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AUTHORITY

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Stress Analysis of the B-36 Nose Gear

50803

(None)

Ades, C.S.
Bendix Aviation Corp., Bendix Products Div., South Bend, Ind.
(Same)

R-813

(Same)

Feb '47 Unclass. U.S. English 21 diagrs, graphs, drwgs

A stress analysis was made of the nose gear of the B-36 bomber. The analysis covers the axle, inner and outer cylinder, piston, torque fittings and arms, and shock. The appendix shows the computations for the nose gear loads, loads at points O,O' and O'', loads at sections in the fork, torque arm geometry, and loads at the upper and lower bearings, trunnion and drag brace. A table of the minimum margins of safety is included.

(1) Structures (7) (6) Stress Analysis of Specific Aircraft

(1) Landing gears - Stress analysis (54537); Landing gears, Nose - Static Tests (54538.6); B-36 (13869.6)

BENDIX PRODUCTS DIVISION
DIVISION OF BENDIX AVIATION CORPORATION
SOUTH BEND, INDIANA, U. S. A.

ENGINEERING DEPARTMENT

REPORT NO. 813

TITLE STRESS ANALYSIS OF THE B-36 NOSE GEAR

C.S. Cobb

PREPARED BY:
C. S. Cobb
Date 2-20-47

APPROVED BY:
J. G. Mantear
Date 4-16-47

No. of Pages 17

BENDIX PRODUCTS DIVISION
DIVISION OF BENDIX AVIATION CORPORATION
SOUTH BEND, INDIANA, U. S. A.

Report #815

Written by C.S.A. Date 2-20-47
Checked by S.D.G Date 4-8-47
Subject Stress Analysis of B-36 Nose Gear

Page No.
No. of Pages
Model B-36

TABLE OF CONTENTS

Report #813

Written by C.S.A. Date 2-20-47 Page No. 1
Checked by E.D.C Date 4-8-47 No. of Pages
Subject Stress Analysis of the B-36 Nose Gear Model B-36

INTRODUCTION

The nose landing gear of the Consolidated B-36 airplane is of the semi-cantilever retracting type. It is supported in the airplane at three hinge points: one at the top of the gear where it is connected to the drag brace, and two at the ends of two trunnion arms extending from the outer cylinder twenty-five inches below the first point. Retraction is accomplished through a lever bolted to one of the trunnion arms. In landing position, an inner cylinder sliding within the outer cylinder, is "fully extended," at which time the overall length of the gear from drag brace to axle is about ninety inches. The shock of landing is absorbed by hydraulic fluid contained within the inner cylinder, the pressure being gradually relieved by the escape of the fluid through a fixed orifice (no metering pin). The axle contains dual wheels, splined to it so as to be co-rotating.

The loads imposed on the gear are in general in accordance with ANC-2. In addition, due to the dual wheels, the following distribution of loads to the wheels is used: 50% - 50%, 60% - 40% and 60% - 0%. Since also the wheels are co-rotating, the torque from side load is assumed taken by tire scrubbing. This makes the 60-0 conditions critical for torque, but the result is practically the same in either case. For ready reference, all loads tables will be found in the Appendix. Loads used in the analysis are assumed in general to come from this source without further reference. The two obviously critical conditions for the axle were for convenience numbered Conditions I and II.

Sketches are freely used throughout the analysis to indicate the sections and dimensions checked. Dimensions given at critical sections take into consideration the machining allowances so that the "minimum" section is obtained. Critical margins of safety are computed and indicated; although where it is evident that the margin is large (.50 or greater), the abbreviation "amp." for ample is quite often used. The following general remarks also apply:

1. Since most of the material of the strut is steel with a minimum heat treat value of 205,000 psi ultimate tensile strength, this is assumed to be the case unless it is otherwise noted. Allowable stresses are obtained from ANC-5, extrapolated where necessary.

2. Since scaling is known to be small for this type of material, no allowance is made for it except as it is cared for by an excess margin of safety.

Report #813
Written by C.S.A. Date 2-20-47 Page No. 11
Checked by G.D.G Date 4-8-47 No. of Pages
Subject Stress Analysis of B-36 Nose Gear Model B-36

INTRODUCTION (CONT'D)

3. No special allowance is made for the fact that the lower end of the inner cylinder is a bent tube. This agrees with Bendix's experience in testing struts containing such tubes.

4. Thin tubes, D/t ≥ 25, are checked for local instability by the method of ANC-5, paragraph 1.633.

5. Bending modulus of rupture values for tubes are taken from ANC-5, Fig. 4-20. This value for non-circular sections is taken equal to 1.5 x F_{ty}, which is felt to be conservative.

Report 813

Written by C.S.A. Date 2-20-47 Page No. 111
Checked by C.D.G. Date 4-5-47 No. of Pages
Subject Stress Analysis of B-36 Nose Gear Model B-36

LIST OF REFERENCES

(1) Consolidated Vultee Aircraft Corporation — "Preliminary Nose Gear Stress Analysis YB-36, YB-36A, and B-36A Airplanes." Rept. ZAS-36-157. Fort Worth Div., January, 1946.

(2) U.S.A.A.F. — Drawing 25A2821, Change "C".

(3) Army-Navy Civil Committee on Aircraft Design Criteria — "ANC-5, Strength of Aircraft Elements," Rev., 1942.

(4) Roark, R. J. — "Formulas for Stress & Strain." McGraw-Hill Book Co., New York, 1943.

(5) Binzel and Crafts — "The Alloys of Iron and Chromium," Vol. I. McGraw Hill Book Co., New York, 1939.

(6) Lundquist — "Strength Tests of Thin Walled Duralumin Cylinders in Combined Transverse Shear and Bending." N.A.C.A. Tech. Note 523.

(7) Oberg and Jones — "Machinery's Handbook." The Industrial Press, New York, 1944.

(8) Timoshenko, S. — "Theory of Plates and Shells." McGraw Hill Book Co., New York, 1940.

(9) Timoshenko, S. — "Strength of Materials," Part II. D. Van Nostrand Co., New York, 1941.

Report 813

Written by C.S.A. Date 3-20-47
Checked by C.D.G. Date 4-8-47
Subject Stress Analysis of B-36 Nose Gear

TABLE OF MARGINS OF SAFETY

Report 3813

Written by C.S.A. Date 2-26-47 Page No. V
Checked by G.D.G. Date 4-8-47 No. of Pages
Subject Stress Analysis of B-36 Nose Gear Model B-36

TABLE OF MARGINS OF SAFETY (CONT'D)

Sections	Page	Crit. Load Cond.	M. S.
Outer Cylinder Analysis (Cont'd.)			
Upper End Fitting (Cont'd.)			
-Section 1-1	51	1(b)	+ .50
-Section 2-2	52	7-1(a)	+ .15
-Tearout of Lugs	53	7-1(a)	+ .49
-Bending of Lugs	54	7-1(a)	Amp.
-Tearout from Cylinder Head	55	7-1(a)	Amp.
Gland Nut	56		Amp.
Piston			
Tube	64	1(a)	+.08
Orifice Plate-Threads Connecting Ring to Plate	66	1(a)	Amp.
-Inner Ring	67	1(a)	Amp.
-Outer Ring	68	1(a)	Amp.
-Middle Ring	69	1(a)	Amp.
-Threads Connecting to Piston Tube	70	1(a)	+ .43
Tube at Threads Connecting to Orifice Plate	71	1(a)	+ .26
Inner Cylinder Torque Fitting (Ref. Sketch, p. 72)			
Bolt Connecting Arm to Fitting	73	1(c)	+ .01
Section 1-1	74	1(c)	+1.16
Section 2-2	75	1(c)	+1.28
Weld	75	1(c)	+ .50
Torque Yoke (Ref. Sketch, p. 76)			
Tearout of Fitting from Yoke	77	1(c)	+ .17
Yoke Stop	81	1(c)	+ .27
Nut	82	1(c)	Amp.
Bushing	82	1(c)	+ .35
Torque Arms (Ref. Sketch, p. 83)			
Lugs at Fitting End	84	1(c)	+ .33
Lug at Apex End-Section 1-1	85	1(c)	+ .21
Section 2-2	86	1(c)	+ .25
Section 3-3	87	1(c)	+ .56
Jams			
Plug-Upper Jam Lock	88		+ .44
Keys-Lower Jam	89		+ .39
Telescoping Lever (Ref. Sketch, p. 91)			
Lug and Bolt at Jack Attaching Point			+ .[illegible]
Lug and Bolt at Trunnion Connection			+ .[illegible]

Written by C.S.A. Date 2-20-47
Checked by S.D.G. Date 4-8-47
Subject Stress Analysis of B-36 Nose Gear

TABLE OF MARGINS OF SAFETY (CONT'D)

Section	Page	Crit. Load Cond.	M. S.
Retracting Lever (Cont'd.)			
Sections 1-1 and 2-2	93		+ .72
Section 3-3	94		+ .16
Section 4-4	95		Amp.
Shimmy Damper Connections			
Upper Lug and Bolt	99		+ .33
Lower Lug and Bolt	100		+ .45
Lower Lug and Bolt	101		+ .28
Torque Yoke Arm- Section 1-1	102		+ .05
-Section 2-2	103		+ .10
-Tearout from Yoke Barrel	104		+ .12
-Lug	105		+ .30

Report #813

Written by C.S.A. Date 2-20-47 Page No. viii

Checked by S.D.G. Date 4-8-47 No. of Pages

Subject Stress Analysis of B-36 Nose Gear Model B-36

SYMBOLS

A_s = Area of cross-section

A_m = Area enclosed by median line of section

R (subscript) = Radial

A_H = Hydraulic area

p = Hydraulic pressure or radial pressure (on cylinder)

f_h = Hoop stress

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Written by _____ Date 12-29-38 Page No. _____
Checked by _____ Date 12-29-38 No. of Pages _____
Subject Standard Structural Symbols M&M S-1T

A--Area of cross section
a--Subscript "allowable"
b--Width of section; subscript "bending"
br--Subscript "bearing"
c--Distance from neutral axis to extreme fiber; subscript "compression"
D--Diameter
E--Modulus of elasticity in tension
F--Allowable stress
f--Internal (calculated) stress
F_b--Allowable bending stress, modulus of rupture in bending
F_{st}--Modulus of rupture in torsion
G--Modulus of elasticity in shear
I--Moment of inertia
I_p--Polar moment of inertia
L--Length
L.B.--Lower bearing
M--Applied moment or couple, usually a bending moment
n--Subscript "normal"
P--Applied load
psi.--Pounds per square inch
Q--Static moment of a cross section
R--Subscript "resultant"
r--Radius
S--Shear force
s--Subscript "shear"
T--Applied torsional moment, torque
t--Thickness, subscript "tensile"
U.B.--Upper bearing
u--Subscript "ultimate
y--Subscript "yield"
ρ(RHO)--Radius of gyration
CG--Center of gravity
MS--Margin of safety
O.D.--Outside diameter
I.D.--Inside diameter

STANDARD LOAD SYMBOLS:
In analyzing the main landing gear, the left wheel (from cockpit, looking forward) is considered. The following symbols are used for loads:

Loads Perpendicular and Parallel, Resp., to Ground:
V--Vertical load, positive up D--Drag load, positive back
R--Side load, positive out

Loads Perpendicular and Parallel, Resp., to Strut A:
X--Drag load, positive back Y--Vertical load, positive up
Z--Side load, positive out

Positive directions of moments are determined by the right hand rule; i.e., a positive moment is one that is clockwise, looking along the positive direction of the corresponding force vector. The symbols for moments are:--

M_V--Moment about V axis
M_D--Moment about D axis
M_R--Moment about R axis
M_X--Moment about X axis
M_Y--Moment about Y axis
M_Z--Moment about Z axis

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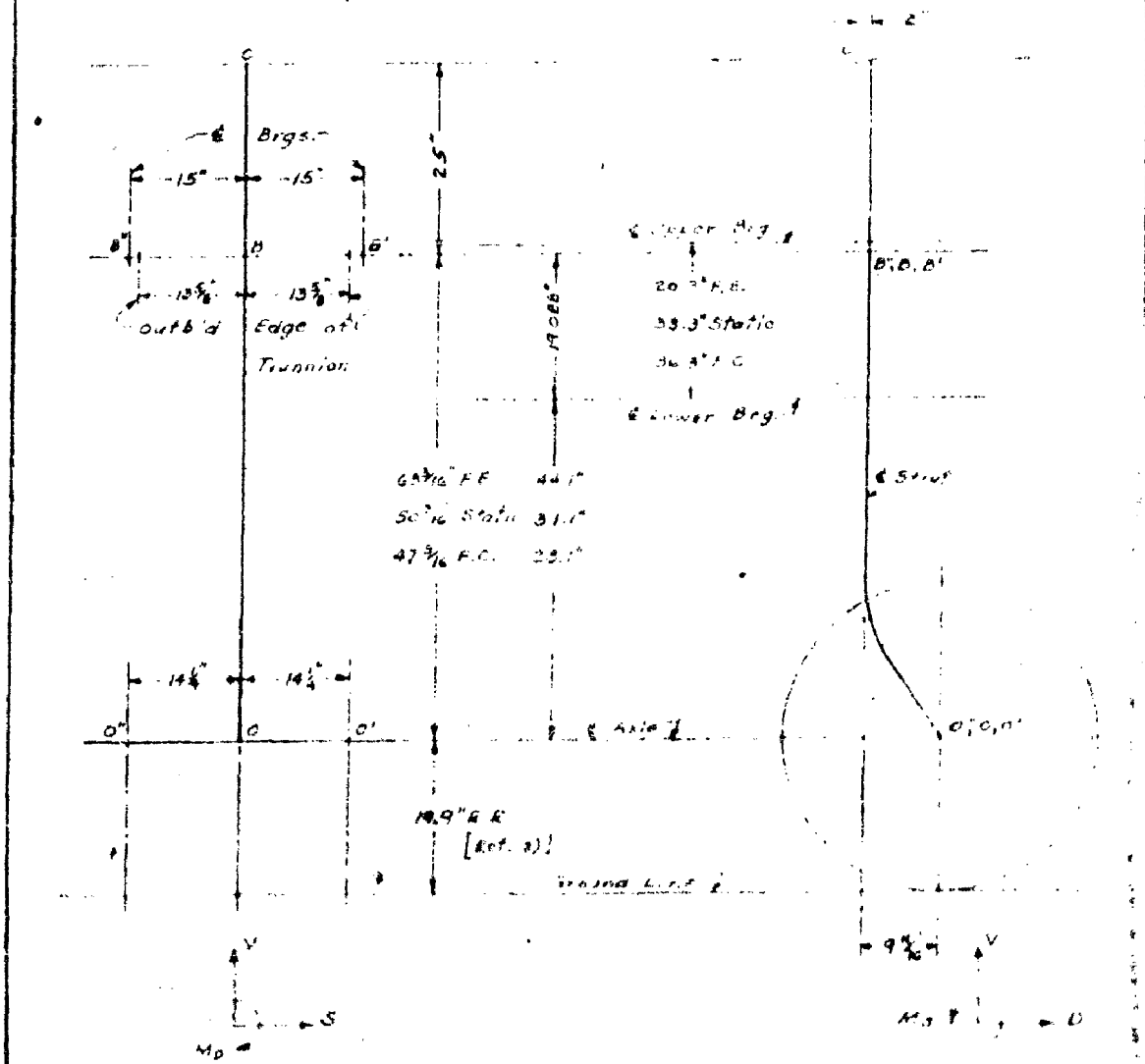
Written by CSA Date 2/13/47
Checked by E. D. T. Date 2/14/47
Subject GEOMETRY OF STRUT

Dept. No. [illegible]
Page No. 1
No. of Pages 10
Model E-36, 11-D



S-120

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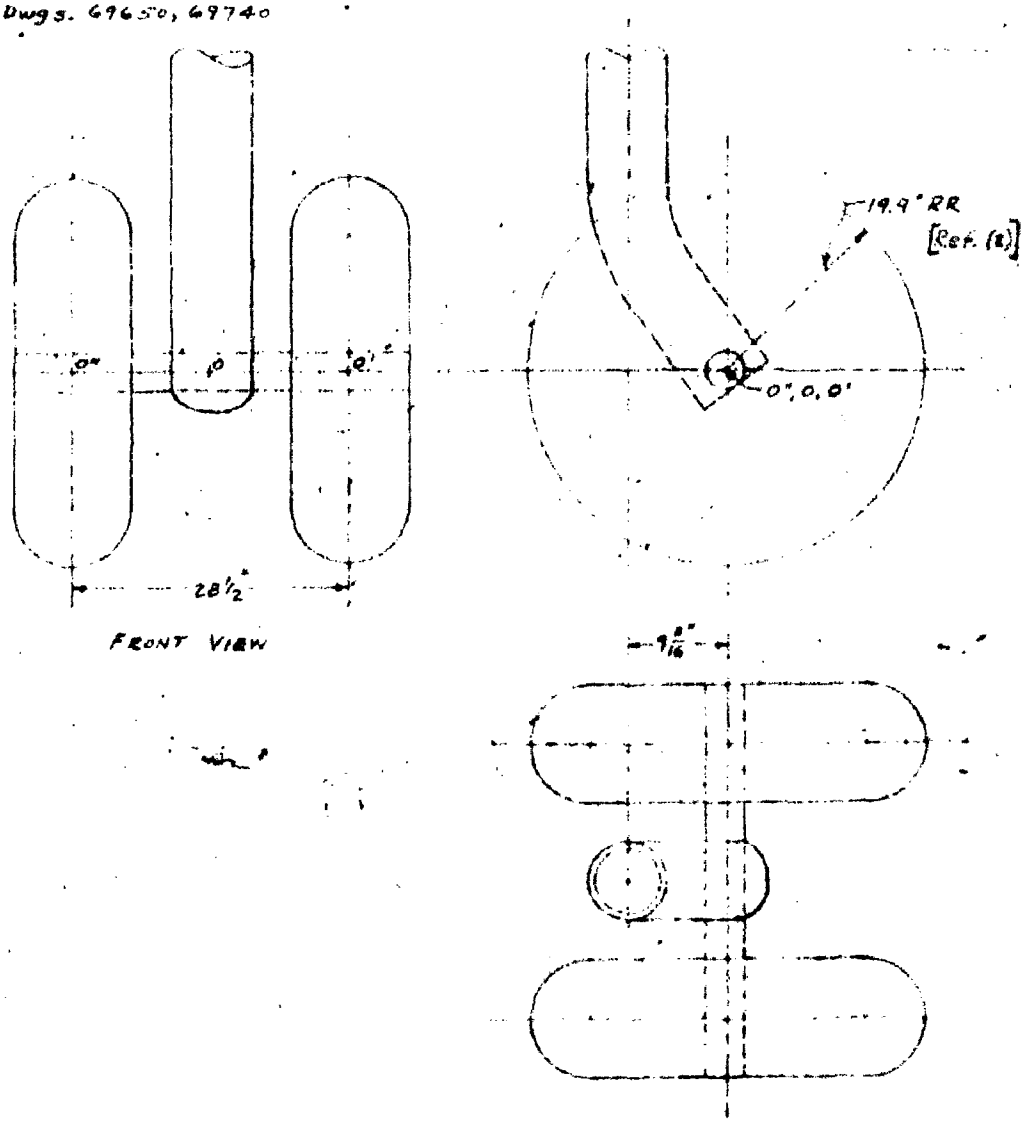
Written by CSA Date 11/15/46
Checked by E. D. Y. Date 4-8-47
Subject AXLE & ADJACENT STRUCTURE

Rept. # 814
Page No. 2
No. of Pages 111
Model B-36 N.G.

Ref. Dwgs. 69650, 69740



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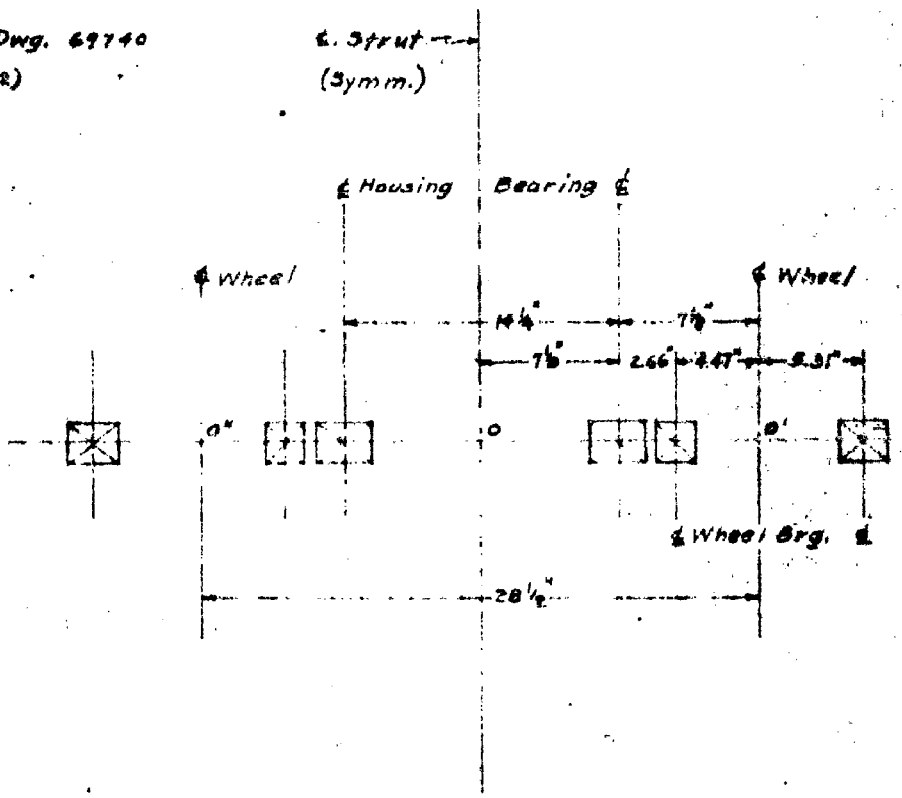
Written by CBA Date 11/15/46
Checked by G.D.G Date 4-8-47
Subject AXLE PLAN

Rept. # 813
Page No. 3
No. of Pages 111
Model B-25 N.B.

Ref. Dwg. 69740
Ref. (2)

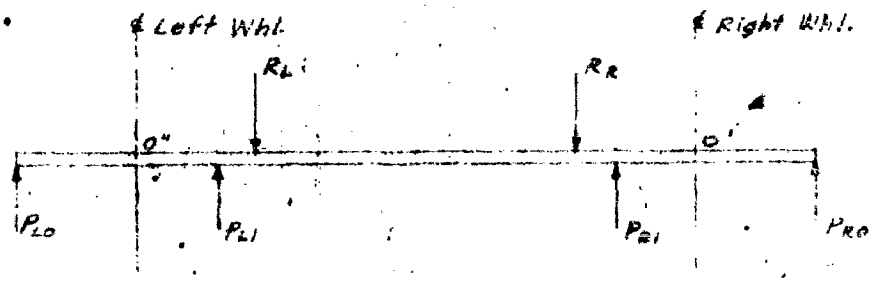


B-128

Written by C.S.A. Date 11/15/46
Checked by G.D.G Date 4-8-47
Subject AXLE LOADS

Rept. # 813
Page No. 4
No. of Pages 111
Model B-36 N.G

CONDITION I - 3WLIR 60-40 DIST.



Assume 60% on right whl.

$P_{RI} + P_{RO} = .6(166{,}200^2 + 84{,}900^2)^{\frac{1}{2}} = 105{,}000\#$

$P_{LO} + P_{LI} = .4(166{,}200^2 + 54{,}700^2)^{\frac{1}{2}} = 70{,}000\#$

$P_{RI} = 105{,}000\,(5.31/9.78) = 57{,}000\#$

$P_{RO} = 105{,}000\,(4.47/9.78) = 48{,}000\#$

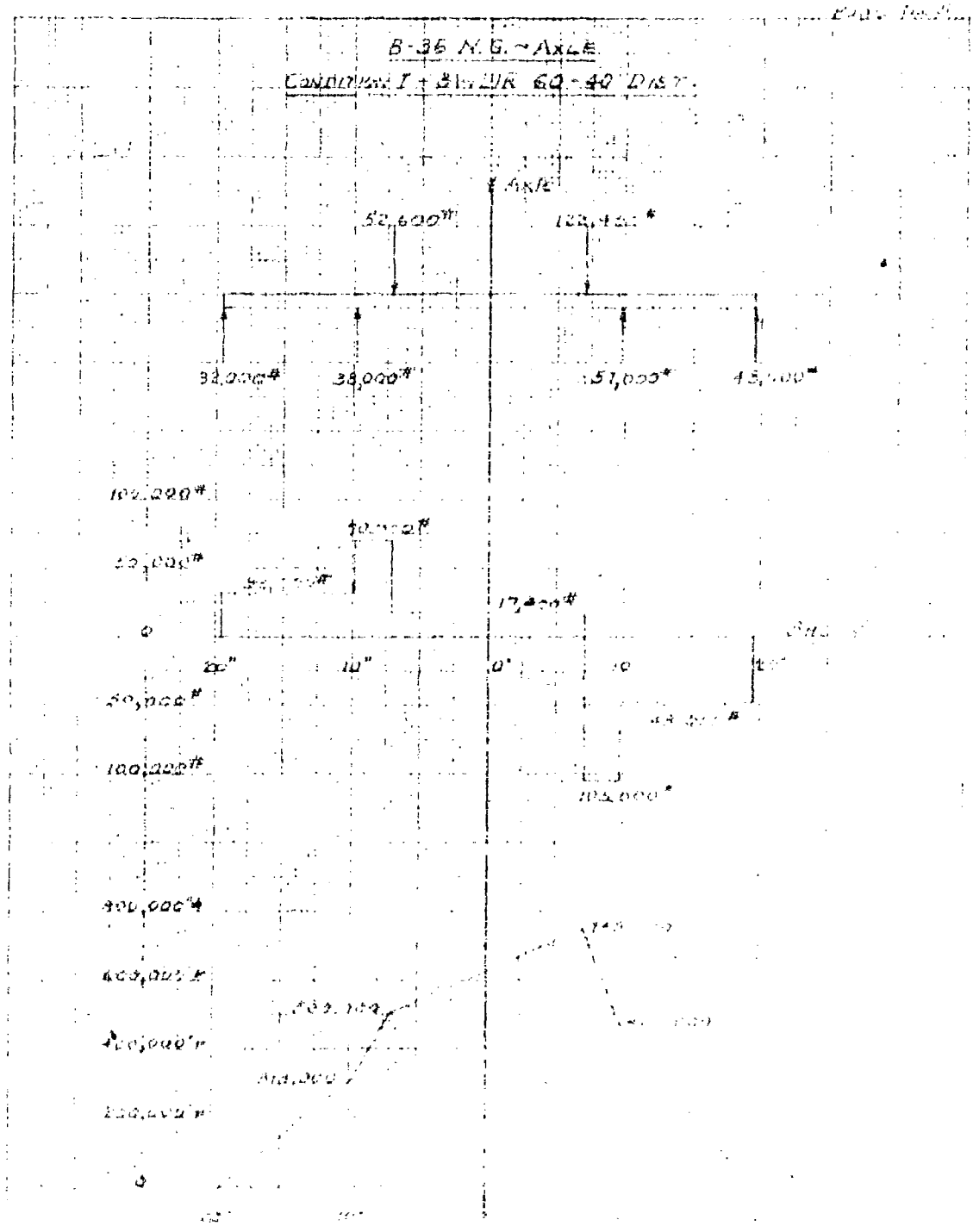
$P_{LI} = 70{,}000\,(5.31/9.78) = 38{,}000\#$

$P_{LO} = 70{,}000\,(4.47/9.78) = 32{,}000\#$

$R_R = (105{,}000 \times 21.4 - 70{,}000 \times 7.13)/14.25 = 128{,}400\#$

$R_L = (70{,}000 \times 21.4 - 105{,}000 \times 7.13)/14.25 = 52{,}600\#$

* Ref. # 3

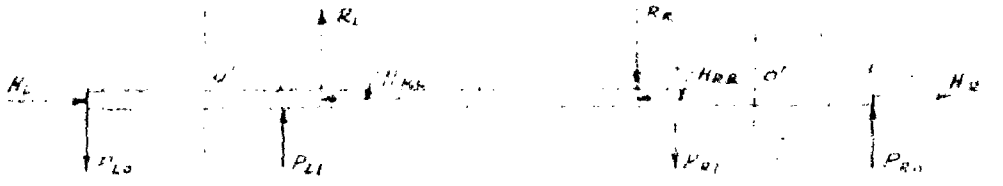

B-36 N.G. - AXLE
CONDITION I - 31 - 2 JK 60 - 40 DIST.
AXLE
52,600#
32,000#
38,000#
51,000#
45,000#
10"
0"

Written by CSA Date 11/21/46
Checked by [illegible] Date 4-8-47
Subject AXLE LOADS

Dept # 813
Page No. 6
No. of Pages 111
Model B-36 N.G.

