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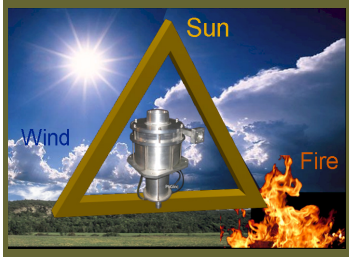

NEW TURBINE WORKSHOP

Lesson 3

Turbogenerator Construction

Case Construction

Ken Rieli, Instructor

Now that we have the most critical part of the engine built, it's time to move on to case construction. We'll start with a couple of easy parts, and then move on to the more detailed assemblies.

Case Spacers

Let's begin by opening up the Turbogen Web to the DIY 7" Tesla Turbogenerator/Drawings section. Click on *#19 - Case spacer*.

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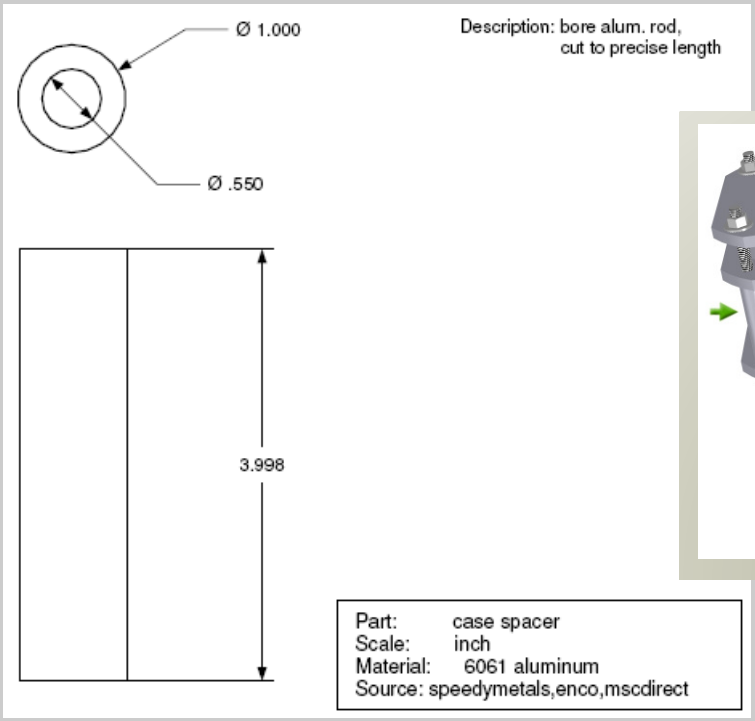

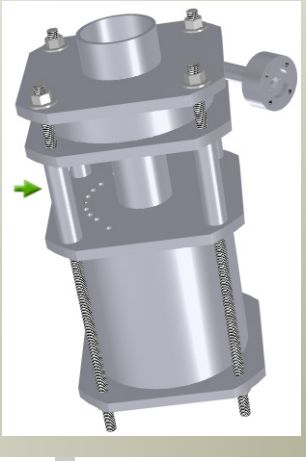

Figure 1 Case spacers

Materials you will need:

6061 aluminum round rod	(4) 1" diameter x 4.25" long
Standard aluminum tubing	7"ID x 7.5"OD x 8" long
Standard aluminum/steel tubing	7"ID x 7.5"OD x 1.844" long
6061 aluminum plate	(4) 9" x 9" x ½" long
6061 aluminum round rod	3 ½" diameter x 2" long

Step-by-step:

- Cutting & boring case spacers
- Lower case ring
- Inlet ring, boring a tangential hole
- Bottom plate
- Boring, drilling & tapping stator plate
- Lower hot rotor plate
- Top plate & outlet

(Continued from page 1)

There are four case spacers that help stabilize the mid-section of the engine and keep the bearings and shaft assembly aligned with the rest of the case.

Cut four (4) pieces of 1-inch aluminum rod to 4.25" long. (We'll trim these later.) Bore each piece of rod down the axial center with a 0.55" drill bit. – Set these (4) pieces aside for now.

Lower Case Ring

Next, click on drawing *#24 - Lower case ring*.

We see a piece of standard aluminum tubing 8 inches long, and turned on the lathe to slightly over 7" I.D. and slightly under 7.5" O.D.

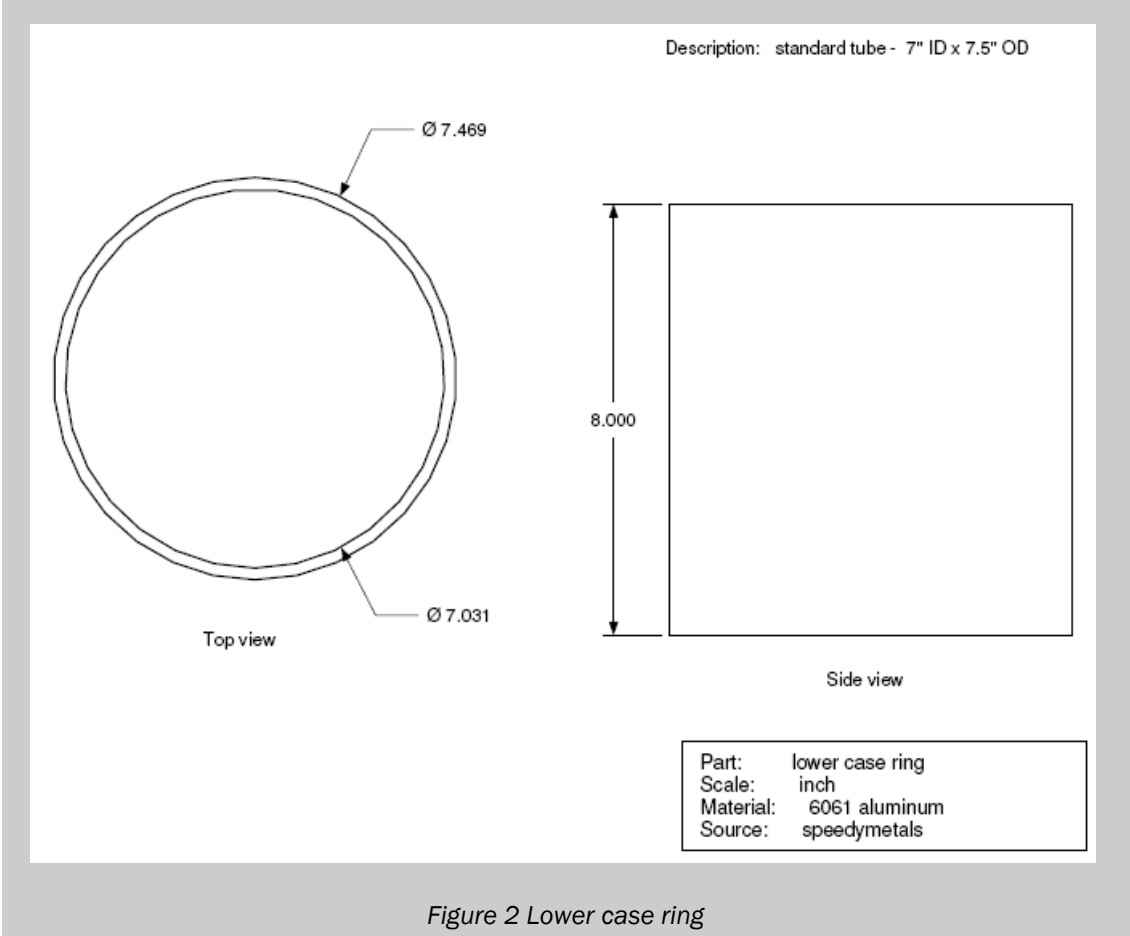

Figure 2 Lower case ring

What I do to minimize the amount of material I have to remove is to first true up the tubing shape. Most tubing is manufactured out-of-round. I use a shop press (usually my mill) to compress the outer diameter that is the largest dimension, pushing down slightly past the 7.5" mark, letting it spring back to exactly 7.5" diameter.

