Constructing an IMU Horn for 78 Ghz

Ken Schofield W1RIL – 11/06

This article will describe the construction of an IMU dual mode horn for 78 Ghz using brass rod and hobby brass tubing. The amount of materials needed is small. A lathe is required for its construction. Several have been made using the method described below and successfully used in the field. In an attempt to make the process easily understandable pictures of the procedures are included. The text will follow the picture numbers to explain the fabrication of the horn.

MATERIALS LIST

2 Pieces - 5/16 inch brass rod - 1 inch long.
K&S 5/16 inch hobby brass tubing - ~ 11/16 inch long.
K&S 1/8 inch hobby brass tubing for use as waveguide on 78 Ghz.

FIGURE 1:

Insert the 5/16 inch brass rod into a 4 jaw lathe chuck with ¾ of an inch extending from the jaws. Using a dial indicator "zero it in" to center it up in the chuck.

FIGURE 2:

Make a facing cut across the exposed end of the rod.

FIGURE 3:

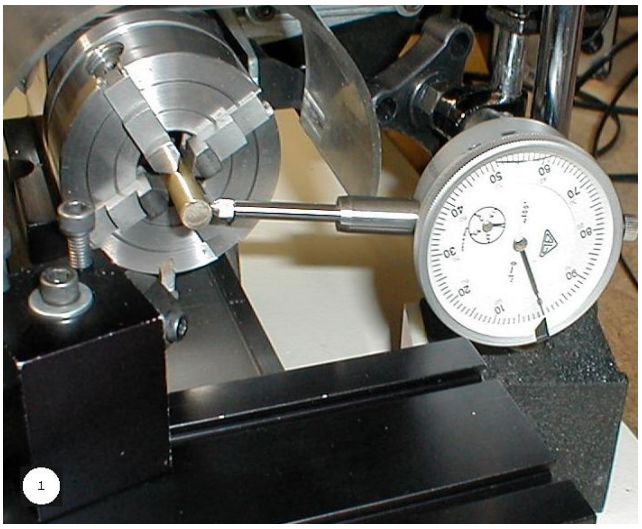
Mount a drill chuck in the tailstock and with a centering drill locate and drill the center. A number 2 centering drill was used in the photo, which was just right for the next operation. Note the beginning of the cone indent made by the centering drill.

FIGURE 4:

Drill a center hole through the piece using a #40 drill bit backing out the drill to clean out the chips several times during the drilling process. The liberal use of lubricating oil is recommended. If you are fortunate enough to have a 0.098 chucking reamer use a #42 drill bit in lieu of the #40 and ream the center hole to 0.098.

FIGURE 5:

The Sherline lathe uses a compound slide accessory which mounts on the cross slide. Using this setup material is cut on the upward rotation at the rear. The cutting tool is mounted upside down. This allowed the use of a 1/16 - 2 flute end mill, to be positioned in the compound slide and used as the cutting tool. Note the use of shims under the end mill to center the tool on the material. The end mill is also rotated to set the cutting edge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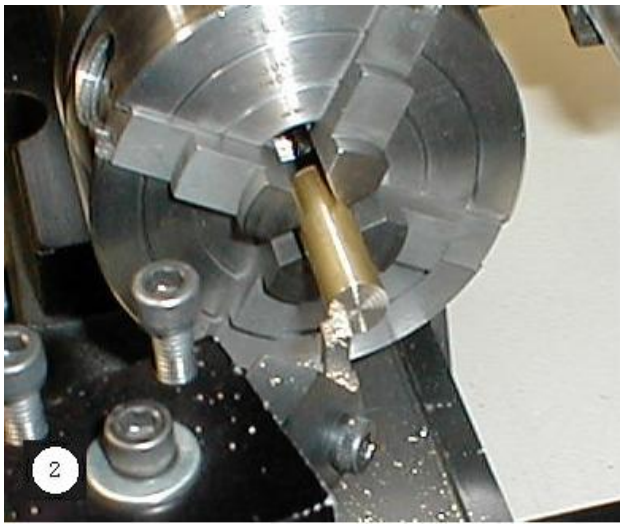
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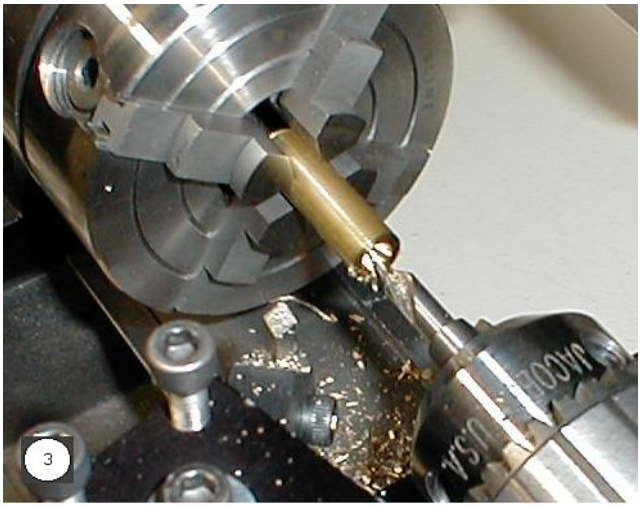
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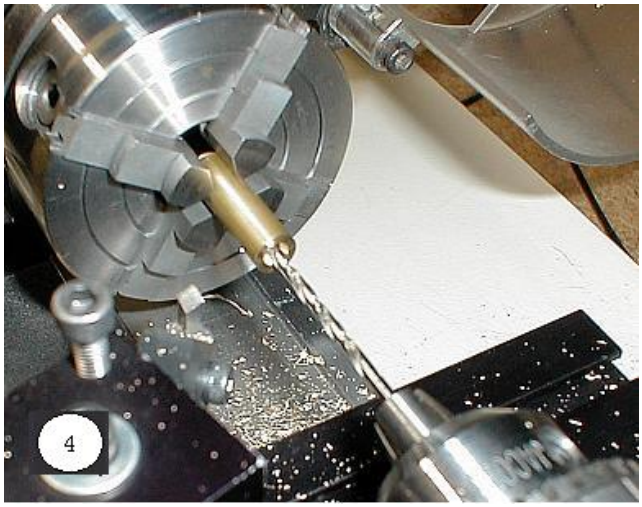
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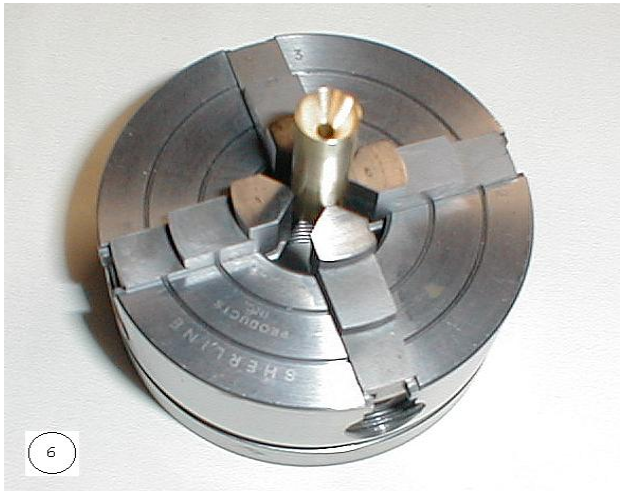
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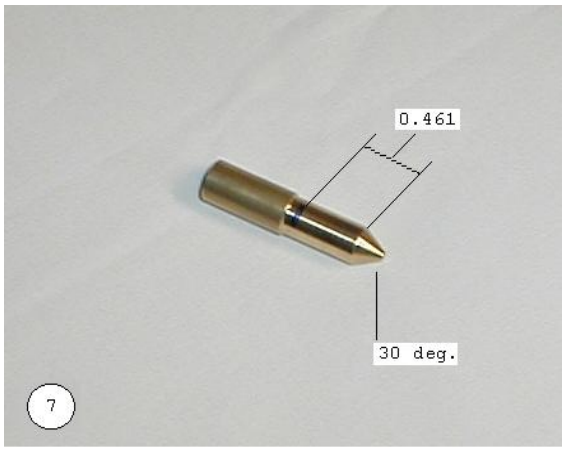
properly. Set the compound slide angle to 30 degrees and make very small 0.002 cuts from the outer edge to the center hole. Continue this until the outer edge of the cone is very sharp. Do not allow the cutter to enter too far into the center hole and damage the opposite wall of the 0.098 bore.

