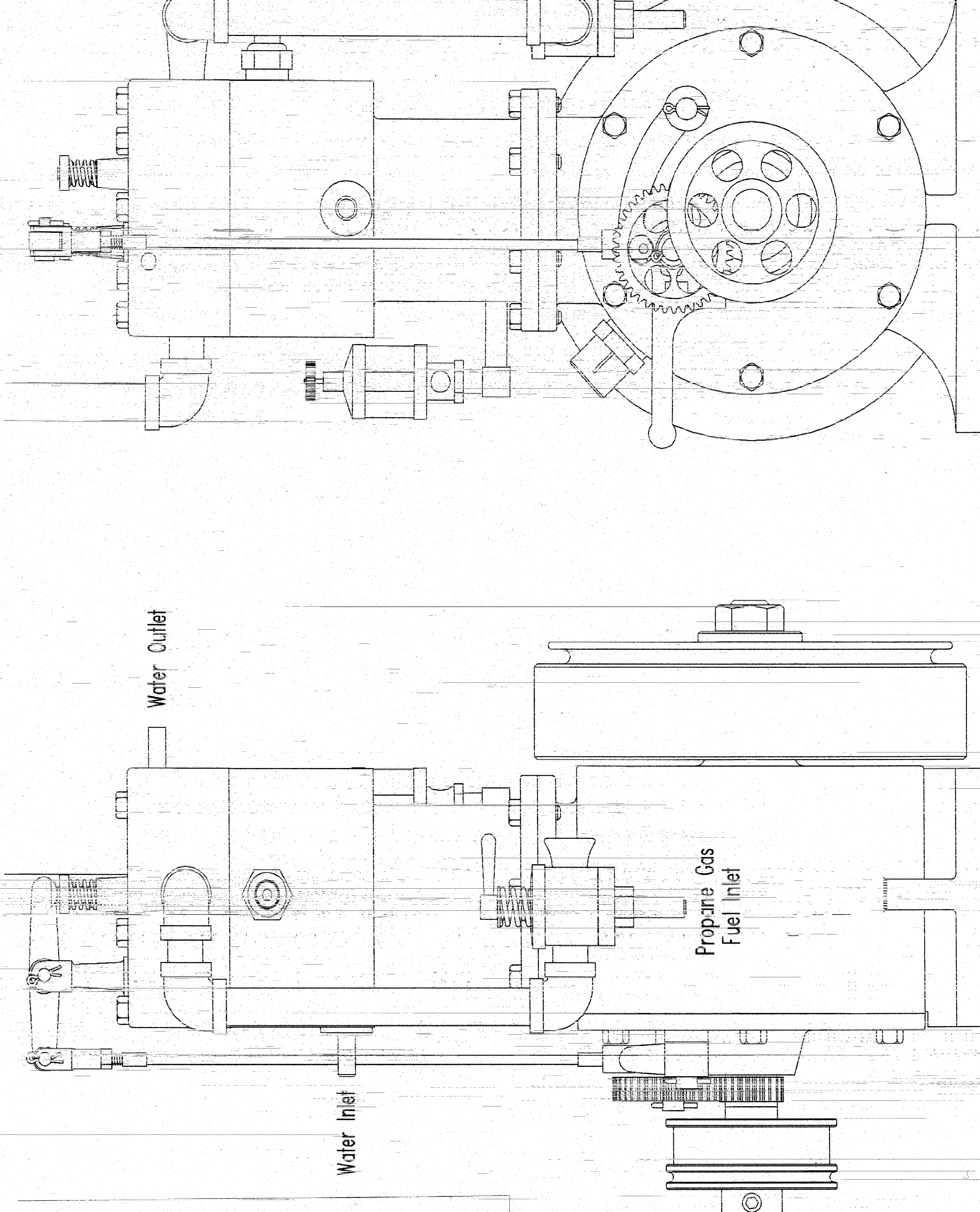

Drawn Actual Size

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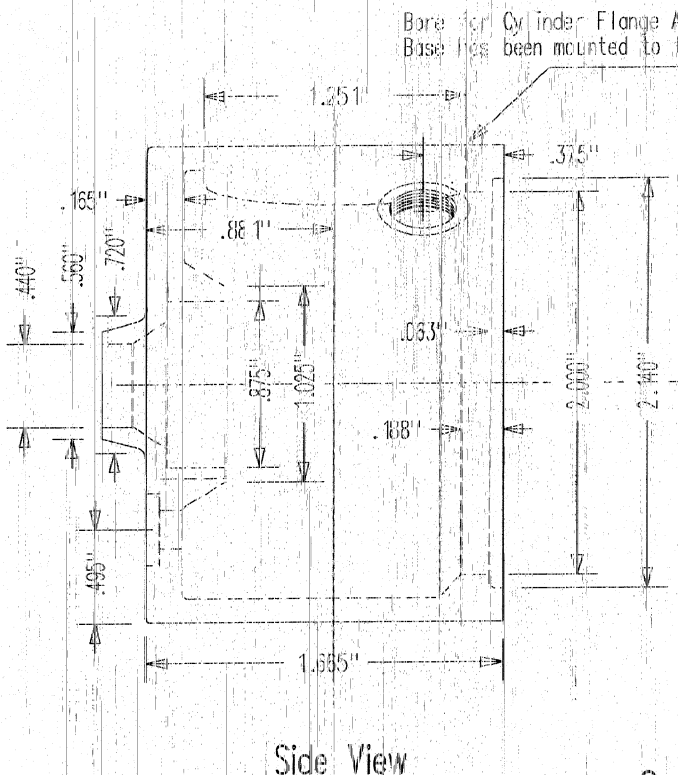
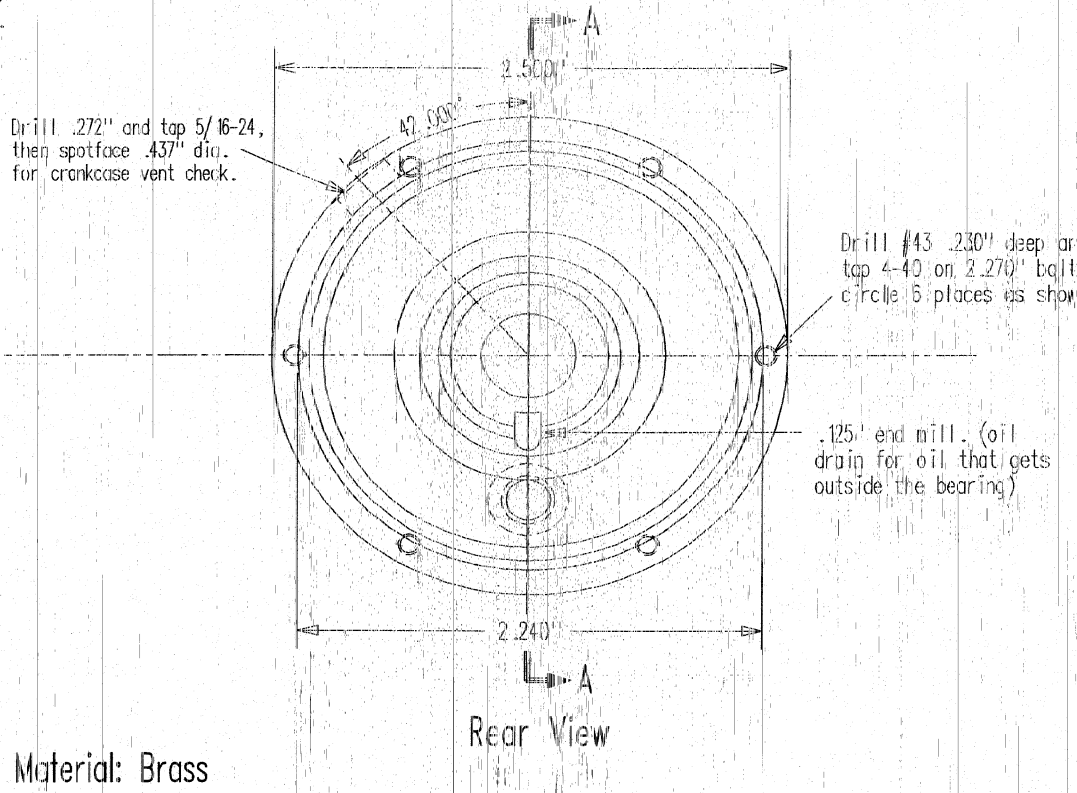
Jerry E. Howell	Project: "Bill" - 1906 Four Cycle Gas Engine		
7990 Basket Drive Colorado Springs, CO 80908	Sheet # 1	Date: 06/29/02	By: Jerry E. Howell
Model Project Plans & Kits			

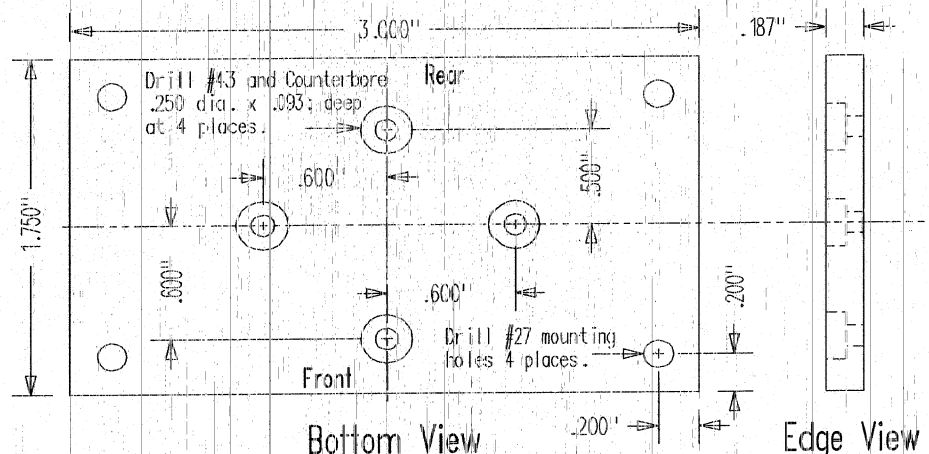


Side View



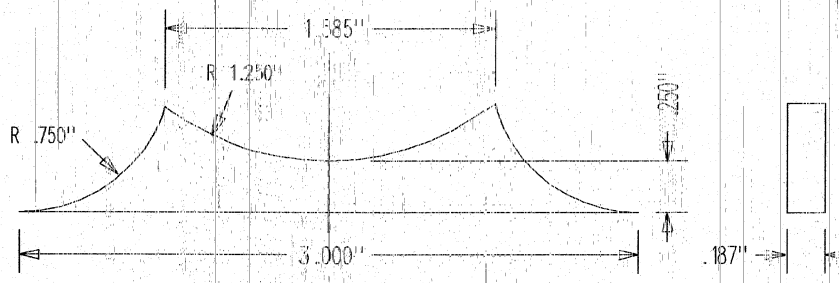
Rear View

Crankcase Material: Brass



Bottom View

Edge View



Face View

End Vie

Crankcase Base Plate Material: Brass

Base Main Rib Material: Brass

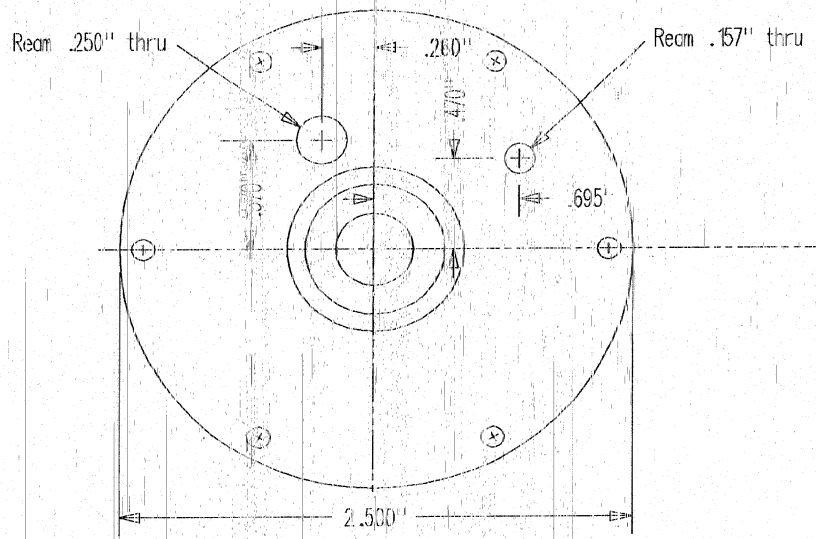
(Also see Sheet #4)

