

James Engine
HEX-4

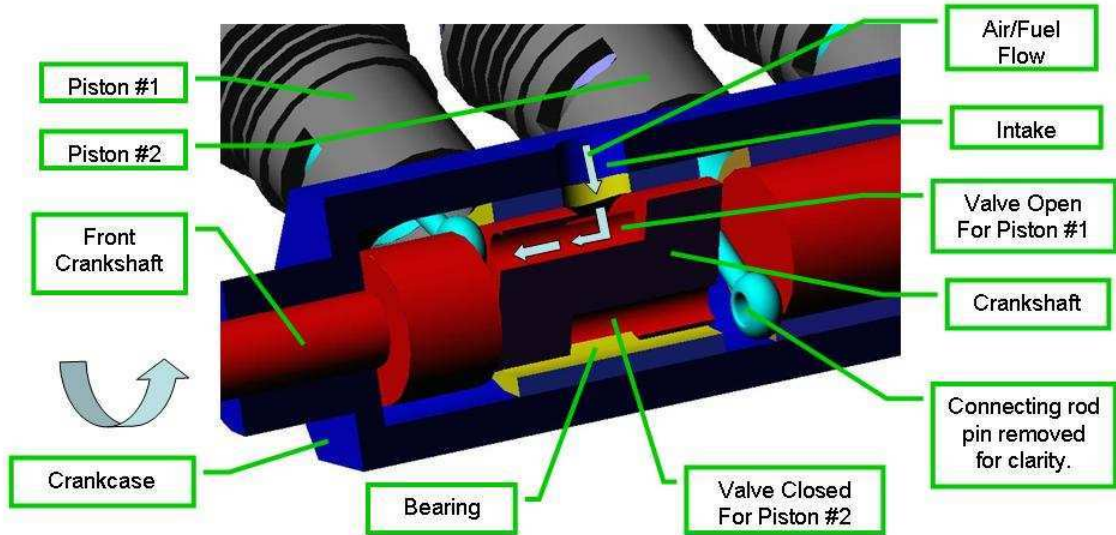
Patent Pending
Patent Applied For

Designed by: Jerry James
Type: 4 cylinder inline 2-cycle
Bore: .406 in.
Stroke: .386 in
Displacement: .196 cui

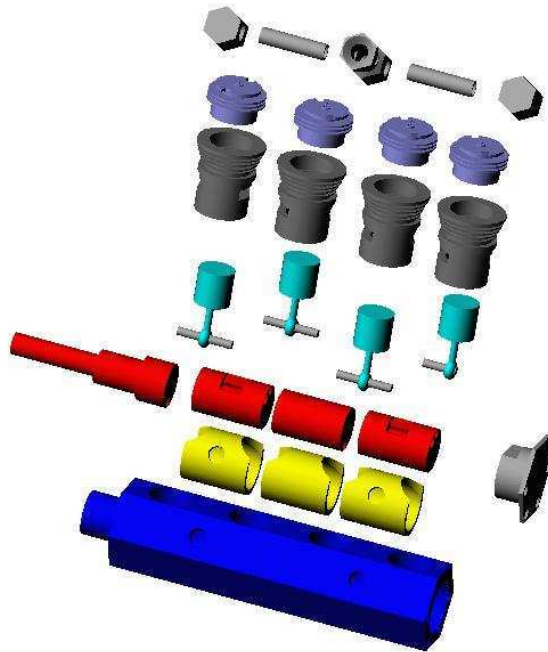


This is a license to build one James Engine Hex-4. You may not sell the engine or engine parts except for the Cox™ engine parts for commercial purposes. This engine is experimental and therefore you assume all risk and liabilities associated with building and/or running this engine.

How the HEX-4 crankshaft rotary valve works.



As the crankshaft rotates, a slot in the crankshaft (valve) aligns with the intake and an air and fuel mixture flows through the crankcase, bearing and a hole in the crankshaft into the crankcase space below the piston. As the crankshaft continues to rotate, the crankshaft valve closes. (Counter clockwise rotation.)



HEX-4 Construction Notes:

These steps are presented here in an order that minimizes material waste and reduces machining operations.

NOTE: The bearings are not machined separately – they are inserted into the crankcase and machined along with the crankcase. These bearings are not required if building the crankcase alternative.

