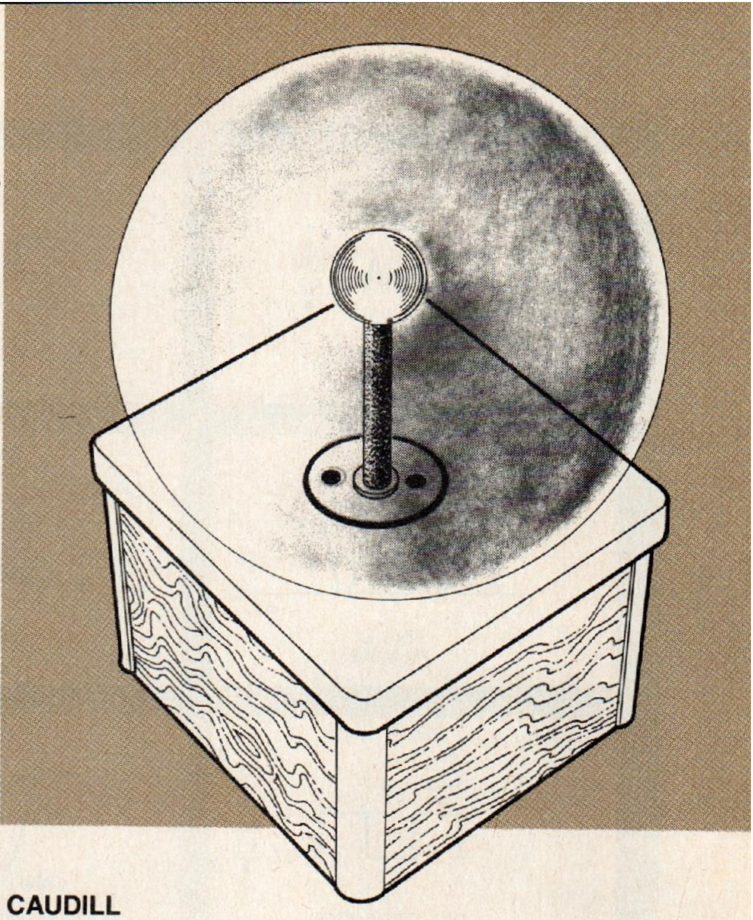
PLASMA DISPLAY GLOBE



You can save really big bucks by home-brewing your plasma display globes. Here's how you do it.

JEFFERY C. CAUDILL

ALTHOUGH THE PLASMA-DISPLAY POWER supply featured in the March 1988 issue of **Radio-Electronics** is relatively inexpensive, the globe itself—which, depending on size, can cost well over $200—often proves to be beyond the budget of many experimenters. But if plasma displays fire your enthusiasm, you can get them at a relatively low cost by making the plasma globes yourself.

Yes, you read correctly: We did say make the globes yourself. You can do it even if you know next to nothing about glass-blowing because our prototype—which costs about $45—is made from a conventional glass lighting globe.

Although making your own plasma globe sounds like a complex project, in reality it is rather easy to do, and it can be a lot of fun. So follow our instructions in the context of fun, rather than as a chore.

Construction

The globe itself is a 14-incher, the kind used for outdoor yard-post lighting fixtures; it can be obtained from a local lighting-equipment supply house for about $20.00. Typical of lighting globes, it has an opening with a curled lip that allows the globe to be held in place by three thumbscrews. As you'll see, we will use the globe's curled lip to ensure an airtight assembly.

The globe's base is made from a 12 × 10 inch piece of ¾-inch Corian—a material that's used for cabinet tops. (It can be purchased at local kitchen-cabinet shops; it's usually the scrap from the sink cut-out.) As shown in Fig. 1, use a router to cut a ⅜ inchW × ⅜ inchD circular groove that matches the diameter of the curled lip; the groove should be centered.

Drill a 5⁄16-inch hole in the center of the grooved circle. Then, as shown in Fig. 1, drill a ⅛-inch hole that is offset as far as possible from the center hole. The ⅛-inch hole will be needed for pulling a vacuum on the completed globe.

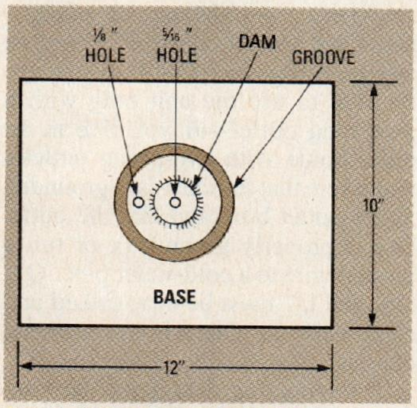


FIG. 1—PREPARE THE BASE by drilling two holes, routing a mounting groove, and building an epoxy dam between the two holes.

