Design Report 1

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06/07/2026

EML2322L - Fall 2024

Design Description

The following design is for a compressed-air powered blender attachment that uses the rotational output of the air engine to drive a mixing blade through a belt-driven transmission system. The air engine rotates a modified flywheel (A5), which serves as the main drive component of the system. To prevent the belt from riding upward and slipping off the flywheel when operating, a steel retaining lip is welded around the upper outer diameter of the flywheel. The flywheel is mounted flush with the top surface of the aluminum base (A3), allowing the belt to remain aligned throughout its operation.

Belt tension is adjusted using a manually movable tensioner assembly consisting of a tensioner arm (A1), bearing (A2), and retaining nut (A4). A slotted cutout in the base allows the tensioner assembly to slide back and forth, adjusting the tension as necessary per the shaft diameter speed adjustment. Once the desired tension is achieved, the nut is tightened from beneath the base to lock the assembly in position. The bearing contacts the outer surface of the belt and minimizes friction while maintaining proper belt engagement, alignment, and tensioning.

Power is transmitted through the flywheel to a vertical shaft (B2). The shaft is supported by bearings (B1 and B3), which reduce rotational friction and provide radial support during high-RPM operations. Two drive diameters are machined into the shaft easily utilizing a lathe. A larger lower diameter provides a slower mixing speed while a smaller upper diameter provides higher rotational speed. Both pulley surfaces incorporate retaining lips to prevent the belt from any unwanted misalignment. Some fluctuations in height are expected. The air engine can be stopped at any time to reposition the belt between pulley diameters to select the desired mixing speed.

The upper end of the shaft connects to an Oster drive pin (OTS08) that threads directly into the shaft and transfers torque to the blender blade assembly. The drive pin extends through the lid platform (B4), which is supported above the base by aluminum support rods. An Oster blade assembly is installed on the drive pin and sits flush with the lid platform surface. The blade assembly locks into the drive pin and rotates with the shaft.

A food-grade rubber gasket (B5) is positioned around the outer diameter of the blade assembly to create a seal between the rotating blade assembly and the lid components. A lid adapter (B6) is permanently attached to the lid (B7) using food-safe silicone adhesive, creating a single assembly that threads onto a standard wide-mouth mason jar. A central opening in the lid adapter allows the blade assembly to pass through while maintaining proper alignment. The completed lid assembly is secured to the lid platform using a bayonet-style twist-lock mechanism, allowing for rapid installation and removal while constraining the mason jar during operation.

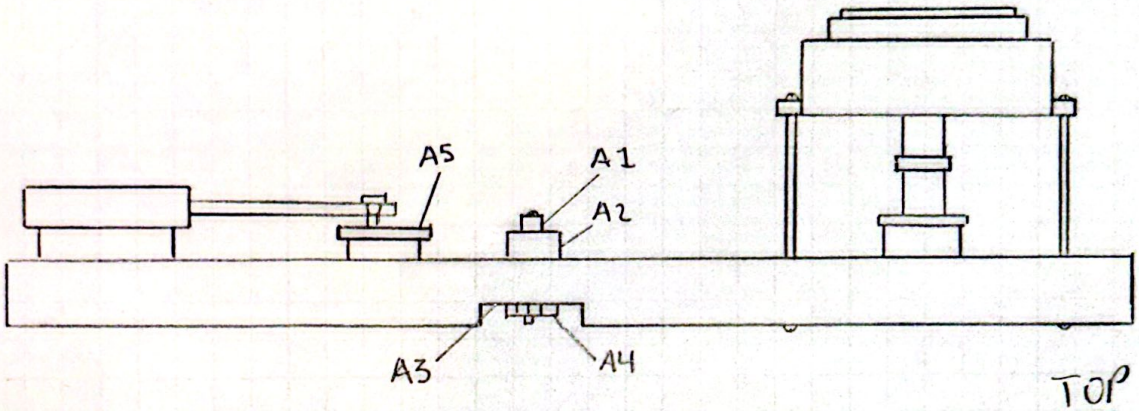
When compressed air is supplied to the air engine, rotational motion is transferred through the flywheel, to the belt, along the shaft, and rotates the Oster drive pin to the blender blades, providing mechanical mixing of the jar contents.

The base (A3), tensioner arm (A1), shaft (B2), platform supports, and lid adapter (B6) are manufactured from aluminum due to its high strength-to-weight ration, machinability, suitability for food-related applications, and it is cost effective. The flywheel (A5) is steel to provide increased rotational inertia. Bearings (A2, B1, and B3) (OTS05) are commercially available bearings selected for their low friction and long service life. The rubber gasket (B5) is manufactured from food-grade rubber material to provide the capability to seal the jar contents. The drive pin and blade assembly are off-the-shelf parts selected for their ease of access and practicality for this specific design.