Crankshaft holding tool:

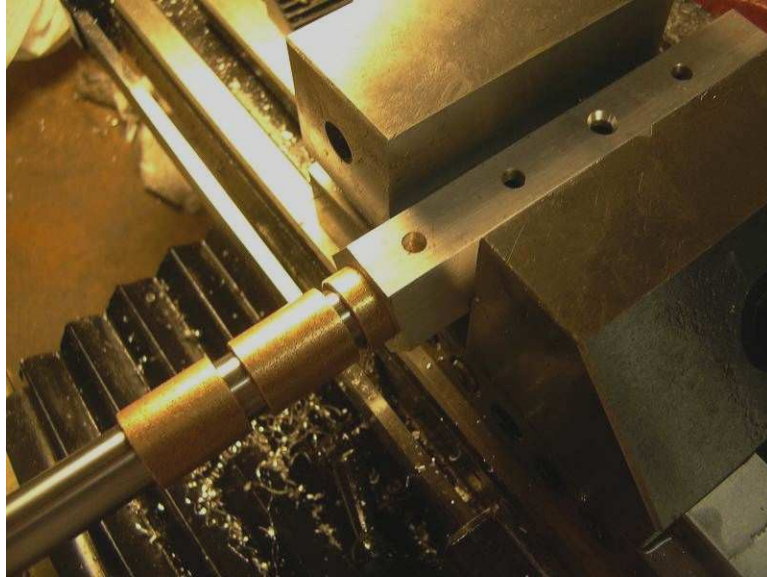
1. Mount 7/8" stock.
2. Center drill and drill 1/2" hole 1/2" deep.
3. Part to length.
4. Cut slot on side using hacksaw.

Back plate:

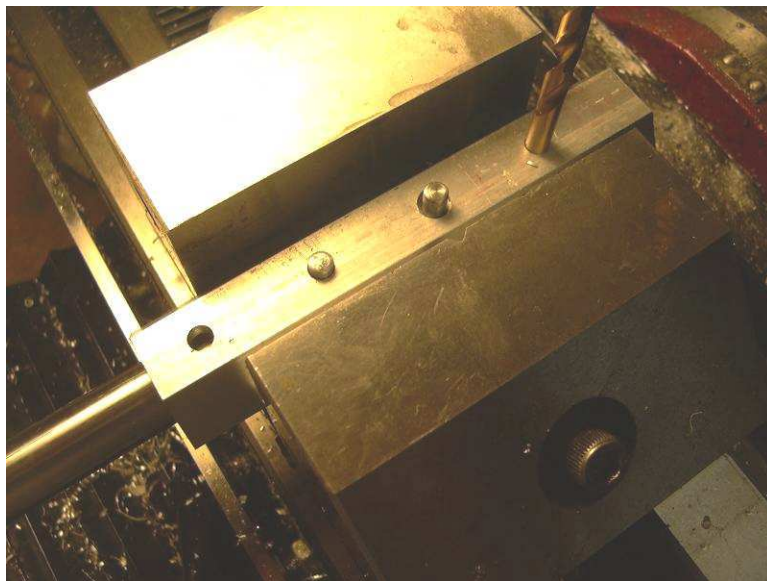
1. Mount the 7/8" hex rod in the lathe.
2. Face and turn the shoulder.
3. Mount in mill and drill 4 #43 holes for back plate 1/2" deep – holes will be enlarged to 1/8" after parting
4. Mount in lathe - part back plate long.
5. Reverse back plate in lathe and face to length.
6. Enlarge holes to 1/8".

Crankcase (see alternative below):

1. Mount 7/8" hex rod in lathe.
2. Face and center drill.
3. Drill 3/8" hole through center.
4. Enlarge 3/8" hole to 1/2" 3.600" deep.
5. Bore the 1/2" hole to 0.625" diameter 3.600" deep. Complete the hole long and then face the hex rod to length to get the 3.600" deep hole. The inside corner does not have to be square. You can turn the edge of the crankshaft end to match the same contour of the crankcase corner left from boring.
6. Mark and center drill cylinder locations.
7. Drill .177 (#16) hole – do not drill to 1/2" diameter at this time.
8. Turn spacer pins on the lathe .177 diameter .500" long. You can use two spacer pins and the drill bit as a third spacer.
9. Ensure crankcase is clear of chips. Coat the outside bearings with Loctite (maximum strength) and place in crankcase. Use spacer pins to properly locate the bearings as seen in the photo. Use 1/2" TGP (Turned Ground Polished) stock to align the bearings axially. If chips come in contact with the Loctite they will be bonded to the engine – make sure the crankcase is clean of chips.



Use 1/2" TGP to align bearings in crankcase.