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Use a caliper to measure across several points of diameter, and repeat the ramming or compressing process until the tubing is as close to round as you can get it. Only then do you want to chuck the tubing in the lathe or mill and turn it down to a perfectly symmetrical part.

Make sure you start with a piece of tubing a little over 8" long so you can cut across the diameter with a lathe bit to square off the ends. Set this finished piece aside.

Inlet Ring

Next, pull up the *#23 - Inlet ring (sheet a)* and *(sheet b)*.

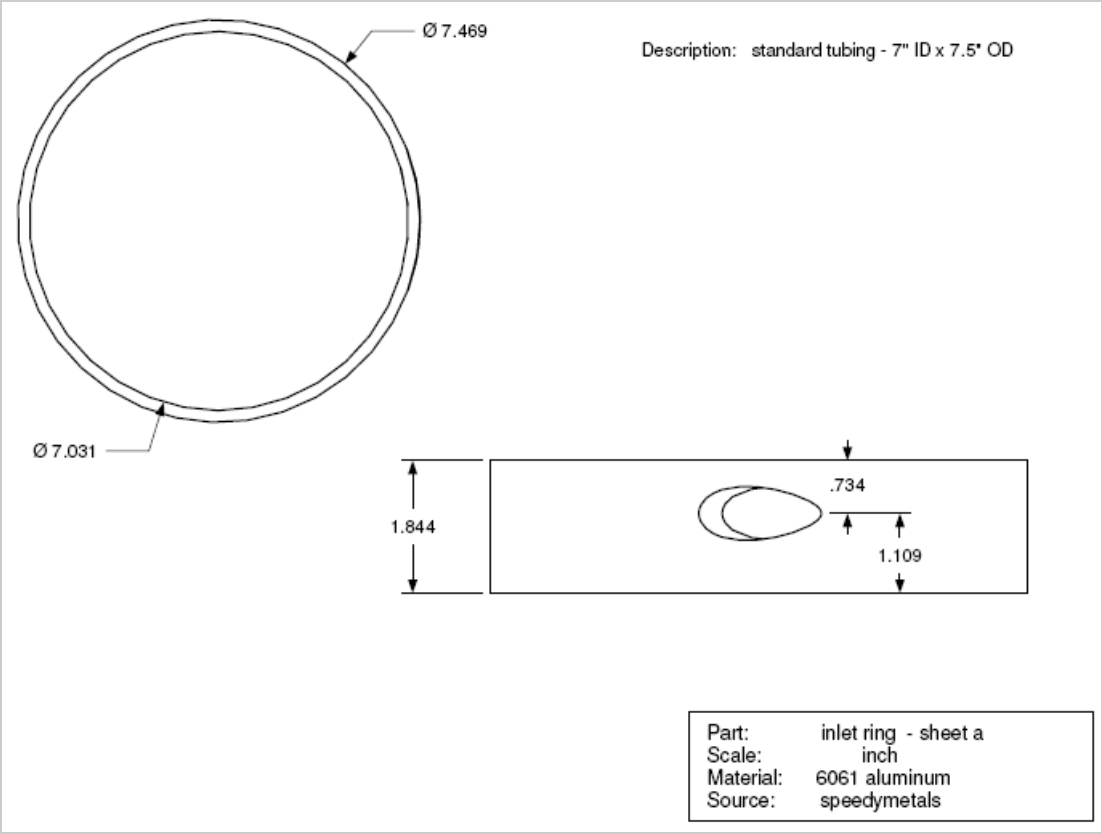

Figure 3 Inlet ring sheet-a

This is another piece of 7" x 7.5" aluminum or steel tubing, cut and trued up to 1.844" length, and bored with a 0.75" end mill at a 0.734" offset.

The best way to bore this hole is to clamp the tubing flat to the mill table and use a horizontal mill head.

NOTE:

Take note that this is a tangential boring process that is offset about 0.125" from the outer diameter.

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If you don't have a horizontal mill, simply clamp the tubing upright in a heavy milling vise and slowly cut down from the top, or in from the side – ending 0.125" in from the outer diameter. The tangential hole can be bored before or after truing the diameter and finishing it to the noted I.D. and O.D. Set this part aside.

Case Plates

Let's move on to machining the case plates. There are (4) plates in this engine, held together in alignment with (4) case rods that run the entire length of the engine. Each of the case plates has (4) corresponding holes bored in its (4) corners to allow the rod to pass through the plate – so these corner holes are exact and common to all of the plates. The rest of the plate features are unique to each plate.

All (4) plates have the same outer profile dimensions. I usually cut the plates at 9" x 9", then square them together on the mill to the finish size of 8.75". Since I true-up the faces on my lathe, batch finishing the outer edges is faster.

After finish squaring the edges, locate the center of each plate by scribing diagonal lines, corner to corner.

NOTE:

If you use a fly cutter or face mill to finish the faces, you could also cut the edges one at a time on the mill. If you have a CNC mill, this may be the preferred procedure.

