

# David Kerzel

Pompano Beach, Florida USA

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Assembly:  
Horizontal Hit and Miss 1

Title:  
Complete Engine

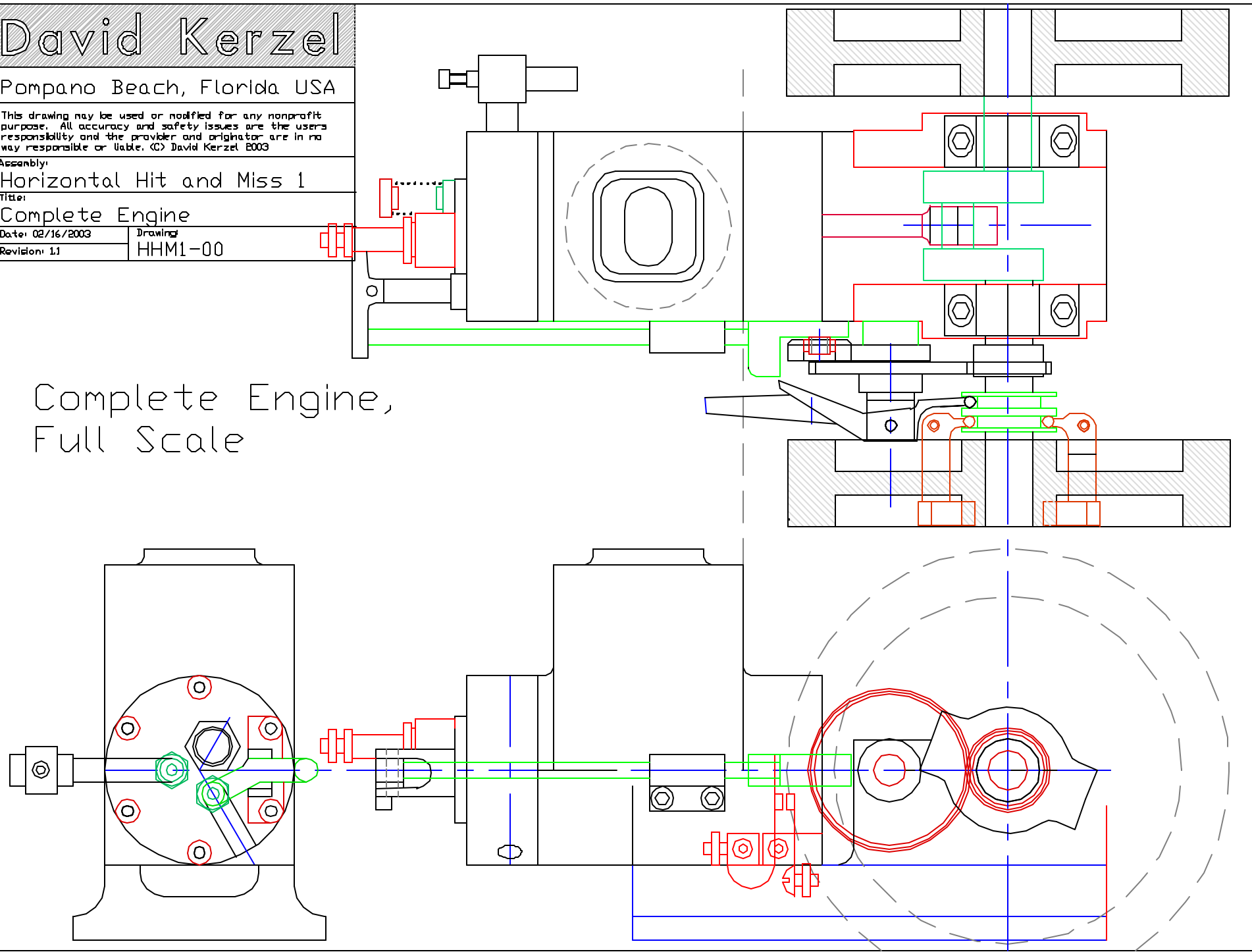
Date: 02/16/2003

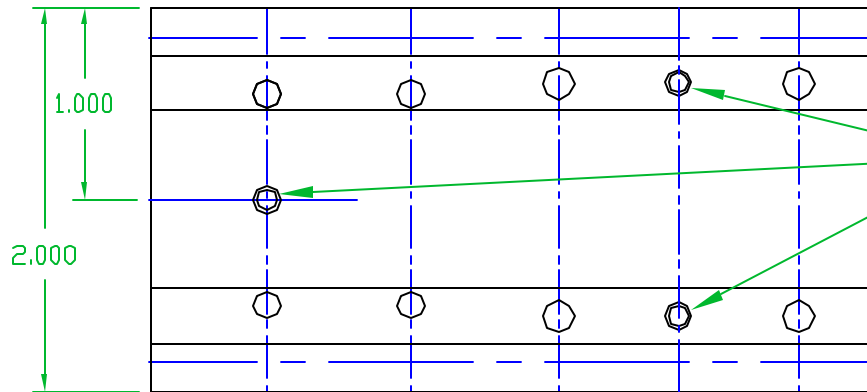
Drawing:

HHM1-00

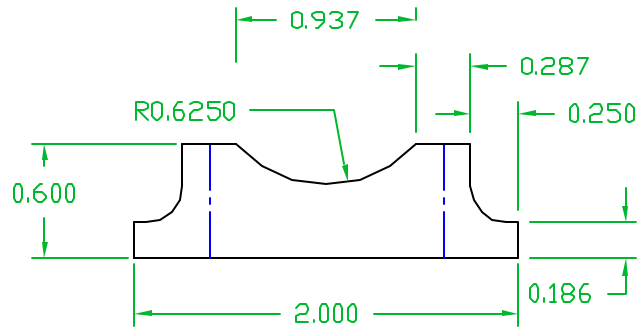
Revision: 1.1

Complete Engine,  
Full Scale

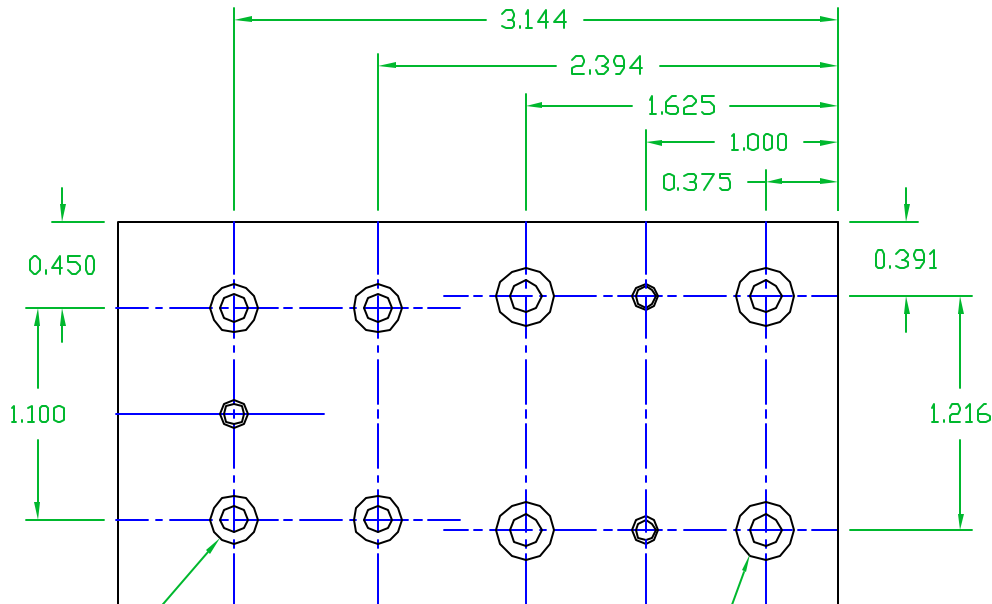
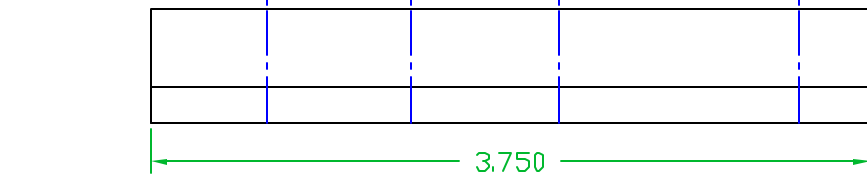




Drill #36 (.107)  
Tap 6-32  
Mounting holes



Note: Center area need to be relieved. The .625 radlus was cut with a boring bar mounted between lathe centers and the base was mounted to a angle plate on the carriage. This area could be milled out with a depth of .125.



