

# **Design Report 1**

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EML2322L – Summer 2026

# Design Description

The following design is for an air engine powered mixer attachment that uses the provided compressed-air engine to drive a blender blade inside a standard wide-mouth mason jar. The air engine is mounted to an aluminum Base (P1), which also supports the Shaft (P2), tensioner assembly, and H-Block subassembly. The base is made from 6061 aluminum for strength, rigidity, and machinability. Bearing 1 (OTS07) is press fit into the lower bearing counterbore (A1) to support the shaft. The H-Block (P3) is located using snug fitment pockets (A2), keeping the jar interface aligned with the shaft. Four shoulder screws (OTS16) pass through the base and thread into the H-Block at (A3/B4), clamping the subassembly to the base. Stacked hex jam nuts (OTS11) are epoxied to the bottom of the base at (A4) to provide clearance for the lower tensioner knob and improve stability.

Rotational power is transferred from the air engine flywheel to the shaft using a 1/4 inch wide flat belt (OTS15). The flywheel and belt rotate counterclockwise, transferring torque through the flywheel contact surface (D2). The belt wraps around either the smaller step pulley diameter (D1) or larger step pulley diameter (D4) on the shaft. These two diameters provide mechanical speed adjustment. To change speeds, the user loosens the tensioner, moves the belt to the desired pulley diameter, and retightens the tensioner.

The tensioner assembly is placed on the right side of the lower belt span since the flywheel drives the belt counterclockwise, the tensioner is placed there to press into the slack side and maintain belt engagement without interfering with the tight power-transmitting span. This pushes into the slack side and improves belt grip between the flywheel and step pulley. The tensioner consists of a 1/4-20 male threaded star knob (OTS09), washer shims (OTS10), two Bearing 2 bearings (OTS08), hex jam nuts (OTS11), a thick flat washer (OTS12), and a T-style through knob (OTS13). The star knob applies clamping force at (F1), while washer shims at (F1/F3) separate the stack so the bearings rotate freely. Bearing 2 contacts the belt at (F2/D3), allowing rolling contact instead of sliding. Jam nuts lock the stack height at (F4), the T-style knob tightens from below at (F5), and the thick flat washer spreads the clamp load at (F6). The threaded stack is oriented so belt force does not loosen the tensioner, and the base slot allows hand adjustment.

The low carbon steel Shaft (P2) transmits rotation from the step pulley to the blade attachment. Low carbon steel was selected to resist belt-induced radial bending loads and torsional shear at the drive interface. The lower shaft surface (C2) press fits into Bearing 1 in the base, while the upper shaft surface (C1) press fits into a second Bearing 1 in the H-Block counterbore (B2). This two-bearing layout keeps the shaft concentric and reduces wobble. The top threaded drive hole (C3) accepts the Oster square drive pin (OTS14), which engages the female drive socket of the Oster 4961 blade housing (OTS06).

The H-Block (P3) supports the jar interface and houses the upper bearing, Oster 4961 blade housing, rubber gasket, and Lid Block (P4). It is made from PETG at 40% infill to satisfy the one-additively-manufactured-part limit while allowing the complex support geometry to be printed with sufficient strength. The bearing counterbore (B2) aligns the shaft with the center of the jar. Above it, the Oster 4961 blade housing sits inside the Oster/gasket counterbore (B3), which locates the housing and provides the lower sealing surface. From bottom to top, the jar interface stack is the H-Block, upper Bearing 1, shaft and drive pin, Oster 4961 blade housing, rubber gasket, modified mason jar lid, Lid Block, and mason jar. The Oster 4961 stainless/rubber assembly and the mason jar lid liner are the intended food-contact surfaces; the epoxy bond, PETG H-Block, aluminum Lid Block, and low carbon steel shaft are outside the sealed food-contact volume.

The Lid Block (P4) locks into the H-Block using two opposing L-style twist-lock tabs. The tabs slide into the H-Block slots and rotate along the twist-lock interface (B1), pulling the Lid Block downward. This compresses the modified mason jar lid, rubber gasket, and Oster blade housing into the H-Block counterbore (B3), seating the blade housing and helping prevent leakage. The twist-lock design also allows the lid and blade assembly to be removed without tools for cleaning or for swapping compatible Oster-style attachments. Other attachments can be used if they have the proper Oster-style housing and matching square drive pin interface.

A standard wide-mouth mason jar lid (OTS05) is modified with a center clearance hole (E2) so the Oster 4961 blade housing can pass through it. The modified jar lid is bonded to the aluminum Lid Block using 3M DP420 epoxy at (E1), preventing rotation between the lid and Lid Block during mixing. Once assembled, the mason jar screws into the modified OTS lid while the H-Block and Lid Block maintain gasket compression. The jar is retained by its threaded engagement with the modified OTS lid, while the lid block twist-lock prevents the lid/blade assembly from lifting out of the H-Block.

Overall, the design converts air engine flywheel rotation into controlled blade rotation using a flat belt, step pulley, and adjustable tensioner. The base and H-Block constrain the shaft with two press-fit bearings, while the tensioner maintains belt tension and enables tool-free speed adjustment. Material choices match component function: 6061 aluminum provides rigid support, low carbon steel resists shaft loading, PETG enables the H-Block geometry, and the stainless/rubber Oster assembly provides the food-contact blade and gasket interface.

