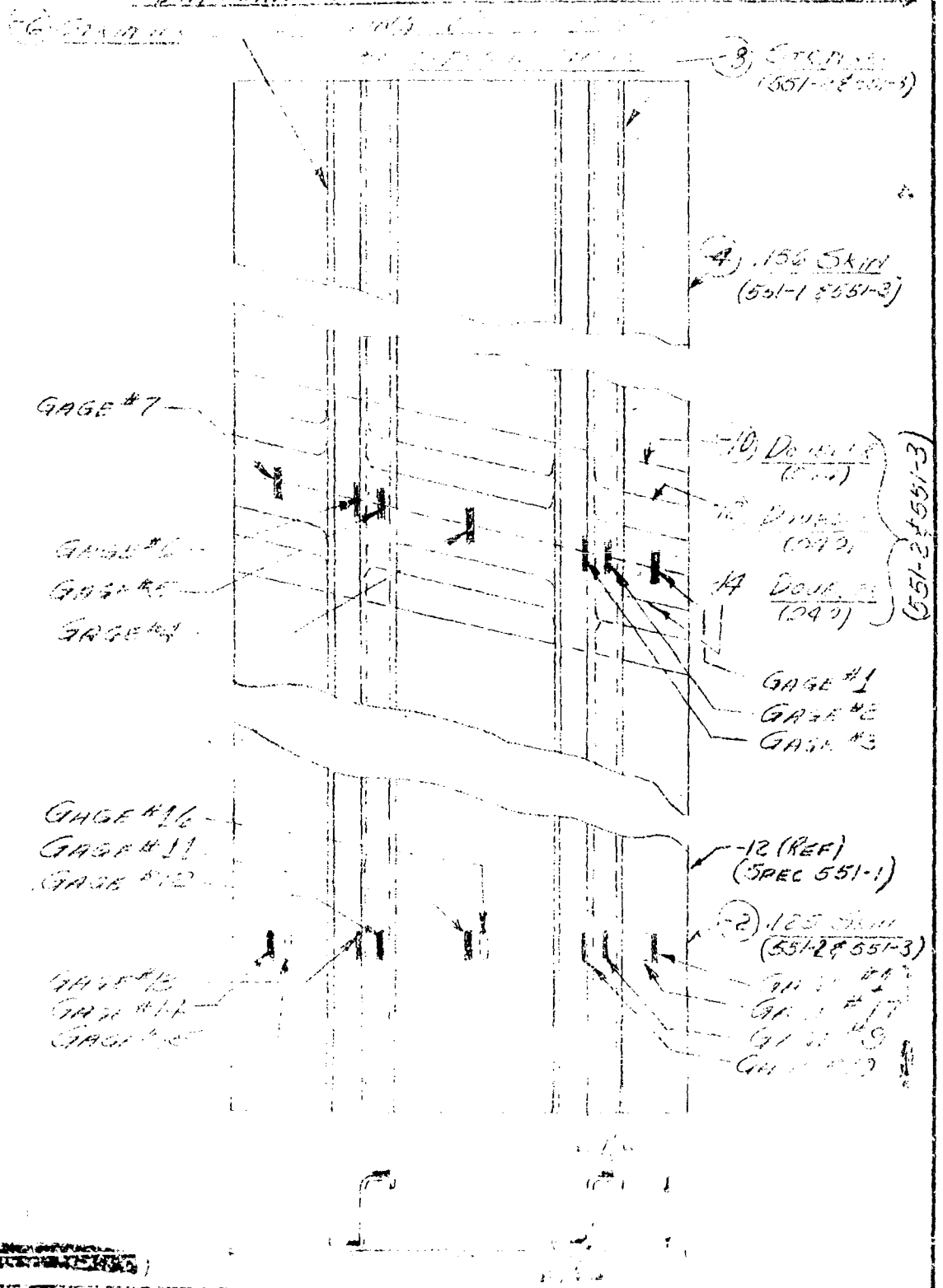
All Specimens tested were satisfactory.

Inasmuch as Specimen 551-2 failed after holding 100% design load for only two minutes, it was found necessary to replace some of the 1/4 in. diameter 17ST rivets with 1/4 in. diameter monel rivets in the splice of Specimen 551-3 so as to reduce the rocking effect of the rivets and the slippage of the skin. Specimen 551-3 was warranted in preference to Specimen 551-2 because it failed at 112% design load.

([redacted])

[redacted]

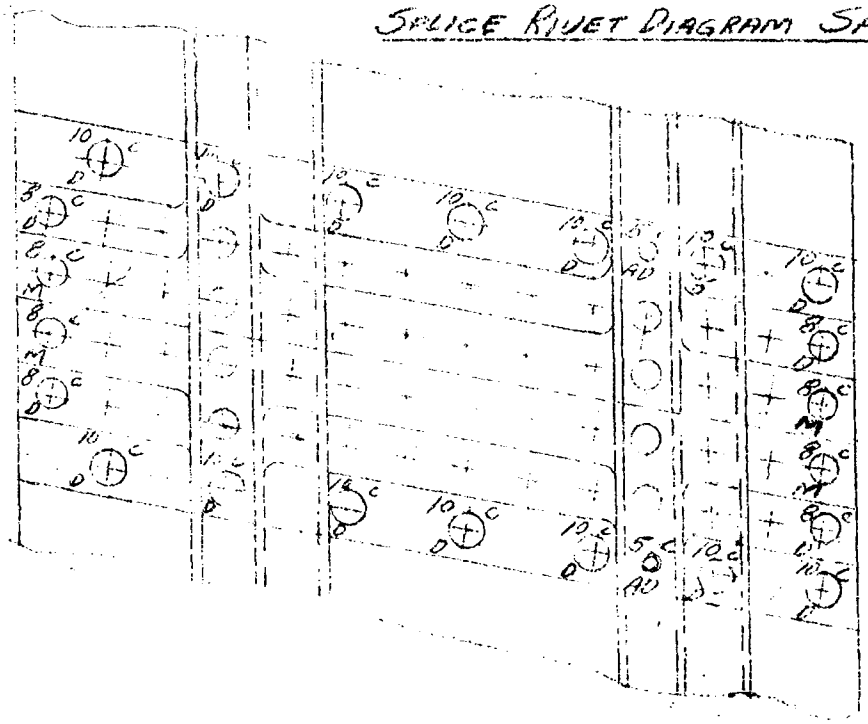
DIAGRAM OF SPEC 551-2 & 551-3 (551-1 SIMILAR)



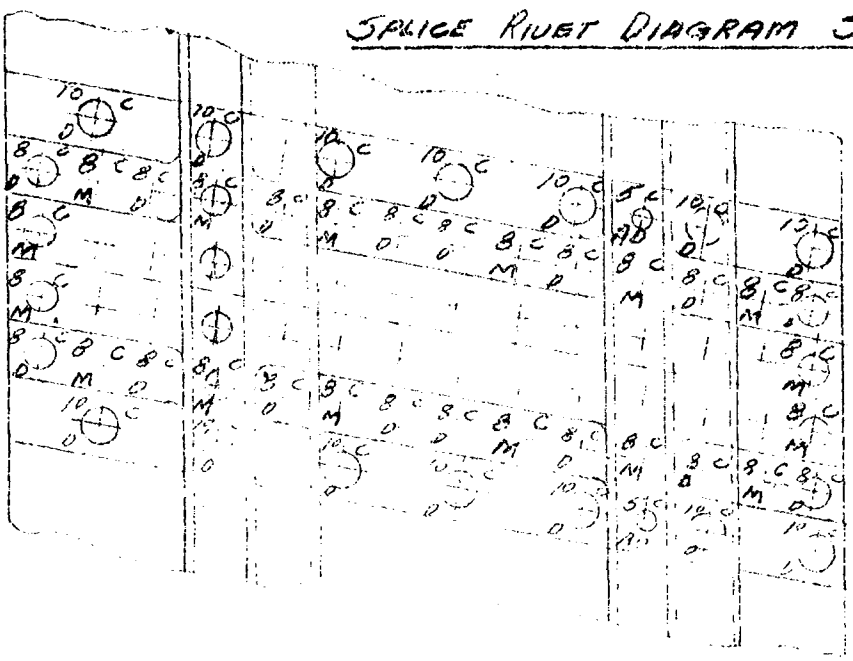

[redacted]

