BELOW-THE-HOOK LIFTING DEVICE
Engineering Note Cover Page

Lifting Device Numbers:

FNAL Site No.: 98 if applicable Div. Specific No.: _____ if applicable Asset No. _____ if applicable

ASME B30.20 Group: (check one)
- ✓ Group I Structural and Mechanical Lifting Devices
- Group II Vacuum Lifting Devices
- Group III Magnets, Close Proximity Operated
- Group IV Magnets, Remote Operated

Device Name or Description: MDT A OCTANT LIFTING/TURNING FIXTURE

Device was: (check all applicable)
- Purchased from a Commercial Lifting Device Manufacturer
  mfg. name: _____
- ✓ Designed and Built at Fermilab
- Designed by Fermilab and Built by a Vendor
  Assy drawing number: _____
- Provided by a User or Other Laboratory
- Other. Describe: _____

Engineering Note Prepared by: Tony Legand Date: 9/29/99

Engineering Note Reviewed by: ANG LEE Date: 11-18-99

Lifting Device Data:

Capacity: 800 lbs

Fixture Weight: 425 lbs

Service: normal heavy severe (refer to B30.20 for definitions)

Duty Cycle: NA 8, 16 or 24 hour rating (applicable to groups III, and IV)

Inspections Frequency: _____

Rated Load Test by FNAL (if applicable): Date: _____ Load: _____

Check if Load Test was by Vendor and attach the certificate.

Satisfactory Load Test Witnessed by: _____

Signature (of Load Test Witness): _____

Notes or Special Information:

FERMILAB ENGINEERING NOTE	SECTION	PROJECT	SERIAL-CATEGORY	PAGE
				1

SUBJECT	NAME	
LIFTING/TURNING FIXTURE	Tony Leonard	
	DATE 9-29-99	REVISION DATE

ANALYSIS 373511

OCTANT WEIGHT = 800 lbs

MATERIAL PROPERTIES:

ASTM A-500 TUBING F_{ty} = 46 KSI

REF: STEEL CONTRUCTION MANUAL P 5-118 A500 46/50 NOTE G

σ_a Allowable stress = $\frac{F_{ty}}{3}$ = 16 KSI

REF: ASTM B30.20-1993 P17, 20-1.2.2

τ_1 Allowable shear = $\frac{\sigma_a}{2}$ = 8 KSI

SECTION PROPERTIES

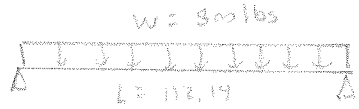
4" x 3" x 1/8 wall tubing

$$I = \frac{(4^3 \times 3) - (3.75^3 \times 2.75)}{12} = 3.91 \text{ in}^4$$

$A = 1.69 \text{ in}^2$

FRAME BENDING:

FREEBODY:



ASSUME:

1) OCTANT WEIGHT IS UNIFORMLY DISTRIBUTED

2) FRAME IS SUPPORTED AT 3 BOLTING POINTS

3) 3 MEMBERS CARRY WEIGHT

$$M = \frac{PL}{8} = \frac{800 \times 112.189}{8} = 11.33 \text{ kip}\cdot\text{in}$$

$$f_b = \frac{Mc}{I} = \frac{11.33 \times 10^3 \times 2}{3.91 \times 3} = \underline{1.9 \text{ KSI} < 16 \text{ KSI}}$$

FERMILAB
ENGINEERING NOTE

SECTION	PROJECT	SERIAL-CATEGORY	PAGE
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SUBJECT: LIFTING/TURNING

NAME: Tony Levand

DATE: 9-29-99

REVISION DATE:

ANALYSIS

VERTICAL LIFTING:

W = 800 lbs octant + 200 lbs Frame

FREEBODY:

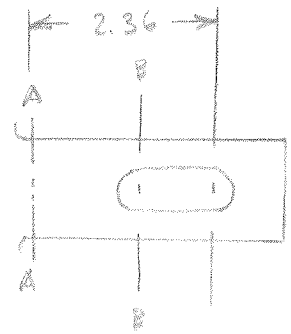
MATERIAL: ANSI A-36

$F_a = \frac{36}{3} = 12\,KSI$

$F_s = 6\,KSI$

COMMECTION PLATE
373128

Assume:
weight is share by 3 plates



BENDING:

$M = PL = \frac{800}{3} \times (2.360) = 629$ in lbs

$I = 1.5 \times \frac{.5^3}{12} \times 2 = .031\ in^4$

$f_b = \frac{Mc}{I} = \frac{629 \times .25}{.031} = 5.032\ KSI$ SECTION A-A

$I = .44 \times \frac{.5^3}{12} \times 4 = .018$

$M = \frac{800}{3} \times (1.64 - .25) = 370$ in lbs

$f_b = \frac{370 \times .25}{.018} = 5.055\ KSI < 12\ KSI$ SECTION B-B

SHEAR:

$f_s = \frac{\frac{800}{3 \times 2}}{.44 \times .5} = .606\ KSI < 6\ KSI$

FERMILAB ENGINEERING NOTE	SECTION	PROJECT	SERIAL-CATEGORY	PAGE 3
SUBJECT: LIFTING/TURNING	NAME: Tony Levan	DATE: 9-29-97	REVISION DATE	

ANALYSIS: TAP PLATE 373480

ASSUME LOAD IS CARRIED BY 2 PLATES

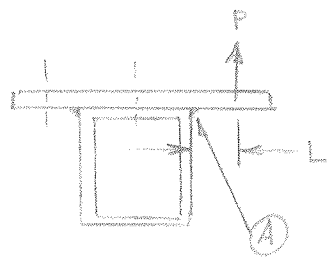
BENDING:

$$M = \frac{P}{2} L = \frac{800+200}{2} \times \left(\frac{6.375-3}{2}\right) = 843 \text{ in-lbs}$$

$$I = \frac{.5^3}{12} \times 4 = .042$$

$$f_b = \frac{Mc}{I} = \frac{843 \times .25}{.042} = \underline{5.06 \text{ KSI}} < 12 \text{ KSI}$$

$$f_s = \frac{500}{4 \times .5} = \underline{250 \text{ PSI}}$$

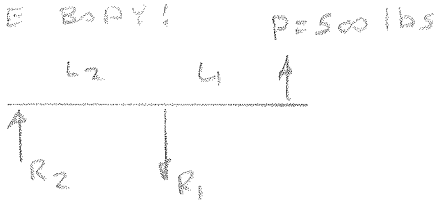


WELD STRESS:

SECTION (A):

ASSUME WELD ON parallel sides only

FREE BODY:



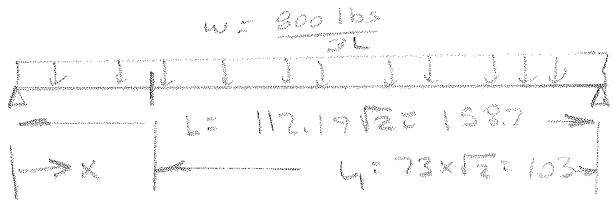
$$R_2 = P\frac{L_1}{L_2} = 500 \times \frac{1.69}{3} = 281 \text{ lbs}$$

$$R_1 = P + R_2 = 781 \text{ lbs}$$

$$f_w = \frac{P+R_1}{A} = \frac{781}{4 \times \frac{.125}{\sqrt{2}}} = \underline{2.2 \text{ KSI}}$$

ANALYSIS

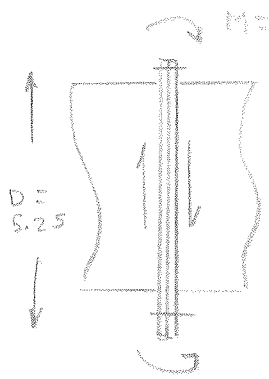
BOLTED CONNECTION 373541



$y = (158.7 - 103) = 55.7$

$$M_x = \frac{wx}{2}(L-x) = \frac{800(55.7)}{3 \times 158.7} \times \frac{(103)}{2} = 4.8 \text{ Kip·in}$$

FREEBODY:

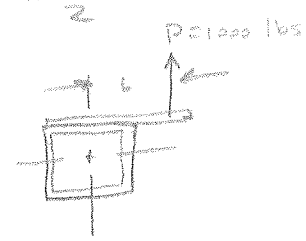


$$\text{shear} = \frac{800}{3} \text{ lbs} = 267 \text{ lbs}$$

$$\text{BOLT TENSION} = \frac{M}{D \times 2} = \frac{4800}{5.25 \times 2} = \underline{457 \text{ lbs}}$$