Figure 2 shows the dimensions for the globe's discharge assembly. The 1¾-inch discharge ball used in the prototype is aluminum; it has a 1-inch deep 5⁄16-inch threaded hole for its support rod. (The ball was made by a local machine shop for $12.)

The support is a 5⁄16-inch threaded brass rod that is 8¼-inches long. It is a standard electrical part that is used to repair table lamps.

Assembling the globe

Screw the rod into the aluminum and then cover the rod with at least four layers of heat-shrink tubing or plastic electrical tape. (Try for eight layers of insulation, if possible.) Leave the bottom threads uncovered for 1¼ inches so that the rod can be fastened through the base.

Apply a nut and a washer to the exposed end of the brass rod, insert the rod through the center hole in the base, and using another washer and another nut, fasten the rod securely. Then sandwich a solderless wire connector between the bottom mounting nut and a third nut. (If you can get the appropriate size lockwasher, use one on each side of the connector.)

To ensure an airtight seal, both the top and the bottom of the rod—as well

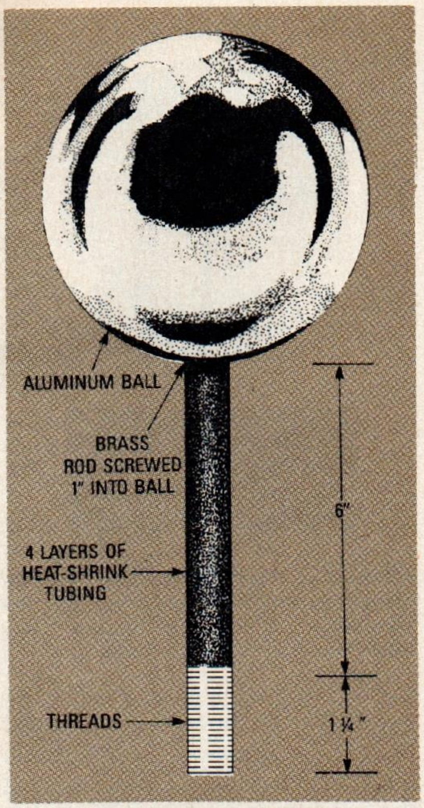


FIG. 2—THE DISPLAY ASSEMBLY consists of an aluminum ball that is mounted on a brass rod that is threaded on both ends.

as where the rod passes through the base—*must* be sealed with epoxy cement. And not just a *smear* of epoxy; really pile it on—the thicker the better. Try for a ¼-inch thickness of epoxy, and make certain the epoxy covers everything: the washers, the nuts, the end of the rod, etc.

Next, install a 1¼-inch length of ⅛-inch steel automotive brake-line tubing (from an auto parts store) into the base's ⅛-inch hole. Do not allow the tubing to protrude into the globe as that will cause the center rod to arc to the tube. In fact, you should manage to install the tubing so that it is about ⅛–¼-inch below the top of the base. (Leaving at least ⅞-inch of the tubing below the Corian will ensure that the tubing is positioned properly.)

The tubing's joint also *must* be sealed at the top and the bottom with epoxy cement, but use extra care not to get any epoxy into the tube.

Since the tubing will be relatively close to the discharge-assembly's rod, there is the possibility that most of the display arc will travel from the bottom of the rod straight across the Corian to the metal tube. To prevent that from happening, it is necessary to increase the length of the path between the rod and the tube. That is done by building a small epoxy dam—made from *epoxy putty*—around the discharge assembly's rod. Epoxy putty comes in stick form; it can molded and shaped much like children's *Play Dough*. Work the putty with your fingers until it's soft, then roll it between your palms until it forms a string having a diameter of about one-half to three-quarters of an inch.

As shown in Fig. 1, use the epoxy string to form a dam on the base between the tube and the discharge rod. Press the dam against the base and then pull it upward so that it looks like a mountain ridge. The higher you stretch the "ridge" the greater the discharge path between the rod and the tube. Try for a height of at least 1-inch, keeping in mind that only the height of the dam is important—not its thickness.

