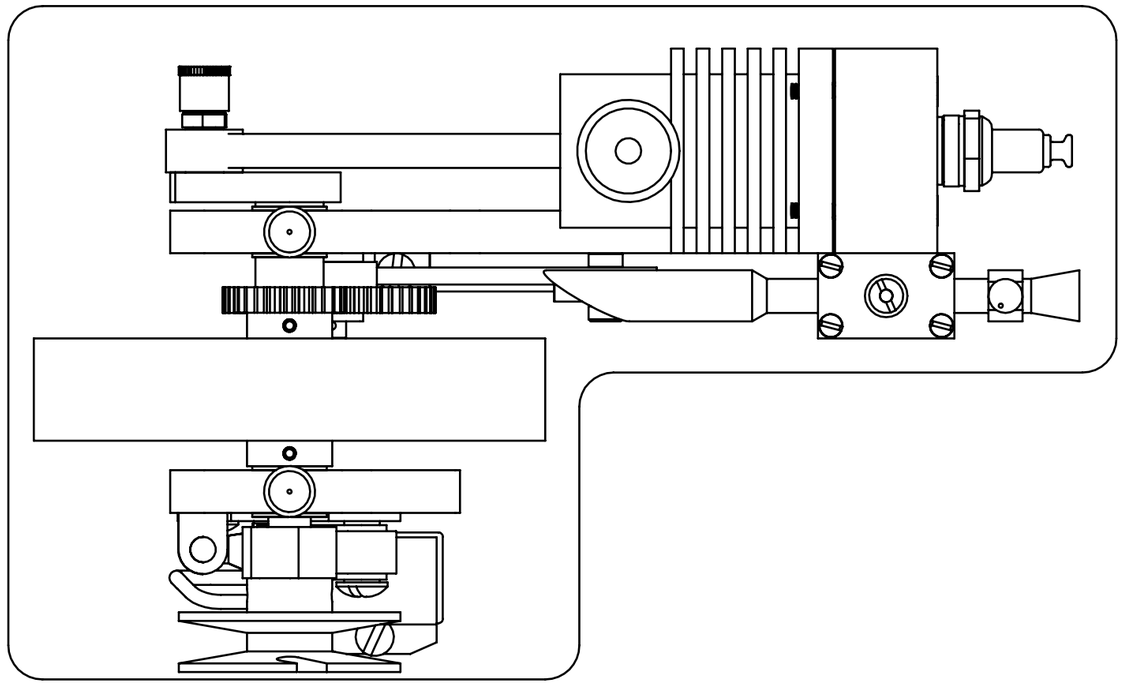
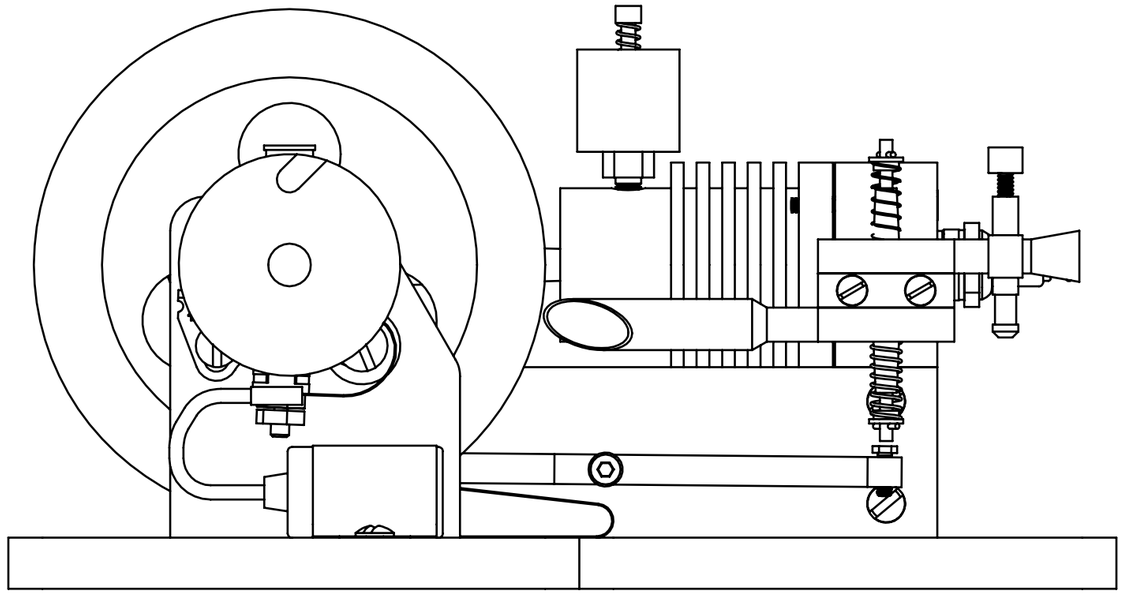
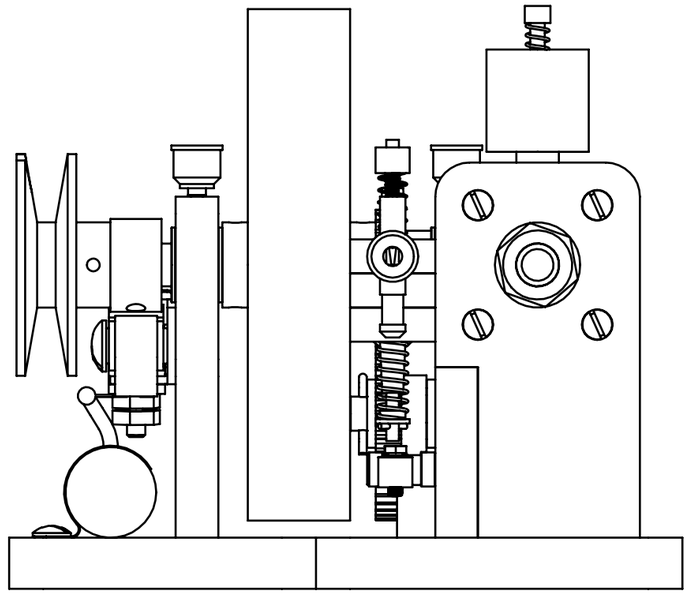


Webster Engine Works
4 Cycle Gas Engine

Displacement: .75 ci
Bore: .875"
Stroke 1.25"





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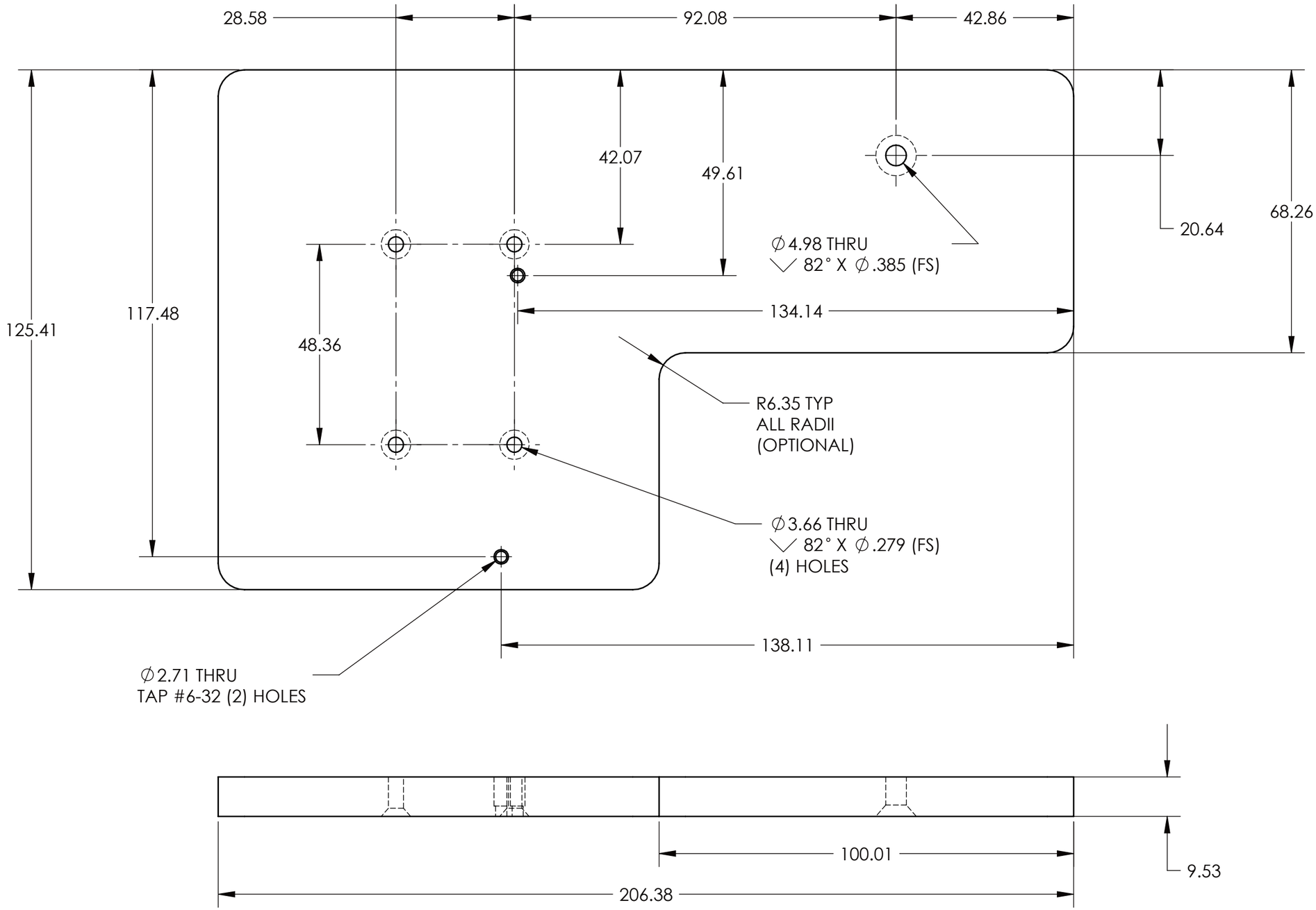
125 √	+/- .015	+/- .005	+/- 30'	N/A	N/A	7/6/2011	.9 : 1	B	GENERAL ARRANGEMENT
SURFACES	2 PLC DEC	3 PLC DEC	ANGLES			DATE	SCALE		
TOLERANCE UNLESS OTHERWISE NOTED				FINISH	MATERIAL	JBW	1 OF 21	SIZE	(C) Joe Webster 2004
						DETAILER	SHEET NO.		



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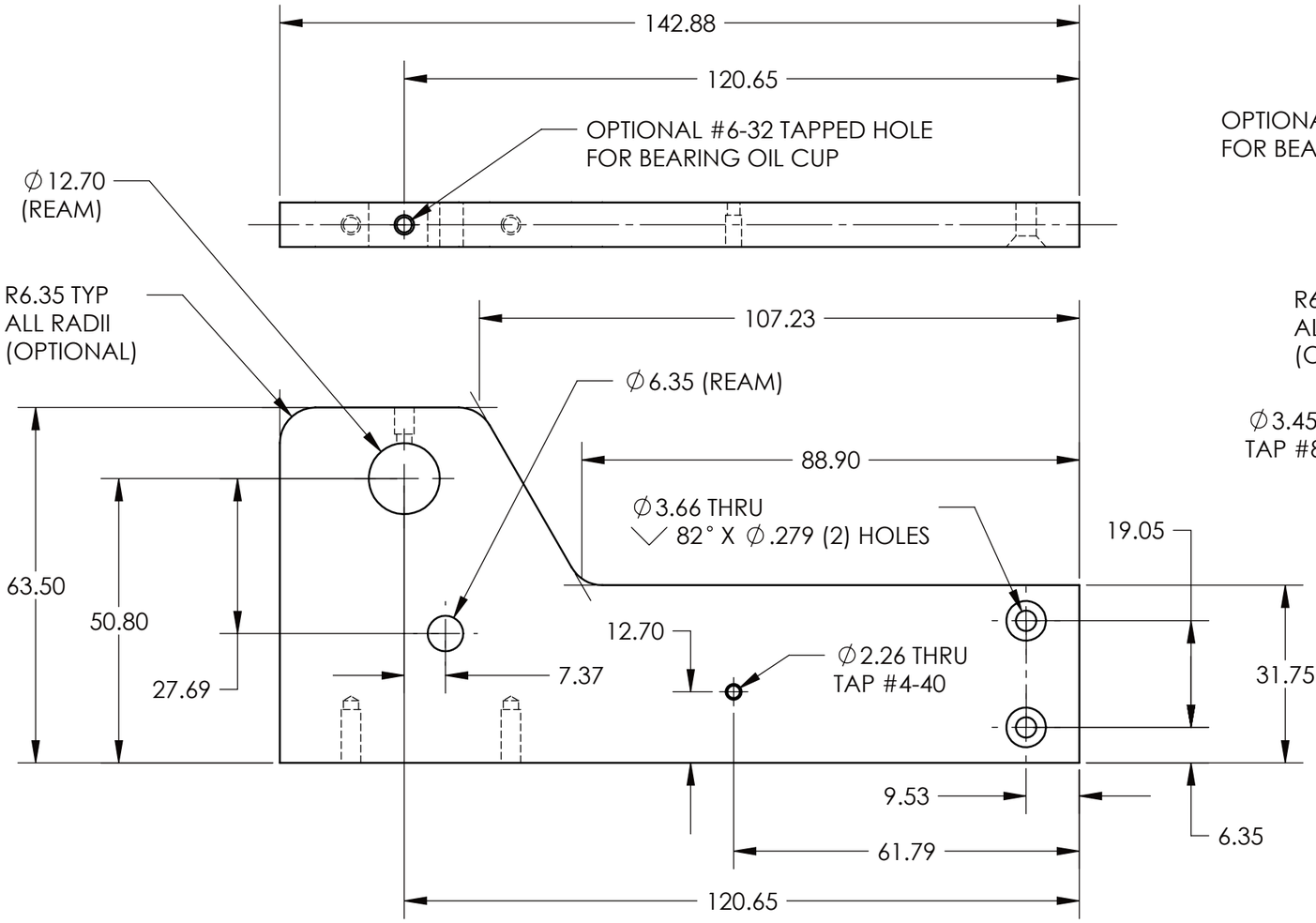
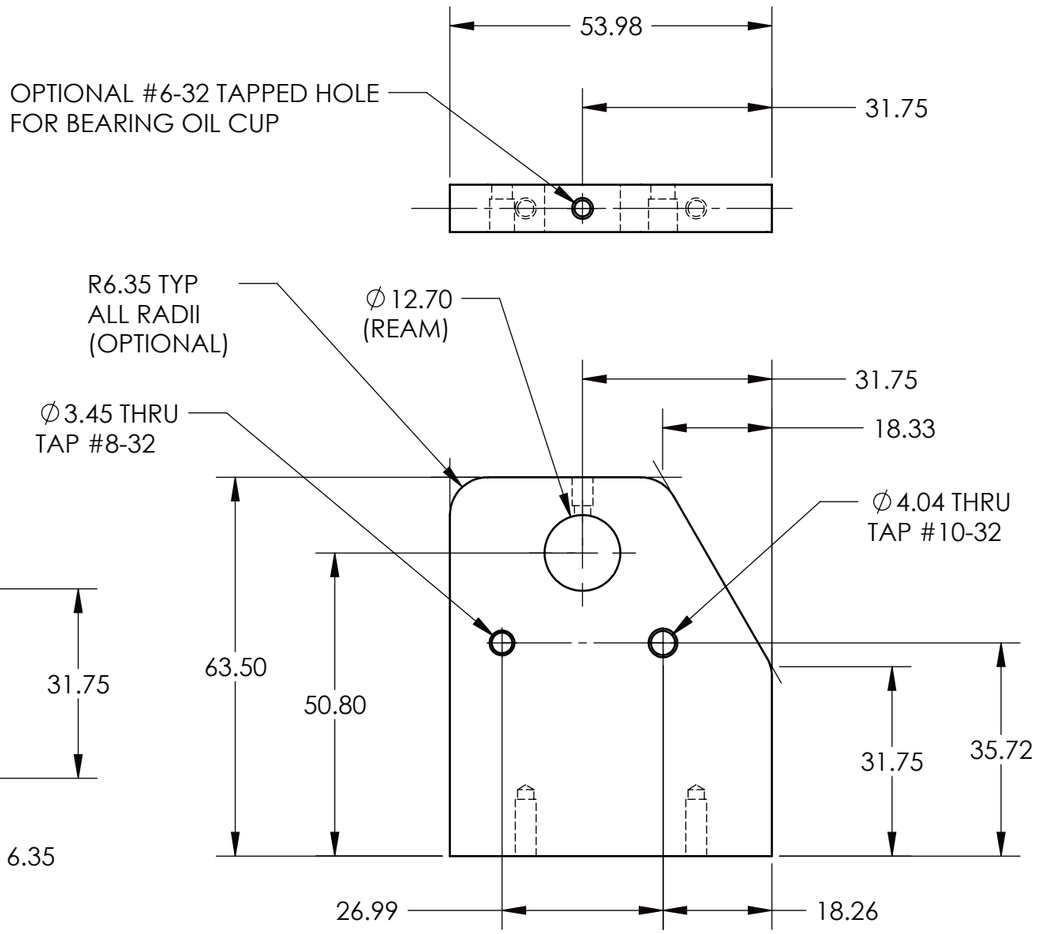
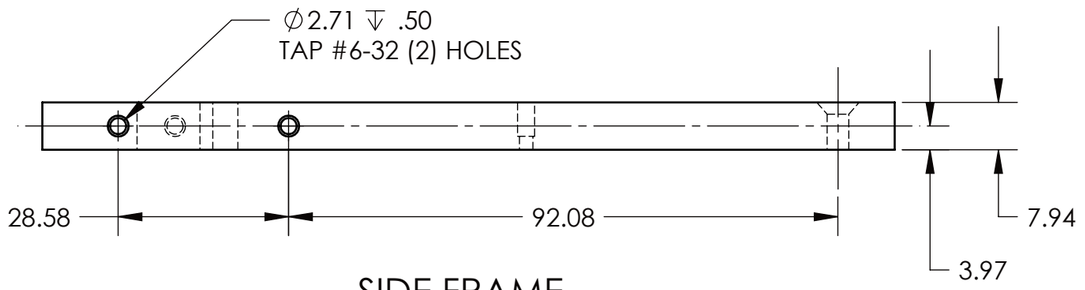
125 √	+/- .015	+/- .005	+/- 30'	ANODIZE, DYE BLACK	ALUMINUM ALLOY	7/6/2011	1:1	B	BASE PLATE (1) REQD.
SURFACES	2 PLC DEC	3 PLC DEC	ANGLES			DATE	SCALE		
TOLERANCE UNLESS OTHERWISE NOTED				FINISH	MATERIAL	JBW	2 OF 21	SIZE	(C) Joe Webster 2004
						DETAILER	SHEET NO.		