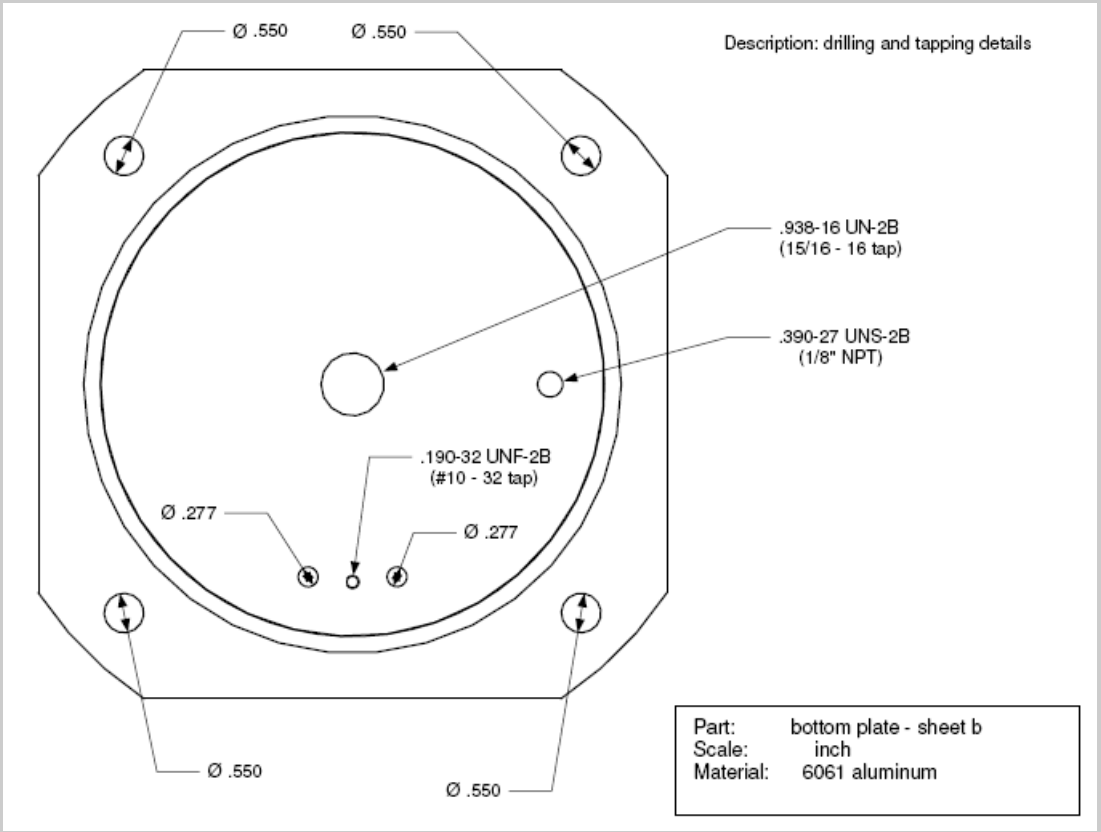

Figure 4 Bottom plate sheet-b

Mount one of the (4) plate blanks in an 8-inch 4-jaw chuck on the lathe. Most 4-jaw chucks have independent jaws so you can drift the work piece to align its center with the lathe tailpiece exactly.

I also mount the work piece with a spacer, to hold the plate slightly proud of the chuck jaws, so I can run a lathe bit across the face to true it perfectly flat.

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Although you can use a mill to true up the face, I like using the lathe for this first operation.

After truing the front and back faces, I cut the corner radii. Since the chuck jaws hold the work piece on its flat edges, a lathe bit will usually just clear the chuck jaws when rounding the corners.

Bottom Plate

Open *#18 – Bottom plate sheet-b*.

We'll begin detail operations by boring a 0.79" center hole. Use a 15/16 (0.938)-16 tpi tap to finish the hole.

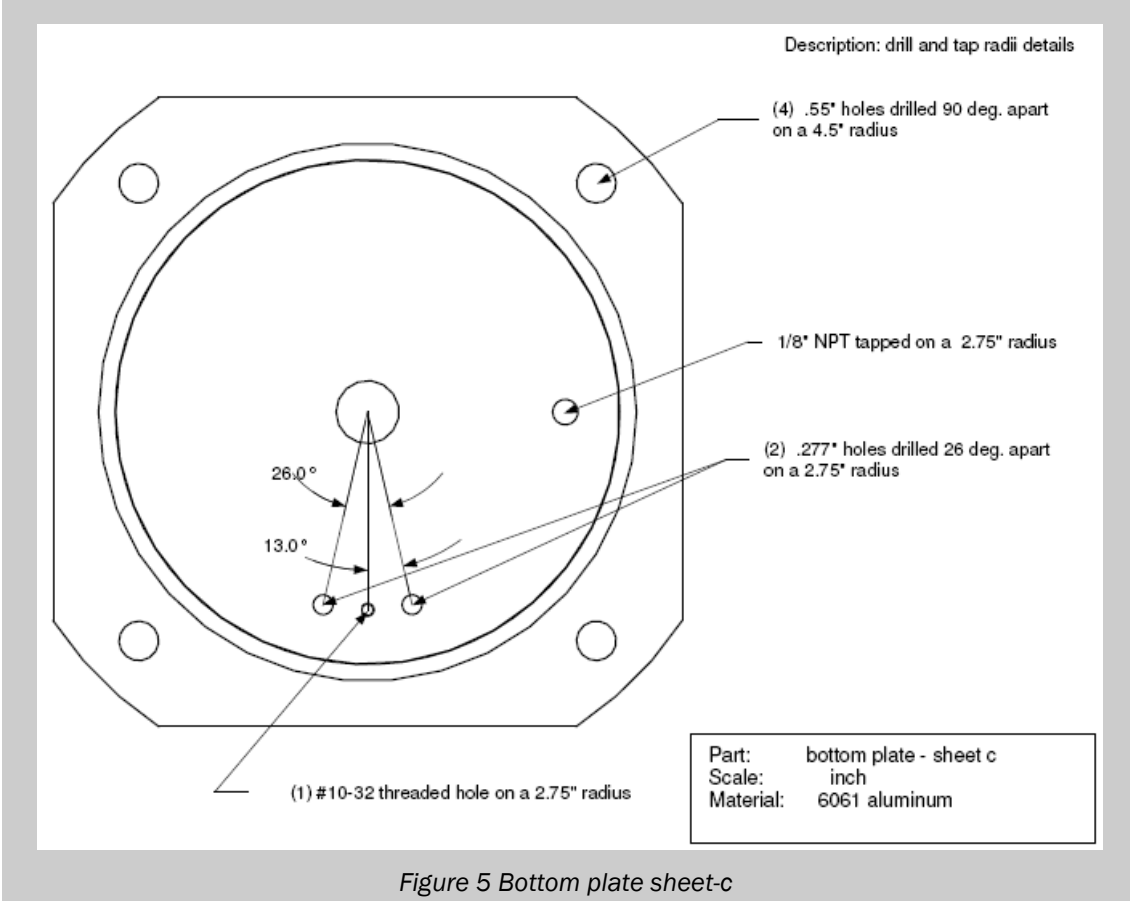

Figure 5 Bottom plate sheet-c

Next, open *Bottom plate sheet-c*. With the lathe turned OFF, move the lathe cross-slide and position the point of the lathe bit 2.75" from the center.

Spin the work piece at about 200 rpm and move the lathe bit into the work piece just about 0.032" – just enough to make a circular mark. This is the radius for the (4) smaller holes.

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Again, *with the lathe shut down*, move the bit out to a 4.5” radius; power up the lathe and mark the 4.5” radius – this is for the corner holes.

Finally, mark the work piece at 3.5” and 3.75” radii, with the same procedure.

Open *Bottom plate sheet-d*.