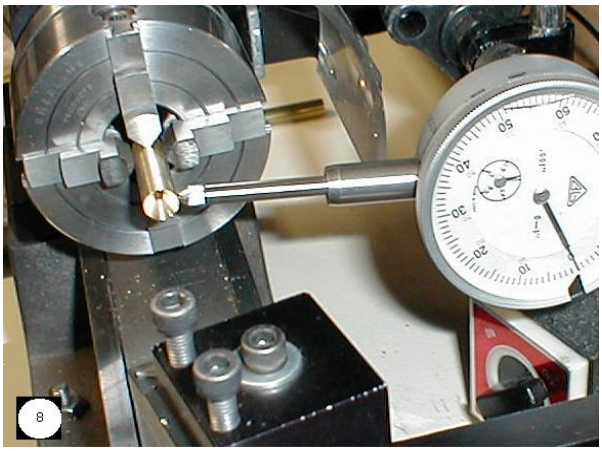
FIGURE 6:

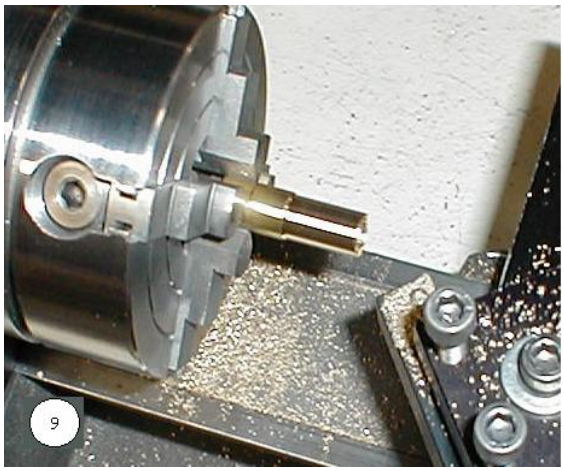
The 4 jaw chuck was removed from the lathe and set aside for this picture. Note the sharp edge on the cone leading to the center hole.

FIGURE 7:

The gauge shown is machined from a second piece of 5/16 inch brass rod. It was set up in a separate chuck so as not to disturb the work in the 4 jaw and take advantage of the compound slide already set up on the lathe. A 30 degree angle was cut on the end and the outer diameter turned down to be a sliding fit into the 5/16 inch brass tubing using a standard cutting tool ***not*** the 1/16 end mill. The cutting tool is mounted upside down on the compound slide. Mark off the distance 0.461 inches from the angle shoulder to a point on the shank as shown. This will be used later in assembly to set the internal distance of the 5/16 tubing.







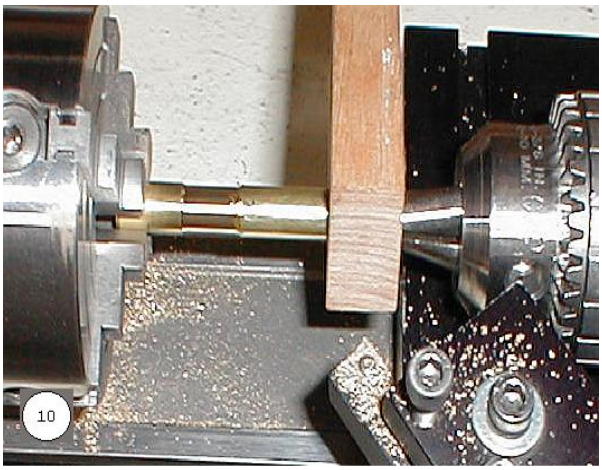


FIGURE 8:

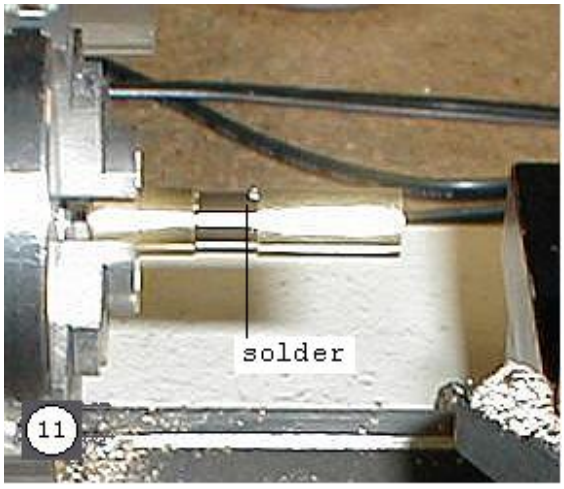
Reinstall the 4 jaw chuck containing the work piece onto the head stock and recheck that it is “zeroed in”.

