PTFE* VHF antenna insulators

Turn your own for best performance and appearance

Several years ago I undertook a project that involved the construction of a number of identical antennas for 144 MHz and 432 MHz. Through-the-boom insulated elements seemed to be the best method of construction, but I was not satisfied with the insulators available. Because I'm retired and have a fairly well equipped home machine shop, I decided to make my own.

After experimenting with a variety of materials, and after many weeks of work, I finally discovered that Teflon™ had all the properties I was seeking but one — low price. Teflon possesses a happy combination of ductility and elasticity, which, when combined with its superior insulation property, makes it ideal for my purposes. When installed in the boom, it will lock itself to the boom with a friction fit on the element holding it firmly in place.

The machine-made insulator is much faster and easier to make and install than the hand-made version. Its dimensions are shown in **fig. 1**; the body of the insulator, measuring 0.312 inch (0.79 cm) diameter at the shoulder, tapers about 0.005 inch (0.013 cm) toward the other end. They're made to fit 5/16 inch (0.794 cm) holes (through the boom) and 3/16 inch (0.476 cm) diameter elements. The hole through the center is 1/8 inch (0.318 cm). When placed in the 5/16 inch (0.794 cm) hole in the boom and expanded, the insulator forms an internal shoulder that locks it to the boom.

lathe-turned insulators

My first insulators were made from 3/8 inch (0.953 cm) diameter Teflon rod. With the Teflon held in the headstock chuck, a hole was drilled through the center with a 5/32 inch (0.397 cm) inch drill. A series of cuts was made using a 3/16 inch (0.476 cm) wide chisel-type cutting tool, leaving a 5/16 inch (0.794 cm) inch diameter body and 1/16 × 3/8 inch (0.159 × 0.95 cm) shoulder. The machining was done with the drill bit remaining in the Teflon to support it and keep it rigid. The individual insulators were then cut apart with an Xacto™ knife held against the shoulder with the stock rotating in the lathe. In this manner I could make about eight insulators at one time.

There was one problem, however. Because Teflon of this diameter is quite flexible, when the drill extends into the Teflon that lies beyond the support of the chuck jaws, it tends to "wander" and become eccen-

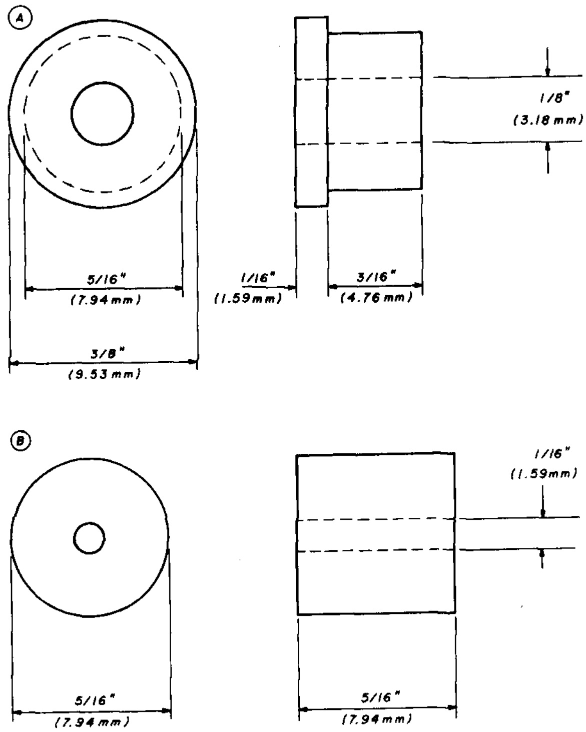

fig. 1. Teflon insulators: (*A*) machine-made, (*B*) hand-made.

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*Polytetrafluorethylene

tric. At the time I was tapering the ends of the elements and simply driving them through the insulators, letting them expand in the boom. This approach worked quite well, and I still have some antennas in use that were assembled in this manner several years ago. I did not realize that Teflon would tolerate, without fracture, the degree of expansion I later discovered. Further research in my plastics supply catalog revealed that heavy-wall Teflon tubing is available (at almost double the price of the rod) in 3/8-inch OD and 1/8-inch ID. I bought some, tried it, and have used it as my basic material since then. With no holes to drill, my production rate skyrocketed. What had been a chore now became a pleasure.

