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UNCLASSIFIED

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SYSTEMATIC DECLASSIFICATION REVIEW	
1st Review Date 6-08-79	Classification Retained: U
Authority: ☐ ADC ☒ ADD ECRP-RR	Downgrade to:
2nd Review Date 5-05-97	Cancel UCNI
Authority: ADD	Comments
Name W. Layne	Undossified

14-56-12

INVENTORIED 5-23-

A STUDY OF THE PROBLEM OF SUPERSONIC CARRIAGE OF THE MK 7

SYSTEMATIC DECLASSIFICATION REVIEW AND REGRADING OR DECLASSIFICATION STAMP	
CLASSIFICATION CHANGED TO: U	AUTHORITY: W C Layne
Emelda Scott 5/7/97 PERSON CHANGING MARKING & DATE	RECORD ID: 97SN1732
Carmela Dalligar 5/20/97 PERSON VERIFYING MARKING & DATE	DATED: 5-5-97

Frank L. Renscoter

1958

ABSTRACT

The aviation industry is presently in a transition period regarding increases in flying speeds. When carrying the Mk 7 weapon externally at sonic and at supersonic speeds, special problems are encountered.

A study of the Mk 7 Mod 4 at Mach 1.3 and sea level has been made and is summarized herein.

[redacted]

Case No. 527.00

UNCLASSIFIED

July 7, 1956

[redacted]

[redacted]

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CALCULATIONS

The calculations are as follows.

LOADS AND STRESS ANALYSIS

M = 1.3

ALTITUDE = SEA LEVEL

no p.2

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[redacted]

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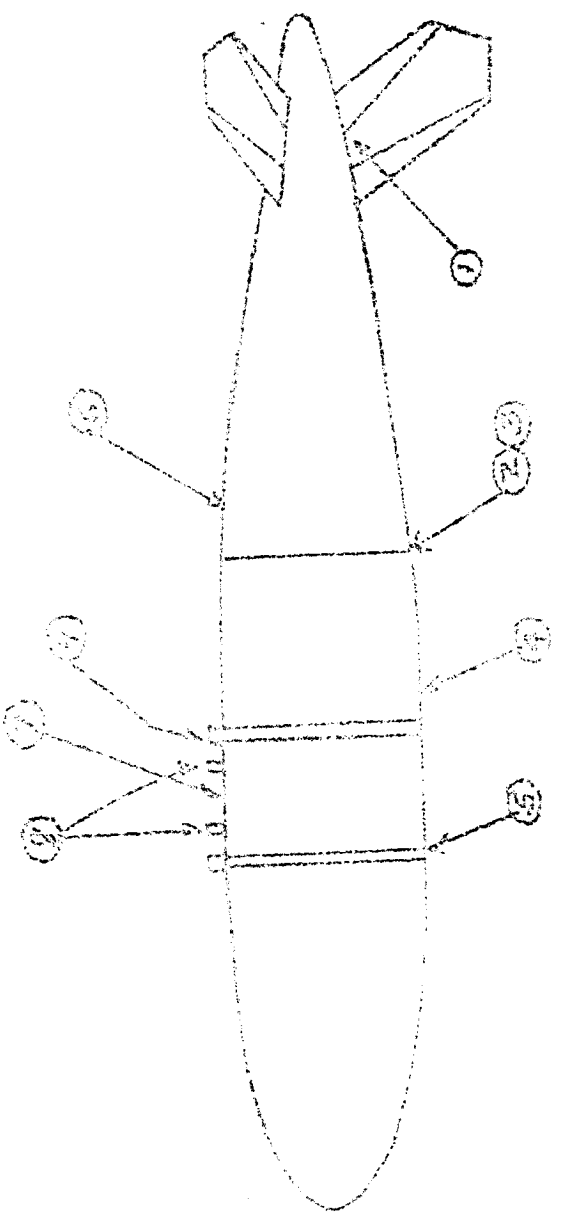

FIG 1

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BY ..... DATE .....
CHKD. BY ..... DATE .....