TORSION IN TUBE MEMBER VERTICAL LIFTING

$$f_s = \frac{T}{2Abt} \quad (1) \qquad T = PL = 1000 \cdot \frac{6.375}{2} = 3188 \text{ in·lbs}$$



$$f_s = \frac{3188}{2 \times 4 \times 3 \times .125} = \underline{1063 \text{ PSI}} < 8 \text{ KSI}$$

(1) Ref Boeing Design Manual fig 12.1.3-2, page 12.1.3-1

FERMILAB
ENGINEERING NOTE

SECTION	PROJECT	SERIAL-CATEGORY	PAGE
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SUBJECT: LIFTING / TURNING

NAME: Levand

DATE: 10/13/79

REVISION DATE:

ANALYSIS

BOLT CONNECTION TO ULTANT

2 1/2 in bolts / PLATE

P = 800 lbs

N = 6 BOLTS

$f_t = \frac{P}{N} = \frac{800}{6} = 133$ lbs / Bolt, good by inspection

BOLTED CONNECTION 373541

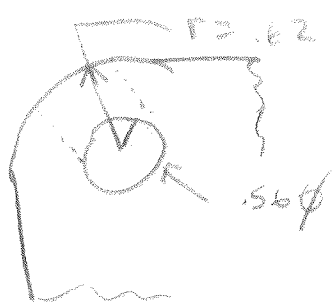
BOLT TENSION: 1/2" BOLTS

M = 4800 in lbs

D = 5.25"

$f = \frac{M}{D} = \frac{4800}{5.25 \times 2} = 457$ lb/BOLT, good by inspection

Shear tearout / edge distance



$A = \left[.62 - \frac{.56}{2}\frac{\sqrt{2}}{2}\right] 2 \times .375 = .316 \text{ in}^2$

$\tau = \frac{P}{A} = \frac{800}{3 \times .316} = 842$ PSI

610856

SUBJECT: LIFTING TURNING FIXTURE

NAME: Levand

DATE: 10/17/79

REVISION DATE:

RIVNUT ANALYSIS

50-150 RIVNUT, STEEL MATERIAL

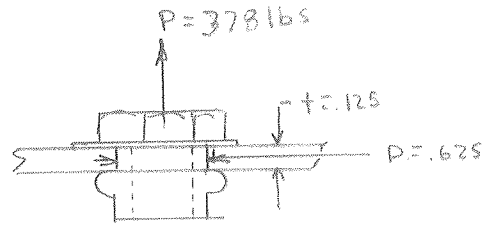
1010 CF STEEL $F_{TY} = 44$ KSI (2)

$F_1 = \frac{F_{TY}}{3} = 14.7$ KSI

$F_S = \frac{F_{TY}}{6} = 7.3$ KSI

ULTIMATE THREAD STRENGH = (1) $\frac{11,500 \text{ lbs}}{3 \times 1.5} = 2555$ lbs allowable

SHEAROUT IN TUBE WALL



$t = .125$

$D = .625$

$P_{allow} = \pi .625 \times .125 \times 7.7 \times 10^3 = 1,889$ lbs

LOAD ON FASTENER (CRITICAL):

$R_1 = 266 \frac{4.61}{2.5} = \frac{492}{2} = 245$ lbs

$R_2 = \frac{756}{2} = 378$ lbs (CRITICAL FASTENER)