( [redacted] )

SPLICE RIVET DIAGRAM SPEC. 551-2



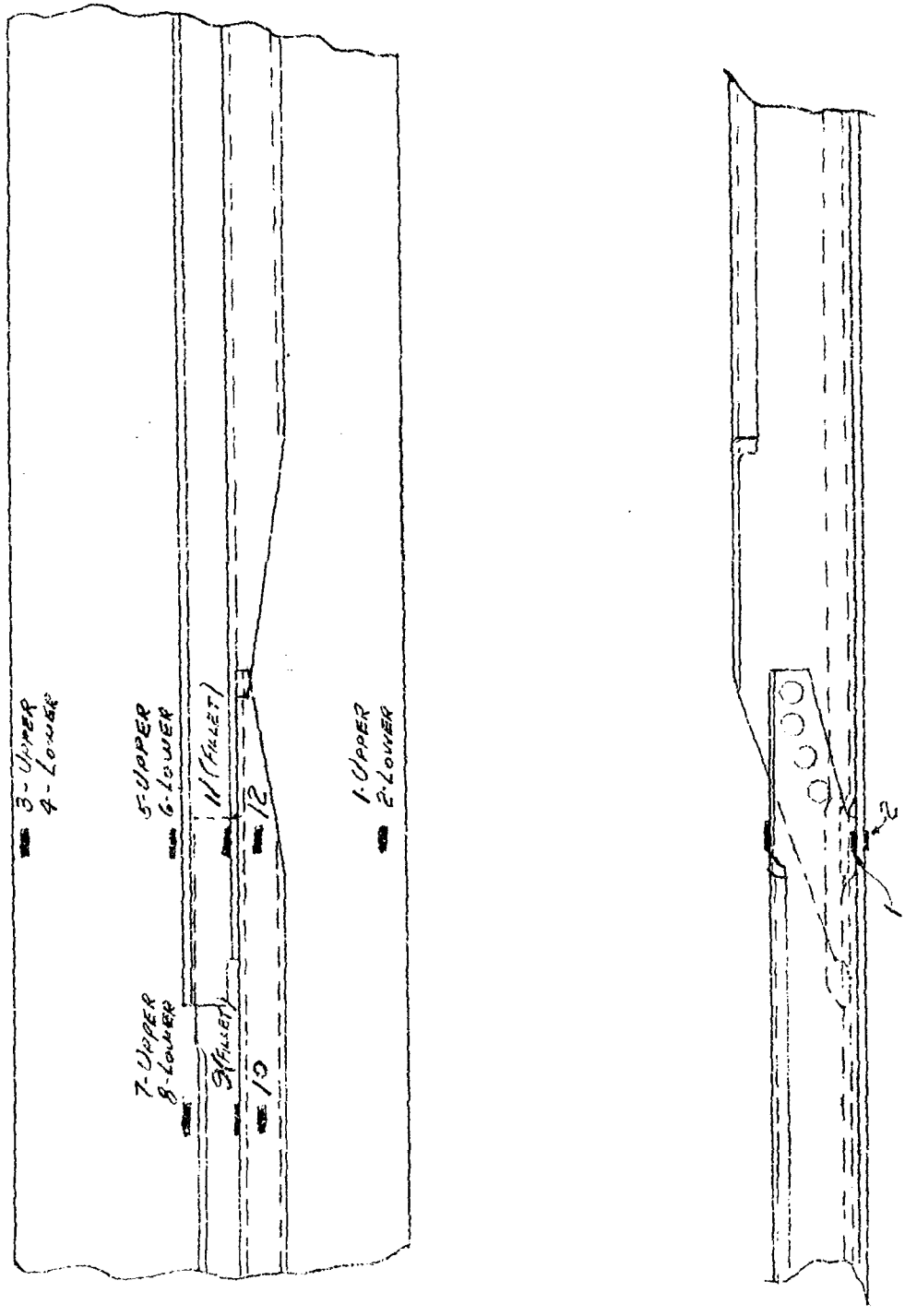
SPLICE RIVET DIAGRAM SPEC. 551-3



( [redacted] )

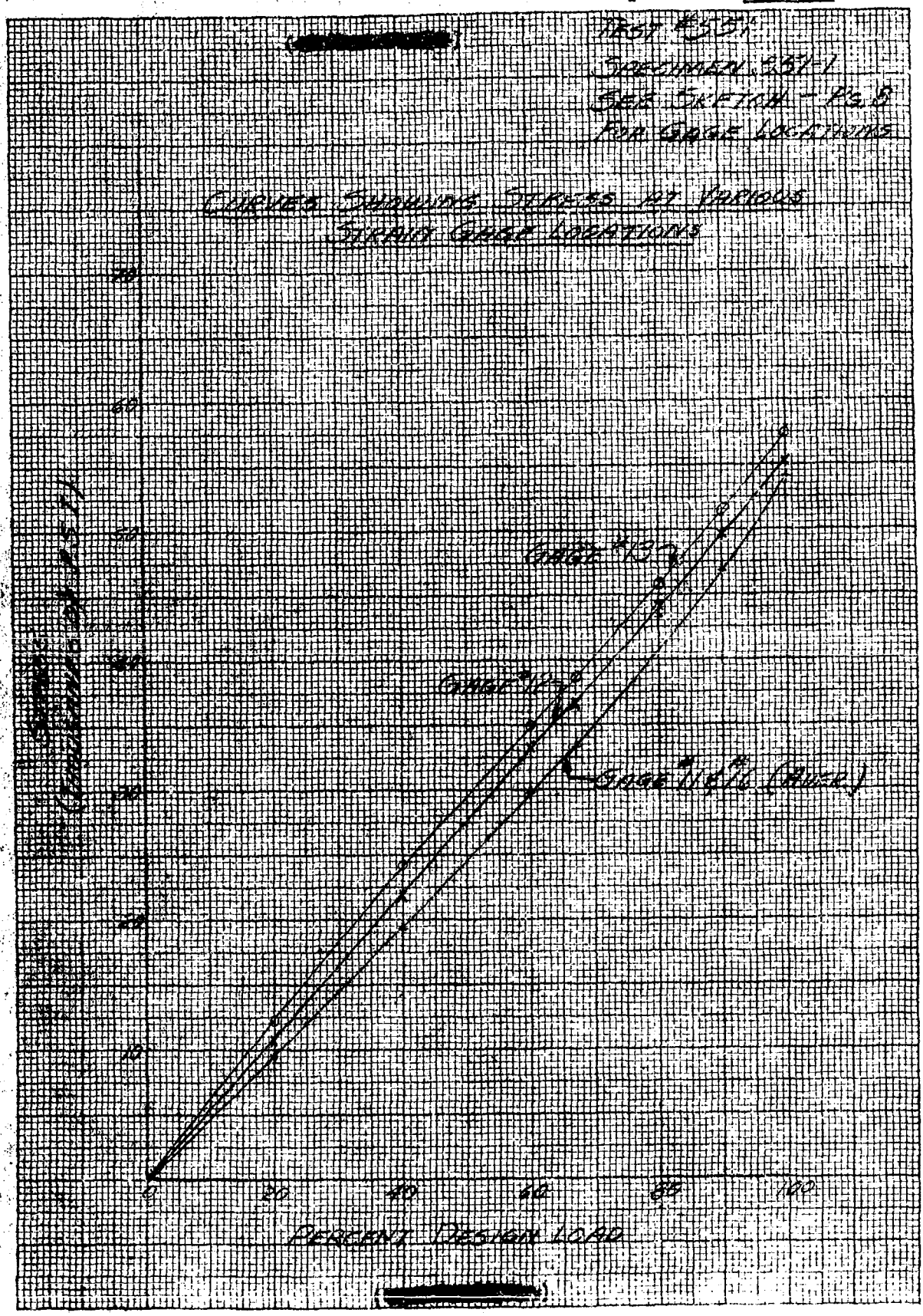
(CONFIDENTIAL)