SUBJECT TECH MEMO 19-56-12

SHEET NO. ..... OF .....
JOB NO 627

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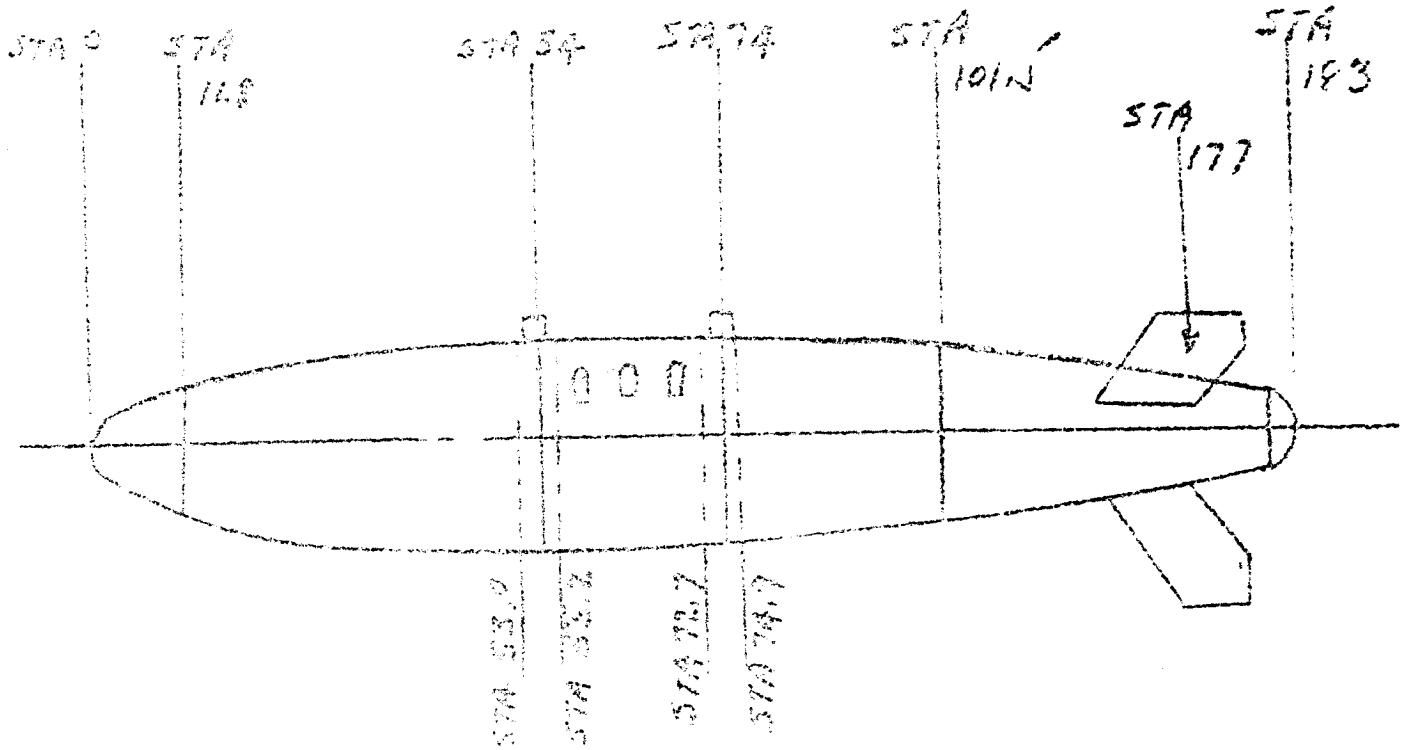

FIG 2

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[redacted] DATE May 1956 TECH MEMO 14-56-12 [redacted]

[redacted] DROP LOADS

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CONDITION yaw = $\pm 10^\circ$ M = 1.3 ALT = Sea Level

$q = 2500\ \#/ft^2$ Area = $5.07\ ft^2$

C.G. is at Sta. 64

Length Bomb = 183 inches.

Where
M = Mach Number
q = dynamic pressure
CG = Center Gravity

From wind tunnel tests

C_L (without tail) = 0.165

$C_{M_{cg}}$ (without tail) = 0.174

Where

C_L = Lift coefficient
$C_{M_{cg}}$ = Moment coefficient about cg.

Body (Without tail)

Lift = 0.165 x 2500 x 5.07 = 2091 lbs.

Moment about CG = 0.174 x 2500 x 5.07 x 183 = 403,515 inch lbs

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[redacted]

From Wind Tunnel Tests

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[redacted]

C_L (with tail) = 0.655

$C_{m_{cg}}$ (with tail) = −0.189

C_L of tail = 0.49

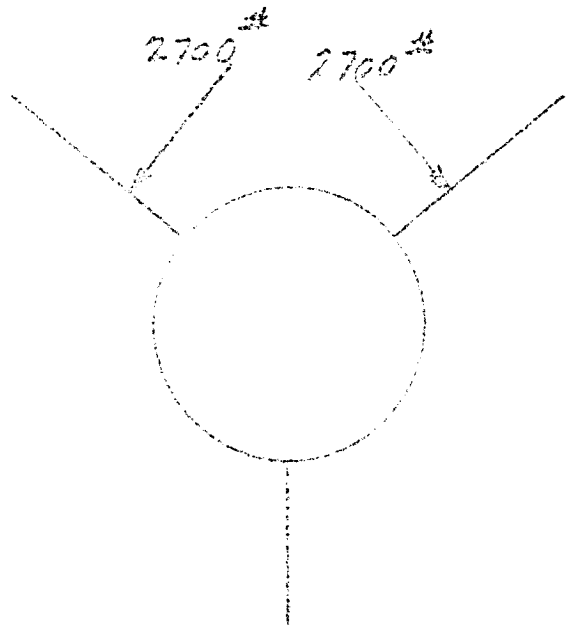
$C_{m_{cg}}$ of tail = −0.303

Tail lift = 0.490 × 2500 × 5.07 = 6210 lbs

Tail Moment = −0.303 × 2500 × 5.07 × 183 = 703,269 in.lbs

$$CP \text{ of tail} = 64 + \frac{703{,}269}{6210} = 177.24 \text{ station.}$$

For strength check of fin use 2700 lbs/in² and locate at 50% of span.