Drill #28 (.140)  
#6 counter bore .300 deep

Drill #19 (.166)  
#8 counter bore .300 deep

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Assembly:  
Horizontal Hit and Miss 1

Title:  
Base Bottom

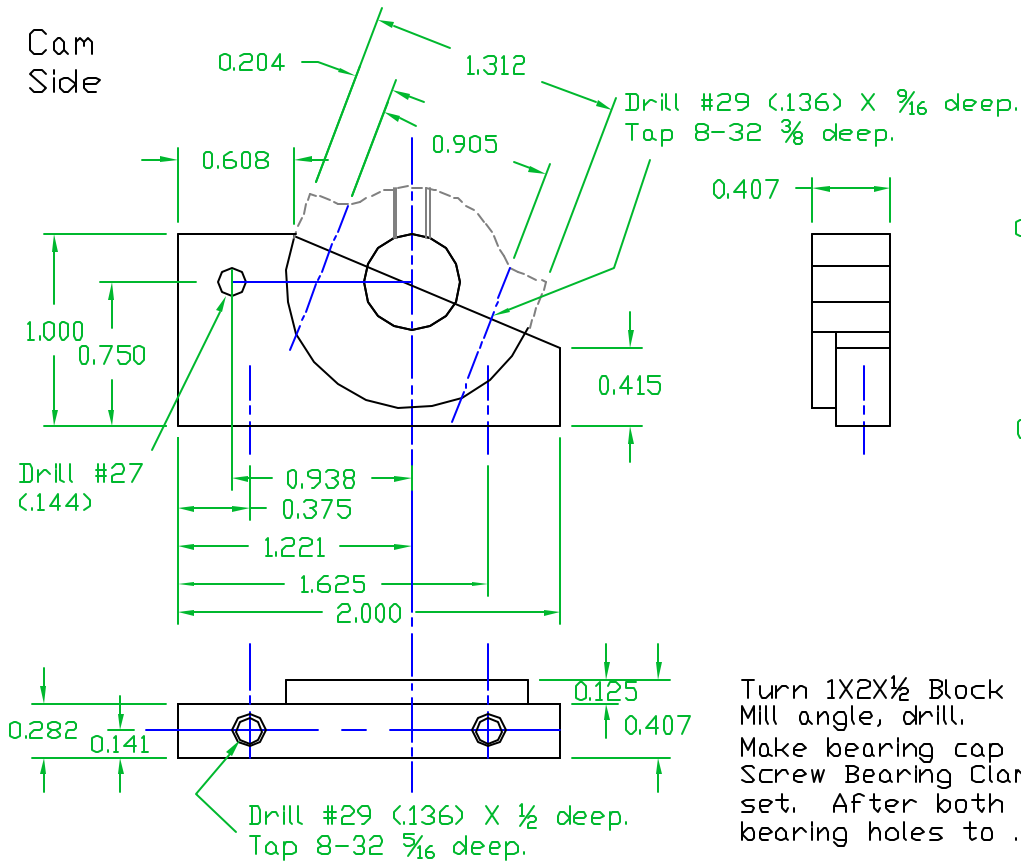
Date: 02/16/2003

Drawing

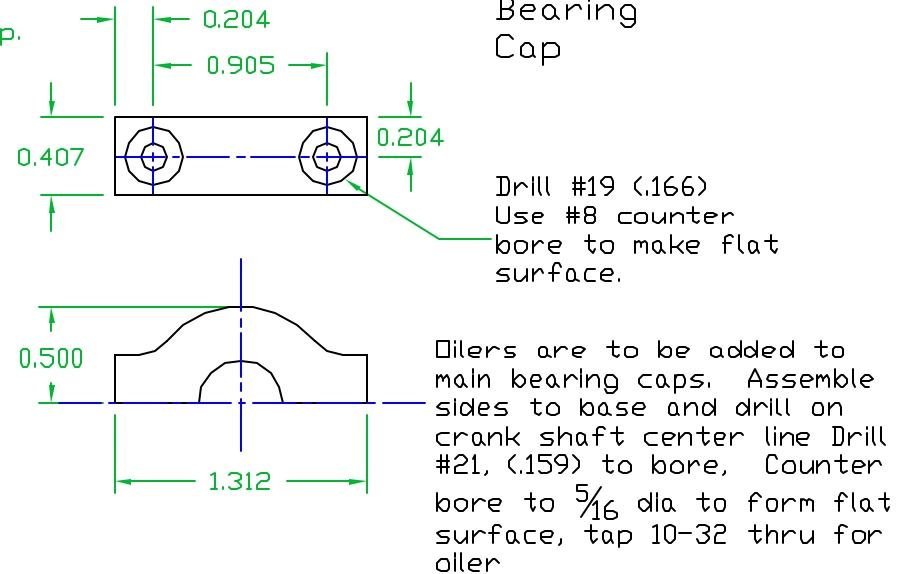
Revision: 1.1

HHM-01

Cam Side



Bearing Cap

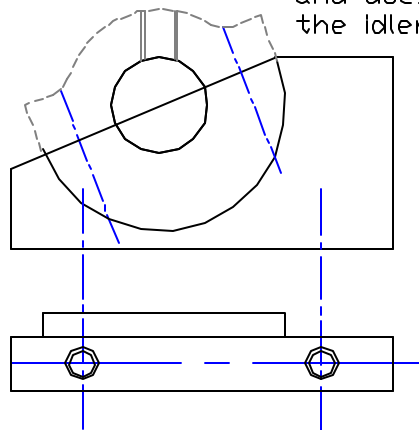


Turn 1X2X1/2 Block in 4 jaw chuck to form lower half of bearing support. Mill angle, drill.

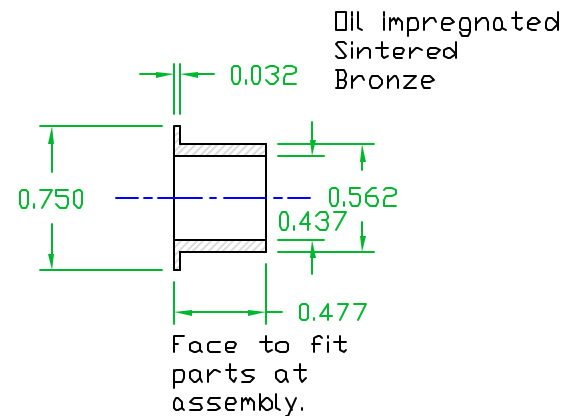
Make bearing cap on rotary table with 3/8 end mill. Layout and drill. Screw Bearing cap to Side and bore bearing hole .550. Mark parts as set. After both sides are done and mounted to base, squarely ream bearing holes to .562

Far Side

Far Side is mirror image of the CAM Side, and does not have the Idler mounting.



Main Bearings



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Assembly:  
Horizontal Hit and Miss 1

Title:  
Base Sides & Bearing Cap

Date: 02/16/2003

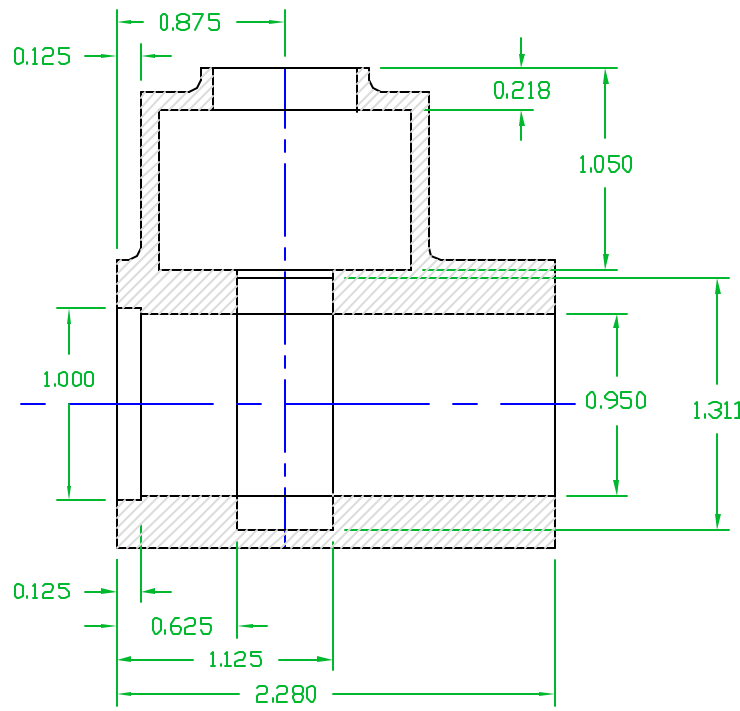
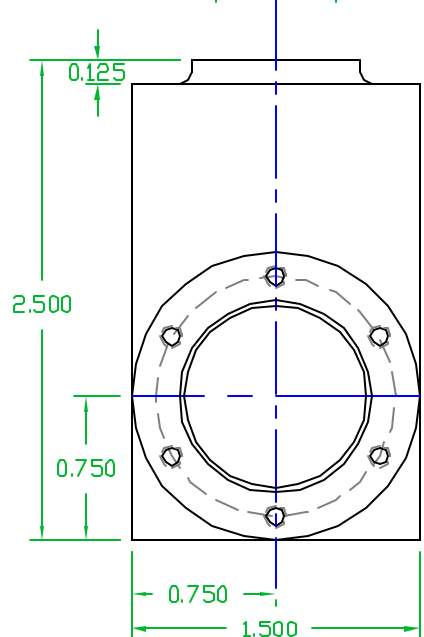
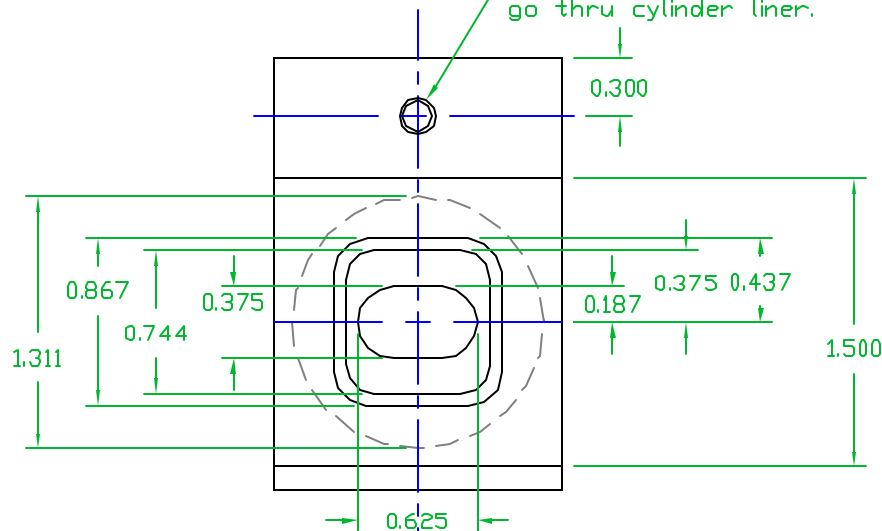
Drawing