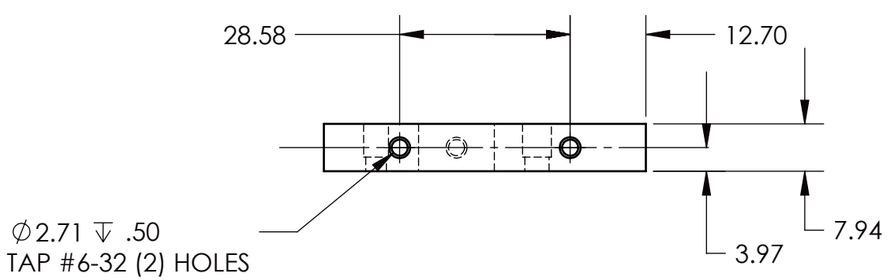


SIDE FRAME





SIDE FRAME



CRANKSHAFT SUPPORT

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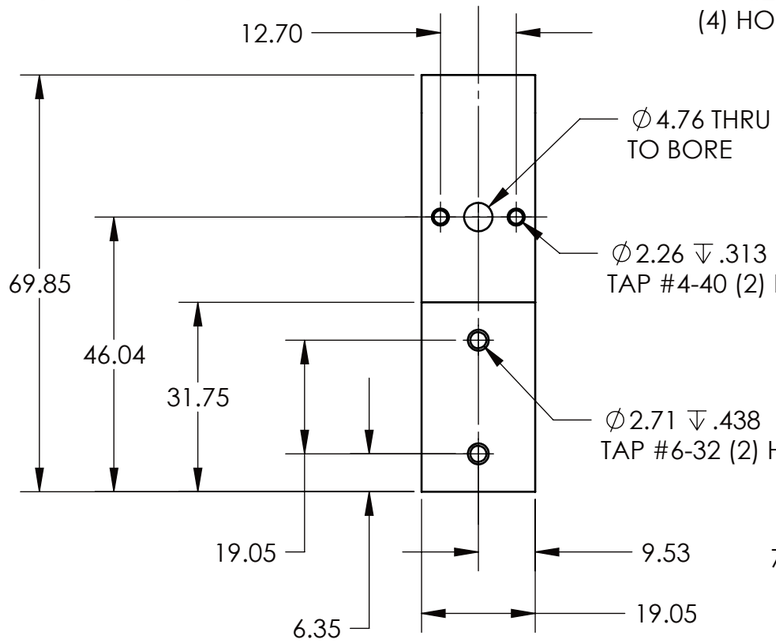
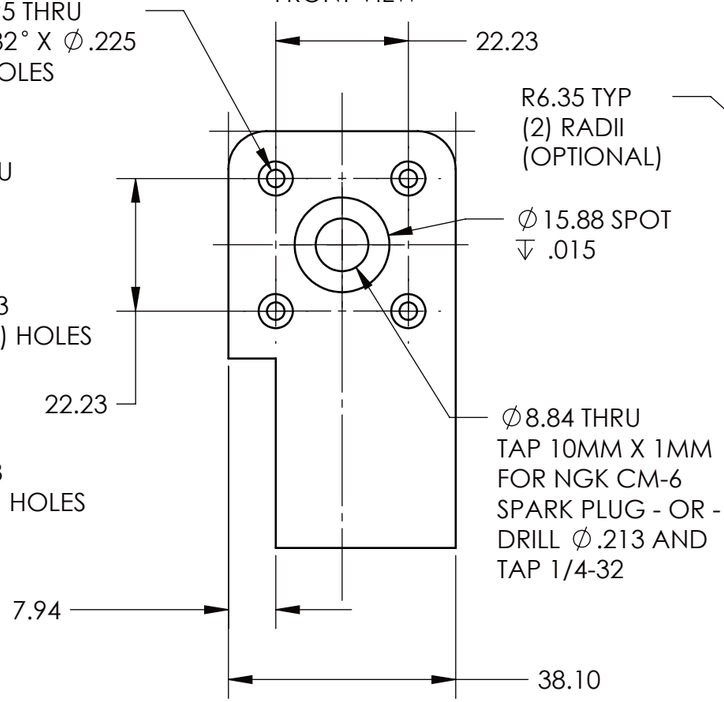
125 √	+/- .015	+/- .005	+/- 30'	ANODIZE, DYE BLUE	ALUMINUM ALLOY	7/6/2011	1:1	B	SIDE FRAME & CRANKSHAFT SUPPORT (1) EACH REQD.
SURFACES	2 PLC DEC	3 PLC DEC	ANGLES			DATE	SCALE		
TOLERANCE UNLESS OTHERWISE NOTED				FINISH	MATERIAL	JBW	3 OF 21		
						DETAILER	SHEET NO.	SIZE	(C) Joe Webster 2004

HIDDEN LINES REMOVED
TO IMPROVE CLARITY

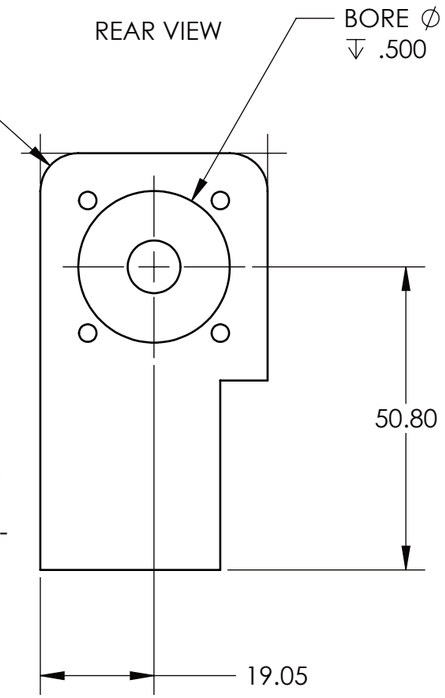
RIGHT VIEW



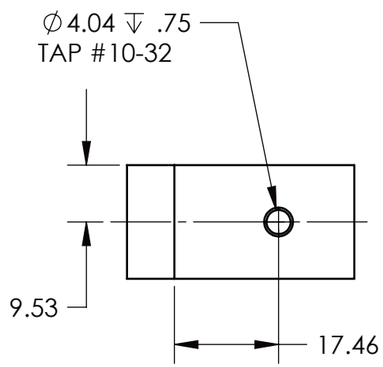
FRONT VIEW



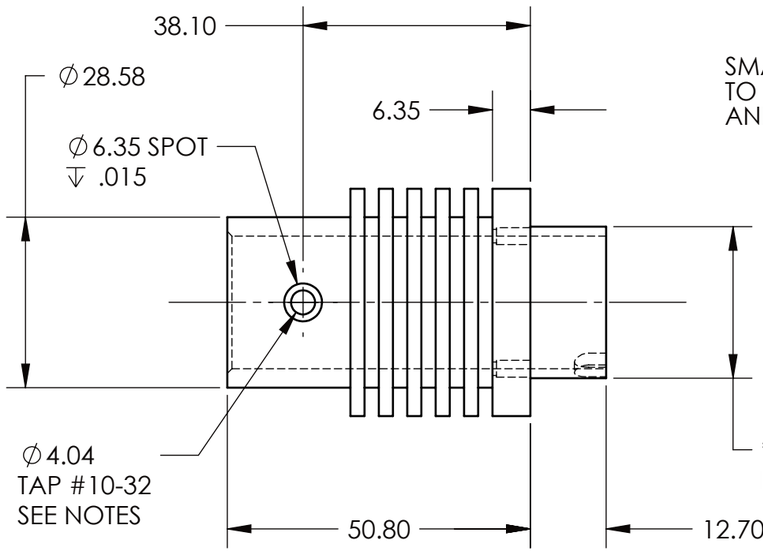
REAR VIEW



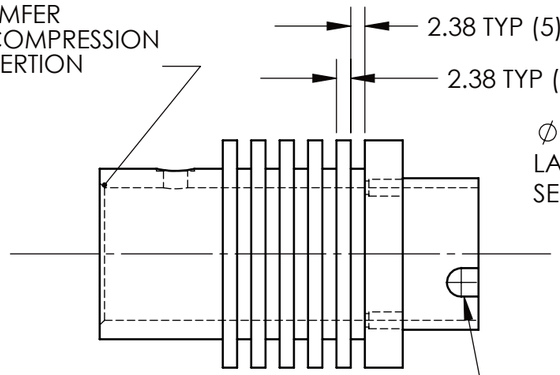
BOTTOM VIEW



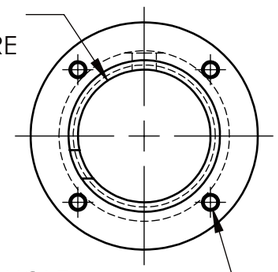
CYLINDER HEAD-FRAME
MATERIAL: ALUMINUM ALLOY
FINISH: ANODIZE, DYE BLUE
(1) REQD.



TOP VIEW



RIGHT VIEW



FRONT VIEW

CYLINDER (1) REQD.
MATERIAL: 12L14 STEEL OR CAST IRON
FINISH: HI-TEMP BLACK PAINT ON
VISIBLE EXTERIOR - TBD @ ASSY.

NOTES:

1. MAKE CYL. HEAD-FRAME FIRST - DRILLING, TAPPING, AND COUNTERSINKING ALL HOLES.
2. MAKE CYLINDER - STOP BORING AT ∅.873 TO ALLOW FOR FINISH LAPPING.
3. USING CYL. FRAME-HEAD HOLES AS A GUIDE, SPOT, DRILL, AND TAP CYLINDER MOUNTING HOLES
4. SCREW CYLINDER TO CYL. HEAD-FRAME WITH (4) #4-40 FH SCREWS AND DRILL PORT HOLE IN CYL. BY SPOTTING THROUGH CYL. HEAD-FRAME
5. SPOT, DRILL, AND TAP #10-32 OILER HOLE ON TOP OF CYL.
6. REMOVE CYLINDER, OPEN PORT HOLE TO SLOT SHAPE AS INDICATED, THEN LAP BORE TO FINISHED SIZE.

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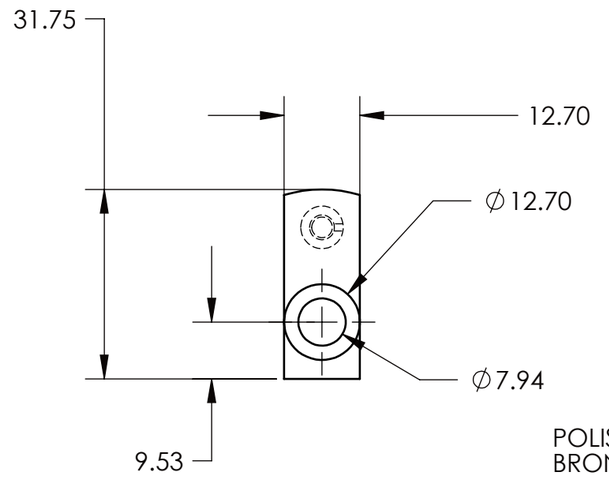
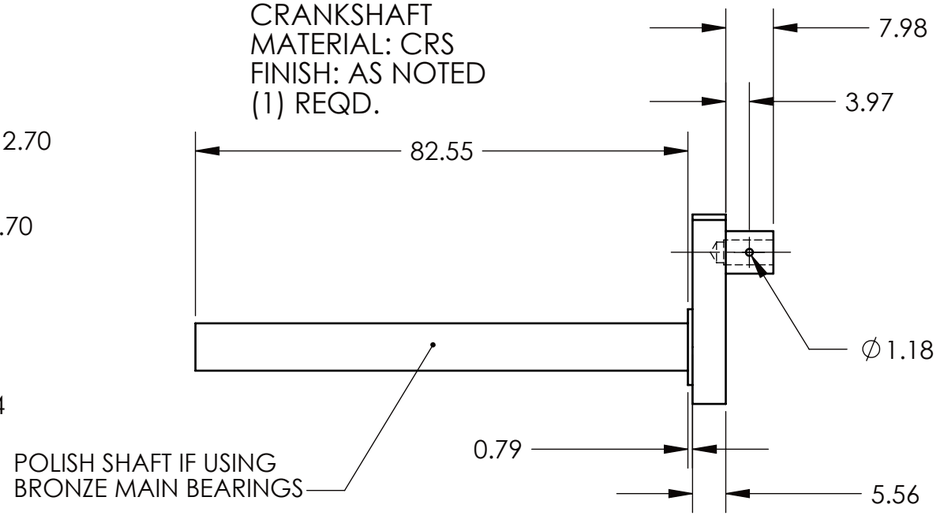
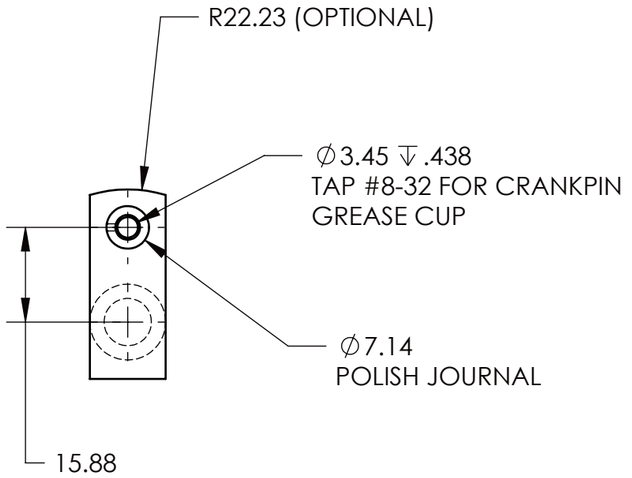
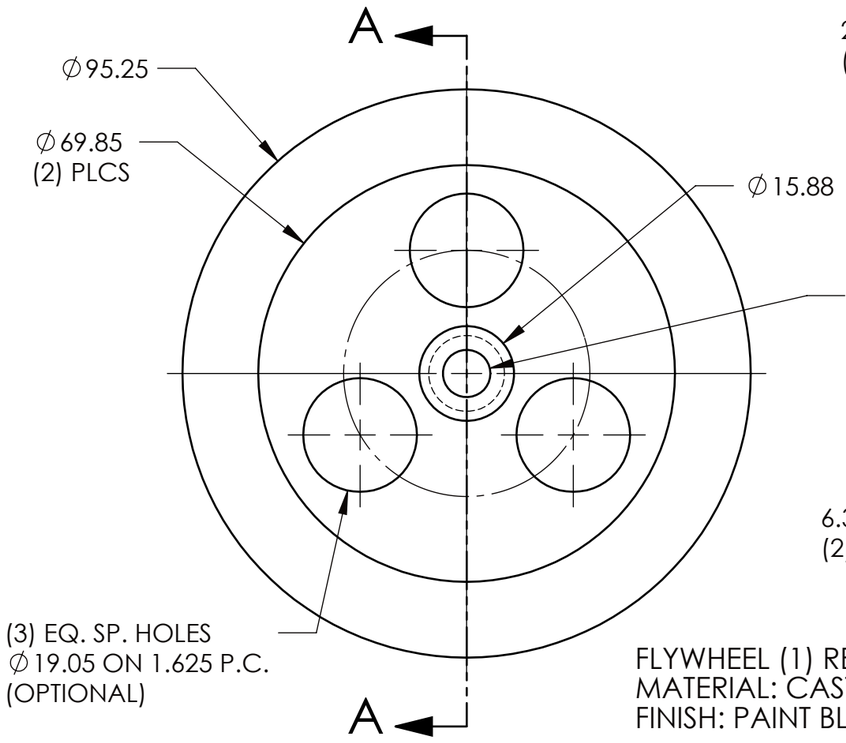
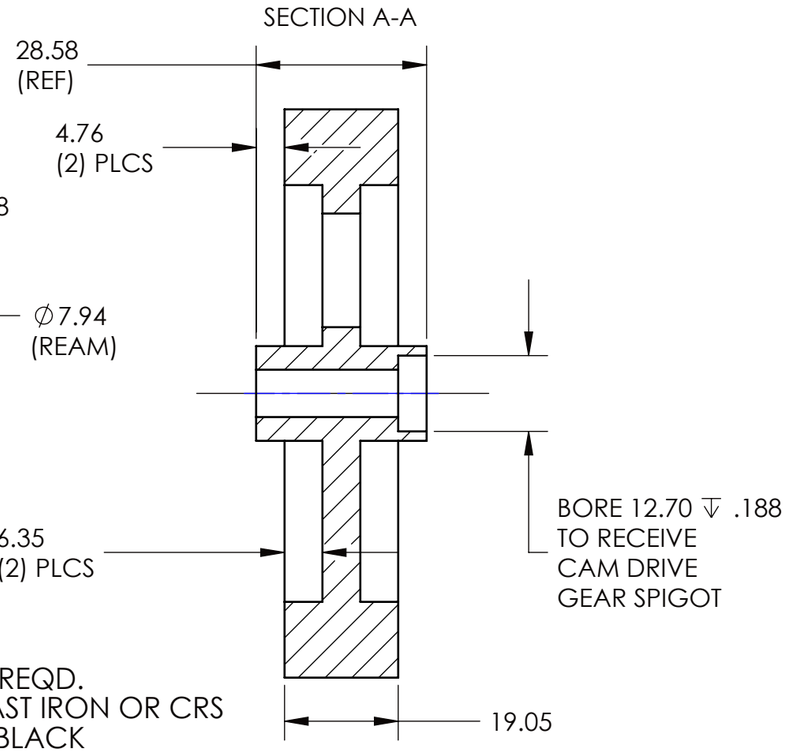
125 √	+/- .015	+/- .005	+/- 30'	SEE ABOVE	SEE ABOVE	7/6/2011	1:1	B	CYL. HEAD-FRAME & CYLINDER (1) EACH REQD.
SURFACES	2 PLC DEC	3 PLC DEC	ANGLES			DATE	SCALE		
TOLERANCE UNLESS OTHERWISE NOTED				FINISH	MATERIAL	JBW	4 OF 21	SIZE	(C) Joe Webster 2004
						DETAILER	SHEET NO.		