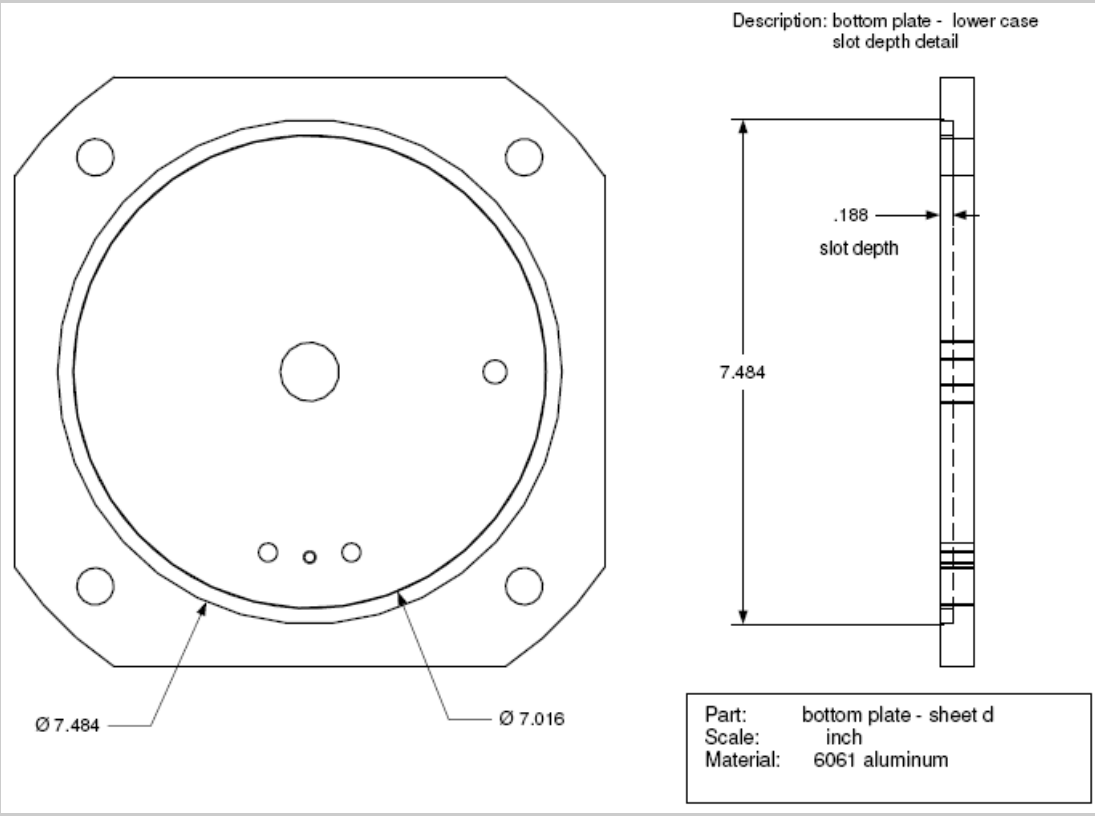

Figure 6 Bottom plate sheet-d

We see on this drawing that the slot for the lower case tube is cut 0.188” deep. Using a chisel-nosed lathe bit, cut out the material between the 3.5” and 3.75” marks to the indicated depth of 0.188”.

Remove the work piece from the chuck. Mark & drill the holes as indicated in *Bottom plate sheet-c*.

Notice that the #10-32 threaded hole is bored with a #25 (0.148”) drill bit and threaded with a #10-32 tap.

NOTE:

Make sure this lower case ring slips easily into the slot without binding.

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Stator Plate

Let's move on now to the stator plate (drawing *#29 - Stator plate sheet-a, b, c, d*).

After finish facing and cutting the corner radii, same as the bottom plate, bore a 1.875" hole in the center of the plate (*sheet-a*).

Drawing *sheet-c* indicates the radii markings for the remainder of the holes. As with the bottom plate, move the cross-slide and use the marking lathe bit at 2.75", 3.09375", 3.5", 3.75", and 4.5" to mark the face of the plate.

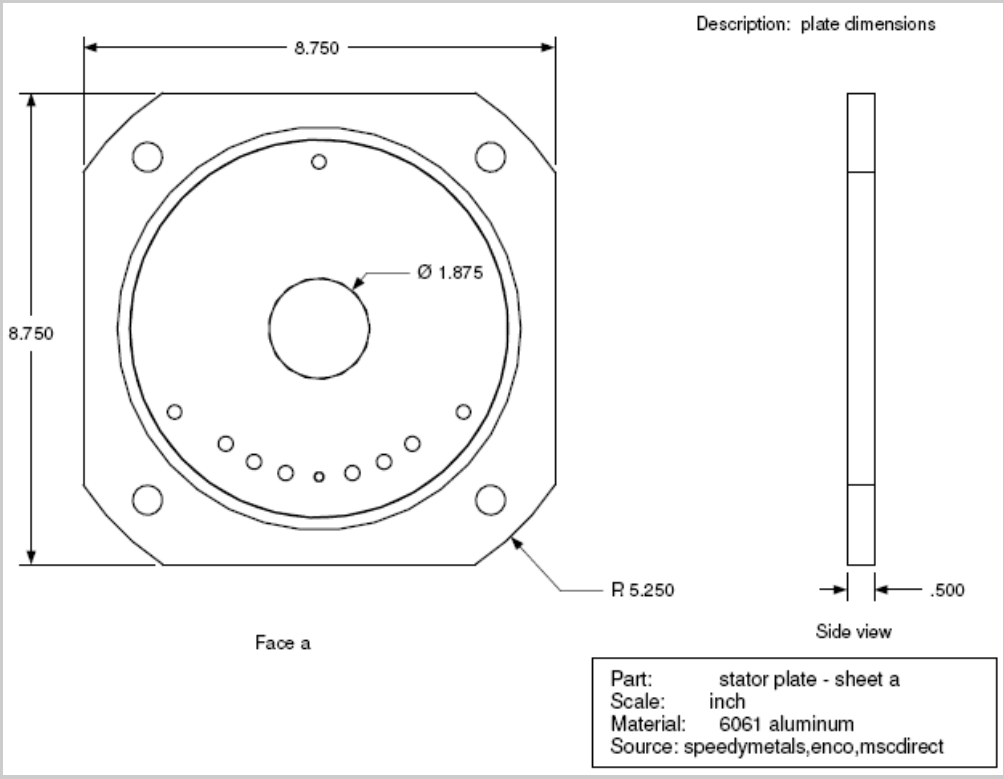

Figure 7 Stator plate sheet-a

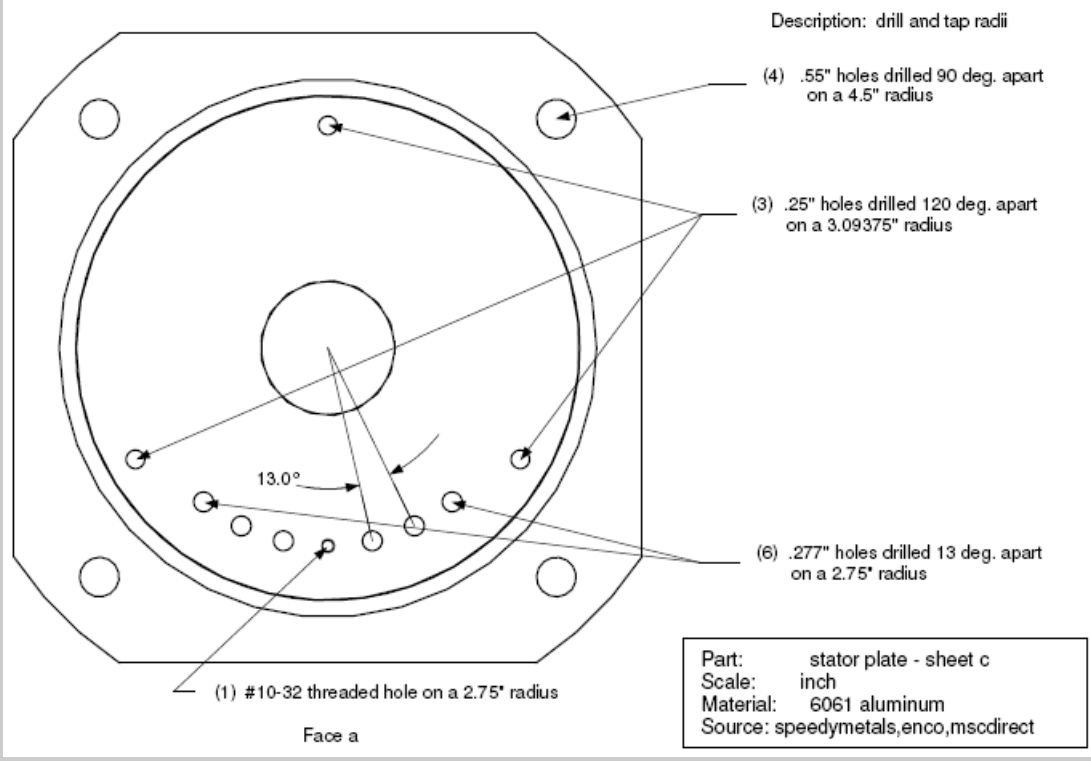

Figure 8 Stator plate sheet-c

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Again, use the chisel bit to remove material between the 3.5” and 3.75” marks – down to a 0.188” depth. Check the lower case tube fit. It should slip into the slot without binding.