Revision: 1.1

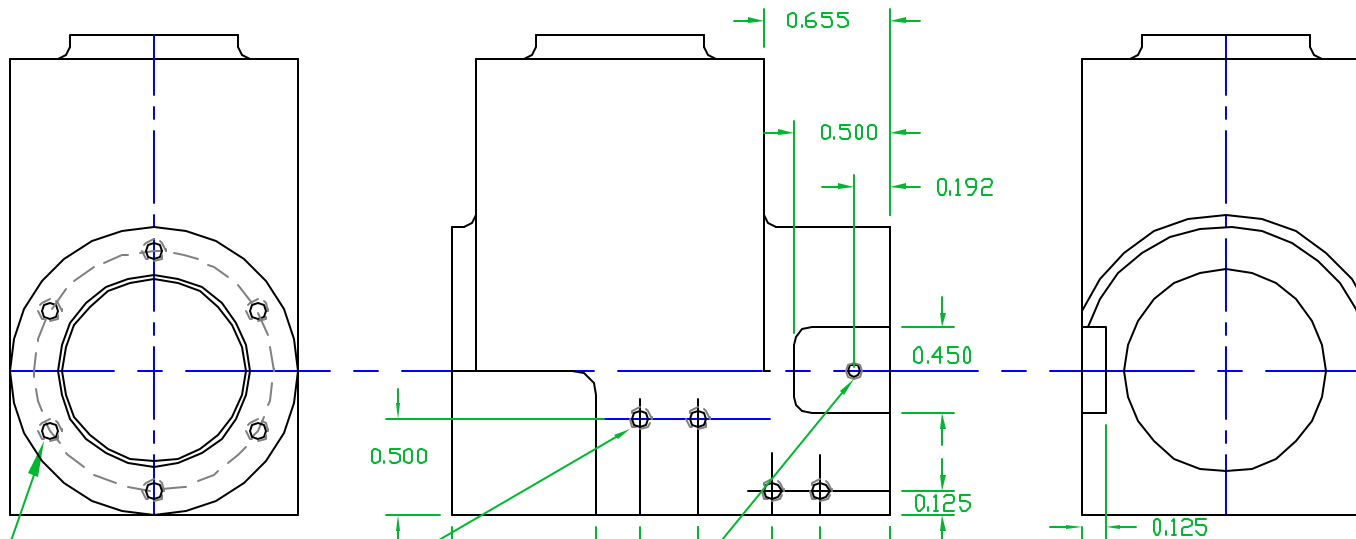
HHM-02

Drill #21, (.159) to bore, tap 10-32 thru (oller).  
 Later a .040 hole will be needed to go thru cylinder liner.

Turn the cylinder liner bore. Under cut to 1.311 dia for coolant area (optional, but it looks good). Turn head end to 1.500 diameter, .125 deep. Turn coolant tank. Under cut inside, corners do not need to be square. Mill square opening in top, mill lip on top, finish lip w/it 1/8 dia ball end mill. Mill slot to coolant passage with 3/8 end mill.



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Assembly: <b>Horizontal Hit and Miss 1</b>	
Title: <b>Cylinder Body 1</b>	
Date: 02/17/2003	Drawing:
Revision: 1.1	<b>HHM1-03</b>

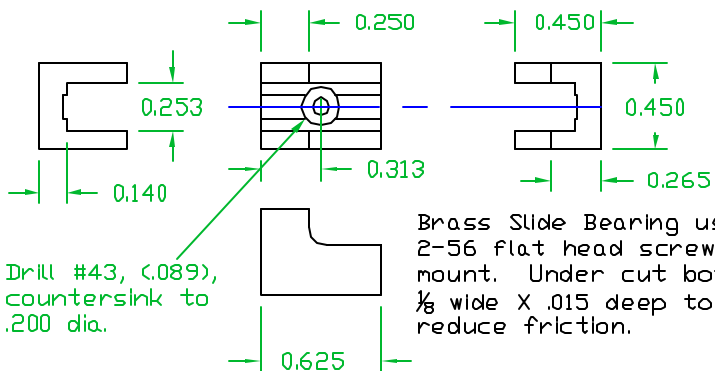


Drill #43, (.089)  
X  $\frac{7}{16}$  deep, tap  
4-40 X  $\frac{1}{4}$  deep,  
4 holes.

Drill #50, (.070)  
thru, tap 2-56.

Drill #38 (.105)  
Tap 5-40  
6 holes on 1.250 bolt circle

### Cam Slide Bearing



Drill #43, (.089),  
countersink to  
.200 dia.

Brass Slide Bearing uses  
2-56 flat head screw to  
mount. Under cut bottom  
 $\frac{1}{8}$  wide X .015 deep to  
reduce friction.

Drill Drill #36 (.107) X  
 $\frac{1}{2}$  deep, tap 6-32  
X  $\frac{1}{4}$  deep, 4 holes.

Mount on a rotary table with the head side up, center on cylinder axis. Drill and tap 6 holes for head. With  $\frac{3}{8}$  dia ball end mill cut radius under cylinder on head end to .750 depth. Flip part on table. Rough mill out most of the material in the back notch, use a clean cutting end mill to do the back surface of the cooling tank. Use a  $\frac{3}{8}$  dia ball end mill to cut the radius around the cylinder. Layout and drill/tap the other mounting holes.

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Assembly:  
Horizontal Hit and Miss 1

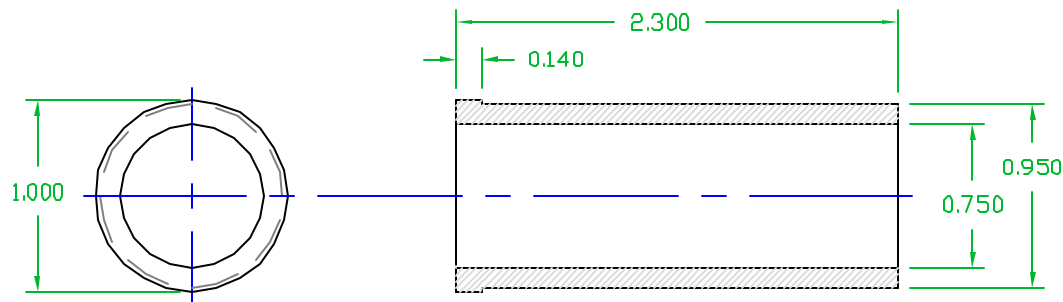
Title:  
Cylinder Body 2

Date: 03/17/2003

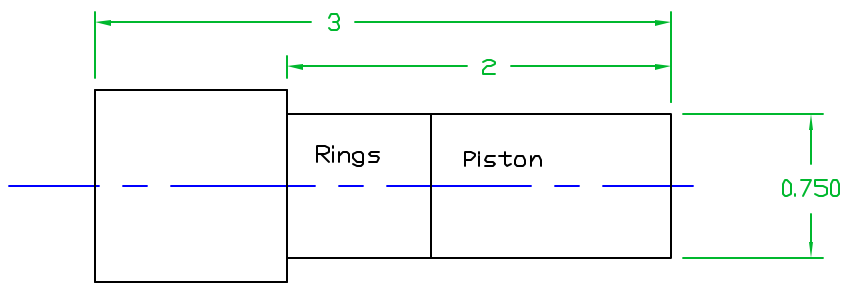
Drawing:

Revision: 11

HHM1-04

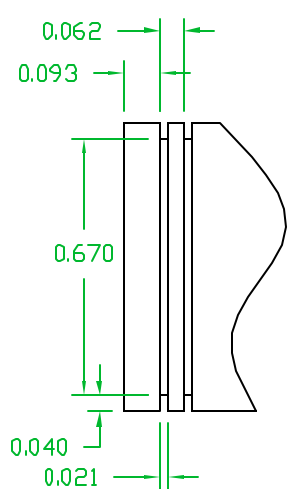


Cylinder liner is made from 1 inch diameter Cast Iron 3 1/4 long. The .950 OD is to have light press fit into Cylinder body. The ID is turned using a live center for support. Bore ID to .747 and lap with an expanding lap to .750. Lap until dull lapped finish is uniform. First lap with 220 grit compound then finish with 400. Do not remove from chuck until done. Chamfer all edges .010.

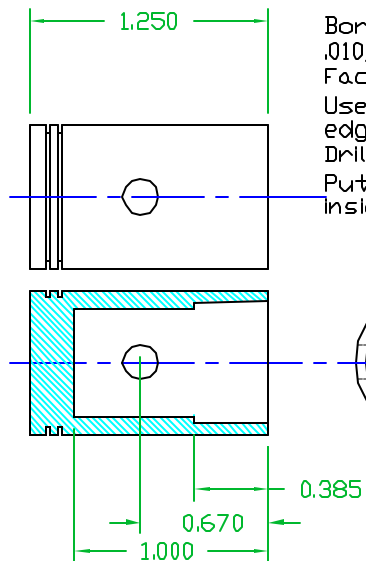


Piston and Rings are made from 1 inch diameter Cast Iron 3 long. Turn to .755 diameter. The OD is turned using a live center for support.

Make a lap with a clamp screw that is 1/2 to 3/4 wide with .750 bore. Lap until dull lapped finish is uniform with 220 grit compound until diameter is .001 larger than actual ID of cylinder. Then continue lapping with 400 grit until the clean piston will enter the clean cylinder with very slight resistance. Do not remove from chuck until internal bores are made. Chamfer all edges .010.



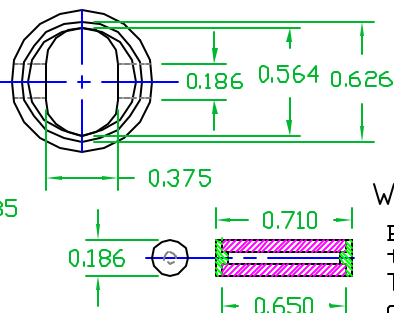
Ring Detail 2:1



Bore piston .375 dia X 1 deep, counter bore .625 X .385 deep, chamfer open end .010, part piston off, .015 long. Face top to length and add .010 chamfer.