Crankcase Parts

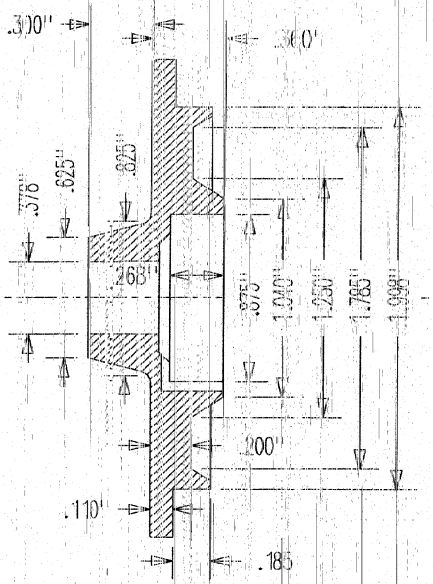
Jerry E. Howell
3980 Becket Drive
Colorado Springs, CO 80906
Model Project Plans & Kits

Project: "Bill" - 1906 Four Cycle Gas Engin

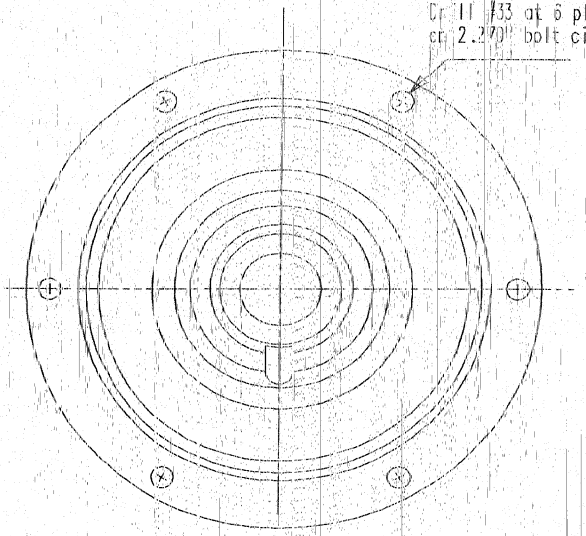
Sheet # 2 | Date: 06/04/02 | By: Jerry E. How



Front View

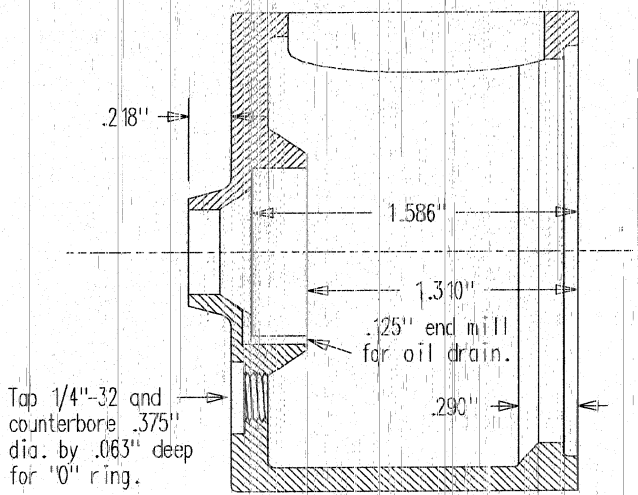


Side View



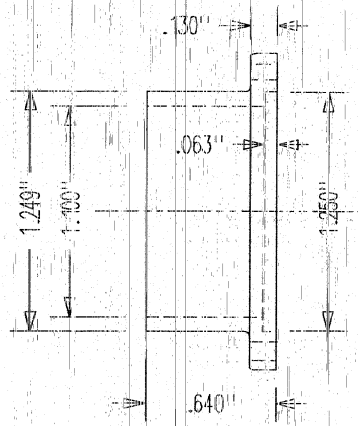
Rear View

Crankcase End Cover Material: Brass

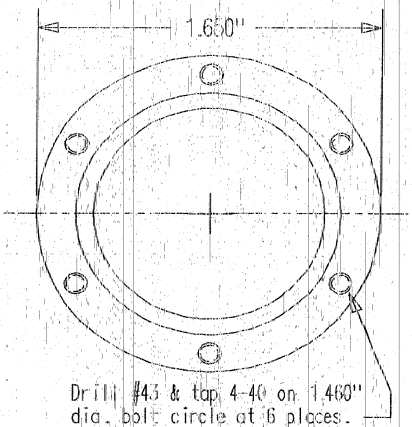


Crankcase Section A-A

From Sheet #2



Side View



Top View

Crankcase Cylinder Flange Material: Brass

Crankcase Cover & Flange

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3980 Beckett Drive
Colorado Springs, CO 80906
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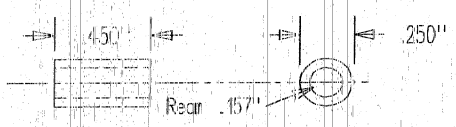
Project: "Bill" - 1906 Four Cycle Gas Engine

Sheet # 3 | Date: 06/04/02 | By: Jerry E. How

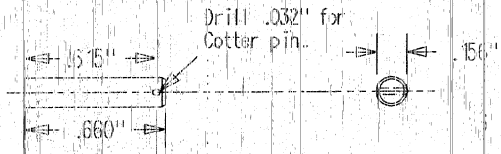


Side View End View

Cam Post Bushing Material: Brass

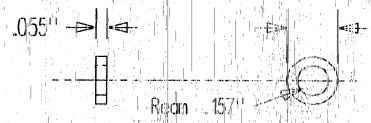
Side View End View

Cam Sleeve Post Material: Drill Rod



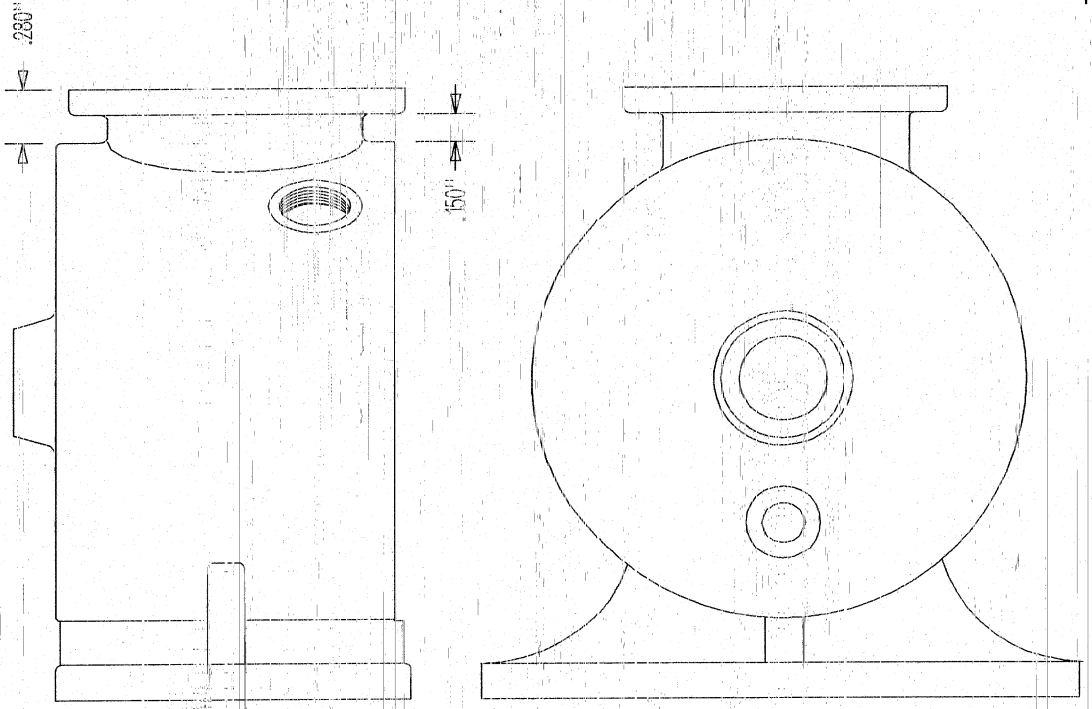
Side View End View

Tappet Arm Post Material: Drill Rod



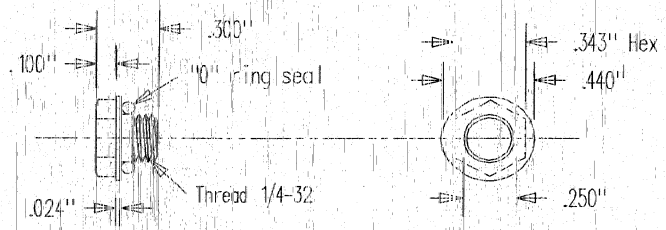
Side View End View

Tappet Arm Post Spacer Material: Brass



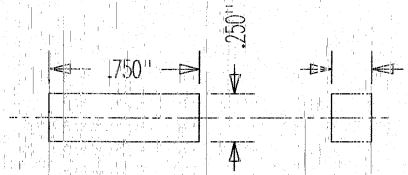
Right Side View Front View

Crankcase Assy. Views & Parts



Side View End View

Oil Drain Plug Material: Steel



Side View End View

Base Rib (2) Material: Brass

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Colorado Springs, CO 80906
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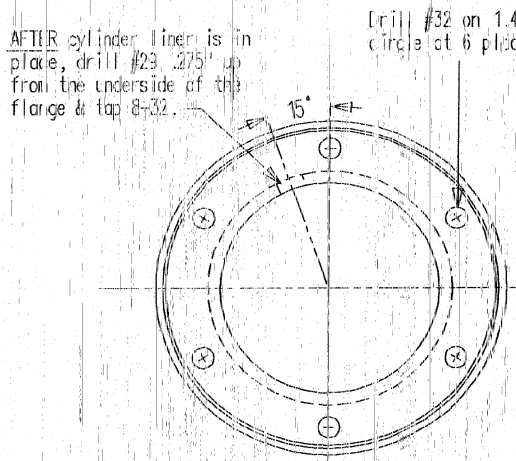
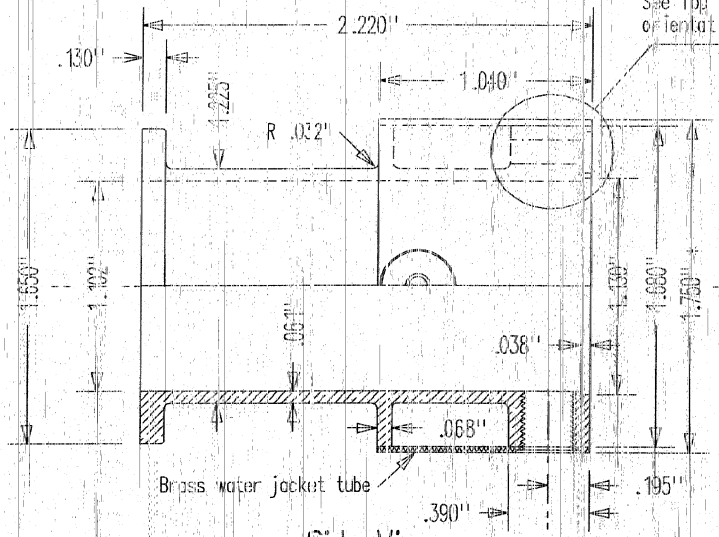
Project: "Bill" - 1906 Four Cycle Gas Engine

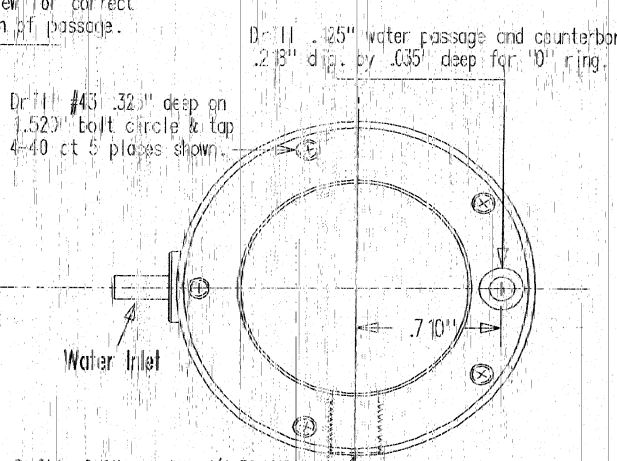
Sheet # 4 | Date: 07/06/02 | By: Jerry E. Howe