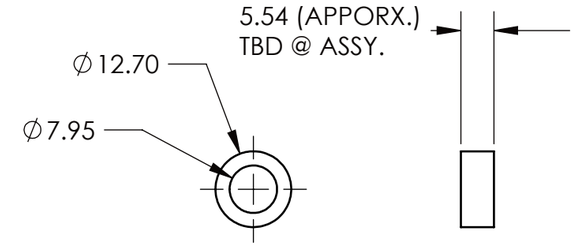




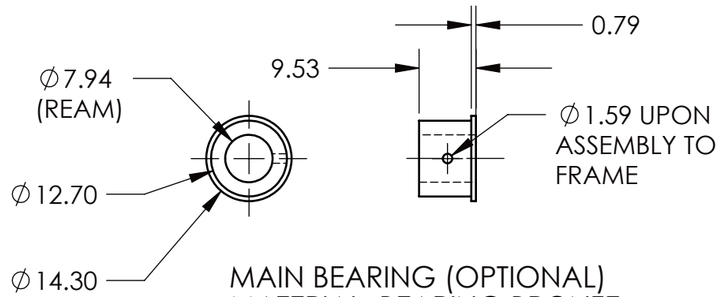




FLYWHEEL (1) REQD.
MATERIAL: CAST IRON OR CRS
FINISH: PAINT BLACK



CRANKSHAFT SPACER
MATERIAL: CRS
FINISH: N/A
(1) REQD.



MAIN BEARING (OPTIONAL)
MATERIAL: BEARING BRONZE
FINISH: POLISH BORE
(2) REQD.

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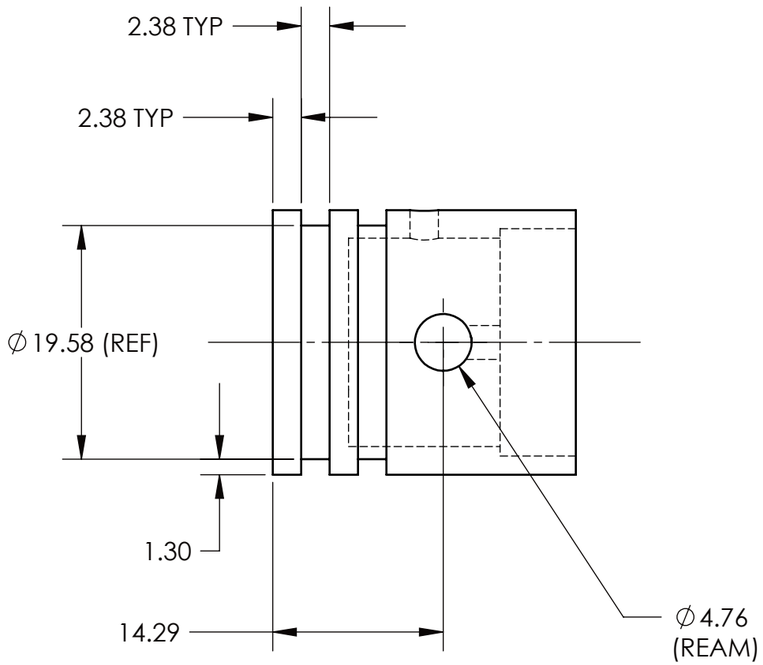
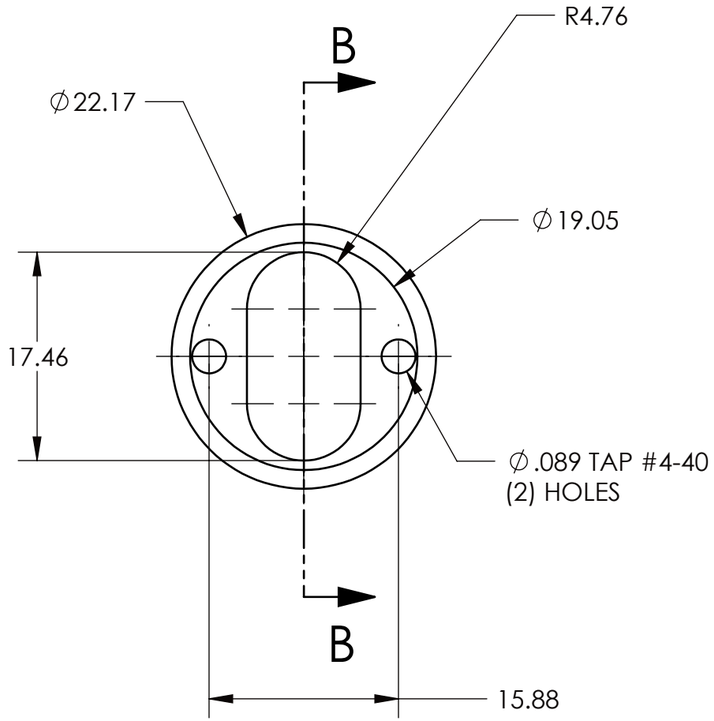
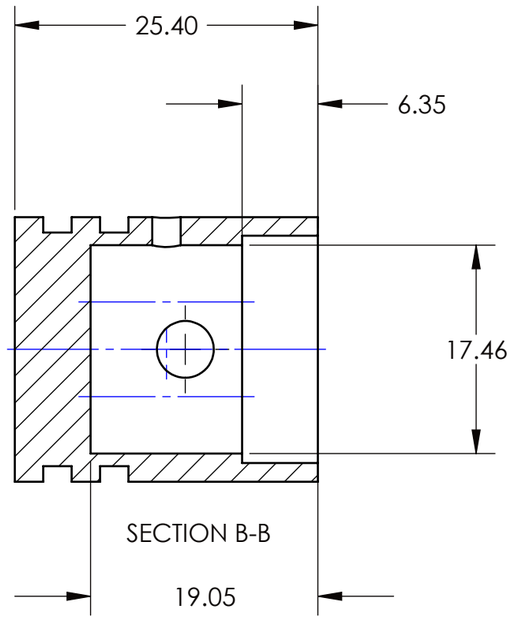
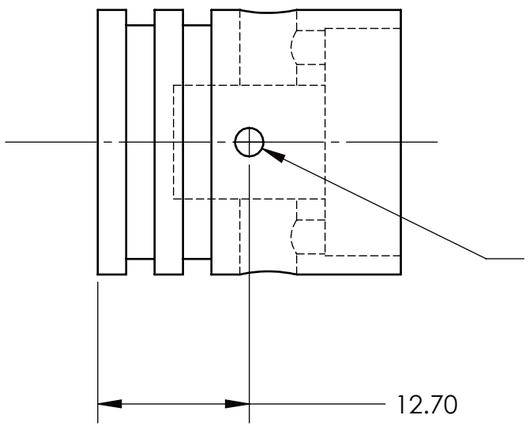
125 √	+/- .015	+/- .005	+/- 30'	SEE NOTES	SEE NOTES	7/6/2011	1:1	B	CRANKSHAFT, FLYWHEEL, CRANK SPACER AND MAIN BEARING
SURFACES	2 PLC DEC	3 PLC DEC	ANGLES			DATE	SCALE		
TOLERANCE UNLESS OTHERWISE NOTED				FINISH	MATERIAL	JBW	5 OF 21	SIZE	(C) Joe Webster 2004
						DETAILER	SHEET NO.		

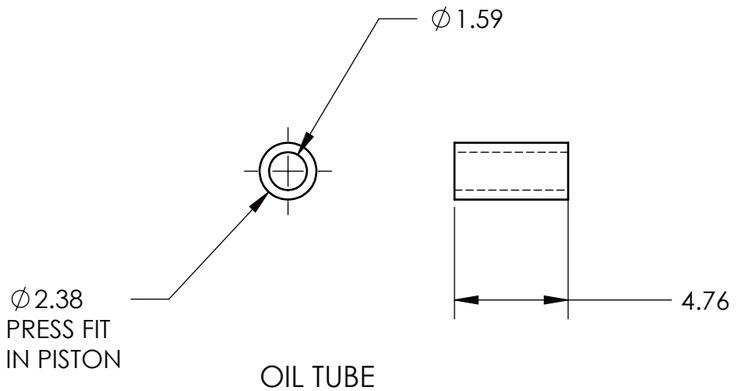








PISTON
SCALE: 2:1
MATERIAL: 6061-T6 ALUMINUM
FINISH: FINE TURNED FINISH, DO NOT POLISH,
MICRO-GROOVES HELP TO HOLD OIL
(1) REQD.



OIL TUBE
SCALE: 4:1
MATERIAL: BRASS
FINISH: N/A
(1) REQD.

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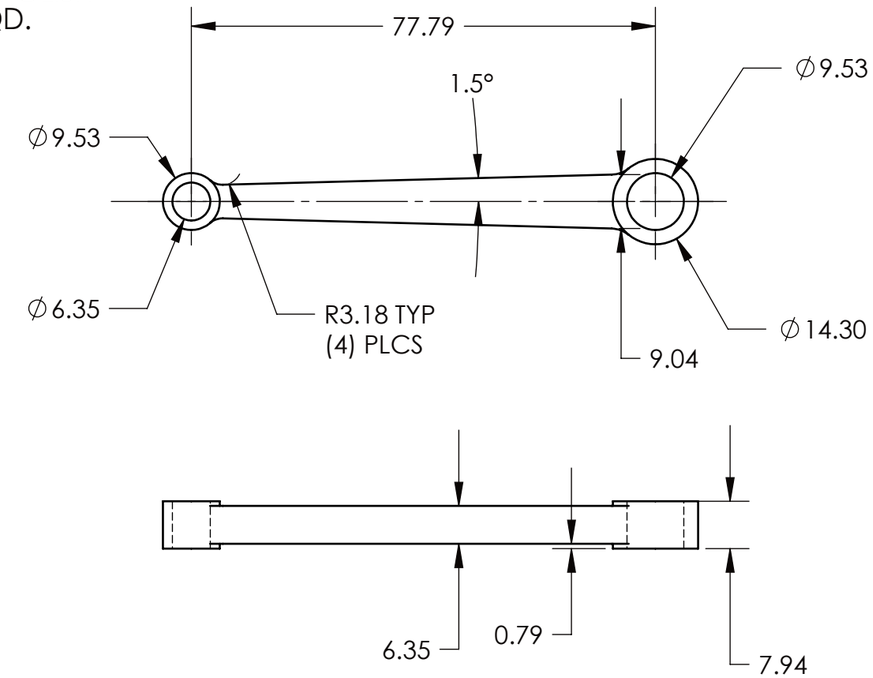
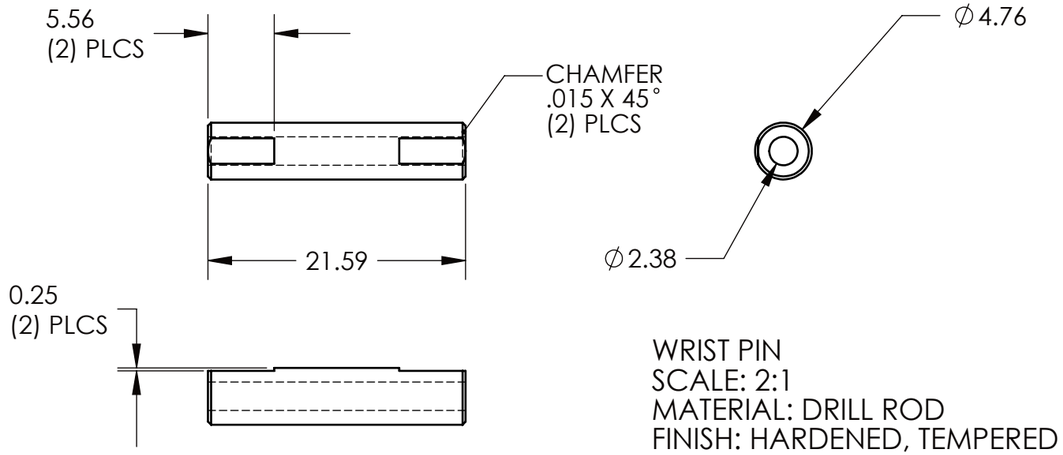
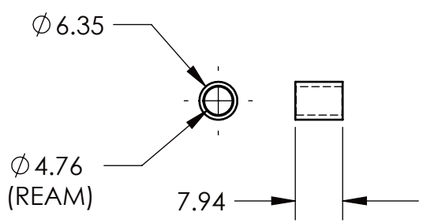
125 √	+/- .015	+/- .005	+/- 30'	SEE NOTES	SEE NOTES	7/6/2011	AS NOTED	B	PISTON AND PISTON OIL TUBE
SURFACES	2 PLC DEC	3 PLC DEC	ANGLES			JBW	6 OF 21		
TOLERANCE UNLESS OTHERWISE NOTED				FINISH	MATERIAL	DETAILER	SHEET NO.	SIZE	(C) Joe Webster 2004

CONNECTING ROD
MATERIAL: 6061-T6 ALUMINUM
FINISH: POLISH
(1) REQD.

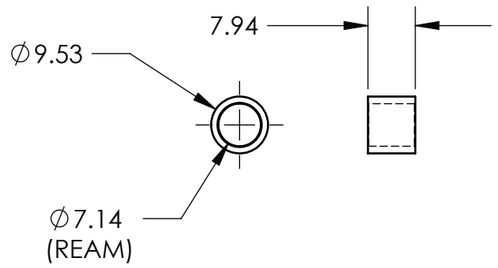




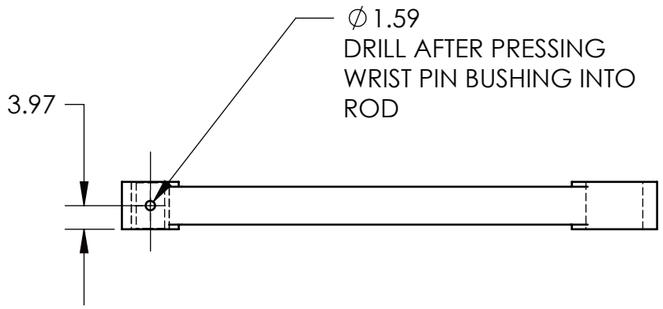
WRIST PIN
SCALE: 2:1
MATERIAL: DRILL ROD
FINISH: HARDENED, TEMPERED & POLISHED
(1) REQD.

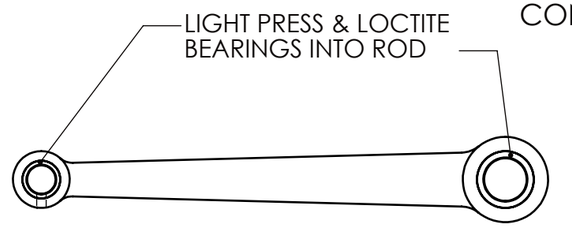


WRIST PIN BUSHING
MATERIAL: BEARING BRONZE
FINISH: POLISH BORE AFTER INSTALLATION
(1) REQD.



CON ROD BUSHING
MATERIAL: BEARING BRONZE
FINISH: POLISH BORE AFTER INSTALLATION
(1) REQD.





CONNECTING ROD ASSY.