Use a .020 slitting saw as lathe tool to cut ring grooves, support blade to 1/8 from edge to prevent deflection. Do not chamfer.

Drill wrist pin hole and ream to .186, this must be exactly centered on the piston. Put a pin in the wrist pin hole to align the piston for milling the 3/8 wide area inside, this must be at 90 degrees.



Wrist Pin

Brass, drill 1/16 thru, press Teflon end caps on.

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Assembly:  
Horizontal Hit and Miss 1

Title:  
Cylinder Liner & Piston

Date: 02/18/2003

Drawing:

Revision: 1.1

HMM1-05

## Spring Winding Mandrel

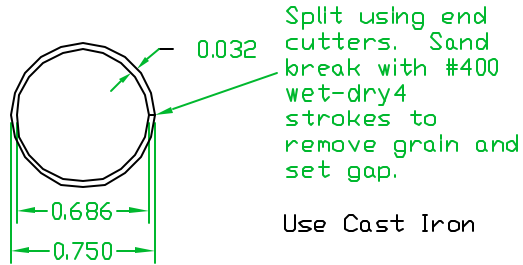
.140 Diameter for starting and ending spring.



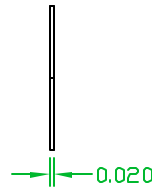
.160 diameter, cut thread,  $\frac{1}{16}$  pitch to depth of .140 to guide wire and set pitch.

Clamp music wire under lathe chuck jaw, wind under power at lowest speed. Wrap 2 Or 3 closely spaced turns then allow wire to enter grooves, at last turn wrap 2 or 3 more closely spaced turns. The spring will change size some when it is released. The spring wire is sharp and it snaps around when it is cut. Be very careful, gloves and safety glasses are essential. Heat treat by wrapping in foil, then heat in oven at 450F for 30 minutes to relax springs. oil them and trim to size. Make several and use the best.

## Piston Rings

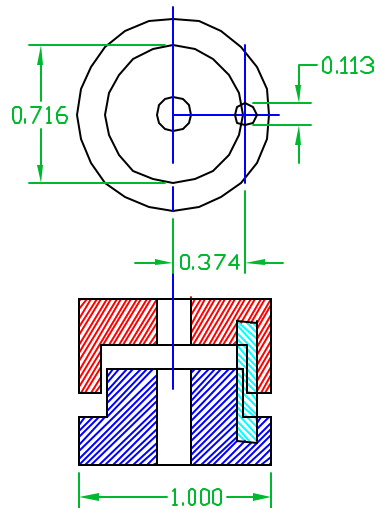


Use Cast Iron



Compression

## Fixture to heat treat



When making a cast iron piston that will be lapped into the cylinder, make the blank  $\frac{1}{2}$  longer than needed for the piston. This material will be the exact piston diameter and have a fine OD finish and can be used for piston rings now or later.

Using a slitting blade part off rings 0.001 thicker than finished ring. Make grooves in piston first using slitting blade. Measure slots with feeler gages, then make ring to fit. Counter bore ring OD+ hole to ring thickness depth in a plug of metal. Use this to remove any burr from parting rings and when adjusting thickness to exact value. Sand the ring while held in the counterbore on 400 grit silicon carbide paper using figure 8 pattern.

Split the ring and put on heat-treating fixture. Heat to about 450F, cover with anti-scale compound, heat to dull red for 3 minutes. Let cool slowly, dissolve anti-scale compound in hot water. Remove rings and oil immediately. About 2/3 of the gap of the heat-treating fixture will be found in the heat-treated ring.

## Springs



Intake Spring  
.010 Music Wire



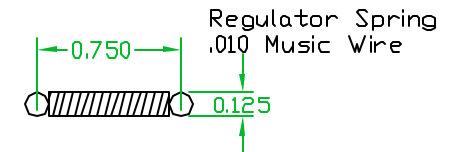
Exhaust Spring  
.014 Music Wire



Cam Follower Spring  
.020 Music Wire



Compression springs are 1.5 turns close spaced each end and 7 turns in middle. All have ID of .210



Springs for the regulator are close wound on a .093 mandrel. Wind about .75 inch, bend over 2 turns to form a end loop, measure .75 from end loop end to bend other loop. Heat treat, oil, trim.

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Assembly:  
Horizontal Hit and Miss 1

Title:  
Rings & Springs

Date: 03/02/2003

Drawing

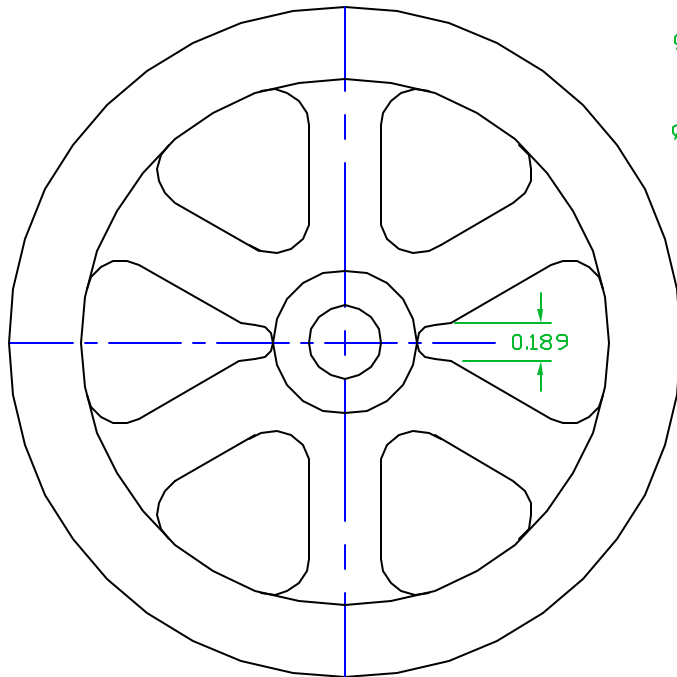
Revision: 1.1

HHM1-06





Turn 2 fly wheels from Cast Iron, steel, or brass. Chamfer all edges .015. Drill set screw hole at angel, #43, (.089), then tap 4-40 thru.



Mount the wheel centered on the rotary table. Center drill and Drill the 6)  $\frac{1}{32}$  dia holes on the 1.588 dia circle.

Center drill and Drill the 12)  $\frac{1}{32}$  dia holes on the 2.375 dia circle 12 degrees left and right of the first hole.

Use a  $\frac{3}{8}$  dia end mill and cut the arc connecting each set of 2 holes. Mill the 2 sides make the triangle, use a angle of 30 degrees from the first hole drilling.

$\phi 3.500$

$\phi 2.750$

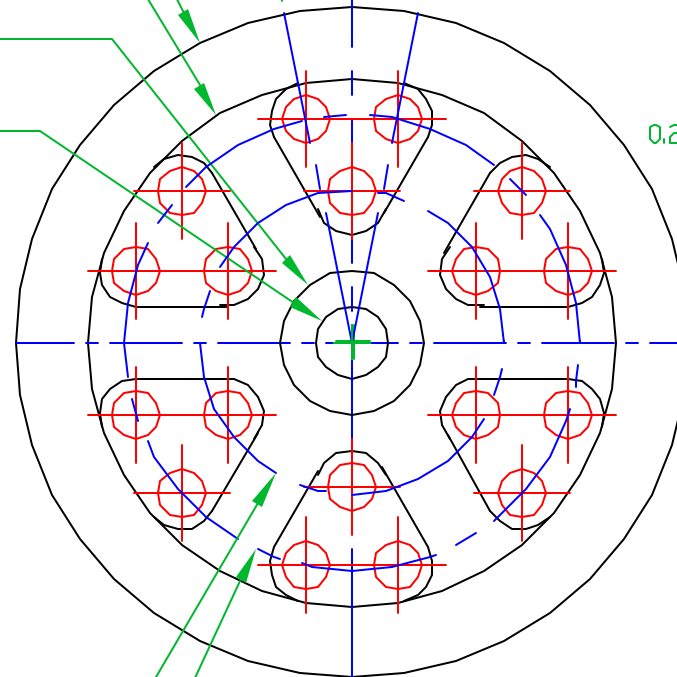
$\phi 0.750$

$\phi 0.376$

$\phi 1.587$

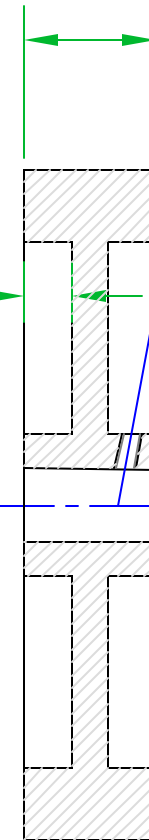
$\phi 2.375$

12°



0.250

0.688



Set screw perpendicular to weights, in line with rib.

The Flywheel for the speed regulator needs 2 slots for the arms that hold the weights. They are milled with a  $\frac{3}{16}$  dia mill to the center hub.