FIGURE 9:

With a conventional cutting tool reduce the diameter of the workpiece in ***very small*** increments such that an 11/16 inch long piece of 5/16 brass tubing can be a pressed fit onto it. Prepared the tubing by facing off both ends and with an exacto knife angle cut the inner edge on one end. Mark this end with an “X”. The inside of the tubing ***must*** be clean. Use a piece of steel wool wrapped around a “Q” tip to do this.

FIGURE 10:

When the workpiece has been reduced in diameter to the proper size the “X” end of the tubing will want to start onto the piece. At this point put a light coating of solder paste around the junction of the two pieces. Rotate the lathe headstock by hand to check that the tubing is properly aligned with the workpiece. When it is, use a block of hard wood as shown, and with the aid of the drill chuck in the tailstock, press it onto the work piece a short distance. Insert the gauge (Figure 7) to check depth, and repeate the process until the distance from the open end of the horn to the angle is 0.461 as marked on the gauge. Push the gauge into the horn with hand pressure and rotate around inside several times to smooth any disturbance to the sharp inner edges caused by assembly.



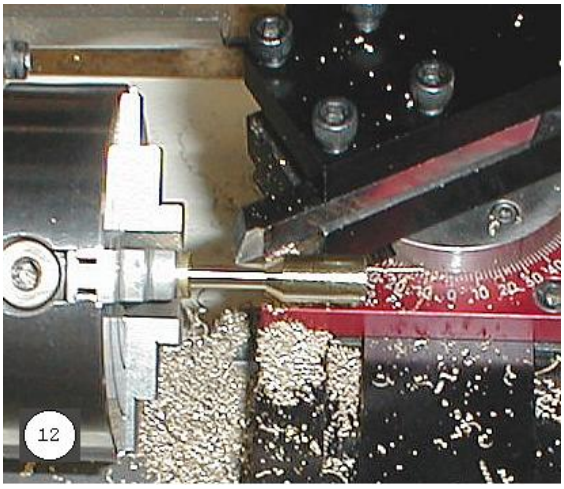


FIGURE 11:

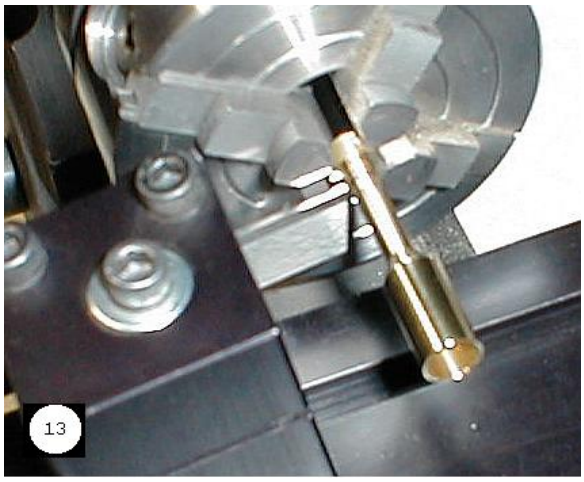
Place a ***small*** piece of solder on the joint between the workpiece and the pressed on tube. Heat the piece with a small torch to sweat the pieces together. Check the inside of the horn for any solder. There should be ***none!***

FIGURE 12:

Reinstall the compound slide accessory with conventional cutter and set to 30 degrees. Measure back from the open end of the horn 0.550 inches and cut into the assembly at the 30 degree angle to a point that when projected toward the chuck will leave a shank diameter of 0.160 to 0.170. Cut the shank diameter as close to the chuck face as possible.