Bottom View

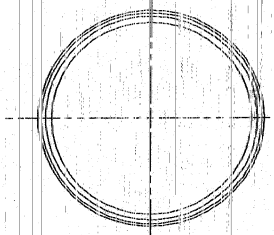


Side View

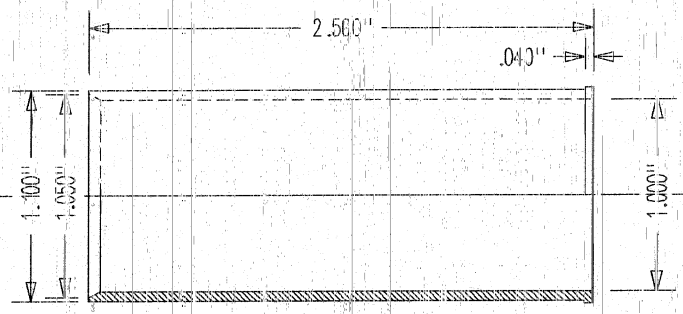


Top View

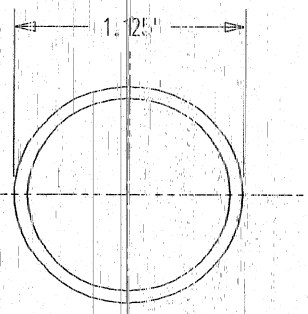
Cylinder Flange/Water Jacket Material: Brass



Bottom View

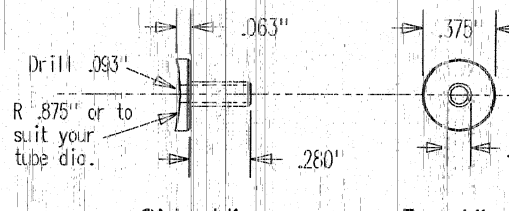


Side View



Top View

Cylinder Liner Material: Cast Iron



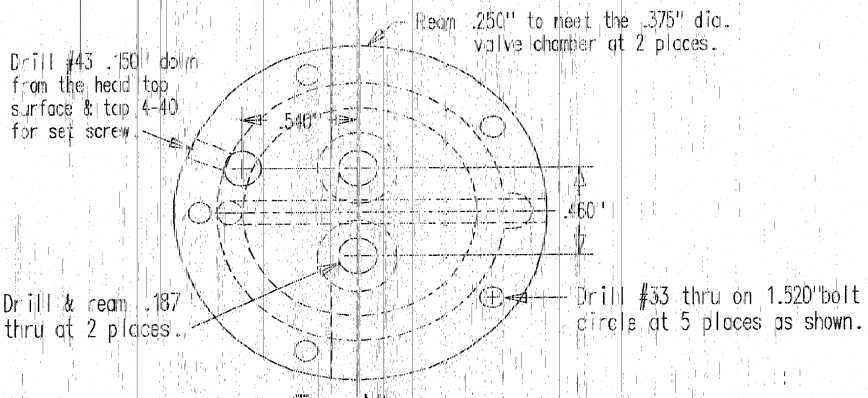
Side View End View

Water Inlet Fitting
Material: Brass

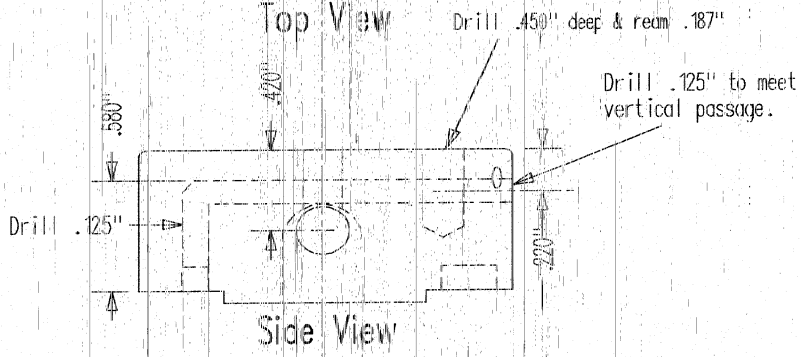
* See Construction Notes

Cylinder Parts

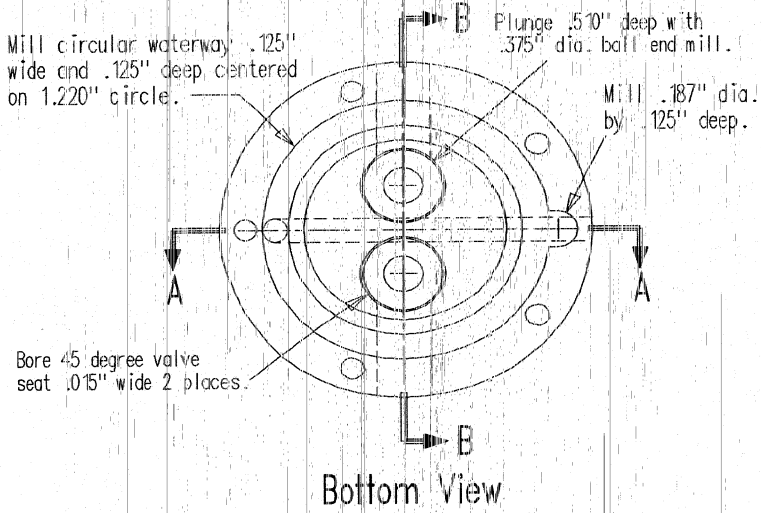
Jerry E. Howell 3980 Becket Drive Colorado Springs, CO 80906 Model Project Plans & Kits	Project: **"Bill" - 1906 Four Cycle Gas Engine**		
	Sheet # **5**	Date: 06/07/02	By: Jerry E. Howe



Top View

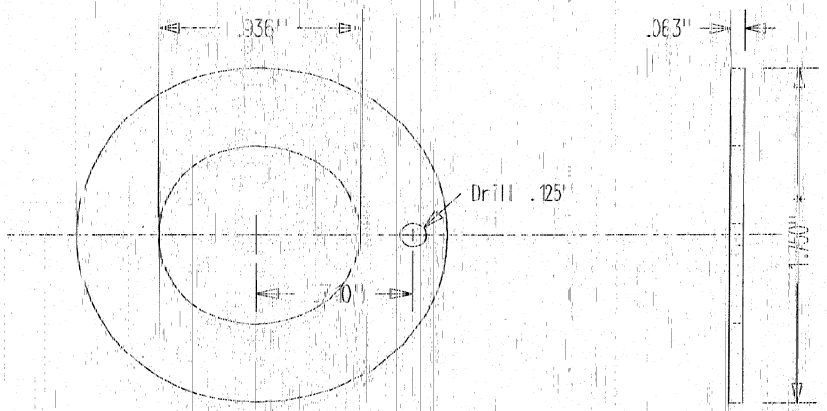


Side View



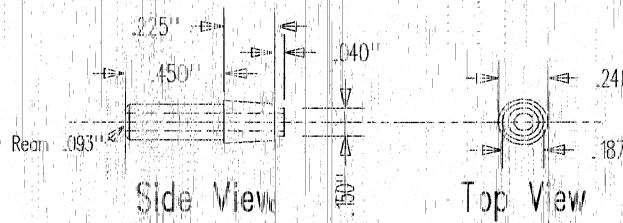
Bottom View

Cylinder Head Material: Brass



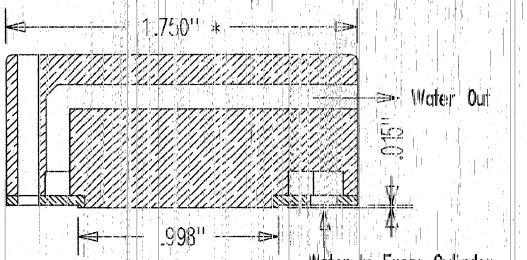
Top View Edge View

Head Water Passage Cover Material: Brass



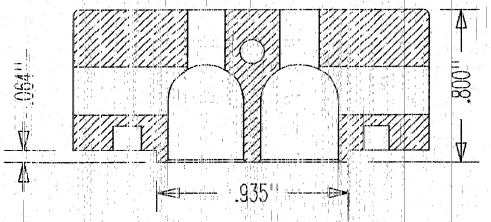
Side View Top View

Valve Guide (2) Material: Bronze



Shown with water cover installed – see Construction Notes.

Section A-A



Section B-B

* Match outside diameter of Cylinder water jacket tube.

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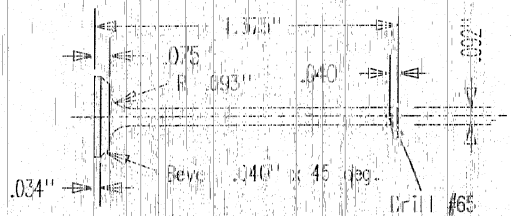
Project: "Bill" - 1906 Four Cycle Gas Engi

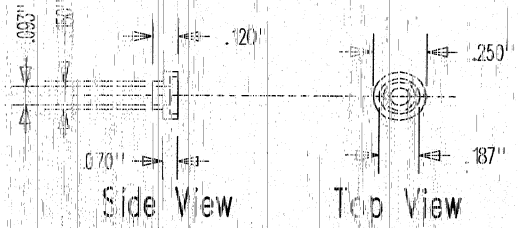
Sheet # 6 | Date: 07/11/02 | By: Jerry E. Ho



Side View Top View

Intake/Exhaust Valve (2)

Material: Stainless Stee



Side View Top View

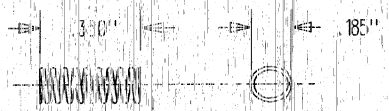
Valve Spring Keeper (2)

Material: Stainless Steel

Side View End View

Valve Spring Keeper P

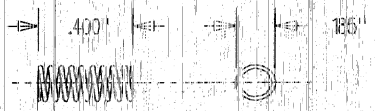
Material: Steel



Side View Top View

Wind 8 turns of .016" spring wire on .125" mandrel.

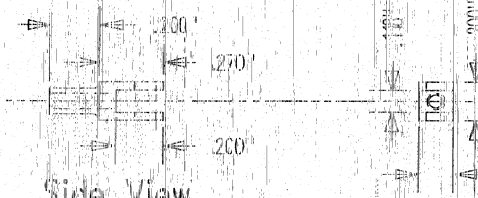
Exhaust Valve Spring



Side View Top View

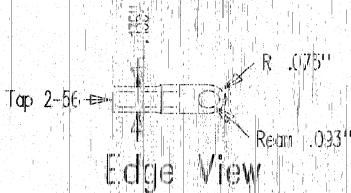
Wind 9 turns of .011" spring wire on .125" mandrel.

Intake Valve Spring



Side View

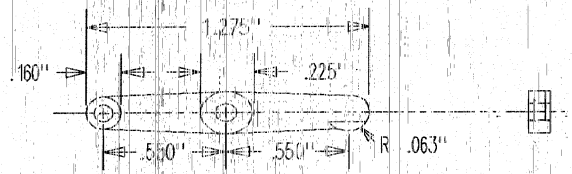
Top Vie



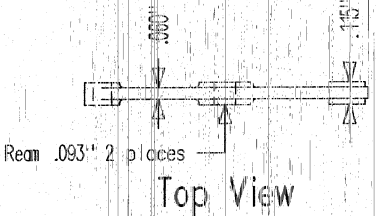
Edge View

Exhause Valve Push Rod (

Material: Stainless Steel



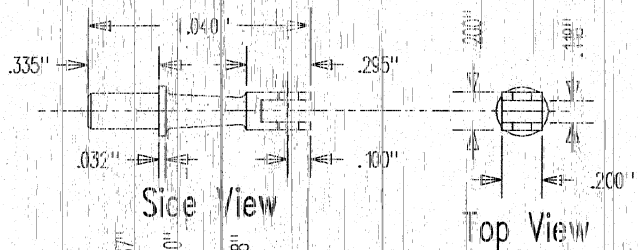
Side View End View



Top View

Exhaust Valve Rocker Arm

Material: Brass

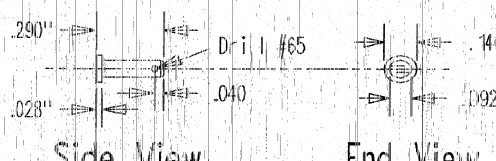


Side View Top View

Edge View

Exhaust Valve Rocker Arm Pivot

Material: Stainless Steel



Side View End View

Rocker Arm Pin (2)

Material: Stainless Steel

Valve Train Parts

Jerry E. Howell
3980 Becket Drive
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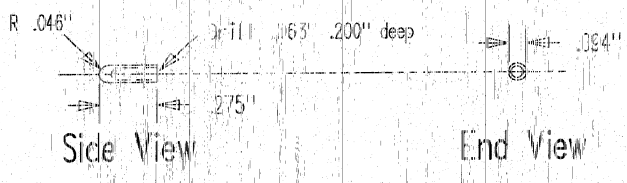
Model Project Plans & Kits