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Assembly:  
Horizontal Hit and Miss 1

Title:  
Flywheel

Date: 02/26/2003

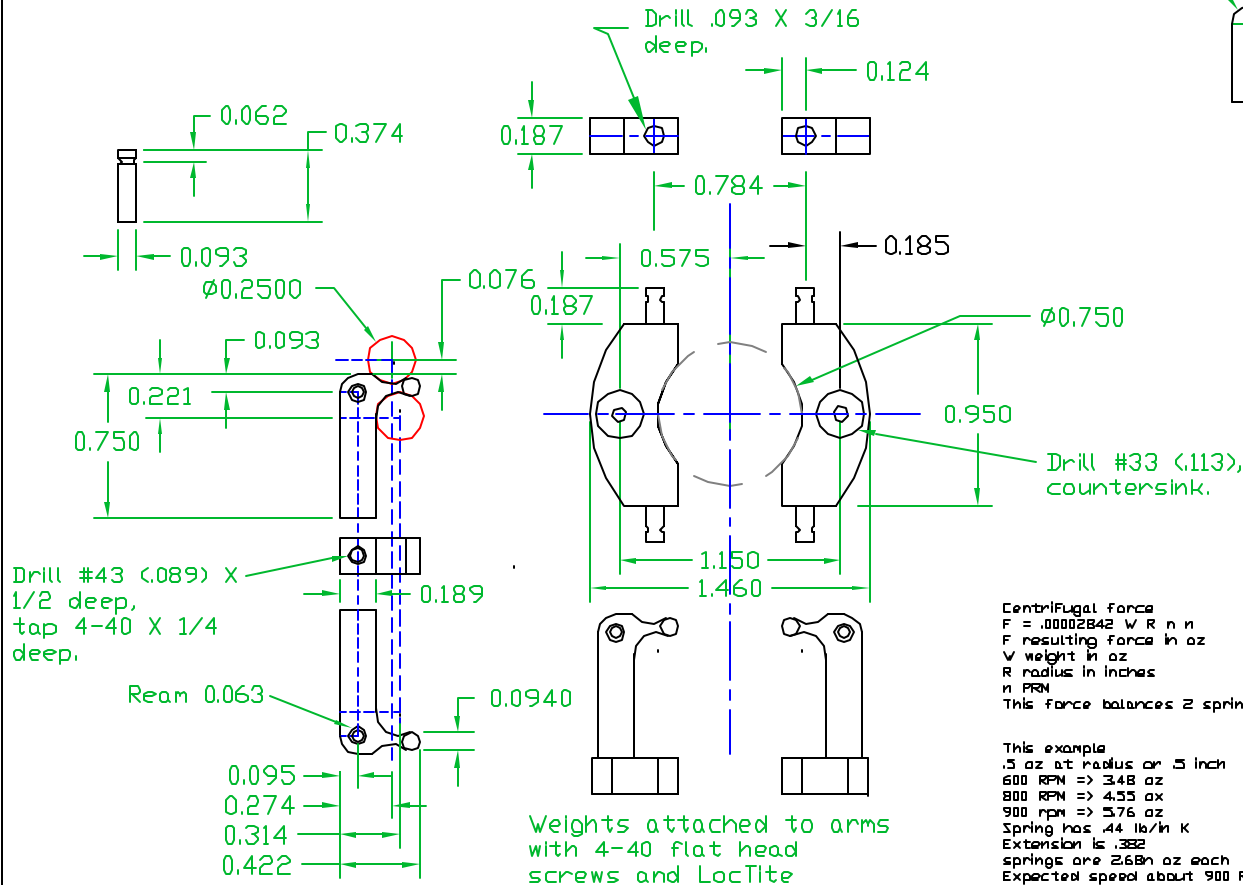
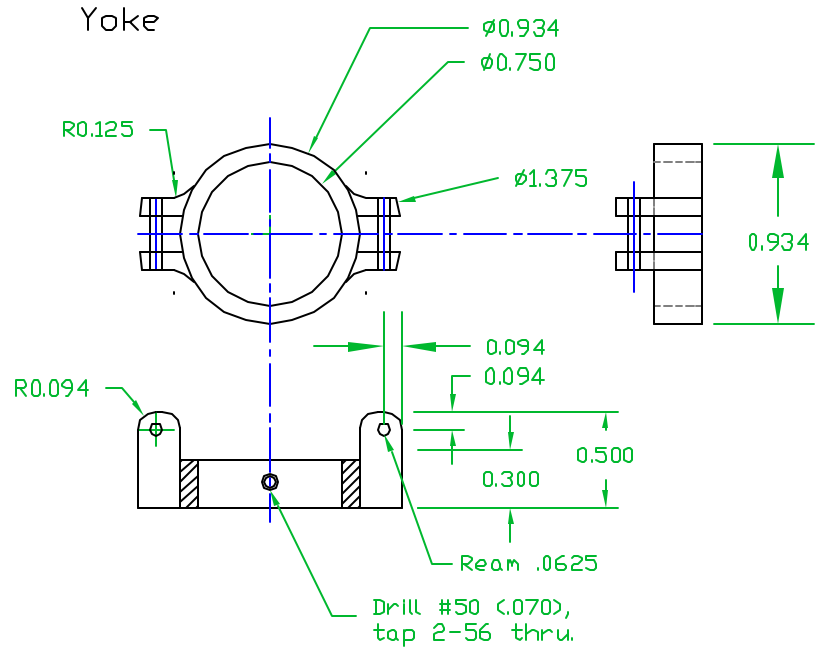
Drawing:  
HHM1-08

Revision: 1.1

Weights: Fasten 1 1/2 inches of 1 X 3/16 brass to a mounting block using the countersunk holes for the arms. Turn a washer of brass, .187 thick, 1.46 OD and .75 ID, chamfer all edges. Mill flats to get .95 dimension, Mill off sharp points.

Arms: lay the arms out on 3/16 X 1/2 brass. Drill the 2) .250 shaping holes. Mill the long part of the arm. Mount to a plate on a rotary table so the round end is centered (I use a plate with a 3/16 hole, align the part over the hole). Use a 3/16 dia end mill and cut the round end. This end must fit in the bobbin slots with about .003 play. Drill and tap end, drill and ream hole for hinge pin. Fasten the weights to the arms with flat head screws and Loctite. Push the spring pins in with some LockTite.

Yoke: Start with a length of Aluminum turn to 1.375 dia. Start with a length of about 1 inch long. Bore the .750 ID 1/2 deep and counter bore to .934, drill thru center 3/16. Use 3/16 hole to mount to rotary table, Use 1/4 dia end mill to shape outside. Put back in lathe and part off. Mill side slots and drill pin holes. Round over ears.



Centrifugal force  
 $F = .0002842 W R n^2$   
 $F$  resulting force in oz  
 $W$  weight in oz  
 $R$  radius in inches  
 $n$  RPM  
 This force balances 2 springs

This example  
 .5 oz at radius of .5 inch  
 600 RPM => 3.48 oz  
 800 RPM => 4.55 oz  
 900 rpm => 5.76 oz  
 Spring has .44 lb/in K  
 Extension is .332  
 springs are 2.68n oz each  
 Expected speed about 900 RPM

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Assembly:  
Horizontal Hit and Miss 1

Title:  
Regulator

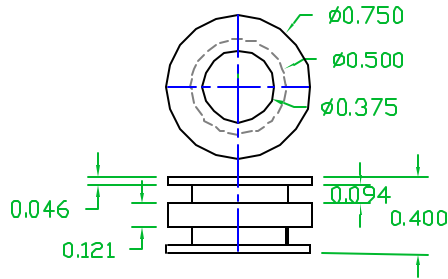
Date: 03/17/2003

Drawing

Revision: 1.1

HHM1-09

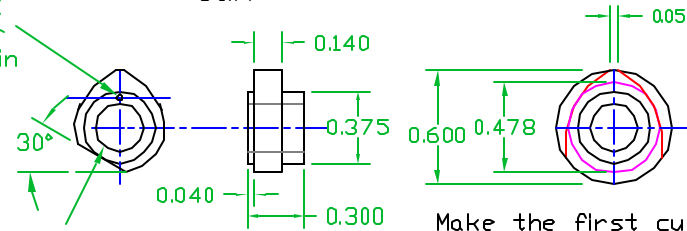
### Regulator Bobbin



Drill .031 dia X 3/16 deep for .031 SS wire pin to couple to timing gear.

Drill and ream to .250 dia.

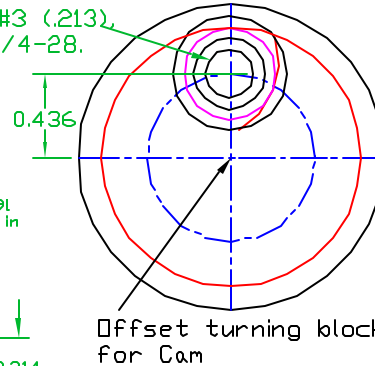
### Cam



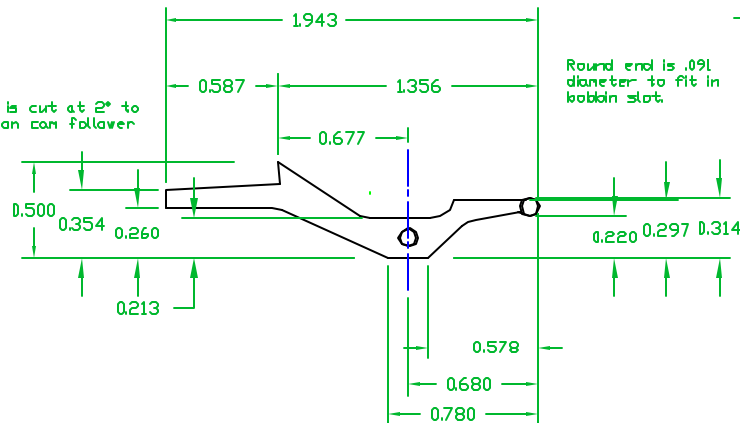
Turn the cam blank. Make the offset turning block out of 1 1/4 or 1 1/2 dia stock. Use a 1/4-28 bolt to fasten the cam to the offset block.

Make the first cut until it measures .538 across the diameter. Lock the cross slide setting, this is the small diameter setting. Rotate the cam about 5-10 degrees and make next cut. Continue until there is .050 length of the large diameter left. File out any facets in the small diameter. Drill the pin hole. Cut the ignition flat. Do this in steps checking on the engine. Follow the steps in the notes to determine the exact depth and angle to get ignition at 1 degree past TDC.