Remove the work piece, mark and drill the holes exactly as indicated. Notice the #10-32 threaded hole; drill first with a #25 bit, then finish thread.

Finally, mount the work piece on a mill rotary table – lower ring slot face down. Cut a slot for the bearing case as indicated in drawing *sheet-d*. Check for a slip fit using the bearing case.

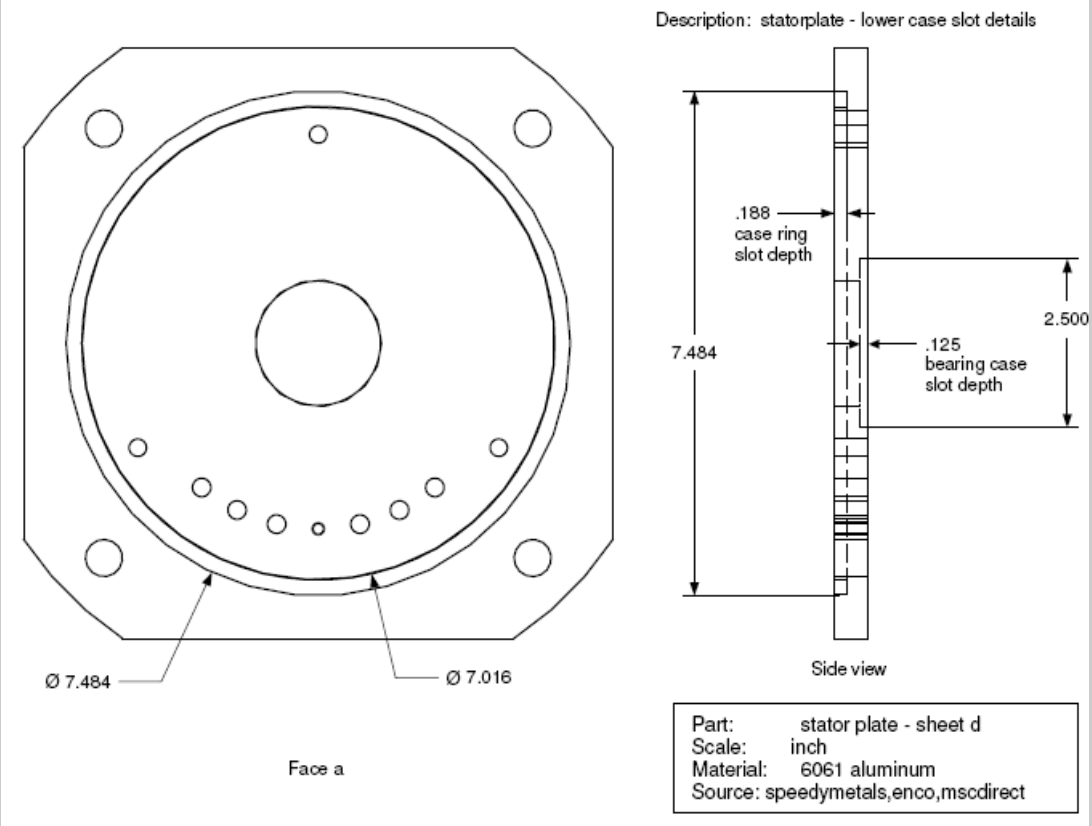

Figure 9 Stator plate sheet-d

Lower Hot Rotor Plate

Moving on to the Lower Hot Rotor plate (drawing #25 - *# Lower hotrotor plate sheet-a, b, c, d*), we can again face and corner cut the next blank – same as the previous 2 plates. Also, bore a 1.875” center hole.

Again, use the marking bit to mark radii at 1.125”, 2.1875”, 3”, 3.5”, 3.75”, and 4.5” as shown in *sheets b and c*.

Next, cut a slot (working from the center hole out) 0.063” deep, out to the 1.25” radius mark as indicated in *sheet c*.

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Cut the upper case ring slot between the 3.5” and 3.75” radii marks to a depth of 0.188”. Check for a slip fit using the upper case ring (inlet ring).

Remove the work piece, drill and tap the holes as indicated on *sheet b*.

The (3) #10-32 holes are predrilled with a #25 bit, then threaded with a #10-32 tap.