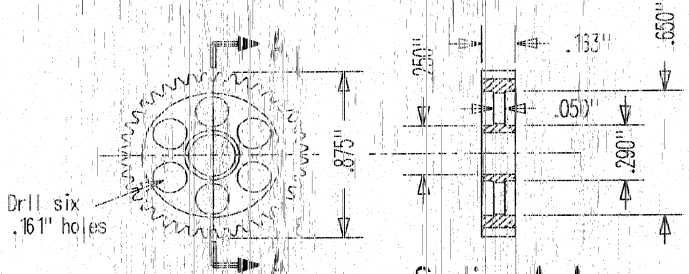
Project: "Bill" - 1906 Four Cycle Gas

Sheet # 7 | Date: 06/12/02 | By: Jerr



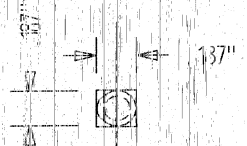
Bottom Push Rod End

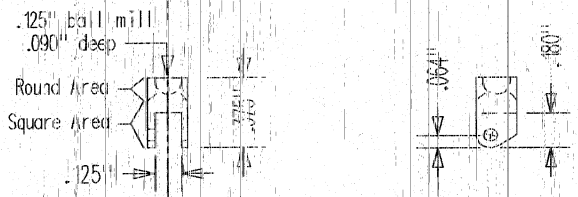
Material: Stainless Steel



48 Pitch 40 Tooth Cam Gear

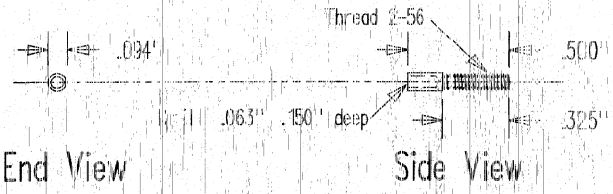
Material: Brass





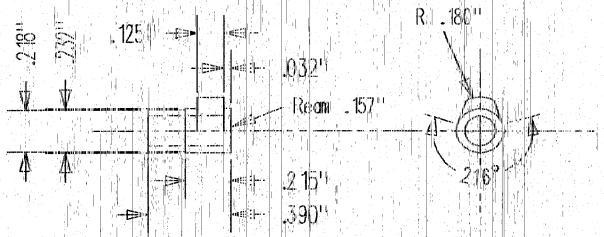
Cam Arm Roller End

Material: Brass



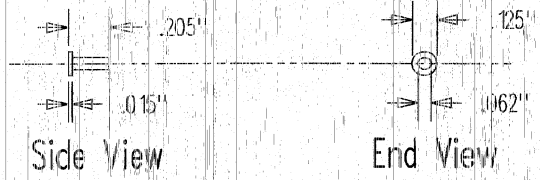
Top Push Rod End

Material: Stainless Steel



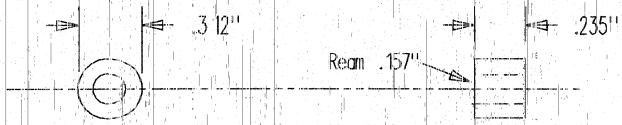
Cam Sleeve

Material: Steel



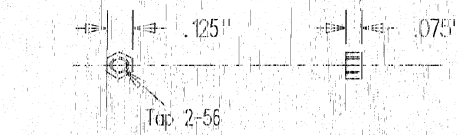
Cam Roller Axle

Material: Drill Rod



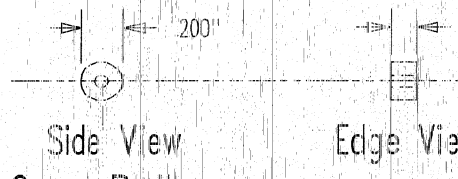
Cam Arm Pivot End

Material: Brass



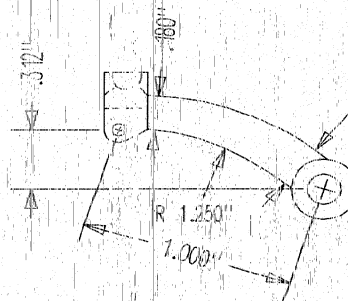
Push Rod Length Adjusting

Material: Stainless Steel



Cam Roller

Material: Drill



Cam Arm Assemb

See the "Construction Notes" for details of Cam Arm fabrication.

Valve Train Parts

Jerry E. Howell
3980 Becket Drive
Colorado Springs, CO 80906
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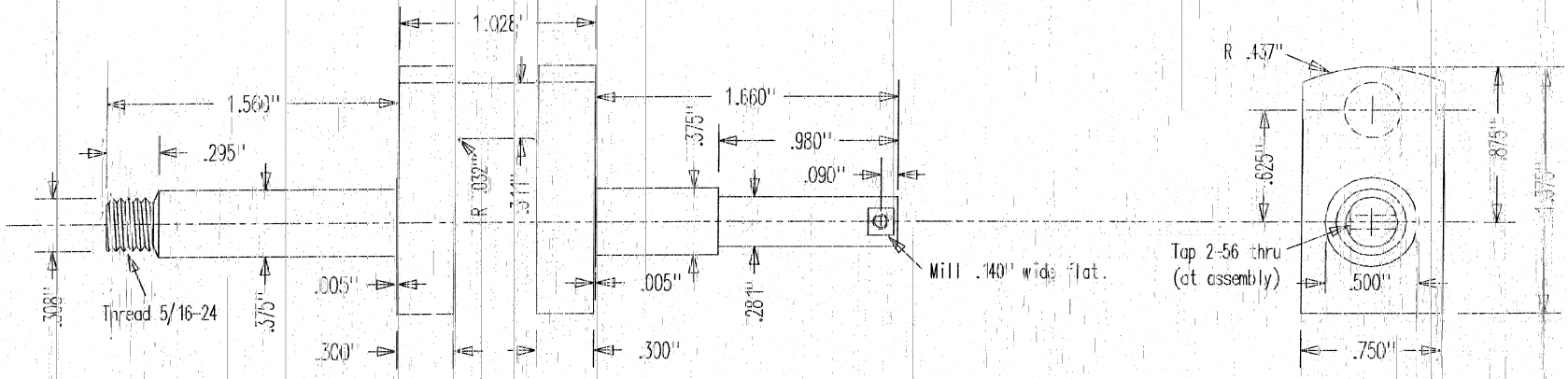
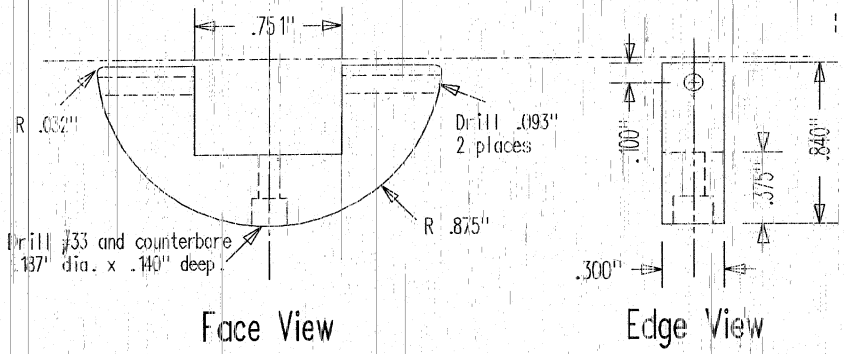
Project: "Bill" - 1906 Four Cycle Gas En

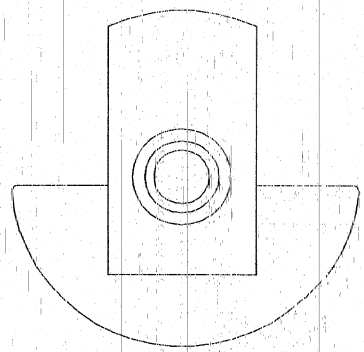
Sheet # 8 | Date: 06/24/02 | By: Jerry E



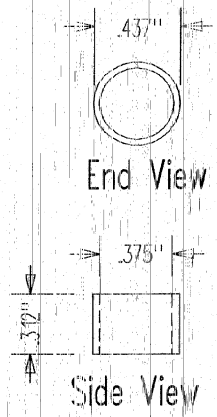
Crankshaft Material: Ground Tool Steel (from 4.25"x.750"x1.375" blank)



Crankshaft Balance Weight (2) Material: Any Steel



Weights Mounted On Crankshaft

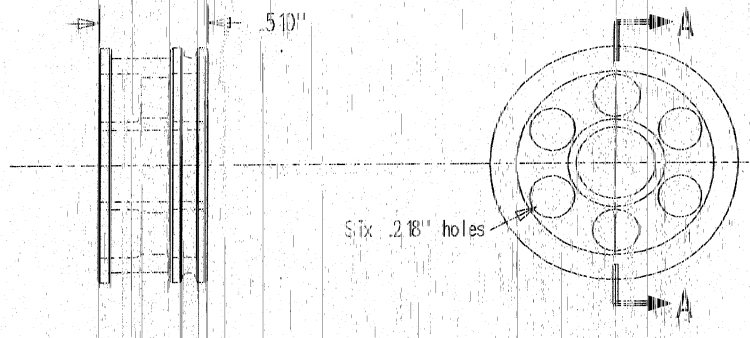


Flywheel Collet Spacer Sleeve
Material: Steel

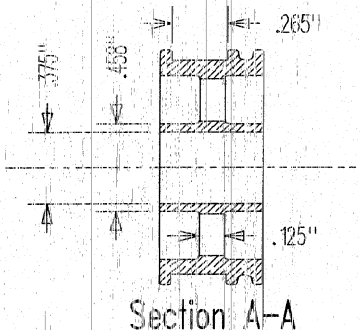
Crankshaft Assembly

Jerry E. Howell
3980 Beckel Drive
Colorado Spring, CO 80906
Model Project Plans & Kits

Project: "Bill" - 1906 Four Cycle Gas Engine
Sheet # 9 | Date: 06/17/02 | By: Jerry E. Howell

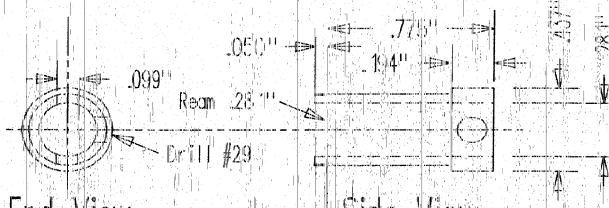


Edge View Face View



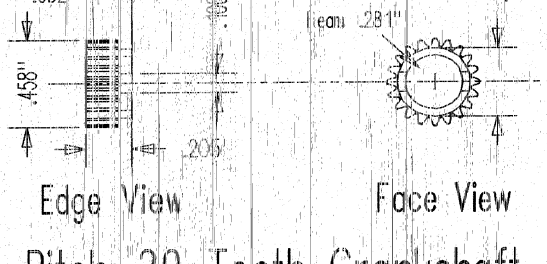
Section A-A

Pulley Material: Steel



End View Side View

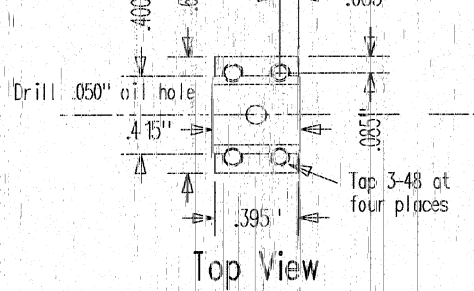
Pulley Hub Material: Steel



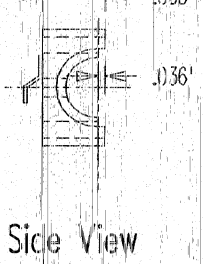
Edge View Face View

48 Pitch 20 Tooth Crankshaft Gear

Material: Steel



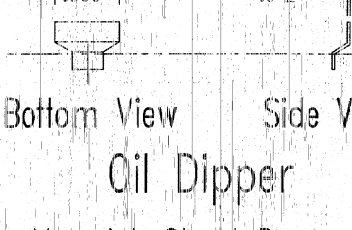
Top View



Side View

Connecting Rod Bearing Lower Half

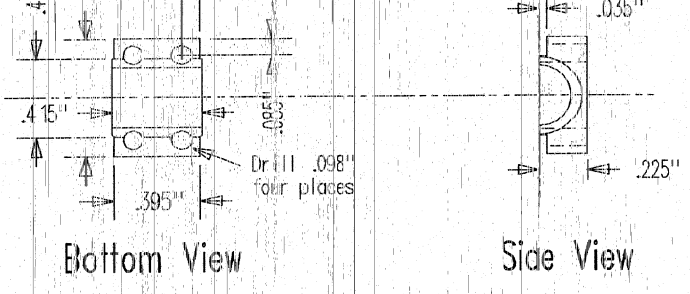
Material: Bronze or Brass



Bottom View Side V

Oil Dipper

Material: Sheet Brass

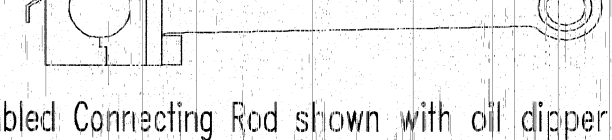


Bottom View

Side View

Connecting Rod Bearing Upper Half

Material: Bronze or Brass



Assembled Connecting Rod shown with oil dipper sold
to lower bearing half, the (4) 3-48 x .5" socket he
screws and the small end bushing installed.