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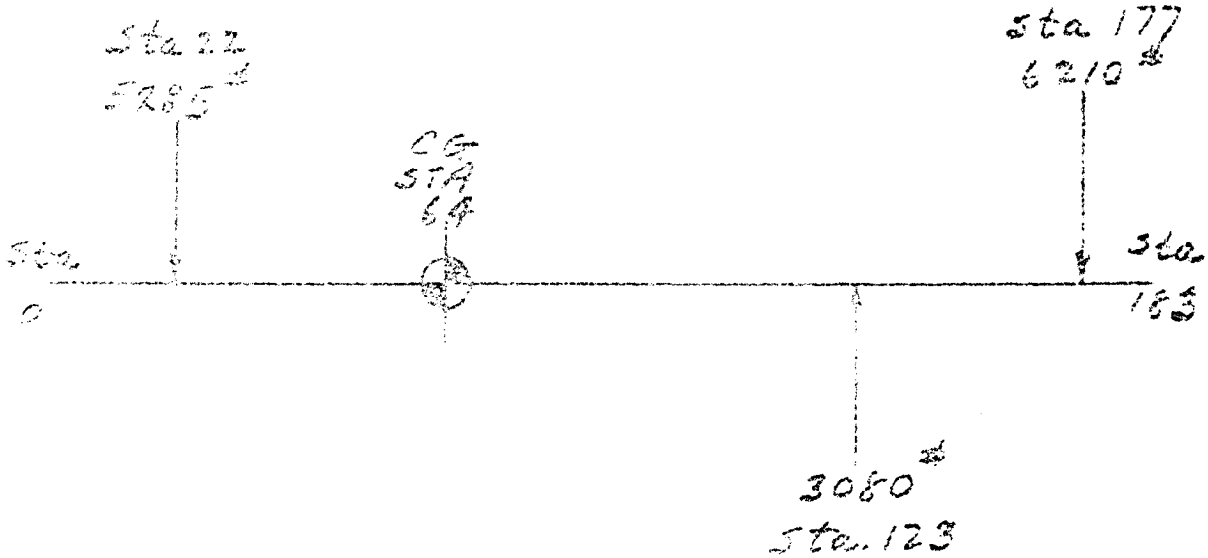
TECH - MEMO
14 - 56 - 12

[redacted]

The estimated distribution of air loads is shown below. 55% of body alone moment at Sta. 22 and 45% of body alone moment at Sta. 123. Fin load is at centerof pressure at Sta. 177



In the strength check of the aft case, only the tail loads will be used in the moment calculations.

Ref: Douglas Aircraft Co
El Segundo - No 15688.

DAC-ES-15688

[redacted]

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[redacted]

A Check tail fin in bending

LOAD = 2700 # per fin
½ span and at Sta. 177.

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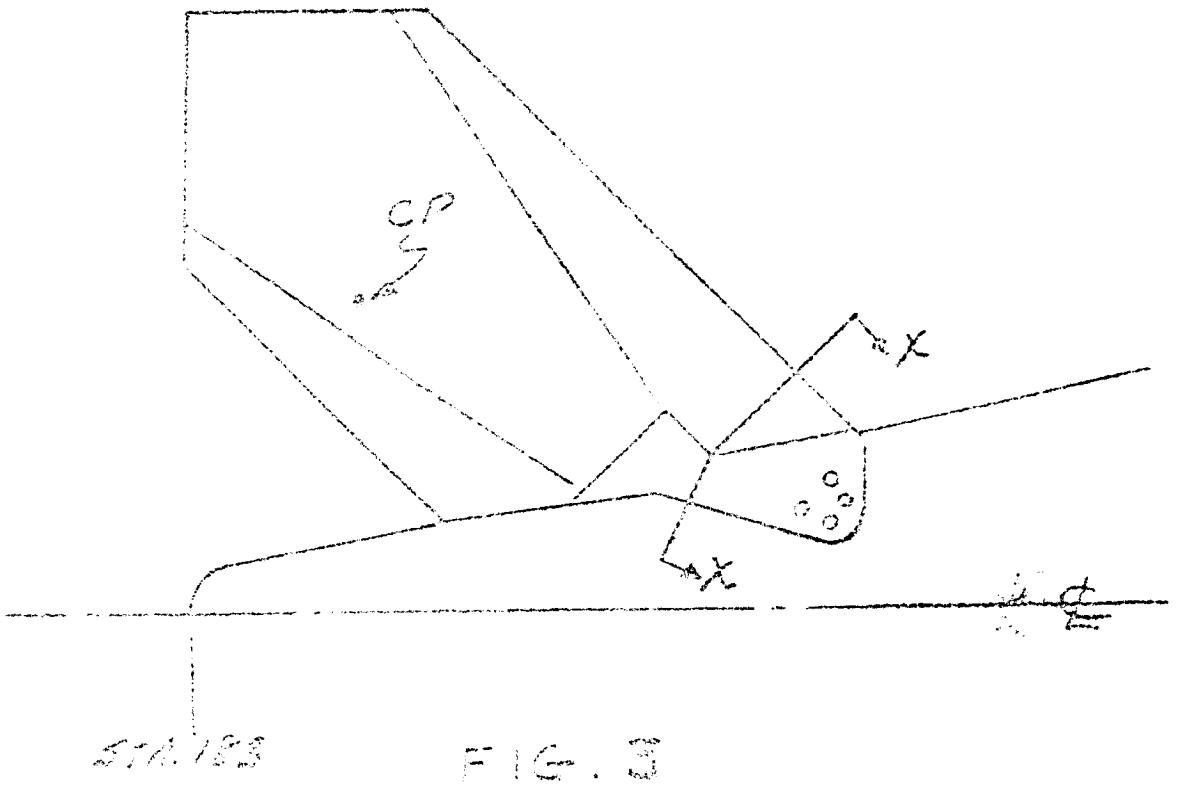