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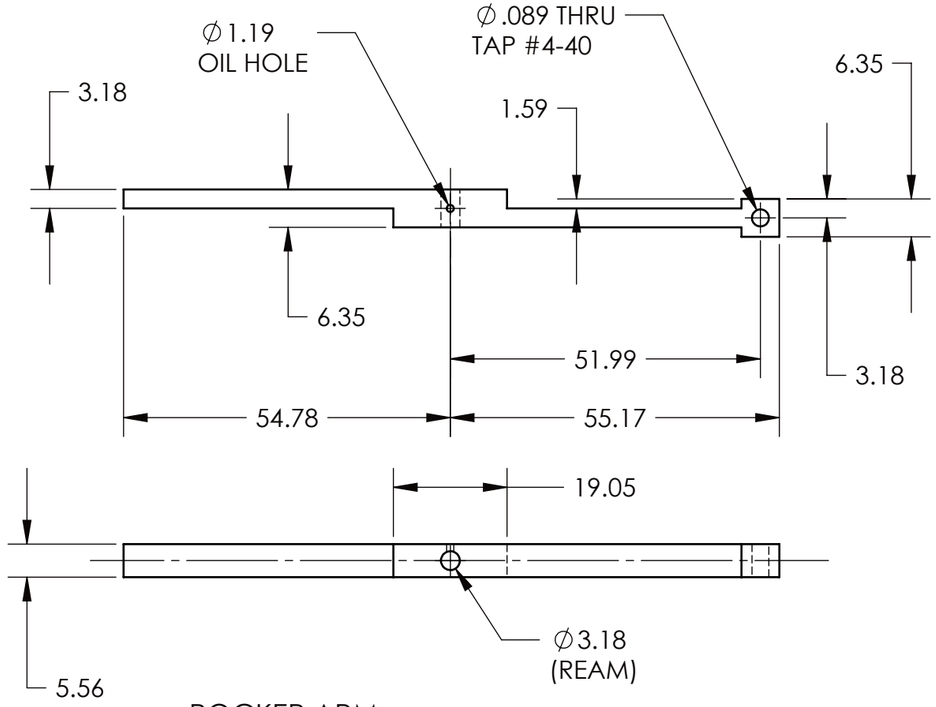
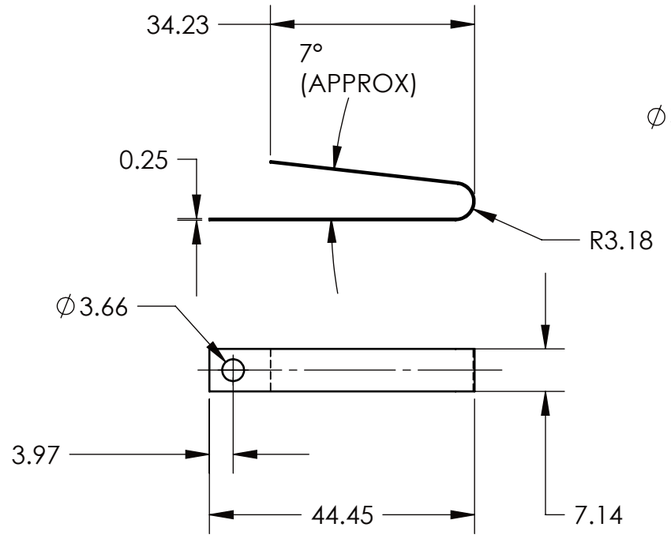
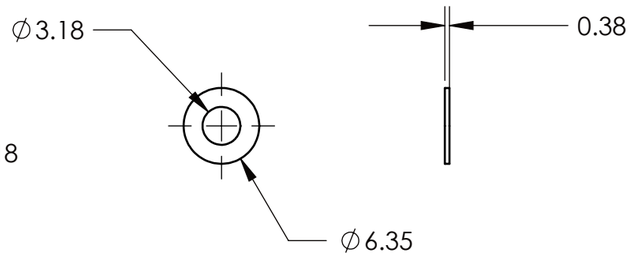
125 ✓	+/- .015	+/- .005	+/- 30'	SEE NOTES	SEE NOTES	7/6/2011	1:1	B	CON ROD, BUSHINGS, WRIST PIN, AND CON ROD ASSY.
SURFACES	2 PLC DEC	3 PLC DEC	ANGLES			DATE	SCALE		
TOLERANCE UNLESS OTHERWISE NOTED				FINISH	MATERIAL	JBW	7 OF 21	SIZE	(C) Joe Webster 2004
						DETAILER	SHEET NO.		



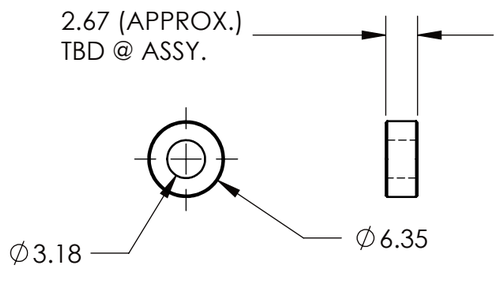
ROCKER ARM
MATERIAL: CRS
FINISH: CASE HARDEN (OPTIONAL)
(1) REQD.



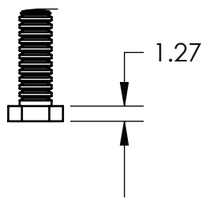
ROCKER ARM SPRING
MATERIAL: SPRING STEEL
FINISH: N/A
(1) REQD.



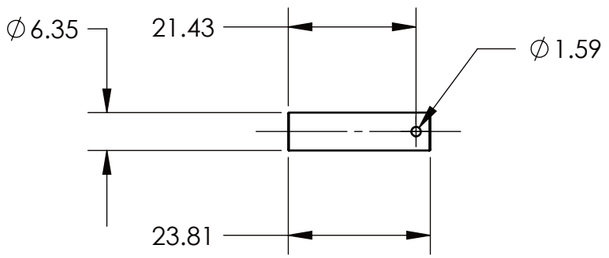
ROCKER ARM WASHER
SCALE: 2:1
MATERIAL: BRASS
FINISH: N/A
(1) REQD.



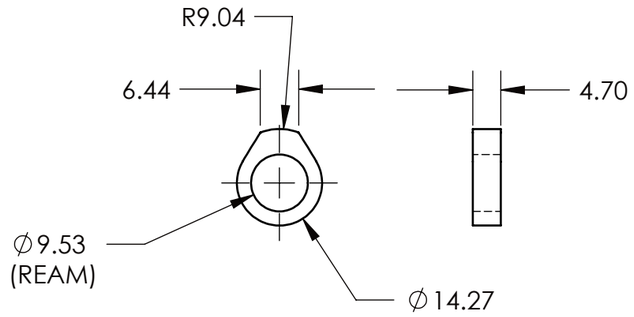
ROCKER ARM SPACER
SCALE: 2:1
MATERIAL: CRS
FINISH: N/A
(1) REQD.



TAPPET
SCALE: 2:1
MATERIAL: 3/8" X #4-40 S.S. SCREW
FINISH: THIN HEAD TO DIM. SHOWN
(1) REQD.



CAM SHAFT
MATERIAL: DRILL ROD
FINISH: HARDEN, TEMPER, POLISH
(1) REQD.



EXHAUST CAM
MATERIAL: CRS
FINISH: CASE HARDEN, POLISH
(1) REQD.

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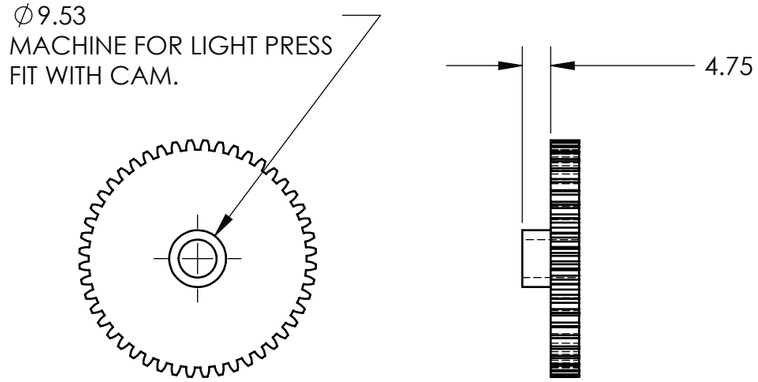
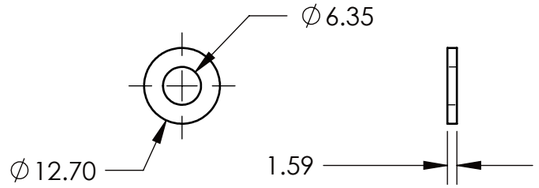
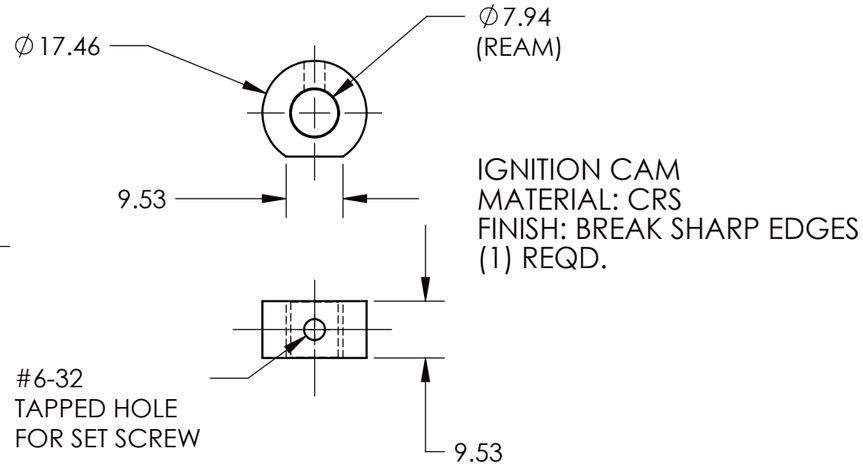
125 √	+/- .015	+/- .005	+/- 30'	SEE NOTES	SEE NOTES	7/6/2011	1:1	B	ROCKER ARM, SPRING, WASHER, SPACER, TAPPET, CAM SHAFT, & CAM
SURFACES	2 PLC DEC	3 PLC DEC	ANGLES			JBW	8 OF 21		
TOLERANCE UNLESS OTHERWISE NOTED				FINISH	MATERIAL	DETAILER	SHEET NO.	SIZE	(C) Joe Webster 2004



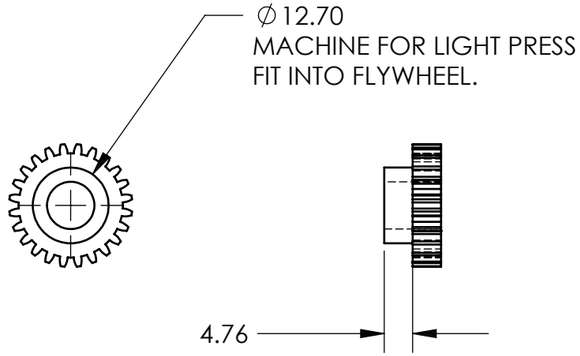
CAM GEAR MODIFICATION (BRASS)
STOCK DRIVE PRODUCTS: A 1B 2-N32048
W.M. BERG: P32S-28-48
(1) REQD.



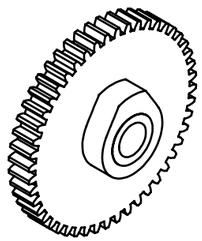
CAM GEAR WASHER
MATERIAL: CRS
FINISH: N/A
(2) REQD.



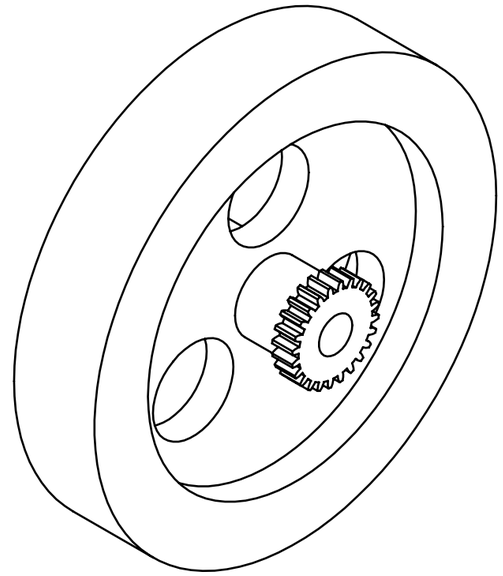
IGNITION CAM
MATERIAL: CRS
FINISH: BREAK SHARP EDGES
(1) REQD.



DRIVE GEAR MODIFICATION (STEEL)
STOCK DRIVE PRODUCTS: A 1C 2-N32024
W.M. BERG: P32S28-24
(1) REQD.



CAM GEAR ASSEMBLY -
LOCTITE AND PRESS CAM TO
CAM GEAR, ARBITRARY POSITION.



FLYWHEEL ASSEMBLY -
LOCTITE AND PRESS CAM DRIVE GEAR
TO FLYWHEEL, ARBITRARY POSITION.

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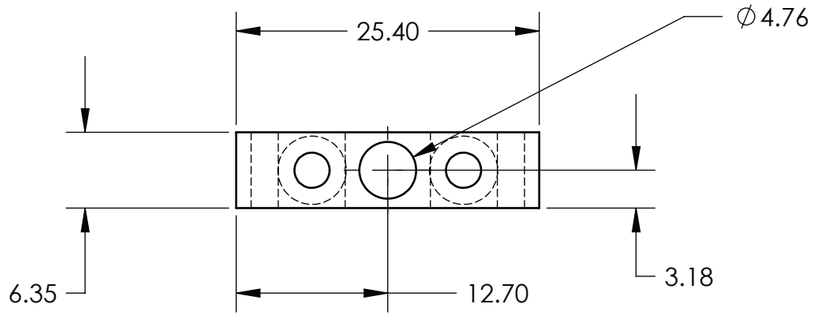
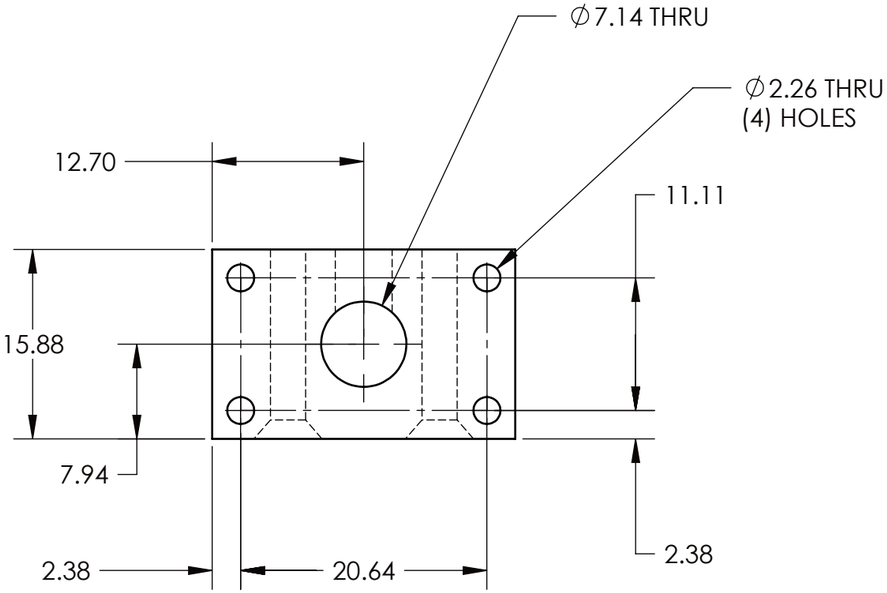
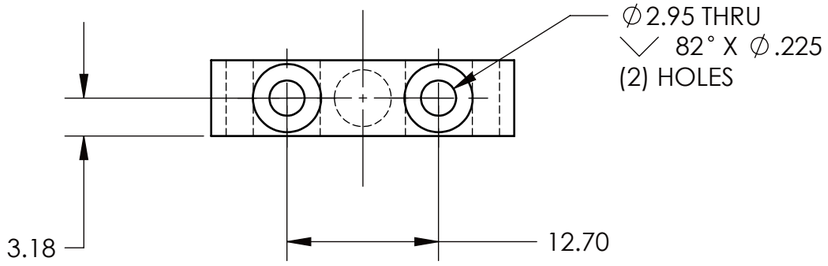
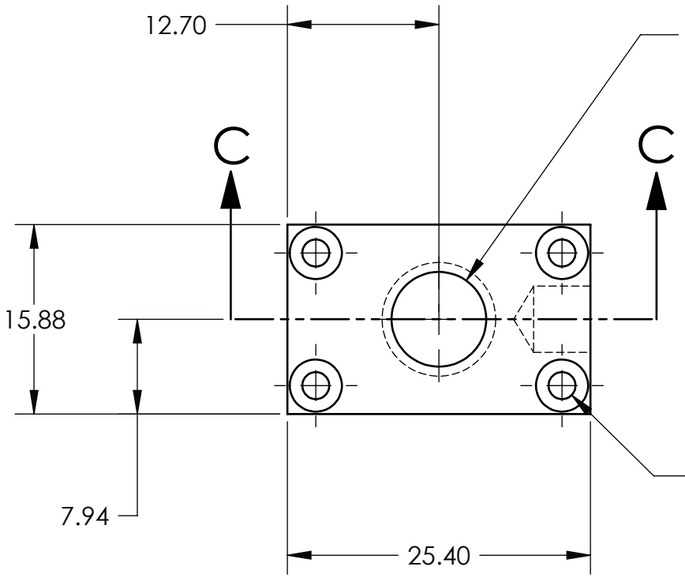
125 ✓	+/- .015	+/- .005	+/- 30'	SEE NOTES	SEE NOTES	7/6/2011	1:1	B	GEAR MODS, C.G. WASHER, IGNITION CAM, C.G. & FLYWHEEL ASSY.
SURFACES	2 PLC DEC	3 PLC DEC	ANGLES			DATE	SCALE		
TOLERANCE UNLESS OTHERWISE NOTED				FINISH	MATERIAL	JBW	9 OF 21	SIZE	(C) Joe Webster 2004
						DETAILER	SHEET NO.		