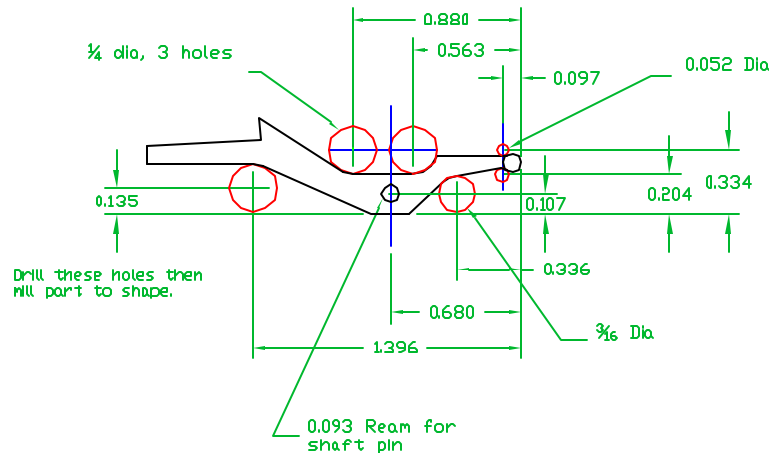
Drill #3 (.213), tap 1/4-28.



Notch is cut at 2° to latch on cam follower



### Regulator Arm



Lay the arm out on 3/16 X 1/2 brass. Drill the 3) .250 shaping holes, 1) .187 hole, and 2) .052 dia. Drill and ream the .093 pin hole. Mill the straight parts of the arm using the holes as reference. Mount to a plate on a rotary table so the round end is centered (I use a plate with a 3/16 hole, align the part over the hole). Use a 3/16 dia end mill and cut the round end. This end must fit in the bobbin slots with about .003 play. The arm needs to move about 15 degrees each way when mounted in the pivot.

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Assembly:  
Horizontal Hit and Miss 1

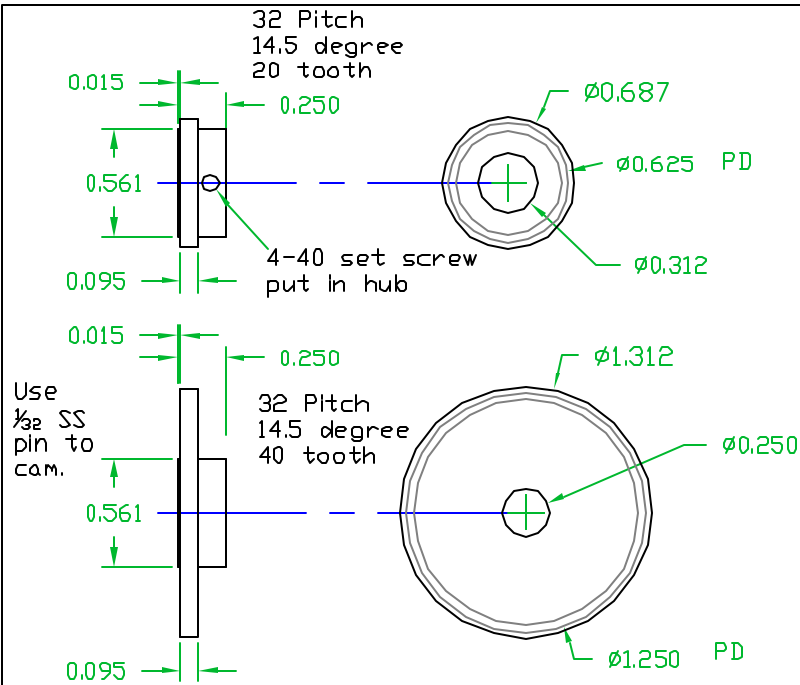
Title:  
Regulator Arm and Bobbin

Date: 03/17/2003

Drawing:

Revision: 1.1

HHM1-10

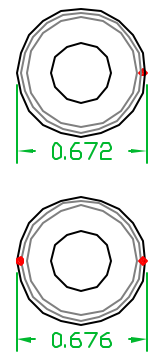
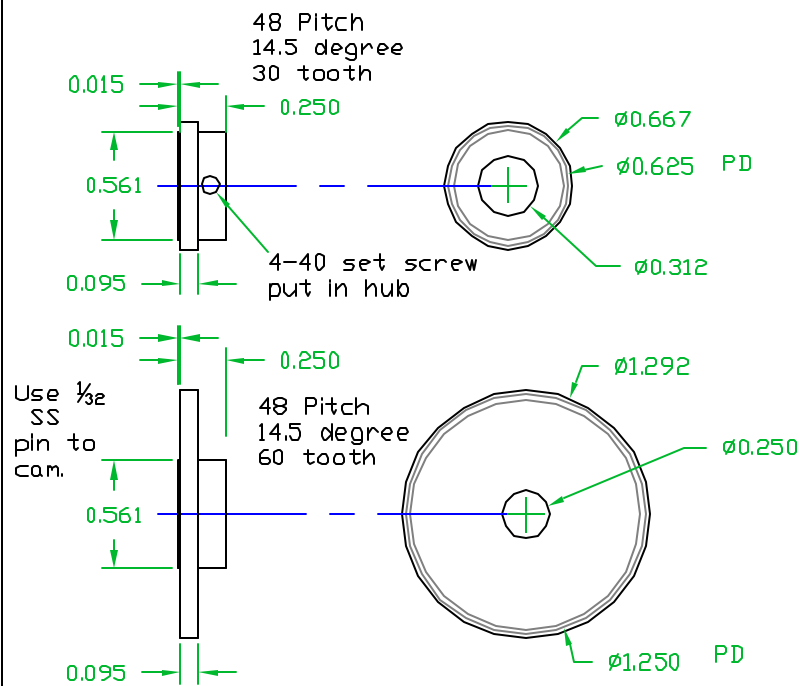


First cut depth set so #55 drill (.052) in slot makes width .690. Cutter is #6.

To inspect final gear use #55 drill in notches on a diameter and verify .694

Two different gear options are shown here, cutting gears is not that hard, see the written description, try it.

32 Pitch steel gears are available from McMaster-Carr, #6325K95 & #6325K97. They will need modifying thickness and hub diameter using a pot chuck.



First cut depth set so #64 drill (.036) in slot makes width .672. Cutter is #4.

To inspect final gear use #64 drill in notches on a diameter and verify .676

For 60 tooth 32 pitch!

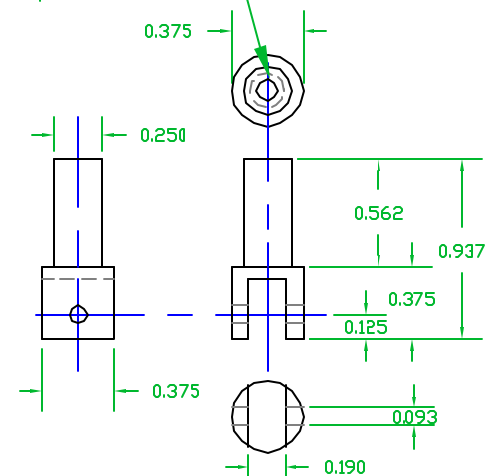
First cut across is 1.297 with #64 pin.

Cutter is #2.

Using two #64 drills as pins diameter should be 1.302

### Regulator Arm Pivot

Drill Drill #36 <107> X 1/2 deep, tap 6-32 X 1/4 deep.



Regulator Arm Pivot is made from 3/8 drill rod. Pin hole is to be reamed .093 dia.

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Assembly:  
Horizontal Hit and Miss 1

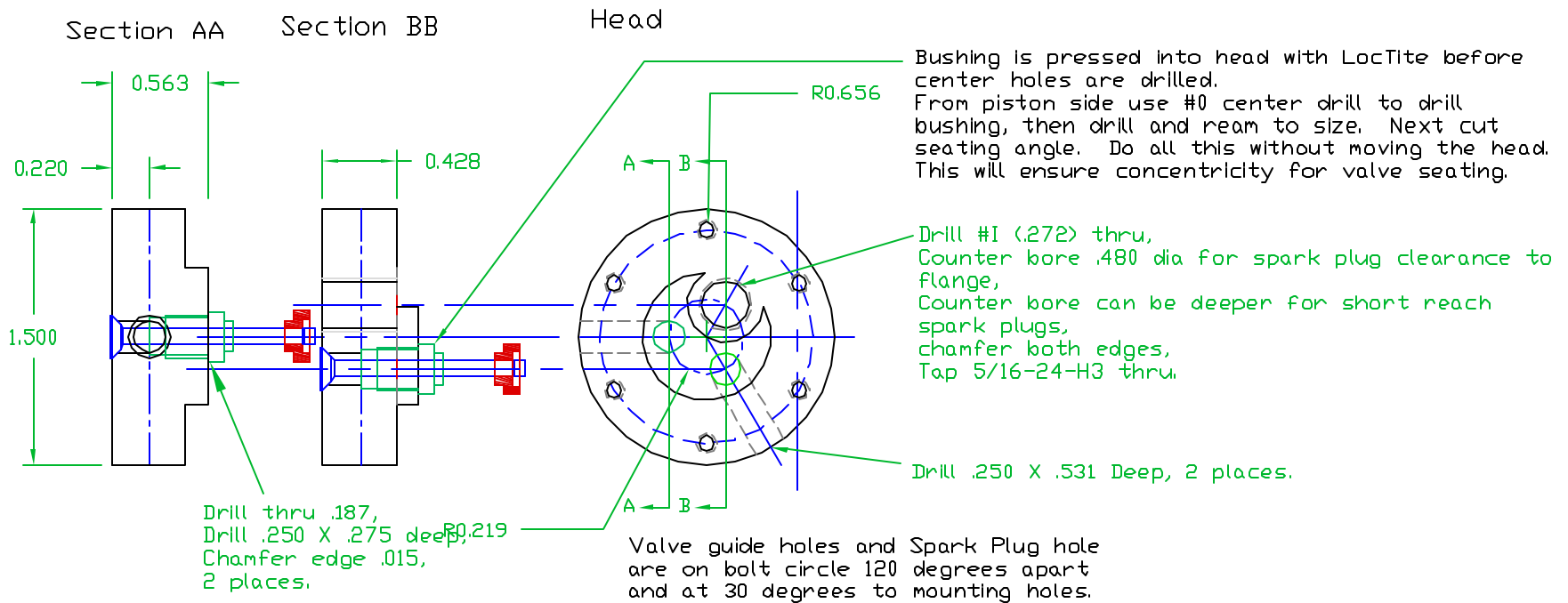
Title:  
Gears

Date: 02/22/2003

Drawing

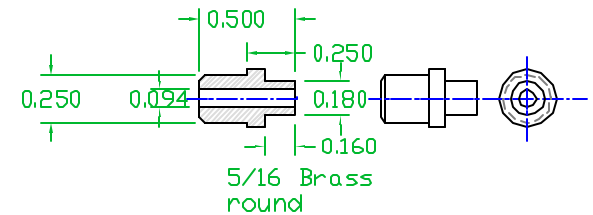
Revision: 1.1

HHM1-11



Make valve end, drill center hole .093. Make the stem about .05 longer than shown out of drill rod. Use a .020 slitting saw in the lathe to cut the lock groove. Assemble parts to correct length, silver solder, apply solder to big end and let it wick in. Face off extra stem material. Oil the stem.