Next, carefully clean the inside of the globe, because once the globe is mounted, there is no way to get inside the globe. Then, fill the routed-groove approximately half-full with epoxy cement and place the globe's lip into the groove. Make certain that the lip is completely submerged—all the way

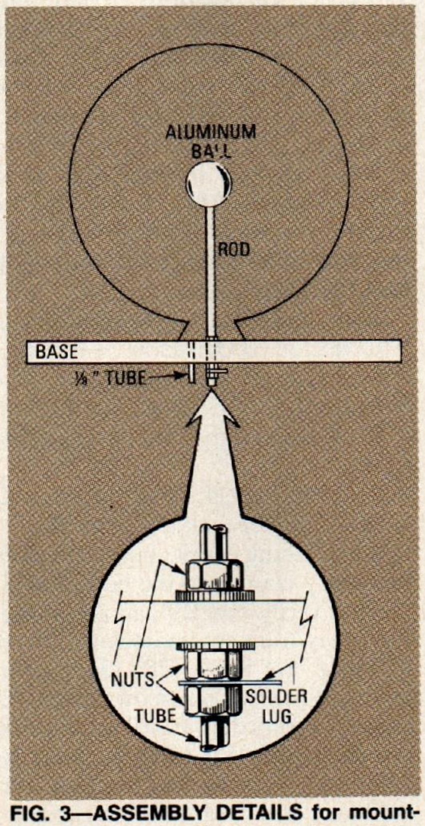


FIG. 3—ASSEMBLY DETAILS for mounting the globe on the Corian base. Take extra care to ensure that the epoxy cement seals the rod and the tubing to the base.

PARTS LIST

- 14-inch round globe
- 1¾-inch aluminum ball
- 8¼-inch length of 5⁄16-inch threaded brass rod
- 10 × 12-inch Corian
- Heat-shrinkable tubing or plastic tape
- Epoxy cement
- Plumber's epoxy
- 1¼-inches of ⅛-inch steel automotive brake tubing
- 5⁄16-inch solderless wire connector
- 5⁄16-inch nuts to match threaded brass rod
- 6-inch length of rubber automotive vacuum line
- ⅛-inch vacuum-line plug

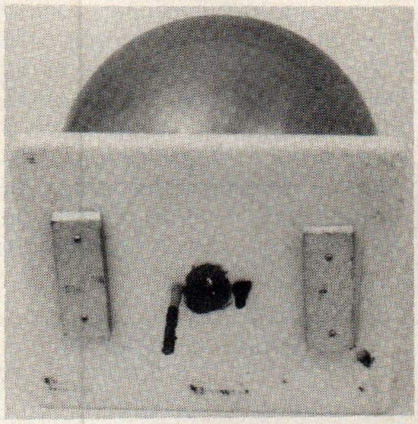


FIG. 4—THIS IS HOW THE BASE of the prototype looks. The second tubing was added to simplify inserting of the gases that change the display's color. Notice the heavy application of the epoxy that is used to seal the tubes and the rod.

around—in the cement. Set the assembly aside for at least 24-hours to ensure complete curing of the epoxy cement.

The completed globe assembly is shown in Fig. 3. Figure 4 shows the underside of the prototype. The two wood strips that are screwed to the base allow the base to be secured to its cabinet

The vacuum

To vacuum the air from the globe, slide a 6-inch piece of rubber automotive vacuum-hose over the metal tube sticking out from the bottom of the base. Connect a vacuum pump—borrowed from the local college, or rented from a neon-sign vendor, an air-conditioning repairman, or a tool shop—to the rubber hose and pull a vacuum in the globe.

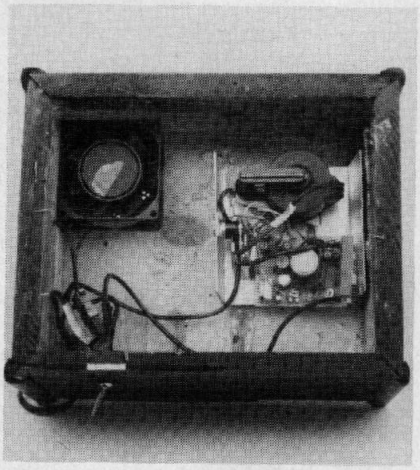


FIG. 5—THE PROTOTYPE'S BASE is made of wood. Holes are drilled in the front and rear for ventilation. Air movement is generated by the small fan mounted in the upper left corner.