LOCATION OF STRAIN GAGES {SPEC. 551-4 / SPEC. 551-5




(CONFIDENTIAL)

[redacted]

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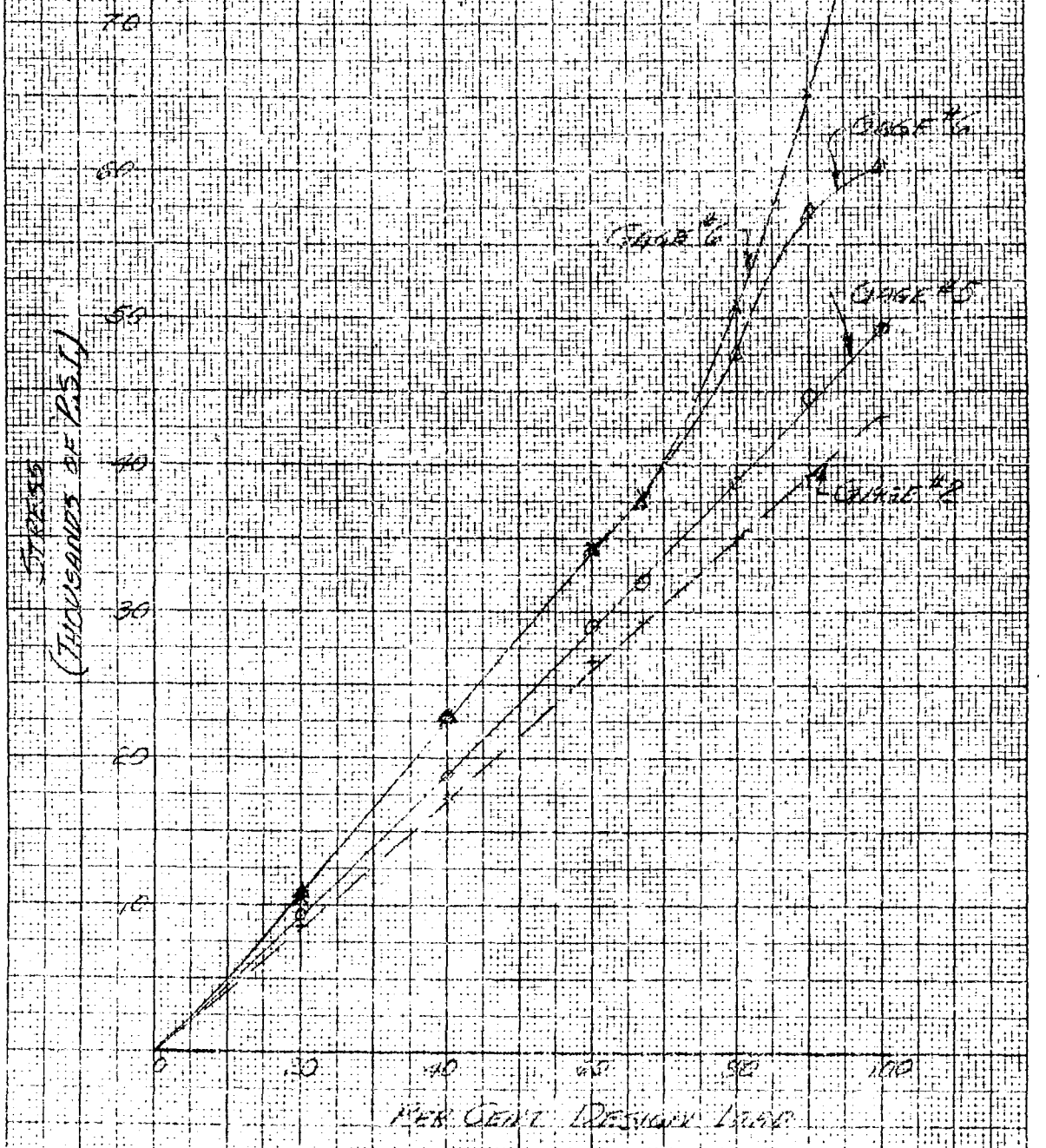
11 & 16 +
12 & 13
X O

([redacted])

TEST #351
SPECIMEN #551-1
SEE SKETCH - PG 8
FOR GAGE LOCATIONS

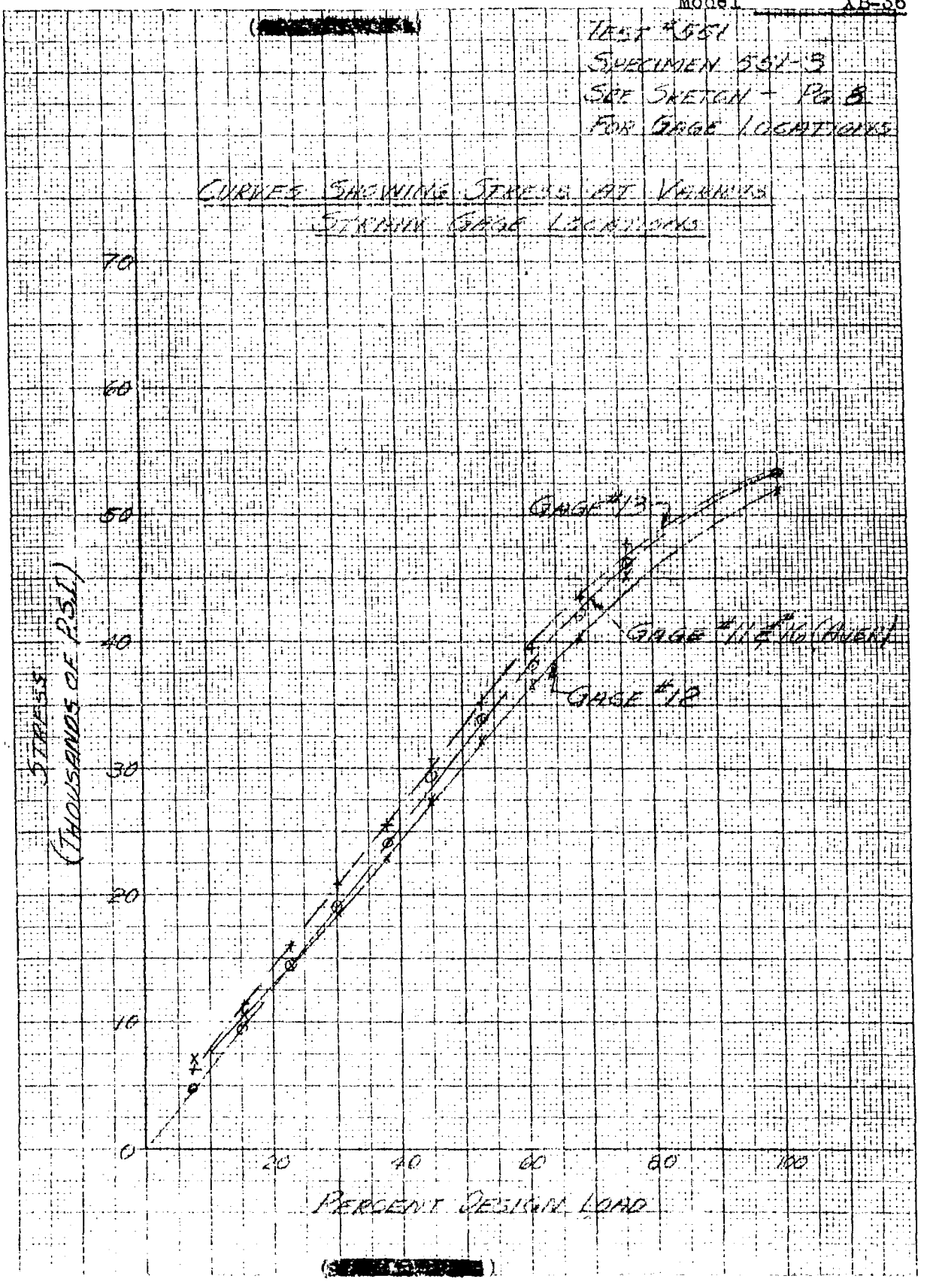
CURVES SHOWING STRESS AT VARIOUS
STRAIN GAGE LOCATIONS




([redacted])

KEUFFEL & ESSER CO., N. Y. NO. 359-11
10 to the half inch, 5th lines accented.
Engraving, 7 x 10 in.
MADE IN U.S.A.