# 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                                   | P1- Base                                                                 | 4.875" x 12.125" x 0.5"                                                                   | A1 - Bearing counterbore - press fit for lower shaft bearing<br>A2 - H-block pockets - locate H-block feet on base<br>A3 - Shoulder screw seats - clamp H-block to base<br>A4 - Foot bonding pads - epoxy surface for stacked hex nut feet                          | Aluminum 6061                          | McMaster Carr          | \$17.18 | 1.00 | 12" x 96" @ 0.5" thick = \$ 329.30; 0.29 \$ per square inch: 4.875" x 12.125" = 59.11 x \$ 0.29 = \$17.14                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 2                                   | P2 - Shaft                                                               | 1.5" x 2.825" Round                                                                       | C1 - Upper bearing surface - press fit into upper Bearing 1<br>C2 - Lower bearing surface - press fit into lower Bearing 1<br>C3 - Threaded drive hole - accepts Oster square drive pin<br>D1/D4 - Step pulley grooves - belt contact surfaces for speed change     | Low Carbon Steel                       | McMaster Carr          | \$3.70  | 1.00 | 1.5" x 144" Round = \$188.58; 1.31\$ per inch in height @1.5" Diameter: 2.825" x 1.31\$ = 3.70\$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 3                                   | P3 - H-Block                                                             | 4.375" x 4.375" x 3.076"                                                                  | B1 - L-lock slots - rotational sliding lock for lid block<br>B2 - Bearing counterbore - press fit for upper shaft bearing<br>B3 - Oster/gasket counterbore - locates blade housing and gasket seal<br>B4 - Threaded screw holes - shoulder screw attachment to base | PETG @ 40% Infill                      | Amazon                 | \$5.27  | 1.00 | 4.375" x 4.375" x 3.076" = 58.877 inches cubed = 964.82 centimeters cubed; 964.82 x 1.27 g/cm^3 (density of PETG) = 1225.32 grams x 0.40 (infill 40%) = 490.13 grams. \$10.75 per 1000 grams; 10.75(490.13/1000) = \$5.27 total cost of filament                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 4                                   | P4 - Lid Block                                                           | 3.756" Diameter, 0.563" Thick                                                             | B1 - L-lock tabs - twist into H-block slots<br>E1 - Bonded lid bore - epoxy interface for mason jar lid                                                                                                                                                             | Aluminum 6061                          | McMaster Carr          | \$7.92  | 1.00 | 4.0" 72" Round = \$710.87; \$1.27 per cubic inch: (pi)(0.563)(3.756/2)^2 = 6.23 cubic inches x \$1.27 = \$7.92                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 5                                   | OTS05 - Mason Jar Lid                                                    | 86-460 3.38" OD, 3.25" ID, 0.5" Height                                                    | E1 - Bonded outer surface - epoxy interface with lid block<br>E2 - Center clearance hole - clearance for Oster blade housing                                                                                                                                        | Gold-Coated Metal with Plastisol Liner | Fillmore Container     | \$0.56  | 1.00 | 6 Cases of 600 = \$336.00 each case; \$336/600 = \$0.56 per lid<br><a href="https://www.fillmorecontainer.com/86-ct-gold-wide-mouth-plastisol.html">https://www.fillmorecontainer.com/86-ct-gold-wide-mouth-plastisol.html</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 6                                   | OTS06 - Oster 4961 Blade/ Blender Housing with Rubber Gasket             | 2.59" OD, 2.3" Height<br>Gasket: 2.59" OD, 1.95" ID, 0.063" Thick                         | B3 - Housing/gasket seat - compression fit in H-block counterbore<br>C3 - Female drive socket - receives Oster square drive pin                                                                                                                                     | Stainless Steel Rubber                 | Goodman's              | \$4.99  | 1.00 | This is where a user could use various attachments to fit the drive pin. As long that it interfaces the drive pin it would fit into the lid block.<br><a href="https://www.goodmans.net/i/2589/ice-crusher-blender-blade-cutter-for-oster-osteriz.htm?ref=google-shopping&amp;ref=i_2589&amp;source=ppc&amp;gad_source=1&amp;gad_campaignid=17954137573&amp;gbraid=0AAAAAD_tyGPokONLCBx6Irlu3qO9u8_Bk&amp;gclid=Cj0KCQjwof_QBhCgARIsADaMzOd7psgg8bxq_rJRzgx692qCanlv2Z1JBJeJ4MBWEwbsc3ZR5Gwwk4aAqfxEALw_wcB">https://www.goodmans.net/i/2589/ice-crusher-blender-blade-cutter-for-oster-osteriz.htm?ref=google-shopping&amp;ref=i_2589&amp;source=ppc&amp;gad_source=1&amp;gad_campaignid=17954137573&amp;gbraid=0AAAAAD_tyGPokONLCBx6Irlu3qO9u8_Bk&amp;gclid=Cj0KCQjwof_QBhCgARIsADaMzOd7psgg8bxq_rJRzgx692qCanlv2Z1JBJeJ4MBWEwbsc3ZR5Gwwk4aAqfxEALw_wcB</a> |
| 7                                   | OTS07 - Ball Bearing 1 (R8-2RS Double Rubber Sealed Roller Ball Bearing) | 0.5" ID, 1.125" OD, 0.3125" Height                                                        | A1/B2 - Outer race fits - press fit into base and H-block<br>C1/C2 - Inner race fits - press fit onto shaft                                                                                                                                                         | Alloy Steel, Rubber                    | Amazon                 | \$1.50  | 2.00 | 10 pack = \$7.49; \$7.49/10 = \$0.749 per bearing x 2 = \$1.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 8                                   | OTS08 - Ball Bearing 2 (Shielded Z2 Lever Ball Bearing)                  | 0.25" ID, 0.75" OD, 0.28125" Height                                                       | F2/D3 - Tensioner roller surface - bearing OD contacts belt                                                                                                                                                                                                         | Alloy Steel                            | Amazon                 | \$2.40  | 2.00 | 10 pack = \$11.99; \$11.99/10 = \$1.199 per bearing x 2 = \$2.40                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 9                                   | OTS09 - 1/4-20 Male Thread Star Knob (Taytools 774007)                   | 1/4-20 male thread, 2" long , knob 2" diameter, 0.8" shoulder diameter, overall length 3" | F1 - Upper clamp surface - applies tensioner stack preload                                                                                                                                                                                                          | Alloy Steel                            | Amazon                 | \$1.97  | 1.00 | 10 pack = \$19.67; \$19.67/10 = \$1.97 per knob x 1 = \$1.97                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 10                                  | OTS10 - Washer Shims (99040A512)                                         | 0.25" ID, 0.375" OD, 0.012" Thick                                                         | F1/F3 - Spacer surfaces - separate bearings, knob, and jam nuts                                                                                                                                                                                                     | 18-8 Stainless Steel                   | McMaster Carr          | \$2.46  | 4.00 | 25 pack = \$15.40; \$15.40/25 = \$0.616 per washer x 4 = \$2.46                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