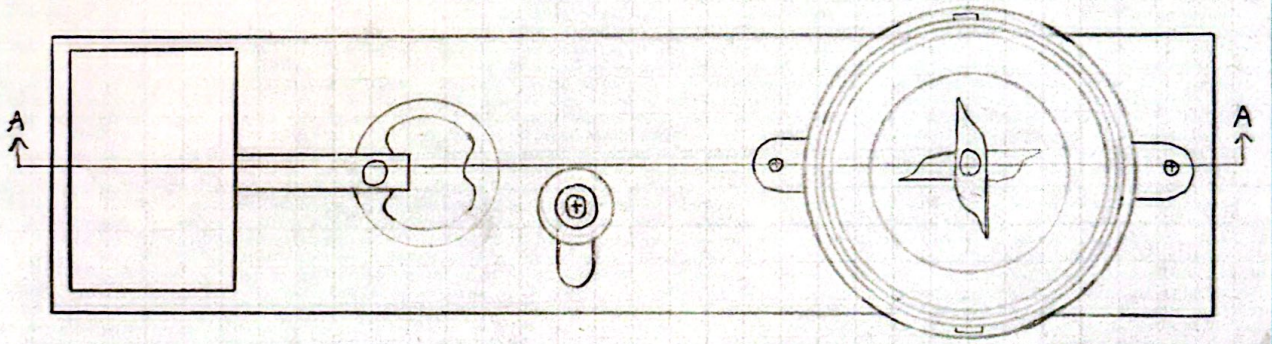
Conceptual Design Sketches

MIXER ASSEMBLY

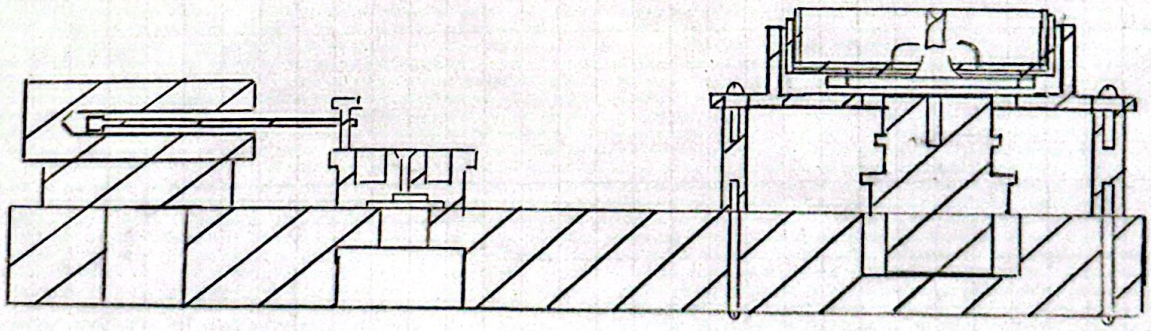
SIDE



TOP



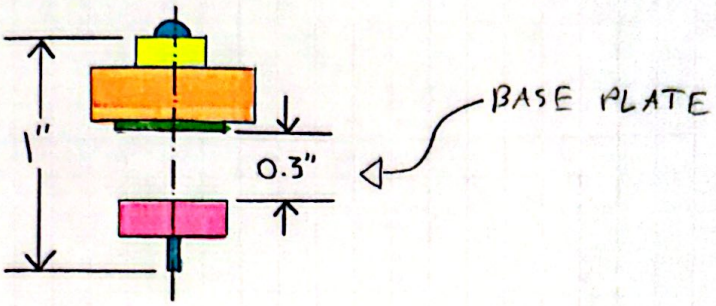
SECTION A-A



* BELT OMITTED FOR VISIBILITY

TENSIONER CONSTRUCTION

SIDE



- SCREW
- TENSIONER ARM
- BEARING
- SPACER
- NUT

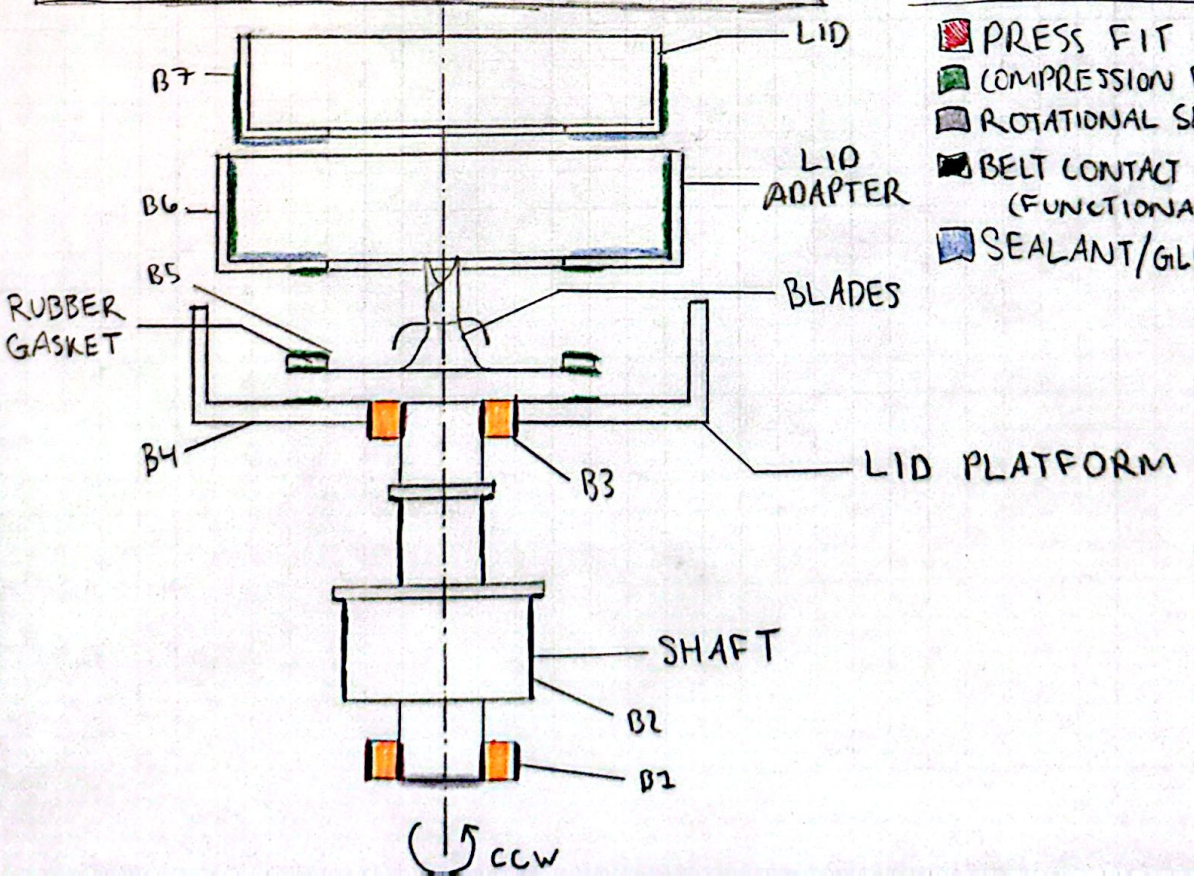
A1 - TENSIONER ARM
A2 - BEARING
A3 - BASE
A4 - NUT
A5 - FLYWHEEL