(redacted)

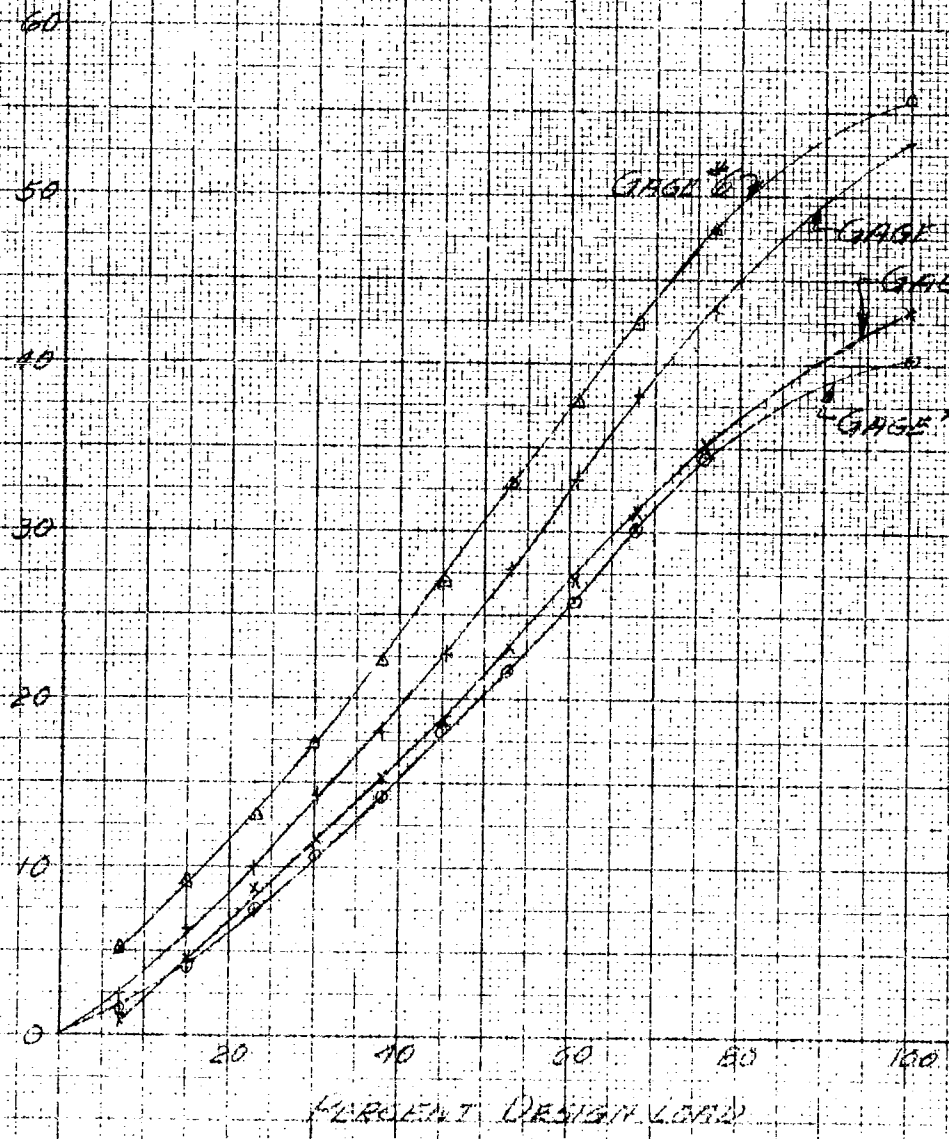



(redacted)

([redacted])

TEST #551
SPECIMEN 551-3
SEE SKETCH - FIG. 8
FOR GAGE LOCATIONS

CURVES SHOWING STRESS AT VARIOUS
STRAIN GAGE LOCATIONS



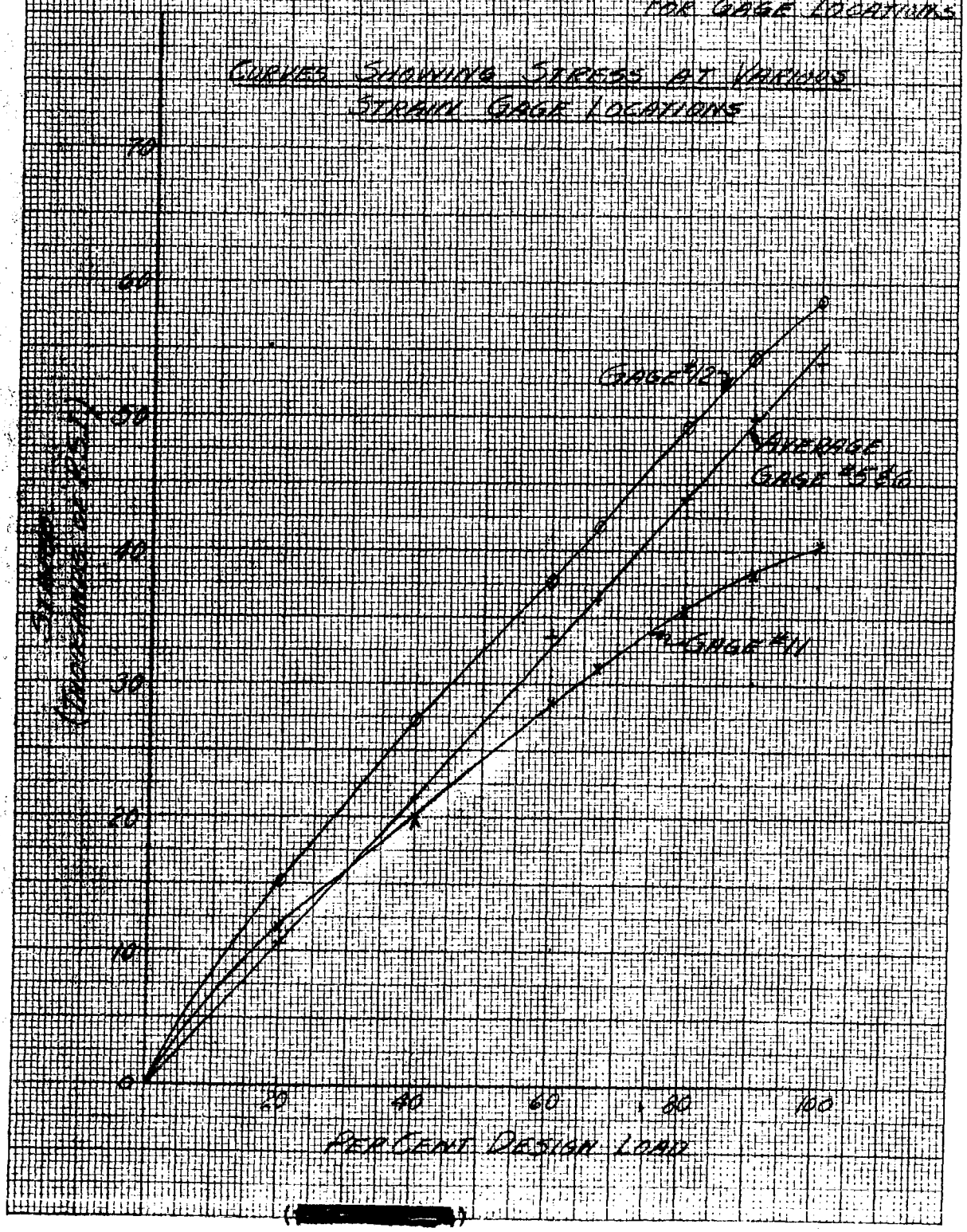

([redacted])

KEUFFEL & ESSER CO., N. Y. NO. 358-11
10 X 10 to the half inch, 5th lines accented.
Engraving, 7 x 10 in.
MADE IN U.S.A.