|        |                                               |                                                                                                          |                                                                                                                                                                       |                               |                   |         |       |                                                                                                                                                                                                                                     |
|--------|-----------------------------------------------|----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|-------------------|---------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11     | OTS11 - 1/4-20 Zinc Plated Finish Hex Jam Nut | 0.25" Diameter, 0.4375" Hex Size, 0.15625" Thick, 20 Threads per inch                                    | F4 - Locking nuts - set tensioner stack height<br>A4 - Foot nuts - stacked base feet bonded with epoxy                                                                | Zinc Plated Steel             | K.L.Jack          | \$0.41  | 11.00 | 100 pack = \$3.72; \$3.72/100 = \$0.037 per nut x 11 = \$0.41<br><a href="https://www.kljack.com/products/25cnfjz/">https://www.kljack.com/products/25cnfjz/</a>                                                                    |
| 12     | OTS12 - Thick Flat Washer                     | 1/4 Flat Washer Extra Thick (11/64"), 0.172" thick                                                       | F6 - Lower washer surface - distributes T-knob clamp force                                                                                                            | 18-8 Stainless Steel          | The Nutty Company | \$0.22  | 1.00  | 5000 pack = \$0.221 per washer<br><a href="https://www.nutty.com/1-4-flat-washer-extra-thick-11-64-18-8-stainless/">https://www.nutty.com/1-4-flat-washer-extra-thick-11-64-18-8-stainless/</a>                                     |
| 13     | OTS13 - T-Style 1/4-20 Thru Knob (QNB3001)    | 1/4"-20 thread, 0.25" Thread Depth, 1.25" Overall Height, 0.75" Width, 2" Long                           | F5 - Lower tightening surface - clamps tensioner to base slot                                                                                                         | Polymer Plastic, Plated Steel | Home Depot        | \$1.80  | 1.00  | 5 pack = \$8.99; \$8.99/5 = \$1.80 per knob x 1 = \$1.80                                                                                                                                                                            |
| 14     | OTS14 - Oster Drive Pin Square (OS-070)       | 0.75" in Height, 0.25" Thread Height, 0.50" Pin Height, 0.157" Thread Diameter, 0.25" x 0.25" Square Pin | C3 - Drive pin interface - threaded end screws into shaft and square end engages Oster blade socket                                                                   | Metal                         | Goodman's         | \$0.79  | 1.00  | Univen blender square drive pin stud<br><a href="https://www.goodmans.net/i/2599/square-drive-pin-for-oster-osterizer-blenders-shor.htm">https://www.goodmans.net/i/2599/square-drive-pin-for-oster-osterizer-blenders-shor.htm</a> |
| 15     | OTS15 - 1/4" Wide Flat Belt (6082K1)          | 0.03" Thick, 0.25" Width, 16" Long                                                                       | D1/D4 - Step pulley contact - transfers torque to shaft<br>D2 - Flywheel contact - receives torque from air engine<br>D3 - Tensioner contact - maintains belt tension | Buna-N, Nylon                 | McMaster Carr     | \$16.00 | 1.00  | \$1 per inch, Increments of 1 inch. Math: D1 = 1.5 in, D2 = 1.5 in, C = 5.50 in. L=2C + (pi)D; Plug in and get about 15.75" in Length. Tensioner accounts for extra slack.                                                          |
| 16     | OTS16 - Shoulder Screw (91259A540)            | 0.25" Diameter, 0.75" Shoulder Length, 0.375" Thread Length, 10-24 Thread                                | A3/B4 - H-block fasteners - clamp H-block to base                                                                                                                     | Alloy Steel                   | McMaster Carr     | \$6.24  | 4.00  | \$1.56 per x 4 = \$6.24                                                                                                                                                                                                             |
| 17     | OTS17 - 3M Scotch- Weld Epoxy Adhesive DP420  | 200mL container, only using 0.416 fl oz                                                                  | A4 - Foot bonding - bonds hex nut feet to base<br>E1 - Lid bonding - bonds mason jar lid to lid block                                                                 | DP420 Epoxy                   | Amazon            | \$7.62  | 1.00  | 200 mL = \$123.87; \$18.32 per fluid ounce. Coverage area is = 0.75 cubic inches 0.75/1.804 inches cubed per fl oz = 0.41 fl oz x \$18.32 = \$7.62 of material used.                                                                |
| TOTAL: |                                               |                                                                                                          |                                                                                                                                                                       |                               |                   | \$81.03 |       |                                                                                                                                                                                                                                     |

# Conceptual Design Sketches



[illegible]

Technical drawing of a circular part with concentric circles and dimensions. The drawing includes the following dimensions and features:

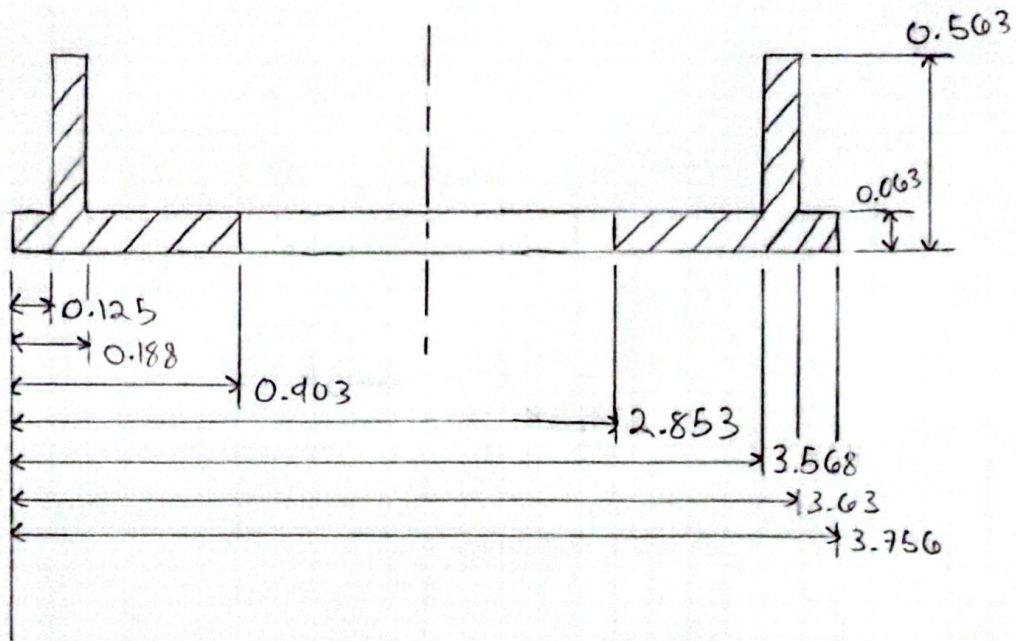
- Overall diameter:  $\varnothing 3.760 \pm 0.563$
- Innermost circle diameter:  $\varnothing 0.25$  THRU
- Second circle diameter:  $\varnothing 1.125 \pm 0.313$
- Third circle diameter:  $\varnothing 2.540 \pm 0.063$
- Fourth circle diameter:  $\varnothing 3.506 \pm 0.563$
- Four corner holes:  $4 \times \varnothing 0.25$  10-24 UNC  $\pm 0.40$
- Vertical dimensions (from top):  $4.375$ ,  $4.125$ ,  $3.875$ ,  $2.14$ ,  $0.50$ ,  $0.25$
- Horizontal dimensions (from left):  $0.25$ ,  $0.50$ ,  $2.14$ ,  $3.875$ ,  $4.125$ ,  $4.375$
- Section line A-A is indicated.