B1 - BEARING
B2 - SHAFT
B3 - BEARING
B4 - LID PLATFORM
B5 - RUBBER GASKET
B6 - LID ADAPTER
B7 - LID

LID/SHAFT CONSTRUCTION

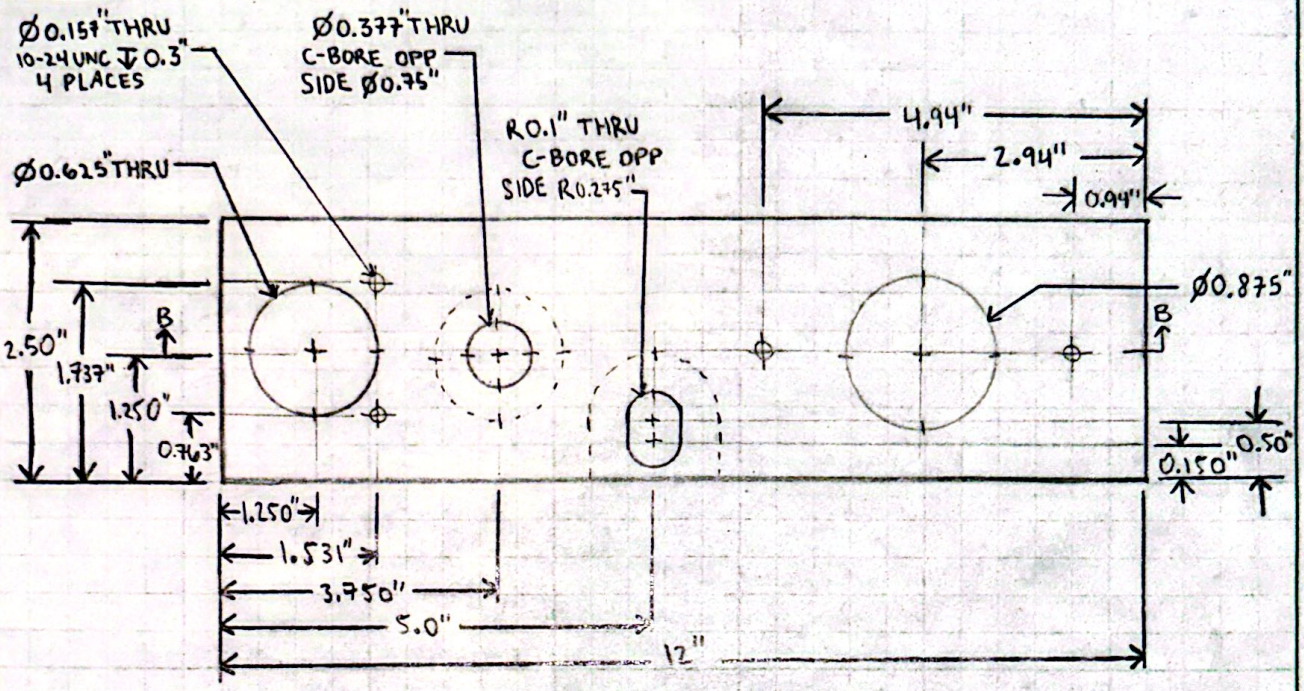
SECTION VIEW

- PRESS FIT
- COMPRESSION FIT
- ROTATIONAL SLIDING
- BELT CONTACT (FUNCTIONAL)
- SEALANT/GLUE

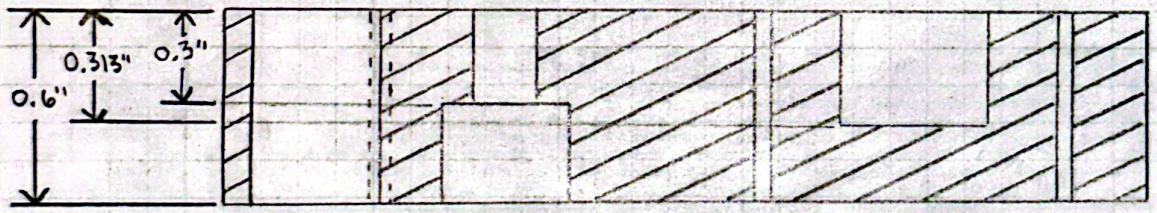


BASE (MODIFIED AIR ENGINE BASE)