(redacted)

TEST #551
SPECIMEN 551-A
SEE SKETCH - PG 10
FOR GAGE LOCATIONS

CURVES SHOWING STRESS AT VARIOUS
STRAIN GAGE LOCATIONS

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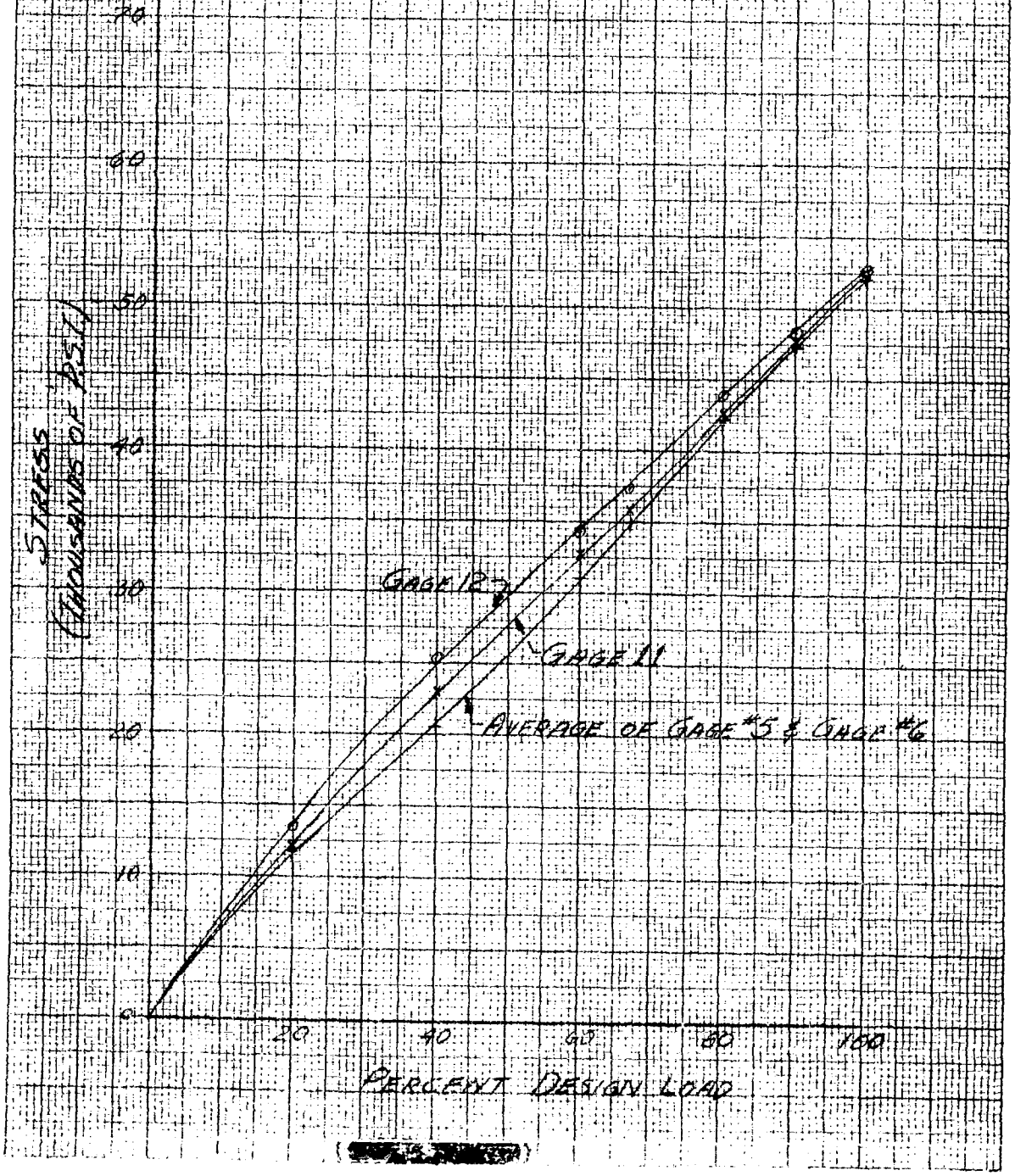
KEUFFEL & ESSER CO., N. Y. NO. 359-17
10 X 10 to the half inch, 5th line accented.
Engraving, 7 X 10 in.
MADE IN U.S.A.

[redacted]

TEST #551
SPECIMEN 557-5
SEE SKETCH - PG 10
FOR GAGE LOCATION

CURVES SHOWING STRESS AT VARIOUS STRAIN GAGE LOCATIONS




[redacted]

KEUFFEL & ESSER CO., N. Y. NO. 359-11
10 x 10 to the half inch, 5th lines accented.
Engraving, 7 x 10 in.
MADE IN U.S.A.

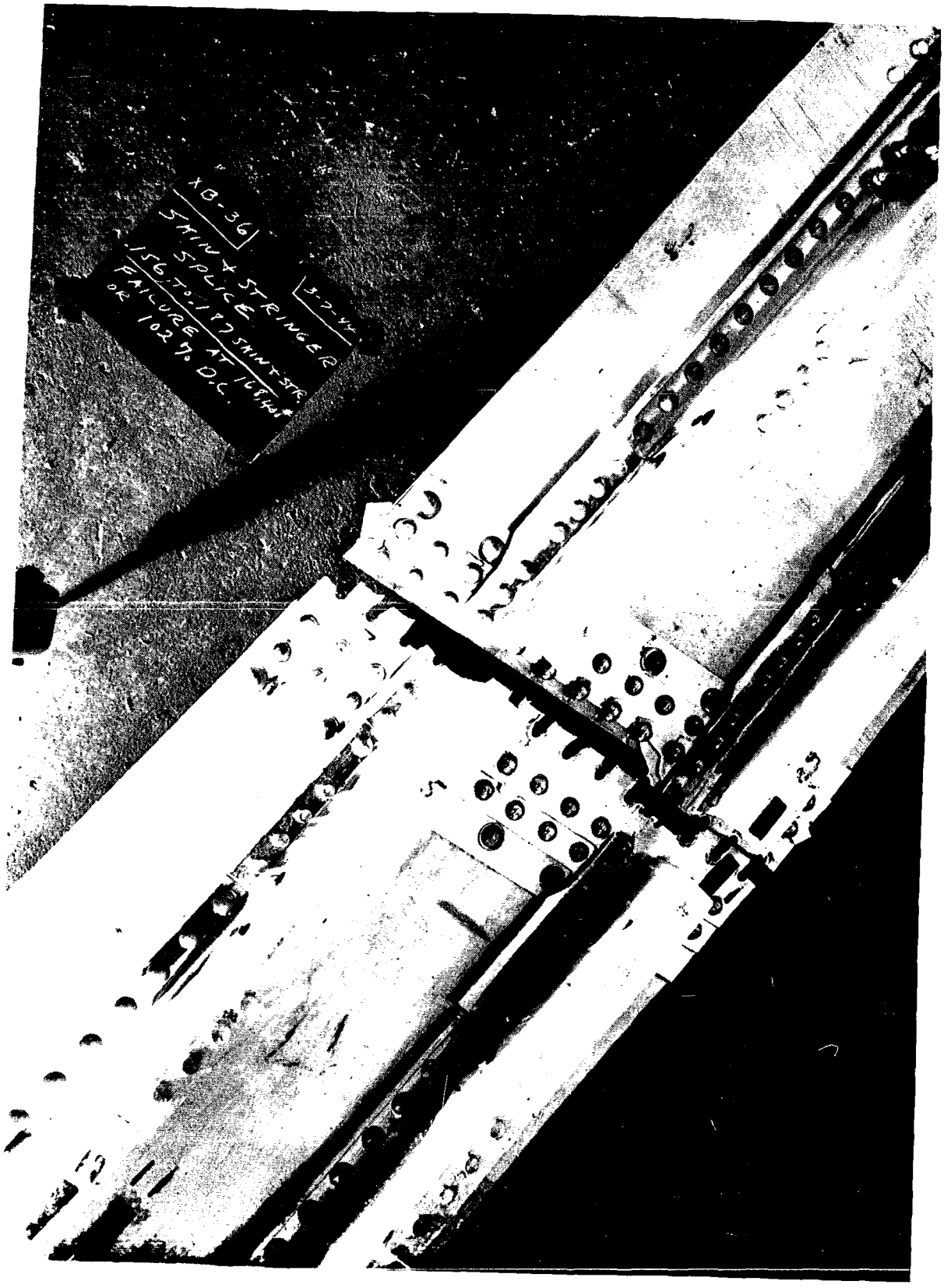
PHOTOGRAPH NO. 114364

VIEW SHOWING BENDING OF SKIN AND DOUBLERS AT 100% D. L.