VALVE BLOCK
(1) REQD.

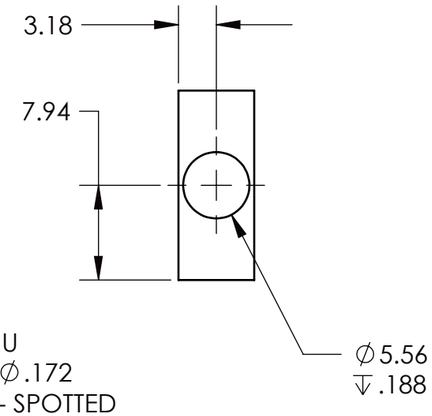




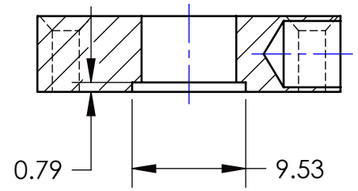




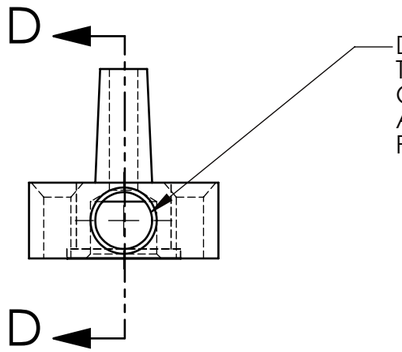
INTAKE VALVE BLOCK
(1) REQD.

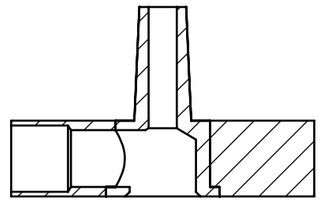


SECTION C-C



* EXHAUST VALVE BLOCK IS IDENTICAL, EXCEPT THE FOUR HOLES ARE TAPPED #2-56 THRU
(1) REQD.





SECTION D-D

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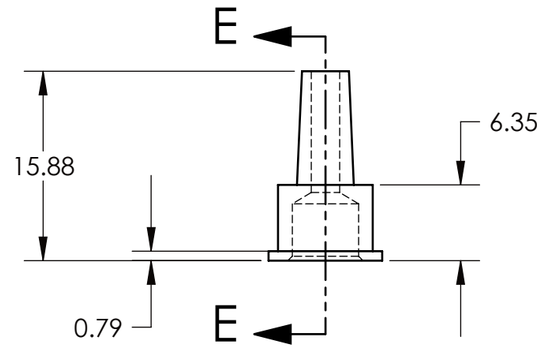
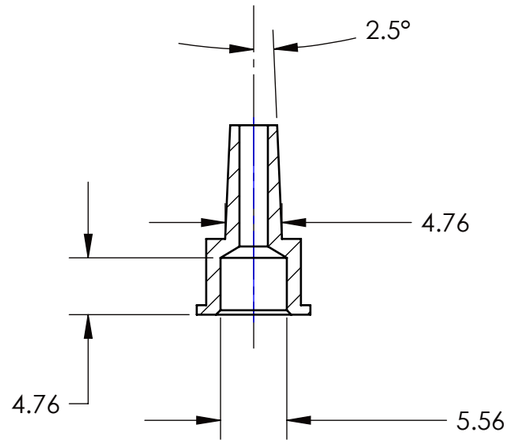
125 ✓	+/- .015	+/- .005	+/- 30'	NATURAL	ALUMINUM ALLOY	7/6/2011	2:1	B	VALVE BLOCK, INTAKE VALVE BLOCK, & EXHAUST VALVE BLOCK
SURFACES	2 PLC DEC	3 PLC DEC	ANGLES			DATE	SCALE		
TOLERANCE UNLESS OTHERWISE NOTED				FINISH	MATERIAL	JBW	10 OF 21	SIZE	(C) Joe Webster 2004
						DETAILER	SHEET NO.		

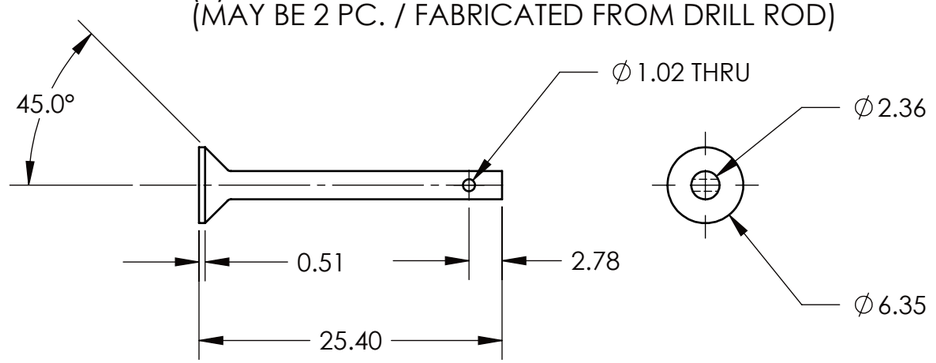
VALVE GUIDE
MATERIAL: BRONZE / BRASS
FINISH: N/A
(2) REQD.)

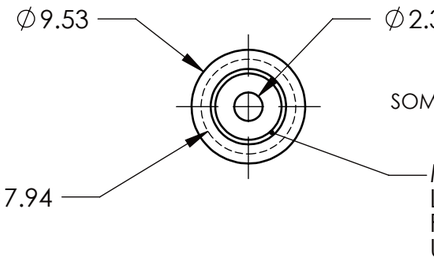




SECTION E-E

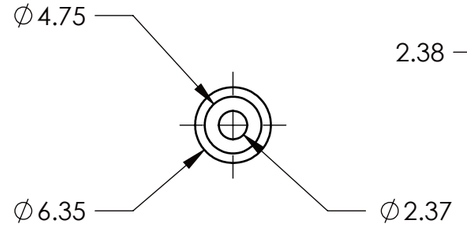
VALVE
MATERIAL: STEEL / STAINLESS STEEL
FINISH: POLISH STEM
(2) REQD.
(MAY BE 2 PC. / FABRICATED FROM DRILL ROD)

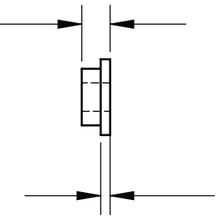




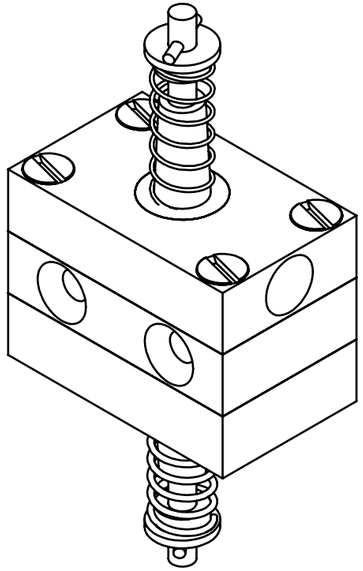
SOME HIDDEN LINES REMOVED TO IMPROVE CLARITY

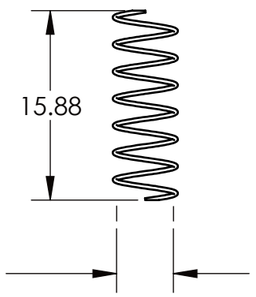
MACHINE 45° X .015 VALVE SEAT - LAP VALVE TO VALVE GUIDE USING FINE VALVE GRINDING COMPUND UPON FINAL ASSY.



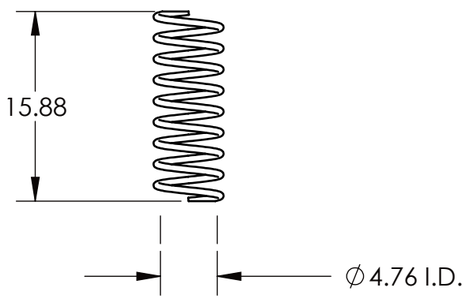


VALVE RETAINER
MATERIAL: STEEL
FINISH: BLUED
(2) REQD.





INTAKE VALVE SPRING
SEVEN TURNS ∅.013 MUSIC WIRE
(1) REQD.



EXHAUST VALVE SPRING
NINE TURNS ∅.022 MUSIC WIRE
(1) REQD.

VALVE BLOCK ASSY. -
1. INTAKE VALVE SPRING ON TOP WITH INTAKE PORT POINTING TOWARDS THE FRONT OF THE ENGINE.

2. VALVE BLOCK SANDWICHED BETWEEN INT. & EXH. VALVE BLOCKS - NO GASKET OR SEALER REQD. W/ CAREFUL MACHINING.

3. RETAINER PINS ARE .25 LONG SECTIONS OF DRILL ROD, MUSIC WIRE, ETC...

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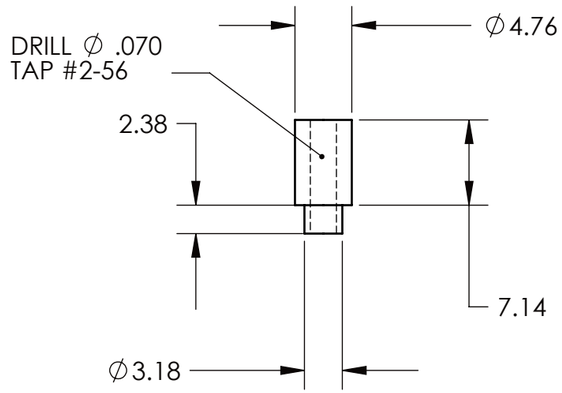
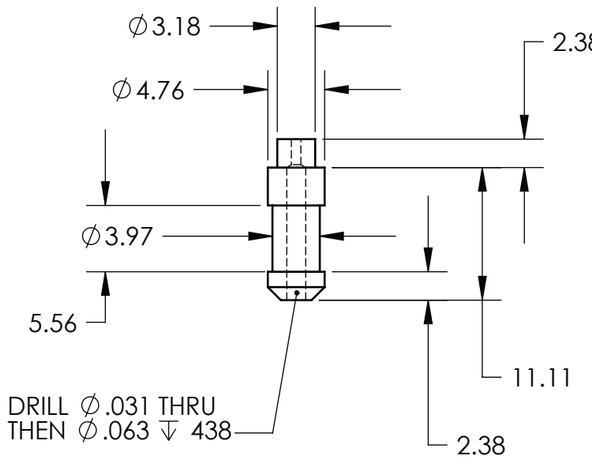
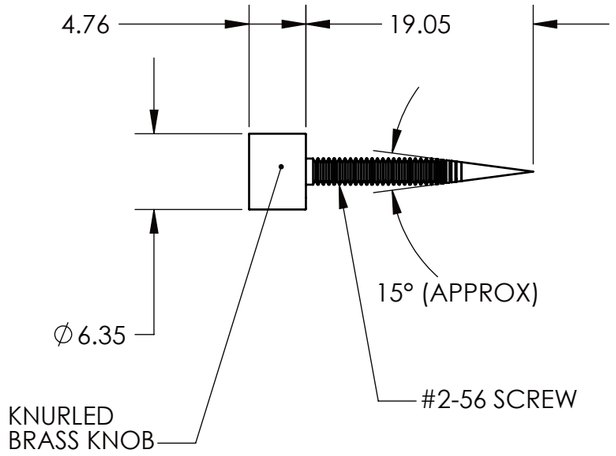
125 ✓	+/- .015	+/- .005	+/- 30'	SEE NOTES	SEE NOTES	7/6/2011	2:1	B	VALVE GUIDE, VALVE , VALVE RETAINER, VALVE SPRING
SURFACES	2 PLC DEC	3 PLC DEC	ANGLES			DATE	SCALE		
						JBW	11 OF 21		
TOLERANCE UNLESS OTHERWISE NOTED				FINISH	MATERIAL	DETAILER	SHEET NO.	SIZE	(C) Joe Webster 2004



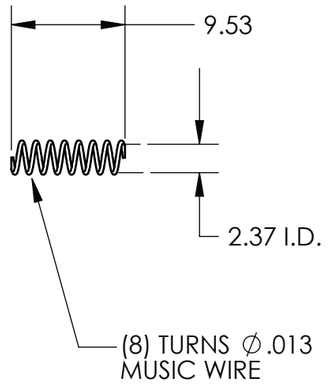
N.V. BLOCK
MATERIAL: BRASS
(1) REQD.



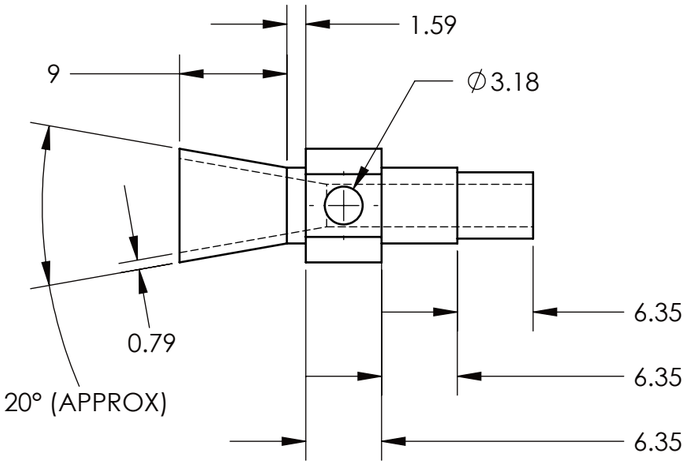
N.V. SEAT
MATERIAL: BRASS
(1) REQD.

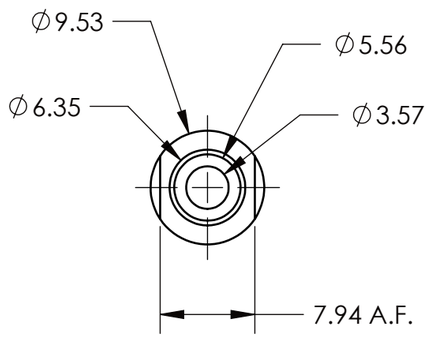


NEEDLE VAVLE ASSY.
(1) REQD

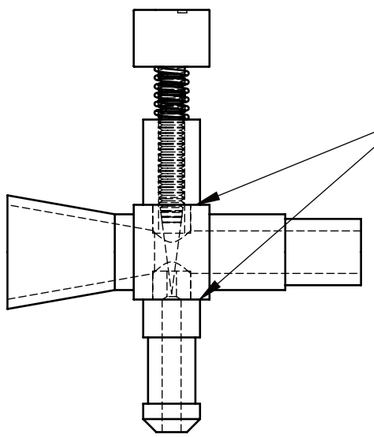


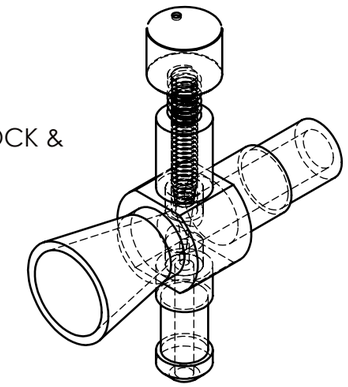
N.V. SPRING
(1) REQD.





VENTURI
MATERIAL: BRASS
(1) REQD.





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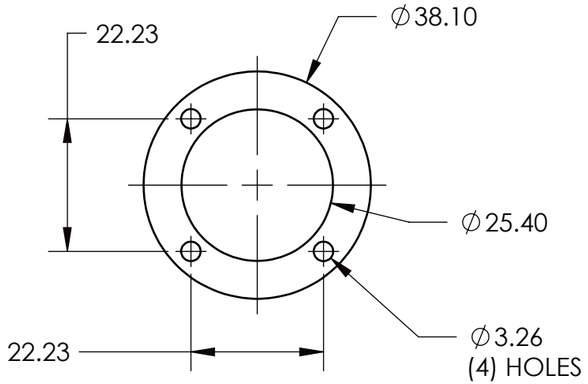
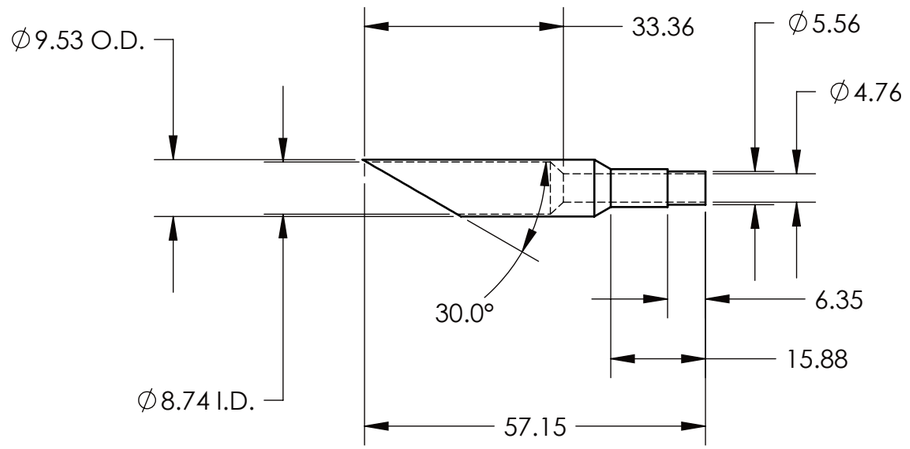
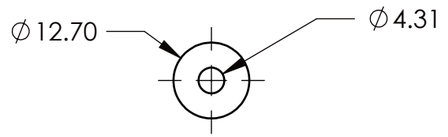
125 √	+/- .015	+/- .005	+/- 30'	SEE NOTES	SEE NOTES	7/6/2011	2:1	B	VENTURI & NEEDLE VALVE ASSEMBLY
SURFACES	2 PLC DEC	3 PLC DEC	ANGLES			DATE	SCALE		
						JBW	12 OF 21		
TOLERANCE UNLESS OTHERWISE NOTED				FINISH	MATERIAL	DETAILER	SHEET NO.	SIZE	(C) Joe Webster 2004



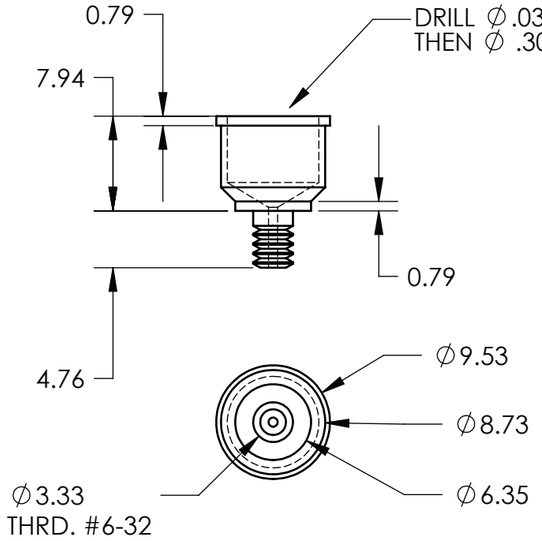
HEAD GASKET
MATERIAL: .015 COPPER, TEFLON,
OR STD. AUTO GASKET STOCK.
(1) REQD.