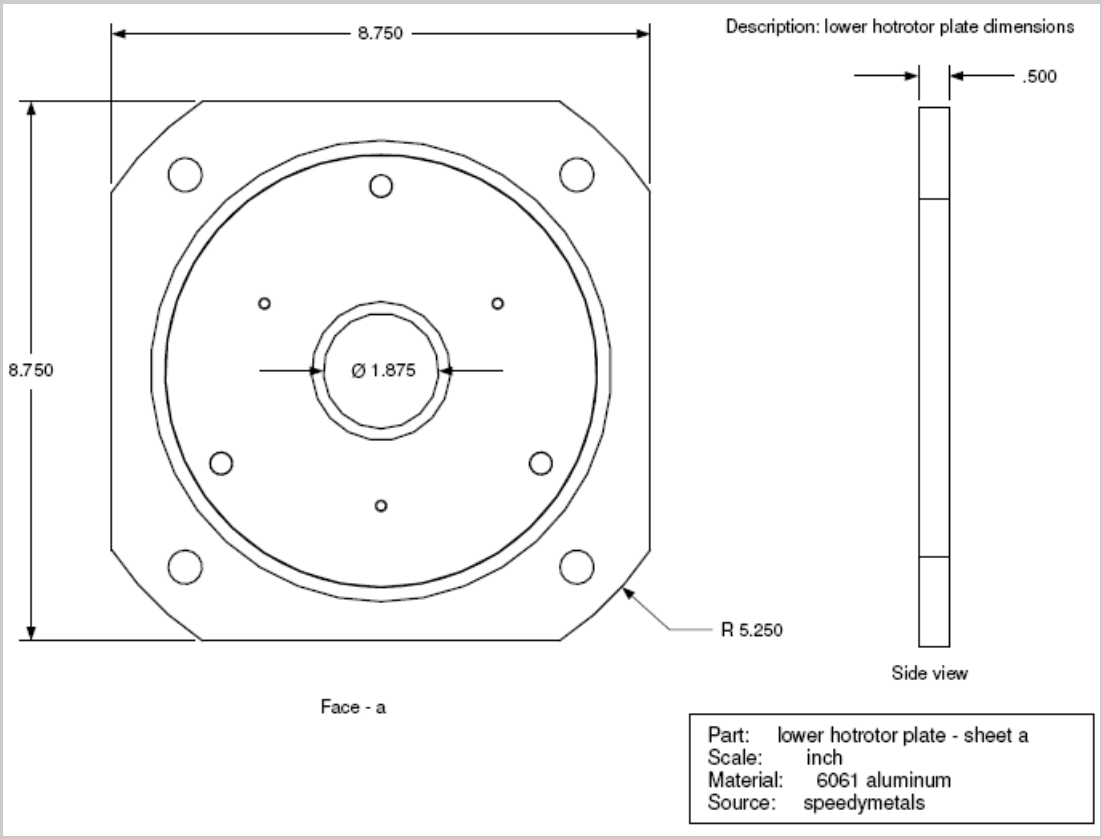

Figure 10 Lower hotrotor plate sheet-a

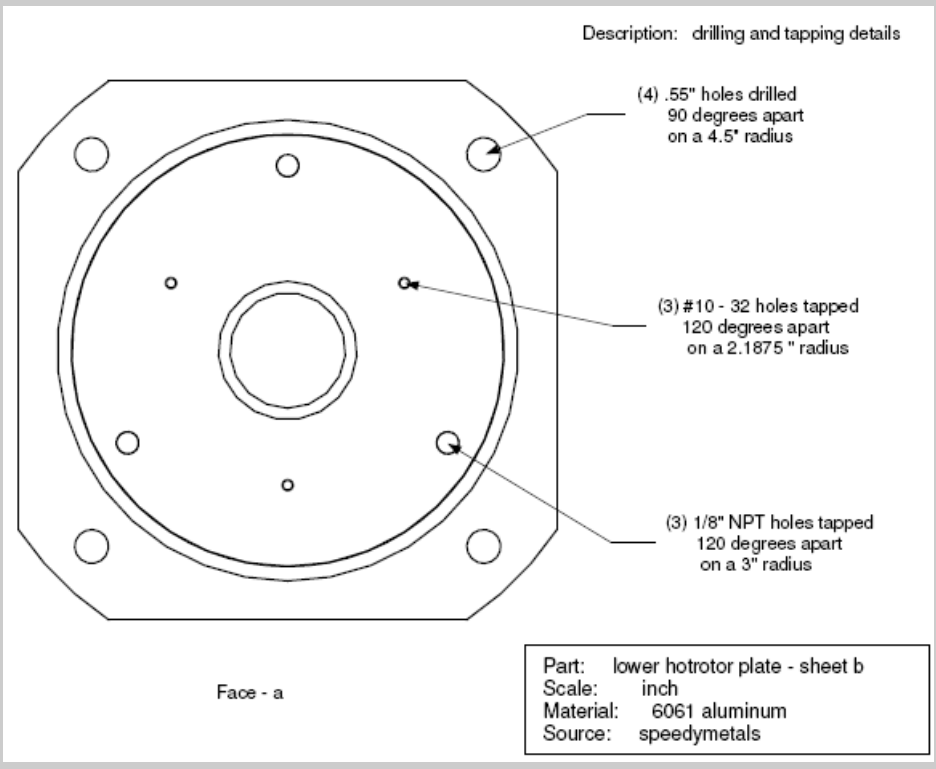

Figure 11 Lower hotrotor plate sheet-b

The 1/8” NPT holes are predrilled with a 0.3125” bit, then threaded with a 1/8” tapered pipe tap.

The final operation for this plate is the same as for the stator plate:

- Mount the plate on the rotary mill table, inlet ring face down.
- Mill a slot from the inner hole out to a diameter of 2.5”, and a depth of 0.125”.
- Check for a slip fit using the bearing case.

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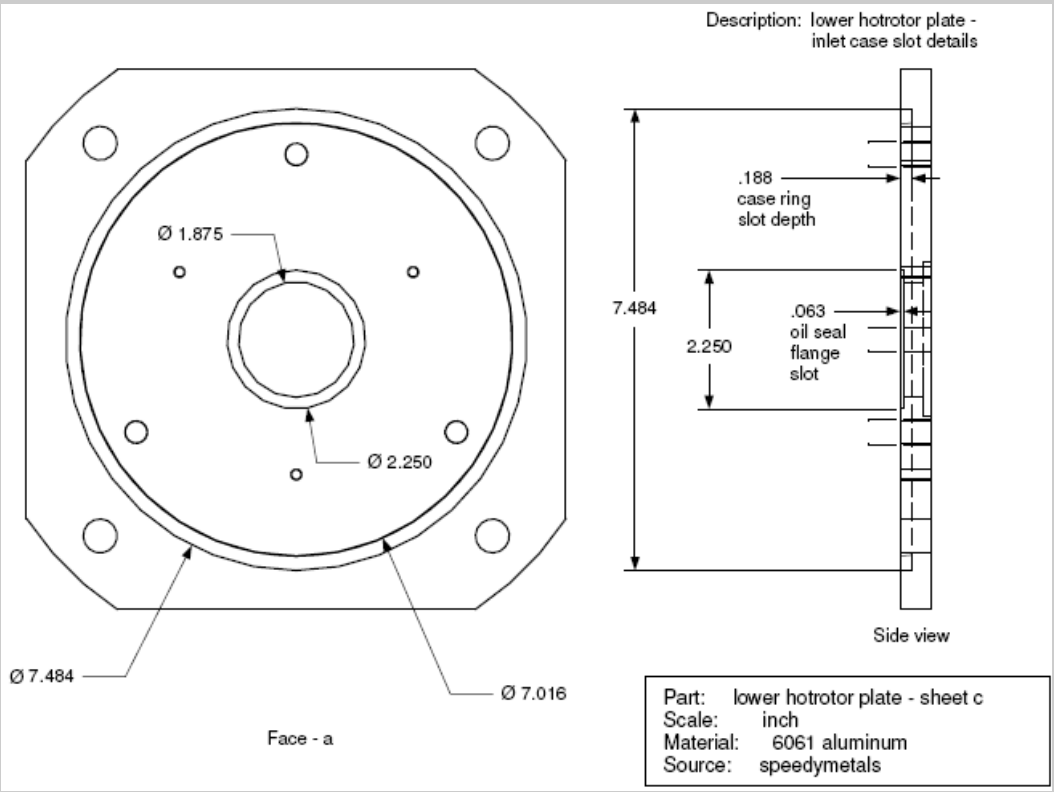