Condition II - Side Drift 60-40 Dist

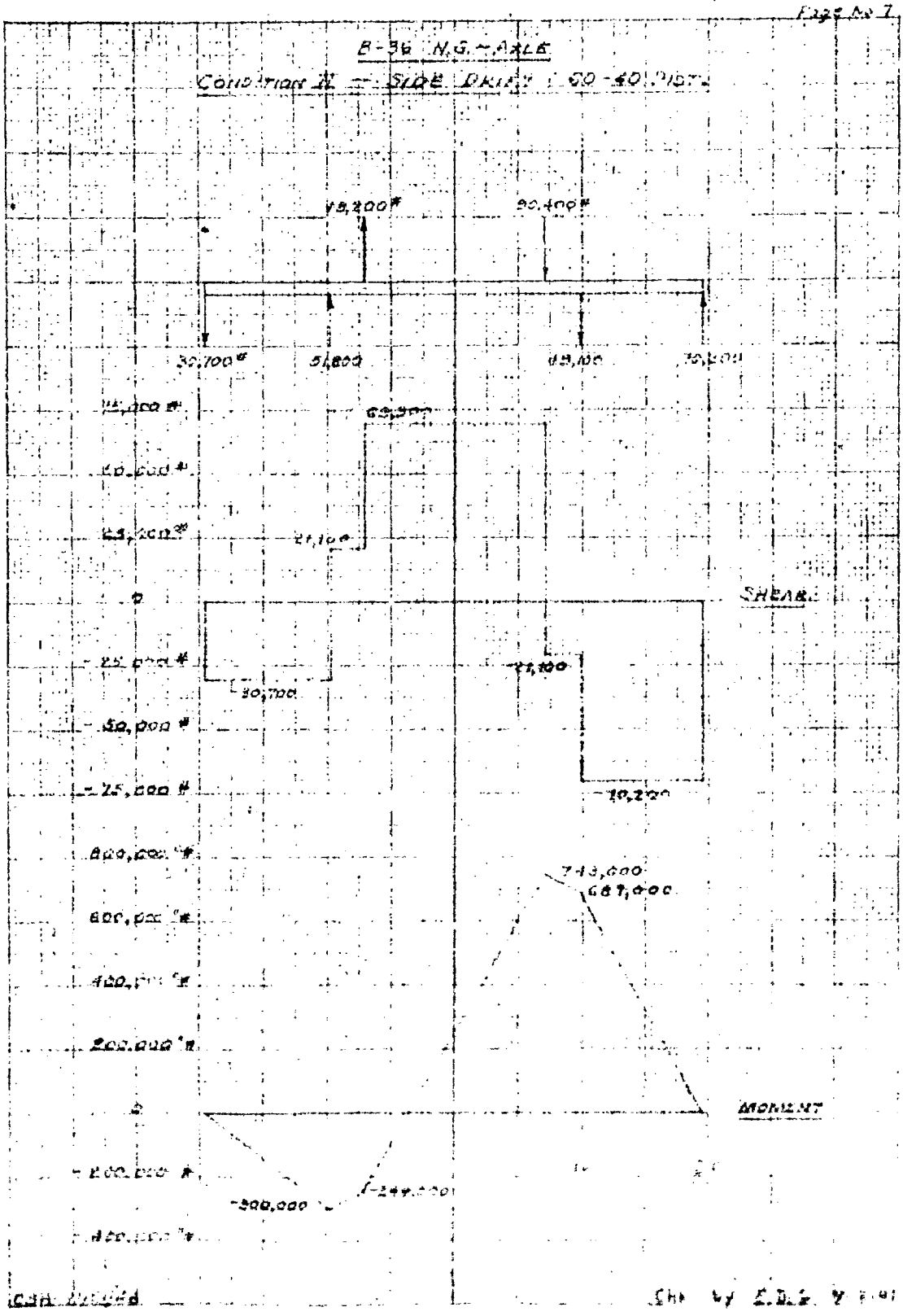
Assume all side load torque to be taken by scrubbing (Ref. memo of telephone conversation with CIAC, 11/21/46).
Side load torque = 41,600 x 9.69 = 481,000 "#
Scrubbing load/whl. = 481,000/28.5 = 16,900#
Assume an .8 coef. of friction [Ref. (1)]
Vert. load from scrubbing/whl. = 16,900/.8 = 21,100#



H_L = .4 x 41,600 = 19,800
H_R = .6 x 41,600 = 24,800
P_{LO} = - 19,800 x 14.9/9.78 + 21,100 x 4.41/9.78 = - 30,700#
P_{LI} = 19,800 x 4.89/9.78 + 21,100 x 5.31/9.78 = 21,800#
P_{RO} = 21,800 x 14.9/9.78 + 21,100 x 4.41/9.78 = 42,200#
P_{RI} = - 24,800 x 4.89/9.78 + 21,100 x 5.31/9.78 = - 49,100#
R_R = - 49,600 x 4.89/14.25 - 21,100 = - 38,400#
R_L = 41,600 x 14.9/14.25 - 21,100 = 22,200#
H_{RL} = H_{RR} = 41,600/2 = 24,800#
Torque on shaft = 16,900 x 9.69 = 164,000"#

B-36 N.G. - AXLE

Condition 'A' - SIDE DRIFT : 60 - 40 PSF



Written by CBA Date 11/19/46
Checked by E.D.G Date 4-8-47
Subject AXLE LOADS

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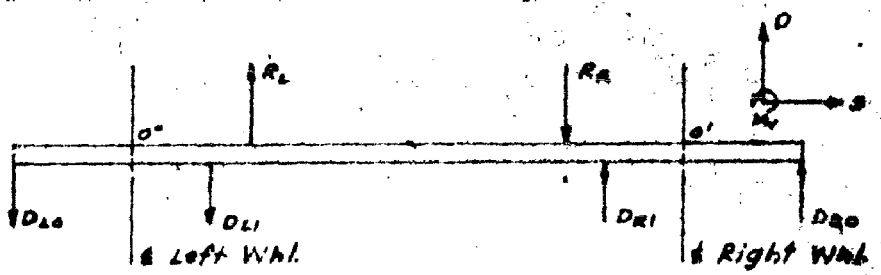
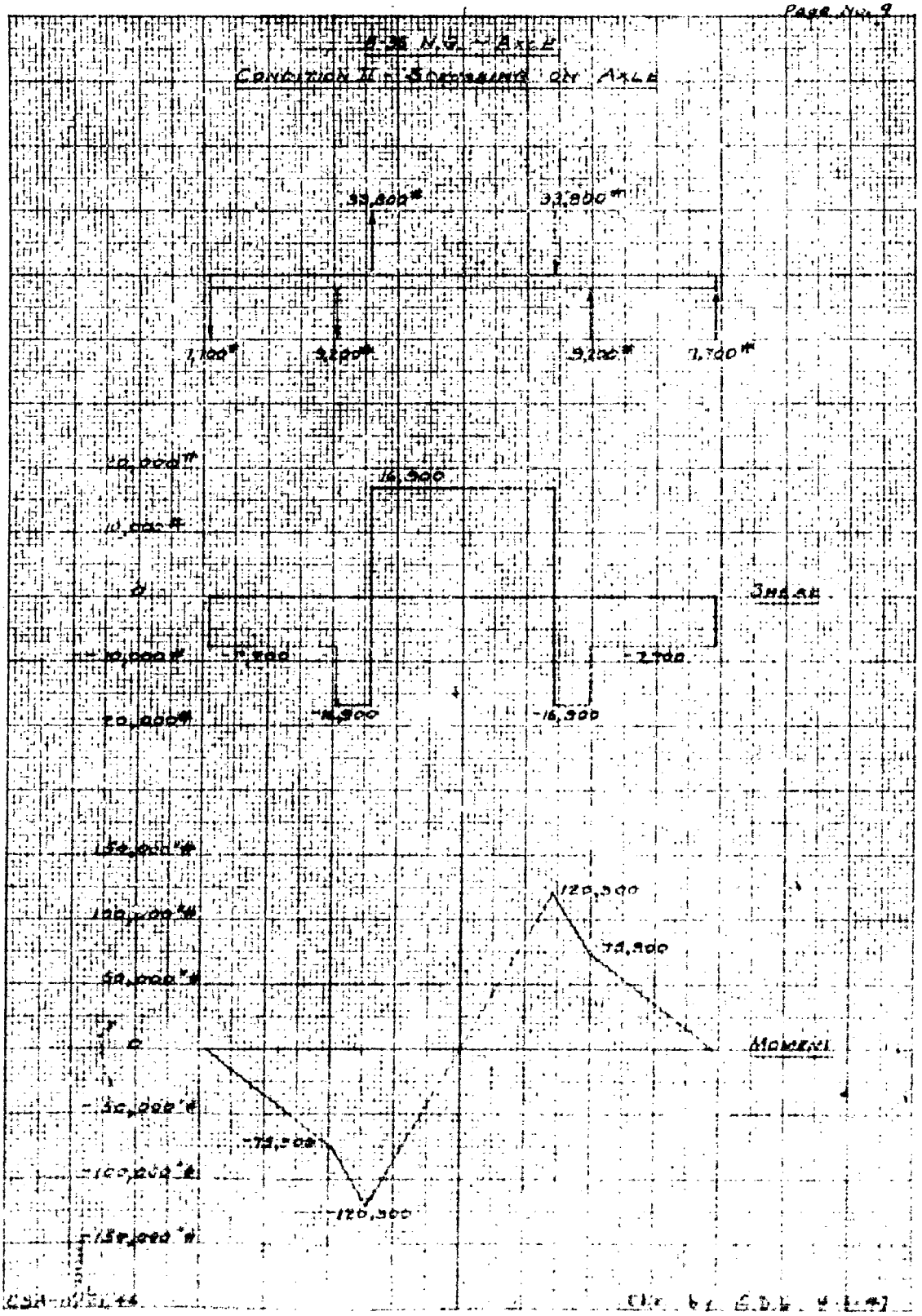
Page No. 3
No. of Pages 111
Model B-34 Mod.

CONDITION II - SCRUBBING ON AXLE



$D_{Lo} = -D_{Ro} = 16,900 \times 4.47/9.78 = -7,700$#
$D_{Li} = -D_{Ri} = 16,900 \times 5.31/9.78 = -9,200$#
$R_L = -R_R = 16,900 \times 28.5/14.25 = 33,800$#


B-36 N.G. - AXLE
CONDITION II - STRADDLING ONE AXLE
33,800#
32,800#
1,100#
2,200#
9,200#
7,700#
18,000#
16,500
4,000#
3MS.AB
-10,000#
-7,200
-2,700
-16,500
-16,500
20,000#
120,000#
100,000#
80,000#
0
-40,000#
-73,500
-120,000#
-160,000#
120,500
74,900
MOMENTS

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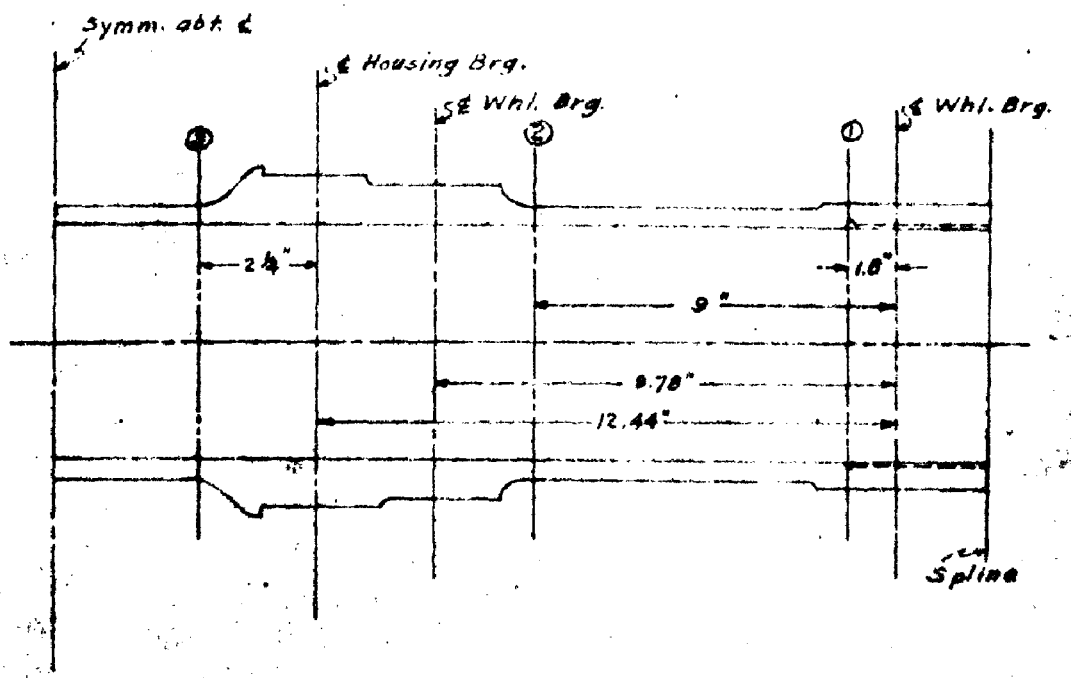
SOUTH BEND, INDIANA, U. S. A.

Written by CSA Date 11/19/46
Checked by E. D. G Date 4-8-47
Subject AXLE SECTION

Rept. # 818
Page No. 10
No. of Pages 111
Model B-36 N.G.

SKETCH SHOWING SECTIONS TO BE INVESTIGATED

Ref. Dwg. 69740



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Rept. # 813
Written by CSA Date 11/21/46 Page No. 11
Checked by E.D.G. Date 4-8-47 No. of Pages 111
Subject AXLE SECTIONS Model B-36 N.G.

SECTION I

CONDITION II CRITICAL

Tension = 29,800 #

Torque = 336,000 #

Shear = $\sqrt{(70,200)^2 + (7,700)^2}$ = 70,600 #

M = 70,600 × 1.8 = 127,000 "#

SECTION PROPERTIES

OD = 4.998" ID = 4.535" t = .232" D/t = 21.6" L/D = 2

A_s = 3.46 A_{mi} = 17.86 I/c = 3.95

ALLOWABLES

F_{st} = .71 × 205,000 = 146,000 F_s = .12 × 146,000 = 175,000 f_b = 247,000

STRESSES

f_t = 29,800/3.46 = 8,600

f_{sc} = 336,000/2 × 17.86 × .232 = 40,500

f_s = 2 × 70,000/3.46 = 40,800

f_b = 127,000/3.95 = 32,200

MS

R_t = 8,600 / 205,000 = .042

R_{st} = 40,500/146,000 = .278

R_s = 40,800/175,000 = .233

R_b = 32,200/247,000 = .130

$MS = \frac{1}{\sqrt{(.278 + .233)^2 + (.042)^2}} - 1 = \underline{.411}$

B-123

Written by C.S.A. Date 11/21/46
Checked by E.D.G. Date 4-8-47
Subject AXLE SECTIONS

Rept. # 813
Page No. 12
No. of Pages 111
Model B-36 N.G.

SECTION 2

CONDITION II CRITICAL

Tension = 29,800#
Torque = 336,000"#
Shear = 70,600# (As in sect. 1)
M = 70,600 x 9 = 635,000"#

SECTION PROPERTIES

OD = 4.833" ID = 4.385" t = .224" D/t = 21.6 L/D = 2
As = 3.22 Am = 16.7 I/c = 3.56

ALLOWABLES = Same as for section 1.

STRESSES

f_t = 29,800/3.22 = 9,300
f_{sc} = 336,000/2 x 16.7 x .224 = 44,900
f_s = 2 x 70,600/3.22 = 43,900
f_b = 635,000/3.56 = 178,400

MS

R_t = 9,300/205,000 = .045
R_{sc} = 44,900/146,000 = .308
R_s = 43,900/175,000 = .251
R_b = 178,400/247,000 = .722

$$MS = \frac{1}{\sqrt{(.722 + .045)^2 + (.308)^2}} - 1 = +.21$$

Written by C.S.A. Date 11/21/46
Checked by E.D.G. Date 4-8-47
Subject AXLE SECTIONS

Rept. # 313
Page No. 13
No. of Pages. 111
Model B-36 N.G.

SECTION 3

CONDITION I CRITICAL

Shear = 17,400#

M = 710,000"#

SECTION PROPERTIES & ALLOWABLES - Same as for section 2.

STRESSES

f_b = 710,000/3.56 = 199,400

$MS = \frac{217,000}{199,400} - 1 = +.24$

CONDITION II

Tension = 5,000#

Torque = 336,000"#

Shear = $\sqrt{(69,300)^2 + (16,900)^2}$ = 71,300#

M = $\sqrt{(595,000)^2 + (84,000)^2}$ = 601,000"#

STRESSES

f_t = 5,000/3.22 = 1,550

f_{sc} = 336,000/2 × 16.7 × .224 = 44,900

f_s = 2 × 71,300/3.22 = 44,300

f_b = 601,000/3.56 = 169,000

MS

R_t = 1,550/205,000 = .008

R_{sc} = 44,900/146,000 = .308

R_s = 44,300/175,000 = .253

R_b = 169,000/247,000 = .684

$MS = \frac{1}{\sqrt{(.008+.684)^2 + (.308)^2}} - 1 = +.32$

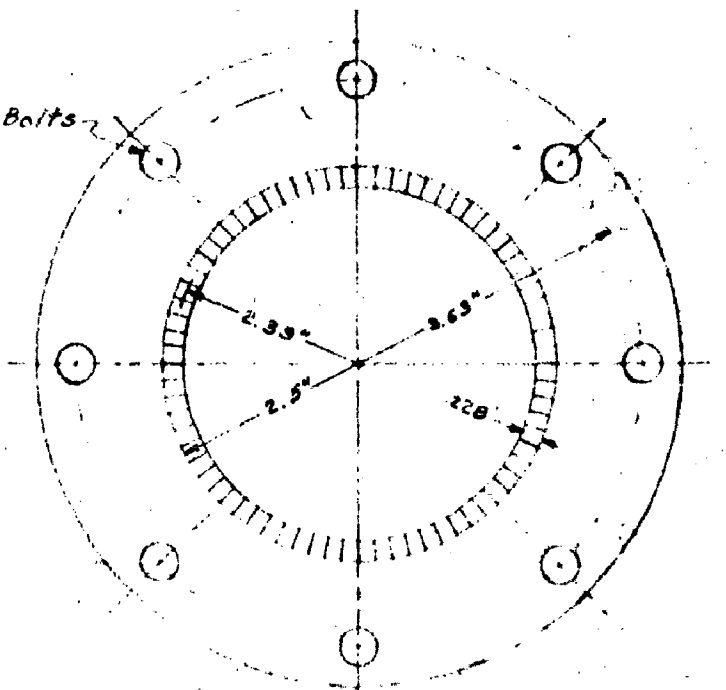
BENDIX PRODUCTS DIVISION

DIVISION OF BENDIX AVIATION CORPORATION
SOUTH BEND, INDIANA, U. S. A.

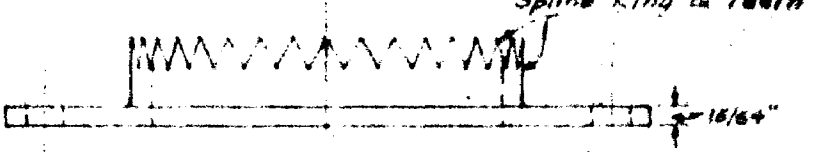
Written by C.S.A. Date 11/20/46
Checked by E.D.G. Date 4-8-47
Subject AXLE CLUTCH

Rept. # 813
Page No. 14
No. of Pages 111
Model B-36 M.G.

Ref. Dwg. 61741



Spline Ring & Teeth



S-115

Written by CSA Date 11/20/46
Checked by E.D.G. Date 4-8-47
Subject AXLE CLUTCH

Rept. # 813
Page No. 15
No. of Pages 11
Model B-36 N.G.

GAGE OF PLATE

CONDITION II CRITICAL

Thrust = 29,800#

Torque = 49,600 × 9.69 × 19.9/28.5 = 336,000 "# Assuming all side load torque taken by scrubbing in accordance with telephone conversation and memo of, 1/21/46.

ALLOWABLES

F_b = 1.5 × yld. = 1.5 × 170,000 = 255,000 psi

F_s = 117,500 psi Ref. (5), p 297

STRESSES

In computing the max. bending stress, the plate is considered circular with a hole in the middle, simply supported at the bolt ℄ and fixed at the spline ring. The presence of the latter is considered to reduce the tangential stress to a negligible value, and the fixed end condition is conservative for the radial stress. The latter is computed by the formula at ref. (4), p. 194, case # 22:

$$f_{br} = \frac{3W}{2\pi t^2}\left[\frac{2a^2(m+1)\log(a/b) + a^2(m-1) - b^2(m-1)}{a^2(m+1) + b^2(m-1)}\right].$$

This can be simplified, however, to $f_{br} = \frac{\beta W}{t^2}$, where β is given on p. 209 of loc. cit. Plotting β vs a/b gives $\beta = .388$ for $a/b = 3.63/2.5 = 1.45$. Then,

$f_{br} = \beta W/t^2 = .388 \times 29,800/.234^2 = 211,000$ psi

$f_{sc} = 336,000/2\pi \times 2.5^2 \times .234 = 34,500$ psi

$$MS = \frac{1}{\sqrt{\left(\frac{211,000}{255,000}\right)^2 + \left(\frac{34,500}{117,500}\right)^2}} - 1 = +.19$$

BENDIX PRODUCTS DIVISION
DIVISION OF BENDIX AVIATION CORPORATION
SOUTH BEND, INDIANA, U. S. A.

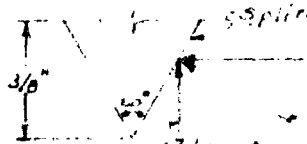
Written by CSA Date 11/22/44
Checked by E.D.G Date 4-8-47
Subject AXLE CLUTCH

Rept. # 313
Page No. 16
No. of Pages 111
Model B-36 N.G.

SPLINE RING

CONDITION 1" CRITICAL

In addition to the loads given on the preceding page, the ring will be subjected to a thrust from the torsion acting thru the teeth. This will be computed, conservatively neglecting the friction acting between the axle, ring, and nut.



1 Spline Tooth

q_t = shear flow from torque

$= q_t / \cos 30°$

Thrust $= q_t \tan 30°$

Tot. Induced Thrust $= 2\pi f q_t \tan 30°$

$= \frac{2\pi \times 2.39 \times 336{,}000 \times .572}{2\pi \times 2.39^2} = 81{,}200$ #

Tot. thrust $= 81{,}200 + 29{,}800 = 111{,}000$ #

$f_c = 111{,}000 / 2\pi \times 2.39 \times .228 = 32{,}400$

$f_{sc} = 336{,}000 / 2\pi \times 2.39^2 \times .228 = 41{,}000$ MS = Amp.

SPLINE TEETH

LOADS - as above

$q'_t = 111{,}000 / .572 \times 36 = 5330$ #/Tooth (Tot from thrust + torque)

M (base of tooth) $= 5330 \times .375/2 = 999$ "#

SECTION PROPERTIES

L_t = tooth length $= .417"$ $t = .228"$ $I/c = Lt^2/6 = .00661$

STRESSES

$f_c = 111{,}000 / 36 \times .417 \times .228 = 32{,}400$

$f_s = 5 \times 5330 / .417 \times .228 = 84{,}000$

$f_b = 999 / .00661 = 151{,}000$ MS = Amp.

B-133

Written by CSA Date 11/25/46
Checked by E.P.G Date 4-8-47
Subject AXLE CLUTCH

Rept # [illegible]
Page No 17
No. of Pages 111
Model B-36 N.G.

BOLTS - PLATE TO WHEEL Ref. Dwg. 67407

CONDITION II CRITICAL
Thrust = 29,800#
Torque = 336,000"#

SECTION PROPERTIES
Consider made from AN 79A12; min. O.D. = .558"; min. R.D. = .45," A = .159

STRESSES
Thrust/bolt = 29,800/8 = 3,720#
Shear/bolt = 336,000/3.63×8 = 11,570#
f_t = 3720/.159 = 23,400
f_s = 11,570/.159 = 72,800
$(f_s)_{max.} = \sqrt{(72,800)^2 + (23,400/2)^2}$ = 74,000
f_{br} (on plate) = 11,570/.234 × .558 = 88,700
f_{br} (on whl.) = 11,570/.558 × .585 = 35,400
(.558 = av. thd. dia. for heli-coil.)
f_s (whl. threads) = 3,720/(.558/2) × .558π = 7,260

ALLOWABLES
F_s (bolt) = 75,000
F_{br} (bolt) = 175,000
F_{br} (magnesium whl.) = 44,000
F_s (" ") = 16,000

MS
Bolt shear MS = 75,000/74,000 − 1 = +1.01

Brg. on whl. MS = 44,000/35,400 − 1 = +.24

Shear, thrds. in whl. MS = 16,000/7,260 − 1 = +1.21

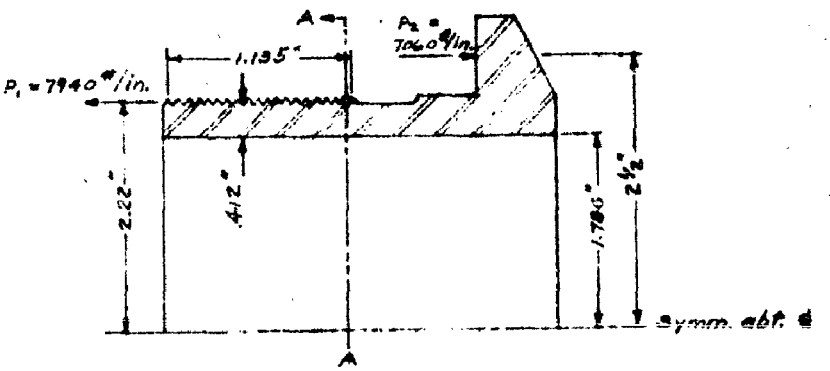
Written by CSA Date 4/4/47
Checked by E.D.G Date 4-8-47
Subject AXLE

Rept. # 813
Page No. 18
No. of Pages 111
Model B-36 N.G.

AXLE NUT Ref. Dwg. 69743

CONDITION II CRITICAL

The nut is subjected to axial tension from spline action and side load, and to hoop compression from thread action.



P_1 = 111,000*/ 2π x 2.22 = 7,940 #/in.

P_2 = 111,000/ 2π x 2.5 = 7,060 #/in.

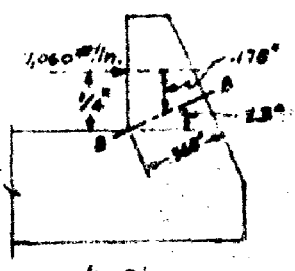
STRESSES - SECT. A-A

Hoop comp = .0919 P/Lt = .0919 x 111,000 / 1.135 x .412 = 21,800

f_t = 111,000/2π x 2.0 x .412 = 21,400

f_s (thrds.) = 7940 / 1.135/2 = 14,000

FLANGE STRESSES - SECT. B-B



M = 7060 x .178 = 1260 #/in.

P_v = 7060 sin 23° = 2760 #/in. P_H = 7060 cos 23° = 6500 #/in.