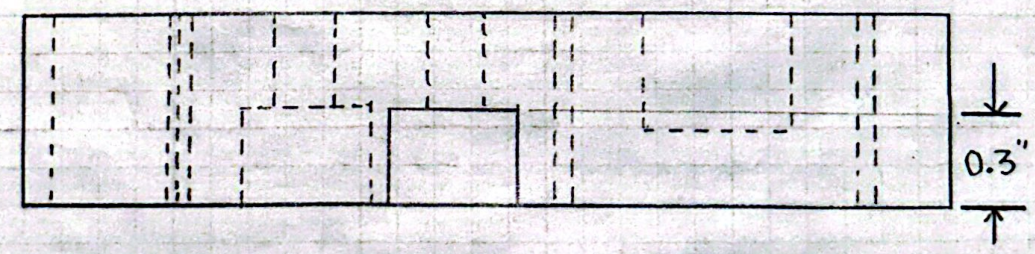
TOP



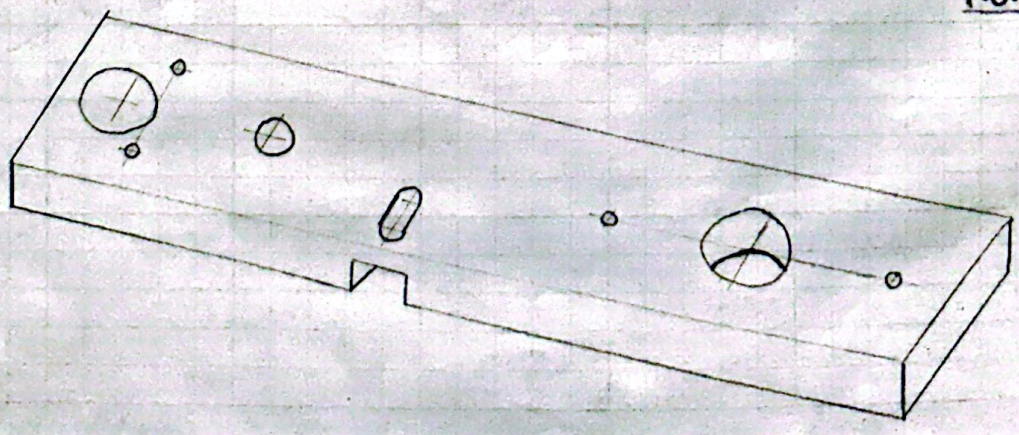
SECTION B-B



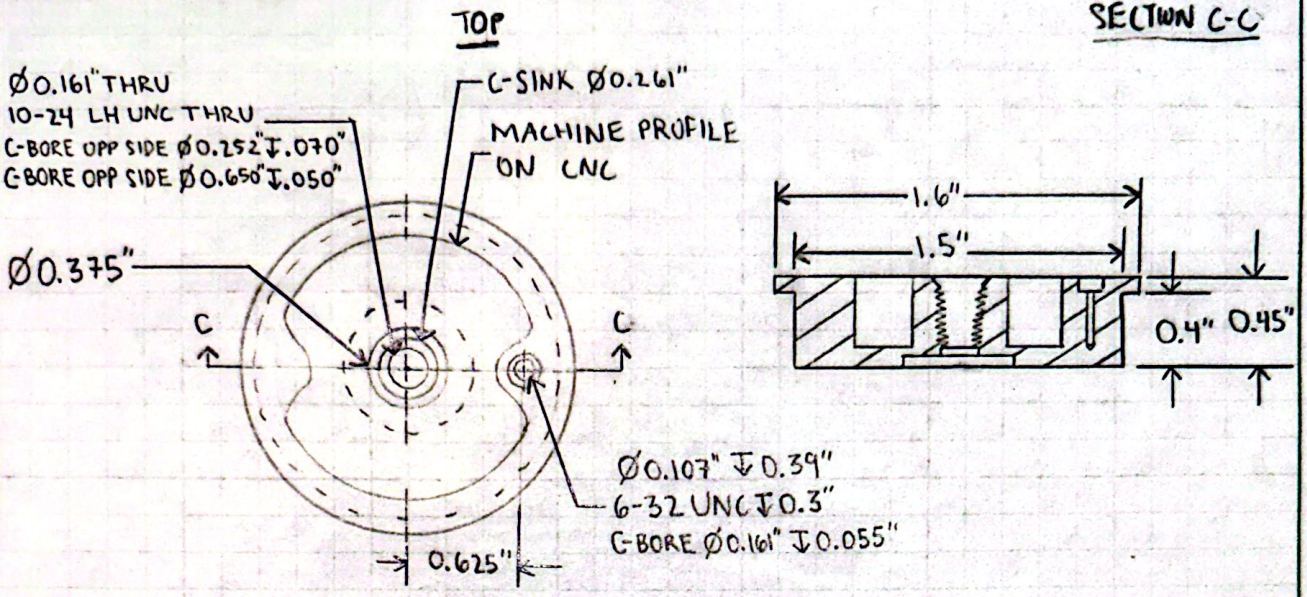
SIDE



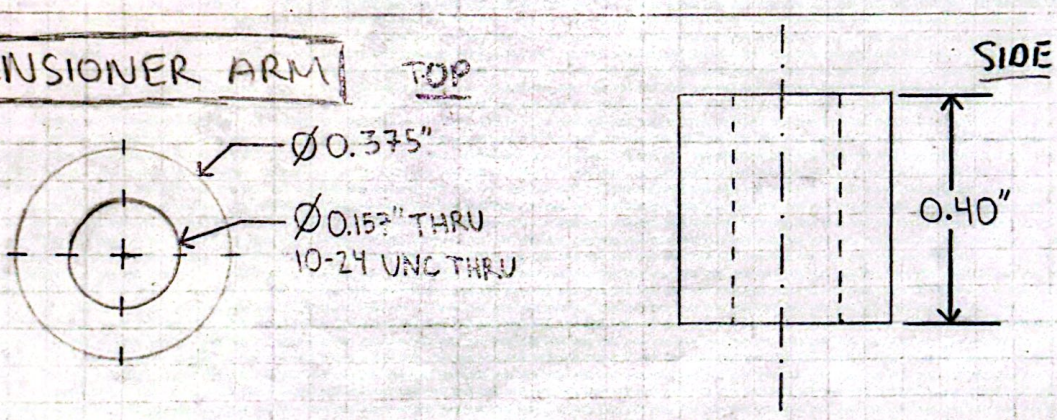
ISOMETRIC



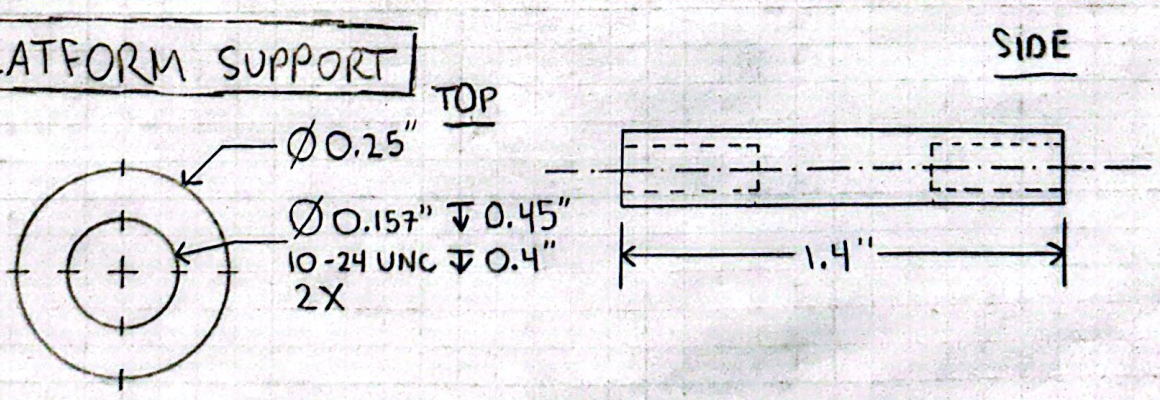
FLYWHEEL (MODIFIED AIR ENGINE FLYWHEEL)