FIG. 3

Let

t_u = Tensile strength Aluminum 75-ST

f_b = Bending Stress - lbs/in²

f_b = Limit stress in bending - lbs/in²

M_s = Margin of safety.

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[redacted]

Moment at X-X

$2700^{\#} \times 10.5'' = 28,350$ inch-lbs.

wing equivalent section Fig. 1.
= 3" x 1" - 75 ST ALUMINUM

$$f_b = \frac{28,350 \times t/2}{\frac{1}{12} \times 3 \times (1)^3} = \frac{28,350 \times .5}{\frac{5}{12} \times 1}$$

$$= \frac{14,175 \times 12}{3} = 14,175 \times 4 = 56,700 \ \#/in^2$$

$F_b = 1.5 \times 82,000 = 123,000$

$$M_b = \frac{123,000}{56,700 \times 1.5} - 1 = \frac{123,000}{85,050} - 1 = +.446$$

$M_b = +.446 = 0.45$

[redacted]

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[redacted]

3 CHECK STRENGTH IN BENDING STA 101.5
Ref DAC-ES-15688

t = thickness skin = 0.064"

Bending Moment = 6210 #(177-101.5) = 468,855 in #

Rad Case at 101.5 = 14½"

f_b = Bending stress = #/in²
F_b = Limit stress in bending = #/in²
M_s = Margin of safety

$$f_b = \frac{BM}{\pi r^2} = \frac{468,855}{\pi \times (14.5)^2} = 710 \ \#/in$$

$$\frac{710}{t} = 11,094 \ \#/in^2$$

Assume access doors fwd of STA 101.5 cause an increase in stress by factor = 2

F_b (at doors) = 22,188 #/in²

Thin walled cylinders in bending

f_b = 13,000 #/in²

$$M_s \left(\begin{matrix}\text{skin}\\ \text{Case}\end{matrix}\right) = \frac{13,000}{11,094 \times 1.5} - 1 = -.42$$

$$M_s \text{ (door)} \quad \frac{13,000}{20,188 \times 1.5} - 1 = -.61$$

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[redacted]

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C CHECK STRENGTH OF SPLICE AT STA 101.5

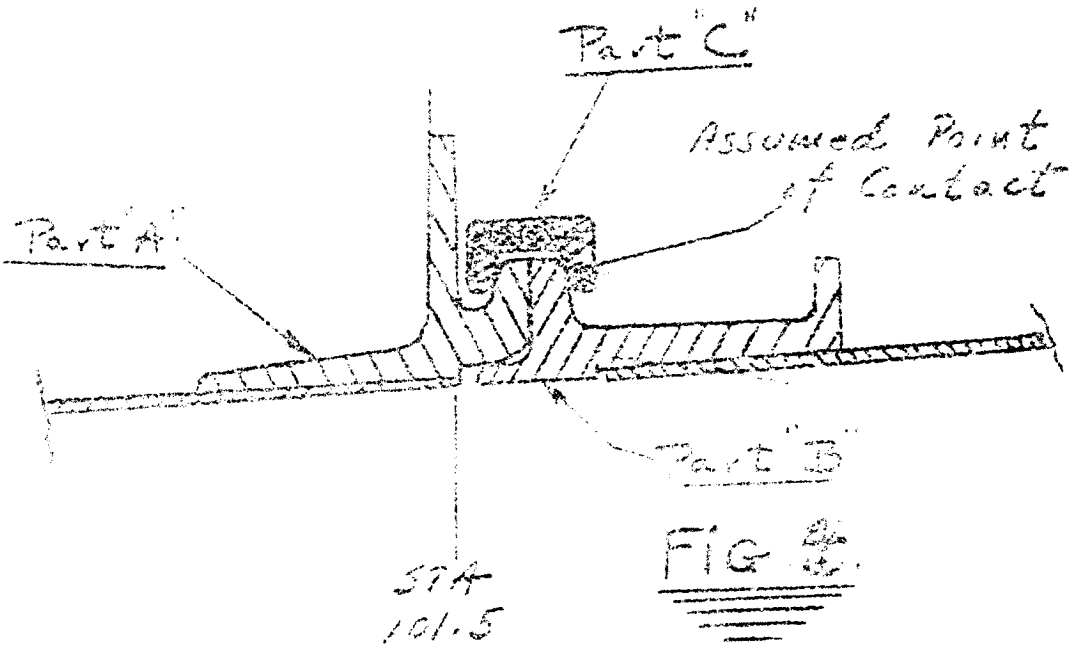

FIG 4

Tension load carried by splice = 1420 # per inch
See [E] 710 #/inch

Bend Moment Part "C" = 1420 x .25 = 355 inch lbs

$$f_b = \frac{M \times \frac{.156}{2}}{\frac{1}{12} \times 1 \times (.156)^3} = \frac{355 \times .078}{.00374} = 87{,}540 \text{ psi}$$