Use spacer pins to properly space bearings.

10. Turn crankcase bottom side up and mark, center drill, drill and tap three holes for the 8/32" set screws – drill/tap completely through crankcase and bearing. Insert set screws. The set screws will help hold the bearings in place while the rest of the crankcase is machined.
11. An alternative to step 10 is to use the intake holes to hold the two outside bearings. Drill the holes for the intake and insert pins into the holes while drilling the cylinder holes. You will still need to install a set screw for the middle bearing but can be placed on the same face as the intake. It will be hidden under the venturi upon final assembly.
12. Turn crankcase top side up and drill 1/2" holes for cylinders. Tap to 17/32-40 or turn the threads on the lathe using a 4-jaw chuck.
13. Turn crankcase so that intake side is face up. Center drill and drill #12 holes.
14. Mount in lathe – front of crankcase towards the tail stock.

15. Face to length and turn shoulder on front of engine.
16. Using the 1/2" TGP stock, grind a D-bit reamer in the end as shown in the photo.
17. Ream bearings to remove any burrs left from previous machining operations.



Using the D-bit reamer to remove burrs.

Crankshaft end:

1. Mount 1/2" TGP in stock. You may use other steel stock you may have that is easier to machine for the crankshaft end. Use TGP for the other crankshaft pieces to ensure a good fit and smooth finish.
2. Cut .250" and .375" shoulders. .250" shoulder may be turned to any length desired.
3. Cut the 1/4-20 threads using a die.
4. Part long.
5. Reverse in lathe and part to length.
6. The shoulder internal to the crankcase can be contoured to fit the contour of the boring operation in the crankcase.
7. DO NOT drill connecting rod pin hole at this time.

Crankshaft:

1. Cut and face to length 3 - 1/2 TGP pieces .800" long
2. Set up to drill connecting rod pin hole.
3. Using same setup – center drill and drill all connecting rod dowel pin holes, including the one for the crankshaft end. Ensure all pin holes are the same distance from the edge. The holes must not vary by more than a few thousandths between parts. If during final assembly you find that one of the holes is off you may be able to remedy the problem by drilling the hole slightly larger. If the holes are off then the crankshaft will bind while turning.
4. Set up to drill the 1/8" passageways. The hole is on the **right** of the connecting rod pin hole for the face of the crankshaft nearest the front of the engine (front face). The hole is on the **left** of the connecting rod pin hole for the end nearest the rear of the engine (rear face).



Using shim stock to measure distance between dowel pin and .125" hole. Face of crankshaft nearest the front of the engine shown (front face).

5. Mill slots in crankshaft. Measure from the **right** side of the crankshaft holding tool to the **right** side of the connecting rod pin for the face closest to the front of the engine. Measure from the **left** side of the crankshaft holding tool to the **left** side of the pin for the face closest to the rear of the engine. See photo. Remove any burrs with a file.



Measuring from right side of holding tool to right side of pin. 0.475 measurement is for display only – actual measurement for the HEX-4 is 0.456. Face of crankshaft nearest the front of the engine shown (front face).

Venturi and Intake:

1. Machine venturi and intake to drawing specs.
2. Other alternatives include bending brass tubing instead of using the machined elbows.
3. The critical dimensions on the venturi are the inside and outside diameter of the venturi around the needle valve to ensure proper fit of the needle valve – if using the COXtm needle valve. You can shape the rest to your liking.
4. You can use the needle valve from the COX engine. This can be removed by driving it out with a punch pin. The end where the fuel line attaches will have to be turned down slightly to fit in the cross hole of the venturi. The needle valve is then gently driven into the venturi with the needle valve hole facing down. Other needle valves may be used but venturi will have to be dimensioned to fit your needle valve.

Crankcase Alternative:

1. This alternative applies to the interior of the crankcase. One purpose of the bearings is to provide clearance for the connecting rods. You may use the crankcase as a bearing surface as well. This requires that you cut grooves in the crankcase for the connecting rod clearance.
2. Ream center hole to .501” 3.600” deep instead of boring to .626”
3. Cut grooves using a side cutting or custom built boring bar to allow for connecting rod clearance. The dimensions are not critical as long as the connecting rod does not contact the crankcase as it rotates.
4. Do not drill and tap 8-32 set screws – not needed.
5. Do not use bearings – not needed. The crankcase becomes the new bearing surface for the crankshaft.