Figure 12 Lower hotrotor plate sheet-c

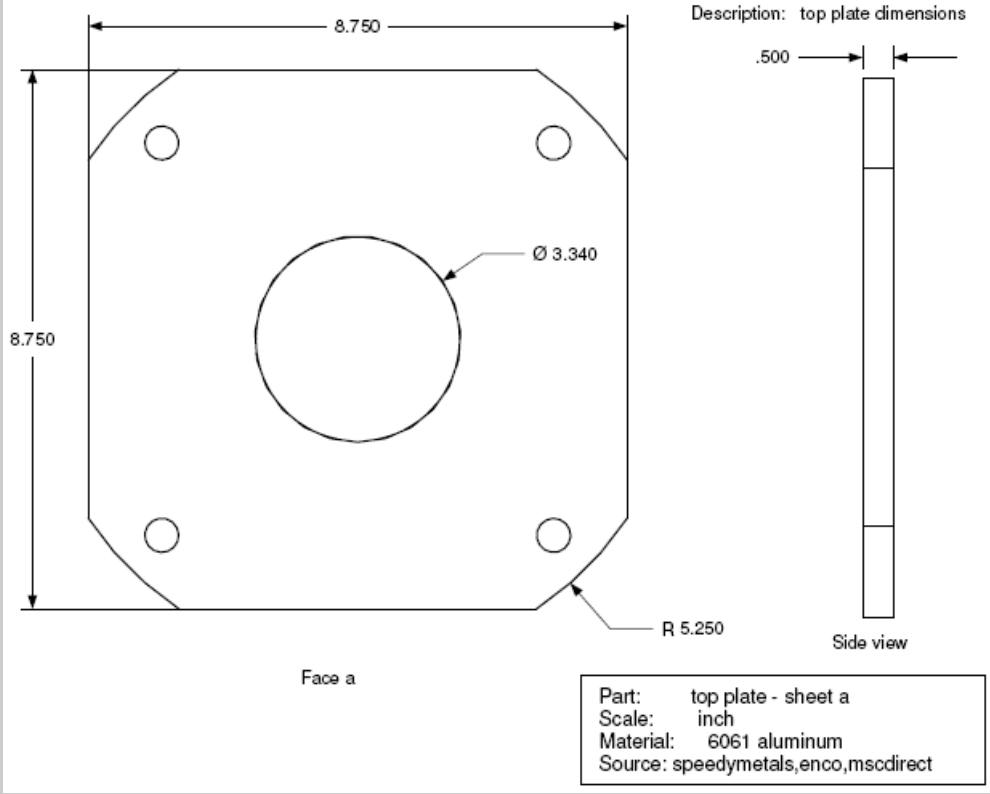

Figure 13 Top plate type 1 sheet-a

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Top Plate

Moving on to the Top Plate, pull up drawing *#31 - Top plate type 1 sheets-a & b*, and *#27 - Outlet, type 2 sheets-a & b*.

Begin by finishing the front and back faces, and round off the corners just like the other 3 plates.

Next, bore a 3.34” diameter center hole as in *#31 sheet-a*. Use the cross-slide marking bit to scribe a mark at the 4.5” radius for the (4) corner holes – as shown in *sheet-b*.

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Pulling up *sheet-c*, we see (2) slots in the drawing. Use the marking bit to scribe marks at 1.74", 3.5", and 3.75" radii.

Use the chisel lathe bit to cut the slot between the 3.5" and 3.75" marks – to a depth of 0.188".

Cut the final slot from the inner bore out to the 1.74" mark, 0.25" deep. Check the inlet ring slot for fit.

Take the work piece out of the chuck, mark and drill the corner holes.

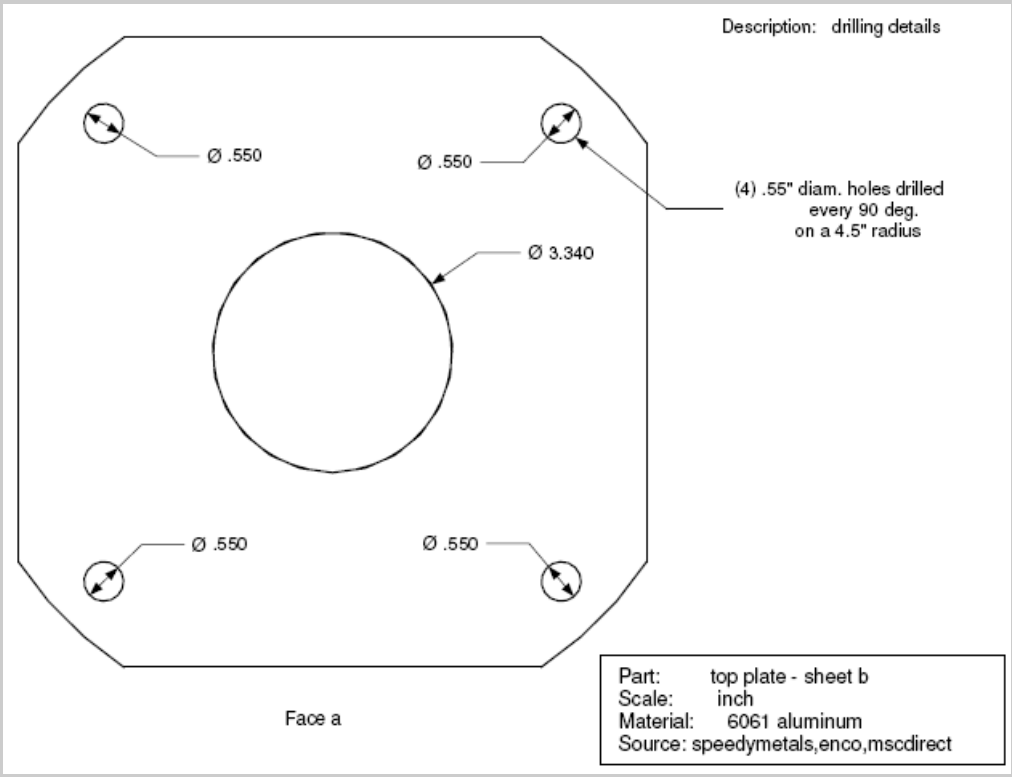

Figure 14 Top plate type 1 sheet-b

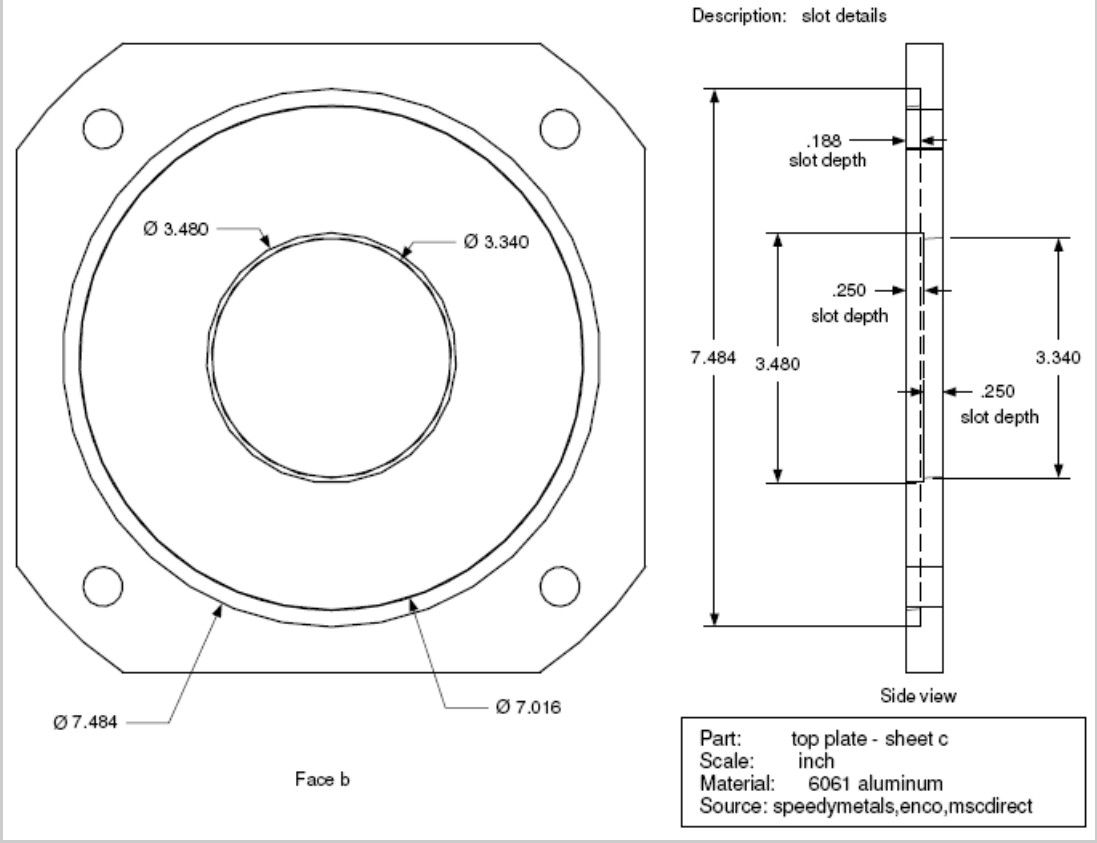

Figure 15 Top plate type 1 sheet-c

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Open drawing *#27 - Outlet, type 2 sheets-a & b*.