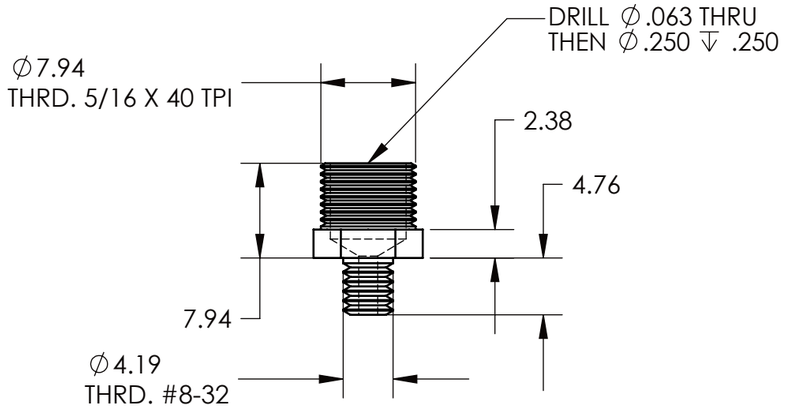
EXHAUST PIPE
MATERIAL: ALUMINUM, BRASS, OR STEEL
FINISH: POLISH
(1) REQD.



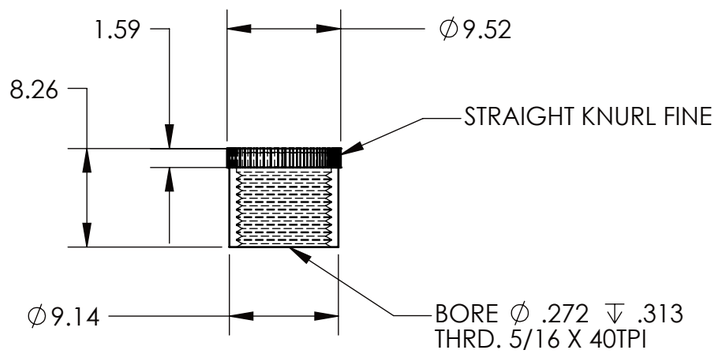
CON ROD KEEPER
MATERIAL: .015 THK. BRASS OR STEEL
(1) REQD.



CRANK OILIER CUP
MATERIAL: BRASS
FINISH: POLISH
(2) REQD.
SCALE: 2:1



CRANK PIN GREASE CUP BODY
MATERIAL: 5/16" HEX BRASS
FINISH: POLISH
(1) REQD.
SCALE: 2:1



CRANK PIN GREASE CUP CAP
MATERIAL: BRASS
FINISH: POLISH
(1) REQD.
SCALE: 2:1

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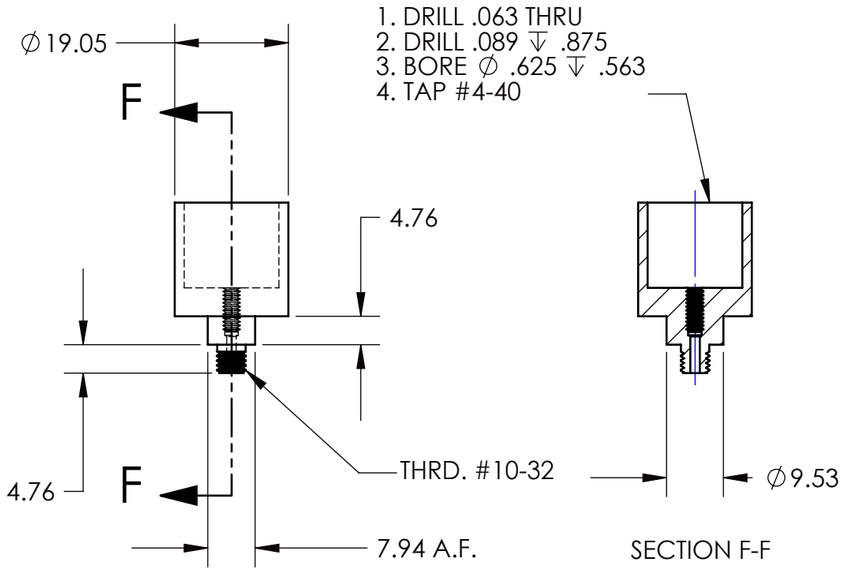
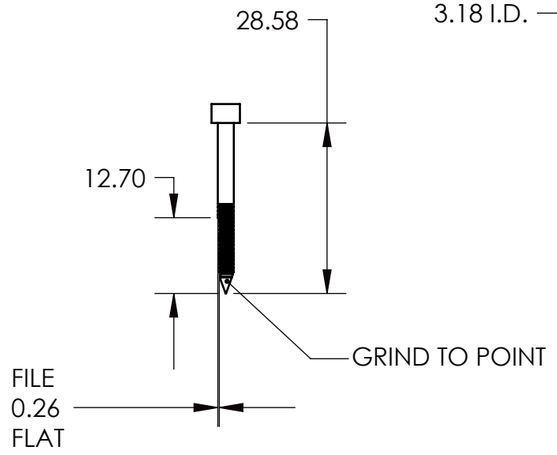
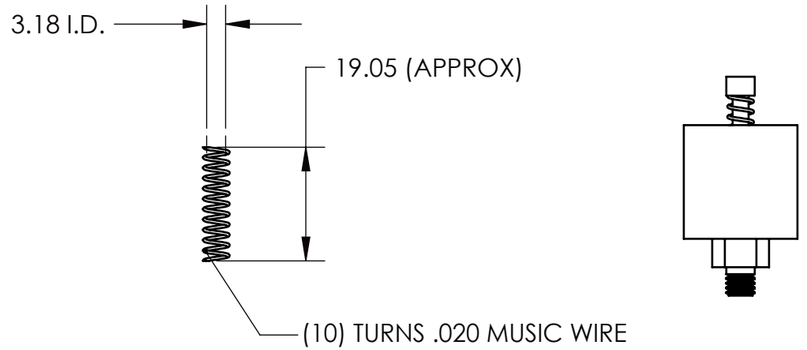
125 ✓	+/- .015	+/- .005	+/- 30'	SEE NOTES	SEE NOTES	7/6/2011	1:1	B	HEAD GASKET, EXH. PIPE, CRK. KEEPER, CRK. OILER & GREASE CUP ASSY.
SURFACES	2 PLC DEC	3 PLC DEC	ANGLES			DATE	SCALE		
						JBW	13 OF 21		
TOLERANCE UNLESS OTHERWISE NOTED				FINISH	MATERIAL	DETAILER	SHEET NO.	SIZE	(C) Joe Webster 2004



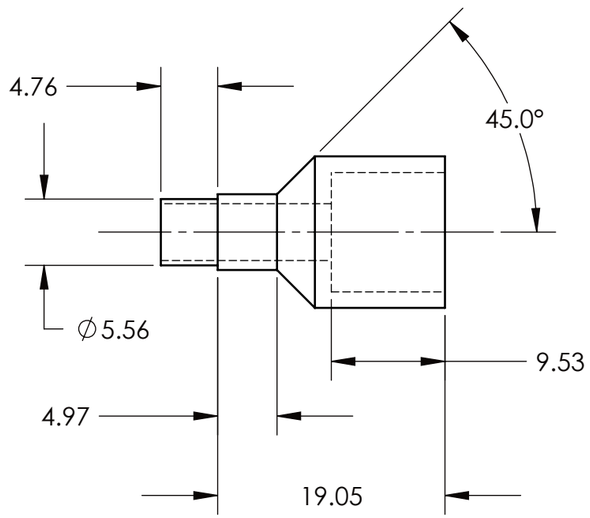
CYL. OILIER BODY
MATERIAL: BRASS OR ALUMINUM
FINISH: POLISH
(1) REQD.

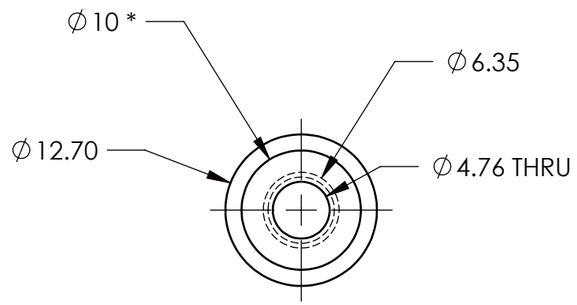


CYL. OILIER VALVE
MATERIAL: #4-40 SHCS
FINISH: AS SHOWN
(1) REQD.



CYL. OILIER SPRING
(1) REQD.





RC CARB. ADAPTER
MATERIAL: BRASS OR ALUMINUM
FINISH: POLISH
(1) REQD.
SCALE: 2:1

* SIZED TO FIT CHOICE OF CARBURETOR. THROUGH EXPERIMENTATION IT WAS FOUND THAT THE ENGINE RUNS BEST WITH RATHER A SMALL BORE CARB. I USED A CARB FROM AN O.S. MAX .12 CZ RADIO CONTROL CAR ENGINE THAT HAS A BORE OF .166" AND IT GIVES AN RPM RANGE OF ABOUT 1000 - 5000 RPM.

IT IS RECOMMENDED THAT A SIMILAR CARB BE USED OR FABRICATED BECAUSE THE NEEDLE VALVE AND VENTURI GIVES ONLY MARGINAL PERFORMANCE - ALTHOUGH IT IS AN EASY/CHEAP ALTERNATIVE.

(I SIMPLY USED HI-TEMP LOCTITE TO AFFIX THE CARB INTO THE ADAPTER.)

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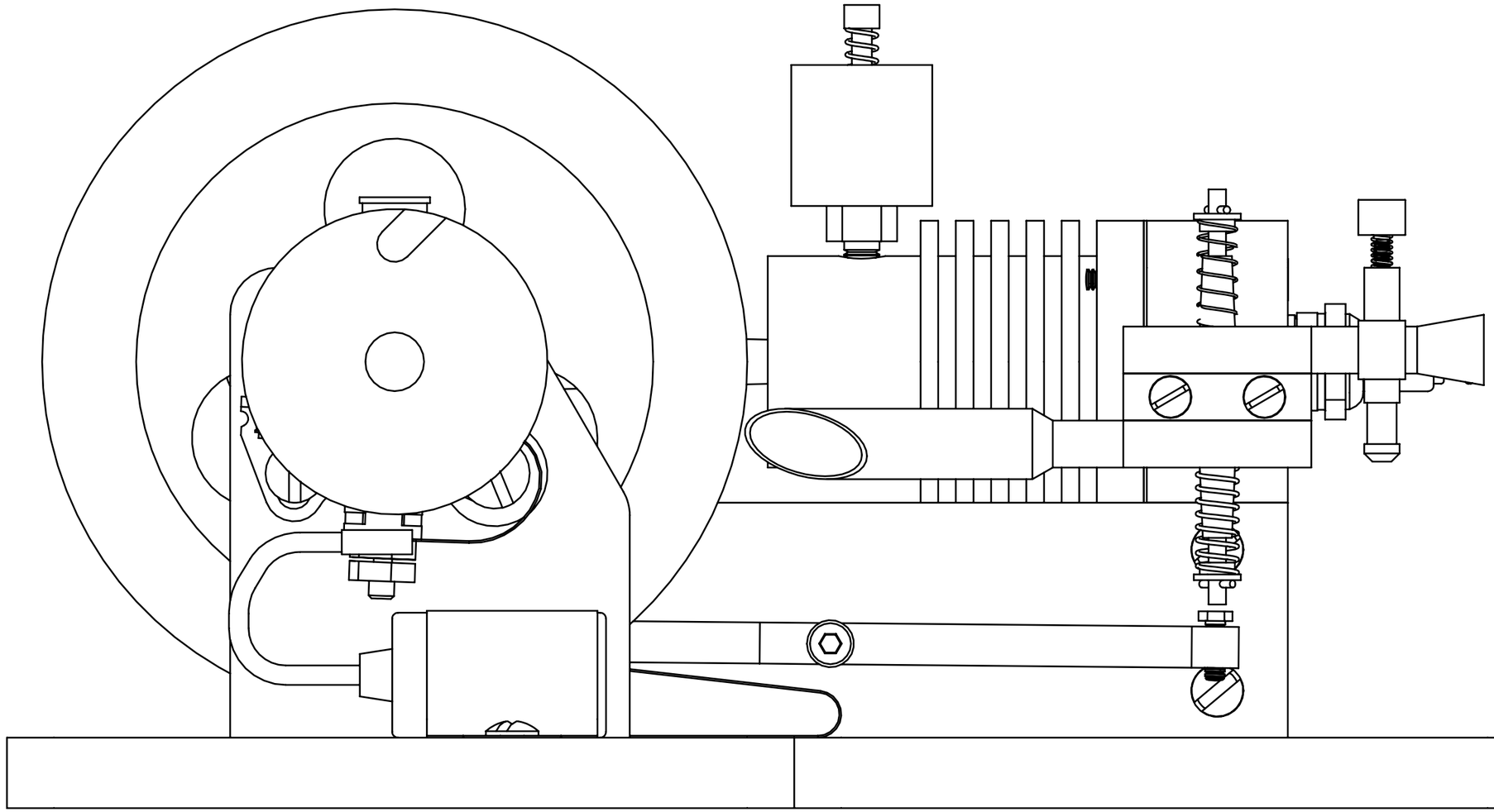
125 ✓	+/- .015	+/- .005	+/- 30'	SEE NOTES	SEE NOTES	7/6/2011	1:1	B	CYL. OILER & CARB. ADAPTER,
SURFACES	2 PLC DEC	3 PLC DEC	ANGLES			JBW	14 OF 21		
TOLERANCE UNLESS OTHERWISE NOTED				FINISH	MATERIAL	DETAILER	SHEET NO.	SIZE	(C) Joe Webster 2004



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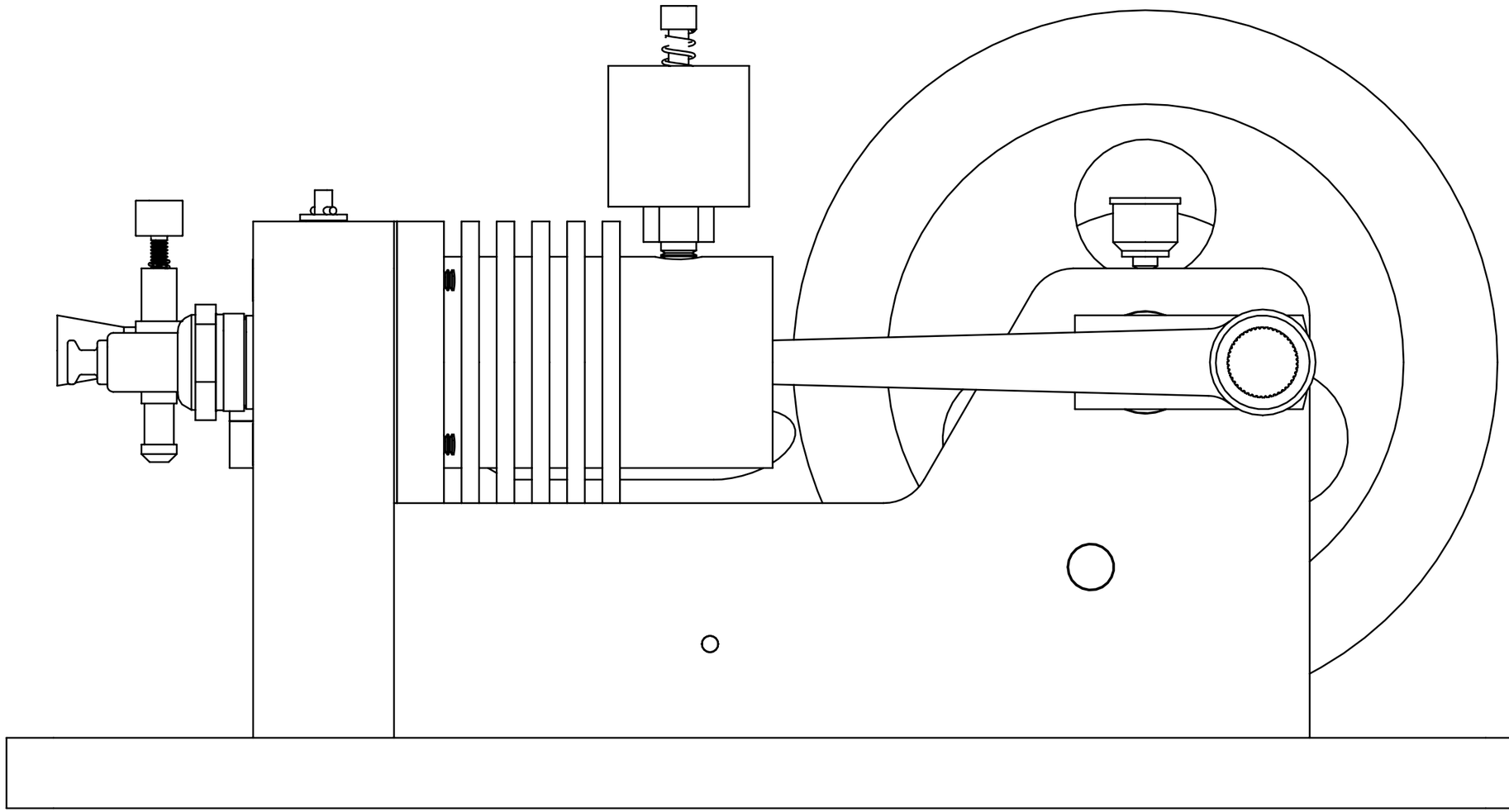
125 √	+/- .015	+/- .005	+/- 30'	N/A	N/A	7/6/2011	1.5:1	B	RIGHT SIDE VIEW
SURFACES	2 PLC DEC	3 PLC DEC	ANGLES			DATE	SCALE		
TOLERANCE UNLESS OTHERWISE NOTED				FINISH	MATERIAL	JBW	15 OF 21	SIZE	(C) Joe Webster 2004
						DETAILER	SHEET NO.		