A = .368" I/C = 1x.368³/4 = .0226

f_b = 1260/.0226 + 2760/.368 = 55,700 + 7500 = 63,200

f_s = 1.5 x 6500/.368 = 26,500

1½ Size

ALLOWABLES - H.T. = 180,000 psi MS = AMS

High energy is maintained to allow for over tightening of nut.

*Spline tooth thrust, ref. p. 16.

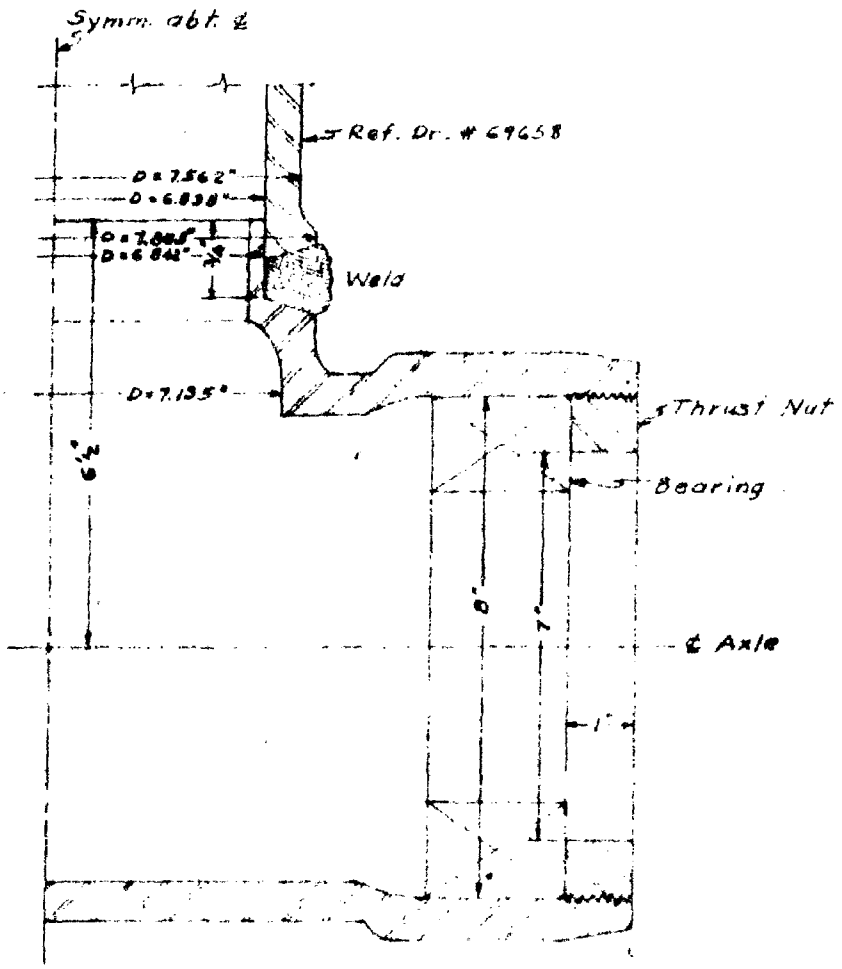
BENDIX PRODUCTS DIVISION

DIVISION OF BENDIX AVIATION CORPORATION
SOUTH BEND, INDIANA, U. S. A.

Written by C.S.A. Date 11/26/46
Checked by E.D.G. Date 4-8-47
Subject AXLE HOUSING

Rept. # 813
Page No. 19
No. of Pages 111
Model B-36 N.G.

Ref. Dwgs. # 69 657, 69 659, & 69 660



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DIVISION OF BENDIX AVIATION CORPORATION
SOUTH BEND, INDIANA, U. S. A.

Written by SSA Date 12/4/46
Checked by E. W. G. Date 4-8-47
Subject AXLE HOUSING

Rept. # 81-
Page No. 20
No. of Pages (1)
Model B-36 N.G.

THRUST NUT Ref. Dwg. 69742

CONDITION 2. CRITICAL.
Thrust = 49,600 #

STRESSES
f_{br} = 49,600/π · 7.5 × .5 = 4210
f_s (on thrds.) = 49600/8.118" × 46 = 1,230
f_c (hoop comp.) = .0919 × 49,600 / 92 × .5 = 9110

ALLOWABLES
H.T. = 170,000 MS = Amp.

NOTE: Sections are weld checked under three variables below.

JACK PAD Ref. Dwg. 69739

LOADS
V = 50,400# D = ± 12,600# S = ± 12,600#

SECTION PROPERTIES
These are for weld only. Stresses in other parts are considered small and not critical.
L = 2" = 6.28" t(av) = 3/16"

STRESSES
Vert ld. taken by direct brg.
Shear = 12,600/.72 = 17,800#

ALLOWABLE H.T. after weld'g.
P × Allows = .48 × 6.28 × 3/16 × 90,000 = 30,800# MS = Amp.

BENDIX PRODUCTS DIVISION

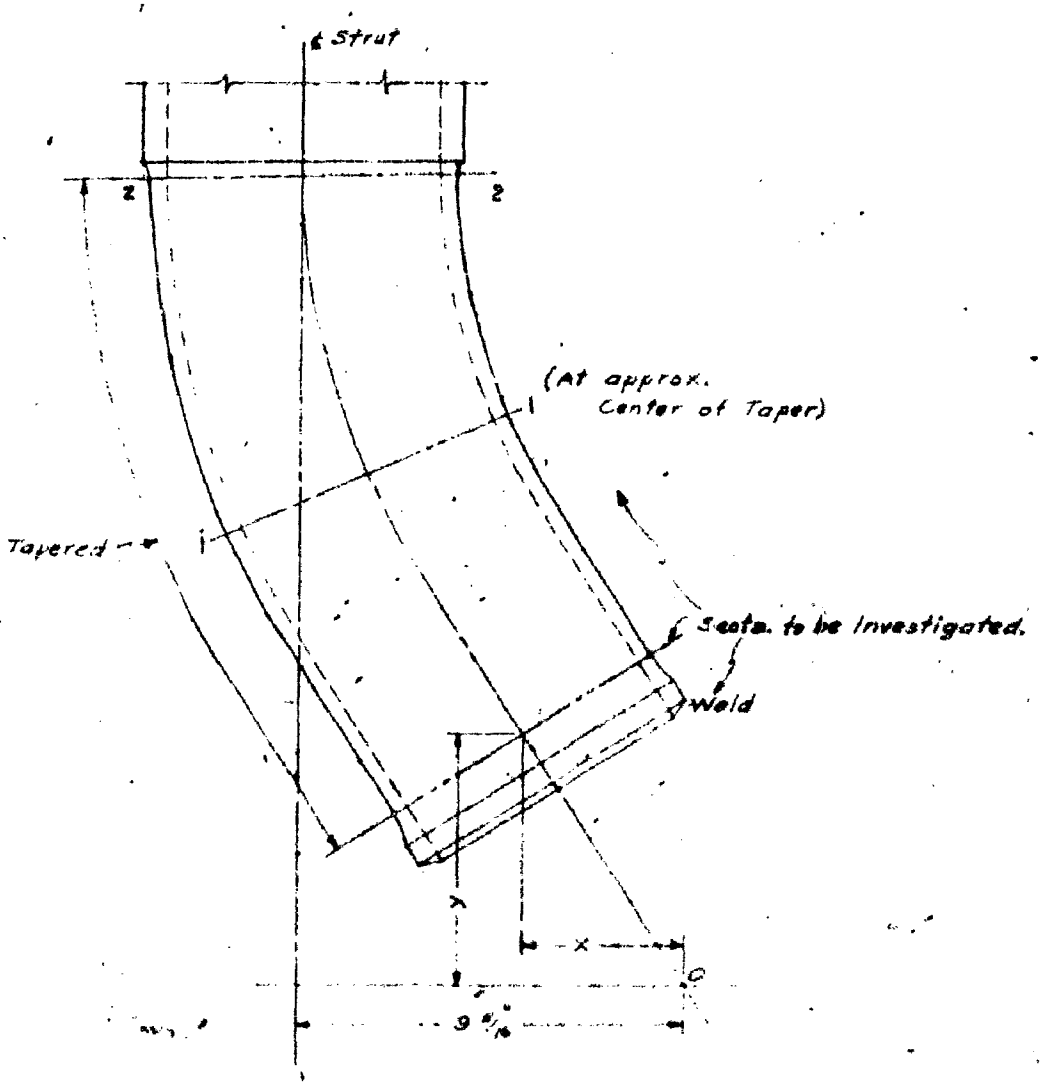
DIVISION OF BENDIX AVIATION CORPORATION
SOUTH BEND, INDIANA, U. S. A.

Written by CSA Date 12/4/46
Checked by G.D.G. Date 1-8-47
Subject INNER CYLINDER

Rept. # 313
Page No. 21
No. of Pages 111
Model B-36 N.G.

SKETCH OF LOWER - BENT PORTION 1/4 Scale

Ref Dwgs. 69458, 69870



B-138

Written by C.S.A. Date 12/5/46
Checked by E.R.G. Date 4-5-47
Subject INNER CYLINDER

Rept. # 813
Page No. 22
No. of Pages 111
Model B-36 N.G.

SECTION AT WELD TO HOUSING

CONDITION 1(C) CRITICAL For Lds, see Appendix

Comp. = 66,200#
Torque = 1,159,000"#
Shear = 81,400#
M = 1,063,000"#

SECTION PROPERTIES

OD = 7.865" ID = 6.842" t = .512" D/t = 15.4 L/D = 5.5
A_s = 11.86 A_{in} = 42.5 I/c = 20.3

STRESSES

f_c = 66,200/11.86 = 5,590
f_{st} = 1,159,000/2 × 42.5 × .512 = 26,600
f_s = 2 × 81,400/11.86 = 13,700
f_b = 1,063,000/20.3 = 52,400

ALLOWABLES

F_c = 90,000 (Ref. Dr. # 69869)
F_{st} = .723 × 90,000 = 65,100
F_s = 1.20 × 65,100 = 78,100
F_b = 110,600 (ANC-5, fig. 4-2a for F_{tu} = 90,000).

MS

R_c = 5,590/90,000 = .062
R_{st} = 26,600/65,100 = .409
R_s = 13,700/78,100 = .175
R_b = 52,400/110,600 = .474

$$MS = \frac{1}{\sqrt{(.474 + .062)^2 + (.409)^2}} - 1 = .48$$

S-123

Written by CSA Date 12/5/46
Checked by E.D.G Date 4-8-47
Subject INNER CYLINDER

SECTION IN PARENT METAL ABOVE WELD

CONDITION I(c) CRITICAL - Use same loads as at welded section; see prec. page.

SECTION PROPERTIES

OD = 7.562" ID = 6.838" t = .362" D/t = 20.9 L/D = 3.5

A_s = 8.09 A_m = 40.7 I/c = 13.97

STRESSES

f_c = 44,200/8.09 = 11,180

f_{st} = 1,159,000/2 x 40.7 x .362 = 39,400

f_s = 2 x 81,400/8.09 = 20,100

f_b = 1,063,000/13.97 = 76,100

ALLOWABLES

F_c = .8 x 205,000 = 164,000

F_{st} = .68 x 164,000 = 111,600

F_s = 1.2 x 111,600 = 134,000

F_b = .8 x 249,000 = 199,200

MS

R_c = 8,180/164,000 = .050

R_{st} = 39,400/111,600 = .353

R_s = 20,100/134,000 = .150

R_b = 76,100/199,200 = .382

$$MS = \frac{1}{\sqrt{(.382+.050)^2 + (.353)^2}} - 1 = +.79$$

Written by CSA Date 12/6/46
Checked by G. D. G Date 4-8-47
Subject INNER CYLINDER

SECTION 1-1

CONDITION 1(C)

Comp. = 74,700#
Torque = 972,000"#
Shear = 68,200#
M = 1,676,000"#

SECTION PROPERTIES

OD = 7.632" ID = 6.838" t = .397" D/t = 17.2 L/D = 3.5
A_s = 9.03 Am = 41.8 I/c = 15.56 x .98* = 15.25

STRESSES

f_c = 74,700/9.03 = 8,300
f_{st} = 972,000/2 x 41.2 x .397 = 29,700
f_s = 2 x 68,200/9.03 = 15,100
f_b = 1,676,000/15.25 = 110,000

ALLOWABLES

F_c = 170,000 [Ref. (5), p. 297]
F_{st} = .696 x 205,000 = 142,700
F_s = 1.2 x 142,700 = 171,300
F_b = 254,000

MS

R_c = 8,300/170,000 = .052
R_{st} = 29,700/142,700 = .208
R_b = 110,000/254,000 = .433

$$MS = \frac{1}{\sqrt{(.433 + .052)^2 + (.208)^2}} - 1 = +.90$$

*Correction for bending is about 2% which changes I/c about 2%.

Written by ESA Date 12/6/46
Checked by G.D.G. Date 4-8-47
Subject INNER CYLINDER

Rept. # 813
Page No. 25
No. of Pages 111
Model B-36 N.G.

SECTION 1-1 (Cont'd)

CONDITION 1(6) CRITICAL

Comp. = 132,900#
Torque = 323,000"#
Shear = 113,700#
M = 2,090,040"#

STRESSES

f_c = 132,900/9.03 = 14,700
f_{sy} = 323,000/2×41.2×.397 = 9,870
f_s = 2×113,700/9.03 = 26,200
f_b = 2,090,000/15.28 = 137,000

MS

R_c = 14,700/170,000 = .087
R_{sy} = 9,870/142,700 = .069
R_s = 26,200/171,300 = .147
R_b = 137,000/254,000 = .539

$$MS = \frac{1}{\sqrt{(.539+.087)^2 + (.069)^2}} - 1 = +.59$$

Written by C.S.A. Date 12/6/46
Checked by E.D.G. Date 4-8-47
Subject INNER CYLINDER

Dept. # 813
Page No. 26
No. of Pages 111
Model B-36 N.G.

SECTION 2-2

CONDITION 1(b) CRITICAL

Comp. = 166,000#
Torque = 155,300"#
Shear = 54,900 #
M = 2,760,000"#

SECTION PROPERTIES

OD = 7.708" ID = 6.838" t = .432" D/t = 17.8 L/D = 3.5
As = 9.82 Am = 41.6 I/c = 16.90 × .98 = 16.56

STRESSES

f_c = 166,000/9.82 = 16,900
f_{sc} = 155,300/2×41.6×.432 = 4,320
f_s = 2×54,900/9.82 = 11,190
f_b = 2,760,000/16.56 = 167,000

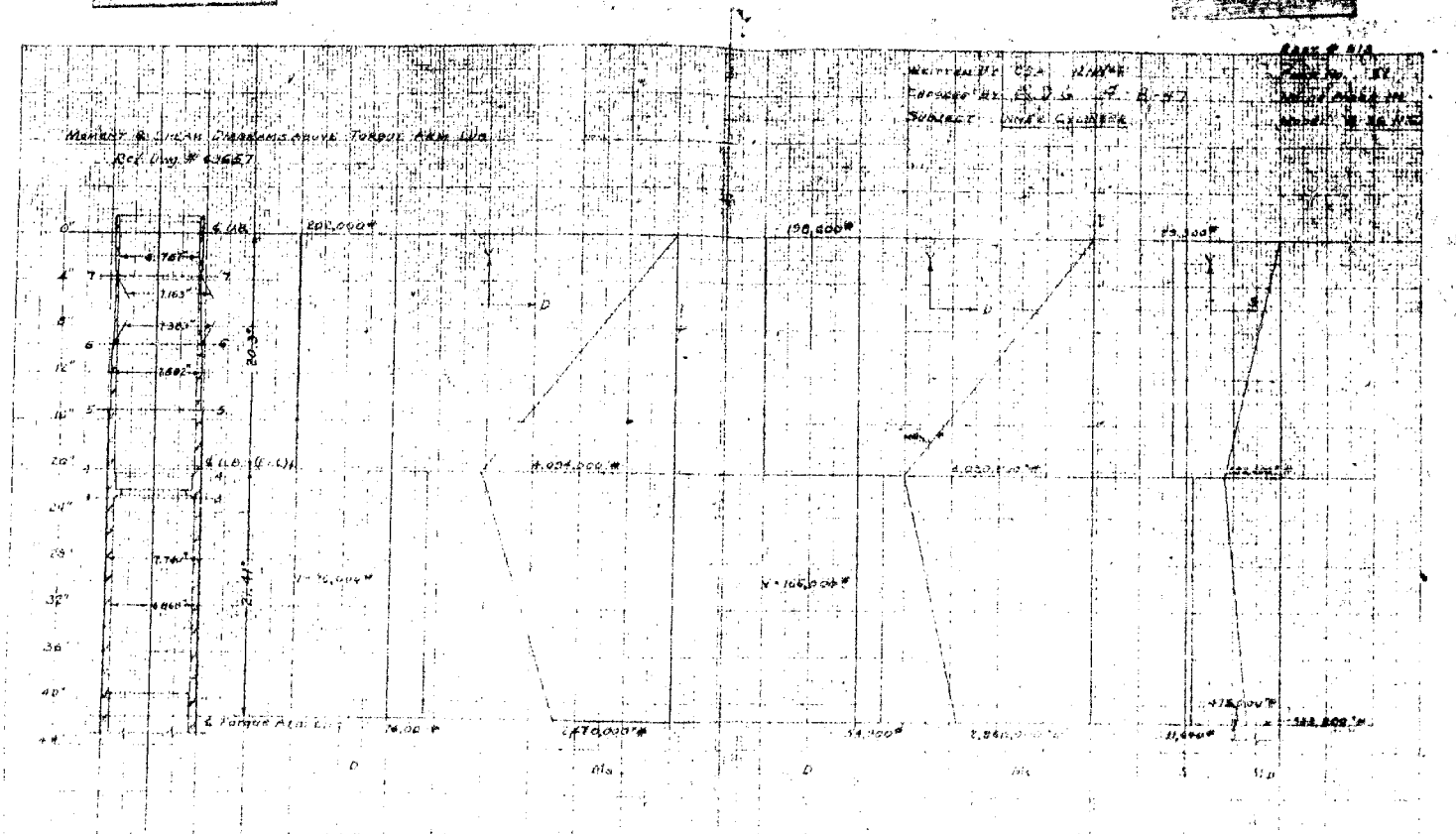
ALLOWABLES

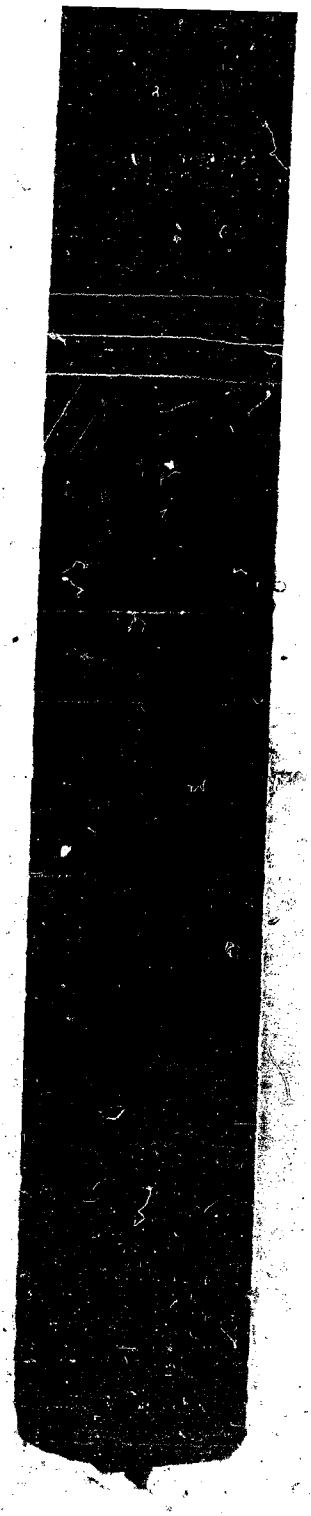
F_c = 170,000
F_{sc} = .704×205,000 = 144,400
F_b = 258,000

MS

R_c = 16,900/170,000 = .099
R_{sc} = 4,320/144,400 = .030
R_b = 167,000/258,000 = .647

$$MS = \frac{1}{\sqrt{(.647+.099)^2+(.030)^2}} - 1 = +.34$$


Market & Ocean Headhouse above Torque Arm Lvl
Rec'd Dwg # 63657
0"
4"
8"
12"
16"
20"
24"
28"
32"
36"
40"
44"
6.78"
7.163"
7.30"
7.882"
7.74"
4.86"
20.35'
21.41'
200,000#
190,600#
43,500#
4,004,000 #
5,020,000 #
V = 76,000#
V = 106,000#
47,000#
54,500#
11,600#
475,000#
382,800'#



BENDIX PRODUCTS DIVISION
DIVISION OF BENDIX AVIATION CORPORATION
SOUTH BEND, INDIANA, U. S. A.

Written by: CSA Date: 12/11/46
Checked by: G.D.G Date: 4-8-47
Subject: INNER CYLINDER

Rept. # 818
Page No. 28
No. of Pages 111
Model B-36 N.G.

SECTION 3-B

CONDITION I(4) CRITICAL

Comp. = 166,000#

Shear = $\sqrt{(\quad,900)^2+(11,640)^2}$ = 56,100#

M_S = 3,880,000"# M_D = 567,000"#

$M = \sqrt{(3,880,000)^2 + (567,000)^2}$ = 3,920,000"#

SECTION PROPERTIES

OD = 7.260" ID = 6.869" t = .4355" D/t = 17.8

A_S = 10.06 I/c = 17.4

STRESSES

f_c = 166,000/10.06 = 16,510

f_s = 2 x 56,100/10.06 = 11,140

f_b = 3,920,000/17.4 = 225,000

ALLOWABLES

F_c = 170,000

F_b = 260,000

MS

R_c = 16,510/170,000 = .097

R_b = 225,000/260,000 = .865

.962

$MS = \frac{1}{.962} - 1 = +.04$

BENDIX PRODUCTS DIVISION
DIVISION OF BENDIX AVIATION CORPORATION
SOUTH BEND, INDIANA, U. S. A.

Written by: CSA Date: 12/11/46
Checked by: C. D. G Date: 4-8-47
Subject: INNER CYLINDER

Rept. # 813
Page No. 28
No. of Pages 111
Model B-36 N.G.

SECTION 3-3

CONDITION I(A) CRITICAL

Comp. = 164,000#

Shear = $\sqrt{(\quad,900)^2+(11,640)^2}$ = 56,100#

M_A = 3,880,900"# M_D = 567,000"#

$M = \sqrt{(3,880,000)^2 + (567,000)^2}$ = 3,920,000"#

SECTION PROPERTIES

OD = 7.240" ID = 6.869" t = .4355" D/t = 17.8

A_c = 10.06 I/c = 17.4

STRESSES

f_c = 164,000/10.06 = 16,310

f_s = 2x 56,100/10.06 = 11,140

f_b = 3,920,000/17.4 = 225,000

ALLOWABLES

F_c = 170,000

F_b = 260,000

MS

R_c = 16,310/170,000 = .097

R_b = 225,000/260,000 = .865

.962

$MS = \frac{1}{.962} - 1 = +.04$

Written by CSA Date 12/11/46
Checked by E.D.G Date 4-8-47
Subject INNER CYLINDER

Rept. # 813
Page No. 29
No. of Pages 111
Model B-36 N.G.

SECTION 4-4

CONDITION 1(6) CRITICAL

Comp. = 166,000#

Shear = $\sqrt{(198,600)^2 + (29,300)^2}$ = 200,600#

M_S = 4,030,000"# M_D = 592,400"#

M = $\sqrt{(4,030,000)^2 + (592,400)^2}$ = 4,070,000"#

SECTION PROPERTIES

OD = 7.740" ID = 6.751" t = .4945" D/t = 15.7

$A_H = \frac{\pi}{4} \times 6.751^2$ = 35.8 A_S = 11.32 I/c = 19.25

STRESSES

p = 166,000/35.8 = 4,640 psi

f_{ss} = 4640 x 7.246/2 x .4945 = 34,000

f_s = 2 x 200,600/11.32 = 35,500

f_b = 4,070,000/19.25 = 211,000

ALLOWABLES

F_{sy} = 112,500*

F_b = 272,000

MS

R_{ts} = 34,000/2 x 112,500* = .153

R_b = 211,000/272,000 = .774

.927

$MS = \frac{1}{.927} - 1 = +.08$

* Failure under internal pressure occurs when shear at outer dia. reaches yield. Ref (4), p. 389.

Written by CSA Date 12/18/46
Checked by E.D.G. Date 4-8-47
Subject INNER CYLINDER

Rept. # 813
Page No. 30
No. of Pages 111
Model B-36 N.G.

SECTION 5-5

CONDITION 1(b) CRITICAL

$p = 4640$ psi (Ref. prec. page)

Shear = 200,600 #

$M_S = 3{,}020{,}000$ "# $M_P = 450{,}000$ "#

$M = \sqrt{(3{,}020{,}000)^2 + (450{,}000)^2} = 3{,}055{,}000$ "#

SECTION PROPERTIES

OD = 7.592" ID = 6.751" $t = .4205$" $D/t = 18.1$

$A_s = 9.42$ $I/c = 16.0$

STRESSES

$f_{sc} = 4640 \times 7.17/2 \times .4205 = 39{,}500$

$f_s = 2 \times 200{,}600/9.42 = 42{,}600$

$f_b = 3{,}055{,}000/16.0 = 190{,}900$

ALLOWABLES

$F_{sy} = 112{,}500$

$F_b = 259{,}000$

MS

$R_{cs} = 39{,}500/2 \times 112{,}500 = .176$

$R_b = 190{,}900/259{,}000 = .737$

$.913$

$MS = \frac{1}{.913} - 1 = +.10$

Written by CSA Date 12/12/46
Checked by E.D.G. Date 4-8-47
Subject INNER CYLINDER

Rept. # 318
Page No. 31
No. of Pages 111
Model B-36 N.G.

SECTION 6-6

CONDITION 1(b) CRITICAL

p = 4,640 psi (Ref. p. 29)

Shear = 200,600#

M_S = 1,900,000 "# M_D = 258,000 "#

$M = \sqrt{(1,900,000)^2 + (258,000)^2}$ = 1,920,000 "#

SECTION PROPERTIES

OD = 7.383" ID = 6.751" t = .316" D/t = 23.4

A_s = 6.99 I/c = 11.83

STRESSES

f_{cp} = 4,640 × 7.07/2 × .316 = 51,900

f_s = 2 × 200,600/6.99 = 57,300

f_b = 1,920,000/11.83 = 162,300

ALLOWABLES

F_{sy} = 112,500

F_b = 242,000

MS

R_{fs} = 51,900/2 × 112,500 = .231

R_b = 162,300/242,000 = .671

.902

$MS = \frac{1}{.902} - 1 = +.11$

Written by C&A Date 11/10/47
Checked by E.D.G Date 4-8-47
Subject INNER CYLINDER

Rept. # 813
Page No. 32
No. of Pages 111
Model B-36 N.G.

SECTION 7-7

CONDITION 1(b) CRITICAL

p = 1440 psi (Ref p. 29)

Shear = 200,600#

M_A = 740,000"# M_B = 110,000"#

$M = \sqrt{(740,000)^2 + (110,000)^2}$ = 748,000"#

SECTION PROPERTIES

OD = 7.168" ID = 6.751" t = .206" D/t = 34.8 L/D = 2.7

A_s = 4.48 I/c = 7.58

STRESSES

f_{bt} = 1440 × 6.96/2×.206 = 48,500

f_s = 2×200,600/4.48 = 89,600

f_b = 748,000/7.58 = 98,700

f_b (pt. max. bending) = (48,500 + 98,700)/2 = 88,600

ALLOWABLES

F_{bu} = 205,000 F_{by} = 112,500

F_{su} = 117,500 F_b = 224,000

F_{sy} = .72 × .61 × 205,000 = 150,000

MS

R_t = 48,500/205,000 = .237
R_{sy} = 89,600/150,000 = .597
R_b = 98,700/224,000 = .437
R_{ss} = 48,500/2×117,500 = .349

MS = $\frac{1}{\sqrt{(.237)^2 + (.597)^2}} - 1 \doteq +.41$

MS = 1.786 = +.27

* In check for local instability, shear is considered to predominate.
Ref. ANC-, par. 1.6.3.3

Written by G.S.A. Date 12/12/46
Checked by [illegible] Date 4-2-47
Subject INNER CYLINDER

Rept. # 813
Page No. 33
No. of Pages 111
Model B-36 N.G.