Begin with a 2” length of solid aluminum rod, 3.5” in diameter. After mounting the rod in the lathe chuck, lightly turn the outer diameter to a perfectly round O.D. at 3.49”-3.50”.

Cut across both faces to make them flat and parallel.

As shown in *sheet-a*, turn down the outer diameter to 3.4” for a length of 1.625”, leaving the last 0.375” at 3.5” O.D.

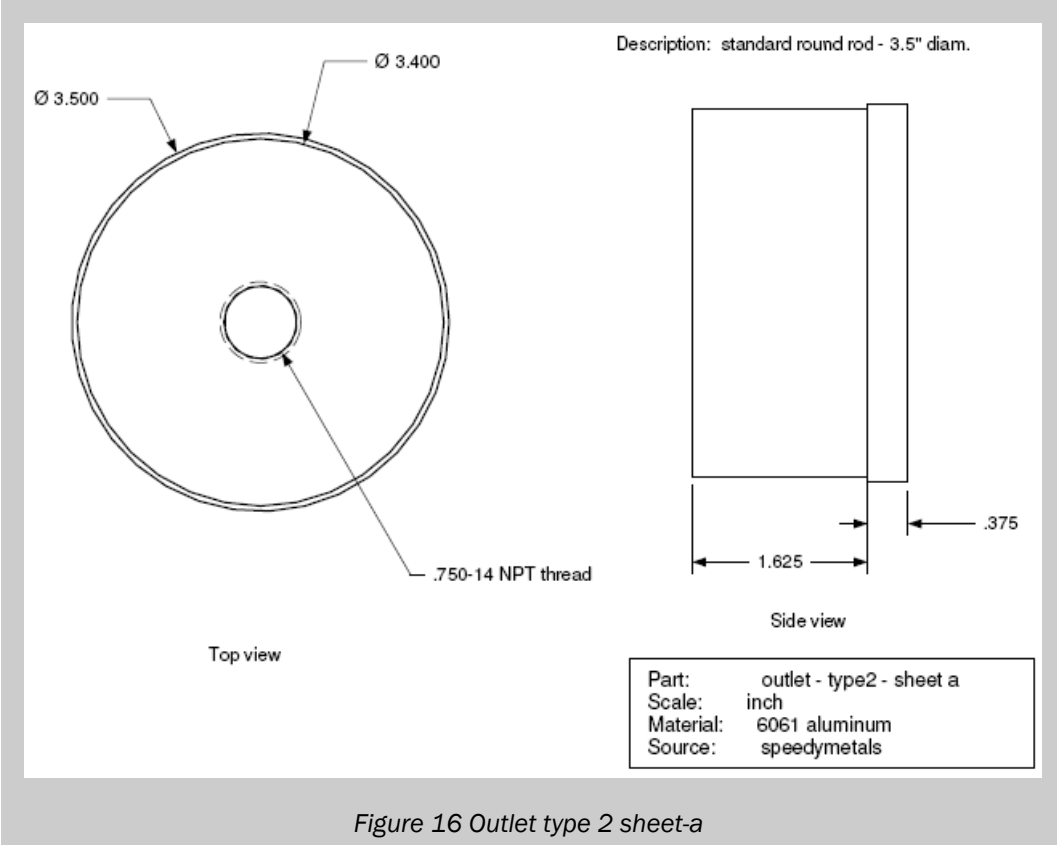

Figure 16 Outlet type 2 sheet-a

Remount the work piece in the chuck with the 3.5” O.D. end facing outward. Referring to the cross-section in *sheet-b*, first bore a 0.9375” hole through the rod.

Using a boring bar, bore out the end of the rod approximately 1” deep, out to a diameter of 3 inches.

Remove the work piece and thread the end of the rod with the 0.9375” hole with a ¾-14 tapered pipe tap.

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Use a mechanical or hydraulic press to drive the outlet into the top plate such that the inlet ring slot faces downward, while the outlet faces upward (see the turbogenerator assembly).

After pressing the parts together, heliarc the 2 pieces for a gas-tight seal.

# # #

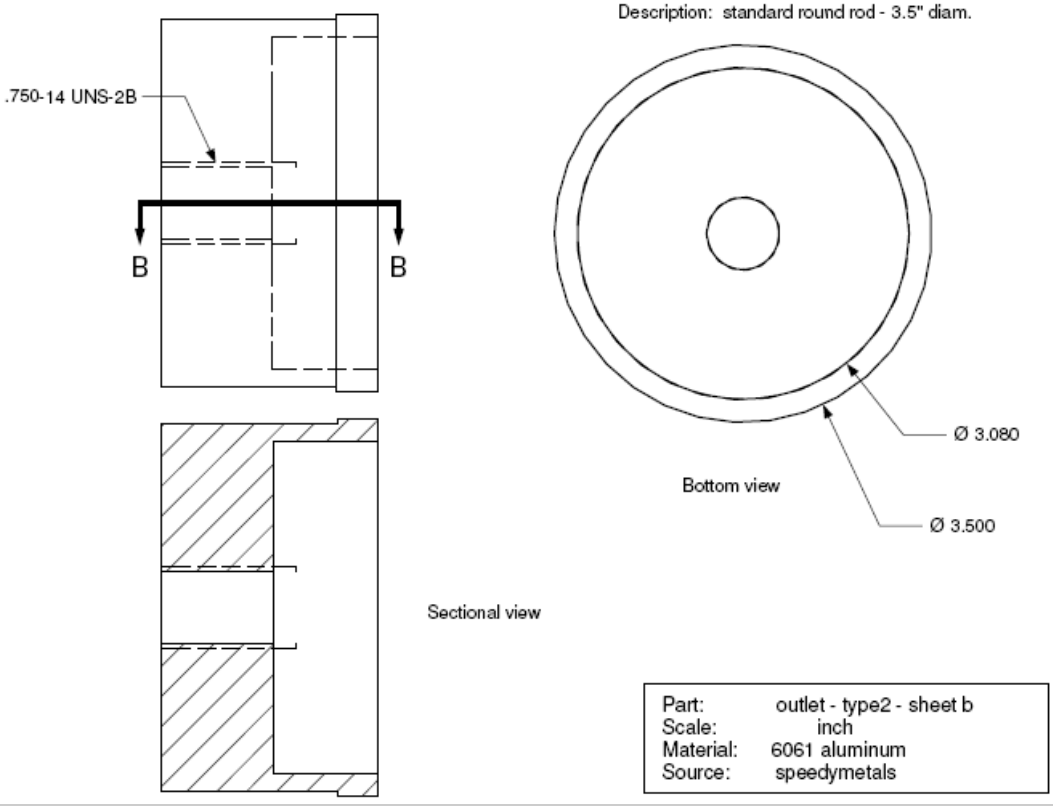

Figure 17 Outlet type 2 sheet-b