Crankshaft Gear / Connecting Rod

Jerry E. Howell
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Colorado Springs, CO 80906
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Project: "Bill" - 1906 Four Cycle Gas Eng

Sheet # 10 | Date: 06/27/02 | By: Jerry E.

Piston Ring Options

Information on making your own high quality piston rings was printed in Strictly I.C. magazine 1989, Vol. 2, issues #7, #8 & #9. Back issues are available as of this date.

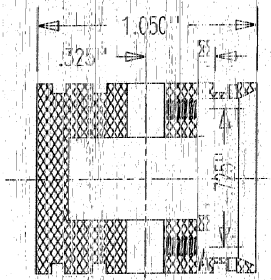
Strictly I.C. Magazine
24920 43rd Avenue S.
Kent WA 98032

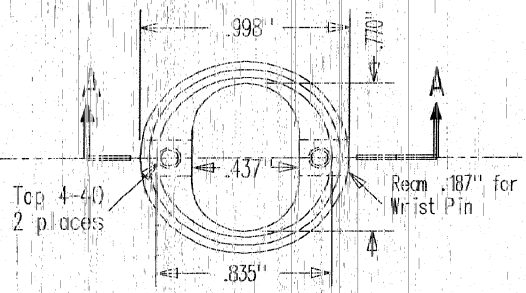
E-mail: strictlyic@earthlink.net
Web Site: strictlyic.com

By increasing the piston ring width and depth to suit their rings, high quality and reasonably priced piston rings 3/32" in height can be purchased from:

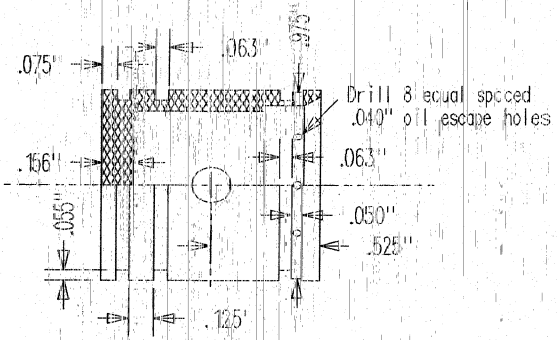
Otto Gas Engine Works
2167 Blue Ball Road
Elkton, MD 21921

E-mail: otto@dol.net
Phone: (410)-398-7340



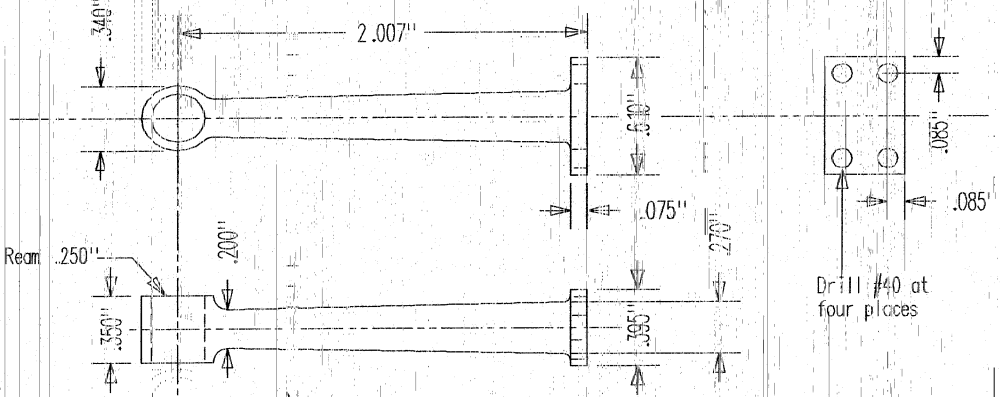


Bottom View

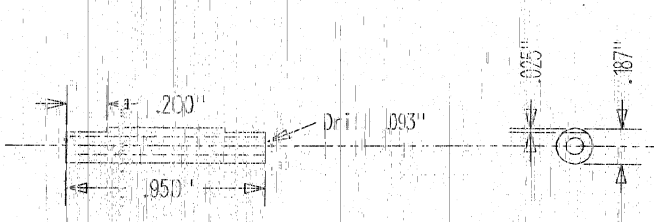


Side View

Piston Material: 6061 T6 Aluminum Alloy

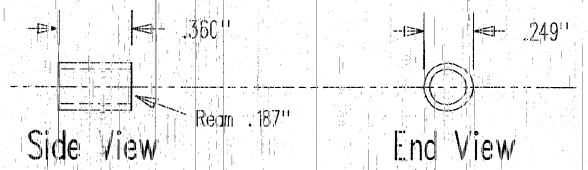


Connecting Rod Material: Steel



Side View End View

Wrist Pin Material: Drill Rod



Side View End View

Connecting Rod End Bushing

Material: Bronze or Brass

Piston / Connecting Rod

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3980 Becket Drive
Colorado Springs, CO 80906
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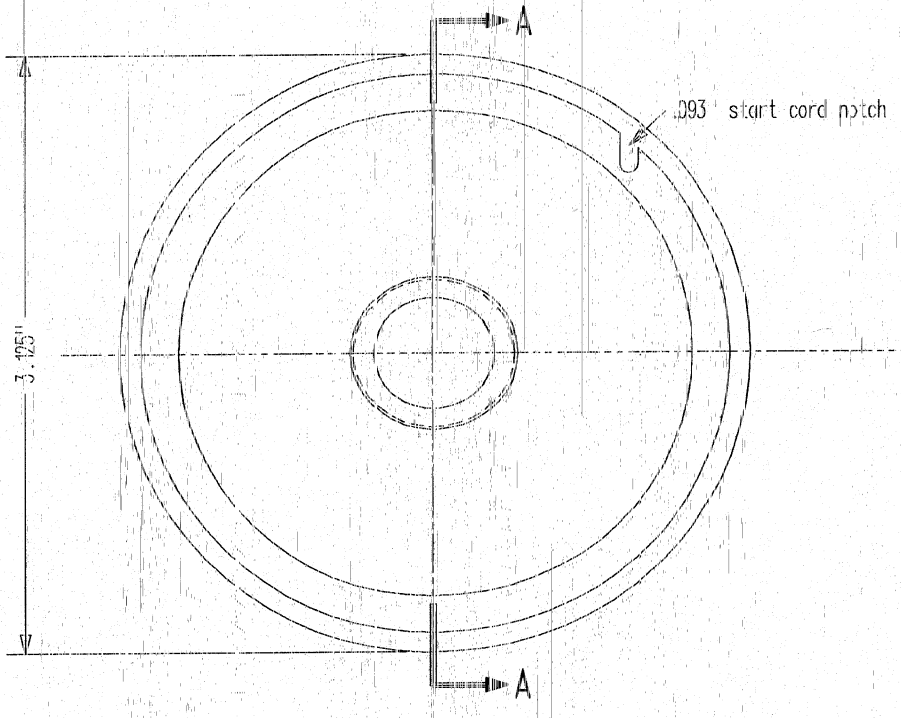
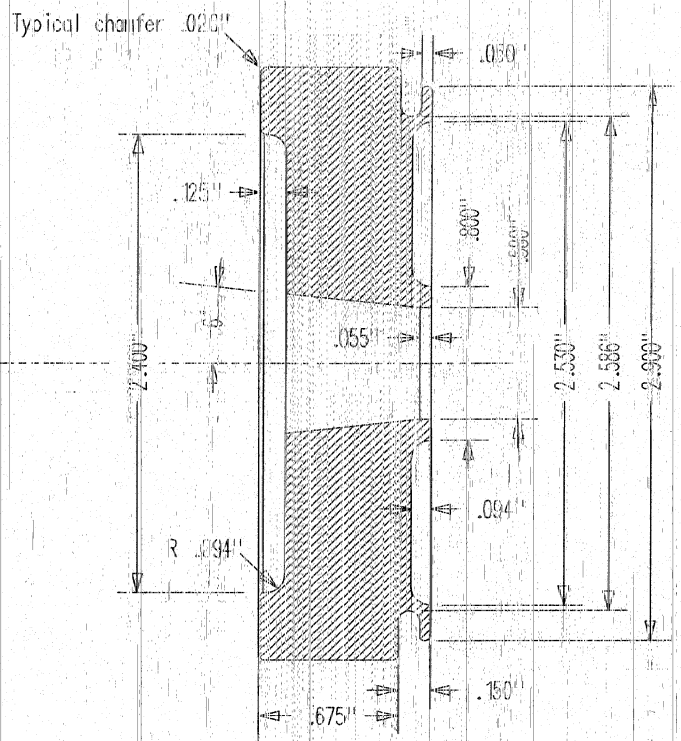
Project: "Bill" - 1906 Four Cycle Gas Engin
Sheet # 11 | Date: 07/05/02 By: Jerry E. Ho

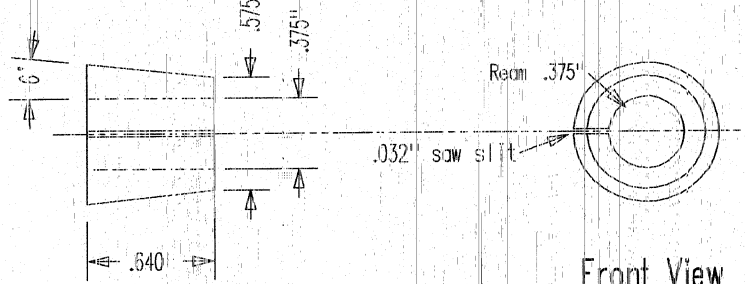


Front View



Section A--A

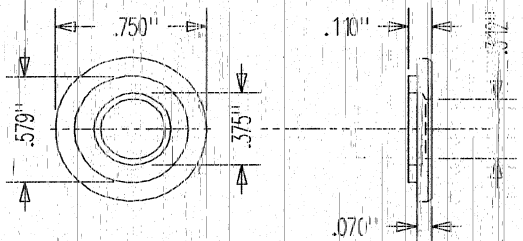
Flywheel Material: Stainless Steel



Side View

Front View

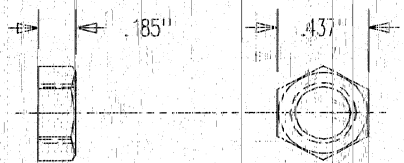
Flywheel Collet Material: Steel



Rear View

Edge View

Flywheel Washer Material: Stainless Steel



Side View

Front View

5/16-24 Steel Hex Nut

Flywheel Assembly

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Colorado Springs, CO 80906
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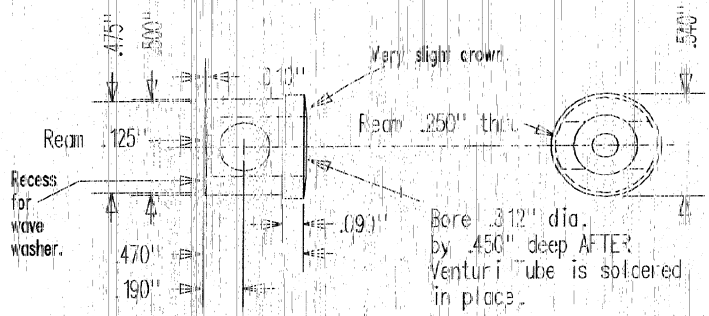
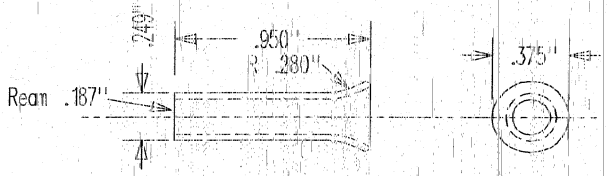
Project: "Bill" - 1906 Four Cycle Gas Engine

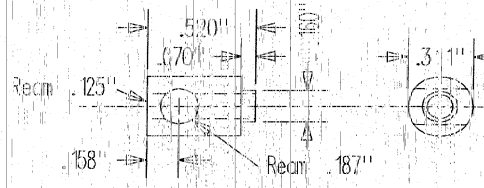
Sheet # 12 | Date: 06/20/02 | By: Jerry E. How