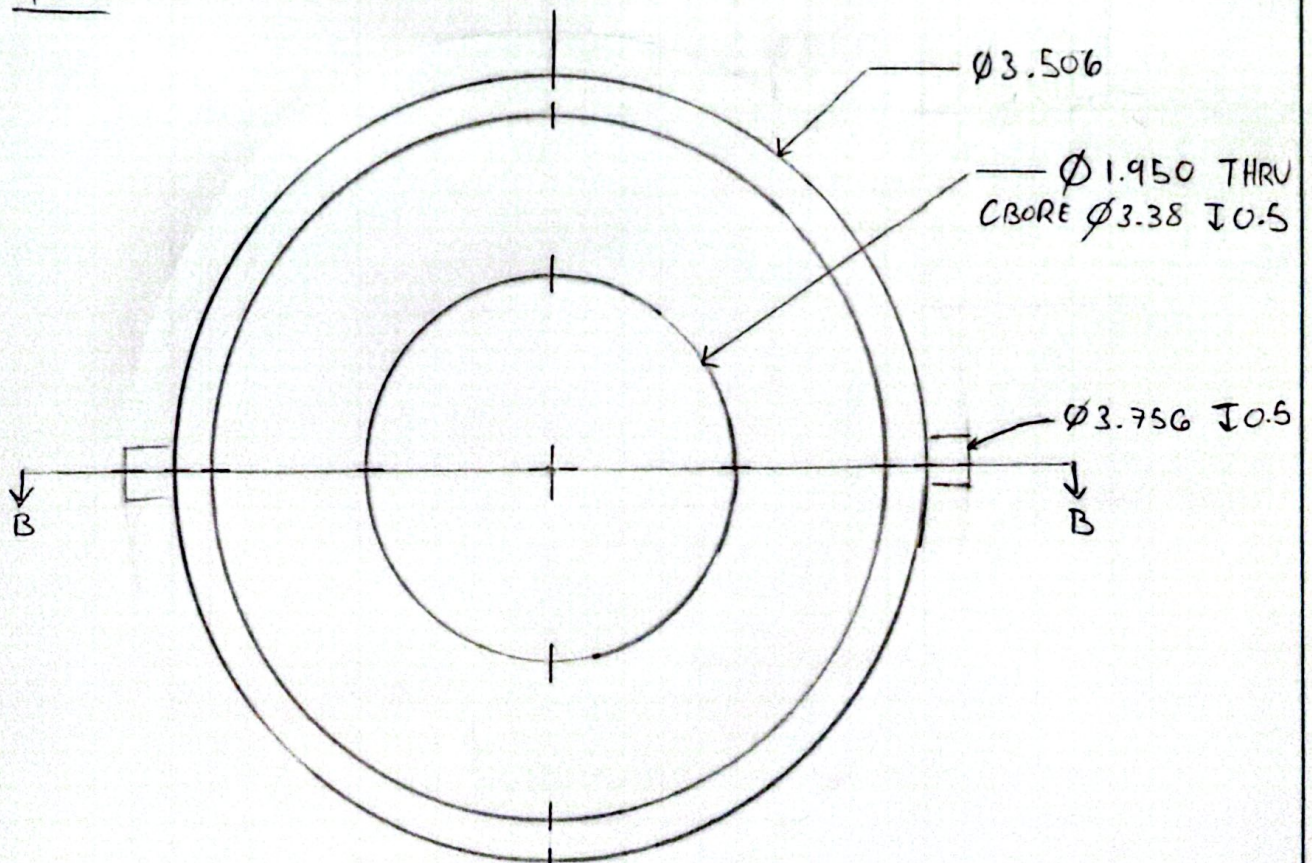
LID BLOCK

6061 Aluminum

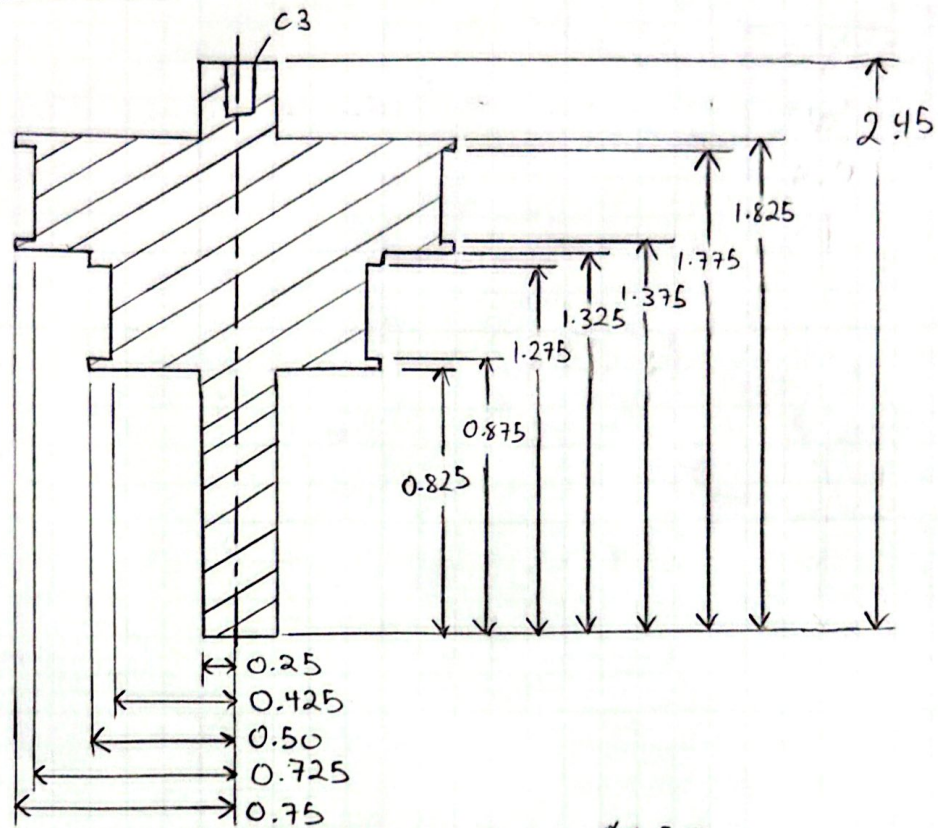
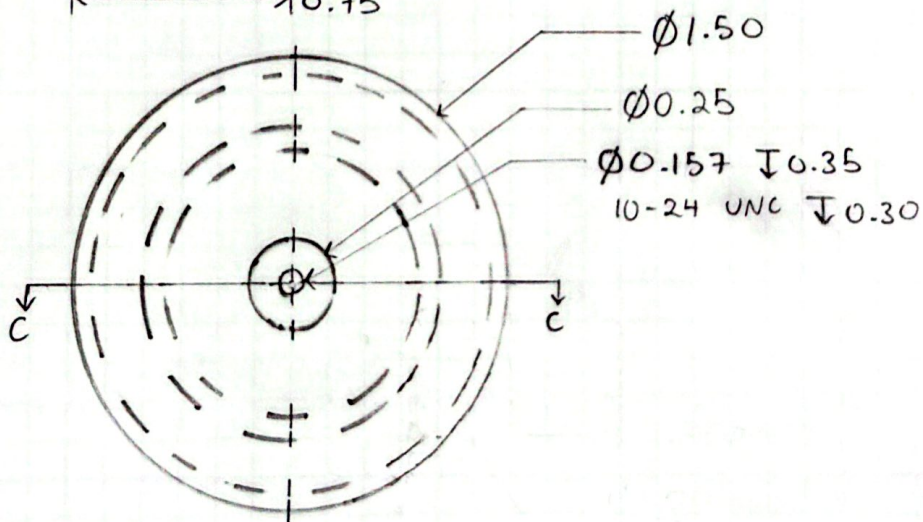
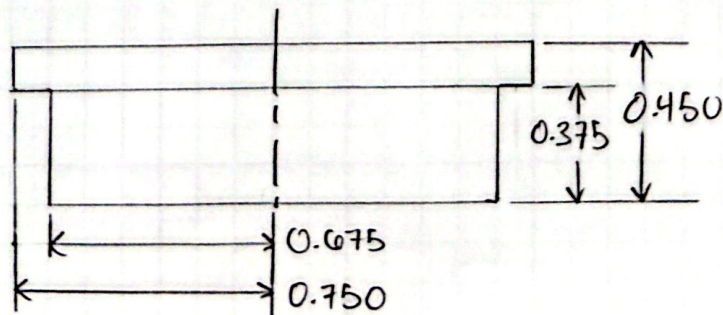
SECTION B-B