The lathe configuration is illustrated in **fig. 2**. The heavy wall tubing is inserted through the chuck into the lathe spindle, extending approximately 2-1/2 inches (5.127 cm) out of the chuck. To support the Teflon during machining, use 1/8 inch (0.3175 cm) diameter drill rod, held in the tailstock chuck. Insert it in the center hole of the teflon tubing all the way to the headstock chuck. The drill rod acts as a mandrel to support the Teflon during turning and cutting processes, so there's no problem making ten insulators at one time. When finished they're simply removed from the mandrel, and the process is repeated.

It's not necessary to measure the shoulders for thickness. An "eye-ball" 1/16 inch (0.16 cm) is satisfactory. But it *is* necessary to measure the body and produce the insulators uniformly. I use a dial indicator caliper for this purpose. After turning a few, I take note of the cross-feed index. If I find that I'm getting uniform production, I put on a cross-feed stop, adjust it so that the cutting tool feeds into the work to the proper depth and can go no further. Thereafter, the cross-feed is fed in until it stops; it is then withdrawn, and the lathe carriage is moved forward 1/4 inch (0.635 cm). The process is repeated until the mandrel is full of insulators. (A skilled operator could easily turn out 200, and perhaps 300, insulators per hour.)

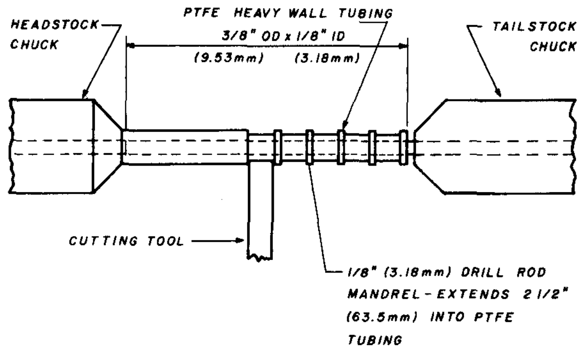

fig. 2. Metal lathe set-up for production of insulators. The cutting tool (chisel-type, 3/16-inch, 0.4763 cm) wide *is fed straight into the PTFE to reduce diameter to 0.312* inch (0.792 cm). Shoulders are 1/16-inch (0.1588-cm) thick. (The drawing is expanded.) The clearance between the end of the Teflon and tail-stock chuck need not be more than 1/8-inch (0.3175 cm). After ten cuts have been made, insulators are separated by holding a sharp knife edge against the insulator "body" at the right-hand edge of each shoulder, with the work rotating in the lathe.

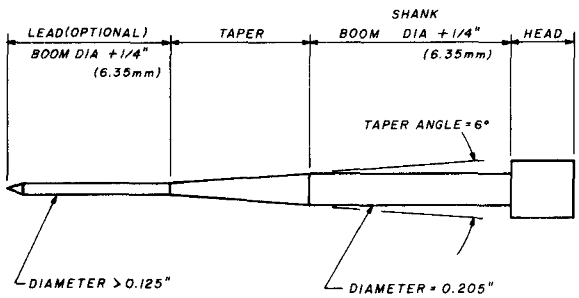

fig. 3. The expanding tool may be made of brass, bronze, aluminum, or steel. W5JTL uses a 1/4-inch (0.6350-cm) brazing rod.

installation

Insulators with a 1/8 inch (0.318 cm) center hole will require more than a slight taper of the element if the element is to be used for expansion. After much experimentation, I've concluded that a 6-degree included angle (3 degrees each side of center) taper is about optimum. This would result in reduction of the element diameter of nearly 1 inch (2.54 cm) at each end, and could adversely affect the design resonance, particularly at 432 MHz and above. My first expansion tools were 0.188 inch (0.476 cm) in diameter and less tapered — perhaps only 8 or 10 degrees; these occasionally produced sheared insulators. At the 1984 Central States VHF (CCSVHF) Conference, Jan King, W3GEY, expressed an interest in obtaining some of my insulators. I took him to my hotel room to give a demonstration of how to use them and — you guessed it — promptly sheared off a couple of them. Nevertheless, he left with a few hundred insulators and I came home and went back to the drawing board. I now make the expanding tools 0.205 inch (0.521 cm) in diameter, with a long taper. (These are illustrated in the drawings of **fig. 3**.) When withdrawn from the insulator, the hole immediately shrinks to 0.175 to 0.180 inch diameter and provides ample friction to hold the element.