Assembly:

1. Assemble the engine without the cylinders and pistons. The spacing between the crankshaft sections is 0.130”. Grind the connecting rod pins to length if need be. You can also pack the holes with small chips if the connecting rods are not long enough. The chips will not come out during engine operation.
2. Ensure that the crankshaft turns freely. You may have to turn the engine with a drill or engine starter to break it in and ensure a smooth turning crankshaft. The most likely binding will occur if the connecting rod pin holes are not properly located on the crankshaft sections or if burrs are on the milled slot.
3. Assemble and mount the intake using Loctite.
4. Assemble the complete engine.
5. Ensure the fuel level in your fuel tank is approximately 1/2” below the venturi for good operation. A 1/2” drop in the fuel level may require a change in the needle valve setting.
6. Ensure that ALL the glow plugs have proper voltage, 1.5v, for a good glow.
7. If the engine becomes hard to turn over it may be flooded. This may also damage the glow plugs and the engine will not run. You can use an air compressor to blow out some of the fuel or let it set and the fuel will evaporate.
8. The engine will run on 3 cylinders – look for any cylinder that is dumping un-burnt fuel out of the exhaust and check the glow plug and voltage.

Crankcase Modification:

Several prototypes of the HEX-2 and HEX-4 were built without modifying the 7/8" hex rod and all the engines ran. However, if you measure the distance from the seating surface of the cylinder to the top of the crankshaft pin on a COXtm engine you will get approximately 0.169". If you measure this same distance on the HEX-4 you will get approximately 0.199". To increase the compression ratio of the HEX-4, you may machine down the top portion of the HEX-4 crankcase to bring the measurement closer to the 0.169" measurement of the COXtm engine. Do not remove too much material on the crankcase as this will allow the piston to hit the cylinder head at TDC.