SECTION THRU BASE OF THREAD NEAR U. UPPER BEARING

CONDITION 7-1(a) CRITICAL

Shear = 202,000# (Critical)

SECTION PROPERTIES

RD = 7.201" ID = 6.751 A_s = 4.95 t = .225" D/t = 32 L/D = 2.9

STRESS

f_s = 2 x 202,000/4.95 = 81,700

ALLOWABLE

F_s = 1.2 x .628 x 205,000 = 154,400 MS = 154,400/81,700 − 1 = 1.89

Rebound load causing possibly some tension on root area is not critical.

UPPER AND LOWER BEARINGS

Ref. Dwgs. 67651, 69672, 69687

CONDITION 7-1(a) CRITICAL

U. Brg. Ld. = 202,000#
L. " " = 278,000#

SECTION PROPERTIES

U. Brg. A = 3.12" x 8.37" = 26.1
L. " " = 5.54 x 7.55 = 41.7

STRESSES

U. Brg. f_{br} = 202,000/26.1 = 7,730 psi
L. " f_{br} = 278,000/41.7 = 6,670 "

Written by C.S.A. Date 12/13/46
Checked by E.D.G. Date 4-8-47
Subject INNER CYLINDER

Rept. # 513
Page No. 34
No. of Pages 111
Model B-36 N.G.

DIAPHRAGM Ref. Dr. # 69669

CONDITION 1(a) or 1(b) CRITICAL
$V = 166,000\#$

SECTION PROPERTIES
$R_2 = 3.928"$ (Spher.) $R_1 = 3.51"$ (Spher.) $t = .418"$ D of Hyd. A. = 6.75"
OD = 6.513" (incl. allowance for chamfer) Bey. ID = 6.383"

STRESSES
Consider to be thick sphere, and use formulas of Ref. (4), p. 264.
$p = 166,000 / \pi \times \overline{6.74}^2 / 4 = 4640$ psi

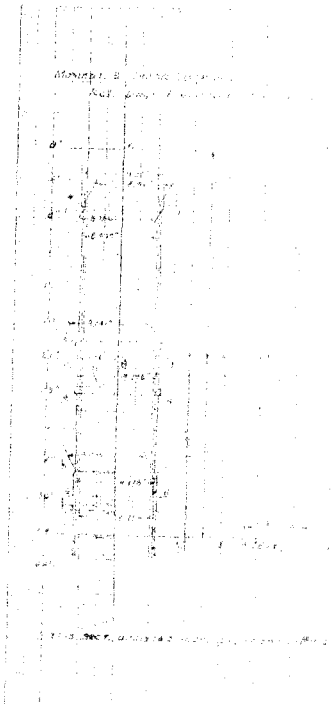
$f_{c\,max.} = p\frac{3R_2^3}{2(R_2^3 - R_1^3)} = \frac{4640 \times 3 \times \overline{3.928}^3}{2(\overline{3.928}^3 - \overline{3.51}^3)} = 24,300$ (at inner surface)

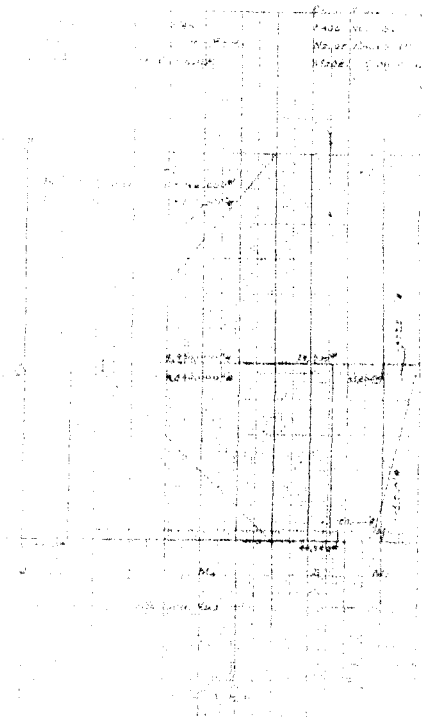
f_c (at outer surface) $= p\frac{R_1^3 + 2R_2^3}{2(R_2^3 - R_1^3)} = \frac{4640(\overline{3.51}^3 + 2 \times \overline{3.928}^3)}{2(\overline{3.928}^3 - \overline{3.51}^3)} = 22,000$

f_{c_3} (" " ") $= p = 4640$
f_s (" " ") $= (22,000 - 4640)/2 = 8,680$
f_s (punching @ R = 2.2") $= 4640 \times \pi \times \overline{2.2}^2 / 2\pi \times 2.2 \times .418 = 12,230$
$f_{br} = 4640 \times \pi/4 \times \overline{6.691}^2 / \frac{\pi}{4}(\overline{6.513}^2 - \overline{6.383}^2) = 85,100$

ALLOWABLES Mat'l. = 17ST
$F_{cu} = 55,000$
$F_{su} = 34,000$
$F_{bru} = 105,000$

$MS = \frac{105,000}{85,100} - 1 = +.23$





Written by CSA Date 12/17/46
Checked by E.D.G Date 4-8-47
Subject OUTER CYLINDER

SECTION 1-1

CONDITION 7-1(a) CRITICAL

Tension = 76,600 #
Shear = 222,000 #
M = 1,560,000"#

SECTION PROPERTIES

OD = 8.756" ID = 8.379" t = .1885" D/t = 46.4 L/D = 2.6
A_s = 5.11 I/C = 10.71

STRESSES

f_t = 76,600/5.11 = 15,000
f_s = 2×222,000/5.11 = 87,000
f_b = 1,560,000/10.71 = 145,600

ALLOWABLES

F_{tu} = 205,000
F_s = 1.2 × .587 × 205,000 = 137,100
F_b = 213,000

MS

R_t = 15,000/205,000 = .073
R_s = 87,000/137,100 = .635
R_b = 145,600/213,000 = .683

$$MS = \frac{1}{\sqrt{(.683 - .073)^2 + (.635)^2}} - 1 = +.$$

*Note: Since this is a check for local instability (see "Introduction"), it is considered safe to neglect the small amount of air pressure present (Ref. p. 53). This is further true since the failure would occur on the compression side of the cylinder, and the R_t is therefore subtracted [Ref. (6)].

Written by CSA Date 12/12/46
Checked by E.D.C Date 4-8-47
Subject OUTER CYLINDER

Report No. 818
Page No. 37
No. of Pages 111
Model B-29 MA

SECTION 2-2

CONDITION 7-1(a) CRITICAL

Tension = 76,600#
Shear = 222,000#
Moment = 4,890,000"#

SECTION PROPERTIES

OD = 9.191" ID = 8.839" t = .376" D/t = 24.3 L/D = 2.8
A_s = 10.28 I/c = 21.6

STRESSES

f_c = 76,600/10.28 = 7,450
f_s = 2 x 222,000/10.28 = 43,200
f_b = 4,890,000/21.6 = 226,000

ALLOWABLE STRESSES

F_{tu} = 205,000
F_s = .42 x .678 x 205,000 = 166,800
F_b = 240,000

M_S

R_t = 7,450/205,000 = .036
R_b = 226,000/240,000 = .942
.978

$MS = \frac{1}{.978} - 1 = +.022$

Written by C.S.A. Date 12/18/46
Checked by G.D.G. Date 4-8-47
Subject OUTER CYLINDER

Report # 818
Page No. 38
No. of Pages 111
Model B-36 N. G.

SECTION 3-3

CONDITION 7-1(a) CRITICAL
Tension = 76,600 #
Shear = 278,000 #
Moment = 5,310,000" (NO DEFLECTION LOAD)

SECTION PROPERTIES
OD = 9.146" ID = 8.379" t = .8335" D/t = 23.9
Assume Sect. as Follows:

$$I = \frac{\pi}{64}\left(\overline{9.146}^4 - \overline{8.379}^4\right) + \frac{4 \times 1 \times \overline{2.76}^3}{36} + 4 \times \tfrac{1}{2} \times 1 \times 2.76 \times \left(\tfrac{2}{3} \times 2.76\right)^2$$

$= 101.7 + 2.33 + 18.67 = 122.70 \quad I/c = 122.70 \times 2/9.146 = 26.9$

$A_3 = \frac{\pi}{4}\left(\overline{9.146}^2 - \overline{8.379}^2\right) + 4 \times \frac{1}{2} \times 1 \times 2.76 = 10.60 + 5.52 = 16.12$

STRESSES
f_t = 76,600/16.12 = 4,750
f_b = 5,310,000/26.9 = 197,300 For shear check, see Sect. 4-4, following page.

ALLOWABLES
F_{tu} = 205,000
F_b = 243,000

MS
R_t = 4,750/205,000 = .023
R_b = 197,300/243,000 = .812
.835

$MS = \frac{1}{.835} - 1 = +.20$

Written by CSA Date 12/18/[illegible]
Checked by E. D.G. Date 4-8-57
Subject OUTER CYLINDER

Report # 818
Page No. 39
No. of Pages 111
Model B-35 N.G.

SECTION 4-4

CONDITION 7-K@ CRITICAL

Shear = 278,000#

M = 4,400,000" #

SECTION PROPERTIES

OD = 9.115" ID = 8.879" t = .388" D/t = 24.8 L/D = 4.8

A_s = 10.13 I/C = 21.3

STRESSES

f_s = 2 × 278,000/10.13 = 54,900

f_b = 4,400,000/21.3 = 206,500

ALLOWABLES

F_s = 1.2 × .690 × 205,000 = 169,800

F_b = 242,000

MS

R_s = 54,900/169,800 = .323

R_b = 206,500/242,000 = .854

$$MS = \frac{1}{\sqrt{(.854)^2 + (.323)^2}} - 1 = +.09$$

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Subject OUTER CYLINDER

Rept # 818
Page No. 49
No. of Pages 111
Model B-36 N.G.

SECTION 5-5

CONDITION 7-1(a) CRITICAL

Shear = 278,000#

M = 2,030,000"#

SECTION PROPERTIES

OD = 8.896 ID = 8.379" t = .2585" D/t = 34.4 L/D = 1.9

A_s = 7.02 I/c = 14.73

STRESSES

f_s = 2 × 278,000/7.02 = 79,200

f_b = 2,030,000/14.73 = 138,000

ALLOWABLES

F_s = 1.2 × .63 × 205,000 = 155,000

F_b = 224,000

MS

R_s = 79,200/155,000 = .511

R_b = 138,000/224,000 = .616

$$MS = \frac{1}{\sqrt{(.511)^2 + (.616)^2}} - 1 = +.38$$

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SOUTH BEND, INDIANA, U. S. A.

Written by CSA Date 12/14/46
Checked by E.D.G. Date 4-8-47
Subject OUTER CYLINDER

Rept. # 818
Page No. 52
No. of Pages 111
Model B-36 N.G.

SECTION 6-6

CONDITION 7-1(a) CRITICAL

Shear = 278,000 #

M = 1,230,000 "#

SECTION PROPERTIES

OD = 9.178" ID = 8.755" t = .2115" D/t = 43.4 L/D = 1.9

A_s = 5.97 I/c = 13.10

STRESSES

f_s = 2 x 278,000 / 5.97 = 93,200

f_b = 1,230,000 / 13.10 = 93,900

ALLOWABLES

F_s = 1.2 x .585 x 205,000 = 143,800

F_b = 214,000

MS

R_s = 93,200 / 143,800 = .648

R_b = 93,900 / 214,000 = .439

$$MS = \frac{1}{\sqrt{(.648)^2 + (.439)^2}} - 1 = +.28$$

B-638

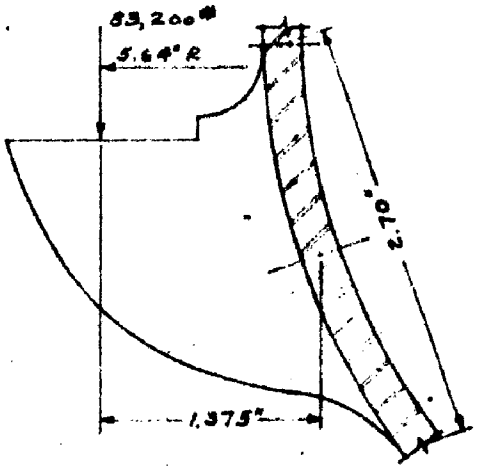
Written by C.S.A. Date 1/20/47
Checked by C.I.G. Date 4-8-47
Subject OUTER CYLINDER

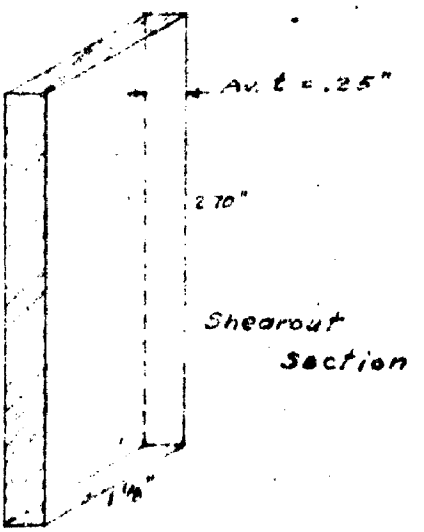
Rept # 918
Page No. 42
No. of Pages 111
Model B-36 N.G.

SHEAROUT OF TORQUE YOKE STOPS

CONDITION I(c) CRITICAL
Ld. = 89,200# (Ref. p. 79)

SECTION PROPERTIES





$$I = \frac{2 \times .25 \times \overline{2.70}^3}{12} + 2 \times 1.125 \times .25 \times \overline{1.35}^2 = .82 + 1.08 = 1.85 \text{ ins.}^4$$

STRESSES

f_s = 89,200 × 1.375 × 1.35/1.85 = 89,500

ALLOWABLES

F_{su} = 157,500 (f.s. to take acct of mod. of rept. effect.)

MS = Amp.

Written by CBA Date 1/21/47
Checked by G.D.G Date 4-8-47
Subject OUTER CYLINDER

Dept. # 813
Page No. 43
No. of Pages 111
Sheet 8-36 N.B.

SHOULDER FOR TORQUE YOKE Ref. Dwgs. # 69679 & 69680

CONDITION 1(C) CRITICAL

(See also p. 79)

M causing brg. on shoulder nut = 35,200 x 11.50 = 405,000"#

SECTION PROPERTIES

Bronze bushing: OD = 10.05" ID (for brg.) = 9.80" R.M. = 9.925"
I/c = 16.8

Cyl. Shoulder:

A = .3 x 1 = .3 $\overline{ins.}^2$/in.
I/c = bh²/6 = 1 x .3²/6 = .015 $\overline{ins.}^3$/in.

STRESSES

P_{max}: (405,000/16.8).225 = 5420#/in.
f_c = 5420 x 1.5/.3 = 27,100
f_b = 5420 x .16/.015 = 57,800

ALLOWABLES

S_{tu} = 205,000 MS = Amp.

* For bushing check, see p. 82.

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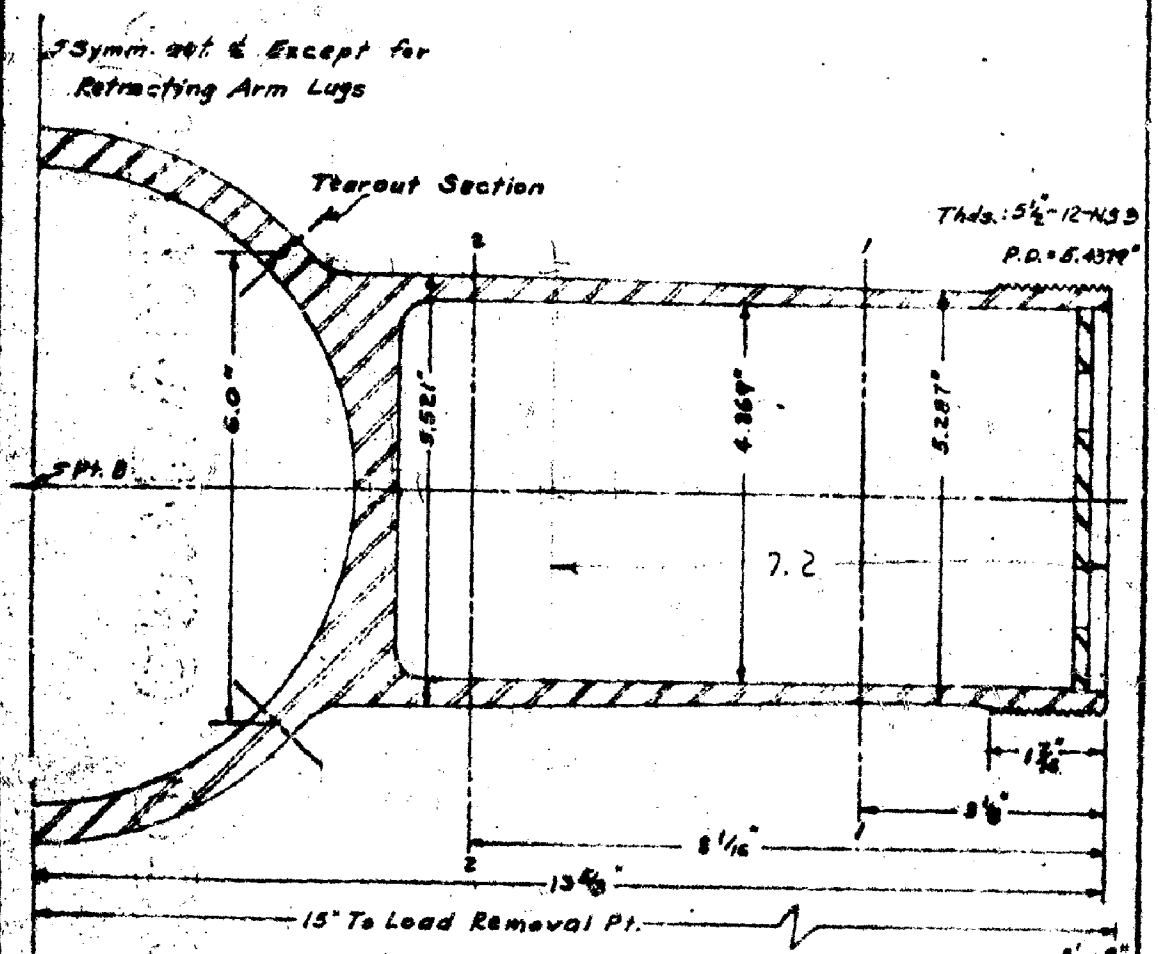
Written by C.S.A. Date 12/20/46
Checked by E.D.G. Date 4-8-47
Subject OUTER CYLINDER TRUNNION

Rept. # 813
Page No. 44
No. of Pages 111
Model B-36 N.G.

SKETCH OF TRUNNION ½ Scale

Ref. Dwgs. # 69677, 69679, 69680



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Written by CSA Date 12/20/46
Checked by G. D. G Date 4-8-47
Subject OUTER CYLINDER TRUNNION

Rept. # 813
Page No. 45
No. of Pages 111
Model B-36 N.G.

SECTION AT THREADS

CONDITION 1(b)

$P_B' = 166{,}700\#$

$S_B' = 0$

$M = 166{,}700\left(15.00'' - 13.625'' + \frac{2\frac{1}{8}''}{2}\right) = 354{,}000''\#$

CONDITION 4(b)

$P_B' = 158{,}900\#$

$S_B' = -24{,}800\#$

$M = 158{,}400 \times 2\frac{1}{8}'' = 336{,}000''\#$

SECTION PROPERTIES

P.D. = 5.438"

Min. screw O.D. = 5.4888" Max. nut I.D. = 5.4188" [Ref (7), pp 1158-6]

h (min. for thrd.) = (5.4888 − 5.4188)/2 = .035"

Assume effective L for thrd. = 1.25"

STRESSES

Because of the short thrd. length with respect to the diameter, little socket action is obtained, and for stress analysis, the bending moment is considered transferred by shear stresses in the thrds. Deformation of the tube is not considered as it is prevented by the bulkhead.

Condition 1(b)

$f_{s\,max.} = 4M/\pi L D^2 = 4 \times 354{,}000/\pi \times .625 \times 5.438^2 = 24{,}400$

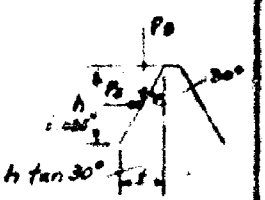
$P_{s\,max.} = 24{,}400 \times .625 = 15{,}250\ \#/in.$

$f_{br}\,(bending) = 15{,}250/.035 \times 1.25 \times 12 = 29{,}000$

$f_{br}\,(direct) = 166{,}700/.035 \times .577 \times 5.438 \times 1.25 \times 12$

$= 101{,}000$

Tot. $f_{br} = 130{,}000$



*Dist. from t. strut to last removal point = 15.00"

Written by C9A Date 12/20/46
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Subject OUTER CYLINDER TRUNNION

Rept # 813
Page No. 46
No. of Pages 111
Model B-36 N.G.

SECTION AT THREADS (Cont'd)

STRESSES (Cont'd)

Condition ~~1(b)~~

$$f_{s\,max.} = \frac{4M}{\pi L D^2} + \frac{S}{\pi D L} = \frac{4 \times 338{,}000}{\pi \times .625 \times 5.438^2} + \frac{24{,}300}{\pi \times 5.438 \times .625}$$

$$= 23{,}300 + 2320 = 25{,}620$$

f_s (Top of thrd.*) = 23,300 − 2320 = 20,980

P_s (" ") = 20,980 × .625 = 13,120 #/in. Cond. 1(b) critical for brg.

Note: Bending + shear on total sect., more critical at Sect. 1-1.

ALLOWABLES

F_{su} = 117,500

f_{br} = 210,000

MS = Amp.

* that is, at top of trunnion barrel.

B-121

Written by C.S.A. Date 12/23/46
Checked by E.D.G. Date 4-8-47
Subject OUTER CYLINDER TRUNNION

Dept. # 813
Page No. 47
No. of Pages 111
Model B-36 N.G.

SECTION 1-1

CONDITION 1(b) CRITICAL

P_B = 166,700#

S_B = 0

M = 166,700 (1 3/8 + 3 1/2) = 750,000"#

SECTION PROPERTIES

OD = 5.287" ID = 4.869" t = .209" D/t = 25.3 L/D = 1.6

A_s = 3.88 I/C = 4.02

STRESSES

f_s = 2 × 166,700/3.30 = 101,100

f_b = 750,000/4.02 = 186,500

ALLOWABLES

F_s = 1.2 × .69 × 205,000 = 169,800

F_b = 239,000

MS

R_s = 101,100/169,800 = .594

R_b = 186,500/239,000 = .780

$$MS = \frac{1}{\sqrt{(.594)^2 + (.780)^2}} - 1 = +.02$$

B-120

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Written by C.S.A. Date 12/23/46
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Subject OUTER CYLINDER TRUNNION

Rep't # 813
Page No. 48
No. of Pages 111
Model B-36 N.G.

SECTION 2-2

CONDITION 1(6) CRITICAL

$P_B' = 166,700$

$S_B' = 0$

$M = 166,700(1\frac{3}{8} + 8\frac{1}{16}) = 1,574,000$ "#

SECTION PROPERTIES

OD = 5.521" ID = 4.869" t = .326" D/t = 16.9 L/D = 1.5

$A_s = 5.34$ $I/c = 6.56$

STRESSES

$f_s = 2 \times 166,700/5.34 = 62,400$

$f_b = 1,574,000/6.56 = 240,000$

ALLOWABLES

$F_s = 1.2 \times .75 \times 205,000 = 184,500$

$F_b = 265,000$

MS

$R_s = 62,400/184,500 = .338$

$R_b = 240,000/265,000 = .905$

$MS = \frac{1}{.905} - 1 = +.10$

Written by C3A Date 12/23/46
Checked by G.D.G Date 4-8-47
Subject OUTER CYLINDER TRUNNION

TEAROUT OF ARM FROM CYLINDER TUBE

CONDITION 1(b) CRITICAL

$P_{81} = 166{,}700$

$M = 166{,}700\ (1\tfrac{3}{8} + 9\tfrac{3}{4}) = 1{,}854{,}000$ "#

SECTION PROPERTIES

OD = 6.0" t = .3135" (Ref. p.38)

Since the sect. is on the surface of a cylinder and measures 6.6" approx. on the curve, the sect. props. will be increased by the ratio 6.6/6.0 = 1.1.

STRESSES

The load will be assumed transferred by shear near the neutral axis, which is at the reinforced portions of the cylinder.

$$f_{s\,max.} = \frac{4M}{\pi D^2 t} = \frac{4 \times 1{,}854{,}000}{\pi \times 6.0^2 \times 1.1 \times .3135} = 155{,}400$$

ALLOWABLES

$F_s = F_{sc} = 157{,}500$ Use F_{sc} to take acct. of modulus of rupture effect.*

$$MS = \frac{157{,}500}{155{,}400} - 1 = +.013$$

* Conservative since effect of thickening of section at cylinder reinforcements is not taken into account in the section properties.

BENDIX PRODUCTS DIVISION

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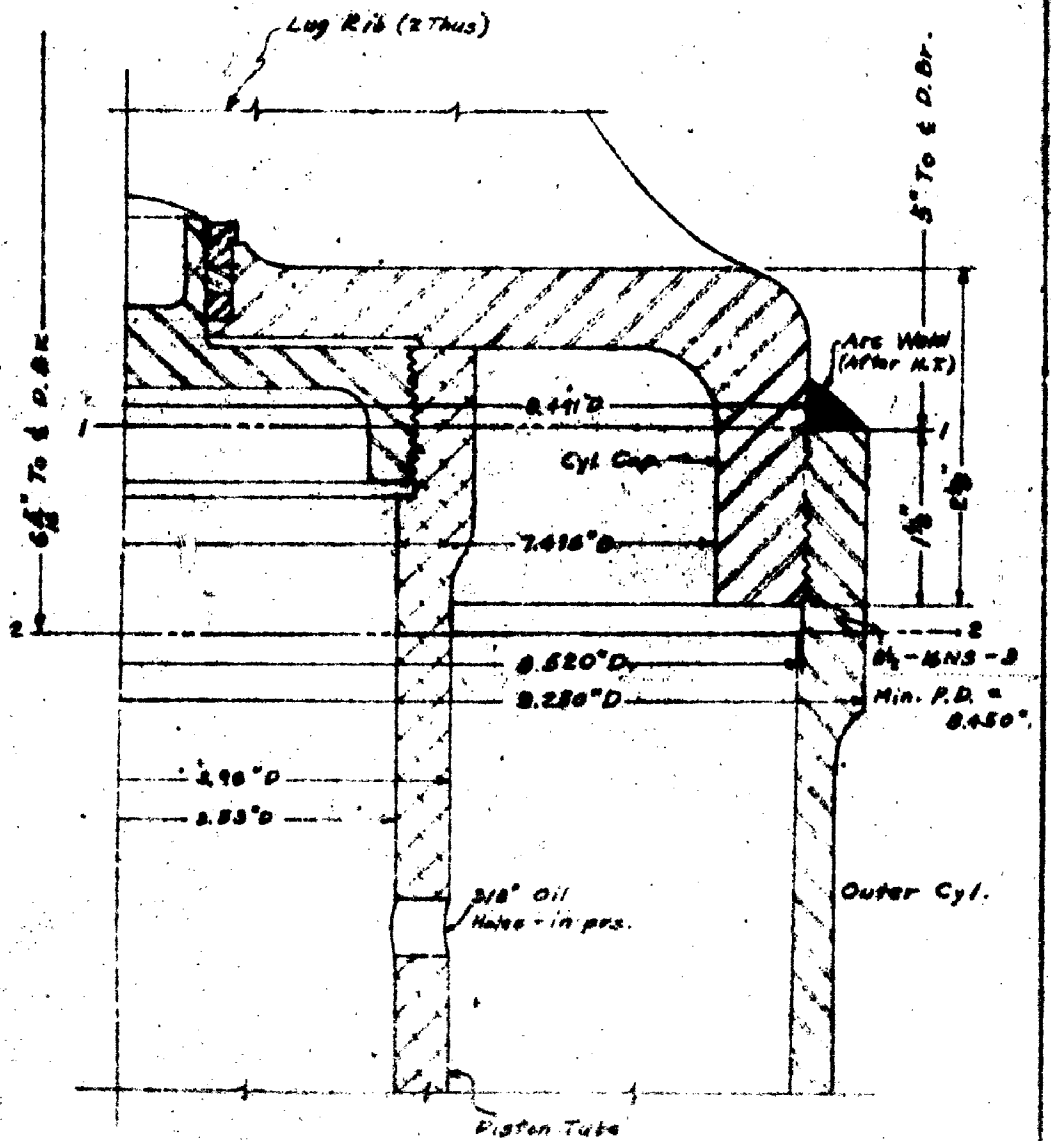
SOUTH BEND, INDIANA, U. S. A.