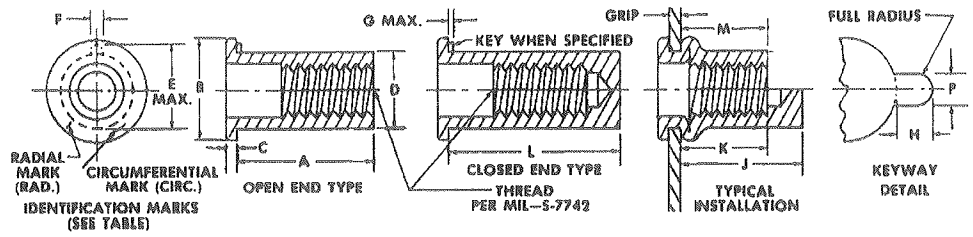
$378 < 1,889$ lbs

(2) Mechanical Engineering Design, Shigley, 1972, P 719, Table A-12

(1) RIVNUT DATA

610856

Flat head RIVNUT® fastener — Unified Thread System



Code:
Diameter and grip range as tabulated. First letter of type number indicates material: "A" for 6053 aluminum, "S" for C-1010 or C-1110 steel, "SS" for Type 430 corrosion resistant steel, "CH" for heat treated 4037 steel, "BR" for brass, NM for type 384 stainless steel. Letter between dash numbers indicates type: "—" for keyless open end, "K" for keyed open end, "B" for keyless closed end, "KB" for keyed closed end, "R" for ribbed shank.

Examples:
A25K80 = Aluminum alloy keyed open end 1/4-20 internal thread .020 to .080 grip range.
SS6KB200 = Corrosion resistant steel keyed closed end No. 6-32 internal thread .160 to .200 grip range.

Weights:
For Brass RIVNUTS multiply weight of aluminum RIVNUTS by 3.13. Weights for "CH" RIVNUTS (4037 steel) and "SS" RIVNUTS (Type 430 corrosion resistant steel) same as for "S" RIVNUTS.

First No. of Type No.	Thread Size*	B ±.015	C Nom.	D +.000 −.004	E Max.	F +.005 −.000	G Max.	Install Drill Size (Ref.)	Install Hole Size Min.	Install Hole Size Max.	Keyway Dimensions P+.003 −.000	Keyway Dimensions H
4	# 4-40 UNC-3B	.270	.025	.155	.198	.054	.023	5/32	.156	.158	.062	.046-.048
6	# 6-32 UNC-3B	.325	.032	.189	.240	.054	.023	# 12	.190	.193	.062	.056-.058
8	# 8-32 UNC-3B	.357	.032	.221	.271	.054	.023	# 2	.222	.226	.062	.056-.058
10	#10-32 UNF-3B	.406	.038	.250	.302	.054	.023	E	.251	.256	.062	.056-.058
25	1/4-20 UNC-3B	.475	.058	.332	.382	.054	.035	Q	.333	.338	.062	.056-.058
31	5/16-18 UNC-3B	.665	.062	.413	.505	.120	.040	Z	.414	.423	.128	.097-.102
37	3/8-16 UNC-3B	.781	.088	.490	.597	.120	.040	12.5 M M	.491	.500	.128	.110-.115
50	1/2-13 UNC-3B	.906	.085	.625	.733	.120	.040	5/8	.626	.635	.128	.110-.115

*Both UNC and UNF threads are available in No. 10 and larger thread sizes
† Additional Grip Ranges are available.