James Engine HEX-4

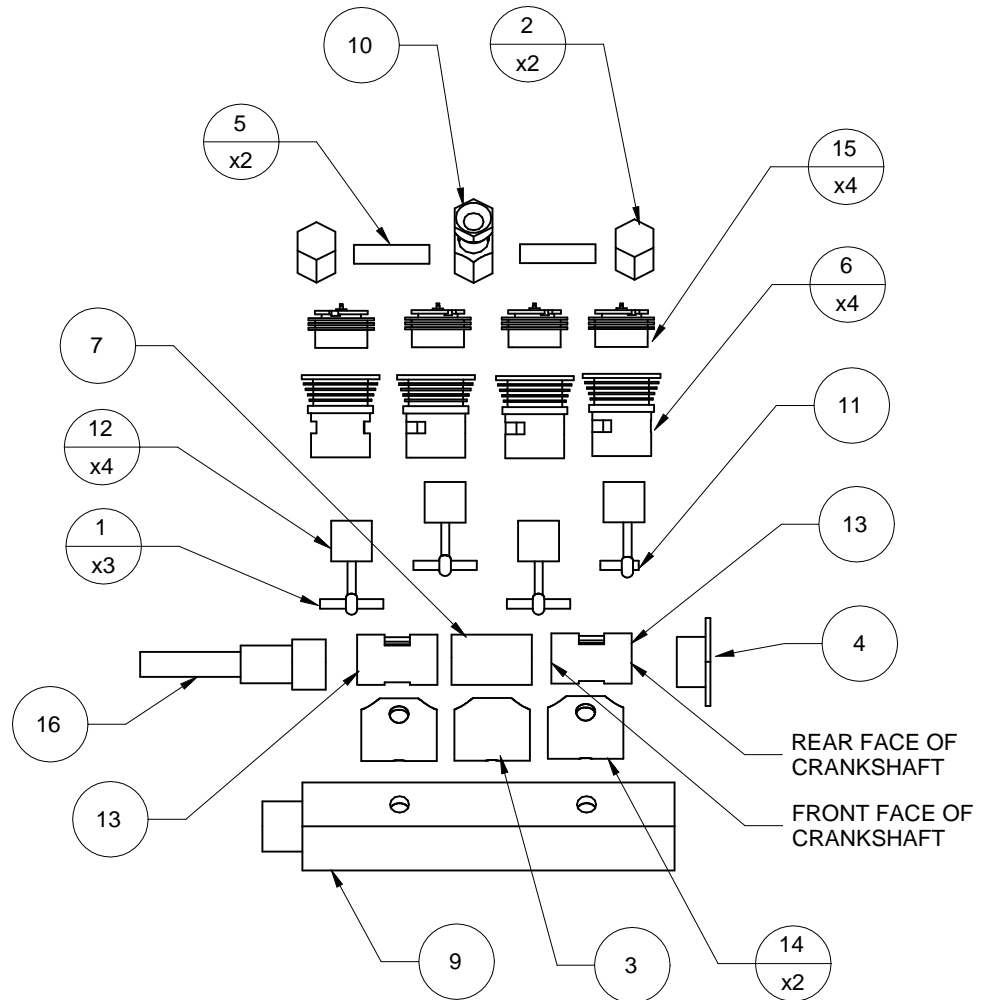
ZONE

REV

Designed by: Jerry James

2 Feb 07

Item Number	Qty	Part Name	Comment
1	3	Crankshaft Pin	3/32" X 5/8" DOWEL PIN
2	2	Elbow	3/8" HEX ROD
3	1	Bushing Center	1/2" ID 5/8" OD 3/4 BUSHING
4	1	Back Plate	7/8" HEX ROD
5	2	Tube	3/16" BRASS TUBE
6	4	Cylinder	COX
7	1	Crankshaft Center	1/2" TGP
8	4	Connecting Rod	COX
9	1	Crankcase	7/8" HEX ROD
10	1	Venturi	3/8" HEX ROD
11	1	Crankshaft Pin End	3/32" X 5/8" DOWEL PIN
12	4	Piston	COX
13	2	Crankshaft	1/2" TGP
14	2	Bushing	1/2" ID 5/8" OD 3/4 BUSHING
15	4	Glow Plug	COX
16	1	Crankshaft Front	1/2" TGP
17	4	4-40 3/8" Hex Screw	Not Shown
18	3	8-32 3/16 Set Screw	Not Shown



SIZE A	Title HEX-4 ASSEMBLY	REV
SCALE None	SHEET 1 of 5	

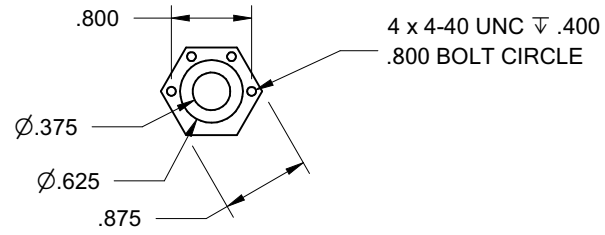
James Engine HEX-4

ZONE

REV

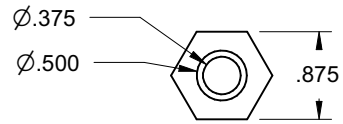
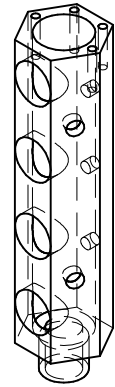
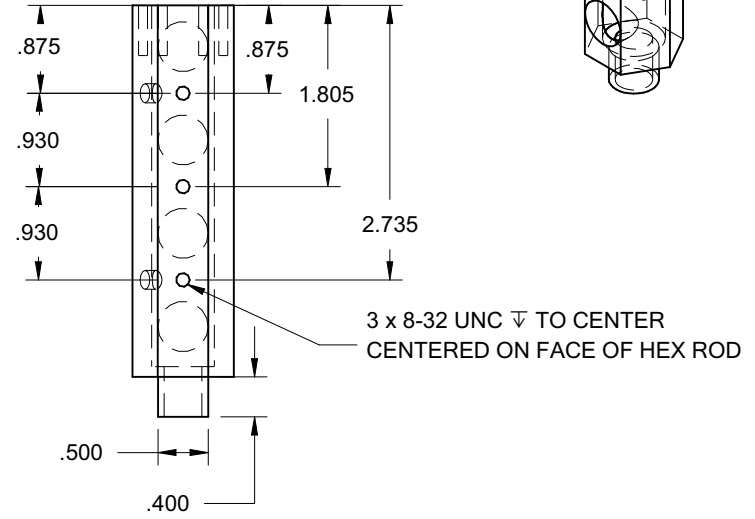
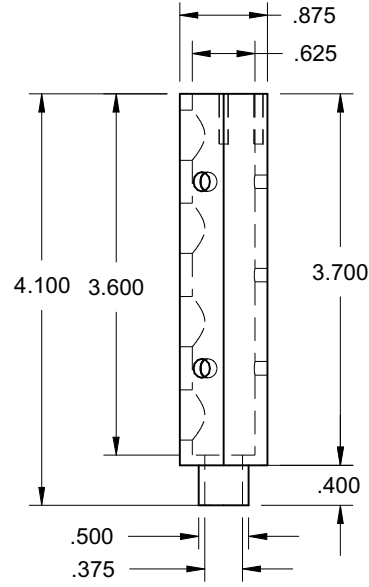
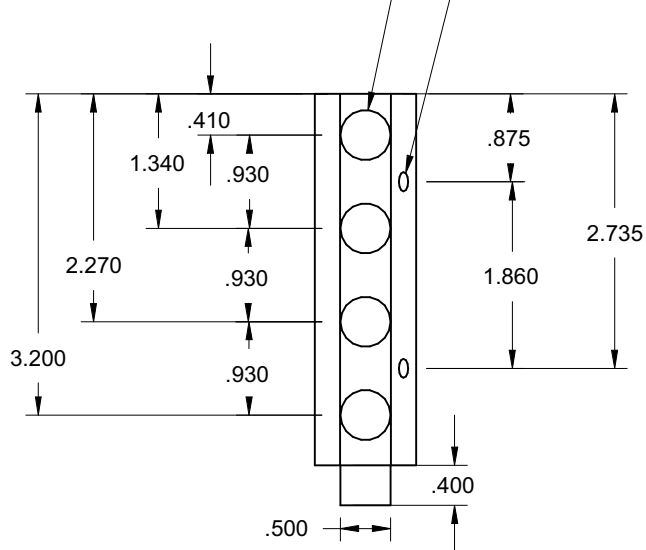
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4 x ϕ .500 ∇ THRU TO CENTER
CENTERED ON FACE OF HEX ROD