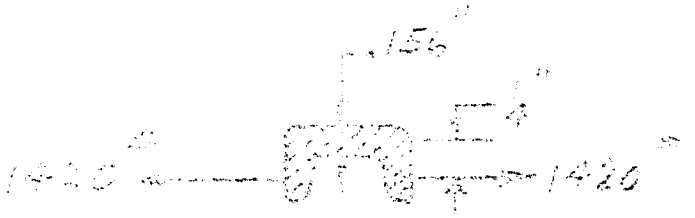

FIG 5

[redacted]

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[G] continued

Material is 75ST Alum Bar $F_b = 75{,}000$

$$M_{S\,USE} = \frac{75{,}000}{37{,}540 \times 1.5} - 1 = -.43$$

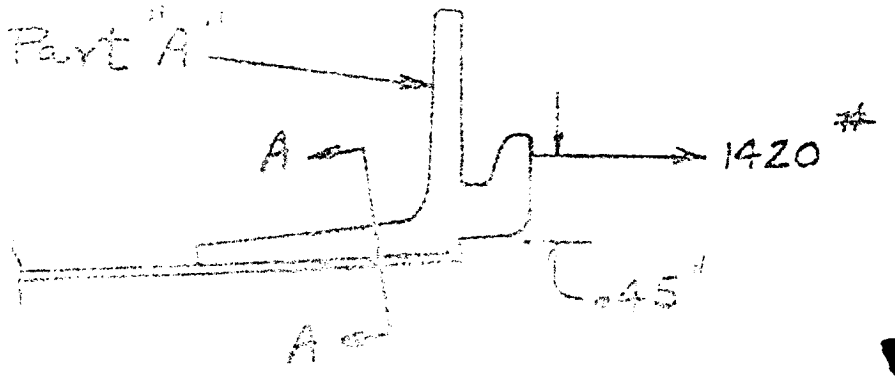

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FIG 6

Bending Moment Part A = .45" × 1420# = 640 inch#
Thickness = .17 (Approx)

$$f_b = \frac{M \times \frac{.17}{2}}{\frac{1}{12} \times 1 \times (.17)^3} = \frac{640 \times .085}{.00353 \times .005}$$

$$= \frac{544}{.000042} = 129{,}524 \ \#/in^2$$

Material is 24ST Aluminum Bar
F_b = (Using 1.4 Bending Modulus)
= 62,000 × 1.4 = 86,800

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[redacted]

[C] Continued

UNCLA

$$M_{S\ ULT} = \frac{86,800}{129,524 \times 1.5} - 1 = -.56$$

[D] CHECK CASE IN BENDING AT STA. 76

TAIL LOAD = 6210 #
Case Thickness = .064" 24 ST Alum.

$M = 6210 \times (171 - 76) = 627,210$ in lbs.

$$f_b = \frac{M}{\pi r^2 t} = \frac{627,210}{3.14(15.25^2) \times .064} = 13,430\ \#/in^2$$

TN 479 Ref NACA $F_b = 12,000\ \#/in^2$

$$M_S = \frac{12,000}{13,430 \times 1.5} = -.40$$

STA 1.2 8 bolt attachment

$$\text{Max load per bolt} = \frac{2\pi \times 15.25}{8} \times .064 \times 13,430\ \#$$

$$= 10,310\ \#$$

Allowable shear 7/8 inch bolt
Allowable bearing in .125" 75 ST Al = 6640 #

$$MS = \frac{6640}{10,310 \times 1.5} - 1 = -.57$$

[redacted]

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[redacted]

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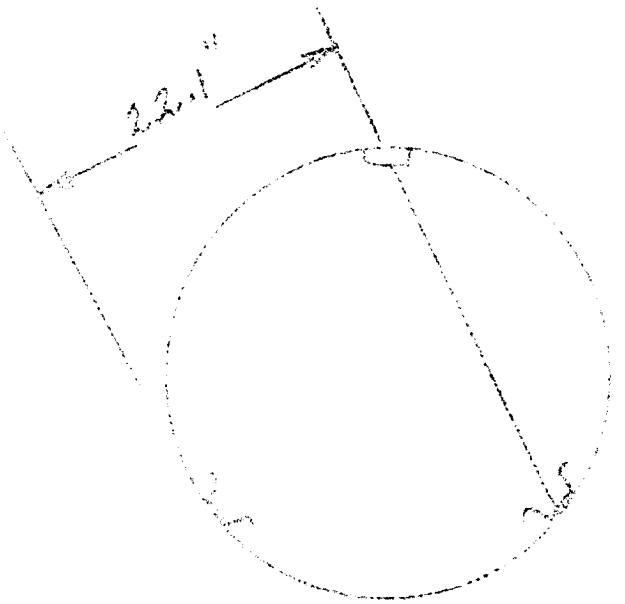
[E] CHECK BENDING STRENGTH OF CASE BETWEEN FRAMES 55.5 AND 72.5.