TOP





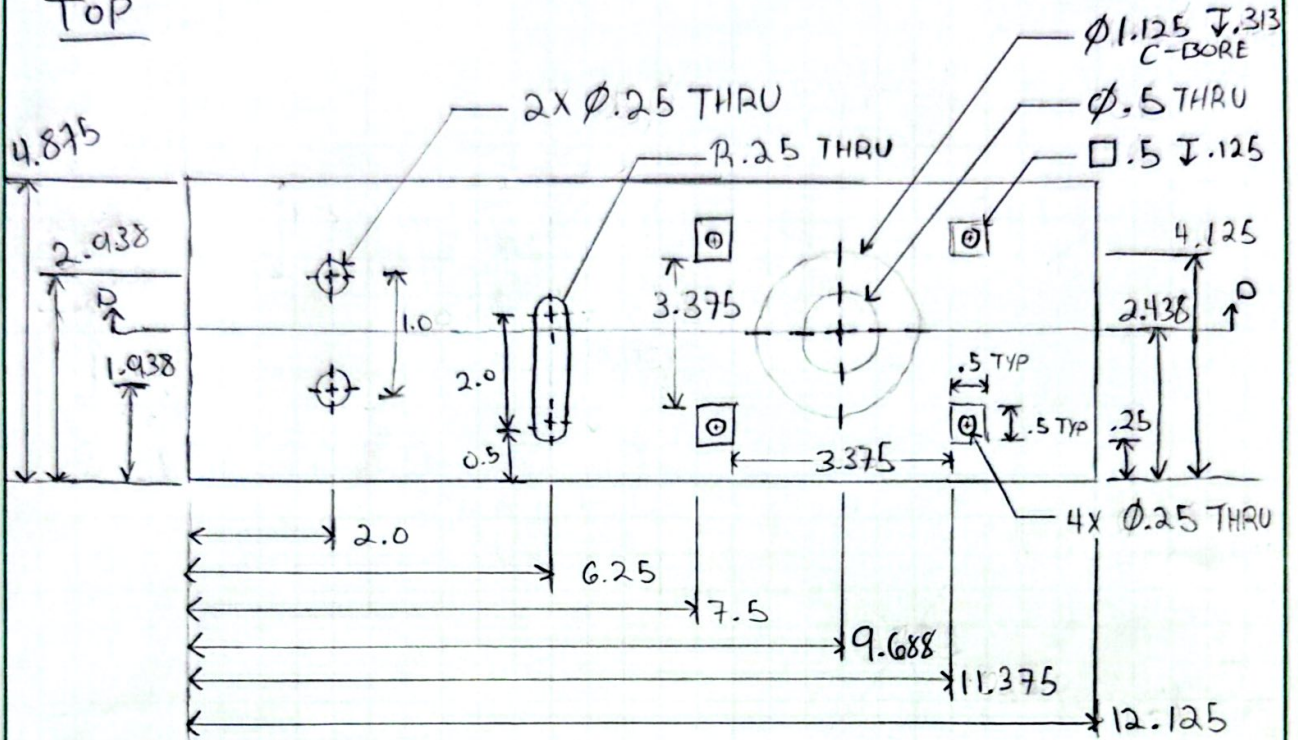
SECTION C-CTOPMODIFIED FLYWHEELSIDE



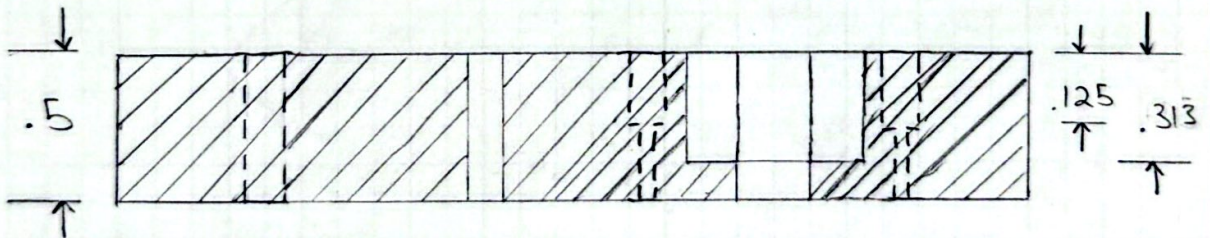
BASE

6061 Aluminum

TOP

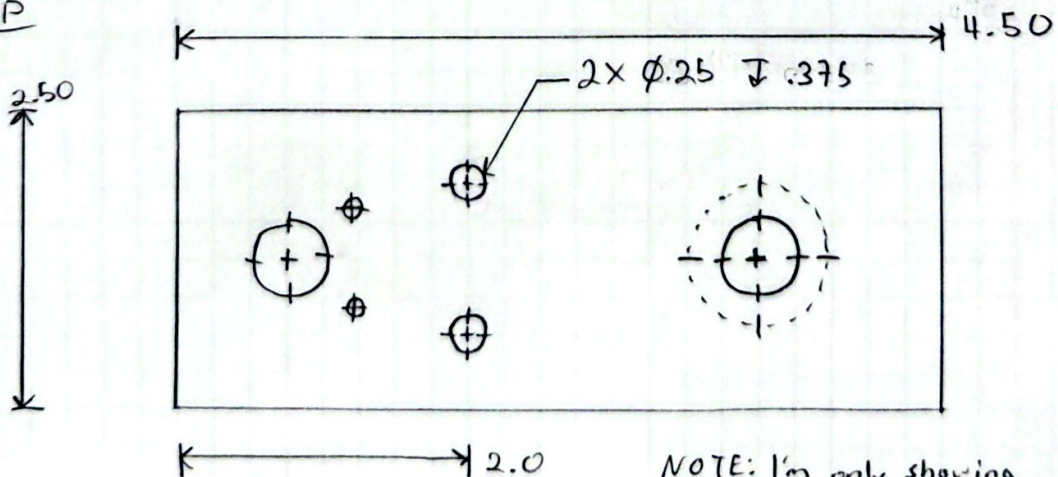


SECTION D-D



MODIFIED AIR ENGINE BASE

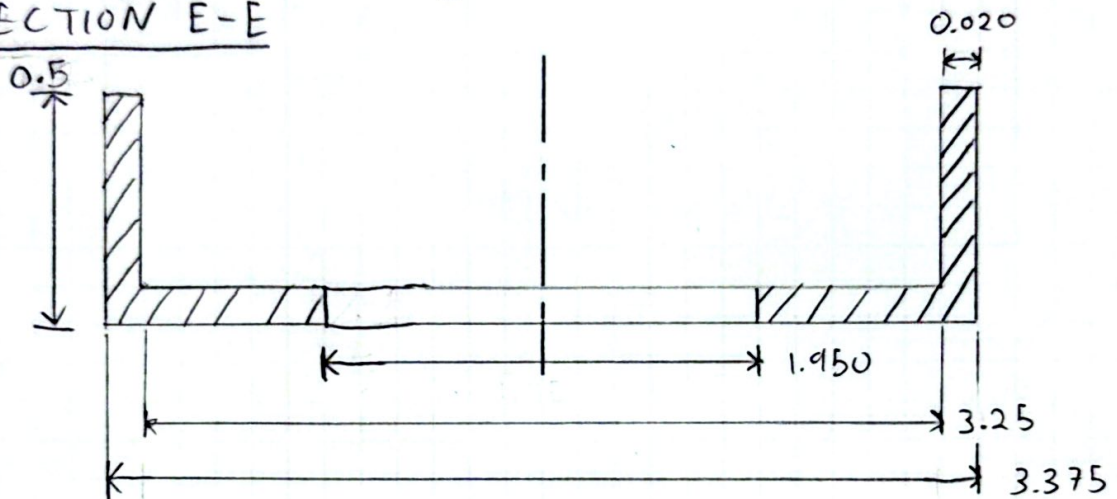