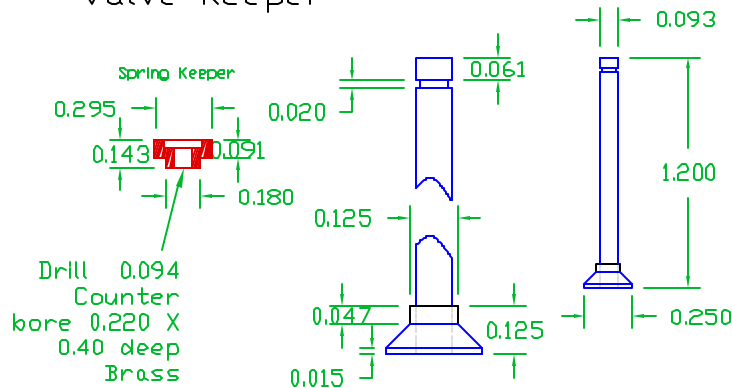
Valve Guide



Valve

Material is:  
Drill Rod  
shaft  
316 SS disk  
Silver solder  
slip fit  
together

Valve Keeper



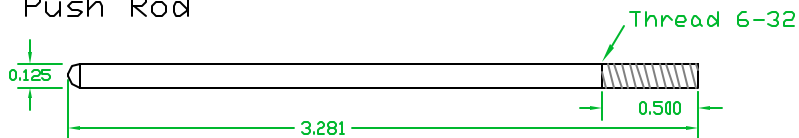
Areas in ports

Shaft .027  
Port .108  
Difference .081

Valve .075  
Seat .196  
Difference .121  
70% for 45° =>  
.086

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Assembly: Horizontal Hit and Miss 1	
Title: Head & Valves	
Date: 02/28/2003	Drawing
Revision: 1.1	HHM1-12

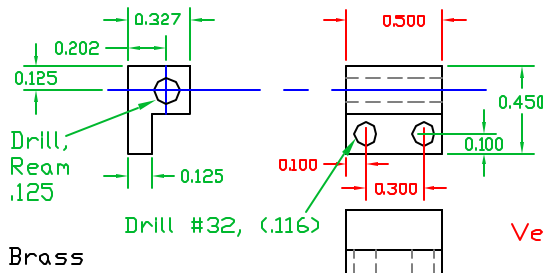
### Push Rod



Form 1/8 dia ball on end of 1/8 dia brass rod. Rod must slide in bearing freely.

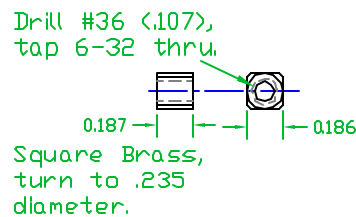
#36, (.107)

### Push Rod Bearing



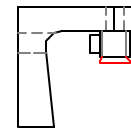
Brass

### Push Rod Lock Nut

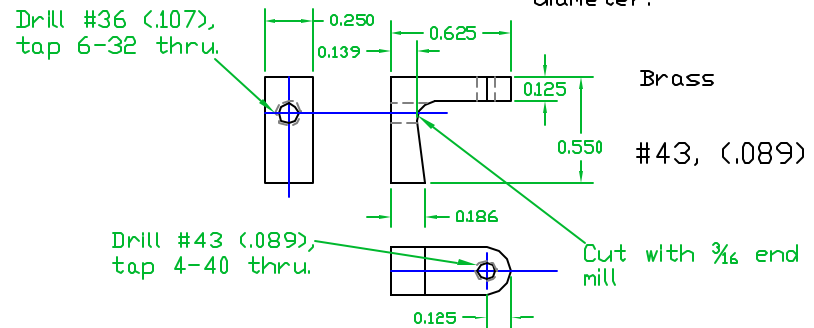


Square Brass, turn to .235 diameter.

### Cam Follower



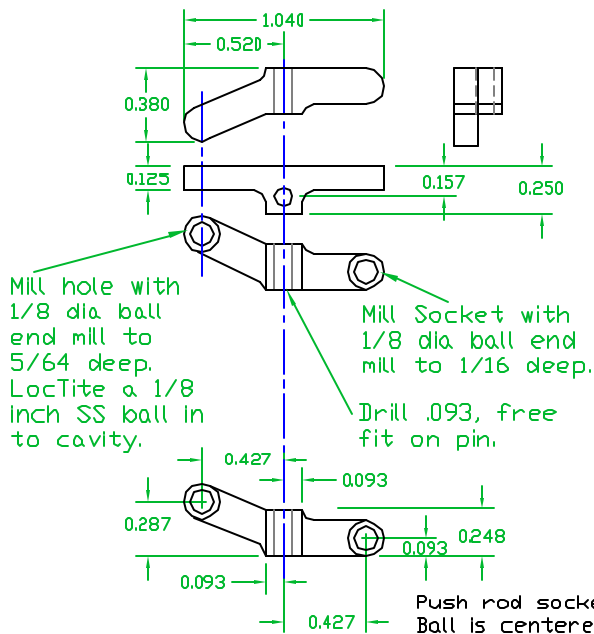
A .250 OD, .125 ID ball bearing is used to follow the cam. Use a 4-40 flat head screw turned down to .187n diameter.



Brass

#43, (.089)

### Rocker Arm

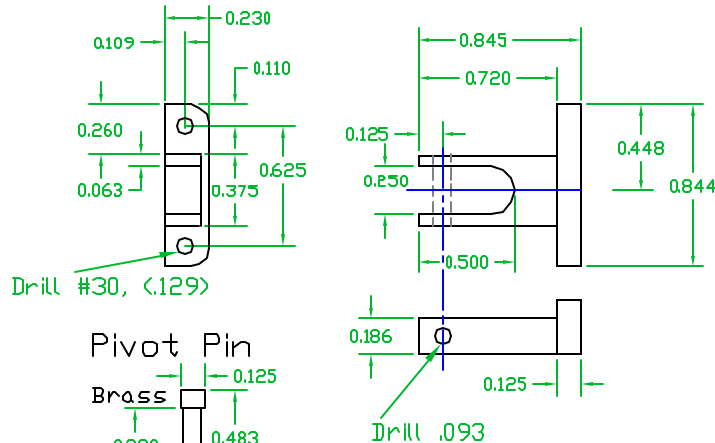


Mill hole with 1/8 dia ball end mill to 5/64 deep. Loctite a 1/8 inch SS ball in to cavity.

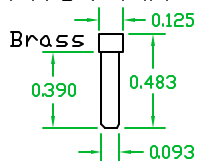
Mill Socket with 1/8 dia ball end mill to 1/16 deep. Drill .093, free fit on pin.

Push rod socket is on cylinder centerline. Ball is centered on valve stem.

### Rocker Arm Pivot



### Pivot Pin



Brass

Pivot pin should have a finger push fit into pivot.

Rocker arm can be brass or aluminum, pivot is aluminum.

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Pompano Beach, Florida USA

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Assembly: Horizontal Hit and Miss 1

Title: Rocker Arm

Date: 03/17/2003

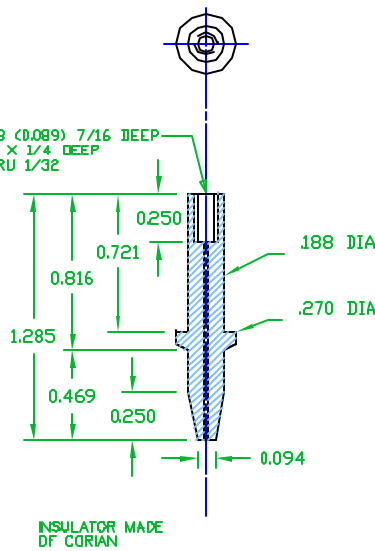
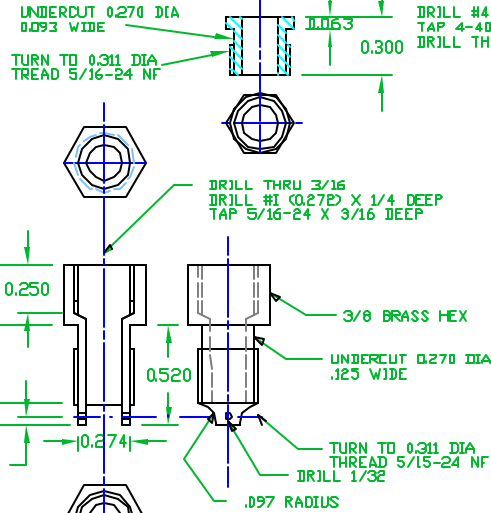
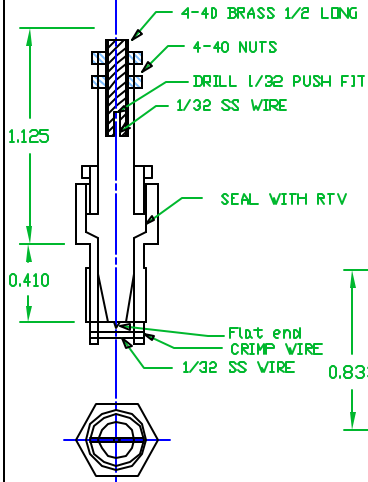
Drawing:

Revision: 1.1

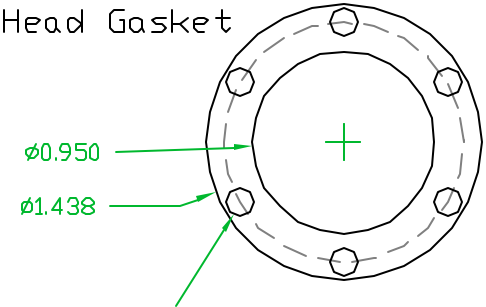
HHM1-13



### Spark Plug

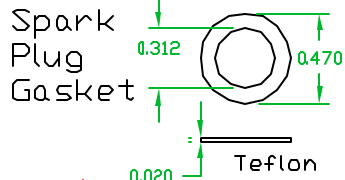


### Head Gasket

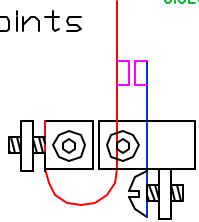


6) 5/32 holes on 1.250 bolt circle

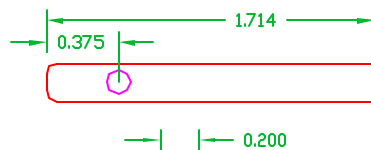
Make gasket from .005 thick Teflon film. Make punches from scrap and brass tube, put film on cardboard and push and turn punch to cut.



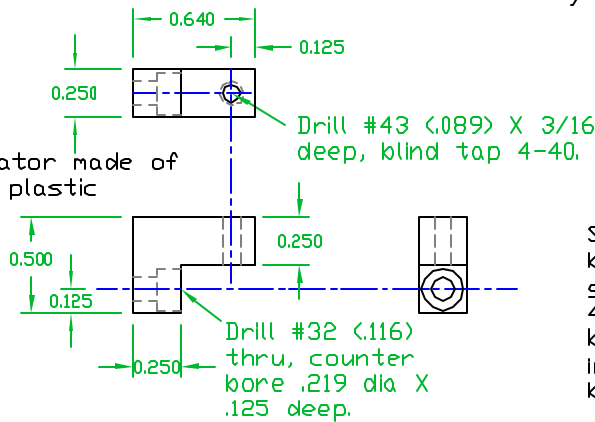
### Points



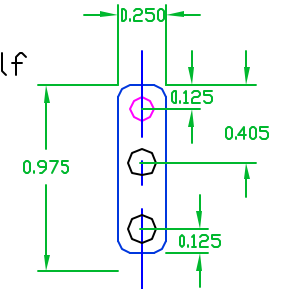
### Flexing Half



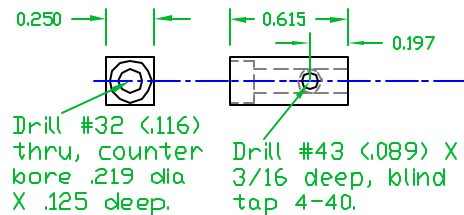
Insulator made of hard plastic



### Stationary Half



Solder a 1/8 dia Tungsten button to the .031 brass strip. Solder a 1/4 long 4-40 brass screw to bottom hole, fasten to insulator with 1/4 long 4-40 brass screw.

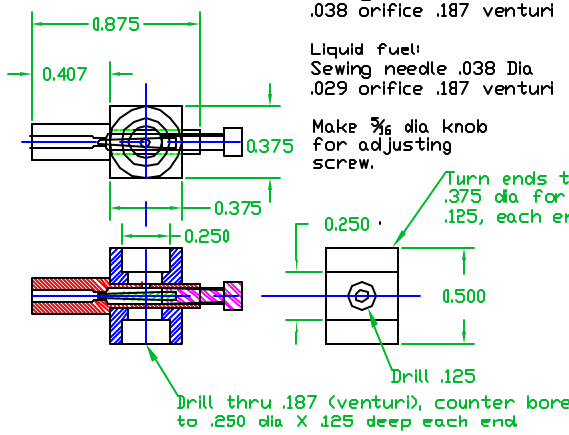


Solder a 7/16 long stud made of 4-40 brass screw in tapped hole.

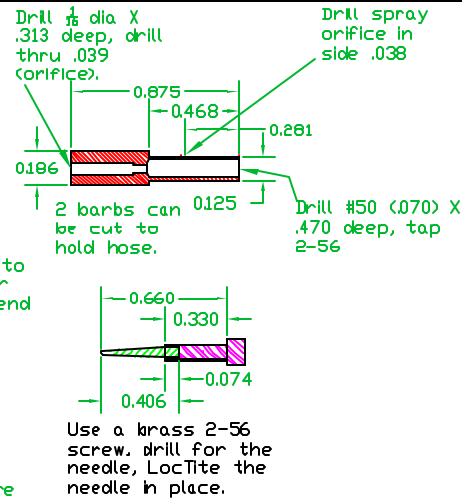
Solder a 1/8 dia Tungsten button to the .020 beryllium copper strip. Bend the radius, solder the strip to the brass grounding block.

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Assembly:	Horizontal Hit and Miss 1
Title:	Spark Plug & Points
Date: 03/12/2003	Drawing:
Revision: 1.1	HMM1-14

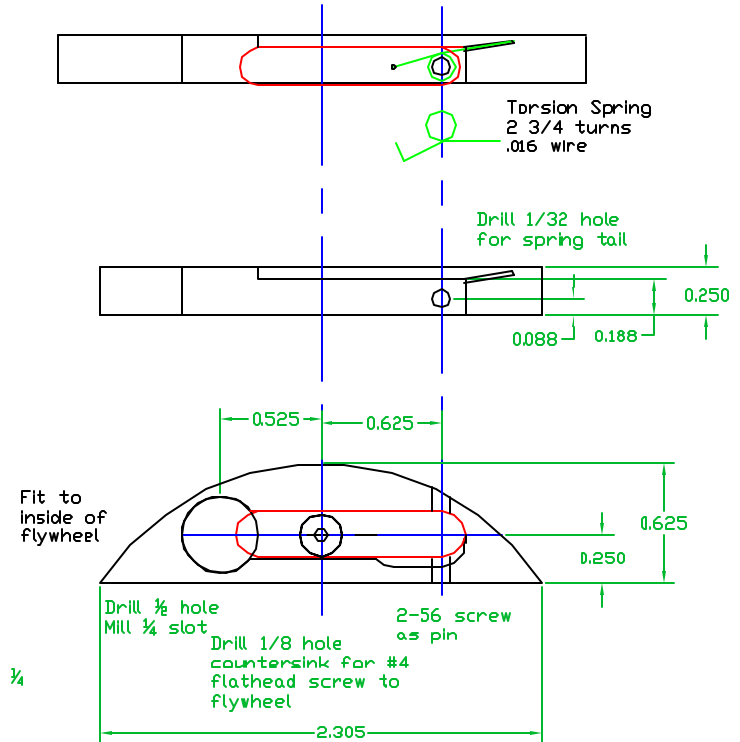
# Carburetor



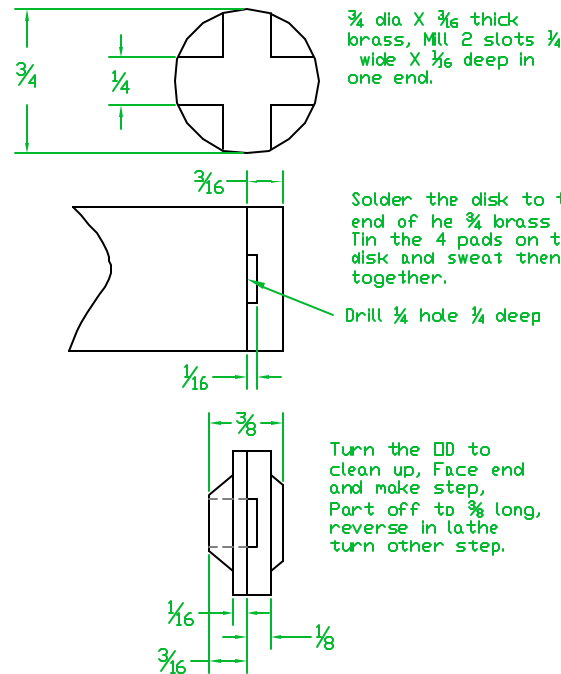
Carburetor for Propane runs well at 2.5 turns out, Liquid fuel runs at about 1 turn out.



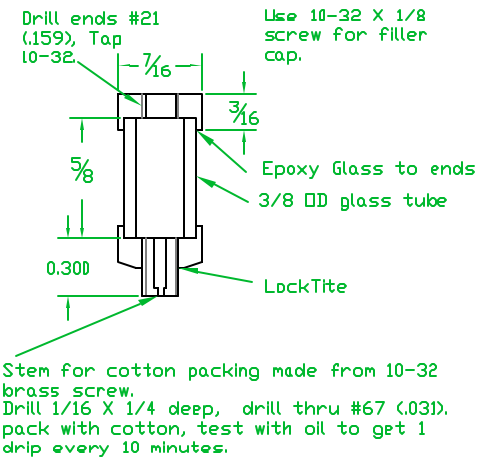
# Optional Start Level



# Muffler



# Oiler



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Assembly: Horizontal Hit and Miss 1	
Title: Carburetor	
Date: 03/23/2003	Drawing:
Revision: 1.1	HHM1-15