Calculate Bending Moment at Sta. 72.5

$$M_{72.5} = 6210(177-72.5) - 3080(123-72.5)$$
$$= 6210 \times 104.5 - 3080 \times 50.5$$
$$= 493,400 \text{ in lbs.}$$

Assume that 50% of this moment is resisted by the chamber at this frame and 50% is carried by the case forward to STA. 55.5

$$M_{72.5-55.5} = \frac{493,400}{2} = 246,700 \text{ inch lbs.}$$



Bending Section
72.5 - 55.5

[redacted]

FIG. 7

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[redacted]

E continued

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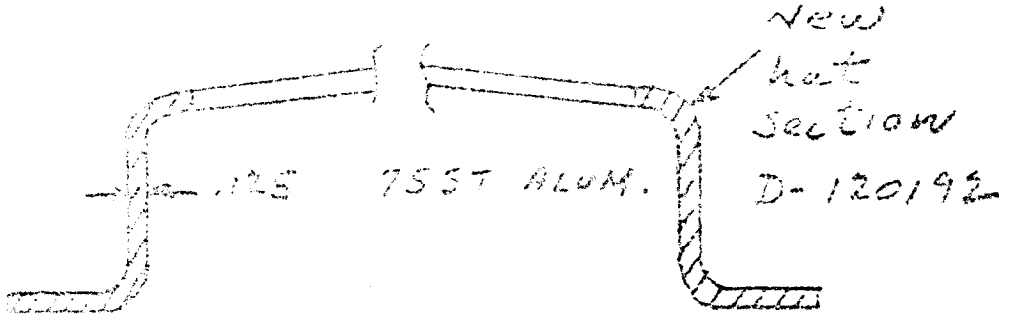
BENDING STRENGTH (HAT SECTION) 55.5 - 72.5

Load in any one of the hat sect. members

$M_{72.5-55.5} = 246,700$ in lbs

$f = \frac{246,700}{22.1} = 11,163^{\#}$



[redacted]

FIG 8

Area section = $0.4 in^2$

$f_c = \frac{11,163}{.4} = 27,908 \ \#/in^2$

Use $f_c = 20,000$ on basis of column strength

$M_S = \frac{20,000}{27,908 \times 1.5} = -.52$

End attachment hat section is 3 - ¼" bolts
Allowable strength in bearing = $3 \times 3200^{\#} = 9600^{\#}$

$M_S = \frac{9600}{11,163 \times 1.5} - 1 = -.43$

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BY ..... DATE ..... SUBJECT TECH MEMO 14-56-12 SHEET NO. 14 OF 21

CHKD. BY ..... DATE ..... Berscoter JOB NO. 627.0

[redacted]

STATIC TEST CALCULATIONS STA. - 106

Load applied at STA 155
Failure in bending at STA 106

Moment = 6,350# (155-106) = 311,350 in #

Moment due to air loads @ M = 1.3 and @ Sea level

M = 1010 (177-106) - 3020 (123-106) = 388,550 in lbs

STRESS IS PROPORTIONAL TO MOMENT

$$MS_{ult} = \frac{311,150}{388,550 \times 1.5} - 1 = -.47$$

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F EJECTOR LOADS

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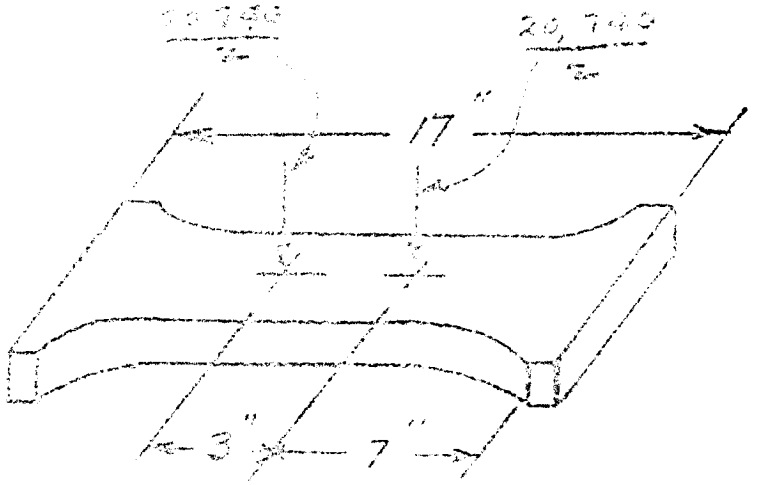
Ejector load = 12.2 g at c.g. of weapon

12.2 × 1700# = 20,740#



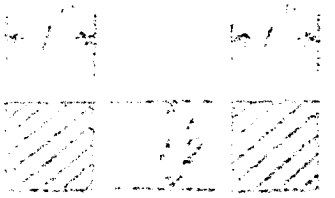
[redacted]