Written by CSA Date 12/24/46
Checked by E. D. G Date 4-8-47
Subject OUTER CYLINDER UPPER END FITTING

Engr. # 213
Page No. 60
No. of Pages 111
Model B-36 N.G.

SECTION Full Scale Ref. Dwgs. # 69652, 69677, 69678, 69698, 69699



Written by CSA Date 12/29/46
Checked by E.D.G Date 4-2-47
Subject OUTER CYLINDER UPPER END FITTING

Rept. # 813
Page No. 81
No. of Pages 111
Model B-36 N.G.

THREADS - CAP TO CYLINDER

CONDITION 1(b) CRITICAL FOR SHEAR

Thrust = 166,000.
Shear = 203,000
M = 203,000 × 5 9/16 = 1,130,000"#

SECTION PROPERTIES

P.D. = 8.450" Assume effective L = ½ length of thrd. = ½ × 1⅛" = 9/16"
Min. thrd. h (for brg.) = (8.9910 − 8.9403)/2 = .02535" [Ref. (7), pp. 1157-8]

STRESSES

$$f_{s_{max.}}^{*} \text{ (Ind. side)} = \frac{P}{\pi DL} + \frac{6M}{\pi D^2 L} = \frac{166,000}{\pi \times 8.45 \times .5625} + \frac{6 \times 1,130,000}{\pi \times 8.45^2 \times .5625}$$

= 11,120 + 35,980 = 47,020 f_s(aft side) = 35,900 − 11,120 = 24,780

$P_{s_{max.}}$ = 47,020 × .5625 = 26,450 #/in. P_s(" ") = 24,780 × .5625 = 13,940

f_{br} (bend'g + thrust) = 13,940/.02535 × 1.125 × 16 = 30,500 (aft side)

Note: Considerable of the shear can be transferred by the weld thru shear at the N.A. Let us assume ½ transferred thus.

f_s (weld) = 2 × 101,500/π × 8.375 × .375 = 19,400 (a.k., allowable = 48,200)

f_{br} = 101,500/.02535 × .577 × 8.450 × 1.125 × 16 = 45,600 (Ref. p. 45)

Tot f_{br} = 30,500 + 45,600 = 76,100

ALLOWABLES - Weld after N.T.

F_s = 70,000 (For alt. cond. of mod. of rupture effect.)
F_{br} = 125,000.

$$MS = \frac{70,000}{47,020} - 1 = +.49^{**}$$

* The weld is not considered to resist any bending or direct stress at the pt. of max. bending. Computation shows it to be stressed rather highly by the radial stresses between the threads.

** Cond. 7-1(a) more critical for bearing; see following page.

Written by CSA Date 12/31/46
Checked by G.D.G Date 4-8-47
Subject OUTER CYLINDER UPPER END FITTING

Rept. # 213
Page No. 82
No. of Pages 111
Model B-36 N.G.

THREADS - CAP TO CYLINDER (Cont'd)

CONDITION 7-1(a) CRITICAL FOR BEARING

Thrust = 76,600#

Shear = 222,000#

M = 222,000 × $5\frac{9}{16}$ = 1,233,000"#

STRESSES

Note: Some items are computed by proportion from data on preced'g page.

$$f_{s\,max} = \frac{76,600}{\pi \times 8.45 \times .5625} + \frac{4 \times 1,233,000}{\pi \times 8.45^2 \times .5625}$$

= 5,130 + 39,100 = 44,230 (fwd. side)

f_s (aft side) = 39,100 - 5,130 = 33,970

$P_{s\,max}$ (fwd. side) = 44,230 × .5625 = 24,900 #/in.

P_s (aft ") = 33,970 × .5625 = 19,100 #/in.

f_{br} (bend'g + thrust, aft side) = 30,500 × 19,100/13,940 = 41,800

f_{br} (from ½ shear Id., " ") = 48,600 × 111,000/201,500 = 49,900

Tot. f_{br} (" ") = 91,700

ALLOWABLES - See prec. page. MS = $\frac{125,000}{91,700} - 1$ = +.36

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Written by C.S.A. Date 12/26/46
Checked by G.D.G Date 4-8-47
Subject OUTER CYLINDER UPPER END FITTING

Rept. # 813
Page No. 53
No. of Pages 111
Model B-36 N.G.

WELD - AIR PRESSURE CHECK

Static Ld. = 28,700#

O.D. inner cyl. = 7.740" (Ref. p. 27)

A " = $\frac{\pi}{4} \times 7.74^2 = 47.1$

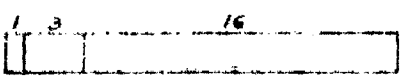
Static Air Press. = 28,700/47.1 = 610 psi

Compression Ratio = 4-1 (Ref. Dwg. # 69450)

Fully Compressed Air Press. = 610 x 4 = 2440 psi

Weld to withstand 3300 psi (Ref. Dwg. # 69652)

$MS = \frac{3300}{2440} - 1 = +.35$



Fully Extended Air Pressure = 610 x 4/17 = 143.5 psi

B-132

Written by CSA Date 4/4/47
Checked by E D E Date 4-5-47
Subject OUTER CYLINDER UPPER END FITTING

Rept. # 813
Page No. 54
No. of Pages 111
Model B-36 N.S.

SECTION 1-1

CONDITION 1(b) CRITICAL

T_{thread} = 166,000 #

S_{thread} = 203,000 #

M = 203,000 × 5 = 1,015,000 #

SECTION PROPERTIES

OD = RD + PD − .041 = 8.459 − .041 = 8.418 [Ref: 9, p. 157 - A]

ID = 7.416" t = .377" $I_{/c}$ = .69 A_s = 12.11 I/c = 23.1

STRESSES

f_t = 166,000/12.35 = 13,400

f_s = 2 × 203,000/12.35 = 32,900

f_b = 1,015,000/23.1 = 43,900

$P_{s\,max}$ (two sides) = 26,450 #/in. (Ref p. 51)

p = P_s tan 30°/2 = 26,450 × 577/1125 = 13,570 (two sides)

P_s (one side) = (26,700 − 11,120) .5626 = 13,14 #/in.

$p = P_s + f_{t\,(one\,side)} = \frac{13,140 \times 577}{1125} + \frac{191.5}{1125 \times .456} = 1,150 + 10,400 = 12,210$ (all sides)

f_{bs} (two sides) = −(13,570 × 7.912/2 × .497) 2.5 = −27,000 # in 2"

cent. is used since it is known if at the outer fiber as the dist. from the outer end of the thread increases that is up to 2" also the web tends to reduce the ring stress by reducing the radial deflection from thrust outside.

f_{bs} (one side) = −27,000 × 7.912/(13,570) = 25.4 By ratio

f_{cc} (one side) = −27,000 × 11,120/13,570 = −6.0/c by ratio

$f_{sha} = \sqrt{(32,900)^2 + \left(\frac{43,900 + 6,210}{2}\right)^2}$ = 34,300

$f_{t\,min}$ = 34,300 + 13,400 − 6210/2 = 37,800

$f_{t\,max}$ = 47,900 + 13,400 = 51,300

Tension from thrust only.

Written by CSA Date 4/7/47
Checked by [illegible] Date 4-8-47
Subject OUTER CYLINDER UPPER END FITTING

SECTION 1-1 (Cont'd)

ALLOWABLES Weld after H.T.

F_{tu} = 80,000
F_{su} = 50,000
F_{cy} = 42,500 *(See p. 2-7)
F_L = mod. of rupt. for F_{tu} = 80,000
= 100,000

MS

R_s = 34,300/50,000 = .68.6
R_t = 13,400/80,000 = .168
R_b = 43,900/100,000 = .439
R_{nc} (fwd side) = 27,000/2 × 42,500 = .318
R_{nc} (aft side) = 35,400/2 × 42,500 = .417 (f_c at P_c limit on aft side)

$$MS = \frac{\quad}{\quad} / \frac{\quad}{\quad} - 1 = \frac{.168 + .439 + .318}{.925} - 1 = +.08$$

CONDITION 7-1(a)

Thrust = 76,600#
Shear = 222,000#
M = 222,000 × 5 = 1,110,000"#

STRESSES

f_c = 76,600/12.35 = 6,200
f_s = 2 × 22,000/12.35 = 36,000
f_b = 1,100,000/23.1 = 48,000
F_{cmax} (fwd side) = 24,000 #/in. (col. 7 A2
P (fwd side) = 14,900 × .517/1.125 = 12,[illegible]
P_c (aft side) = 19,10[illegible] #/in. (col. 1, A2
P (" ") = 9,100 × .517 + 111,000 = 4,700 + 11,[illegible] = 2,470
1.125 .925 × 9450

Written by CSA Date 4/7/47
Checked by G.D.G Date 4-8-47
Subject OUTER CYLINDER UPPER END FITTING

Rept. # 813
Page No. 86
No. of Pages 111
Model B-36 N.G.

SECTION 1-1 (cont'd)

STRESSES (Cont'd)

f_{hc} (fwd. side) = (12,770 × 7.913/2×.497).25 = -25,400

f_{hc} (aft side) = 25,400 × 21,470/12,770 = -42,700

f_{hc} (N.A.) = 25,400 × 5,130/44,230 = - 2,940 (Ref. p. 52)

$f_{s\,N.A.} = \sqrt{(26,000)^2 + \left(\frac{6200 + 2940}{2}\right)^2} = 36,300$

$f_{ex.} = 36,300 + (6,200 - 2,940)/2 = 37,700$

$f_{s\,max.} = 48,000 + 6,200 = 54,200$

ALLOWABLES - See prec. page.

MS

$R_s = 36,300/50,000 = .726$

$R_t = 6,200/80,000 = .078$

$R_b = 48,000/100,000 = .480$

R_{hc} (fwd side) = 25,400/2×42,500 = .299

R_{hc} (aft ") = 42,700/2×42,500 = .503

$$MS = \frac{1}{.480 + .503 - .078} - 1 = \pm .10$$

.905

S-12a

Written by C.S.A. Date 12/27/46
Checked by E.D.G. Date 4-8-47
Subject OUTER CYLINDER UPPER END FITTING

Rept. # 813
Page No. 57
No. of Pages 111
Model B-36 N.G.

SECTION 2-L

CONDITION 7-1(a) CRITICAL

Thrust = 76,600#

Shear = 222,000#

M = 222,000 × 6 5/16 = 1,401,000"#

SECTION PROPERTIES

OD = 9.250" ID = 8.520" t = .365" D/t = 25.4

A_s = 10.22 I/c = 21.8

STRESSES

f_t = 76,600/10.22 = 7,500

f_s = 2 × 222,000/10.22 = 43,500

f_b = 1,401,000/21.8 = 64,300

p (fwd. side) = 12,770 p (aft side) = 21,470 (Ref. p. 55)

f_{ht} (fwd. side) = (12,770 × 8.885/2 × .365).25 = 38,900

f_{ht} (aft. side) = 38,900 × 21,470/12,770 = 65,800

f_{ht} (N.A.) = 38,900 × 5,130/44,230 = 4,510

$$f_{sNA} = \sqrt{(43,500)^2 + \left(\frac{7500 - 4510}{2}\right)^2} = 43,500$$

f_{tNA} = 43,500 + (7500 + 4510)/2 = 49,505

$f_{t\ max.}$ = 64,300 + 7,500 = 71,800

B-132

Written by C.S.A. Date 2/22/47 — Rept # 8.3
Checked by W. D. M. Date 7-8-47 — Page No. 58
Subject OUTER CYLINDER UPPER END FITTING — No. of Pages 111
Model B-36 N.G.

SECTION 2-2 (Cont'd)

Assume as in Sec. 1-1 - Weld after H.T. but assume some increase because of distance from weld.

F_{tu} = 125,000
F_{su} = 75,000
F_{ty} = 70,000 (See p. 29)
F_b = 139,000

MS

R_t = 7,500 / 125,000 = .060
R_s = 43,500 / 75,000 = .580
R_b = 64,500 / 139,000 = .464
R_{te} (fwd. side) = 38,100 / 2 × 70,000 = .272
" (aft side) = 43,500 / 2 × 70,000 = .468

$$MS = \frac{1}{.464 + .060 + .46} - 1 = \frac{1}{.870} = +.15$$

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Written by CSA Date 12/31/46
Checked by E.D.G Date 4-5-47.
Subject OUTER CYLINDER UPPER END FITTING

Rept # 813
Page No. 59
No. of Pages 111
Model B-36 N.G.

Ref. Drgs. 69677, 69678, 69698, & 69699

111,000# Cond. 7-1/8"

SKETCH OF LUGS (2 THUS) Full Size

R=1.60"

D=2.249"

.20"

1.24"

.86"

B-133

Written by CSA Date 1/2/47
Checked by G.D.G Date 4-8-47
Subject OUTER CYLINDER UPPER END FITTING

CHECK OF LUG - SECTS. a-a & b-b

CONDITION 7-1(a) CRITICAL

Drag Brace Ld. = 222,000# or 111,000# per Lug

SECTION PROPERTIES

Sect. a-a : L = 1.24" t = .476" A = .590"

Sect. b-b : L = 1.24" x = .567" A = .703

STRESSES

f_t = 111,000/2 × .590 = 94,000

f_s = 111,000/2 × .703 = 79,000

f_{br} = 111,000/1.24 × 2.25 = 39,800

ALLOWABLES

F_{tu} = 205,000

F_{su} = 117,500

F_{br} = 210,000

$$MS = \frac{117,500}{79,000} - 1 = +.49$$

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Written by C.J.A. Date 1/2/47
Checked by C. D. G. Date 4-8-47
Subject OUTER CYLINDER UPPER END FITTING

Rept. # 813
Page No. 61
No. of Pages 111
Model B-36 N.G.

SECTION 3-3

CONDITION 7-1(a) CRITICAL

Horiz. Ld. per Lug = 111,000 #
Comp. = 111,000 sin 20° = 38,000 #
Shear = 111,000 Cos 20° = 104,000 #
M = 111,000 × 2.36" = 262,000 "#

SECTION PROPERTIES

$b = 4.74"$ $t = .686"$ $A = 4.74 \times .686 = 3.25$ $I/c = \frac{4.74 \times .686^2}{6} = 2.57$

STRESSES

$f_c = 38{,}000/3.25 = 11{,}700$
$f_b = 262{,}000/2.57 = 102{,}000$
$f_s = 1.5 \times 104{,}000/3.25 = 48{,}000$

ALLOWABLES

$F_{cy} = 205{,}000$ MS • Amp

6-138

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Written by GSA Date 1/2/47
Checked by E.D.G Date 4-8-47
Subject OUTER CYLINDER UPPER END FITTING

Rept # 913
Page No. 62
No. of Pages 111
Model S-56 N.G.

TEAROUT OF LUGS FROM CYLINDER HEAD

CONDITION 7-1(a)

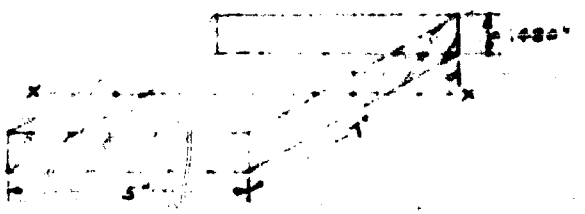
Thrust = 76,600#
Shear = 222,000#
M = 222,000 × 4.25 = 943,000#

CONDITION 1(b)

Thrust = 166,000#
Shear = 203,000#
M = 203,000 × 4.25 = 863,000#

SECTION PROPERTIES

Assumed Tearout Sect:



$A = 2 \times 5 \times .48 + 2 \times 7 \times .48 = 4.80 + 6.72 = 11.52$

$I/c = 2 \times .48 \times \overline{7}^2/6 + 2 \times .48 \times 5 \times 3.50 = 24.6$

Stresses

7-1(a)

$f_{cs} = \frac{76,600}{11.52} + \frac{943,000}{24.6} = 6,700 + 38,300 = 45,000$

$f_{sNA} = 6,700 + 1.5 \times 222,000/11.52 = 6700 + 28,900 = 35,600$

1(b)

$f_{sl} = \frac{166,000}{11.52} + \frac{863,000}{24.6} = 14,400 + 35,100 = 49,500$

$f_{sNA} = 14,400 + 1.5 \times 203,000/11.52 = 14,400 + 26,400 = 40,800$

ALLOWABLES

$F_{cu} = 205,000$

$F_{sl} = 157,500$ (F_{sl} to take acct of type of joint effect.)

$F_{su} = 117,500$

MS = Amp.

Written by C.S.A. Date 1/27/47
Checked by C.D.G. Date 4-8-47
Subject OUTER CYLINDER

Rept. # 813
Page No. 63
No. of Pages 111
Model B-36 N.G.

GLAND NUT Ref. Dwg. # 69688

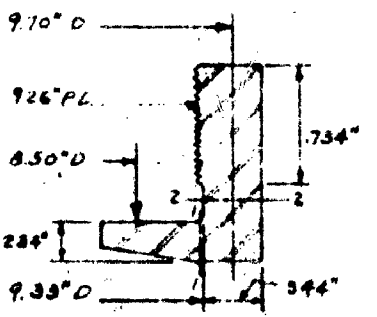
LOADING

P = 4.5 × fully ext. air pressure × area outer cyl.
= 4.5 × 143.5 × $\frac{\pi}{4}$ × $\overline{8.75}^2$ = 38,800# (Ref. p. 53.)

This load will be considered concentrated around circum. of 8.50" dia. circle.

SECTION PROPERTIES

Full cantilever moment will conservatively be assumed.



Sect. 1-1: I/c = 9.39π × $\overline{.734}^2/6$ = .268
A = 9.39π × .284 = 6.87
Sect. 2-2: I/c = 9.70π × $\overline{.344}^2/6$ = .602
A = 9.70π × .844 = 10.5
Threads: A = 9.26π × 734/2 = 10.7

STRESSES

Sect. 1-1: f_b = 38,800(9.39 − 8.50)/2 × .268 = 60,000
f_c = 38,800 × 1.5/6.87 = 8,500
Sect. 2-2: f_b = 38,800(9.70 − 8.50)/2 × .602 = 38,700
f_c = 38,800/10.5 = 3,700
Threads: f_s = 38,800/10.7 = 3,600

ALLOWABLES

F_{cy} = 170,000

MS = Amp.

Written by CSA Date 1/15/47
Checked by G.D.G Date 4-8-47
Subject PISTON

Rept. # 813
Page No. 64
No. of Pages 111
Model B-36 N.B.

PISTON TUBE Ref. p. 50 & Dwg. # 61723

CONDITION 1(a) or 1(b) CRITICAL
Comp. = 166,000 #

SECTION PROPERTIES
OD = 3.96" ID = 2.53" t = .215" D/t = 18.4 L = 22"
A_s = 2.53 ρ = 1.33 L'/ρ = 22/1.33 = 16.5
A_s (at oil holes) = 2.53 - 2 × $\frac{5}{8}$ × .215 = 2.53 - .16 = 2.37

STRESSES
f_c (primary instab.) = 166,000/2.53 = 65,400
f_c (local ") = 166,000/2.37 = 70,000

ALLOWABLES Mat. = 75ST Ref. Revisions to ANC-5, Minutes of April + May, 1946 meetings of ANC-5 Committee.
F_{cy} = 76,000
F_{co} = 1.075 F_{cy} = 81,700

$$F_c = F_{co}\left[1 - \frac{F_{co}(L'/\rho)^2}{4\pi^2 E}\right] = 81,700\left[1 - \frac{81,700 \times 16.5^2}{4\pi^2 \times 10,500,000}\right] = 81,700 \times .946$$

= 77,300

$$MS = \frac{76,000}{70,000} - 1 = +.08$$

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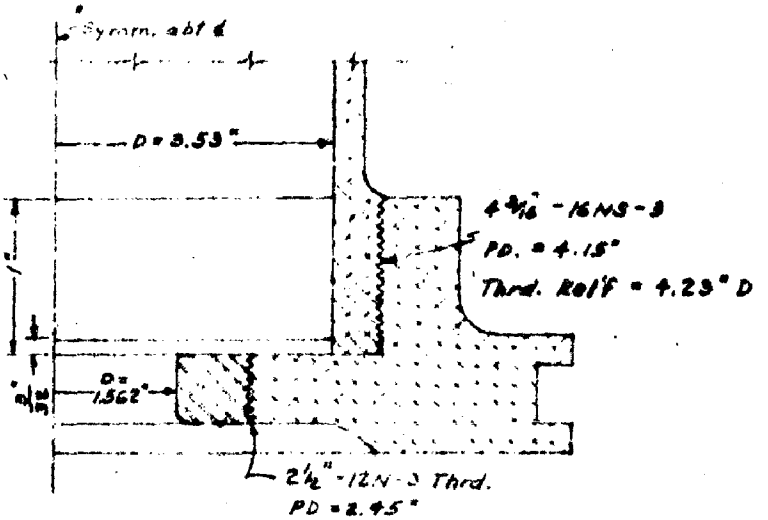
Written by CSA Date 1/3/47
Checked by S.E.G. Date 4-8-47
Subject PISTON

Rept. #813
Page No. 68
No. of Pages 111
Model D-38 N.B.

SKETCH OF ORIFICE PLATE Full Scale Ref. Dwgs. #69724, 69726, 69727



For analysis, the plate will be considered split into circular rings, free at one edge and fixed at the central portion or ring containing the thread for connection to the piston tube. The formulas of ref. (4), pp. 208-9 will be used.

2-138

Written by C.S.A. Date 1/6/46
Checked by C.D.G. Date 4-8-47
Subject PISTON

THREADS CONNECTING ORIFICE RING TO PLATE (Ref. p. 65)

CONDITION (a) or (b) CRITICAL

Hyd. press. = 4,640 psi (Ref. p. 29)

SECTION PROPERTIES

PD = 2.45" ID (of ring) = 1.562" A = 2.80

Assume eff. L of thrd. = .4/2 = .2"

Min. thrd. h = (2.5000 - 2.4188)/2 = .0406"

STRESSES

P = 4640 × 2.80 = 1800#

f_s (thrds.) = 1300/π × 2.45 × .2 = 844 M = Amp.

f_s/in. = 1300/π × 2.45 = 169 #/in.

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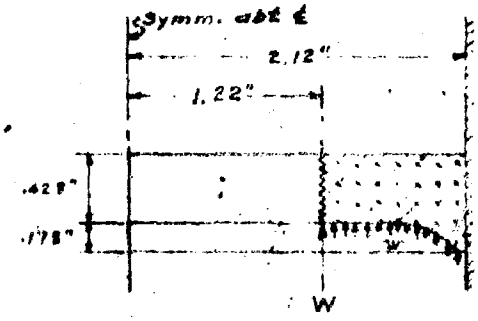
Written by CSA Date 1/6/47
Checked by E. D. G Date 4-8-47
Subject PISTON

Rept. # 813
Page No. 67
No. of Pages 111
Model B-36 N.G.

ORIFICE PLATE - INNER RING



CONDITION 1(a) or (b) CRITICAL

$W = 1300^{\#}$ $w = 4,640$ psi (Ref. prec. page)

SECTION PROPERTIES

$a = 2.12"$ $b = 1.22"$ $a/b = 1.74$ $A = \pi\left(2.12^2 - 1.22^2\right) = 9.42$

STRESSES Ref. (4), p. 209, Cases 17 & 18.

$S_r\,(r=a) = \frac{\beta w a^2}{t^2} + \frac{\beta' W}{t^2}$ Use av. $t = .5$

$= \frac{.364 \times 4640 \times 2.12^2}{.5^2} + \frac{.385 \times 1300}{.5^2} = 30,600 + 1000 = 32,600$

P_s (shear @ a in #/in.) $= (1300 + 4640 \times 9.42)/2\pi \times 2.12 = 3380$ #/in. } Critical

$M_r\,(r=a) = 32,600 \times .5^2/6 = 1360$ #/in.

ALLOWABLES Mat. = 14ST

$F_b = 1.5 \times$ yld. $= 1.5 \times 50,000 = 75,000$ MS - Amp.

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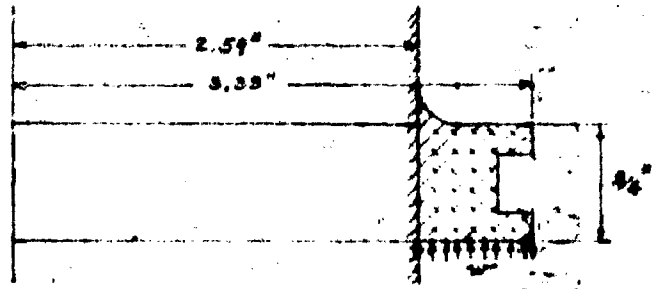
Written by CSA Date 1/6/47
Checked by G. D. G Date 4-8-47
Subject PISTON

Rept. # 813
Page No. 68
No. of Pages 111
Model B-36 N. G.

ORIFICE PLATE - OUTER RING.



CONDITION 1(a) or (b) CRITICAL
$W = 4,640$ psi (Ref. p. 68)

SECTION PROPERTIES
$a = 3.33"$ $b = 2.54"$ $a/b = 1.89$ $A = \pi(3.33^2 - 2.54^2) = 10.8$

STRESSES Ref. (4), p. 209, Case 21.
$S_r\ (r=b) = \beta w a^2/t^2$ Use an $\ell = .80"$
$= .174 \times 4640 \times 3.33^2/.80^2 = 14,400$
P_s (Shear @ b in #/in) $= 4640 \times 13.8/2\pi \times 2.54 = 3940$ #/in. {Not Critical}
$M_r\ (r=b) = 14,400 \times .8^2/6 = 1540$ "#/in.

ALLOWABLES
$F_b = 75,000$ Ref. prec. page MS = Amp.

B-139

BENDIX PRODUCTS DIVISION
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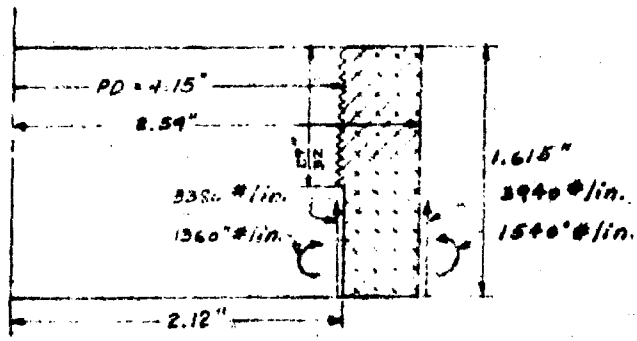
SOUTH BEND, INDIANA, U. S. A.

Written by CSA Date 1/6/47
Checked by E.D.G. Date 4-8-47
Subject PISTON

Rept. # 813
Page No. 69
No. of Pages 111
Model B-36 N.G.