Type Number	Grip † Range	Ident. Mark	Open End Keyed and Keyless A ±.015	M Ref.	Wt. (Lbs./1000) Alum.	Steel	Closed End Keyless L ±.015	J Ref.	K Ref.	Wt. (Lbs./1000) Alum.	Steel	Closed End Keyed L ±.015	J Ref.	K Ref.	Wt. (Lbs./1000) Alum.	Steel
4- 60	.010-.060	Blank	.345	.230	.4	1.3	.500	.385	.230	.6	1.9	.500	.385	.230	.6	1.9
4- 85	.060-.085	1-Rad.	.370	.230	.4	1.4	.525	.385	.230	.7	2.0	.525	.385	.230	.7	2.0
4-110	.085-.110	2-Rad.	.400	.230	.5	1.4	.555	.390	.230	.7	2.0	.555	.390	.230	.7	2.0
4-135	.110-.135	3 Rad.	.425	.230	.5	1.5	.580	.385	.230	.7	2.1	.580	.385	.230	.7	2.1
4-160	.135-.160	4-Rad.	.450	.230	.5	1.5	.605	.385	.230	.7	2.1	.605	.385	.230	.7	2.1
4-185	.160-.185	5-Rad.	.480	.230	.5	1.6	.635	.385	.230	.7	2.2	.635	.385	.230	.7	2.2
6- 75	.010-.075	1-Rad.	.438	.300	.8	2.4	.625	.490	.305	1.2	3.5	.750	.615	.405	1.4	4.1
6-120	.075-.120	3-Rad.	.500	.315	.9	2.6	.625	.440	.255	1.1	3.4	.750	.565	.355	1.3	4.0
6-160	.120-.160	5-Rad.	.500	.270	.9	2.6	.750	.520	.260	1.3	4.0	.750	.520	.310	1.3	4.0
6-200	.160-.200	1-Circ.	.562	.290	.9	2.8	.750	.480	.260	1.3	3.9	.750	.480	.260	1.3	3.9
6-240	.200-.240	2-Circ.	.625	.310	1.0	3.0	.750	.435	.260	1.3	3.8	.750	.435	.260	1.3	3.8
6-280	.240-.280	3-Circ.	.687	.330	1.1	3.3	.812	.455	.265	1.3	4.1	.812	.455	.265	1.3	4.1
8- 75	.010-.075	1-Rad.	.438	.300	1.0	3.0	.625	.490	.305	1.5	4.5	.750	.615	.405	1.7	5.3
8-120	.075-.120	3-Rad.	.500	.315	1.1	3.3	.625	.440	.255	1.4	4.4	.750	.565	.355	1.7	5.2
8-160	.120-.160	5-Rad.	.500	.270	1.1	3.2	.750	.520	.260	1.7	5.1	.750	.520	.310	1.7	5.1
8-200	.160-.200	1-Circ.	.625	.350	1.3	3.9	.750	.475	.265	1.6	5.0	.750	.475	.265	1.6	5.0
8-240	.200-.240	2-Circ.	.625	.305	1.2	3.8	.875	.555	.310	1.9	5.6	.875	.555	.310	1.9	5.6
8-280	.240-.280	3-Circ.	.687	.340	1.3	4.1	.875	.530	.290	1.8	5.6	.875	.530	.290	1.8	5.6
10- 80	.010-.080	Blank	.531	.380	1.5	4.5	.781	.630	.380	2.3	6.8	.781	.630	.380	2.3	6.8
10-130	.080-.130	1-Rad.	.594	.390	1.6	4.9	.843	.640	.390	2.4	7.2	.843	.640	.390	2.4	7.2
10-180	.130-.180	2-Rad.	.641	.390	1.7	5.1	.891	.640	.390	2.4	7.4	.891	.640	.390	2.4	7.4
10-230	.180-.230	3-Rad.	.703	.395	1.8	5.4	.953	.645	.395	2.6	7.8	.953	.645	.395	2.6	7.8
10-280	.230-.280	4-Rad.	.750	.395	1.9	5.7	1.000	.645	.395	2.6	8.0	1.000	.645	.395	2.6	8.0
10-330	.280-.330	5-Rad.	.797	.385	1.9	5.9	1.047	.630	.385	2.7	8.2	1.047	.630	.385	2.7	8.2
25- 80	.020-.080	Blank	.625	.450	3.2	9.7	.937	.760	.440	4.9	15.1	.937	.760	.440	5.0	15.1
25-140	.080-.140	1-Rad.	.687	.450	3.4	10.3	1.000	.760	.440	5.1	15.7	1.000	.760	.440	5.1	15.7
25-200	.140-.200	2-Rad.	.750	.450	3.6	10.9	1.062	.760	.440	5.3	16.2	1.062	.760	.440	5.3	16.3
25-260	.200-.260	3-Rad.	.812	.445	3.8	11.5	1.125	.755	.445	5.5	16.8	1.125	.755	445	5.5	16.8
25-320	.260-.320	4-Rad.	.875	.445	4.0	12.0	1.187	.755	.445	5.7	17.4	1.187	.755	445	5.7	17.4
25-380	.320-.380	5-Rad.	.937	.445	4.1	12.6	1.250	.755	.445	5.9	18.0	1.250	.755	445	5.9	18.0
31-125	.030-.125	Blank	.750	.505	6.0	18.2	1.187	.940	.550	9.6	29.1	1.187	.940	550	9.6	29.2
31-200	.125-.200	1-Rad.	.875	.555	6.7	20.3	1.281	.960	.555	10.1	30.6	1.281	.960	555	10.1	30.7
31-275	.200-.275	2-Rad.	.937	.540	6.9	21.1	1.343	.950	.560	10.3	31.4	1.343	.950	560	10.3	31.5
31-350	.275-.350	3-Rad.	1.032	.560	7.4	22.6	1.437	.965	.570	10.8	32.9	1.437	.965	570	10.8	32.9
31-425	.350-.425	4-Rad.	1.125	.580	7.9	24.0	1.531	.985	.575	11.3	34.3	1.531	.985	.575	11.3	34.4
31-500	.425-.500	5-Rad.	1.187	.565	8.2	24.9	1.593	.975	.580	11.5	35.1	1.593	.975	.580	11.6	35.2
37-115	.030-.115	Blank	.844	.585	9.7	29.7	1.281	1.020	.660	14.8	45.0	1.281	1.020	.660	14.8	45.1
37-200	.115-.200	1-Rad.	.938	.595	10.3	31.4	1.375	1.030	.670	15.4	46.8	1.375	1.030	.670	15.4	46.9
37-285	.200-.285	2-Rad.	1.031	.605	10.9	33.2	1.468	1.040	.680	15.9	48.5	1.468	1.040	.680	16.0	48.6
37-370	.285-.370	3-Rad.	1.125	.615	11.5	34.9	1.562	1.050	.690	16.5	50.3	1.562	1.050	.690	16.5	50.4
37-455	.370-.455	4-Rad.	1.218	.630	12.0	36.7	1.656	1.065	.710	17.1	52.1	1.656	1.065	.710	17.1	52.2
37-540	.455-.540	5-Rad.	1.312	.635	12.6	38.5	1.750	1.075	.715	17.7	53.8	1.750	1.075	.715	17.7	53.9
*50-150	.050-.150	Blank	.906	.605	14.0	42.6	1.328	1.030	.605	21.9	66.6	1.328	1.030	.605	21.9	66.6
50-250	.150-.250	1-Rad.	1.031	.630	15.2	46.3	1.453	1.055	.630	23.1	70.3	1.453	1.055	.630	23.1	70.3
50-350	.250-.350	2-Rad.	1.141	.640	16.2	49.2	1.562	1.060	.640	24.0	73.2	1.562	1.060	.640	24.0	73.2
50-450	.350-.450	3-Rad.	1.250	.650	17.1	52.2	1.671	1.070	.650	25.0	76.1	1.671	1.070	.650	25.0	76.1