FIGURE 13:

Measure back from the open end of the horn 1.2+ inches. Mount a cutoff tool on the lathe and cut through the shank to separate the pieces. Catch the horn as it is cut away to avoid damaging.



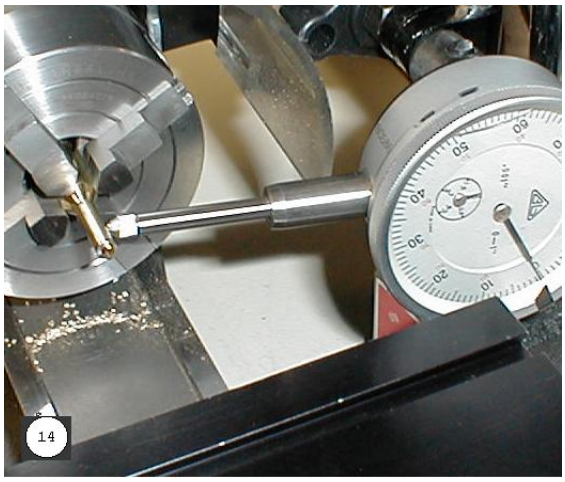
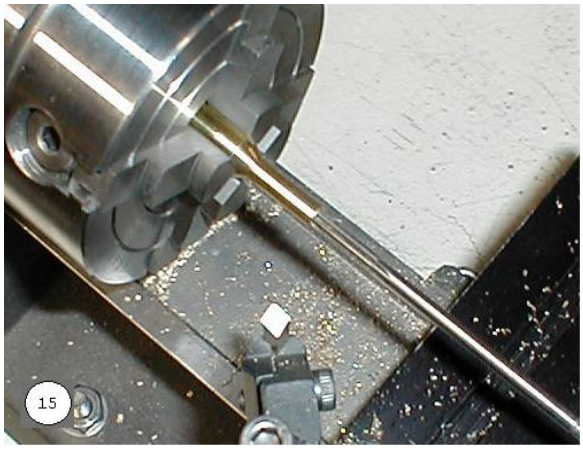


FIGURE 14:

Remove and discard the waste piece from the lathe. Insert the gauge into the horn and put the horn into the lathe chuck with the shank extending outward. Center up on the indicator. Do *not* overtighten the chuck. The gauge was inserted to help prevent any crushing by the chuck jaws. Make small facing cuts across the shank end until the overall length of the horn is ~ 1.2 inches.



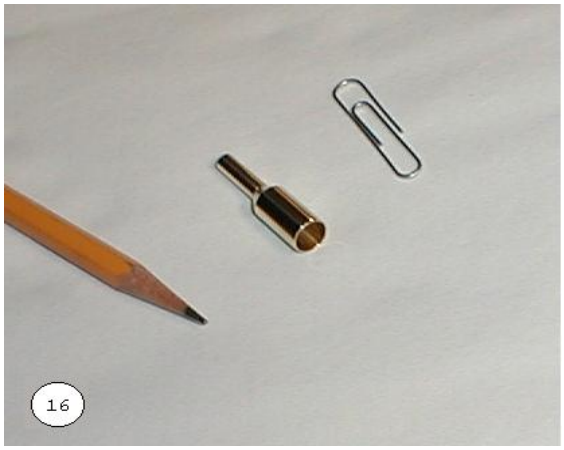


FIGURE 15:

With a #31 drill bit, drill into the horn shank exactly 0.250 inches. Chuck a flat end 0.125 reamer into the drill chuck and ream to a depth of exactly 0.250 inches. Clean up the horn using steel wool and polish with Flitz. The horn can be silver plated using cool-amp if desired. This can be done at a slow speed in the lathe using a damp cloth to apply the cool-amp. Use rubber gloves and cover the lathe ways for protection.

FIGURE 16:

The finished size of the 78 Ghz IMU horn can be seen by comparison to the end of a number 2 pencil and a standard paper clip. The K&S 1/8 inch hobby brass tubing in the materials list is inserted into the shank end of the horn and used as waveguide on 78 Ghz. A short piece of heat shrink tubing holds the piece snugly to the horn.

As evidenced by the pictures and text “micro-machining” can be a valuable asset to the “micro-wave” orientated Radio Amateur.