ORIFICE PLATE - MIDDLE RING



CONDITION 1(a) or (b) CRITICAL

For loads as shown above, see pp. 67 & 68. Tot. Thrust = 166,000#

SECTION PROPERTIES

$I/c = .47 \times 1.615^2/6 = .204$ Assume eff. thrd. L = .47"

STRESSES

Torque/in. = 1540 - 1360 + (3940 - 3380) .47/2 = 312 "#

$f_b = Me\,R\,c/I = 312 \times 2.36/.204 = 3830$ [Ref. (4) p. 223]

$f_{bt} = .0919\,F/Lt = .0919 \times 166{,}000/.9 \times 1.7 = 36{,}100$

$f_{hoop} = 36{,}100 - 3330 = 32{,}800$ (Hoop tens. from shear action considered to reduce rapidly from open end of ring.)

ALLOWABLES Mat. = 14ST

$F_{cu} = 65{,}000$

$F_{su} = 40{,}000$

MS = Amp.

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SOUTH BEND, INDIANA, U. S. A.

Written by C.S.A. Date 1/7/47
Checked by C. D. S. Date 4-8-47
Subject PISTON

Rept. # 813
Page No. 70
No. of Pages 111
Model B-36 N.G.

THREADS CONNECTING ORIFICE PLATE TO TUBE

CONDITION 1(a) or (b) CRITICAL
Thrust = 166,000#

SECTION PROPERTIES
The plate threads are critical being made of same strength material.
PD = 4.15" Assume eff. thrd. L = .9/2 = .45"
Min. thrd. h = (4.1780 - 4.1266)/2 = .0257"

STRESSES
Since the plate tends to deflect away from the end of the tube and the tightness of the pins in their holes is uncertain, the threads will be considered to be assumed to take the total load:
f_s = 166,000/ft = 4.15 × .45 = 28,300
f_{br} = 166,000/ft × 4.15 × .025 × 6 × .9 = 35,400

ALLOWABLES Mat. = 14ST
F_{s_a} = 40,000
f_{br} = 124,000

$$MS = \frac{40,000}{28,300} - 1 = +.41$$

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Written by CSA Date 1/7/47
Checked by G.P.G. Date 4-8-47
Subject PISTON

Rept. # 813
Page No. 71
No. of Pages 111
Model B-36 N.G.

CHECK OF PISTON TUBE AT THREADS CONNECTING TO ORIFICE PLATE

CONDITION 1(a) or (b) CRITICAL

Thrust = 166,000 #

SECTION PROPERTIES

RD = 4.18 - .09 = 4.09" ID = 3.53" t = .28" A_s = 3.36 Eff. L = .9"

STRESSES

f_c = 166,000 / 3.36 = 49,400

f_{bc} = .0919 P/Lt = .0919 × 166,000 / .9 × .28 = 60,500

Since both are comp., the combination is not critical.

ALLOWABLES Mat. = 75ST

F_{cy} = 76,000 (Ref. p. 64)

Assume $F_{cb} = F_{cy}$ = 76,000

$$MS = \frac{76,000}{60,500} - 1 = +.26$$

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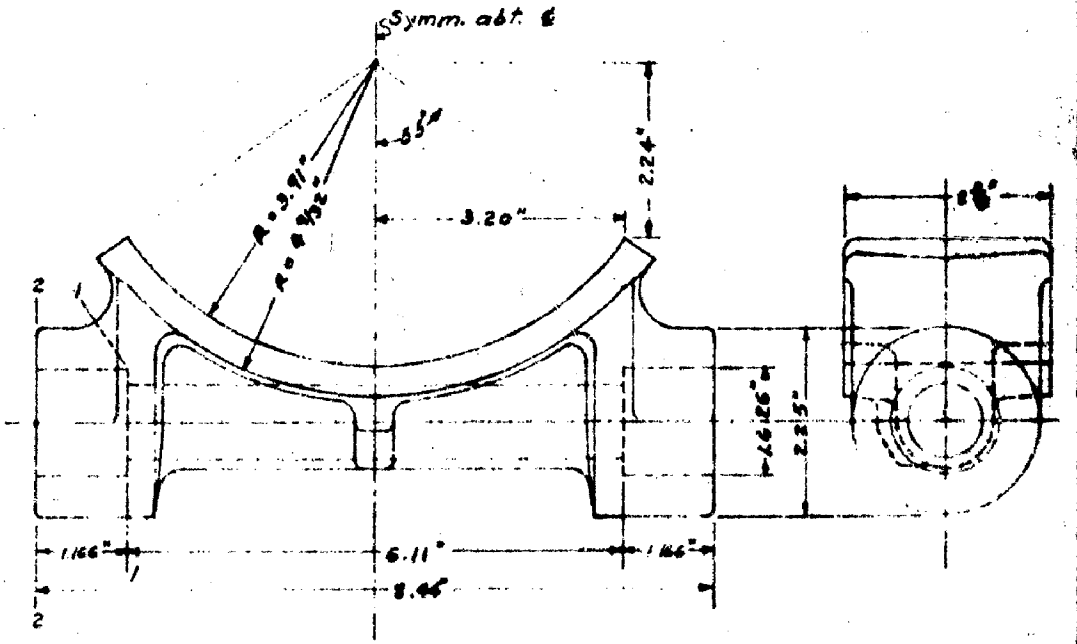
Written by CSA Date 1/8/47
Checked by C.D.G Date 4-8-47
Subject INNER CYLINDER TORQUE FITTING

Dept. # 813
Page No. 72
No. of Pages 111
Model B-36 N.G.

SKETCH ½ Scale Ref. Dwgs. # 69666, 69667, 69657



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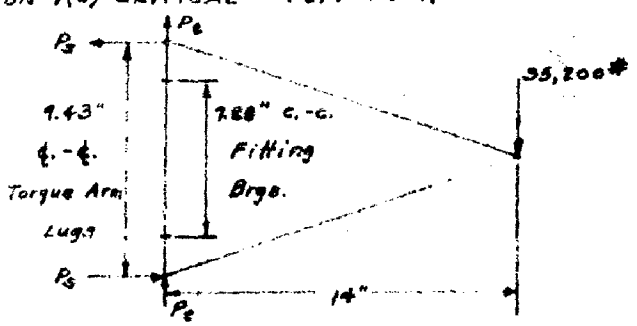
Written by CSA Date 1/8/47
Checked by C.D.G Date 4-8-47
Subject INNER CYLINDER TORQUE FITTING

Rept. # 813
Page No. 79
No. of Pages 111
Model B-26 M.G.

BOLT CONNECTING TORQUE ARM TO FITTING Ref. Dwg. # 69717

CONDITION I(C) CRITICAL Ref. PG 111



$P_s = 35,200 \times 14/9.43 = 52,200$#

$P_t = 35,200/2 = 17,600$#

SECTION PROPERTIES

Bolt D = 7/8" A = .601 $I/c = \pi \times .875^3/32 = .0658$

STRESSES

$f_s = 52,200/.601 = 87,000$

$f_t = 17,600/.601 = 29,300$

$f_{s\,max.} = \sqrt{(87,000)^2 + \left(\frac{29,300}{2}\right)^2} = 88,200$

$f_{t\,max.} = 88,200 + 29,300/2 = 102,850$

$f_{br} = 52,200/.875 \times .75 = 79,600$

ALLOWABLES

$F_{tu} = 180,000$

$F_{su} = 105,000$

$F_{br} = 200,000$

Bearing: $MS = \frac{200,000}{79,600 \times 2.5} - 1 = +.01$

Shear: $MS = \frac{105,000}{88,200} - 1 = +.19$

* Note: Bearing is negative here in accordance with the original design of this joint. Ref. (1), p. 44

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Written by C.S.A. Date 1/16/47
Checked by E.D.G. Date 4-8-47
Subject INNER CYLINDER TORQUE FITTING

Rept # 813
Page No. 74
No. of Pages 111
Model B-36 N.G.

SECTION 1-1

CONDITION 1(c) CRITICAL. See prec. page.

Brg. Ld. = 35,200 × 14/7.28 = 67,700

P_t = 17,600#

M = 67,700 (7.28 − 6.11)/2 = 39,600"#

SECTION PROPERTIES

Lug with its combination considered tube subjected to combined loads.

OD = 2.25" ID = 1.626" t = .312" D/t = 7.2 Brg. d = 1/2"

A_s = 1.90 I/c = .812

STRESSES

f_a = 2 × 67,700/1.90 = 71,300

f_c = 35,200/1.90 = 18,500

p = 67,700/1.626 × 1.125 = 37,000 psi

$f_{hc} = .5^* \frac{2 \times ID^2 \times K^{**}}{OD^2 - ID^2}$ *The .5 coef. is used because the load is shared by the cyl. (Ref. p.54)

$= \frac{1.626^2 \times 37,500}{2.25^2 - 1.626^2} = 40,000$

f_t = 39,600/.812 = 48,700

f_s (S.H.S. f_b) = (18,500 + 40,000 + 48,700)/2 = 53,700

ALLOWABLES

F_{tu} = 205,000 F_c = 170,000 F_{su} = 117,500

F_{by} = 1.2 × .85 × 205,000 = 209,000 F_b = 330,000

MS

R_s = 71,300/209,000 = .341

R_c = 18,500/170,000 = .109

R_M = 48,700/205,000 = .238

R_s (S.H.S. f_s) = 53,700/117,500 = .467**

$MS = \frac{1}{\sqrt{(.341)^2 + (.109 + .238)^2}} - 1 = +1.18$

$MS = \frac{1}{.467} - 1 = +1.13$

** Ref. (7), p. 239

Written by C.S.A. Date 1/16/47
Checked by E.D.G Date 4-8-47
Subject INNER CYLINDER TORQUE FITTING

SECTION 2-7

CONDITION 1(c) CRITICAL

$p = 37{,}000$ psi See prec. page.

SECTION PROPERTIES

OD = 2.25" ID = 1.626"

STRESSES

The lug will be considered a thick cylinder subjected to internal pressure, and checked by the method of Ref. (9), pp. 389-90.

$$f_{hc}\ (@\ OD) = \frac{2\overline{ID}^2 p}{\overline{OD}^2 - \overline{ID}^2} = \frac{2 \times 2.63 \times 37{,}000}{2.43} = 80{,}000$$

$f_c = 18{,}500$ See prec. page

$f_{s\,max.} = (80{,}000 + 18{,}500)/2 = 49{,}250$

ALLOWABLE

$F_{sy} = 112{,}500$

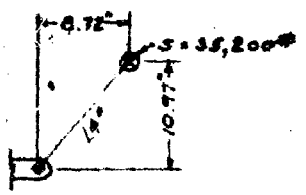
$$M.S. = \frac{112{,}500}{49{,}250} - 1 = +1.28$$

Written by C.S.A. Date 1/16/47
Checked by C.D.G. Date 4-8-47
Subject INNER CYLINDER TORQUE FITTING

Ref. # 813
Page No. 76
No. of Pages 111
Model B-96 N.G.

WELD - LUG TO INNER CYLINDER

CONDITION 1(c) CRITICAL



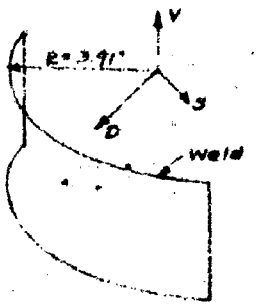
$V = D = 0$

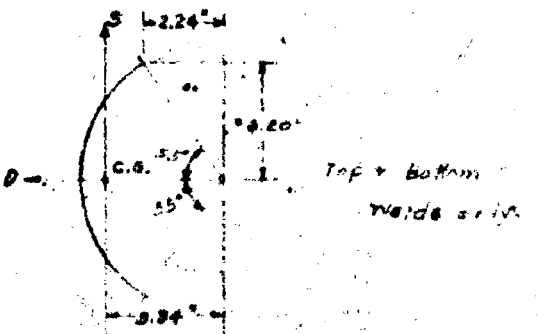
$M_V = 35,200(8.72 + 1.55) = 362,000$ "#

$M_D = 35,200(10.97) = 386,000$ "#

SECTION PROPERTIES

L of weld = $2 \times 2 \times 3.91 \times .960 + 2 \times 2\frac{3}{8} = 15.0 + 4.75 = 19.75$"





Dist. to CG Top + Bott. Welds = $R \sin\alpha/\alpha = 3.91 \times .879/.96 = 3.34$"

" " " all Welds = $15.0 \times 3.34 + 4.75 \times 2.24 / 19.75 = 3.08$"

$I_V = 2R^2(\alpha - \sin^2\alpha/\alpha) + 4x^2$

$= 2 \times 3.91^2(.96 - .879^2/.96) = 2 + 15.0(3.34 - 3.08)^2 + 4.75 \times 3.20^2$

$= 62.2 + 1.0 + 48.7 = 112.0$ ins.^{3}

$I_D = R^2(\alpha - \sin\alpha\cos\alpha) + h^2/12 + 4x^2$

$= 3.91^2(.96 - .879 \times .574) + 2 \times 2.375^3/12 + 2 \times 3.20^2 + 15.0 \times \left(\frac{3.75}{2}\right)^2$

$= 51.6 + 2.2 + 48.7 + 21.1 = 130.6$ ins.^{3}

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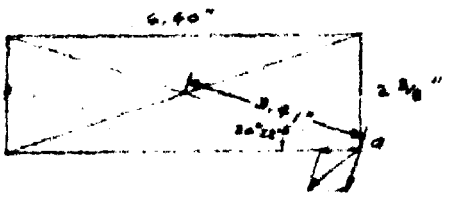
Written by CSA Date 1/10/47
Checked by E.D.G Date 4-8-47
Subject INNER CYLINDER TORQUE FITTING

Rept. # 813
Page No. 77
No. of Pages 111
Model B-96 N.S.

WELD - LUG TO INNER CYLINDER (Cont'd)

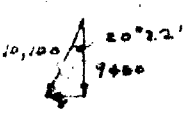
STRESSES Max. at Pt. "a"



$f_S = 35,200/19.75 = 1780$ #/in. (←—)

$f_{SV} = 362,000 \times 3.20/112.0 = 10,300$ #/in.

$f_{SD} = 386,000 \times 3.41/134.4 = 10,100$ #/in



Max. Resultant $f_S = \sqrt{(1780+3520)^2 + (9460)^2 + (10,300)^2}$
$= 15,000$ #/in.

ALLOWABLE Weld before H.T.

Assume min. t for weld = 5/16"

$P = .48 \times 150,000 \times 5/16 = 22,500$ #/in.

$MS = \frac{22,500}{15,000} - 1 = +.50$

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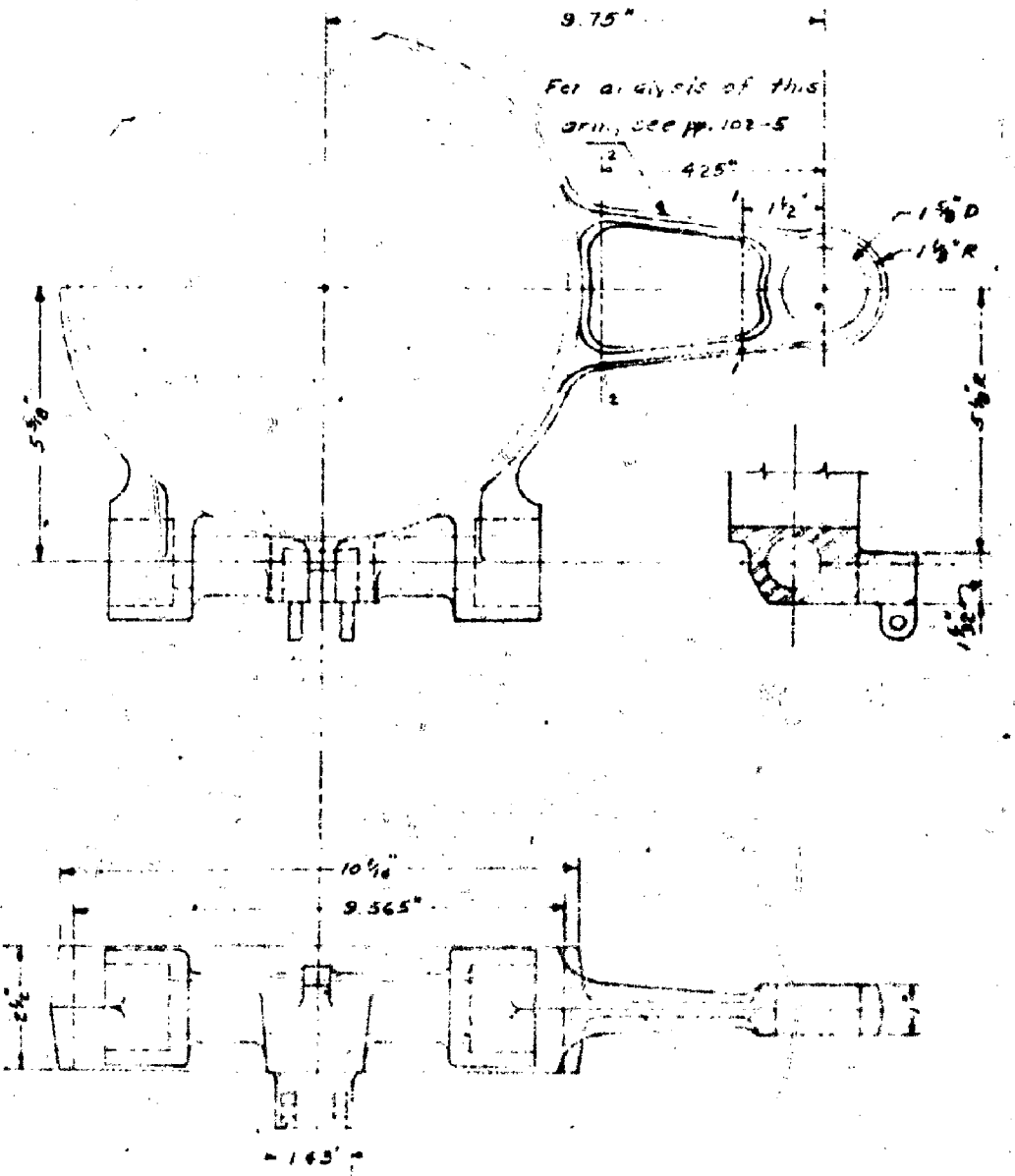
Written by C.S.A. Date 1/16/47.
Checked by C.D.S. Date 4-8-47
Subject TORQUE YOKE

Rept. # 813
Page No. 78
No. of Pages 111
Model B-36 N.G.

SHEET H Ref. Dwgs. # 696-3, 69640, 69691, 69692



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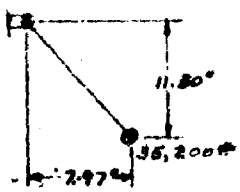
Written by C.S.A. Date 2/12/47
Checked by G.D.G Date 4-8-47
Subject TORQUE YOKE

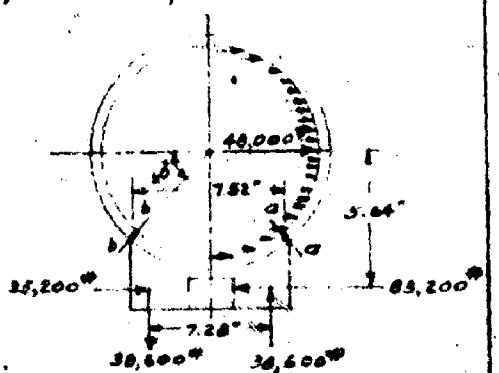
Dept. # 813
Page No. 79
No. of Pages 111
Model B-36 N.G.

Torque arm bolt and fitting lugs are the same as for inner cylinder torque fitting. See pp. 73-75.

TEAROUT OF FITTING FROM YOKE

CONDITION 1(c) CRITICAL V & D = 0 S = 35,200# Torque = 441,000 "#





Ld. on step = 441,000/5.64 = 83,200#

Lds. from Torque Arm

H = 35,200 × 7.97/7.28 = 38,600#

V = 35,200 × 11.50/7.28 = 55,600#

This latter is assumed taken by bearing on the nut and shoulder. Using the distribution as given on p. 43, about 50,000"# of the vert. mom. will be transferred between a-a and b-b. Then,

$V_{a-a} = -V_{b-b} = (105,000 - 50,000)\,7.52 = 47,200\#$

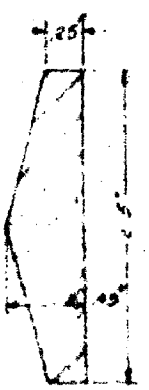
There will be some bending at say a-a due to the big. ld. to the right of the sect., but it is small and not critical.

SECTION PROPERTIES

$$I = \frac{h^3}{48}(b + 4b_1) = \frac{2.5^3}{48}(.18 + 4 \times 2.5) = .334$$

$$A = 2.5(.25 + .09) = .85$$

$$Q_{NA} = .85 \times .456 \times 2.5/2 \times 2 = .242$$



S-1.28

Written by CSA Date 2/12/47
Checked by G.D.G Date 4-8-47
Subject TORQUE YOKE

Rept. # 813
Page No. 80
No. of Pages 111
Model B-36 N.G.

TEAROUT OF FITTING FROM YOKE (Cont.)

STRESSES

Sect. a-a

$f_t = 48,000/.85 = 56,400$

$f_s = 47,200 \times .242/.384 \times .43 = 69,300$

$f_{s max.} = \sqrt{(69,300)^2 + (28,200)^2} = 74,800$

Sect. b-b

$f_t = 38,600 \cos 40°/.85 = 34,$ illegible

$f_s =$ 38, illegible $+ 69,300 = 98,$ illegible

$f_{s max.} = \sqrt{(98,500)^2 + (17,400)^2} = 100,600$

ALLOWABLES

$F_{tu} = 205,000$

$F_{su} = 117,500$

$MS = \frac{117,500}{100,600} - 1 = +.17$

Written by C.S.A. Date 1/20/47
Checked by C.D.C. Date 4-8-47
Subject TORQUE YOKE

Rept. # 819
Page No. 81
No. of Pages 111
Model B-36 N.G.

YOKE STOP

CONDITION 1(c) CRITICAL
Ld. = 83,200# (See p. 79.)

SECTION PROPERTIES
b = 1.02" h = 1.43" A_x = 1.46 I/c = .348
Brg. A (on cyl. stop) = .865 × 1.02 = .882

STRESSES
f_c = 1.5 × 83,200 / 1.46 = 85,400
f_b = 83,200 × .825 / .348 = 197,000
f_{br} = 83,200 / .882 = 94,400

ALLOWABLES Assume H.T. reduced to 200,000
F_{bc} = 115,000
F_b = 1.5 × 165,000 = 247,500
F_{br} = 205,000

$$MS = \frac{247,500}{197,000} - 1 = +.26$$

Written by C.S.A. Date 1/21/47
Checked by G.D.G Date 4-5-47
Subject TORQUE YOKE

Rept. # 813
Page No. 88
No. of Pages 111
Model B-26 N.9.

NUT Ref. Dwg. # 69695

CONDITION 1(c) CRITICAL
$P_{max.}$ = 5420 #/in. (Ref. p. 43)

SECTION PROPERTIES
Assume eff. L = 1/2 × .8 = .4"

STRESSES
f_s = 5420/.4 = 13,600

ALLOWABLES Mat. = 14ST
F_{su} = 65,000
F_{su} = 40,000

MS = Amp.

BUSHING Ref. Dwgs. 69694, 69690

LOADING - See above.

SECTION PROPERTIES
OD = 10.053 ID = 9.697 (Allows for chamfer on torque yoke.)
t = .178"

STRESS
f_{br} = 5420/.178 = 30,500

ALLOWABLE - F_{br} = 80,000 (Ref. 22)

MS = $\frac{80,000}{2.5 \times 30,500} - 1 = +.05$

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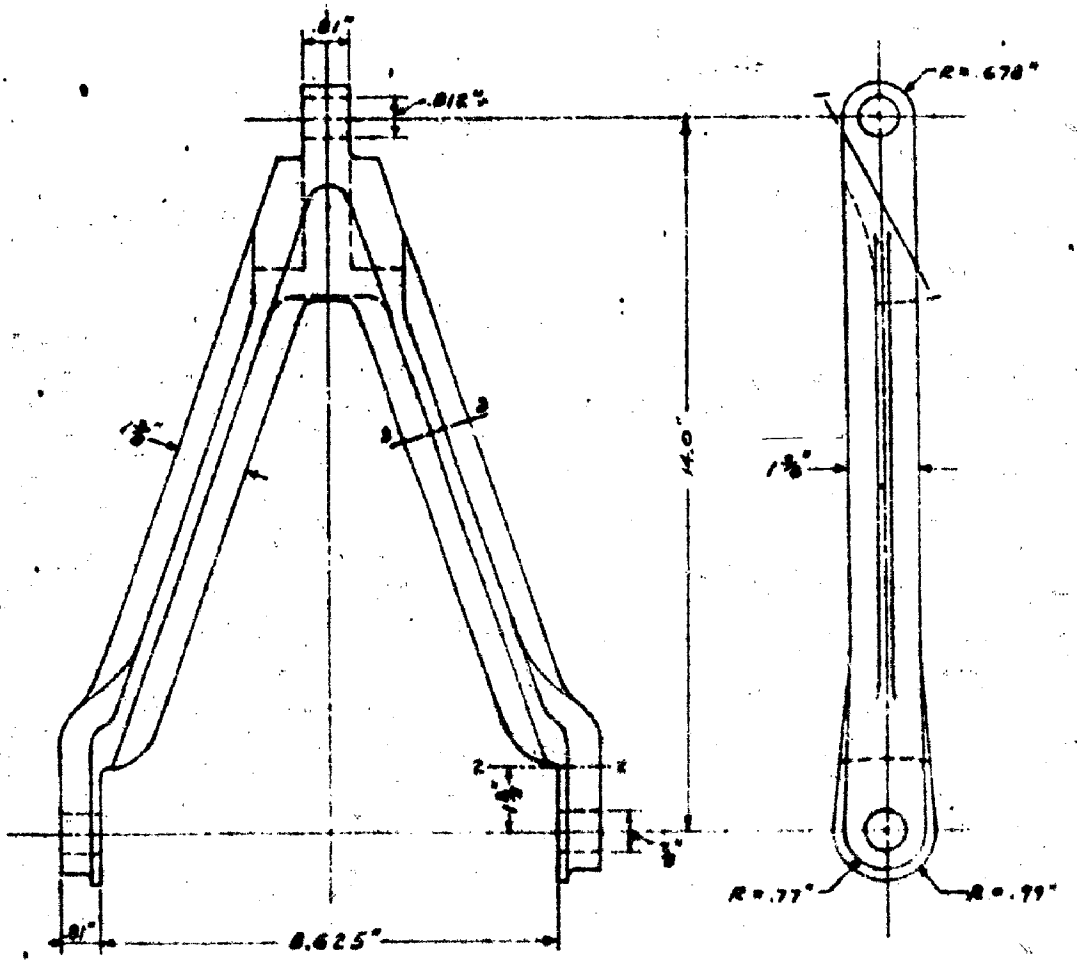
Written by CSA Date 1/22/47
Checked by E.D.G Date 4-8-47
Subject TORQUE ARMS

Rept. # 813
Page No. 93
No. of Pages 111
Model B-36 N.G.

SKETCH - LOWER TORQUE ARM Ref. Dwgs # 69703, 69705, 69878



8-136

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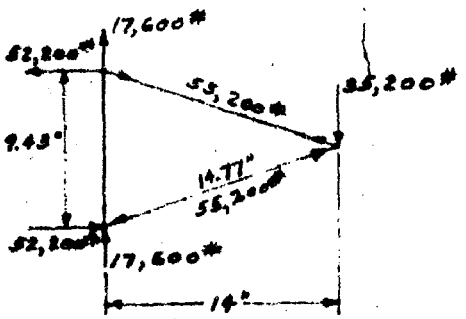
Written by CSA Date 1/22/47
Checked by G.D.G Date 4-8-47
Subject TORQUE ARMS

Rept. # 813
Page No. 84
No. of Pages 111
Model B-35 N.G.