**NOTE: The 1/2" thread size RIVNUTS listed here are of new design and replace type numbers shown in previous issues. Old design still available on special request. Check with RIVNUT Engineered Products or representative for availability of other grip ranges and designs.

RIVNUT® fastener engineering data — Unified Thread System

Upset load (lbs.)

RIVNUT Size	Aluminum		Brass		Steel		Stainless Steel	
	Min. Grip	Max. Grip	Min. Grip	Max. Grip	Min. Grip	Max. Grip	Min. Grip	Max. Grip
# 4-40	400	450	700	800	700	800	800	900
# 6-32	500	600	800	950	850	1000	1000	1300
# 8-32	600	700	1300	1500	1000	1250	1400	1650
# 10-32	750	800	1600	1800	1300	1500	1900	2000
1/4-20	1300	1450	2570	2880	2300	2610	3300	3400
5/16-18	1900	2150	3870	4210	3300	3650	4800	5600
3/8-16	2570	2700	4620	4940	4965	5325	6100	6660
1/2-13	3000	3400	NA	NA	5800	6300	7200	7600

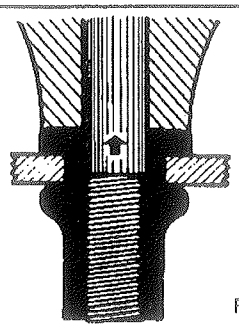


Fig. 1

Ultimate thread strength (lbs.)