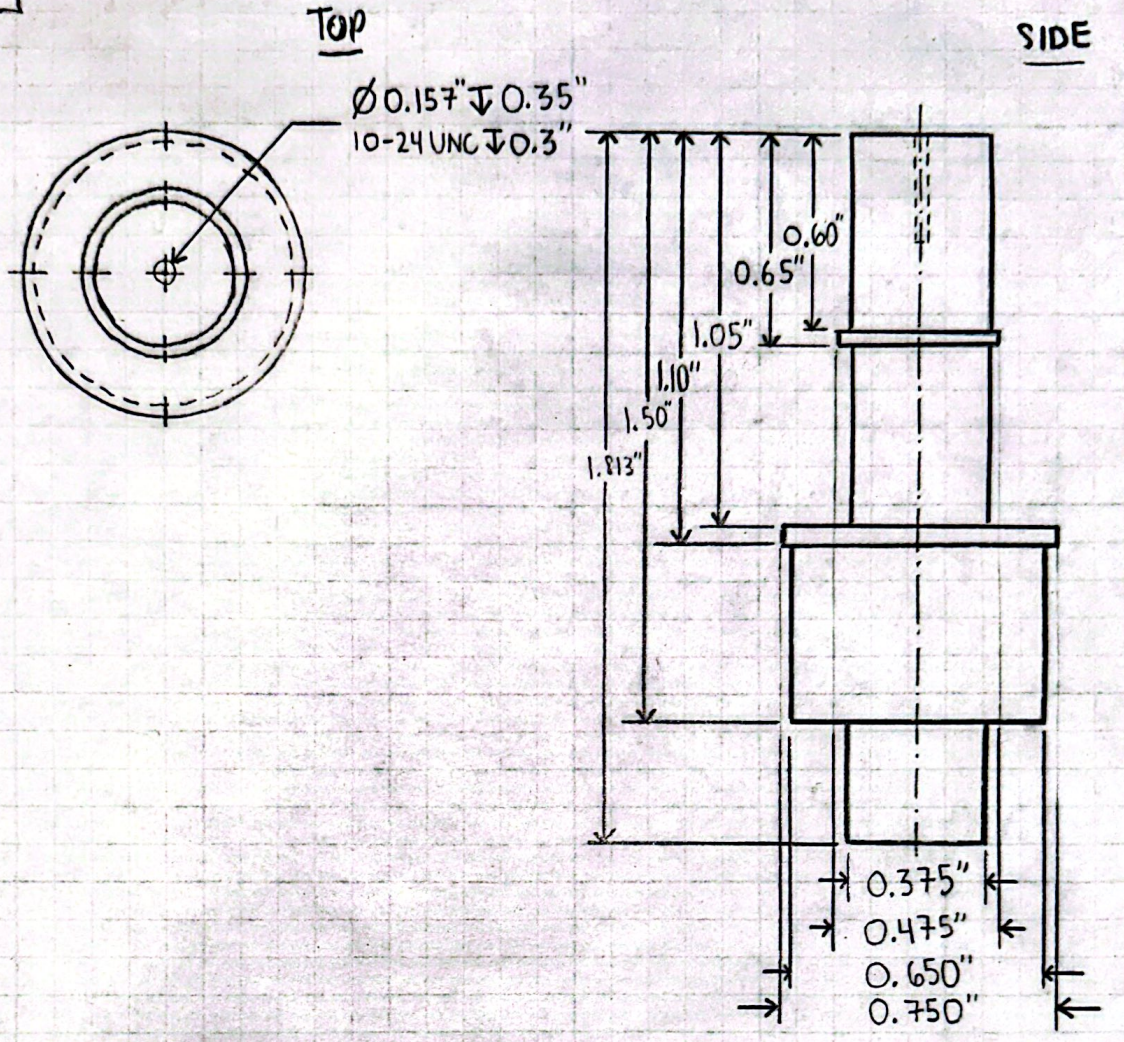
TENSIONER ARM



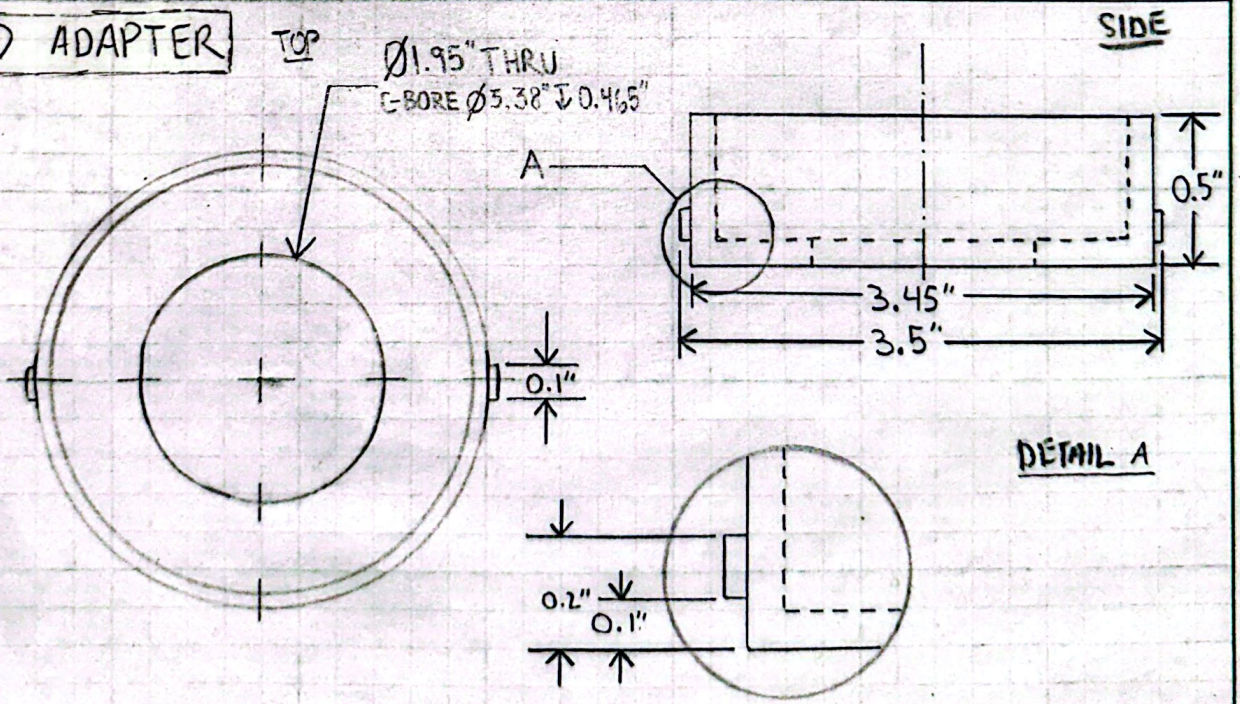