LUGS AT FITTING END

CONDITION 1(c) CRITICAL



Axial Ld. in leg = 35,200 x 14.77/9.43 = 55,200#

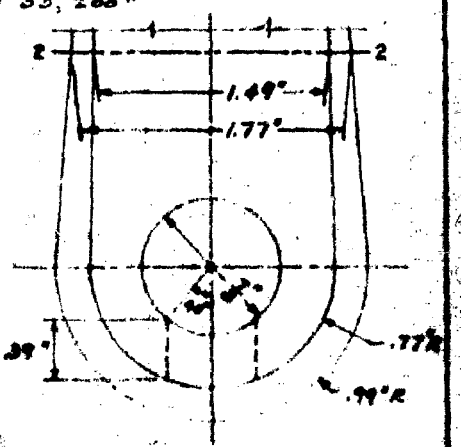
SECTION PROPERTIES See prec. page.

t = .81"

A(tension tearout) = .81(1.54 - .875) = .539

A(shear ") = .81(2 x .89) = .692

A(brg.) = .81 x .875 = .687



STRESSES

f_t = 52,800/.539 = 97,900

f_s = 52,800/.692 = 82,700

f_{br} = 52,800/.687 = 76,800

ALLOWABLES

F_{tu} = 190,000

F_{su} = 110,000

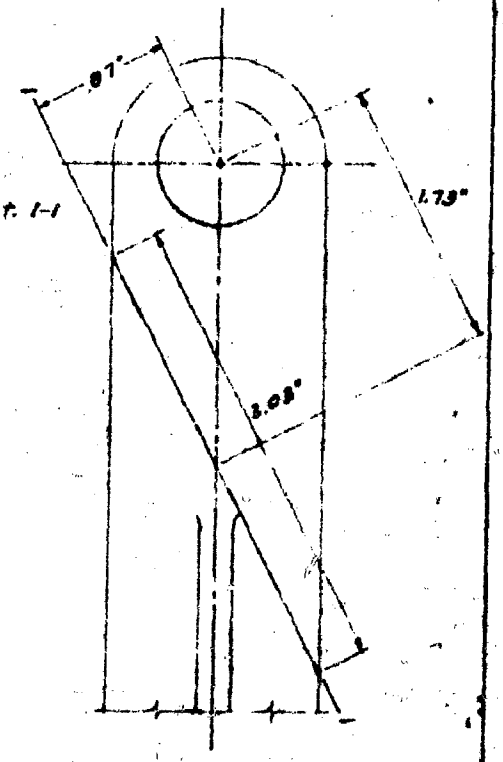
F_{br} = 205,000 (Brg. critical on bolt; see p. 73.)

MS = 110,000/82,700 - 1 = +.33

Written by C.S.A. Date 1/22/47
Checked by G.D.G Date 4-8-47
Subject TORQUE ARMS

Rept. # 813
Page No. 85
No. of Pages 111
Model B-36 N.G.

LUG AT APEX END



CONDITION 1(c) CRITICAL

S = 35,200#

M = 35,200 × .87 = 30,600"# } Sect. 1-1

Torque = 35,200 × 1.73 = 60,900"#

SECTION PROPERTIES

$b = 3.03"$ $h = .81"$

$A_s = 2.46$ $I/c = 3.03 \times .81^2/6 = .331$

STRESSES - SECT. 1-1

$f_a = 1.5 \times 35,200/2.46 = 21,500$

$f_b = 30,600/.331 = 92,300$

$f_{st} = \frac{T}{5}\left(\frac{15b + 9h}{b^2 h^2}\right)$

$= \frac{60,900}{5}\left(\frac{15 \times 3.03 + 9 \times .81}{3.03^2 \times .81^2}\right)$

$= \frac{60,900}{5} \times 1.75 = 107,000$

ALLOWABLES

$F_{cy} = 190,000$ $F_{su} = 110,000$

$F_b = 1.5 \times 165,000 = 247,500$

$F_{sc} = 145,000$

MS

$R_b = 92,300/247,500 = .373$

$R_{sc} = 107,000/145,000 = .738$

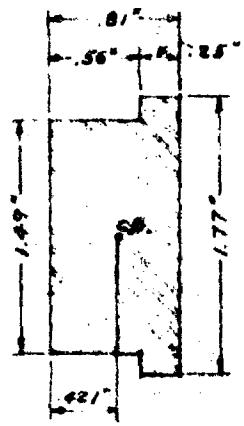
$MS = \frac{1}{\sqrt{(.373)^2 + (.738)^2}} - 1 = +.21$

BENDIX PRODUCTS DIVISION
DIVISION OF BENDIX AVIATION CORPORATION
SOUTH BEND, INDIANA, U. S. A.

Written by CSA Date 1/23/47
Checked by G.D.G Date 4-8-47
Subject TORQUE ARMS

Rept # 813
Page No. 86
No. of Pages 111
Model B-36 N.G.

SECTION 2-2



CONDITION I(C) CRITICAL
For loads, see p. 84.

SECTION PROPERTIES (Ref. pp 83+84)

Section	A	X	AX	AX^2	Each Sect. I_{cc}
1.49 x .56	.834	.28	.234	.0654	.0219
1.77 x .25	.442	.695	.303	.207	.0023
	1.276	.421	.537	.2724	.0242

$S_{NA} = 1.49 \times .421^2/2 = .132$
$I = .2724 + .0242 - 1.276 \times .421^2 = .071$

STRESSES
$M = 17,600 \times 1.37 + 52,200 \times .016 = 25,000$"#
$f_b = 25,000 \times .389/.071 = 137,000$
$f_c = 52,200/1.276 = 40,900$
$f_s = 17,600 \times .132/.011 \times 1.49 = 22,000$

ALLOWABLES
$F_c = F_{cy} \times (n-1)/n = 165,000$
$F_b = 1.5 \times 165,000 = 247,500$

MS
$R_c = 40,900/165,000 = .248$
$R_b = 137,000/247,500 = .553$
$.801$

$MS = \frac{1}{.801} - 1 + .25$

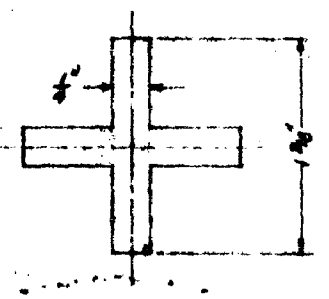
Written by CSA Date 11/23/47
Checked by E. D. G Date 4-8-47
Subject TORQUE ARMS

Rept. # 813
Page No. 37
No. of Pages 111
Model B-36 N.G.

SECTION 3-8

CONDITION I(C) CRITICAL

$P = 55,200\#$ (Ref. p. 84)



SECTION PROPERTIES

Assumed sect. for analysis :-

$A = 1.375 \times .25 + 1.125 \times .25 = .625$

$I = \frac{.25 \times 1.375^3}{12} + \frac{1.125 \times .25^3}{12} = .0557$

$\rho = \sqrt{.0557/.625} = .299$

$L'/\rho = 17/\sqrt{15} \times .299 = 32.8$

STRESS

$f_c = 55,200/.625 = 88,300$

ALLOWABLE

$F_c = 165,000\left[1 - \frac{165,000 \times 32.8^2}{4\pi^2 \times 29 \times 10^6}\right] = 165,000 \times .845 = 139,400$

$MS = \frac{139,400}{88,300} - 1 = +.58$

Written by C.S.A. Date 1/27/47
Checked by E.D.G. Date 4-8-47
Subject CAMS

Rept. # 813
Page No. 11
No. of Pages 111
Model B-36 N.G.

PLUG - UPPER CAM LOCK Ref. Dwgs: # 69675, 69651, 69674

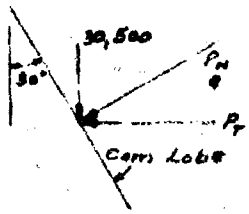
LOADING = Rebound load or 4½ × fully extended air pressure × inner cylinder area.

Rebound P = 24,300#
Fully extended air pressure = 143.5 psi (Ref. p. 53)
$P = 4.5 \times 143.5 \times \frac{\pi}{4} \times 7.75^2 = 30,500$#

SECTION PROPERTIES

OD = .685" RD = .5175" Brg. L = .190"
Shear A = .292 Brg. A = .685 × .190 = .130

STRESSES



$P_N = 30,500 \times 2 = 61,000$#
Ld./plug = 61,000/4 = 15,250#

$f_s = 15,250/.292 = 52,200$
$f_{br} = 15,250/.130 = 117,000$

ALLOWABLES

$F_{tu} = 125,000$
$F_{su} = 75,000$
$F_{brU} = 175,000$

$MS = \frac{75,000}{52,200} - 1 = +.44$

BENDIX PRODUCTS DIVISION

DIVISION OF BENDIX AVIATION CORPORATION
SOUTH BEND, INDIANA, U. S. A.

Written by CJA Date 1/27/47
Checked by G.D.G Date 4-8-47
Subject CAMS

Dept. # 613
Page No. 89
No. of Pages 111
Model B-36 N.G.

REVS - LOWER CAM Ref. Dwgs. # 69685, 69686, 69689

LOADING - See prec. page.

P_T = 30,500 ten 60° = 52,800#

SECTION PROPERTIES

Sect. = $5/16$" × $5/8$" Eff. L = $1\frac{5}{8}$"

Shear A = .312 × 1.625 = .507

Brg. A = .156 × 1.625 = .253

STRESSES

f_s = 52,800 / .507 × 2 = 52,000

f_{br} = 52,800 / .253 × 2 = 104,000

ALLOWABLES

F_{su} = 170,000

F_{su} = 100,000

F_{bru} = 197,000

$MS = \frac{197000}{104,000} - 1 = +.89$

BENDIX PRODUCTS DIVISION

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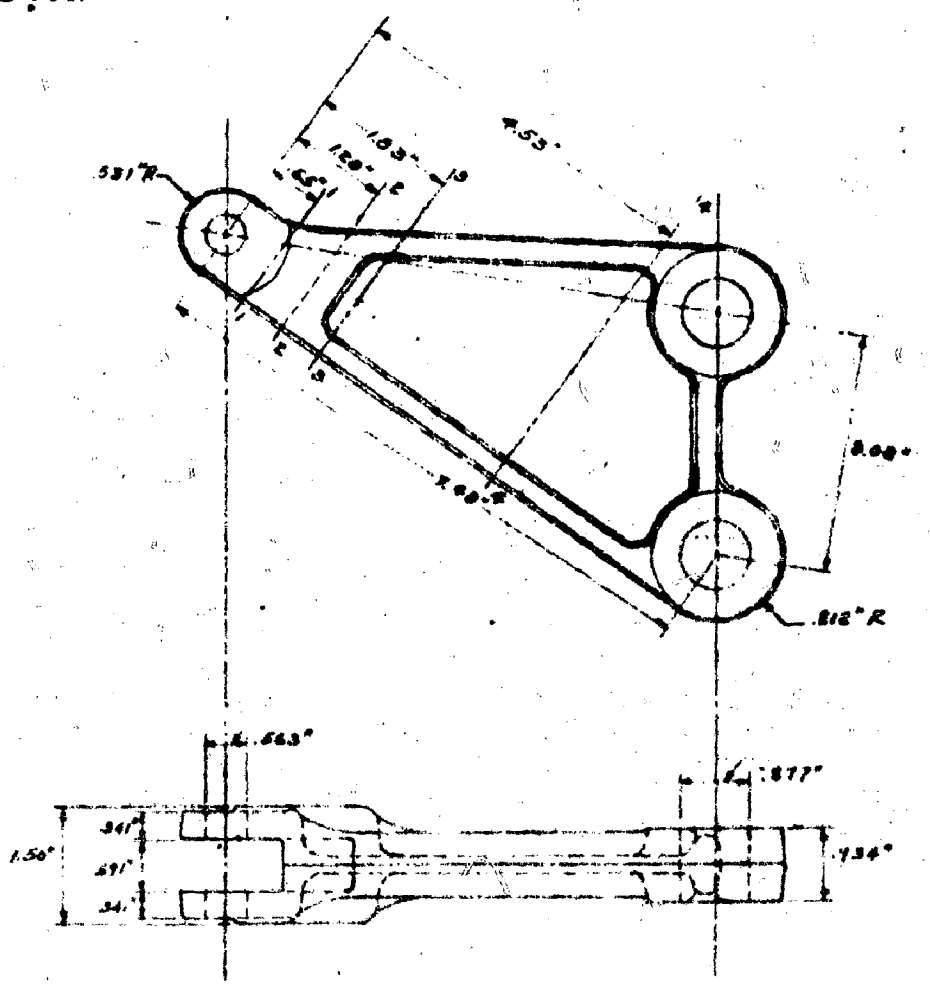
SOUTH BEND, INDIANA, U. S. A.

Written by CSA Date 1/28/47
Checked by E.D.G. Date 4-8-47
Subject RETRACTING LEVER

Rept. # 813
Page No. 90
No. of Pages 111
Model B-36 N.G.

SKETCH Ref. Dwgs. 69730, 69731
½ Scale



Written by CSA Date 12/22/47
Checked by C.D.G Date 4-8-48
Subject RETRACTING LEVER

Rept. # 813
Page No. 91
No. of Pages 111
Model B-36 N.G.

LUG AND BOLT AT JACK ATTACHING POINT

MAX. RETRACTING JACK LOADS

Comp. = 29,200# or
Tension = 21,300# }

These will be assumed to act at any angle which will produce max. stresses in the lever.

SECTION PROPERTIES

Bolt D = 9/16" Brg. A = 2 x .341 x .563 = .384
Shearout A = 4 x .341 x .285 = .389

STRESSES

f_{br} = 29,200/.384 = 76,000
f_s (lug) = 29,200/.389 = 75,000

ALLOWABLES

Bolt = 125,000 H.T. - Single shear P_{all} = 18,630#
F_{bru} = 175,000
F_{su} (lug) = 117,500

MS.

Bolt : $MS = \frac{2 \times 18,630}{29,200} - 1 = +.27$

Lug : $MS = \frac{117,500}{75,000} - 1 = +.57$

Written by CSA Date 1/26/47
Checked by C.D.G Date 4-8-47
Subject RETRACTING LEVER

Repl. # 213
Page No. 92
No. of Pages 111
Model B-36 N.G.

LUGS AND BOLTS AT TRUNNION CONNECTION

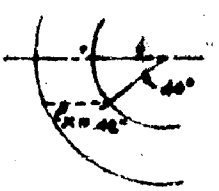
MAX. LOADING (Ref. pp. 90 + 91.)

$P = 39,200 \times 7.46/3.83 = 76,900\#$

SECTION PROPERTIES

Bolt D = 7/8" Brg. A = .875 x .934 = .817

Shearing A = 2 x .42 x .934 = .785



STRESSES

$f_{br} = 76,900/.817 = 94,200$

f_s (lug) $= 76,900/.785 = 98,300$

ALLOWABLES

Bolt = 125,000 H.T. - single shear Ad. = 45,050#

$F_{br} = 175,000$

F_{su} (lug) = 117,500

MS

Bolt:

$$MS = \frac{2 \times 45,050}{76,900} - 1 = +.17$$

Lug "

$$MS = \frac{117,500}{98,300} - 1 = +.20$$

BENDIX PRODUCTS DIVISION
DIVISION OF BENDIX AVIATION CORPORATION
SOUTH BEND, INDIANA, U. S. A.

Written by C.S.A. Date 1/28/47
Checked by C.D.G. Date 4-8-47
Subject RETRACTING LEVER

Rept. # 813
Page No. 93
No. of Pages 111
Model B-36 N.G.

SECTIONS 1-1 & 2-2

LOADING

Shear = 29,200#

Sect. 1-1: M = 29,200 × .65 = 19,000"#

" 2-2: M = 29,200 × 1.28 = 37,400"#

SECTION PROPERTIES

Sect. 1-1: b = 2×.341" h = 1.06" A_s = .723 I/c = .128

" 2-2: b = 2×.405 h = 1.50" A_s = 1.22 I/c = .304

STRESSES

Sect. 1-1: f_s = 29,200 × 1.5 / .723 = 60,600

f_b = 19,000 / .128 = 148,000

Sect. 2-2: f_s = 29,200 × 1.5 / 1.22 = 35,900

f_b = 37,400 / .304 = 123,000

ALLOWABLES

F_{tu} = 205,000

F_{su} = 117,500

F_b = 1.5 × 170,000 = 255,000

$MS = \frac{255,000}{148,000} - 1 = +.72$

BENDIX PRODUCTS DIVISION
DIVISION OF BENDIX AVIATION CORPORATION
SOUTH BEND, INDIANA, U. S. A.

Written by C.S.A. Date 1/29/47
Checked by G.D.G Date 4-8-47
Subject RETRACTING LEVER

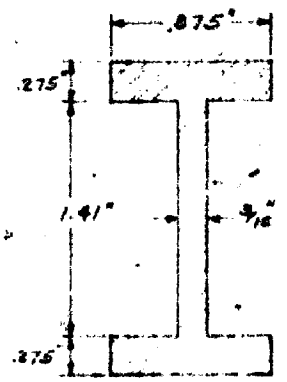
Rept. # 813
Page No. 94
No. of Pages 111
Model B-36 M.G.

SECTION 3-3

LOADING

Shear = 29,200#

M = 29,200 × 1.83 = 53,400"#



SECTION PROPERTIES

Sect. assumed as follows for analysis:

$I = 2\left(\frac{.875 \times .275^3}{12} + .875 \times .275 \times .843^2\right) + \frac{.1875 \times 1.41^3}{12}$

= .0030 + .342 + .0437 = .389

I/c = .389/.98 = .397

Q_{NA} = .875 × .275 × .843 + .706 × .1875 × .352

= .205 + .047 = .252

STRESSES

f_s = 29,200 × .252/.389 × .1875 = 101,000

f_b = 53,400/.397 = 135,000

ALLOWABLES

F_{su} = 205,000

F_{su} = 117,500

F_b = 1.5 × 170,000 = 255,000

$MS = \frac{117,500}{101,000} - 1 = .16$

BENDIX PRODUCTS DIVISION

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SOUTH BEND, INDIANA, U. S. A.

Written by C.S.A. Date 1/29/47
Checked by S.D.G. Date 4-6-47
Subject RETRACTING LEVER

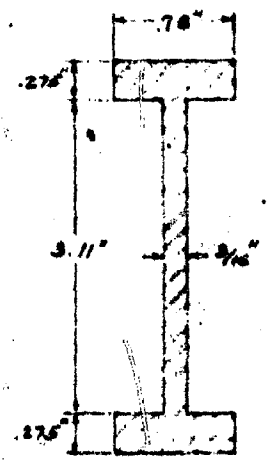
Rept. # 813
Page No. 95
No. of Pages 111
Model B-36 N.G.

SECTION 4-4

LOADING

Shear = 29,200#

M = 29,200 x 4.53 = 132,300"#



SECTION PROPERTIES

Sect. assumed as follows for analysis:

$I = \frac{.78 \times 2 \times .275^3}{12} + 2 \times .78 \times .275 \times 1.693^2 + \frac{.1875 \times 3.11^3}{12}$

$= .003 + 1.233 + .471 = 1.707$

$I/c = 1.707 / 1.83 = .933$

$Q_{NA} = .78 \times .275 \times 1.693 + \frac{1.555^2}{2} \times .1875$

$= .363 + .227 = .590$

STRESSES

$f_s = 29,200 \times .590 / 1.707 \times .1875 = 53,800$

$f_b = 132,300 / .933 = 142,000$

ALLOWABLES

$F_{su} = 205,000$

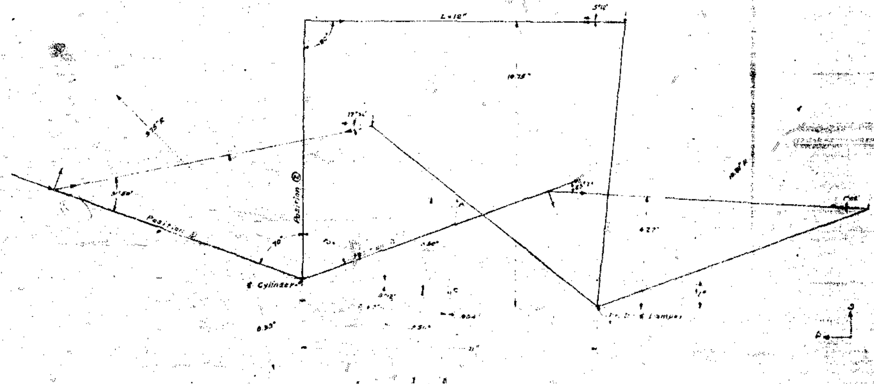
$F_{sy} = 117,500$

$F_b = 255,000$

M.S. = Amp.

Computation shows the section to be safe against lateral instability.

[illegible] DAMPER CONNECTIONS ½ Scale Ref. [illegible]



Notes

[illegible] compressions [illegible]

[illegible]

Max. [illegible] off. dam[illegible] [illegible] at [illegible] position.

[illegible] at [illegible] position

[illegible]

[illegible] attaching bolts [illegible]

[illegible]

[illegible]

[illegible] [Ref. [illegible]]

[illegible]

Written by CSA Date 1/30/47
Checked by G.D.S Date 2-8-47
Subject SHIMMY DAMPER CONNECTIONS

Rept. # 813
Page No. 97
No. of Pages 111
Model B-36 N.G.

LINK LOADS

Position ① $P_D = 285,000/4.27 = 66,700\#$
" ② $P_D = 284,000/10.75 = 27,400\#$
" ③ $P_D = 285,000/8.33 = 34,200\#$

COMPONENTS OF LINK LOADS ⊥ & ∥ TO PLANE OF CONNECTING BOLTS

Position ① $D_D = 66,700 \cos 1°42' = 66,700\#$
$S_D = -66,700 \sin 1°42' = -1,980\#$
Position ② $D_D = 27,400 \cos 5°12' = 27,300\#$
$S_D = -27,400 \sin 5°12' = -2,480\#$
Position ③ $D_D = 34,200 \cos 17°02' = 32,700\#$
$S_D = -34,200 \sin 17°02' = -10,000\#$

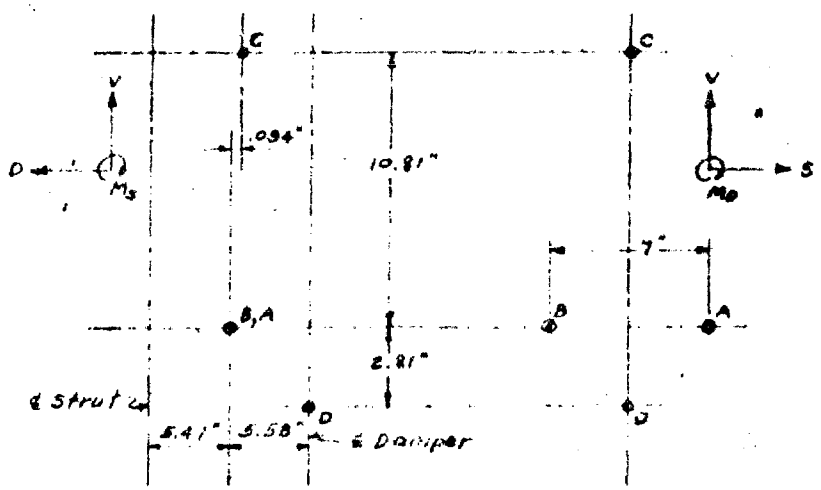
BENDIX PRODUCTS DIVISION

DIVISION OF BENDIX AVIATION CORPORATION
SOUTH BEND, INDIANA, U. S. A.

Written by C.S.A. Date 11/31/41
Checked by C.D.G. Date 4-8-42
Subject SHIMMY DAMPER CONNECTIONS

Rept. # 113
Page No. 98
No. of Pages 111
Model B-36 N.G.

LOADS & MOMENTS ABT. POINT MIDWAY BETWEEN A & B



Position ①

$D = 66,700\#$ $S = -1,980\#$

$M_V = 285,000 - 1,980 \times 5.58 = 273,900"\#$

$M_D = 1,980 \times 2.81 = 5,560"\#$

$M_S = 66,700 \times 2.81 = 187,400"\#$

Position ②

$D = 27,200\#$ $S = -2,480\#$

$M_V = 294,000 - 2,480 \times 5.58 = 280,200"\#$

$M_D = 2,480 \times 2.81 = 6,970"\#$

$M_S = 27,200 \times 2.81 = 76,700"\#$

Position ③

$D = 32,700\#$ $S = -10,000\#$

$M_V = 285,000 - 10,000 \times 5.58 = 229,200"\#$

$M_D = 10,000 \times 2.81 = 28,100"\#$

$M_S = 32,700 \times 2.81 = 91,900"\#$

BENDIX PRODUCTS DIVISION

DIVISION OF BENDIX AVIATION CORPORATION
SOUTH BEND, INDIANA, U. S. A.

Written by C.S.A. Date 1/31/47
Checked by G.D.G. Date 4-8-47
Subject SHIMMY DAMPER CONNECTIONS

Rept. # 813
Page No. 99
No. of Pages 111
Model B-36 N.G.

LUG & BOLT AT PT. C Ref. Dwgs. 69650, 69679-69681

LOADS (Acting on lug)

Position ① D = -187,400/10.81 = - 17,300#
S = 5560/10.81 = 514#

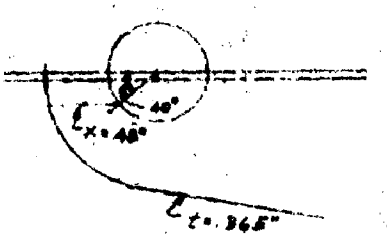
Position ② D = - 76,700/10.81 = - 7,100#
S = 6,970/10.81 = 645#

Position ③ D = -91,900/10.81 = - 8,500#
S = 28,100/10.81 = 2,600#

$P_{max.} = \sqrt{(17,300)^2 + (514)^2} = 17,300$#

SECTION PROPERTIES

Bolt D = 5/8" Brg. A = .625 × .365 = .228
Shearout A = 2 × .49 × .365 = .314



STRESSES

f_{br} = 17,300/.228 = 75,800
f_s (lug) = 17,300/.314 = 55,000

ALLOWABLES

Bolt single shear = 23,000#
f_s (lug) = 117,500

M.S.

Bolt : $MS = \frac{23,000}{17,300} - 1 = +.33$

Lug : $MS = \frac{117,500}{55,000} - 1 = +1.14$

BENDIX PRODUCTS DIVISION
DIVISION OF BENDIX AVIATION CORPORATION
SOUTH BEND, INDIANA, U. S. A.

Written by C.J.A. Date 2/8/47
Checked by G. & D.G. Date 4-8-47
Subject SHIMMY DAMPER CONNECTIONS

Rept. # 313
Page No. 100
No. of Pages 111
Model C-36 N.G.

LUG & BOLT AT PT. A Ref. Dwgs. 69650, 69679-81, & 155449

LOADS (Acting on lug)

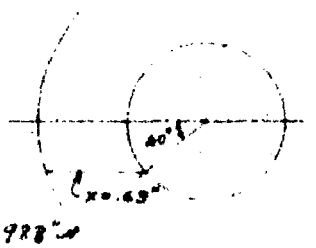
Position ① D = (17,300 + 66,700)/2 + 273,900/7
= 42,000 + 39,100 = 81,100#
S = (-1,980 - 514)/2 = - 1,247#

Position ② D = (7,100 + 27,300)/2 + 280,200/7
= 17,200 + 40,000 = 57,200#
S = (-2480 - 643)/2 = - 1,563#

Position ③ D = (3,500 + 32,700)/2 + 229,200/7
= 20,600 + 32,700 = 53,300#
S = (-10,000 - 2,600)/2 = - 6,300#

Note: These loads can be opposite in sign.

Max. Ld. = $\sqrt{(81,100)^2 + (1,247)^2}$ = 81,200#



SECTION PROPERTIES

Bolt D = .998" A = .783
Brg. A = .998 × .988 = .986
Shearout A = 2 × .63 × .988 = 1.25

STRESSES

f_s (bolt) = 81,200 / 2 × .783 = 51,800
f_{br} = 81,200 / .986 = 82,400
f_s (lug) = 81,200 / 1.25 = 65,000

ALLOWABLES

Bolt: F_{su} = 125,000, F_{su} = 75,000, F_{br} = 175,000
Lug: F_{su} = 117,500

M.S.