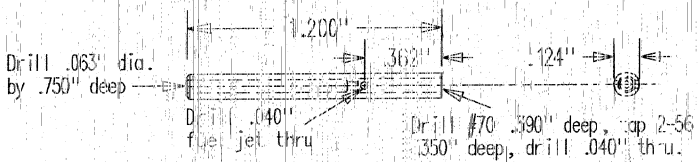
Throttle Body



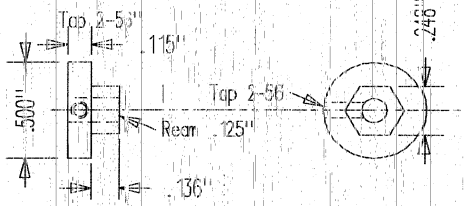
Venturi Tube



Throttle Barrel



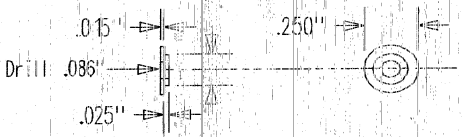
Gas Jet Tube



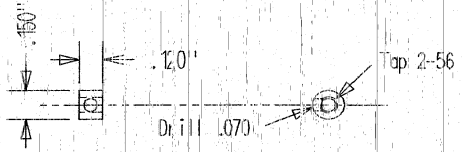
Jet Tube Retainer

Fuel Metering Needle

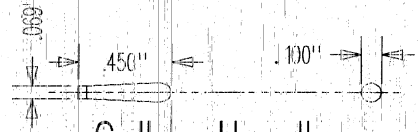
Material: Stee



Spring Washer



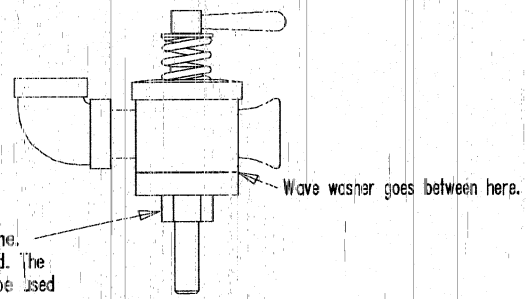
Needle Collar



Collar Handle

Throttle Assembly

(Side View)



Intake and exhaust cast bronze elbows are available from:

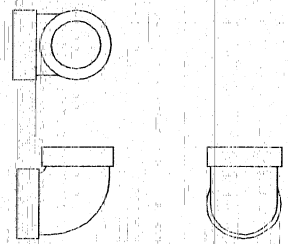
P.M. Research
Department 15M
4110 Niles Hill Road
Wellsville, NY 14895

OR

Superscale Locomotive Co.
367-A Beckett Place
Grover Beach, CA 93433

FAX 805-473-4774

www.pmresearch.com



Throttle (all parts brass unles otherwise stated)

Jerry E. Howell
3980 Becket Drive
Colorado Springs, CO 80906
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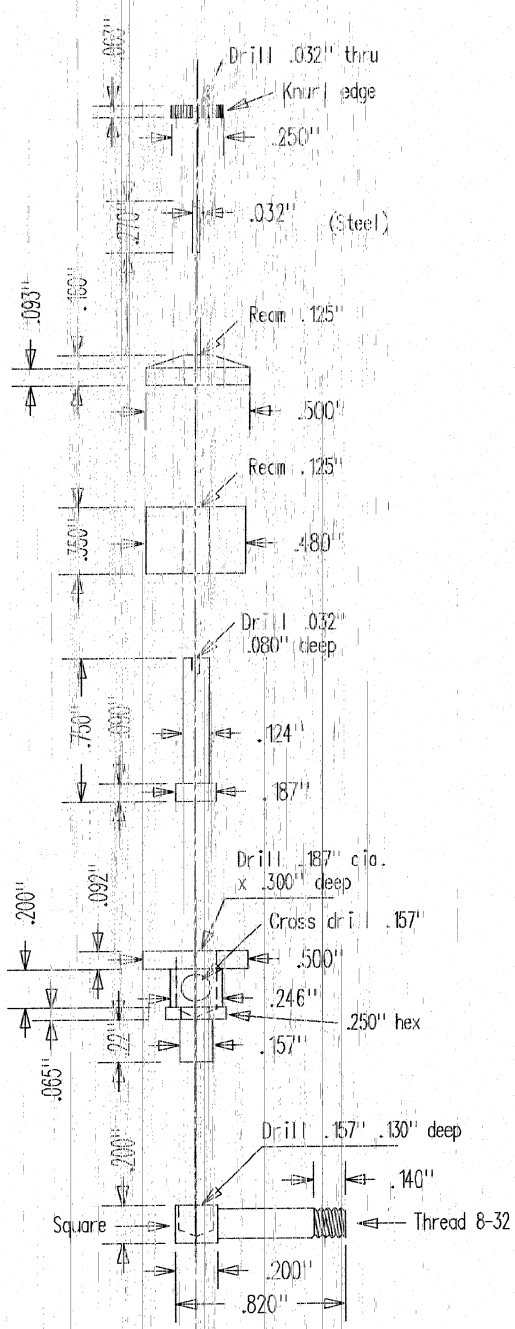
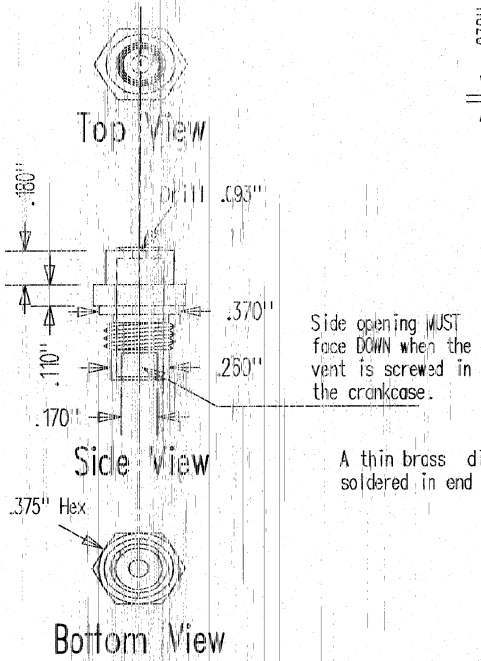
Project: "Bill" - 1906 Four Cycle Gas Engin

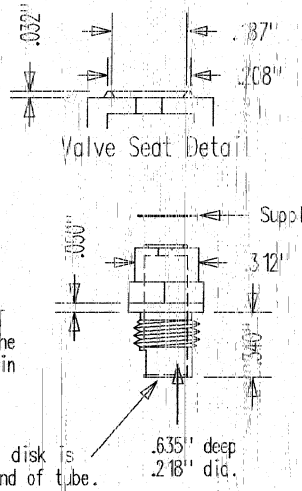
Sheet # 13 | Date: 07/08/02 | By: Jerry E. Ho

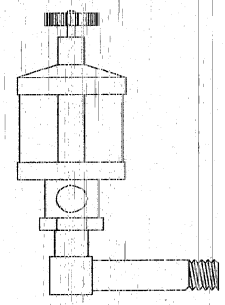


Dummy Lubricator

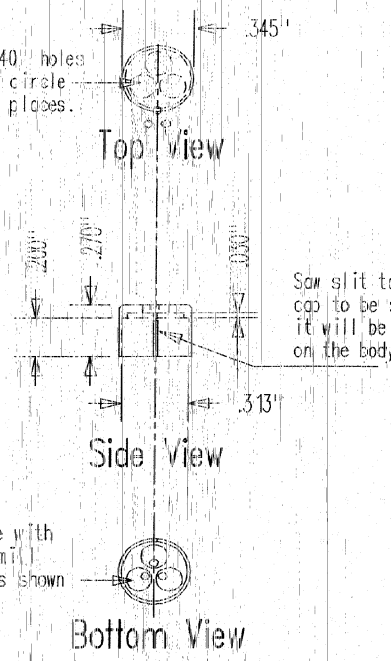


Crankcase Vent Body

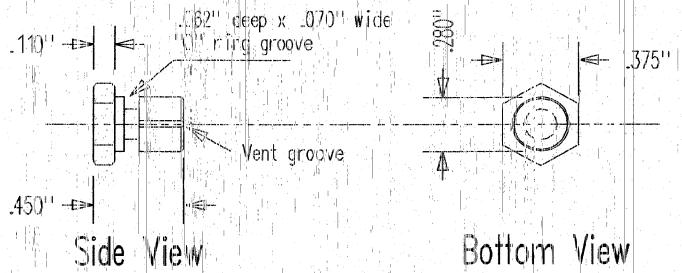




Assembled Lubricator



Crankcase Vent Cap



Radiator Cap

All parts are brass unless otherwise specified.

Misc. Small Parts

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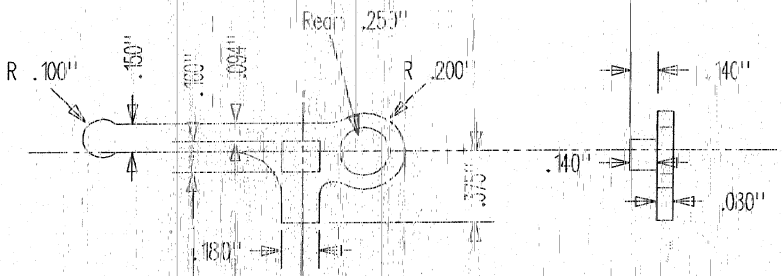
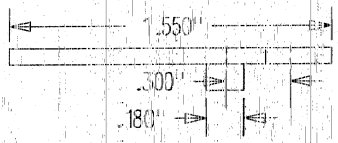
Project: "Bill" - 1906 Four Cycle Gas Engine

Sheet # 14 | Date: 07/08/02 | By: Jerry E. Howe



Side View

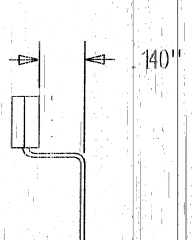
End View



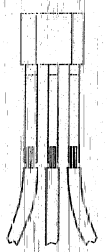
Top View

Timing Advance Arm

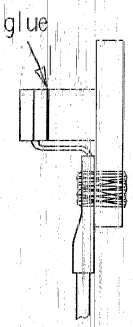
Material: Delrin



Bend Hall Sensor leads to fit arm



Solder wires to the Hall sensor leads



Install heat shrink tubes and bind Hall leads to arm tab with thread and soak with your favorite glue.

Use the smallest stranded wire you can get.

Hall Sensor/Timing Arm Assembly

The "Bill" engine was designed to use the TIM-6 transistor ignition module and a Hall effect sensor m
If you have aversions to electronics, you can use mechanical contacts of your own design instead
would recommend the mounting of a tiny arm type micro switch such that the arm is activated b
keep the dwell time as short as possible with this set up. I am sure you will be able to take it from h
speed the TIM-6 circuit because mechanical switch contacts can't handle the current draw of an ignition coil
long before they fail. TIM-6 takes care of that problem though.

Use super glue or epoxy to mount the magnet in place on the cam gear. As noted below, the center
is 4 gear teeth clockwise of the magnet. The drawing is looking at the cam gear from the engine side

Spread the leads of the Hall sensor apart in rows for ease in soldering the wires to them. Use as s
wire as possible and hold each lead with needle nose pliers or heavy tweezers as heat sinks dur
prevent heat damage to the sensor. The wire I use is .018" diameter and is .040" diameter over the
Radio Shack or other electronic stores should have this.

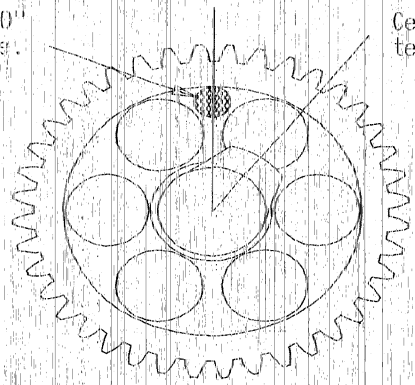
Cut the heat shrink tubing that I include in the TIM-6 kit in thirds and slide them up the Hall sensor wi
solder joints and shrink them on with a little heat from a lighter flame while being careful not to allow
sensor to get hot. Wind a layer or two of common sewing thread around the leads as shown and so
glue.

When Delrin is reamed, the hole will be a tad on the small side which will make the arm a friction
Post Reaming. Push it up against the engine crankcase. The arm requires no retainer or anything
wherever you position it. Raising the arm advances the timing and lowering the arm retards it. Route
and away from the engine and allow a small amount of slack in the wire for bending as the timing
and exit the wire through an appropriate hole in the engine base. Make sure the wire will not be ab
the cam gear.