PLATFORM SUPPORT



SHAFT

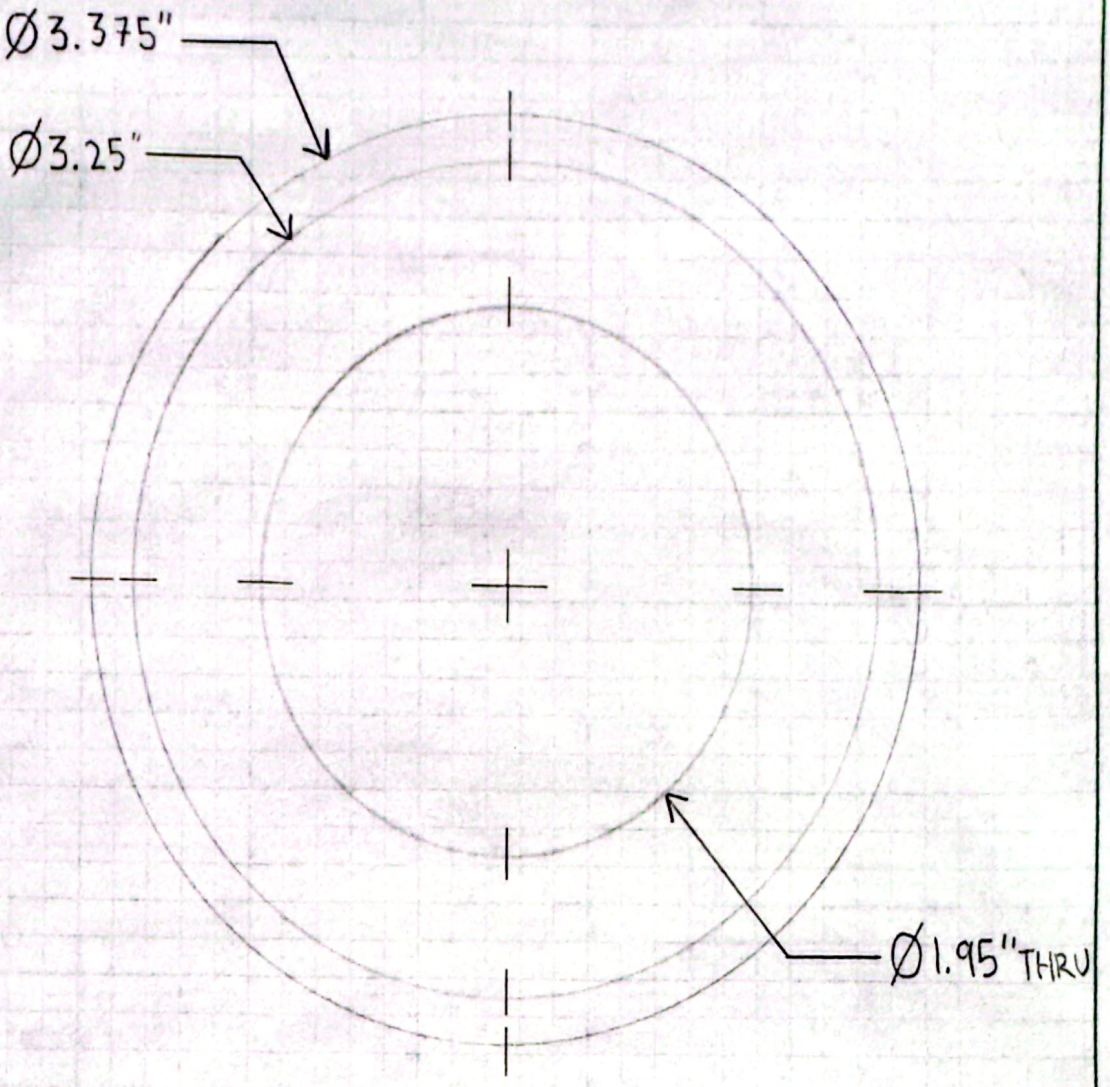


LID ADAPTER



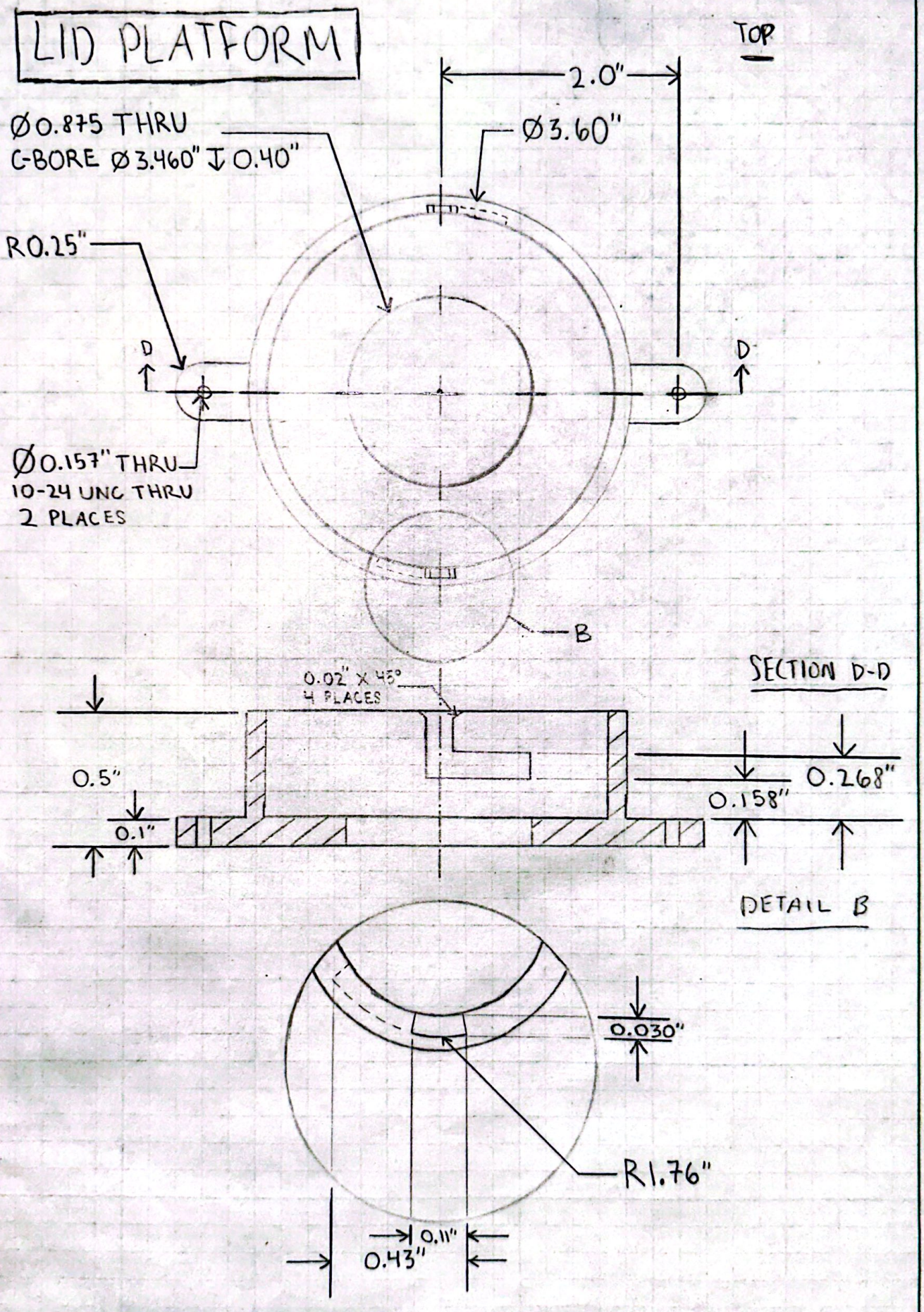
LID

TOP



* STANDARD OTS ONE-PIECE WIDE MOUTH MASON JAR LID WITH CENTER THRU HOLE.