(SPECIMEN 551-1)

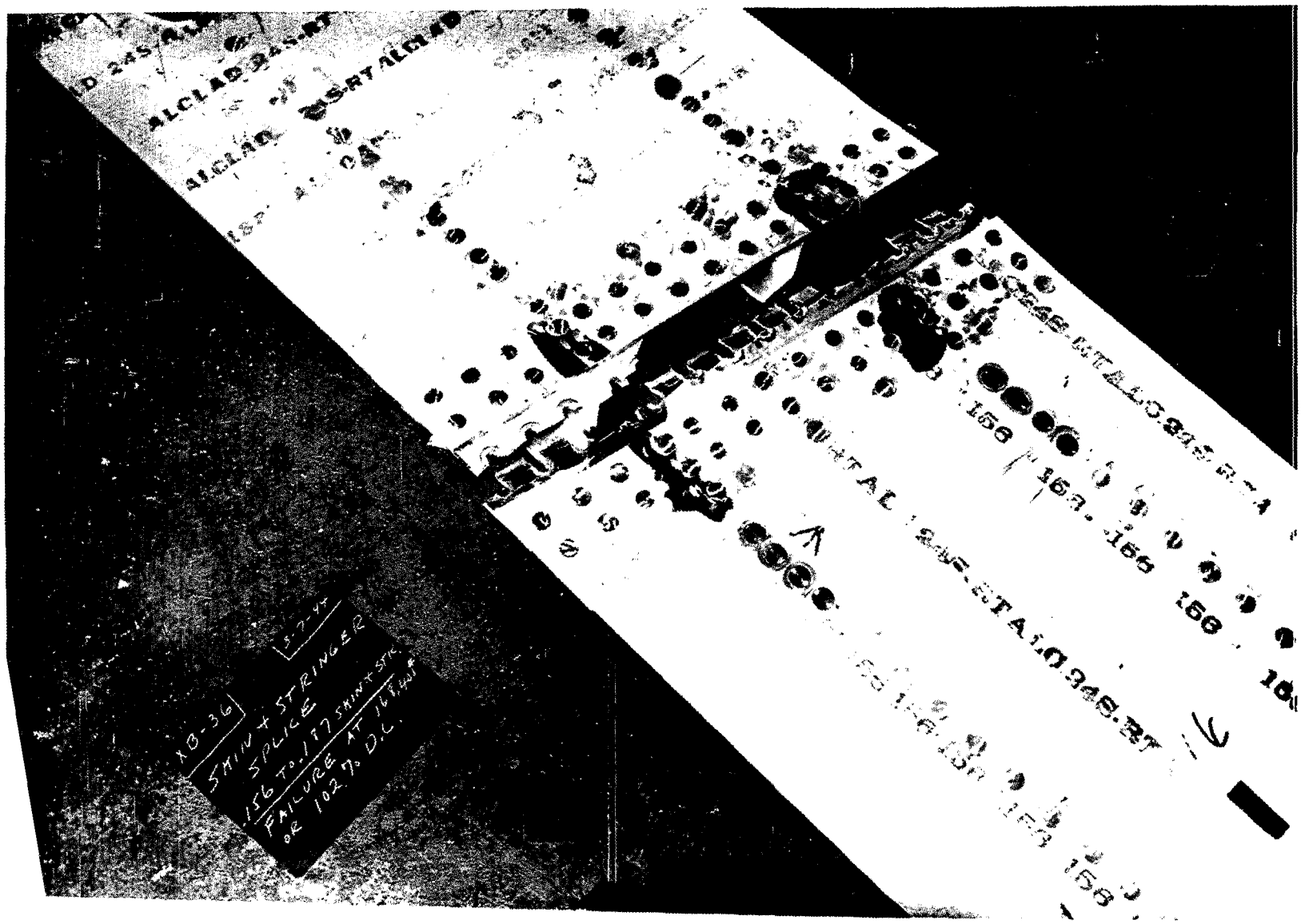
PHOTOGRAPH NO. 114369

FRONT VIEW OF FAILURE (SPECIMEN 551-1)


XB-36
SKIN + STRINGER
SPLICE
.156 TO .187 SKIN + STR.
FAILURE AT 168,400#
OR 102% D.C.
3-7-44

PHOTOGRAPH NO. 114367

REAR VIEW OF FAILURE (SPECIMEN 551-1)


ALCLAD 24S-RT
XB-36
SHIN + STRINGER
SPLICE
.156 TO .187 SHIN + STR
FAILURE AT 168,405
OR 102% D.C.
5-7-44

[illegible]

[illegible] North Regions
[illegible] 13

[illegible]

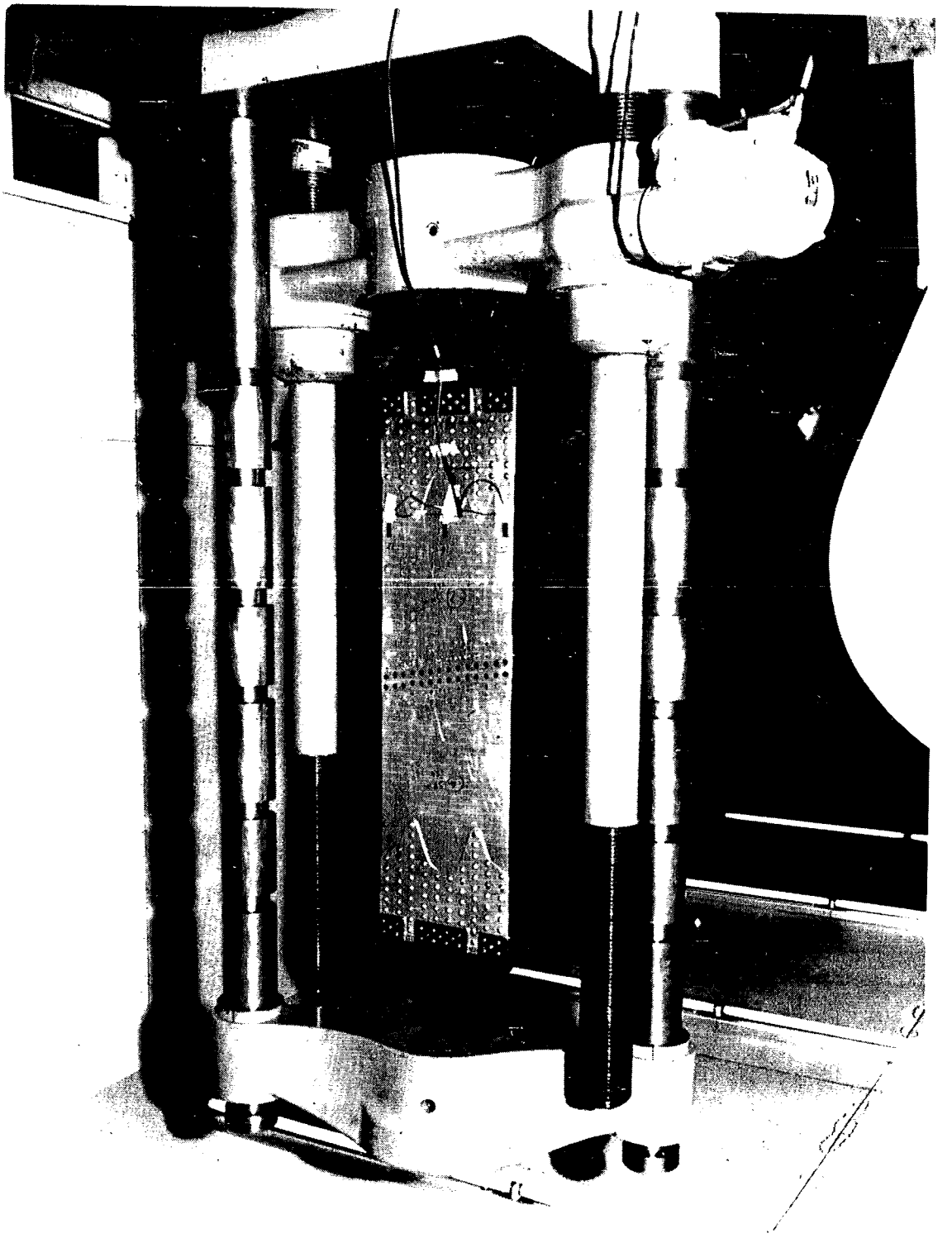
[illegible] 1-2) [illegible] 200,000

[illegible]