Don't forget to provide a ground wire from the engine frame to either the coil or the circuit board
directions included in the kit. Failure to do so will result in the high voltage of the coil spark to find its
coil through the Hall sensor which will destroy it.

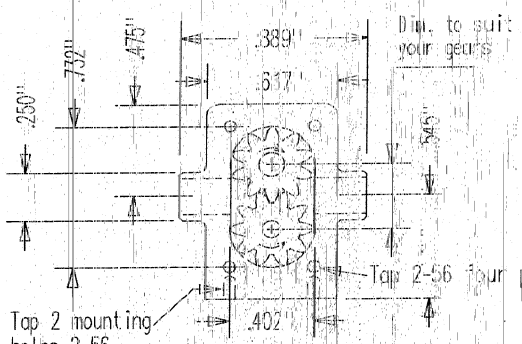
You will find that once properly installed, a Hall Effect sensor pick up will last almost forever and re
adjustments.

Epoxy glue .080" dia. x .040" thick rare earth magnet here.

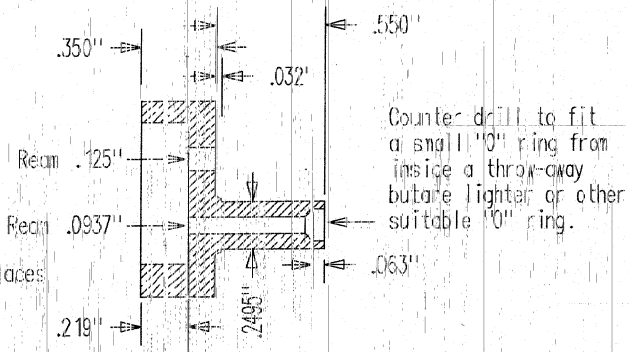


Center of cam i
teeth clockwise

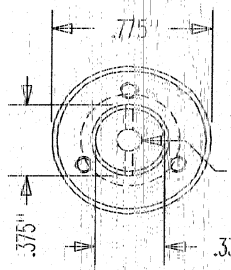
Jerry E. Howell 3980 Becket Drive Colorado Springs, CO 80906 Model Project Plans & Kits	Project: "Bill" - 1906 Four Cycle Ga		
	Sheet # 15	Date: 06/20/02	By: Jer
	© Copyright 2002 by Jerry E. Howell - All rig		

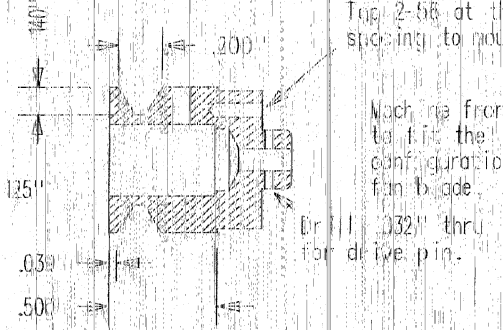


Rear View

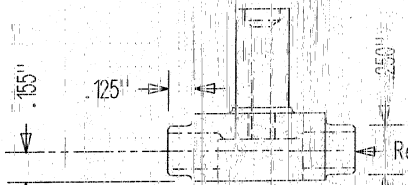


Side View





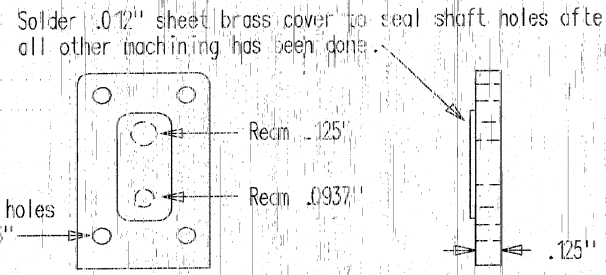
Fan Hub Material: Black Delrin



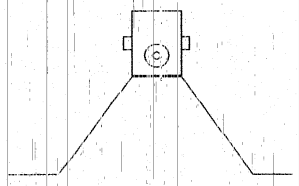
Top View

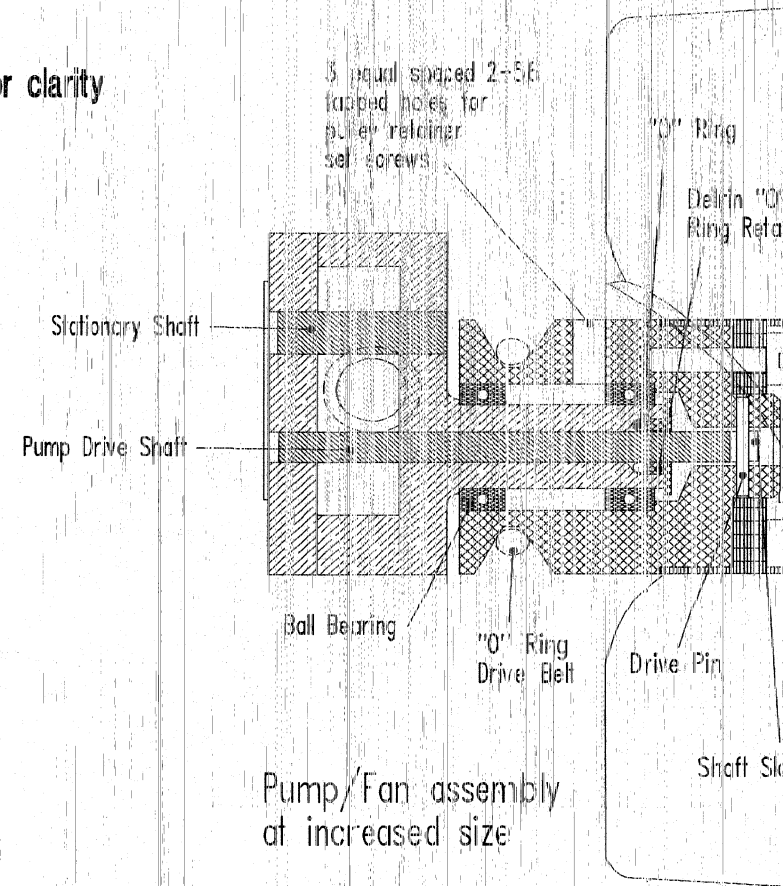
Gear Pump Body Material: Brass

Some hidden lines omited for clarity

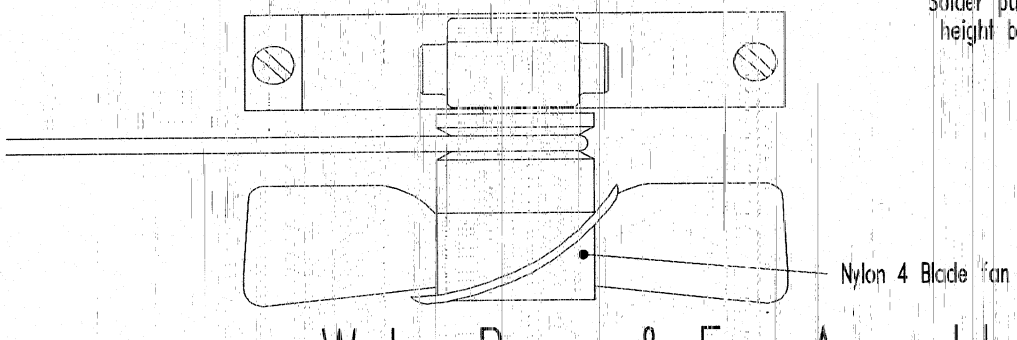


Pump Cover Material: Brass





Pump/Fan assembly at increased size



Water Pump & Fan Assembly

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Project: "Bill" - 1906 Four Cycle Gas E

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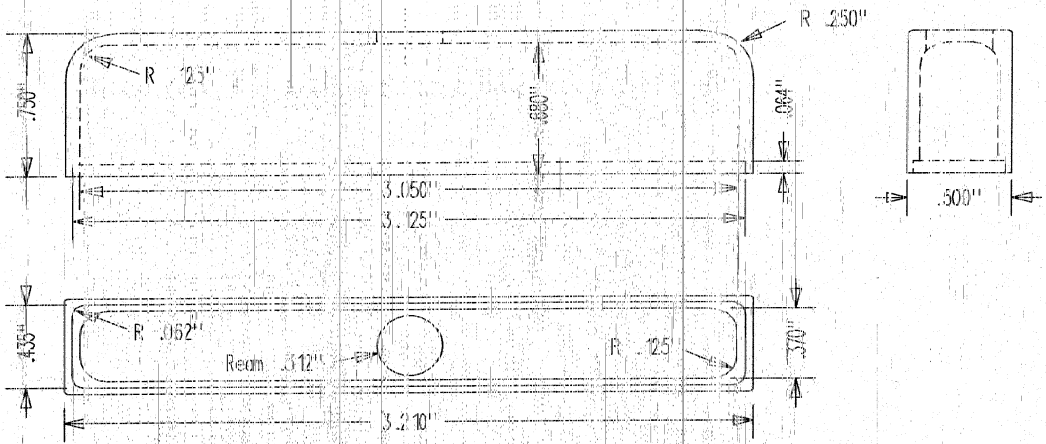
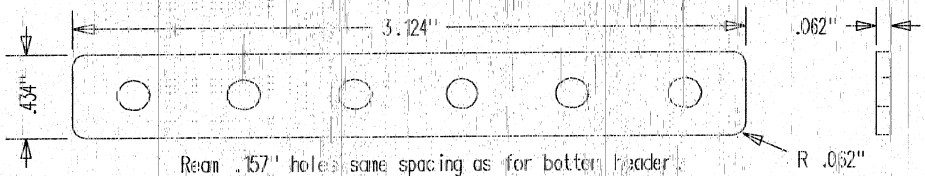
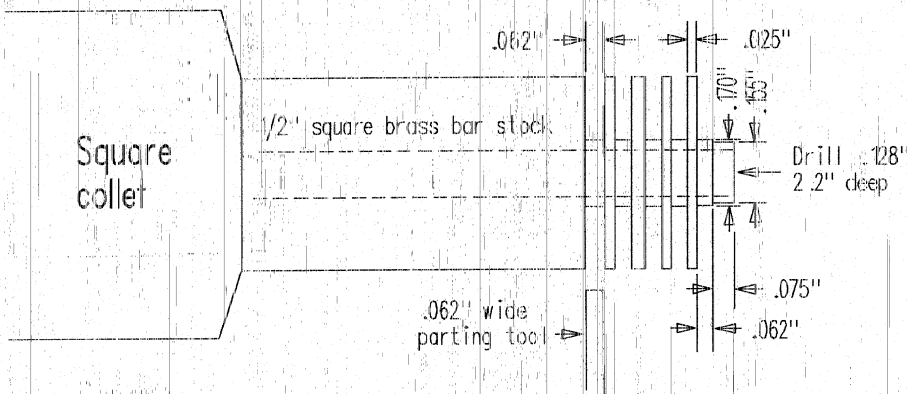


Expansion Tank Header

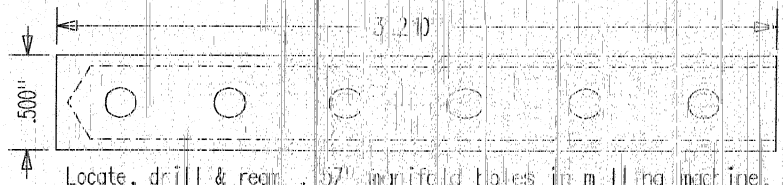


Expansion Tank Floor

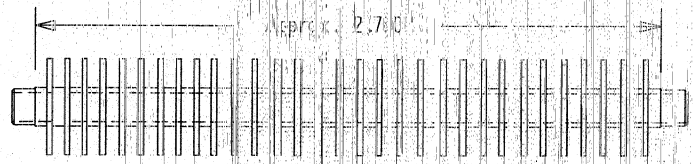
Note -- All parts are brass stock



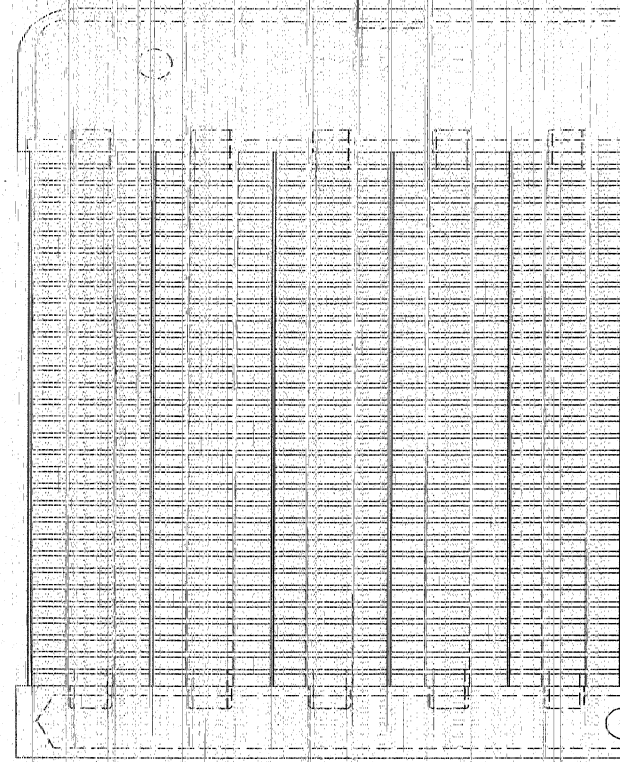
Radiator



Botton Header



Finned Core Strip



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Project: "Bill" - 1906 Four Cycle