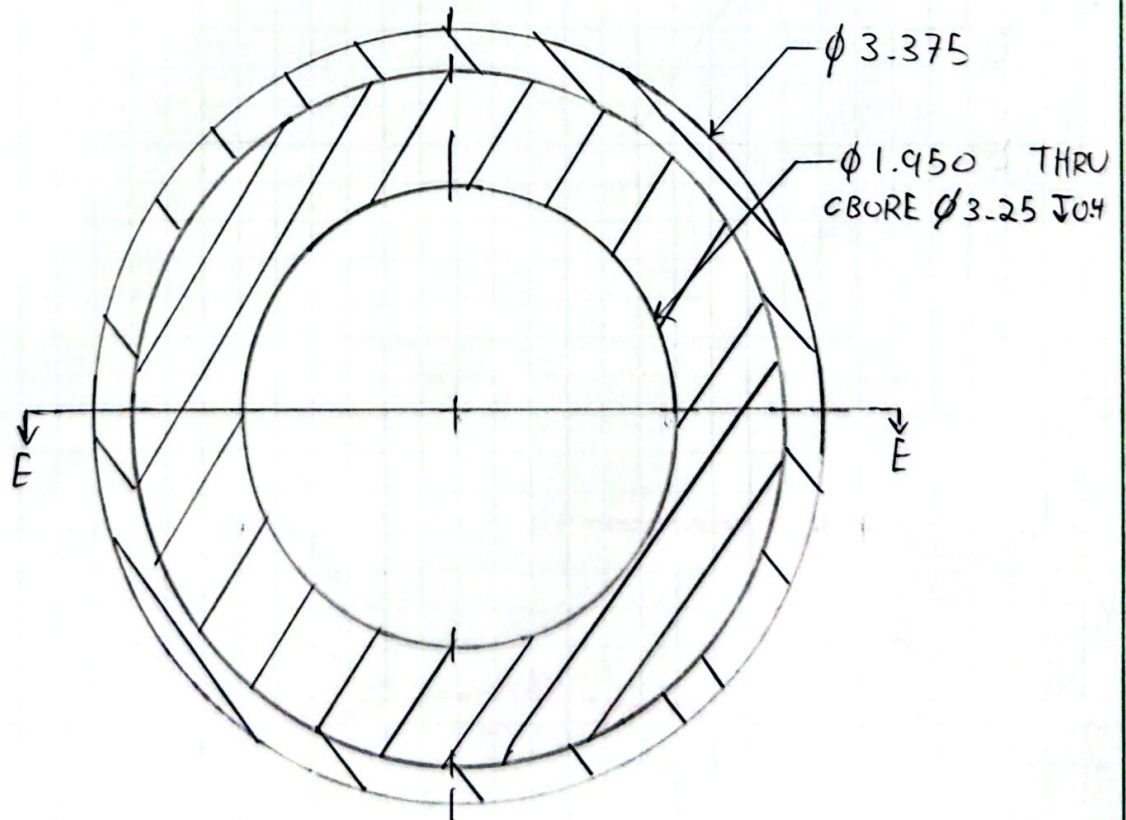
TOP



NOTE: I'm only showing modifications. All undimensioned holes are as per Air Engine Base.

CTOPS

- Taking a standard wide mouth, one-piece, mason jar lid
- Cutting a hole through the center

SECTION E-ETOP



# ASSEMBLY

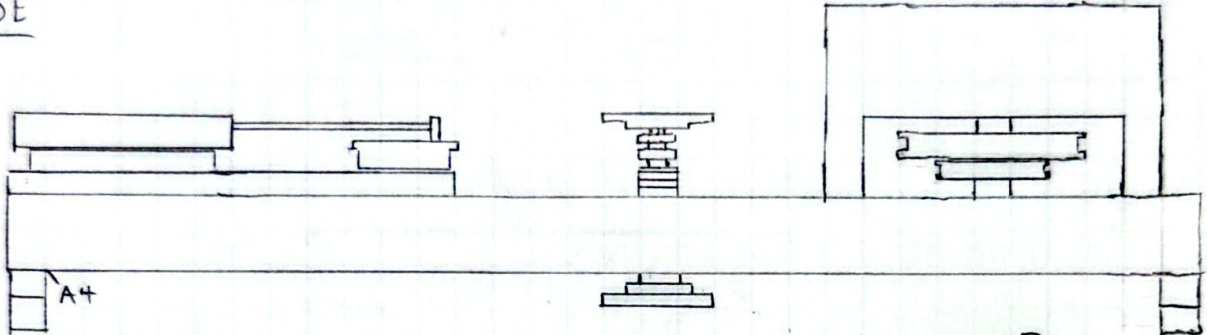
NOTE:

· Drawn without belt for clarity

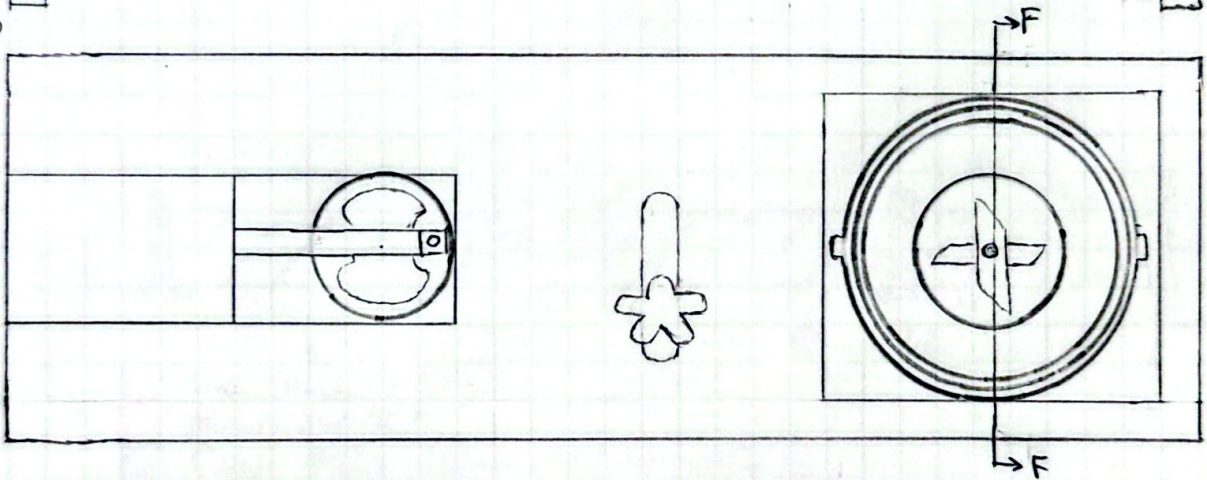
## Critical Surface Reference

|             |               |
|-------------|---------------|
| Base = A    | Belt = D      |
| H-Block = B | Lid Block = E |
| Shaft = C   | Tensioner = F |

SIDE

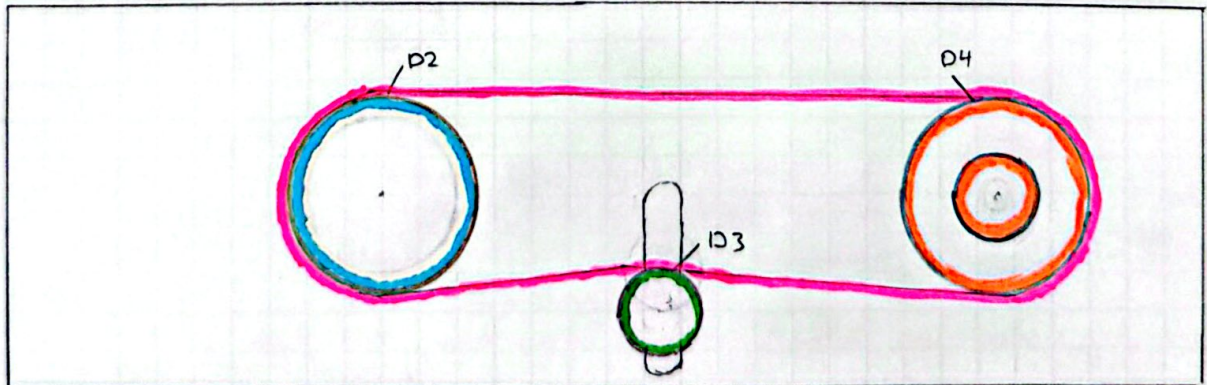


Top



## PULLEY SUB ASSEMBLY

Top



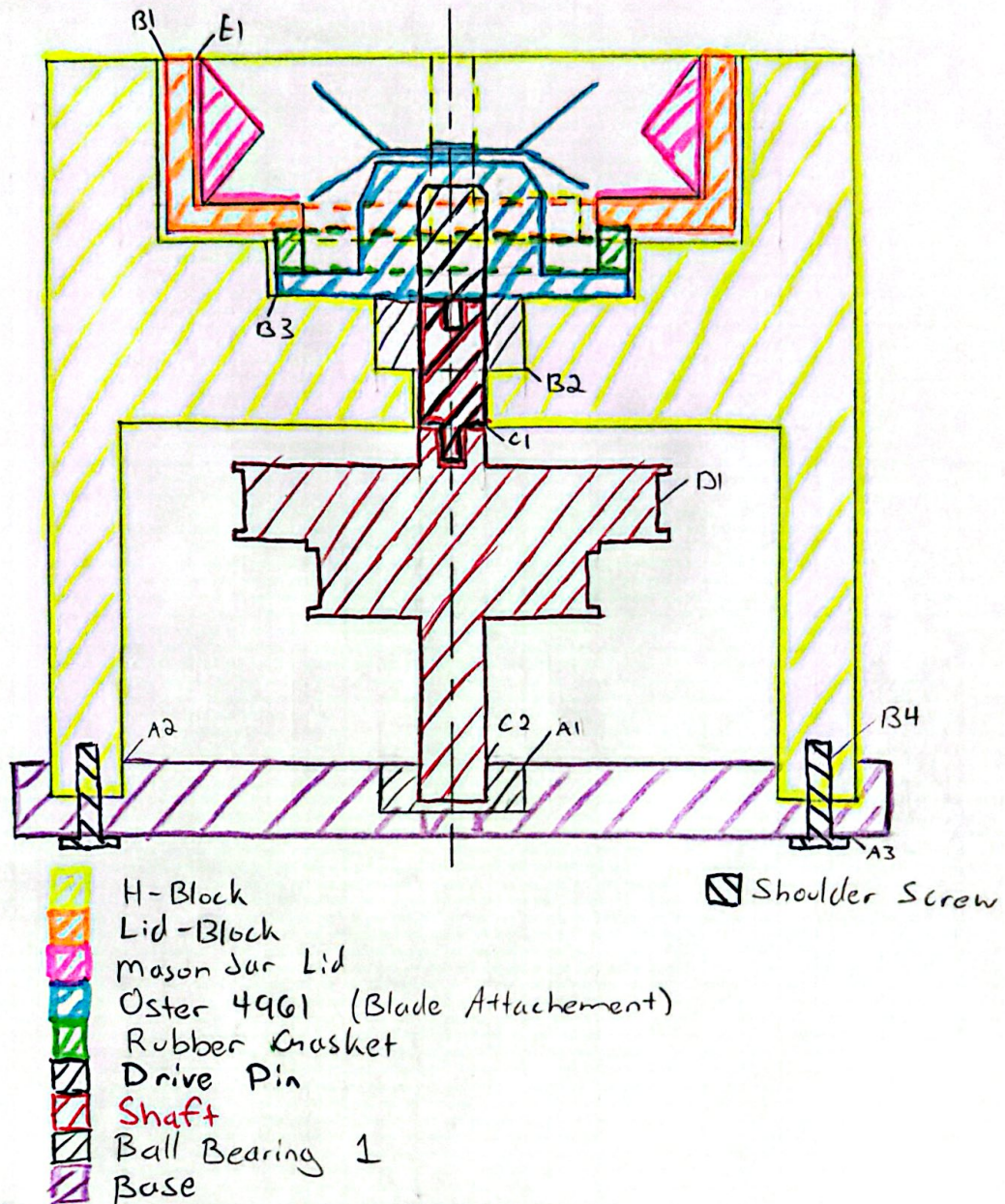
NOTE:

· Only showing flywheel, tensioner, and shaft with step pulley diameters  
· Belt could be placed on either diameters **highlighted**