PHOTOGRAPH NO. 134265

MAIN VIEW OF SKIN SECTION (SPECIMEN 551-2) IN

TEST MACHINE



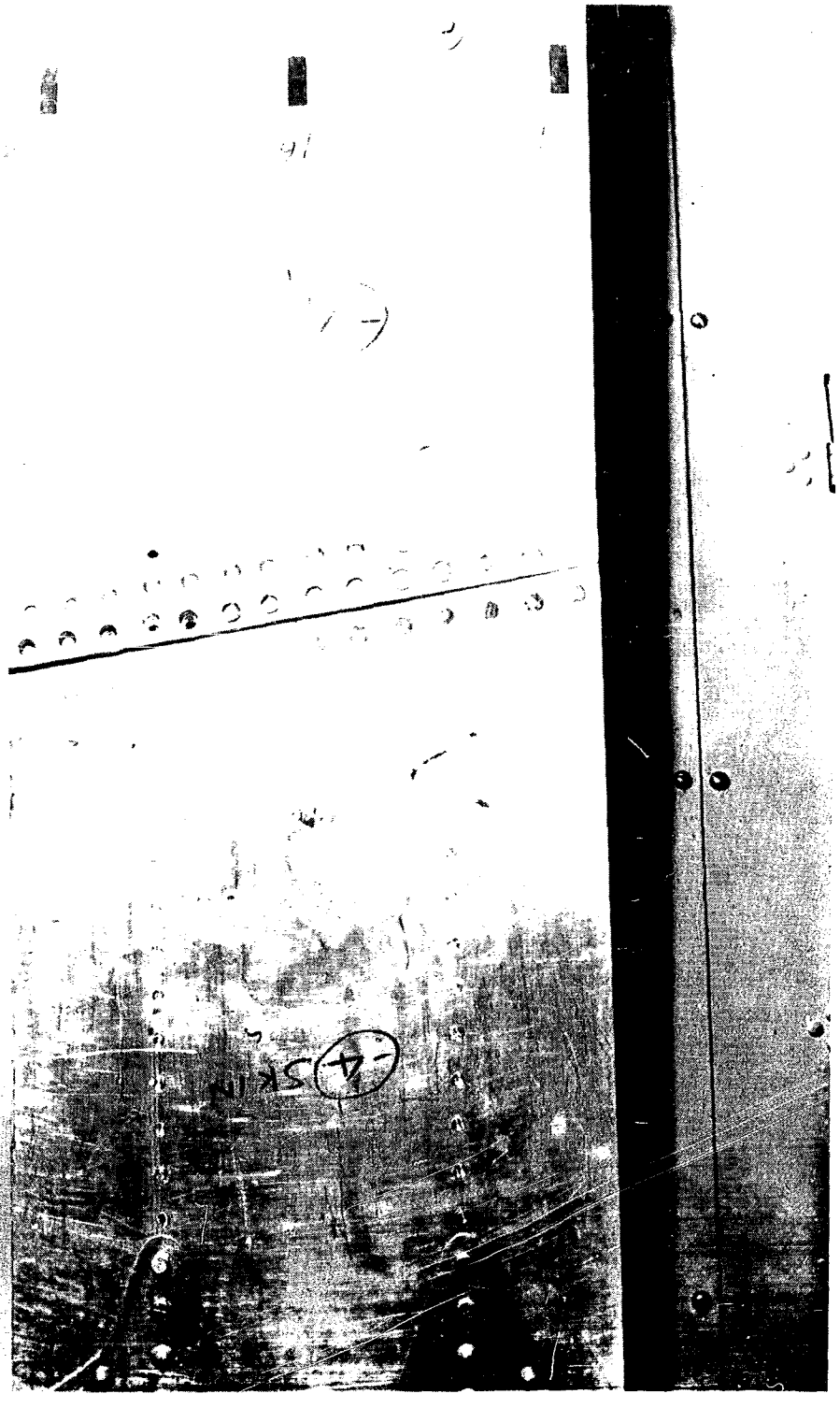
PHOTOGRAPH NO. 114246

FRONT AND SIDE VIEW OF SKIN SPLICE (SPECIMEN 551-8) SHOWING FAILURE AND BENDING OF SKIN AND DOUBLERS

PHOTOGRAPH NO. 114243

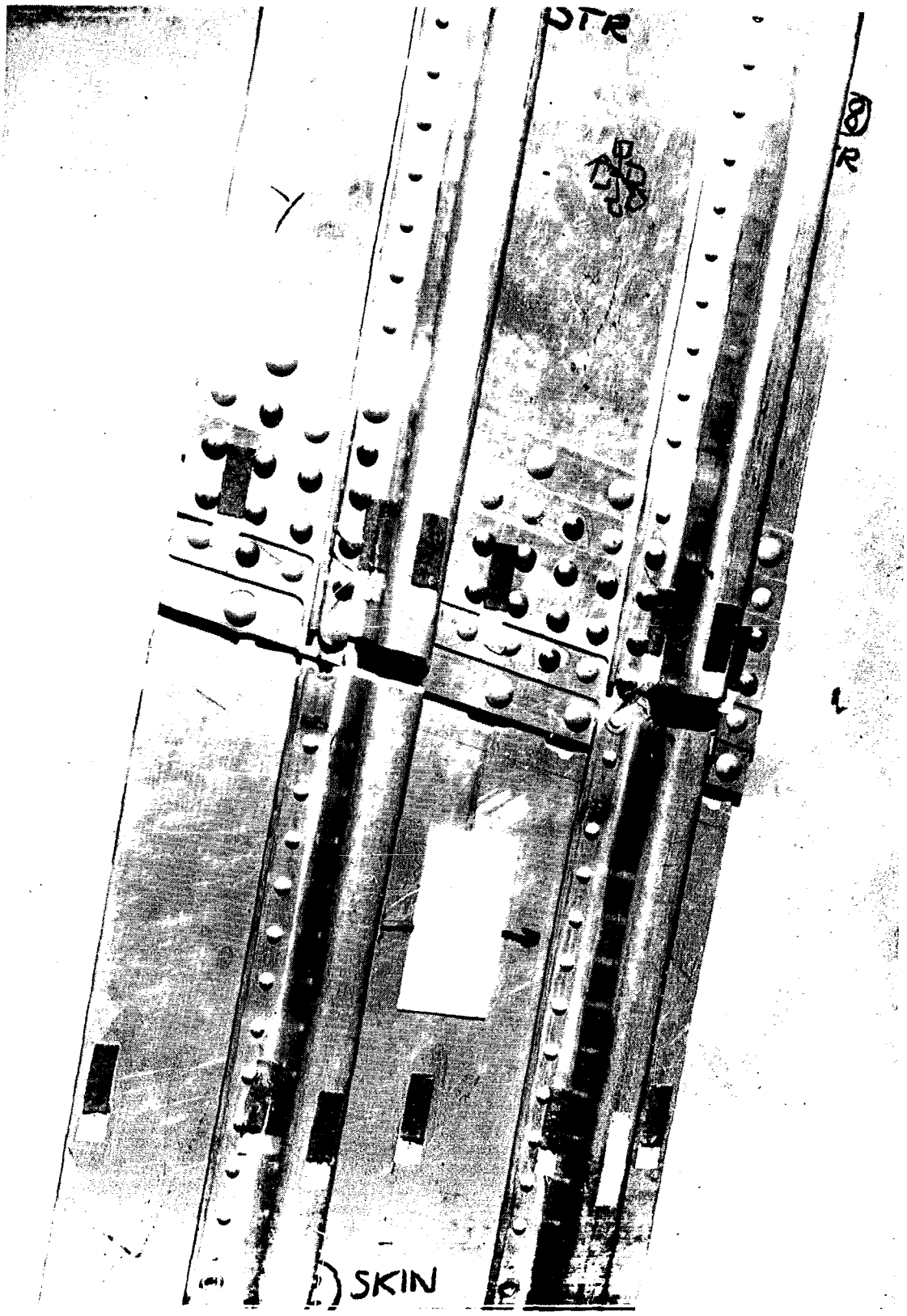
REAR VIEW OF SKIN SPLICE SPECIMEN (551-2) SHOWING