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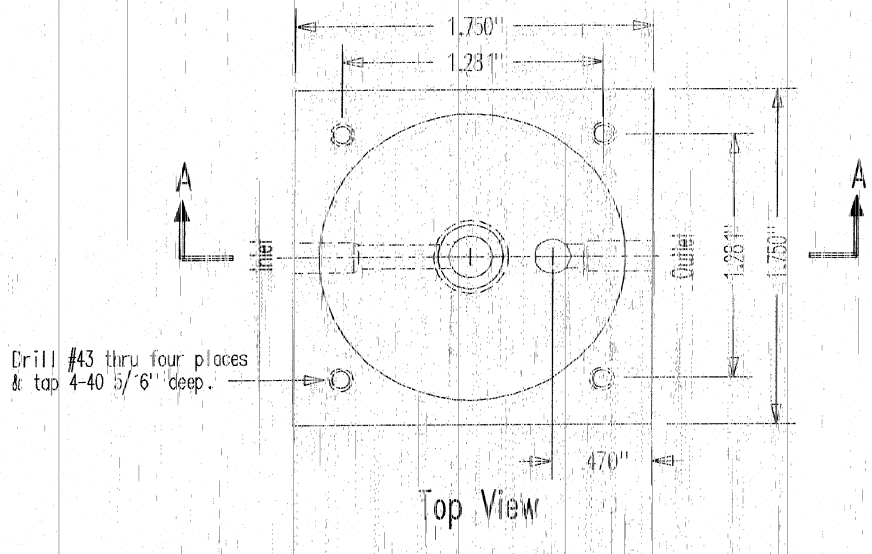
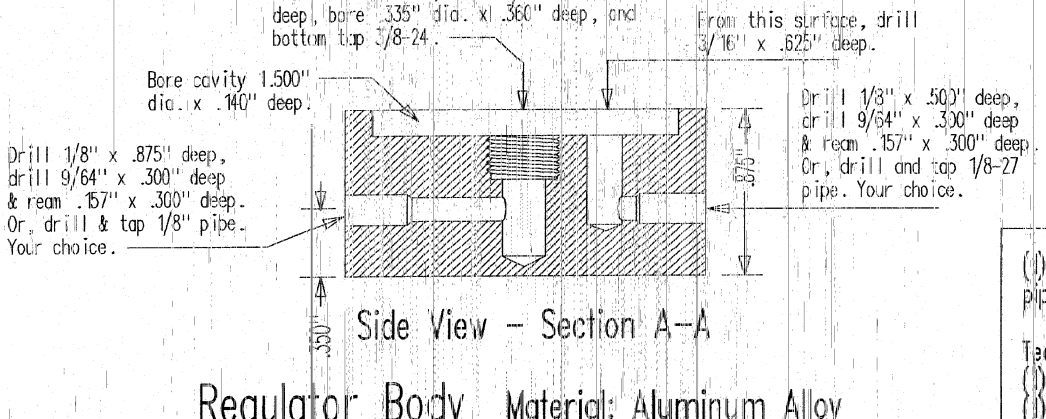


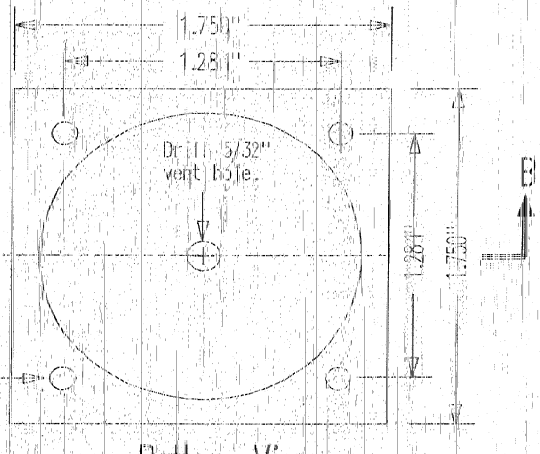
Top View



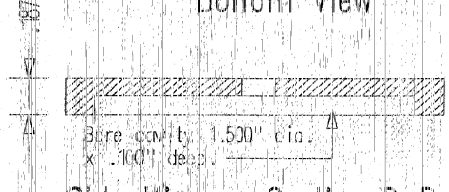
Side View - Section A-A

Regulator Body Material: Aluminum Alloy

Hose Bib (2) Material: Brass Hobby Tube



Bottom View



Side View - Section B-B

Diaphram Cover Material: Aluminum Alloy

(1) Pressure Regulator such as the Coilhose Pneumatic MR1 or other miniature regulator for 1/8-27 pipe thread connection available from MSC, J&L or other industrial supply houses.

Tecumseh Engine Carburetor Parts:
(1) Spring, Needle, Gasket & Seat Assy. #630932A.
(1) Diaphram and Gasket Set #630978.

Assembly: Install the hose bibs using Loctite sealant. With the body upright, put the spring, needle & gasket in the center hole and screw in the brass seat. Lay the diaphram on the body with the meta disk side down. The diaphram gasket is really not needed. That is up to you. Mount the diaphram cover using four 4-40 screws. Pressurize the unit and submerge under water to check for leaks.

Operation: The pressure regulator MUST be mounted directly to a propane torch head such as the Bernz-O-Matic, Turner, etc. Using a pressure gauge, set the pressure regulator output to from 1 to 3 PSA maximum. Silicone tubing with 1/8" bore available at most hobby shops can be used between the regulator and the demand valve and from the demand valve to the engine. Keep hose short.

Propane Demand Valve

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Project: "Bill" - 1906 Four Cycle Gas Engi

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Construction Notes

1906 [illegible] 4-Cycle Gas Engine

For a current full color catalog showing all of my model project plans and kits, visit my large website at www.jerry-howell.com

General - If you have never before built small engines, I recommend that you first gain some experience with a few bar stock steam (compressed air) engines and the first-time [illegible].

These are notes on how I made some of the parts for my engine that may be of help to you in building your engine. This is not intended to be a complete step by step A to Z construction article.

Please read all these notes before making any parts. References to "Loctite" is the high strength 609 variety for sleeve, bearing and stud mounting.

The small zip lock poly bag with the plans contains: (1) 1/32" "O" ring to seal the water joint between the head and the cylinder, (1) crankcase vent check valve disk, (1) friction valve washer for the throttle.

Crankcase - 2 - I made my crankcase from a round solid. You could use heavy wall pipe with an end soldered in.

Two short base ribs are on Sheet #4. Soft solder the three ribs on the Base Plate. Machine the ribs to the dashed line to match the radius of the Crankcase. Then drill through the ribs using the base plate as a drill jig. Position that assembly on the crankcase and drill through the base at the front and rear holes only, for now. Tap these two case holes 4-40. Open up these two holes through the base assembly with a #33 drill. Mount the base assembly to the crankcase using two 4-40 panhead screws and do the same procedure for the two side screws. With the screws all in place, solder the base assembly to the crankcase. To prevent oil seepage at the screws, reinstall them with plenty of thread sealer (Loctite) on the threads.

Now, using the base as a reference you can accurately machine the hole for the Cylinder Flange. On a truly flat surface and with the crankcase on it's base, arrange two stacks of 1-2-3 blocks - parallels, etc. fore and aft of the crankcase so that two metal rails can be places across them - one on either side of the neck of the cylinder flange. The parallel stacks need to be adjusted in height so the top of the cylinder flange is the proper height during propane torch soldering. This procedure insures the cylinder flange is perpendicular to the base and the crankshaft.

Be careful drilling for the six 4-40 screw holes so as not to drill through to the inside. This prevents oil from seeping out along the screw threads. The drawing shows a 5/16-24 thread for the crankcase vent. If you have a finer pitch tap, use it. I had a 5/16-40 tap that I used on mine.

Cylinder - 5 - Before you machine the cylinder, be sure you can get some thin wall 1.750" OD brass tubing or you have brass stock large enough in diameter to make your own tube. The cast iron cylinder liner is a slip fit inside the brass cylinder and is installed using Loctite. Solder the Water Inlet Fitting on the water jacket [illegible]. The water jacket tube is also installed using Loctite.

Cylinder Head - 6 - The brass Water Passage Cover is sweat soldered to the underside of the head and then the five bolt holes are drilled through the cover using the head as a drill guide. Set the water hole in the cover in the proper position before soldering. When drilling the horizontal water passage, be careful not to drill into the bolt hole.

Pump Arm Assembly - 8 - Turn the tapered arm with excess on both ends. Heat to red heat with a torch and bend the arc. Cut the arm to proper length and silver solder the Pump Rod end and the Pivot End onto the arm. Be particular that all is lined up properly with no twist. Upon assembling the roller pin (from the back side) a tiny amount of Loctite will keep the roller pin in place.

Crankshaft - 9 - Using the Crankshaft Balance Weights as drill guides, drill and tap the crankshaft cheeks 4-40 and mount them to the Crankshaft with two 4-40 socket head cap screws. For added insurance, drill the two .093" holes into the shaft cheeks about 3/16" and press in roll pins. Bill uses (2) .375" ID x .875" OD x .281" thick ball bearings on the crankshaft. These are known in the bearing industry as R6-2Z bearings.

Pulley - 10 - Make your pulley to suit whatever it will be used for. Keep the hub thickness to the .510" dimension. The pulley is mounted onto the Pulley Hub with Loctite.

Connecting Rod Bearing - 10 - Drill and ream the big end rod hole 3/12" after both halves are bolted together and being sure the hole is perpendicular to the bearing body.

Piston Rings - 11 - I made the piston rings for my engines based on the Strictly I.C. magazine article but limit heat treat to 900 degrees F. I used three .062" wide rings of .043" wall thickness and machined the ring grooves to suit. If you don't want to make your own rings I would suggest that you use the very excellent and very reasonably priced rings from Otto Gas Engine Works.

Flywheel - 12 - My flywheel is stainless steel. If you are like many builders you don't like to machine stainless. If that is the case, I would suggest you use a leaded steel (12L14) because it turns almost as easy as brass. Don't use aluminum as it is not nearly heavy enough to carry the engine over compression at lower RPM's.

Throttle - 13 - The Gas Jet Tube is installed in the Throttle Barrel with Loctite. The fuel jet holes are centered in the air passage and with the jet holes 90 degrees to the air flow direction.

Dummy Lubricator - 14 - Again, the Dummy Lubricator is assembled using the ever popular Loctite!

Crankcase Vent - 14 - Lay the check disk (supplied) on the body and install the cap. If the cap is too loose a fit, squeeze the skirt together a tad at the saw cut.

Water Pump & Fan [illegible]

[illegible]

Radiator [illegible]

[illegible]

The Water Inlet tube should [illegible]

[illegible]

The fan will pull a lot more [illegible]

[illegible] pump shaft and gears lubr[illegible]

Operation - The 1906 [illegible] engine. Not a high speed [illegible] and will easily power an ap[illegible] at around 1,000 RPM or so.

I can supply the 1/4-32 sp[illegible] module kit and a model eng[illegible] www.jerry-howell.com

I use 6cc of 10w-30 motor [illegible] about 5 full shots from an [illegible] you want the oil level to [illegible] crankshaft counterbalance [illegible] by the connecting rod, but [illegible] throw too much of it into th[illegible] work out the crankcase ve[illegible] some oil out the exhaust an[illegible] occurs, keep an eye on the [illegible] check valve, when working [illegible] easily escape the crankcase [illegible] on the up stroke which cau[illegible] That prevents oil from wor[illegible] quit spitting oil out the exha[illegible] oil after every 10 hours of op[illegible]

Jerry E. Howell 3980 Becker Drive Colorado Springs, CO 80906 Model Project Plans & Kits	Projec[illegible] Sheet [illegible] © Co[illegible]