FIG 9

The Douglas ejector condition is critical for the beam moment. Assume a simple beam

$$M = \frac{20,740}{2} \times 7.0 = 72,590 \text{ in lbs.}$$

The center section is approx as shown



Heat Treat
160,000 #/in²

FIG 10

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[redacted]

[F] continued

$$\text{Bending Stress} = \frac{72,590 \times \frac{1.125}{2}}{\frac{1}{12} \times 2 \times (1.125)^3} =$$

$$= 172,070 \ \#/in^2$$

$$\text{Bending Allowable} = 160,000 \times 1.4 = 224,000 \ \#/in^2$$

$$MS_{ult} = \frac{224,000}{172,070 \times 1.5} - 1 = -.13$$

[G] CHECK THREADS - HOOK LUG TO BEAM

(steady roll condition most severe)

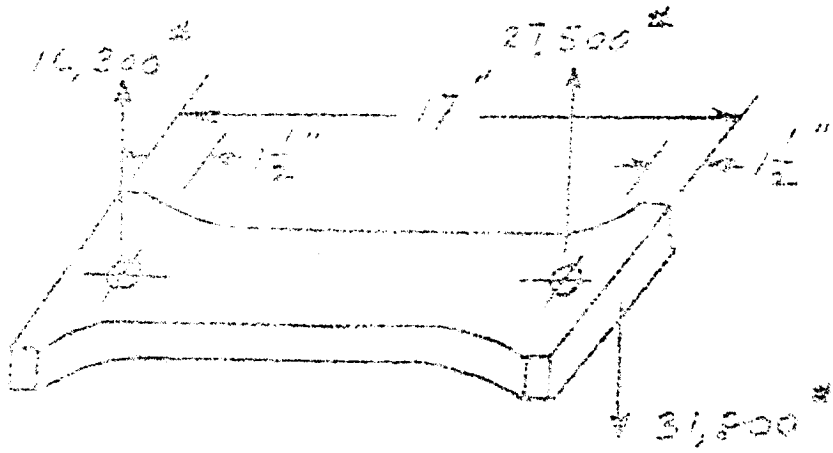

FIG. 11

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Threads $1\frac{1}{8}$ dia by $\frac{7}{8}$" length

$\frac{1}{2}$ thread area $= \pi \times 1.06 \times .875 \times \frac{1}{2}$

$= 3.14 \times 1.06 \times .875 \times .5$

$= 1.46 \text{ in}^2$

Max tension rear hook = 27,500#

$$f_s = \frac{27,500}{1.46} = 18,860 \text{ \#/in}^2$$

Limit stress $F_s = 95,000$ #/in²

$$M_s = \frac{95,000}{18,860 \times 1.5} - 1 = +2.36$$

H CHECK ATTACHMENT OF BEAM TO STA. 72.5

Load = 21,800#

$2 - \frac{3}{4}$" bolts = 100,000 #/in² shear

$f_s = 2 \times 23,600 = 47,200$ #/in²

$$M_{s\,bolt} = \frac{47,200}{21,800 \times 1.5} - 1 = -.01$$

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J AIR LOADS ON A4D AIRPLANE

Moment extrapolated from information received from Douglas Aircraft Corp.

Nose down moment = 61,500 in lbs @ Sea L and M=1.5

ASSUME moment distributed equally about C.G. and the same for each lug.

3-Lug Suspension

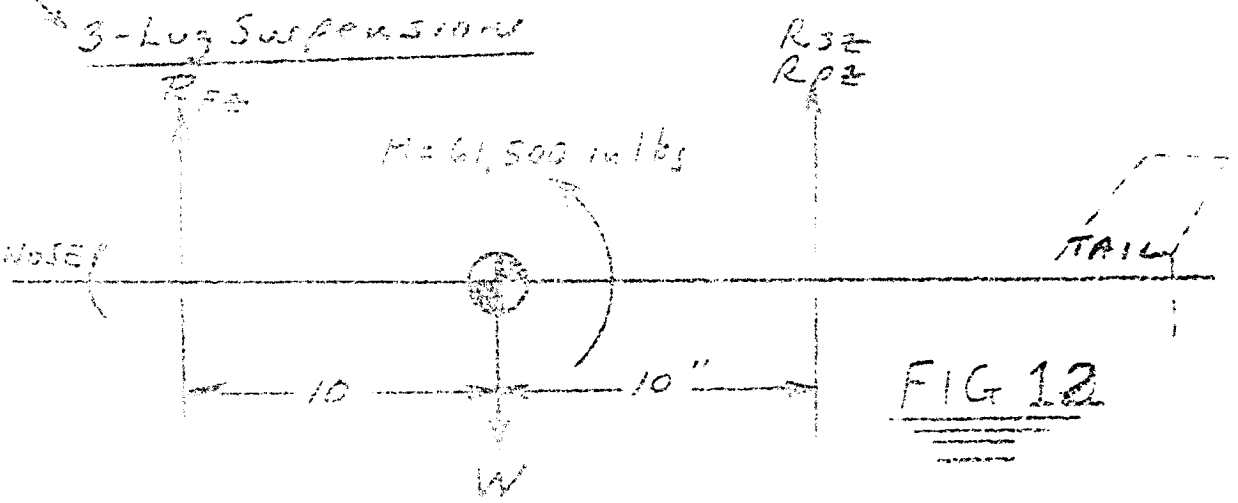

FIG 12

$$\text{Load on front lug} = \frac{61,500}{2 \times 10} = 3075 \text{ (tension)} = R_{FZ}$$

$$\text{Load on rear lug} = -\frac{61,500}{2 \times 10} = -3075 \text{ lbs (compr)}$$

$$\text{Load on rack lug} = -\frac{3075}{2} = -1537.5 \text{ lbs} = R_{SZ} + R_{PZ}$$