2 x ϕ .189 ∇ THRU TO CENTER
CENTERED ON FACE OF HEX ROD



SIZE A	MATERIAL: 7/8 ALUMINUM HEX	Title CRANKCASE	REV
SCALE 1:2	SHEET 2 of 5		

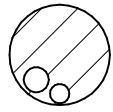
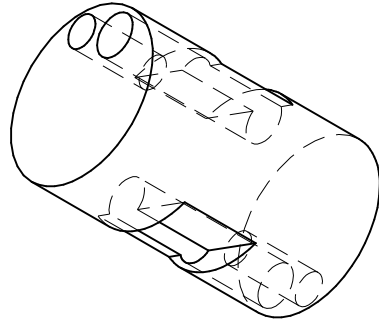
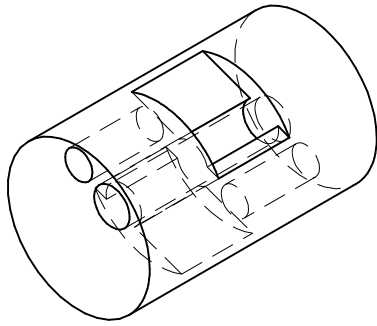
James Engine HEX-4

ZONE

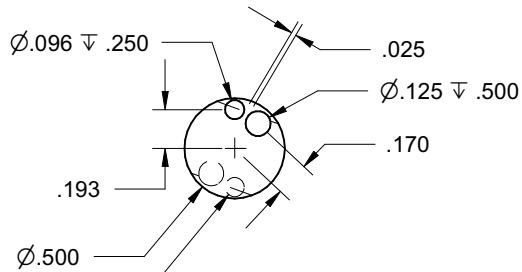
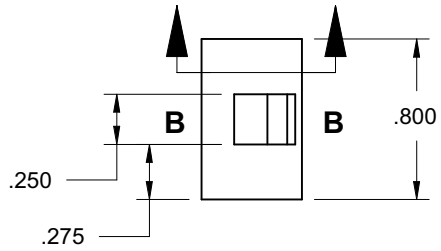
REV

Designed by: Jerry James

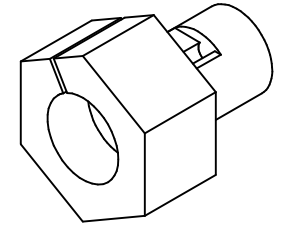
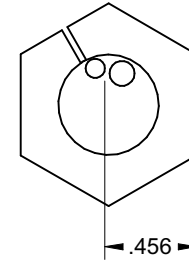
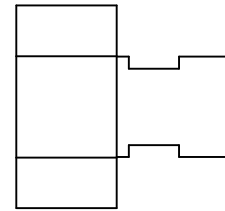
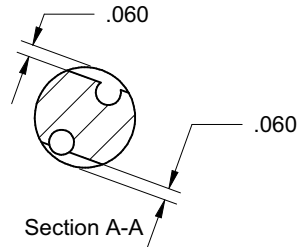
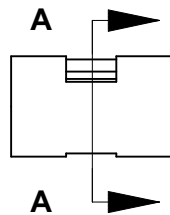
2 Feb 07



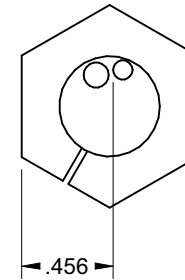
Section B-B



OPPOSITE FACE
180 DEGRESS APART



MOUNT IN HOLDER WITH FRONT OF CRANKSHAFT FACING FORWARD.
MILL .250" SLOT .060" DEEP.