Two opposite side insulators may be installed in the boom at one time if the shank of the installing tool is long enough to go all the way through and the bottom side insulator is supported until it is expanded.

A "lead" section on the expander helps in alignment, but is not necessary. A length of wood measuring approximately 2 × 4 × 12 inches (5.08 × 10.16 × 30.48 cm) with a hole large enough to clear the expander, drilled about 3 inches (7.62 cm) deep [centered on the 2 inch (5.08 cm) side] is a valuable aid in insulator and element installation. It provides support for the bottom insulator during this process. The boom is placed on the wood with the two opposite side insulators in place. The expander is driven through both of them and extracted. The element — with the sharp corners at the end is rounded off 0.005 inch (0.013 cm) with a file or sandpaper — is then driven through until it protrudes an inch or two on the opposite side. Inspect it from the bottom side to make sure that it's centered in the bottom insulator before driving it all the way through. Centering the elements in the boom is done after all have been installed.

hand-made insulators

If you're making a single antenna and want only a few dozen insulators, they can be made without a lathe. Unfortunately, the heavy wall tubing (and it's not available as a stock item with a center hole smaller than 1/8 inch, or 0.318 cm) will not expand sufficiently to form its own shoulders and "stay put" when driving the elements through. Teflon rod of 5/16 inch (0.794 cm) diameter is readily available and is much less expensive than either 3/8 inch (0.953 cm) rod or tubing. All you have to do is drill a hole through the center of it and slice it off into individual insulators. This is easily done in a drill press. Place a short piece of straight metal rod 5/16 inch (0.794 cm) diameter in the drill press chuck. Put a drill press vise on the rod and tighten it with the rod in the vertical "vee" of the vise. You can now drill short pieces, up to about 1-1/2 inches (3.81 cm) long, through the center with sufficient accuracy for our purposes. Use a drill no larger than 3/32 inch (0.238 cm) and preferably 1/16 inch (0.156 cm). Cut the individual insulators about 5/16 inch (0.794 cm) long.

Installation is somewhat similar to the lathe turned insulators, except that they must be put in "bottom side" first. The expanding tool must have a point small enough to enter the smaller hole. Since greater forces are required in this installation, better support of boom and insulator is necessary. The insulator should be "half in and half out" of the hole in the boom during expansion. To maintain things in this position, a relief hole for the insulator is provided by fixing a piece of flat thin gauge metal (1/16 inch, or 0.159 cm, aluminum is OK) to the wooden block before drilling the hole for the expander. Then put a piece of 1/8 inch (0.318 cm) thick aluminum, with a 3/8 inch (0.953 cm) diameter hole through it, over the other metal piece, with the 3/8 inch (0.953 cm) relief hole centered over the expander hole. It can be held in place with glue. Place the boom with insulator in place, on the wooden block and centered over the 3/8 inch (0.925 cm) relief hole. Insert the expander through the vacant top hole in the boom and drive it through the insulator, expanding it. Withdraw the expander. Turn the boom over 180 degrees with insulator in place in what is now the bottom side, insert the expander through the previously installed insulator, and drive it through. It's now ready for element installation, in the same manner as the lathe turned insulators.

conclusion

I've made and disposed of several thousand of these insulators. Every user I've heard from has expressed complete satisfaction. The material cost for the handmade insulators should be no more than 4 cents each, if quantity price of Teflon is obtained. I've made and will continue to make the machine-made variety available to VHFers at that price.

Perhaps some one else can produce them more economically. I claim no proprietary rights and invite anyone so inclined to produce them; I'll be glad to furnish more detailed information to anyone wishing to produce them commercially.

ham radio