Bolt: M.S. = 75,000 / 51,200 - 1 = + .45

Lug: M.S. = 117,500 / 65,000 - 1 = + .81

S-123

BENDIX PRODUCTS DIVISION

DIVISION OF BENDIX AVIATION CORPORATION
SOUTH BEND, INDIANA, U. S. A.

Written by CSA Date 2/10/47
Checked by G.D.C Date 4-8-47
Subject SHIMMY DAMPER CONNECTIONS

Rep't # 813
Page No. 101
No. of Pages 111
Model B-32 N.G.

LUG & BOLT AT PT. B Ref. Dwgs. 69650, 69677-21, & 135448

LOADS (Acting on lug) (See prec. page)

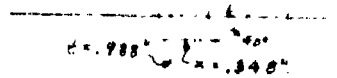
Position ① D = 42,000 - 39,100 = 2,900#
S = -1,247#

Position ② D = 17,200 - 40,000 = -22,800# Max. Ld. = $\sqrt{(22,800)^2 + (1,563)^2}$
S = -1,563# = 22,900#

Position ③ D = 20,600 - 32,700 = -12,100#
S = -6,300#

SECTION PROPERTIES

Bolt D = .498" A = .195
Brg. A = .498 x .988" = .492
Shearout A = 2x.348x.988 = .688



STRESSES

f_s (bolt) = 22,900/2x.195 = 58,700
f_{br} = 22,900/.492 = 46,500
f_s (lug) = 22,900/.688 = 33,300

ALLOWABLES - See prec. page.

MS

Bolt : M.S. = 75,000/58,700 - 1 = +.28

Lug : M.S. = [illegible] = +2.53

BENDIX PRODUCTS DIVISION

DIVISION OF BENDIX AVIATION CORPORATION
SOUTH BEND, INDIANA, U. S. A.

Written by CSA Date 2/10/47
Checked by G.D.G Date 4-8-47
Subject SHIMMY DAMPER CONNECTIONS

Rept. # 813
Page No. 102
No. of Pages 111
Model B-36 N.G.

TORQUE YOKE ARM - Drawing 1-1 (Ref. p. 78)

LOADS (Ref pp. 96+97)

Position ①
P_x = 66,700 cos 23°20' = 61,200#
P_y = 66,700 sin 23°20' = 26,400#

Position ②
P_x = 27,400 cos 90° = 0
P_y = 27,400 sin 90° = 27,400#

Position ③
P_x = 34,200 cos 31°50' = 29,100#
P_y = 34,200 sin 31°50' = 18,100#

SECTION PROPERTIES

Sec. 1 assumed as follows for all 3 positions:

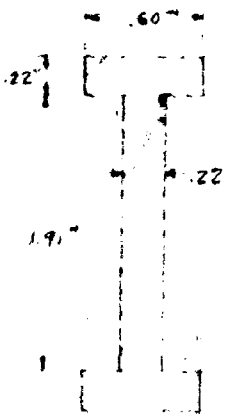
$A = .22 \times 1.91'' + 2 \times .60 \times .22 = .420 + .264 = .684$

$I = \frac{.22 \times 1.91^3}{12} + 2 \times \frac{.60 \times .22^3}{12} + .264 \times .1665^2$

$= .128 + .001 + .300 = .429$

$Q_{NA} = .132 \times .1665 + .210 \times .191/4$

$= .141 + .100 = .241$



STRESSES

f_c = 61,200 / .684 = 89,400

f_t = 26,400 × 1.5 × 1.175 / .429 = 108,400

f_s = 26,400 × .241 / .429 × .22 = 37,200

ALLOWABLES

F_c = 170,000

F_t = 1.5 × [illegible] = 255,000

F_s = 1.15 [illegible]

k_c = [illegible]

F_t [illegible]

[illegible] -1 + .05

B-132

BENDIX PRODUCTS DIVISION

DIVISION OF BENDIX AVIATION CORPORATION
SOUTH BEND, INDIANA, U. S. A.

Written by C.S.A. Date 2/10/47
Checked by G.D.G. Date 4-8-47
Subject SHIMMEY DAMPER CONNECTIONS

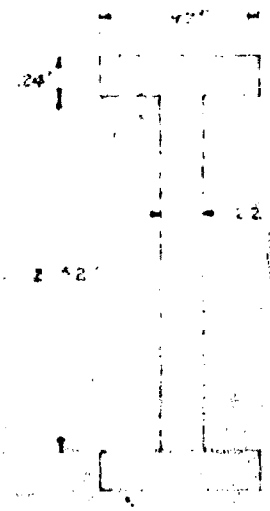
Rept # 813
Page No. 103
No. of Pages 111
Model B-36 N.G.

TORQUE YOKE ARM - SECT. 2-2 (Ref. p. 78)

LOADS (See prec. page.)

P_x = 61,200# P_y = 24,400#

M = 24,400 × 4.25 = 112,200"#



SECTION PROPERTIES

Assume sect a follows for analysis:

$A = 2.52 \times .22 + 2 \times .97 \times .24$

$= .554 + .466 = 1.020$

$I = \frac{.22 \times 2.52^3}{12} + 2 \times .97 \times .24^3 + .466 \times (.38)^2$

$= .293 + .002 + .887 = 1.182$

STRESSES

f_c = 61,200/1.020 = 60,000

f_b = 112,200 × 1.5/1.182 = 142,400

ALLOWABLES

F_c = 170,000

f_b = 1.5 × 170,000 = 255,000

M.S.

$\frac{}{.912}$

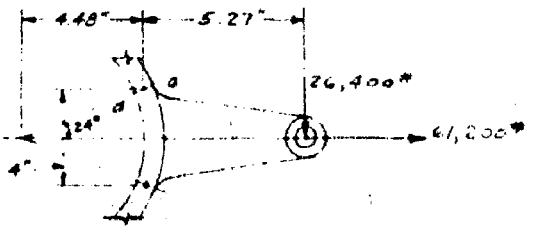
M.S. = .10

Written by GSA Date 2/13/47
Checked by G.D.G Date 4-5-47
Subject SHIMMY DAMPER CONNECTIONS

Rept # 513
Page No. 104
No. of Pages 111
Model B-36 N.G.

TORQUE YOKE ARM - TEAROUT FROM YOKE BARREL

LOADS (Ref. p 102)



$$P_T = 26,400 + \left(\frac{61,200}{2} + \frac{26,400 \times 5.27}{4}\right) \sin 24° = 53,000\#$$

$$P_S = \left(\frac{61,200}{2} + \frac{26,400 \times 5.27}{4}\right) \cos 24° = 59,700\#$$

In addition, there will be a vertical load caused by the [illegible] from the torque arm (Ref. p. 79). Assuming 45% of this [illegible] transferred at the critical sect. a-a, then,

$V_{a-a} = .45 \times 405,000/2 \times 4.48 = 20,300\#$

SECTION PROPERTIES - See p. 79.

STRESSES

$f_t = 53,000/.85 = 62,300$

$f_s = 59,700/.85 + 20,300 \times .242/.284 \times 42 = 100,$[illegible]

$f_{s\,max.} = \sqrt{(100,000)^2 + (31,150)^2} = 104,800$

ALLOWABLES

$F_{su} = 111,500$

M.S. $= \frac{111,500}{104,800} - 1 = +.12$

BENDIX PRODUCTS DIVISION

DIVISION OF BENDIX AVIATION CORPORATION
SOUTH BEND, INDIANA, U. S. A.

Written by GSA Date 2/13/47
Checked by G.D.G Date 4-8-47
Subject SHIMMY DAMPER CONNECTIONS

Rept. # 813
Page No. 105
No. of Pages 111
Model B-36 N.G.

TORQUE YOKE ARM LUG

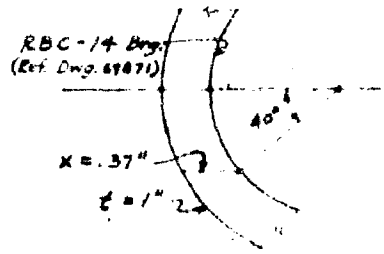
LOADING - P_D = 66,700# (Ref. p. 97)

SECTION PROPERTIES

Bolt D = 7/8"

Brg. A = .875 x 1 = .875

Shearout A = 2 x .37 x 1 = .74



STRESSES

f_{br} = 66,700 / .875 = 76,300 (Not critical)

f_s (lug) = 66,700 / .74 = 90,200

ALLOWABLES

Bolt single shear = 45,050#

F_{su} (lug) = 117,500

MS

Bolt: $MS = \frac{2 \times 44,050}{66,700} - 1 = +.35$

Lug: $MS = \frac{117,500}{90,200} - 1 = +.30$

Written by C.G.R. Date 2/21/47
Checked by C.D.G. Date 4-5-47
Subject

Rept. # 313
Page No. 106
No. of Pages 111
Model B-36 N.G.

APPENDIX

BENDIX PRODUCTS DIVISION

DIVISION OF BENDIX AVIATION CORPORATION
SOUTH BEND, INDIANA, U. S. A.

Written by G2A Date 11/15/46
Checked by E.D.G Date 4-8-47
Subject NOSE GEAR LOADS *

Rept. # 813
Page No. 107
No. of Pages 111
Model B-36 N.G.

CONDITION	OLEO POSITION	V_f	D_f	S_f	LOAD APPLIED AT	COND. No.
3WL/R	FE	168,000	54,900	0	℄ Whl.	1
Side Drift	FE	0	0	±49,600	Ground	4
Bending in Nose Strut	FE	76,600	76,000 -30,650	0	℄ Axle	7-1 7-2
Symm * Static Thrust	Static	58,850	75,800	0	"	9
Ground * Turning	Static	48,420	13,380**	34,810**	Ground	10
Rebound	FE	-24,300	0	0	℄ Whl.	8

* Ref. (1)

** These loads combine to give a resultant side load on the gear = ±36,830#.

* Loads revised 12/2/46, see CVAC letter of 11/22/46.

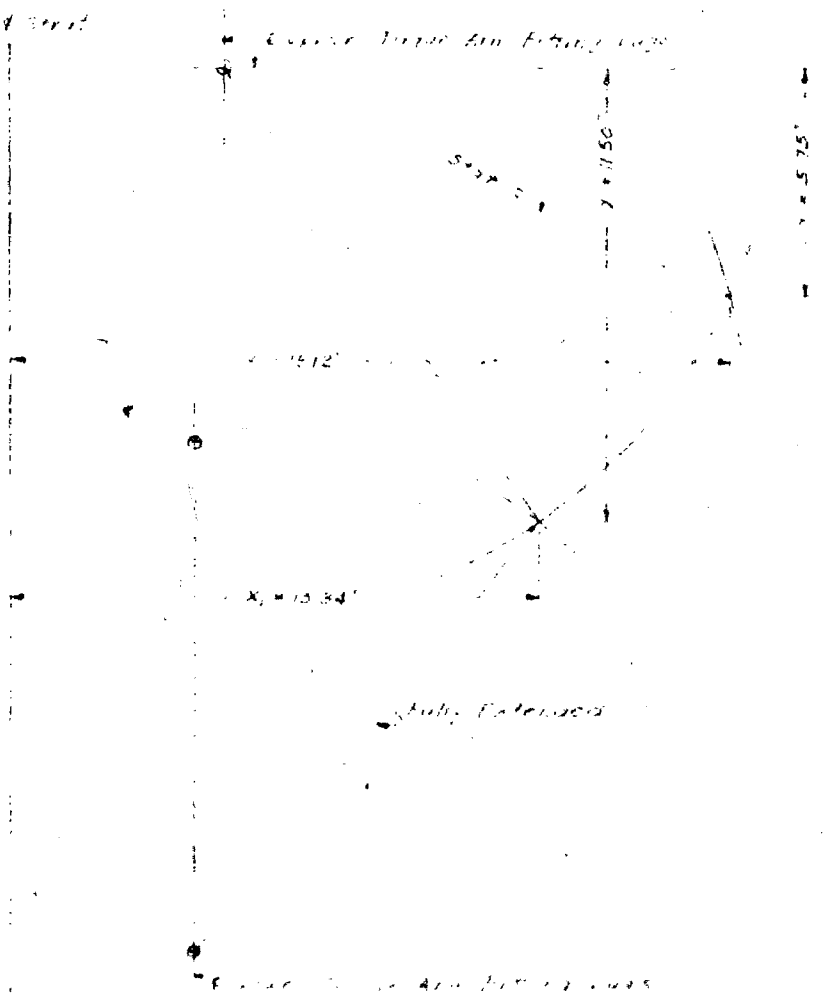
BENDIX PRODUCTS DIVISION

DIVISION OF BENDIX AVIATION CORPORATION
SOUTH BEND, INDIANA, U. S. A.

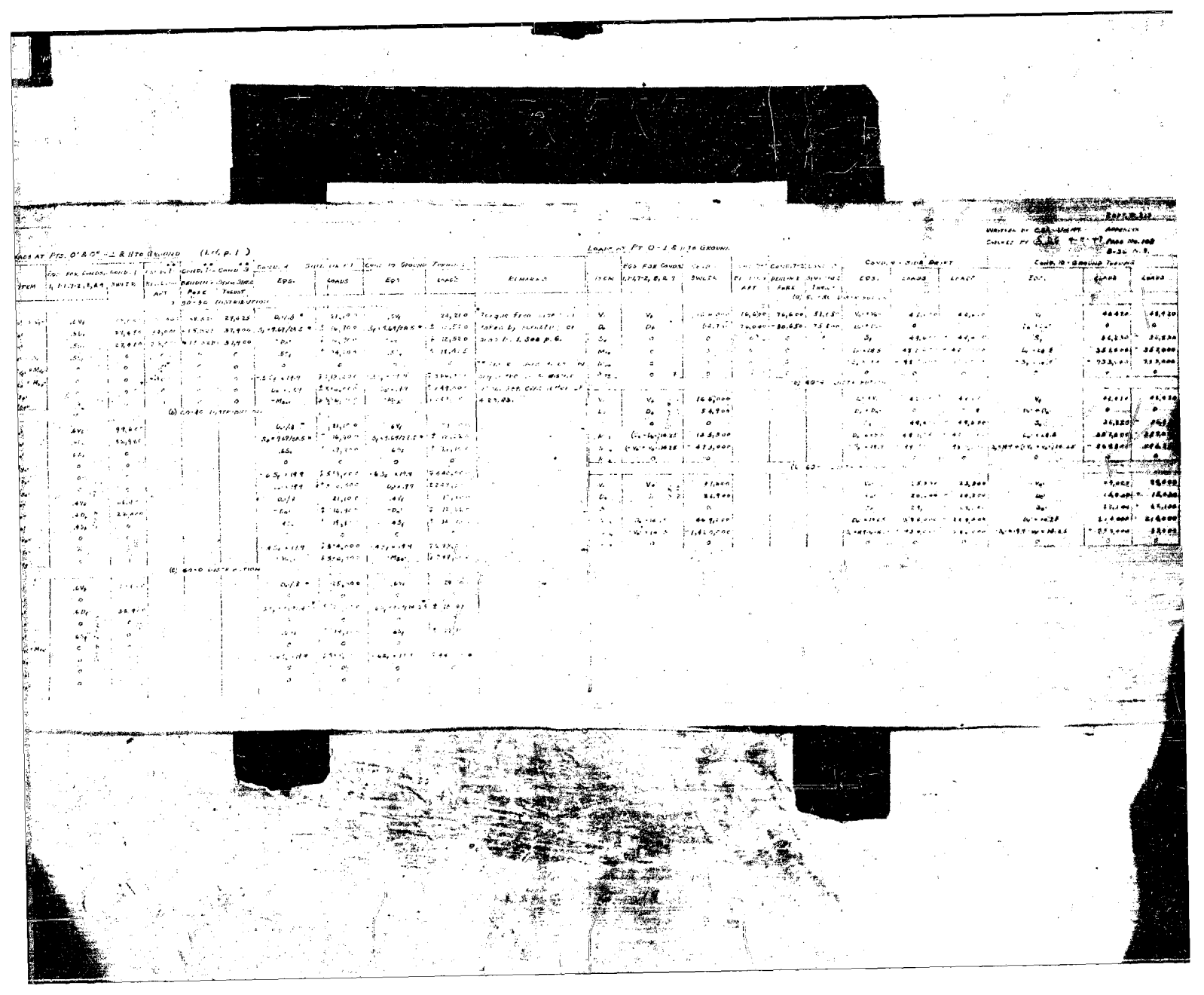
Written by CSA Date 2/24/41
Checked by [illegible] Date [illegible]
Subject TORQUE ARM [illegible]

Rept # 813
Page No. 110
No. of Pages 111
Model B-36 N G.

¼ Scale



S-13D



UPPER & LOWER BEARING LOADS

ITEM / CONDITION	EXT.	(1) $V_p = V_o$	(2) $D_p = D_o$	(3) $S_p = S_o$	(4) TORQUE ABT. STRUT ℄ $M_{V_p} = M_{V_o} - S_o \times 4.69''$	(5) S_p ON TORQUE ARMS $= \frac{M_{V_p}}{x_1}$ *	(6) $\Delta_1 M_b = -S_p(x)$	(7) $\Delta_2 M_b = -S_p(y)$	(8) $M_{a_{LD}} = M_{a_o} + ⑥ + ⑦$	(9) $M_{a_{LB}} = M_{a_o} + V_o(x) + D_o(y)$	(10) $M_b = \sqrt{⑧^2 + ⑨^2}$	(11) $D_{UB} = \frac{⑨}{y_2}$	(12) $S_{UB} = -\frac{⑧}{y_2}$	(13) UPPER BRG. LD. $= \frac{⑩}{y_2}$	(14) $D_{LB} = -(②+⑪)$	(15) $S_{LB} = -(③+⑤+⑫)$	(16) LOWER BRG. LD. $= \sqrt{⑭^2 + ⑮^2}$
(a) 50-50 DISTRIBUTION																	
1	F.E.	166,000	54,900	0	0	0	0	0	0	4,030,000	4,030,000	193,600	0	193,600	-253,500	0	253,500
4	"	42,200	0	49,600	0	0	0	-2,185,000	-3,172,000	409,000	3,200,000	20,000	156,200	157,[illegible]	-20,600	-205,800	207,000
7-1	"	76,400	76,000	0	0	0	0	0	0	4,094,000	4,094,000	202,000	0	202,000	-278,000	0	278,000
7-2	"	76,400	-20,650	0	0	0	0	0	0	-610,000	610,000						
4	Static	88,850	75,800	0	0	0	0	0	0	2,430,000	2,430,000	88,000	0	88,000	-163,800	0	163,800
10	"	48,420	0	36,880	0	0	0	-1,147,000	-1,880,000	469,000	1,937,000	14,100	56,400	58,200	-14,100	-93,280	94,300
(b) 60-40 DISTRIBUTION																	
1	F.E.	166,000	54,900	0	155,300	11,640	-119,450	0	-592,400	4,030,000	4,070,000	193,620	29,300	200,600	-253,500	-40,940	257,000
4	"	42,200	0	49,600	0	0		-2,185,000	-3,172,000	409,000	3,200,000	20,200	156,700	157,600	-20,[illegible]	-205,800	207,000
4	"	42,200	0	-49,600	0	0		2,185,000	3,172,000	409,000	3,200,000						
10	Static	48,420	0	36,880	0	0		-1,147,000	-2,016,000	464,000	2,070,000	14,100	60,500	62,200	-14,100	-97,330	98,300
(c) 60-0 DISTRIBUTION																	
1	F.E.	99,600	38,900	0	461,030	35,200	-361,000	0	-1,781,000	2,415,000	3,000,000	119,000	87,700	147,800	-151,900	-122,900	195,900
4	"	28,300	20,200	27,200	0	0	0	-1,314,000	-2,262,000	1,135,000	2,540,000	55,400	111,800	125,000	-76,100	-141,600	160,800
4	"	28,300	-20,200	-29,800	0	0	0	1,314,000	1,546,000	-645,000							
10	Static	29,000	15,020	22,100	0	0	0	-697,000	-1,540,000	748,000	1,712,000	28,500	46,200	61,400	-57,530	-68,300	77,400

* SYMBOLS & DIMENSIONS
(See also PP. 109-110)

- x = Dist. from [illegible] to ℄ strut = 9.25"
- y = Vert. dist. from [illegible] to ℄ lower brg. = 40.1" F.E.; = 31.1" Static
- x_1 = Dist. from ℄ open torque arm to ℄ strut = 16.24" F.E.; = 15.15" Static
- y_1 = Vert. dist. from open torque arm to ℄ lower brg. = 14.76" F.E.; = 4.81" Static
- y_2 = Vert. dist. from ℄ lower brg. to ℄ upper brg. = 20.8" F.E.; = 33.1" Static

LOADS AT TRUNNIONS & DRAG BRACE LOADS (Ref. pp. 1 & 44)

ITEM / CONDITION	EXT.	$V_b = V_o$	$D_b = D_o + D_a$	$S_b = S_o$	TORQUE IN ARM TRUNNION $M_{V_b} = M_{V_g}$	$M_{a_b} = M_{a_o} - S_o(63.188)$	$M_{s_b} = M_{s_o} + D_o[illegible]$	DRAG BRACE LOAD $D_c = -M_{a_b}/26$	REACTIONS AT B': $V_b' = -V_b/2 + M_{a_b}/30$	$D_b' = -D_b/2 - M_s/30$	$S_b' = -S_b/2$	$P_b' = \sqrt{V_b'^2 + D_b'^2}$	REACTIONS AT B": $V_b'' = -V_b/2 - M_{a_b}/30$	$D_b'' = -D_b/2 + M_s/30$	$S_b'' = -S_b/2$	$P_b'' = \sqrt{V_b''^2 + D_b''^2}$
7-1(a)	F.E.	76,600	298,000	0	0	0	8,545,000	121,000	-38,300	-149,000	0	153,600	-38,300	-149,000	0	153,600
7-2(a)	"	76,600	-78,450	0	0	0	-1,195,[illegible]	47,900	-38,300	39,226	0	54,900	38,300	39,226	0	54,900
1(b)	"	166,000	257,700	0	155,300	-473,000	8,078,[illegible]	[illegible]	-98,770	-134,150	0	166,300	-67,230	-123,770	0	141,[illegible]
4(b)	"	42,200	16,310	49,600	0	-4,170,000	469,[illegible]	6,270	-158,800	-8,155	-24,800	182,900	116,800	-8,155	-24,8[illegible]	136,[illegible]
	"	44,[illegible]	16,870	-49,6[illegible]	0	4,120,[illegible]	407,[illegible]	-4,330	146,000	8,195	24,800	114,[illegible]	-[illegible],200	-8,195	24,800	151,900
1(c)	"	99,600	154,000	0	449,[illegible]	-1,470,000	3,343,[illegible]	[illegible],900	-97,[illegible]	-97,940	0	134,6[illegible]	-[illegible]	61,640	0	[illegible]
4(c)		28,100	26,000	24,800	[illegible]	-2,871,[illegible]	1,561,000	15,800	109,[illegible]	-60,500	-14,900	[illegible]	81,2[illegible]	[illegible]	-14,9[illegible]	[illegible]
	F.E.	25,[illegible]	-6,4[illegible]	-21,600	[illegible]	3,115,000	-1,03[illegible]	-4,2[illegible]	57,[illegible]	80,700	16,900	63,500	-88,1[illegible]	90,7[illegible]	16,9[illegible]	88,[illegible]

SECTIONS IN FORK - LOADS 1 & 11 TO SECTION. (Ref. p. 21)

ITEM / CONDITION	$V_x = V_o$	$V_y = V_o$	$S_x = S_o$	$S_y = S_o$	$M_{x_p} = M_{x_o} - S_o(y)$	$M_{y_p} = M_{y_o} - S_o(x)$	$M_{z_p} = M_{z_o} + V_o(x) + F_o(y)$	$\frac{1}{2}$ LD. $= V_p$	$X_p = V_p \sin\alpha + D_p \cos\alpha$	$Z_p = S_p$	TORQUE $= M_{z_p} \cos\alpha - M_{x_p} \sin\alpha$	$M_{x_p} = M_{y_p} \sin\alpha + M_{z_p} \cos\alpha$	$M_{z_p} = M_{z_p}$	CRITICAL SHEARS	CRITICAL MOMENTS
Sect. J Welds: $x = 3.20"$, $y = 5.05"$, $\alpha = 32°34'51"$									$\cos\alpha = .84261$	$\sin\alpha = .53853$					
7-1(a)	76,600	76,000	0	0	0		629,000								
1(1)	76,600	54,900	0	155,300	- 473,000		803,000	110,100	135,600	0	386,000	- 514,400	803,000		
3(b)	42,200	0	±49,600	± 322,400	- 1,237,000		135,000	55,600	22,800	± 49,600	± 43,700	∓ 86,900	135,000		
10(b)	48,420	0	36,830	238,300	- 1,055,800		155,000	60,800	26,100	36,830	77,100	- 76,100	155,000		
	48,420	0	-36,830	- 238,300	732,200		155,000	60,800	26,100	- 36,830	- 62,300	583,000	155,000		
1(c)	99,600	32,900	0	46,100	- 1,420,000		485,200	66,200	81,400	0	1,159,000	- 445,000	485,200	81,400	1,066,000
4(c)	25,500	20,200	27,800	179,600	- 1,104,500		168,000	10,420	30,660	29,830	757,300	- 327,300	168,000		
Sect. I-I: $x = 8.00"$, $y = 13.25"$, $\alpha = 22°15'$									$\cos\alpha = .92554$	$\sin\alpha = .38460$					
7-1(a)	76,600	76,000	0	0	0		1,416,000								
1(b)	166,600	54,900	0	155,300	- 473,000		2,058,000	193,900	113,700	0	383,000	- 379,000	2,058,000	113,700	2,034,000
4(b)	42,200	0	49,600	84,000	- 1,044,000		338,000	57,100	16,000	49,600	59,900	- 1,028,200	338,000	52,200	1,027,000
10(b)	48,420	0	36,830	61,300	- 1,250,000		387,400								
1(c)	99,600	32,900	0	46,100	- 1,420,000		1,251,000	79,700	68,200	0	972,000	- 1,187,200	1,251,000	68,200	1,674,000
4(c)	25,500	20,200	27,800	5,100	- 1,347,000		968,400								
Sect. 2-2: $x = 9.67"$, $y = 20.32"$, $\alpha = 31°$															
7-1(a)	76,600	76,000	0	0	0		2,238,000								
1(b)	166,600	54,900	0	155,300	- 473,000		2,712,000	193,900	54,900	0	155,300	- 473,000	2,712,000	64,200	2,760,000
4(b)	42,200	0	49,600	0	- 1,497,000		481,000								
10(b)	48,420	0	36,830	0	- 1,628,000		467,000								
1(c)	99,600	32,900	0	46,100	- 1,420,000		1,634,000	91,400	32,900	0	464,000	- 1,420,000	1,634,000	32,900	2,116,000
4(c)	25,500	20,200	27,800	5,200	- 1,564,000		1,000,000								

TITLE: Stress Analysis of the B-36 Nose Gear

ATI- 50803

REVISION (None)

ORIG. AGENCY NO. R-813

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Feb '47	Unclass.	U.S.	English	21	diagrs, graphs, drwgs

ABSTRACT:

A stress analysis was made of the nose gear of the B-36 bomber. The analysis covers the axle, inner and outer cylinder, piston, torque fittings and arms, and cams. The appendix shows the computations for the nose gear loads, loads at points O,O' and O'', loads at sections in the fork, torque arm geometry, and loads at the upper and lower bearings, trunnion and drag brace. A table of the minimum margins of safety is included.

DIVISION: Structures (7)
SECTION: Stress Analysis of Specific Aircraft (6)

SUBJECT HEADINGS: Landing gears - Stress analysis (54537); Landing gears, Nose - Static Tests (54538.6); B-36 (14884.6)

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