MOUNT IN HOLDER WITH REAR OF CRANKSHAFT FACING FORWARD.
MILL .250" SLOT .060" DEEP.

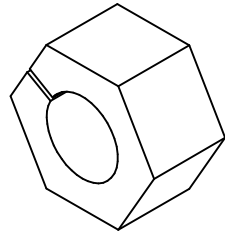
SIZE A	MATERIAL: 1/2" TGP	Title CRANKSHAFT - 2 REQUIRED	REV
SCALE NONE	SHEET 3 of 5		

James Engine HEX-4

ZONE REV

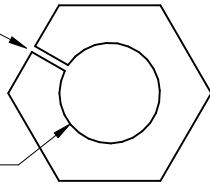
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CUT SLOT

Ø .500

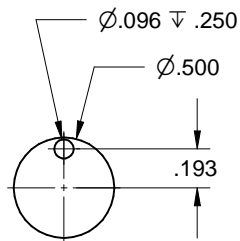
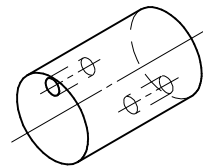
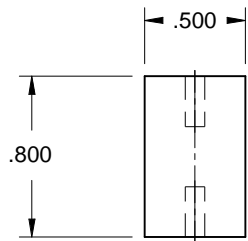


.500



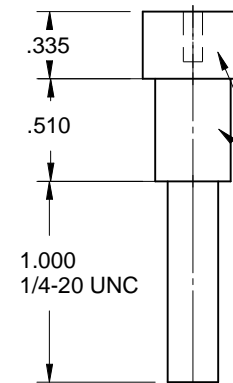
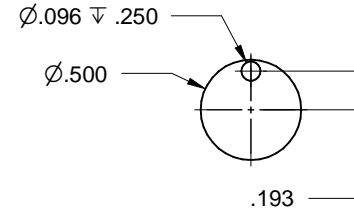
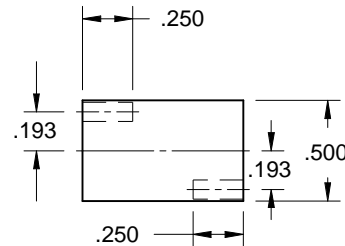
CRANKSHAFT HOLDING TOOL

1 REQUIRED
7/8" HEX ROD

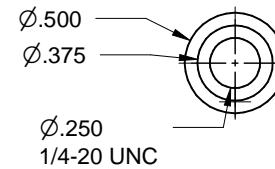


CRANKSHAFT CENTER

1 REQUIRED
TGP .500"

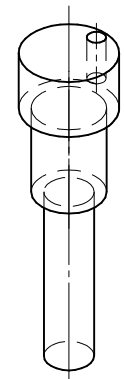


DIMENSION TO FIT
SEE DIRECTIONS



CRANKSHAFT FRONT

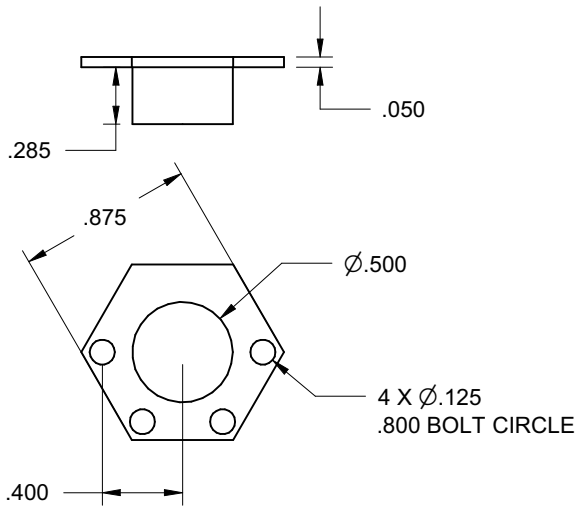
1 REQUIRED
TGP .500" OR SUITABLE SUB



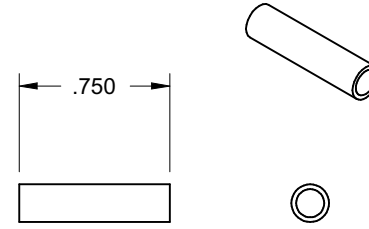
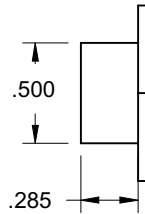
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SCALE None	SHEET 4 of 5	