LID PLATFORM



Design Specifications Table

EML2322L Design Specification Table

Line #	Component (Name and/or Part Number)	Description / Size	Critical Surfaces (surface IDs and brief description)	Material	Vendor (if applicable)	Cost	Qty.	Justification / Notes
1	Base	7.5" x 2.5" x 0.625	A1 - bottom surface interacting with base to clamp down A2 - bearing pushes outward, keeping tension on the belt for 2-step shaft. A4 - nut clamps from top surface to base using a screw.	6061 Aluminum	McMaster Carr	$ 9.12	1.00	8ft x 2.5" x 0.625" ~ $116.65; 116.65 / 8 / 12 x 7.5 = $9.12
2	Flywheel	OD 1.625” ID 1.495” x 0.05	A5 - Surface diameter static friction driving the belt. Critical for functionality.	4130 Alloy Steel	McMaster Carr	$ 0.07	1.00	OD 1.625” ID 1.495” x 6ft ~ $94.65; 94.65 / 6 / 12 x 0.05 = $0.07
3	Shaft	Diam 0.75” x 1.813"	B1 - press fit with shaft and A3 B2 - contact with belt, critical for functionality B3 - press fit with B2 and lid platform for stability	6061 Aluminum	McMaster Carr	$ 0.60	1.00	Diam 0.75” x 12ft ~ $47.55; 47.55 / 12 / 12 x 1.813 = $0.60
4	Platform Support	Diam 0.25" x 1.4"	N/A	6061 Aluminum	McMaster Carr	$ 0.30	2.00	Diam 0.25” x 12ft ~ $15.41; 15.41 / 12 / 12 x 1.4 = $0.15
5	Lid Platform	Diam 3.6" x 0.5"	B4 - compression fit with rubber gasket. Incorporates a bayonet twist lock mechanism for interchangeability.	3D Printed PETG	Amazon	$ 0.14	1.00	Volume (CAD) = 21.31 cm^3; (Conservative 40% infill) 21.31 x 0.4 x 1.27 g/cm^3 x 1kg/1000g x $124/10kg = $0.14
6	Lid Adapter	OD 3.5” ID 3.25” x 0.5	B6 - compression fit with B5 to ensure food seal. Bonding agent on upper face.	6061 Aluminum	McMaster Carr	$ 1.13	1.00	OD 3.5” ID 3.25” x 6ft ~ $161.91; 161.91 / 6 / 12 x 0.5 = $1.13
7	Lid (OTS01)	Thread 86-460, 3.375" x 0.5" Tall	B7 - compression fit with B5 to ensure fothread seal. Bonding agent on upper face.			$ 0.75	1.00	
8	Belt (6082K51) (OTS02)	Wd. 0.25" x Th. 0.03" x 14" Long	A5 - Connects to moified flywheel to drive mechanism. B2 - low speed bottom diameter, high speed upper diameter, friction is critical for functionality.	Buna-N	McMaster Carr	$ 14.00	1.00	
9	Tensioner Arm	Diam 0.875” x 0.4"	A1 - press fit bearing. Static friction with A3 upper face holding tensioner in place.	6061 Aluminum	McMaster Carr	$ 21.00	1.00	Diam 0.875” x 8ft ~ $48.30; 48.30 / 8 / 12 x 0.4 = $0.21
10	1" Screw (6-FMPP-10C100) (OTS03)	10-24 Thread		Stainless Steel	Marine Bolt Supply	$ 0.81	3.00	$0.27 per unit x 3 = $0.81 https://marineboltsupply.com/products/size-10-24-x-1-type-316-stainless-steel-phillips-drive-pan-head-machine-screws
11	0.5" Screw (6-FMPP-10C050) (OTS04)	10-24 Thread		Stainless Steel	Marine Bolt Supply	$ 0.40	2.00	$0.20 per unit x 2 = $0.40 https://marineboltsupply.com/products/size-10-24-x-1-2-type-316-stainless-steel-phillips-drive-pan-head-machine-screws?variant=42275532603454
12	Bearing (BB-R6-ZZ/1) (OTS05)	OD 0.875" ID 0.375" x 0.281" Tall		Chrome Steel	PGN Bearings	$ 1.95	3.00	$0.65 each x 3 = $1.95 https://pgnbearings.com/products/r6-zz-ball-bearing-3-8x7-8x9-32?variant=20475623473265&country=US&currency=USD&utm_medium=product_sync&utm_source=google&utm_content=sag_organic&utm_campaign=sag_organic
13	Spacer (WBB511839) (OTS06)	0.375" ID x 0.625" OD x 0.031" Tall		Low Carbon, Full Hard Steel	Global Industrial	$ 1.15	1.00	$11.50 pack x 10/pack = $1.15 https://www.globalindustrial.com/p/38-inch-id-x-58-inch-od-x-0031-inch-steel-arbor-shim-pack-of-10

14	Nut (0000-103719) (OTS07)	Diam 0.375" x 0.130"		Stainless Steel 18-8	ASMC Industrial	$ 0.17	1.00	Price per Piece: $0.1620 = $0.17 https://www.asmc.net/10-24-coarse-thread-hex-machine-screw-nut-stainless-steel-18-8/#
15	Oster Drive Pin (OS-070) (OTS08)	0.394" x 0.394" x 0.75"		Zinc-Plated Carbon Steel	Goodman's	$ 0.79	1.00	
16	Oster Blade Cutter (OS-010) (OTS09)	Diam 2.59" x 2.2" Tall		304 Stainless Steel	Goodman's	$ 4.69	1.00	
17	Food Grade Silicone Sealant (FGSASI502W-T)	Area = $\pi((3.38/2)^2 - (1.95/2)^2)$ Height = 0.05"		ASI 502 Food Grade Silicone Sealant	TechnologyLK	$ 0.41	1.00	2.8 oz = 79.3787 g, 1.02 g/cm³, $\pi(R^2 - r^2)$ = Area (R = 3.38/2", r = 1.95/2"), glue thickness 0.05"; $\pi((3.38/2)^2 - (1.95/2)^2)$ x 0.05" = 0.299 in³ =4.90 cm³ x 1.02 g/cm³ x $6.42/79.3787g = $0.4046 https://www.technologylk.com/white-food-grade-silicone-sealant--28-oz-squeeze-tube-lk-fgsasi502w-t.htm
18	Weld Filler	Diameter 0.0625" with 36" length		ER70S-2 mild carbon steel alloy copper coated	Amazon	$0.10	1.00	Area = (0.8^2 - 0.75^2) x π = 0.2435 in^2 x Heigh 0.05" = 0.0122 in^3 x 1cm^3/16.3871in^3 x 7.85 g/cm³ x 1lb/453.592g x $17.00/5lb = $0.000044 round to $0.10 just in case