— Belt  
— Flywheel  
— Tensioner  
— Step Pulley



## SECTION F-F



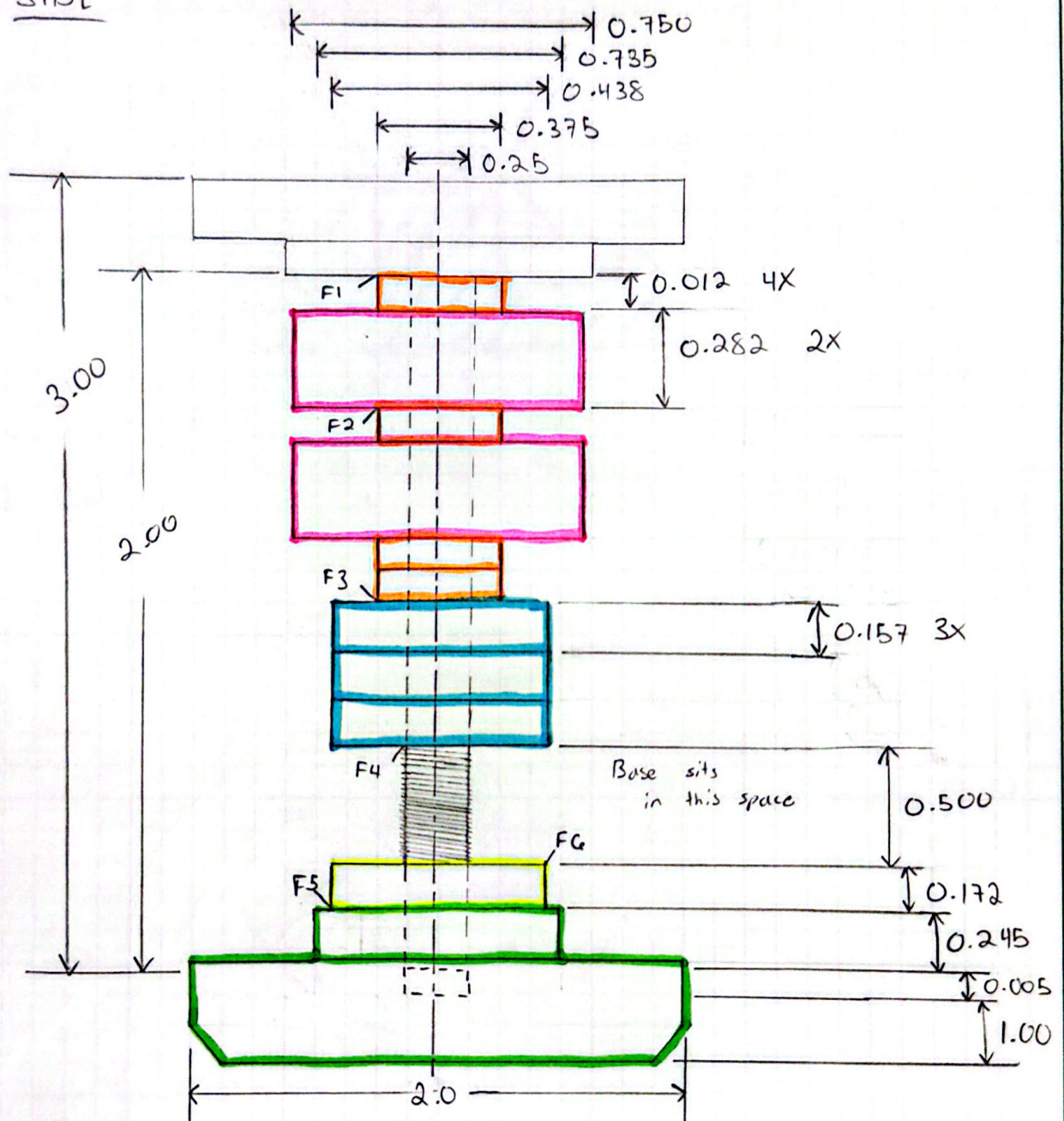
## NOTE:

- Mason jar lid → Lid block
- Oster 4961 → H-block + Ball Bearing 1
- Rubber Gasket → Oster 4961 + H-block + Ball Bearing
- Mason jar lid + Lid Block → Rubber Gasket + Oster 4961 + H-Block + Bearing 1  
 (L twist lock to press everything down)
- Take shaft + Drive Pin and lock it into A and into base.
- Screw base into H-block



# TENSIONER SUB ASSEMBLY

SIDE

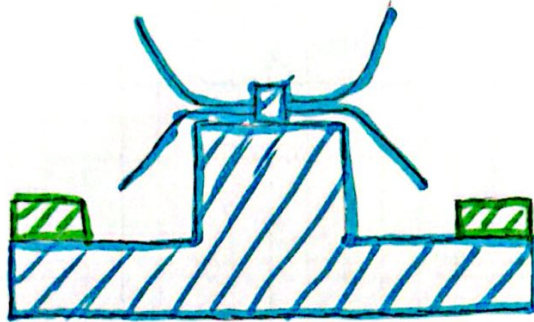


- |  |                               |            |
|--|-------------------------------|------------|
|  | 1/4 -20 male Thread Star knob | (1)        |
|  | 1/4 Washer Shims              | (4)        |
|  | Ball Bearing 2                | (2)        |
|  | Hex Jam Nut                   | (3)        |
|  | Thick Flat Washer             | (1)        |
|  | T-Style Thru knob             | (1)        |
|  |                               | (Quantity) |



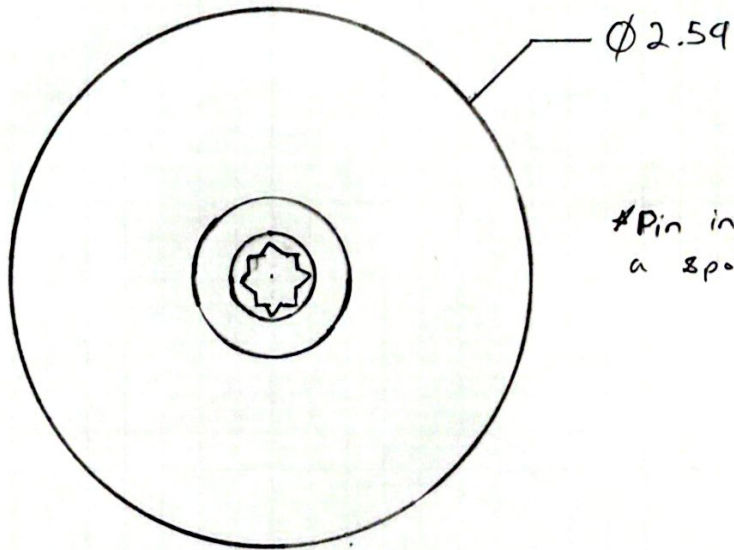
# Blade/Blender Housing (Oster 4961)

SIDE



-  Rubber Gasket
-  Blade/Blender Housing

BOTTOM



\*Pin in center is  
a 3point star pin slot

## Oster Drive Pin Square OS-070

SIDE

TOP



- ↖ Threads into top of shaft
- ↳ Fits into the star slot in Blade Housing