RIVNUT Size	Aluminum		Brass		Steel		Stainless Steel	
	Min. Grip	Max. Grip	Min. Grip	Max. Grip	Min. Grip	Max. Grip	Min. Grip	Max. Grip
# 4-40	675	575	1265	1075	1180	1000	1600	1300
# 6-32	964	820	1740	1480	1705	1450	2400	2000
# 8-32	1095	935	2050	1740	1920	1630	3000	2200
# 10-32	1600	1450	3025	2525	3000	2500	4000	3500
1/4-20	2500	2400	4900	4250	5240	4520	6000	5100
5/16-18	4000	3700	7795	6840	7625	6300	8700	7500
3/8-16	4700	4450	11600	11200	11500	10450	11700	9650
1/2-13	7900	6400	NA	NA	17250	14500	NA	NA

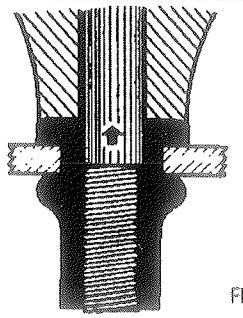


Fig. 2

Ultimate tensile strength (lbs.)

RIVNUT Size	Aluminum	Brass	Steel	Stainless Steel
# 4-40	261	474	458	621
# 6-32	373	678	656	889
# 8-32	485	882	853	1153
# 10-32	617	1120	1085	1470
1/4-20	1150	2020	1850	2510
5/16-18	1600	2995	2750	3730
3/8-16	2075	3925	3900	5280
1/2-13	3100	NA	4900	NA

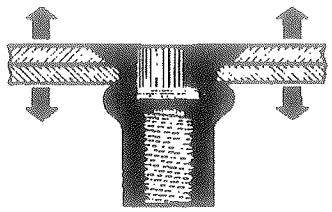


Fig. 3

Ultimate shear strength (lbs.)

RIVNUT Size	Aluminum	Brass	Steel	Stainless Steel
# 4-40	158	300	316	515
# 6-32	230	430	460	749
# 8-32	294	558	588	958
# 10-32	374	710	748	1220
1/4-20	710	1230	1100	1790
5/16-18	930	1850	1750	2850
3/8-16	1260	2425	2420	3940
1/2-13	1270	NA	2440	3970

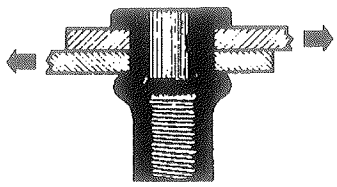


Fig. 4

ıminum RIVNUTS were tested in 2024-T4 aluminum plates. Brass and steel RIVNUTS tested in steel plates. Stainless el RIVNUTS tested in stainless steel plates.

ıese data are average only – certain variations must be expected in practice.

NA – Test data not available.

FERMILAB ENGINEERING NOTE	SECTION	PROJECT	SERIAL-CATEGORY	PAGE 2

SUBJECT: MODIFICATION 373123

NAME: Tony Levand

DATE: 2/13/00

REVISION DATE:

TRIM OFF ONE LEG:

WEIGHT = $\frac{800\text{ lbs}}{2}$ = 400 lbs

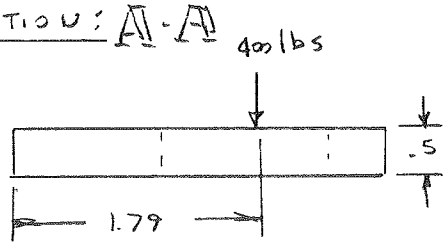
MATERIAL ALLOWABLE:

ASTM A-36

F_{ty} = 36 KSI

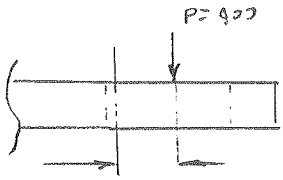
$F_a = \frac{F_{ty}}{3}$ = 12 KSI

SECTION: A-A



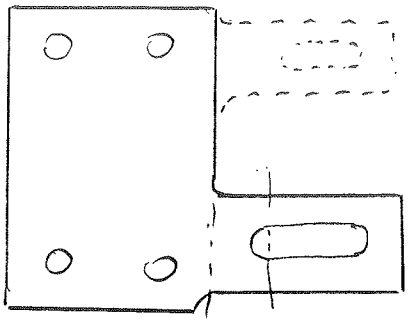
$$f_b = \frac{6rP}{bt^2} = \frac{6 \times 400 \times 1.79}{1.5 \times .5^2} = 11.5\text{ KSI} < 12\text{ KSI}$$