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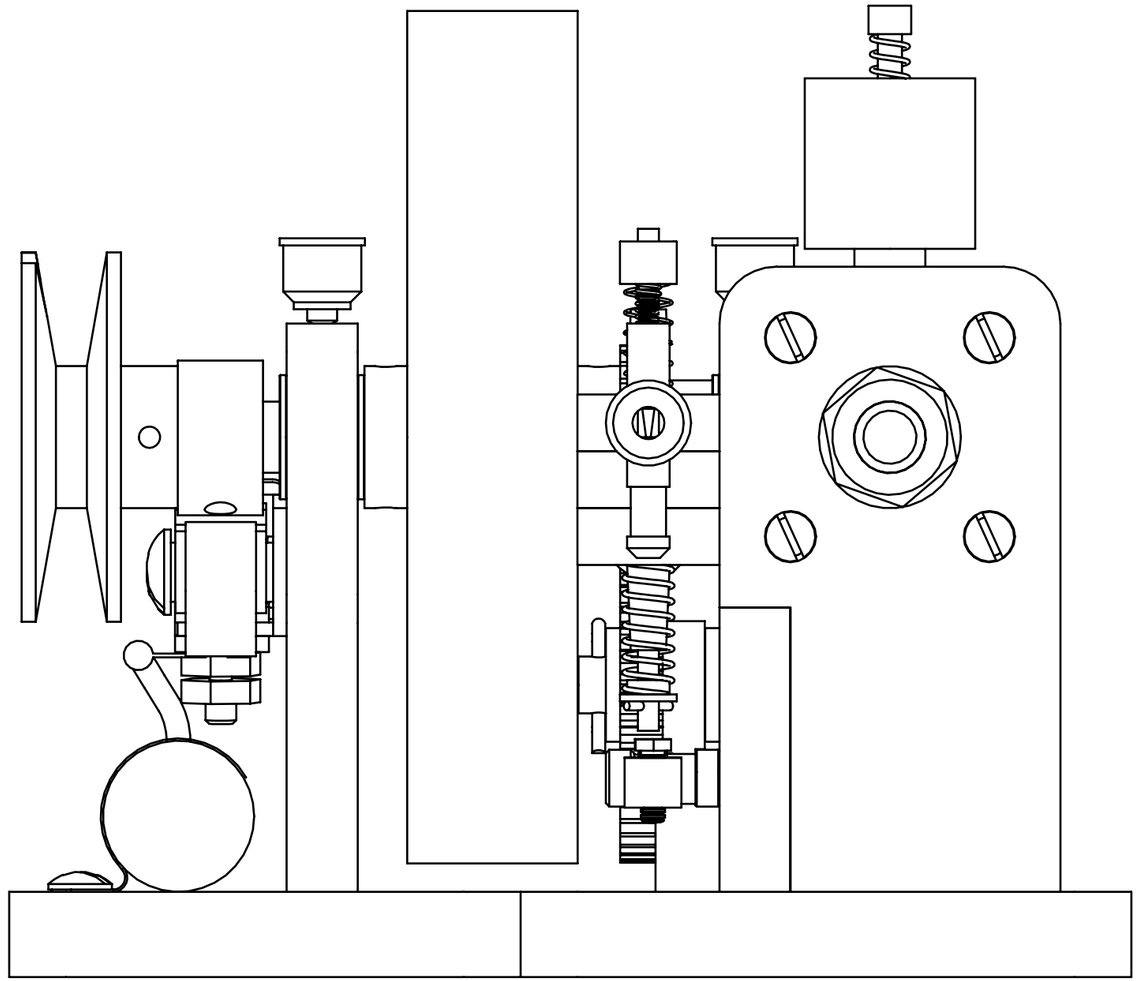
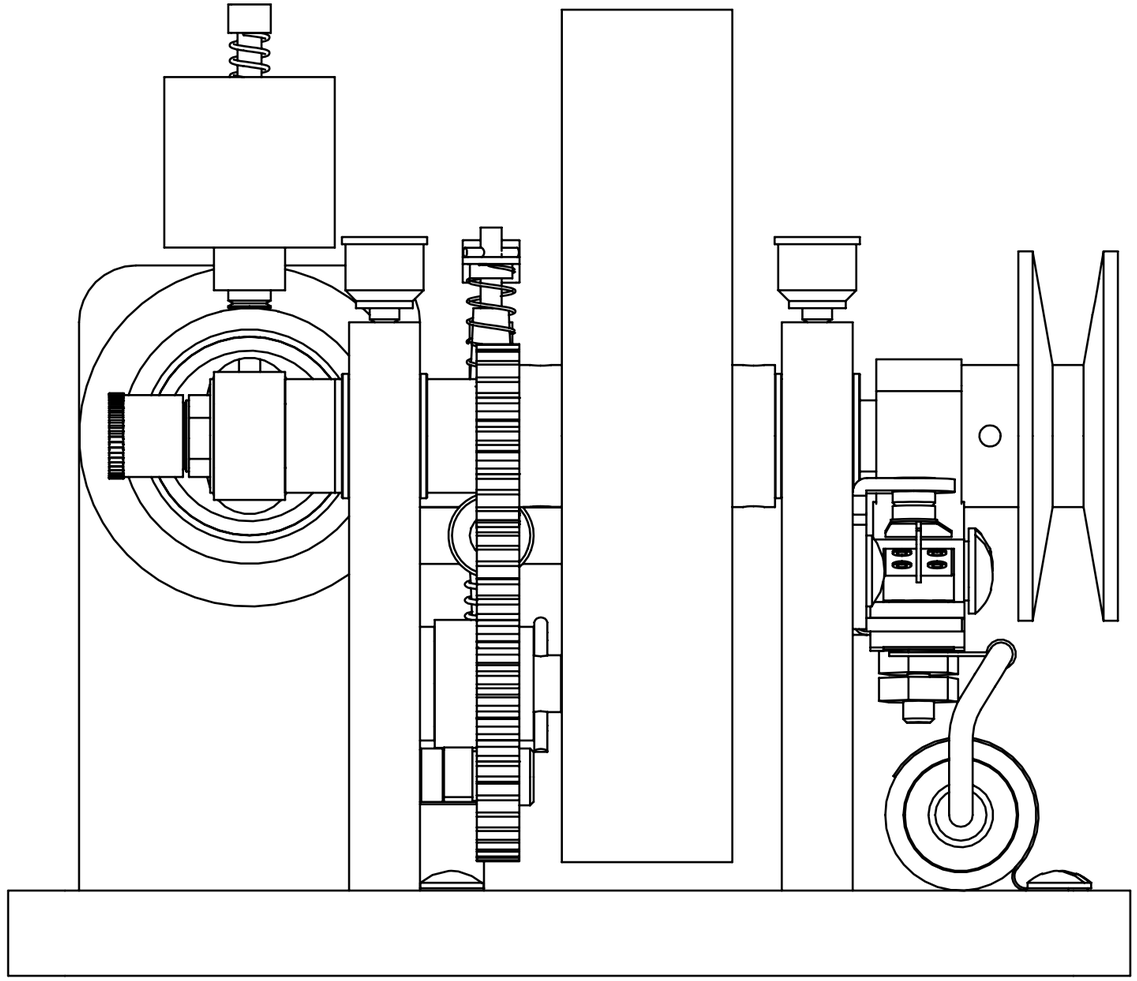
125 ✓	+/- .015	+/- .005	+/- 30'	N/A	N/A	7/6/2011	1.5:1	B	LEFT SIDE VIEW
SURFACES	2 PLC DEC	3 PLC DEC	ANGLES			DATE	SCALE		
TOLERANCE UNLESS OTHERWISE NOTED				FINISH	MATERIAL	JBW	16 OF 21	SIZE	(C) Joe Webster 2004
						DETAILER	SHEET NO.		





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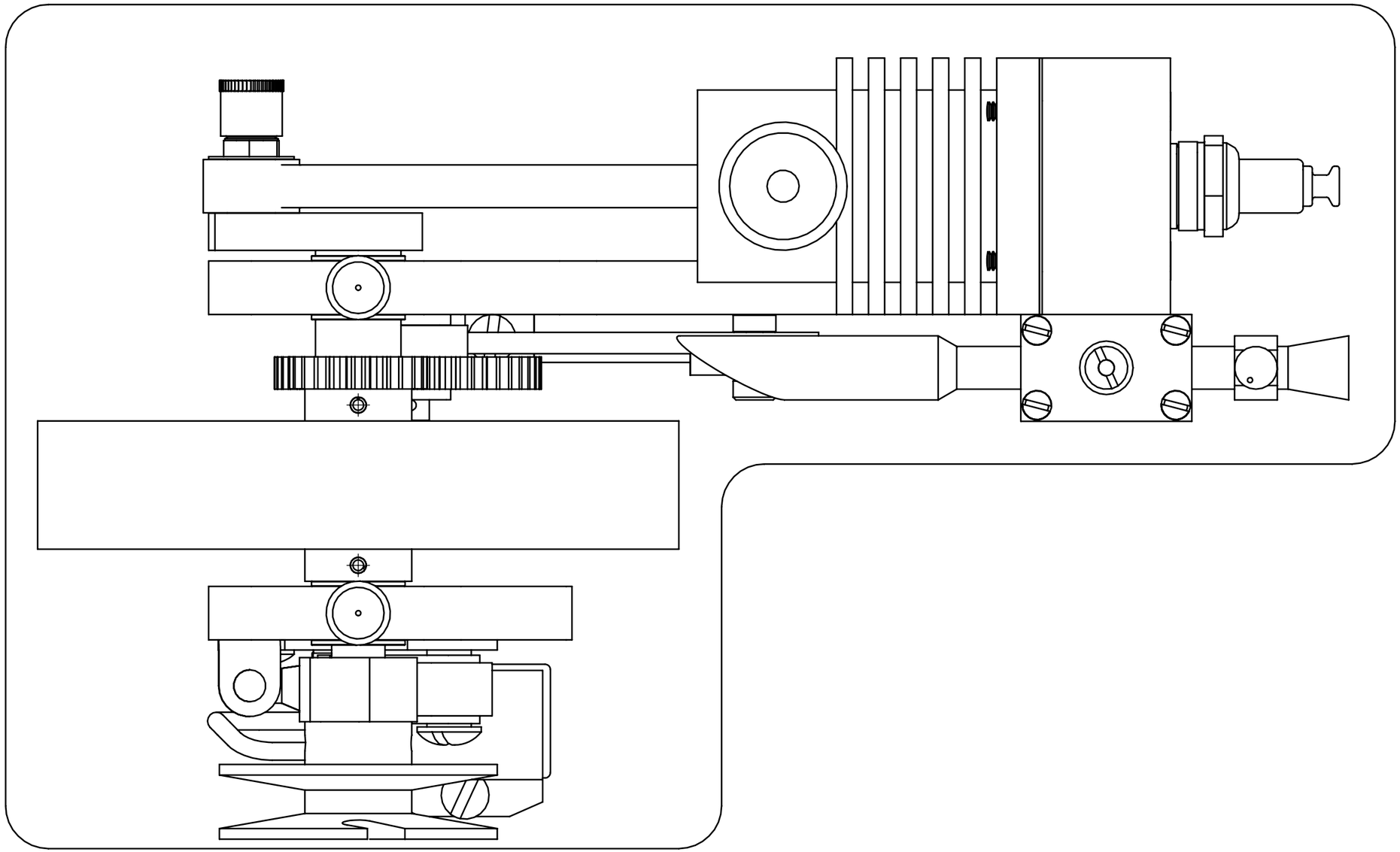
125 √	+/- .015	+/- .005	+/- 30'	N/A	N/A	7/6/2011	1.5:1	B	FRONT AND REAR VIEW
SURFACES	2 PLC DEC	3 PLC DEC	ANGLES			DATE	SCALE		
TOLERANCE UNLESS OTHERWISE NOTED				FINISH	MATERIAL	JBW	17 OF 21	SIZE	(C) Joe Webster 2004
						DETAILER	SHEET NO.		



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125 √	+/- .015	+/- .005	+/- 30'	N/A	N/A	7/6/2011	1:1	B	TOP VIEW
SURFACES	2 PLC DEC	3 PLC DEC	ANGLES			DATE	SCALE		
						JBW	18 OF 21		
TOLERANCE UNLESS OTHERWISE NOTED				FINISH	MATERIAL	DETAILER	SHEET NO.	SIZE	(C) Joe Webster 2004

The following notes aren't meant to be comprehensive, step-by-step building instructions, just a few notes on how and why I did things.

SHEET 1. Just a few views to show the general arrangement of parts.

SHEET 2. BASE - This is the engine baseplate. Since all engine parts mount and align off of this, it is suggested that the holes be layed out and located somewhat accurately. Notice that the countersunk holes are on the bottom of the plate. The external dimensions can be altered to suit as long as the hole spacings for the engine frame remains the same.

SHEET 3. SIDE FRAME & CRANKSHAFT SUPPORT - Again, try to stick to the dimensions given, as these parts, along with the BASE make up the backbone of the engine. Alignment of the remaining engine parts rely on good workmanship here. Also, the bearing and cam shaft holes need to be sized for light press fits of their respective parts and accurately placed for proper gear spacing.

SHEET 4. CYLINDER HEAD-FRAME & CYLINDER - Nothing especially difficult here, but two things are worth noting. There are two options given for a spark plug - use whatever you are comfortable with. I started with the tiny 1/4"-32tpi sparkplug because it is also the same size of a model airplane engine glow plug which I could use to start the engine on glow fuel (without having to rig oiling and an ignition system). I then switched to spark with gas and oil mix, and quickly fouled this tiny spark plug. So I redrilled and retapped for a 10mm x 1mm NGK CM-6 spark plug that I could get from my local motorcycle dealer for a lot cheaper.

The cylinder bore is the other item that needs particular attention - make sure to bore it straight and without any taper. Finish within .002" of size, drill port and oiler holes (using cyl. head-frame as a guide), then lap to a finished size of .875". Simple laps can be fabricated or purchased, and details on how to use them can be found on the Internet, in the model engine newsgroups/web sites.

SHEET 5. CRANKSHAFT, FLYWHEEL, SPACER, and BEARING - I made my crankshaft from a 5" section of 1/2" X 1 1/4" Cold Rolled Steel, both shaft and crankpin were turned between centers, but it could be fabricated and silver soldered together from three pieces if you wanted to go that route. Also, notice that it's not counter-balanced for ease of construction - a lot smoother engine would result if you took the time to redesign the crank and add the appropriate wieghts. The end of the crankpin is drilled and tapped to receive the grease cup - don't forget the tiny crossdrilled hole, and to polish the journal.

The flywheel can be made from cast iron, CRS, bronze, etc... - any heavy metal should work fine. I chose cast iron, in the form of a dumbbell that I purchased from Wal-mart. Be careful if you take this approach as there can be small voids/casting flaws where it matters - I was lucky and none presented any problems. Be certain when boring the .500" counter bore that it's concentric with the crankshaft bore, and that the modified CAM DRIVE GEAR is a snug fit - it will need to be pressed and Loctited in place. See sheet #9 for details.

SHEET 5. cont. - The three .750" holes are for appearance only, as a matter of fact, I skipped them altogether on the prototype engine. A nice cosmetic touch would have been a spoked flywheel, but since it would require a rotary table for the mill, I didn't bother. Again, feel free to experiment.