FAILURE OF SPLICE RIVETS



Page [illegible]
Report No. [illegible]
Model [illegible]
Date [illegible]

Port Worth Report
No. [illegible]


STR
SKIN

PHOTOGRAPH NO. 114257

REAR VIEW OF FAILURE OF SKIN SPLICE (SPECIMEN 551-3)

TOP

PHOTOGRAPH NO. 114200

FRONT VIEW OF STRINGER SPLICE (SPECIMEN 551-4)

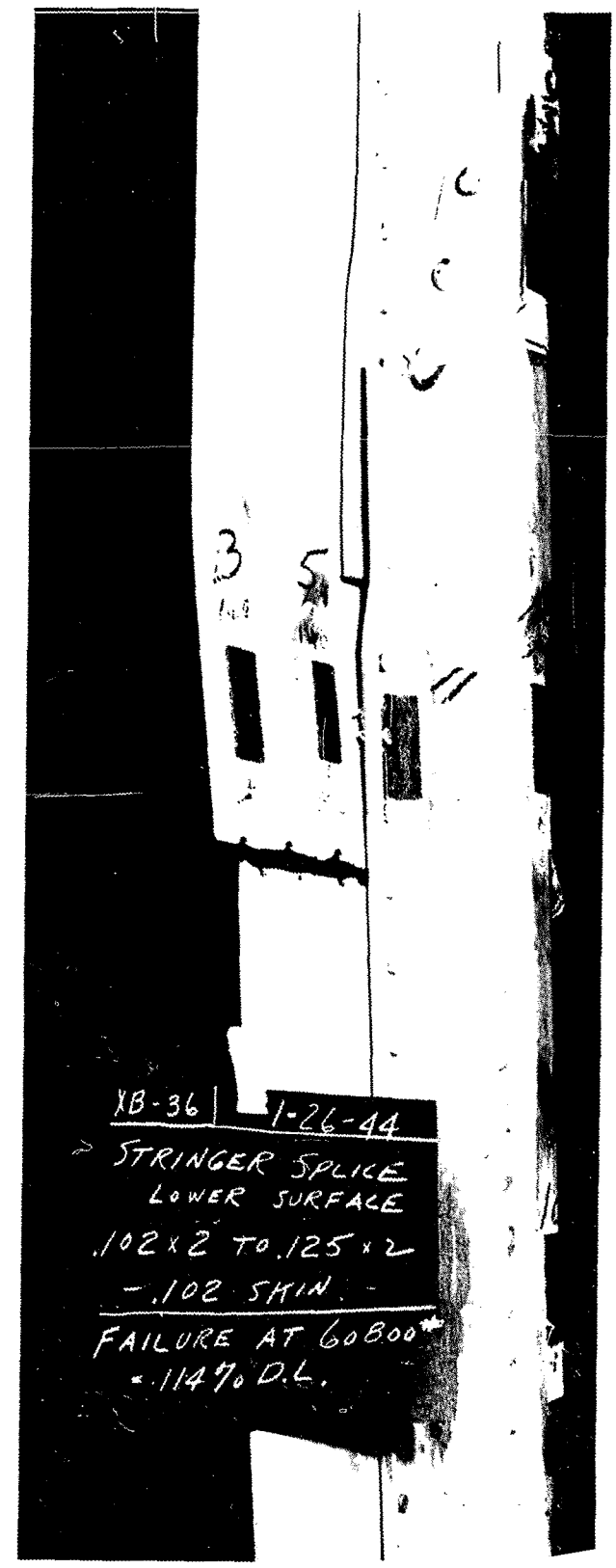
IN TEST MACHINE SHOWING FAILURE

Fort Worth Report
No. FW-FSG 43

PHOTOGRAPH NO. 114201

CLOSEUP SHOWING FRONT AND SIDE VIEW OF STRINGER SPLICE

(SPECIMEN 551-4) FAILURE


XB-36
1-26-44
STRINGER SPLICE
LOWER SURFACE
.102 x 2 TO .125 x 2
-.102 SKIN
FAILURE AT 60800#
= .114% D.L.

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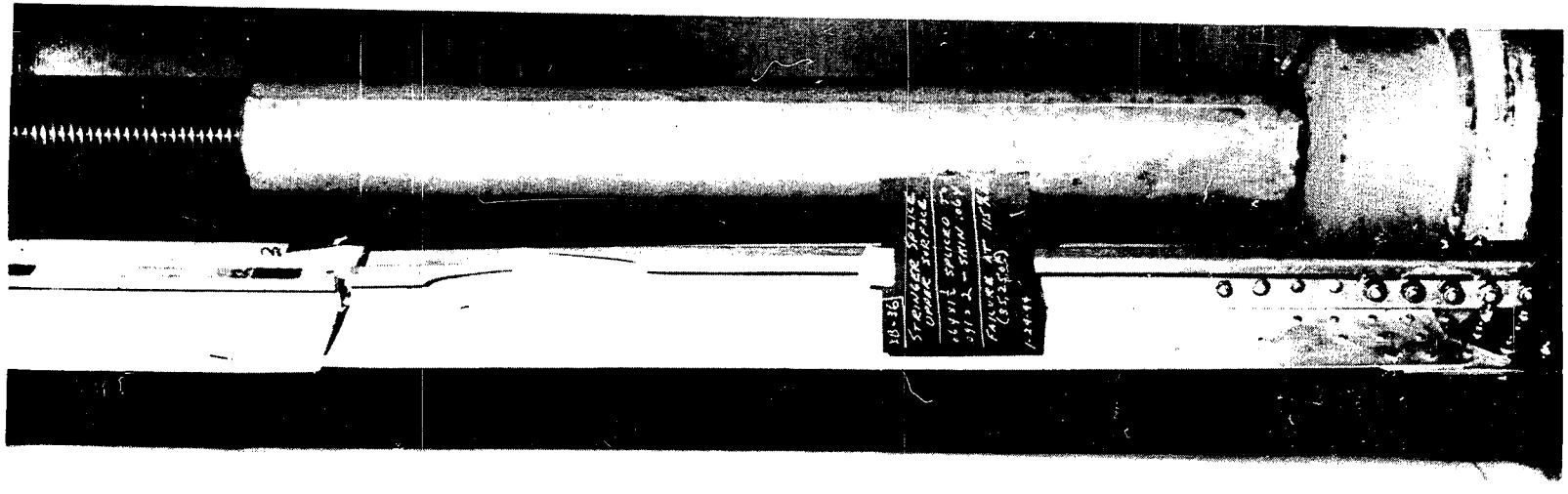
[illegible]
Code: [illegible]
Date: [illegible]

Fort Worth Report
No. [illegible]

PHOTOGRAPH [illegible] 114[illegible]03

VIEW SHOWING SETUP [illegible] SPLICE

(SPECIMEN [illegible])


STRINGER SPLICE
UPPER SURFACE

PHOTOGRAPH NO. 114202

SIDE AND FRONT VIEW OF STRINGER SPLICE (SPECIMEN 551-5) SHOWING FAILURE

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STRINGER AND SKIN SPLICE TESTS XB-36 OUTER WING, LOWER SURFACE - FORT WORTH REPORT NO. FW-FSG 43

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STRUCTURES(7) WINGS - STRUCTURAL TESTS
DESIGN AND DETAILS(3) B-36 - STRUCTURAL TESTS
B-36

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