SECTION 2 B-B



$$L = \frac{1.64 - .820}{2}$$

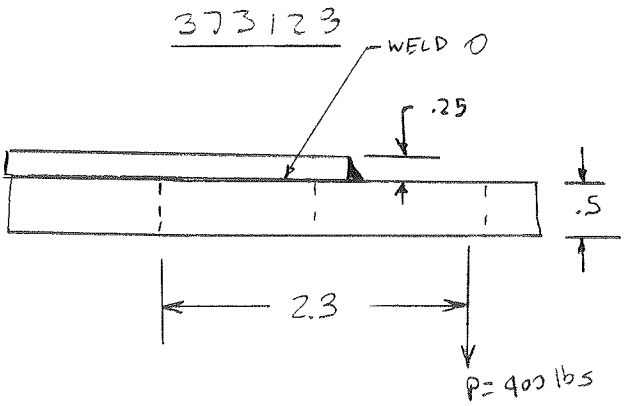
$$f_b = \frac{.820 \times 400 \times 6}{.5^2 \times (1.5 - .63)} = 9.0\text{ KSI} < 12\text{ KSI}$$

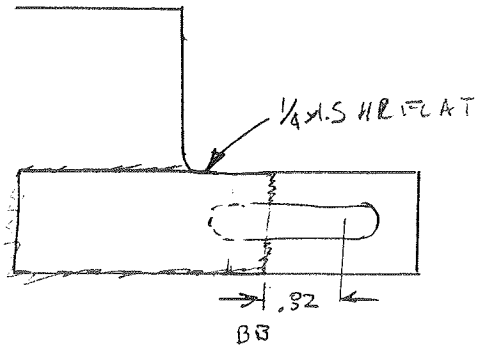


A-A B-B

FERMILAB ENGINEERING NOTE	SECTION	PROJECT	SERIAL-CATEGORY	PAGE 3
SUBJECT: INSTALLATION FIXTURE			NAME: Tony Levand	
			DATE: 2/13/00	REVISION DATE

MODIFICATION:
373123





SECTION A-A

$M = 400 \times 2.3 = 920$ in lbs

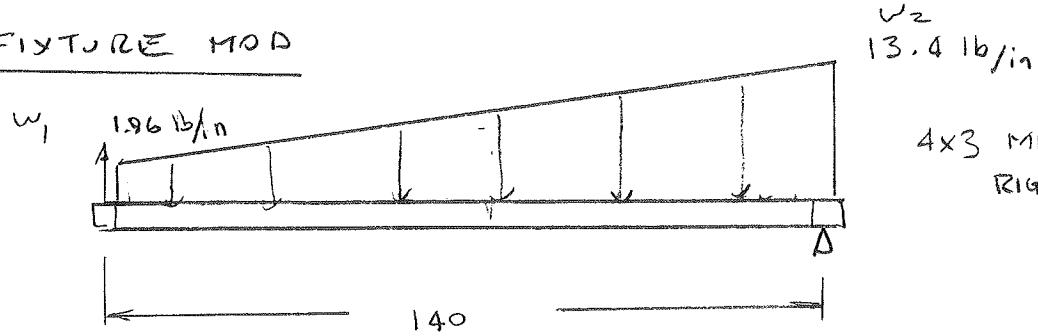
$$f_b = \frac{6M}{WT^2} = \frac{6 \times 920}{1.5 \times .75^2} = 6.5 \text{ KSI} < 12 \text{ KSI}$$

SECTION B-B = 9 KSI (page 2)

FERMILAB ENGINEERING NOTE	SECTION	PROJECT	SERIAL-CATEGORY	PAGE
				1

SUBJECT	NAME	
A LAYER LIFTING/TURNING FIXTURE	T Levand	
	DATE 1/13/00	REVISION DATE

2) FIXTURE MOD



4x3 MEMBER ALONG RIGHT SIDE

$$M_{max} = \frac{W_1 L^2}{8} + (W_2 - W_1)\ .064\ L^2 = 19{,}150 \text{ in lbs}$$

$$\tfrac{1}{8} \times 4 \times 3 \text{ TUBING} \quad I = \frac{3.4^3 - 3.75^3 \times 2.75}{12} = 3.91 \text{ in}^4$$

$$f_b = \frac{19{,}150}{3.91} \times 2 = 9.8 \text{ KSI} < 14 \text{ KSI}$$