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2 lug suspension

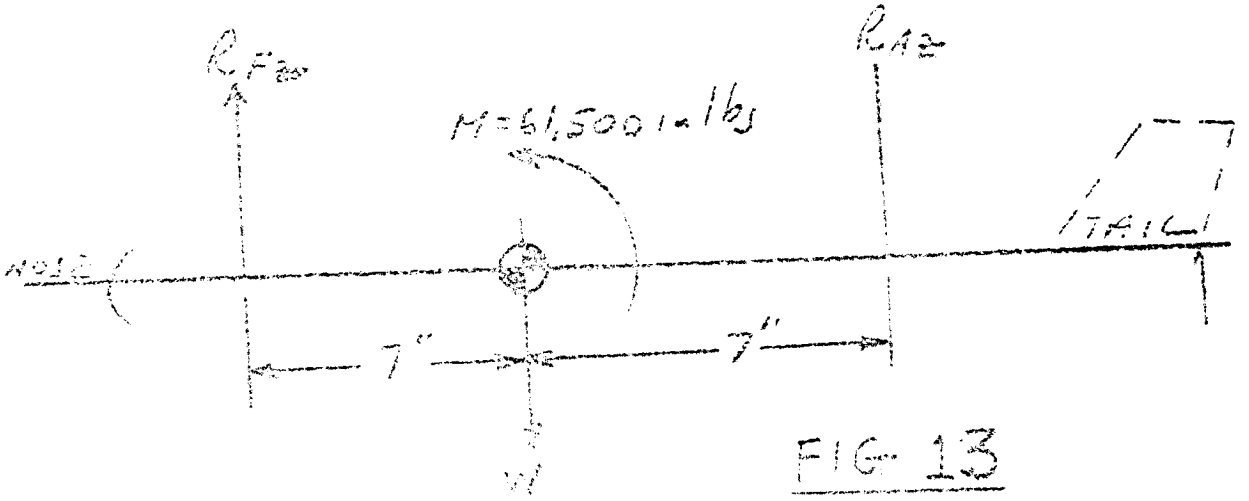

FIG 13

Load on front lug

$$R_{F2} = \frac{61,500}{2 \times 7} = 4396 \text{ in lbs (tension)}$$

Load on AFT lug

$$R_{A2} = -\frac{61,500}{2 \times 7} = 4396 \text{ in lbs (compress)}$$

K DRAG LOADS AT SEA LEVEL

C_D at M=1.3 = 0.33 from ex. data

$q = .7 P M^2 = .7 \times 2116.2 \times (1.3)^2 = 2500 \ \#/ft^2$

Area = 5.07 ft²

$D = .33 \times 2500 \times 5.07 = 4182^{\#}$

[redacted]

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[redacted]

3 HOOK RACK

$$R_{FX} = R_{JX} = R_{PX} = -\frac{4182}{3} = -1391 \text{ lbs}$$

2 HOOK RACK

$$R_X = R_{AX} = -\frac{4182}{2} = -2091 \text{ lbs.}$$

[redacted]

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Item No. Ref.	Critical Station Ref.	Margin of Safety M=.95 @ 30000 ft *	M=1.3 @ Sea Lev	REMARKS
1	177	0.16	0.45	Tail fin in bending
2	101.5	———	-0.22	Strength case in bending - skin
	101.5	0.25	-0.61	" " " " - access doors
3	101.5	0.83	-0.43	Strength of splice - bending moment
	101.5	0.40	-0.54	" " " " "
4	76	0.83	-0.40	Case in bending
	76	0.32	-0.57	Eight bolt attachment
5	55.5-72.5	———	———	Strength case between frames 55.5-72.5
		0.37	-0.52	Strength hat section
		0.65	-0.43	" 3-1/4" bolts
6	106	———	-0.47	Static test load applied 155 - buckling 106
7	55.5-72.5	0.13	-0.13	Ejector loads - main support beam in bendy
8	55.5-72.5	2.36	2.36	Thds main support beam hook lug - Steady roll
9	72.5	0.18	-0.01	Main beam attachment Sta 72.5 - Two 7/8 bolts

TWO AND THREE LUG SUSPENSIONS SATISFACTORY AND CARRIAGE

* From Douglas Air. Co. Report ES15688 - Analysis TK-7 Unit

TABLE I - STRESS ANALYSIS MK-7 CASE M=1.3 @ SEA LEV

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