If you choose not to use ball bearings to support the crankshaft, then you will have to make the two bronze MAIN BEARINGS as shown. Aim for a light press fit into the SIDE FRAME and CRANKSHAFT SUPPORT. Using Loctite as good measure, press them in with the flanges toward the inside of the engine, making sure to align the oil holes with the #6-32 tapped oil cup holes. (Alternatively, wait until bearings are in place before dilling the .063" oil holes.)

Also on this sheet is the CRANKSHAFT SPACER - adjust thickness on final assembly for .001" to .003" of crankshaft endplay.

SHEET 6. PISTON & OIL TUBE - The ring grooves in the PISTON were sized for the rings mentioned elsewhere in these plans. 1/16" wide rings would offer less friction and probably seal just as well - simply adjust the ring grooves to accomodate. Use a 3/8" endmill to machine the con rod slot, being careful not to go beyond the .688" dimension because you may cut into the lower ring groove. Be sure to drill the wrist pin perpendicular and on the exact centerline of the piston - this is not the time to rush things. (Make sure the con rod slot is going in the right direction.) Small #4 set-screws are used to retain the wristpin in it's bore. The OIL TUBE is simply a short section of brass tubing, Loctited into the piston as indicated.

SHEET 7. Nothing too remarkable here. Just be sure to drill both CON ROD holes at the same setting and size the BUSHINGS for a light press fit into the rod ends - use Loctite for added security. Drill the .063" hole in the wrist pin end after the bushing is installed. Be sure this hole is pointed up (towards the OIL TUBE, and ultimately towards the CYLINDER OILER) upon final assy.

SHEET 8. The EXHAUST CAM started out as a .185" thk. disk of steel .712" in diameter with a reamed .375" hole though it. It was offset turned on the lathe as described by Hamilton Upshur in Volume 79 of Strictly I.C. magazine. There are many other methods - use whatever you are comfortable with. The plans call for hardenening of many parts, i.e. CAMSHAFT, CAM, ROCKER ARM, etc... This not necessary, but doing so should result in a longer wearing engine.

When making the CAM SHAFT, shoot for a press fit into the engine frame and a free rotating fit with the CAM GEAR. Alternatively, you could use a set screw though the bottom of the SIDE FRAME to retain the CAM SHAFT in it's bore.

SHEET 9. Modify CAM GEAR and CAM DRIVE GEAR as shown. Use Loctite and press them to their respective parts. The position of the gear teeth are not important at this stage - the engine will be timed on final assembly. When making the IGNITION CAM, round off the sharp edges created when milling the flat spot - it is this flat that operates the ignition points. Use a short #6 set-screw to hold this CAM to the crankshaft - see assembly notes for locating details.

SHEET 10. The INTAKE & EXHAUST VALVE BLOCKS are nearly identical with one exception - the four holes for the #2 screws. I used studs screwed into the EXH. VALVE BLOCK so my INT. VALVE BLOCK had only though holes - no coutersinks. Doesn't really matter what you choose, just make sure all mating surfaces are flat and smooth so you won't need gaskets or messy sealers. The 3/16" port holes aren't drilled until the VALVE GUIDES (shown on sheet 11) are pressed in.

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125 √	+/- .015	+/- .005	+/- 30'	N/A	N/A	7/6/2011	1:1	B
SURFACES	2 PLC DEC	3 PLC DEC	ANGLES			DATE	SCALE	
TOLERANCE UNLESS OTHERWISE NOTED				FINISH	MATERIAL	JBW	19 OF 21	SIZE
						DETAILER	SHEET NO.	

NOTES

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SHEET 11. Onto the VALVE GUIDES - make sure your 3/32" reamed holes are concentric with the valve seats. To cut the valve seats, I simply used a 90° chamfering bit in the lathe's tailstock and lightly touched it to the rotating valve guide, creating a narrow valve seat which was later lapped to the valve. I used brass for the guides on the prototype engine, but I think bronze or cast iron would be a better choice.

The VALVES were made one piece out of whatever steel I had laying around. Stainless steel would be a great choice, or two piece vavles can be fabricated and silver soldered together.

SHEET 12. Do yourself a favor and skip building this VENTURI and NEEDLE VALVE ASSY. While OK for initial starting and breaking in - much better results can be had from conventional throttling carburetors - either ones from radio control glow engines, or ones fabricated to work like one. Shoot for a small bore carb, something from a .10 - .15 ci 2-stroke glow engine or one with a bore of .156" - .188", you won't need anything larger than this.

SHEET 13, 14. Nothing special here, just the remaining components that will need to be fabricated. If you're careful about machining the cylinder spigot and it's fit into the head, you may not need a head gasket - I used one for good measure. The design of the exhaust pipe is mostly cosmetic - I like balogna cut pipes, but do whatever you wish here. (Originally I had second thoughts about pointing the exhaust back, but it was actually found to have a benefit - the unburned oil in the exhaust helps to keep the gears and cam lubricated.)

The CRANK OILER CUP and the CRANK PIN GREASE CUP were purchased from a vendor at Cabin Fever - unfourtunately I don't remember who it was. Approximate dimensions are given should you wish to fabricate your own.

The CYLINDER OILER is an optional item if you mix oil in your fuel. Again, there are other, more attractive designs out there, but this was a quick and dirty way to do it.

Also shown is the optional RC CARB ADAPTER... highly recommended.

ASSEMBLY - Assembly should pose no particular problems, however it is suggested that the parts be made in the order that they are presented on the plan sheets. Although I've tried to be thorough with the notes on the plans themselves, a few points are worth mentioning.

Press the bearing(s) and CAM SHAFT into the SIDE FRAME, slide on one CAM GEAR WASHER, the CAM GEAR ASSY (with the CAM pointing towards the frame) followed by another washer, and secure with a cotter pin. Be sure that the gear spins freely on the shaft - adjust as necessary.

Attach the ROCKER ARM (with TAPPET in place) to the SIDE FRAME using the shoulder screw, washer, and spacer. Fasten on the CYL. HEAD-FRAME and secure this assembly to the BASE PLATE. Attach the CRANKSHAFT SUPPORT (with bearing(s) in place) to the BASE PLATE.

Assemble the CRANKSHAFT, CRANK SPACER, and FLYWHEEL ASSY. - at this point the crank should spin freely, independently of the flywheel - we will adjust timing and secure this later.

The CYLINDER, it's gasket, and the piston/rod assy. must be installed as one group. Slide the piston/rod assy. into the cylinder, and with the crank at BDC, slide the big end of the rod onto the crank pin. Rotate the crank while moving the assy. forward, into the head's bore (don't forget to align the ports). Secure the cylinder to the head, then attach the GREASE CUP using the CON ROD KEEPER like a washer. You did remember to make sure the oil holes in the rod and piston were pointing up, didn't you?

The assembled valve block can now be attatched to the head - no sealer is required if both surfaces are flat and smooth. Exhaust valve timing is set by rotating the crankshaft counter-clockwise (as viewed from the cam side) until it is about 15 - 30° before it's outward most stroke. It is then held in place while the flywheel is rotated C.C. until the cam just starts to lift the exhaust valve off of it's seat. Clamp, lock, & secure everything in place and drill the two roll pin holes as shown on the next sheet. If set properly, the exhaust valve will close a few degrees before TDC.

Timing the IGNITION CAM is much simpler. With the points and ignition cam installed, set the points gap to about .020". Rotate the flywheel until the piston is about 15° before TDC. Loosen the set screw on the ignition cam and rotate it clockwise until the points close and just start to open, lock the ignition cam in place.

The INTAKE and EXHAUST pieces are simply pressed and Loctited in place for sake of simplicity and I haven't had a problem with them so far.

Finish assembly with the oilers, spark plug, igntion condenser, etc... Check that all moving parts are free, and that you have compression / no leaks. Rotating the flywheel counter-clockwise (viewed from the flywheel side) should produce a "snorting" sound through the carburetor as the intake valve lifts. As you pass TDC on the compression stroke the engine should feel "bouncy" or "snappy", indicating good compression and that your engine is ready to run. Some folks like to break-in their engine by driving them with an electric motor, or even connected to the lathe spindle. If yours is free enough, it shouldn't be necessary to do this.

STARTING and RUNNING - I use a 12 volt car coil and 12 volt battery for my ignition system because I don't want any doubts whether it's firing or not. I have a 1 oz. fuel tank set so that the fuel level when full is about 1/4" lower than the needle valve. My engine runs good on straight Ozark Trails camping lantern fuel with 5w-30 motor oil in the cylinder oiler. (Some folks run straight methanol, some run gasoline and oil mix - do whatever works for you.) If you use the oiler, set it so that it drips oil about once every 6-10 seconds - experimentation may be in order to find the right setting to limit smoke, fouled plugs, oily mess, etc... When using an RC carb set at about 1/8 throttle, my engine starts on the first flip and will rev like crazy when prompted. Keep in mind, this is not a high speed engine, there's no balancing and inadequate cooling, so keep the speeds low.

SUMMARY - This engine was designed to be easy & quick to build, so there are no fancy radiuses, complicated governors, forced cooling, exotic materials, etc... It's a bare-bones internal combustion engine in the rawest form. As a matter of fact, mine isn't even painted. Sure, I specify to anodize this, polish that, etc... it's not necessary for operation, but it would be a nice touch don't ya think? If someone took their time and incorporated a few cosmetic details, it would be a pretty decent looking engine (I should know, I did just that in CAD).

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125 √	+/- .015	+/- .005	+/- 30'	N/A	N/A	7/6/2011	1:1	B	NOTES, PG. 2
SURFACES	2 PLC DEC	3 PLC DEC	ANGLES			DATE	SCALE		
						JBW	20 OF 21		
TOLERANCE UNLESS OTHERWISE NOTED				FINISH	MATERIAL	DETAILER	SHEET NO.	SIZE	(C) Joe Webster 2004

THE FOLLOWING ADDITIONAL (NON-DETAILED) ITEMS ARE NEEDED FOR ASSEMBLY:

IGNITION POINTS:
(1) REQ.
SOURCE: PEP BOYS, AUTOZONE, NAPA, ETC...
(1969 DODGE CHARGER, 383, 4BL, W/SINGLE POINT DIST.)

IGNITION CONDENSER:
(1) REQ.
SOURCE: SOURCE: PEP BOYS, AUTOZONE, NAPA, ETC...
(1969 DODGE CHARGER, 383, 4BL, W/SINGLE POINT DIST.)

SPARK PLUG: NGK CM-6
SOURCE: MOTORCYCLE SHOP, ONLINE, ETC...

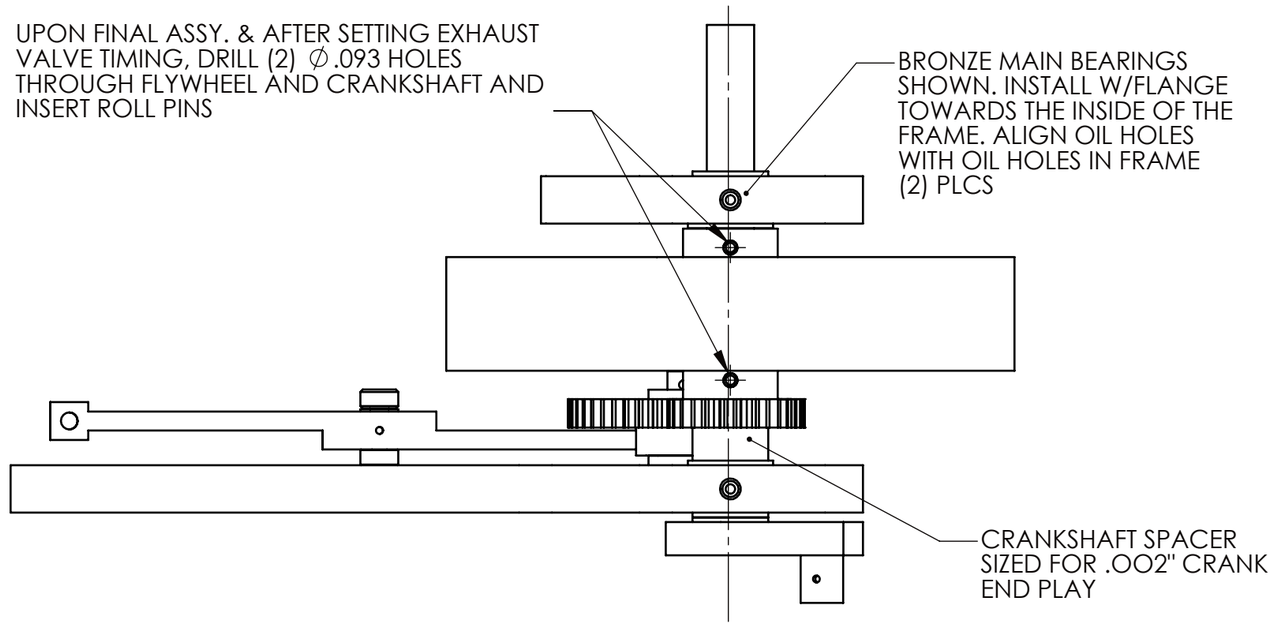
CRANKSHAFT BALL BEARINGS: 5/16" I.D. X 1/2" O.D X 5/32" THK., FLANGED
SOURCE: W.M. BERG: P/N B2-21 -OR- STOCK DRIVE PRODUCTS: P/N A 7Y55-FS5031
(4) REQD.

PISTON RINGS - 3/32" X .875"
(2) REQD.
SOURCE: OTTO GAS ENGINE WORKS
(410)-398-7340
2167 Blue Ball Rd
Elkton MD 21921-3330
http://www.dol.net/~dave.reed/otto.html

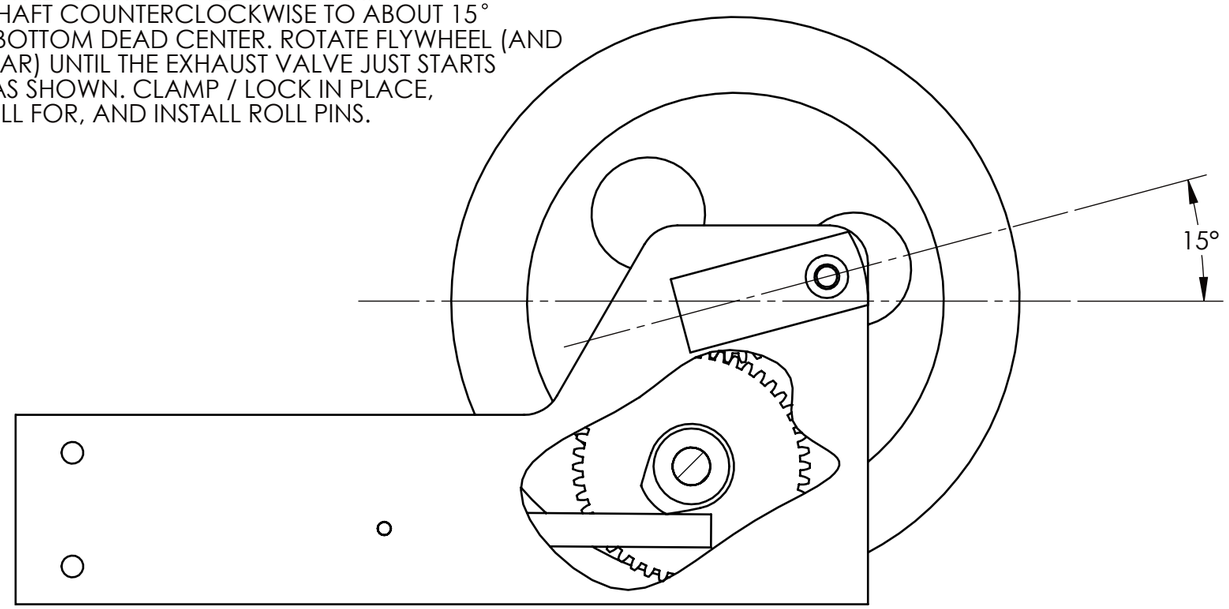
SHOULDER SCREW: 1/8" X 3/8"
(1) REQD.
SOURCE: WM. BERG: P/N PL-5 -OR- STOCK DRIVE PRODUCTS P/N A 9X15-0412

ROLL PIN: .093" X 5/8"
(2) REQD.
SOURCE: HW STORE, STOCK DRIVE PRODUCTS, W.M. BERG, ETC...

COTTER PIN: 1/16" X 1/2"
SOURCE: HW STORE, STOCK DRIVE PRODUCTS, W.M. BERG, ETC...
(1) REQD.



EXHAUST VALVE TIMING IS SET BY ROTATING CRANKSHAFT COUNTERCLOCKWISE TO ABOUT 15° BEFORE BOTTOM DEAD CENTER. ROTATE FLYWHEEL (AND CAM GEAR) UNTIL THE EXHAUST VALVE JUST STARTS TO LIFT, AS SHOWN. CLAMP / LOCK IN PLACE, THEN DRILL FOR, AND INSTALL ROLL PINS.



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125 √	+/- .015	+/- .005	+/- 30'	E513	ALUMINUM	7/6/2011	1:1	B	NOTES PG. 3
SURFACES	2 PLC DEC	3 PLC DEC	ANGLES			DATE	SCALE		
TOLERANCE UNLESS OTHERWISE NOTED				FINISH	MATERIAL	JBW	21 OF 21		
						DETAILER	SHEET NO.	SIZE	(C) Joe Webster 2004