James Engine HEX-4

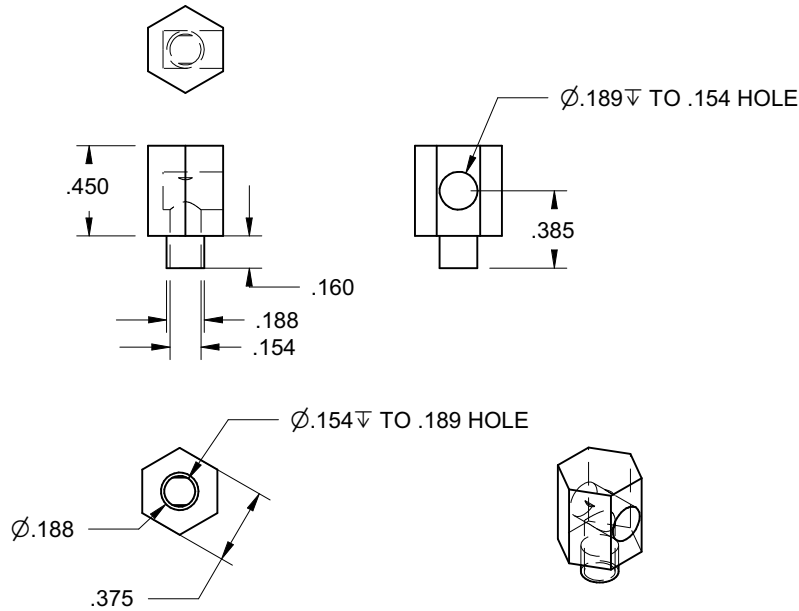
ZONE	REV	Designed by: Jerry James	2 Feb 07
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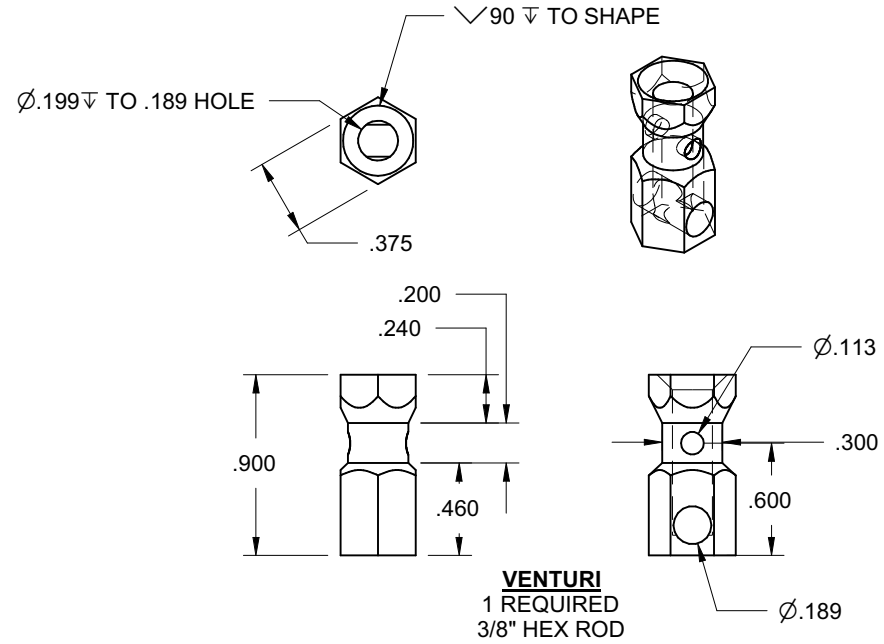
BACK PLATE
1 REQUIRED
7/8" HEX ROD



TUBE
2 REQUIRED
3/16" BRASS TUBE



ELBOW
2 REQUIRED
3/8" HEX ROD



VENTURI
1 REQUIRED
3/8" HEX ROD

SIZE A	Title INTAKE-VENTURI-BACKPLATE	REV
SCALE None	SHEET 5 OF 5	