With the pump running, connect your power supply to the solderless wire-connector on the base of the threaded rod and power up the supply while the pressure in the globe is being lowered. If you have, or can borrow a vacuum pressure gauge, the final pressure should be between one and three torrs. Otherwise, when the display appears the way you want it (different pressures make different displays), clamp off the rubber hose and seal it with a ⅛-inch plug.

The normal display is blue-white streamers. If desired, various display colors can be attained by releasing different inert gases into the globe through the hose. Helium makes yellow streamers, argon makes dark blue, and neon a reddish-orange.

Power modifications

Although the power supply shown in March 1988 issue works well as is, a brighter and more active display can be attained through two minor changes in the power-supply circuit. First, change capacitor C6 from 0.005 μF to 0.004 μF at 1600 VDC. Second, change resistor R1 to 10 ohms at 5 watts, because that display will overheat a 10 ohm 3-watt resistor.

The cabinet

Figure 5 shows the cabinet that houses the power supply and a small fan that is used to provide air circulation. The cabinet is a 9- × 11-inch wood box that was made from scrap wood. The plasma globe display unit sits directly on the box. If you intend to move the display frequently, secure the Corian base to the cabinet using the wood strips as shown in Fig. 4.

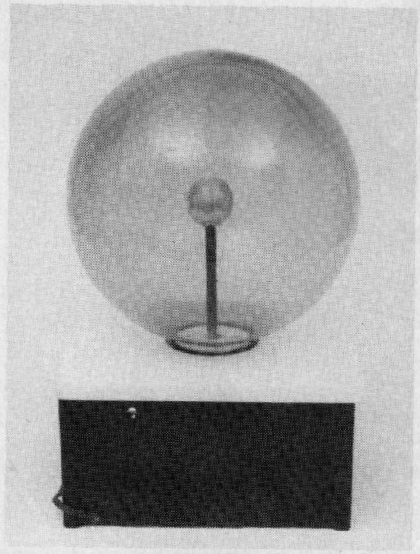


FIG. 6—THE FINISHED PLASMA DISPLAY. The streamers that emanate from the central ball will follow your fingers if you move your hand over the globe.

The completed plasma display is shown in Fig. 6. **R-E**

CARRIER CURRENT

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Alignment

After construction, make sure everything is properly positioned and assembled, and check for poor connections and solder bridges. Also, make sure that the tabs of Q3, Q6, and Q7 are not shorted to the case or to the heat sink. The V_{CC} line should read at least 200 ohms to ground.

Place S1 in the FM position, S2 in LOW, and S3 OFF. Plug in the unit, connect a DC voltmeter to the junction of Dl and D2, and turn on S3—you should read 25 volts DC. If you don't, quickly turn off S3 and correct the problem. If the voltage reading is okay, check for 15 volts across C20. Then turn off S3, connect the voltmeter to test point A, set R22, R23, and R24 to maximum resistance, and set R5 and R9 to their center positions. Connect a 6-volt flashlight bulb to J2, and set the slugs in L2 and L3 half-way into the windings (a plastic TV alignment tool will prevent damage to the slugs). Remove the jumper between J2 and J3 and short J3's center conductor to ground, and then apply power; the voltage at point A should be less than 5 volts. Then adjust R22 (S1 must be in the FM position) for about 8 volts at point A, and check for 12 volts at pin 8 of IC1.

Note: Do not operate this unit with J3 open. Always short J3 to ground when not used during testing, so that F1 will open in the event that C8 should short circuit.

Then make the following checks:

- Collector of Q1: about +8 volts.
- Collector of Q2: 4 to 10 volts.
- Collector of Q3: about 8 volts.
- Collector of Q5: between 0 and 0.5 volts
- Collector of Q4: between 1.0 and 1.5 volts higher than test point A.

If everything checks out, connect a frequency counter to the collector of Q2 and verify that R9 can adjust the frequency from approximately 200 to 350 kHz. Set R9 for 280 kHz—or a period of 3.57 μs on an oscilloscope. Figure 7 shows the various waveforms that are expected at different points in the circuit. Connect an oscilloscope to J2 (across a 10-ohm 2-watt resistor) and adjust L2 and L3 for a maximum output. Next, vary R9 to produce frequencies from 200 to 350 kHz; you should have a nearly constant output level from 220 to 340 kHz.

The 6-volt bulb connected to J2 should glow dimly; it can be used as an output indicator if an oscilloscope is not available. A 10-ohm 2-watt resistor can be used as a dummy load.

Next, place S2 in the NORMAL position and adjust R22 for 30 volts at point A; the lamp should glow brightly. Then set S1 to the AM position and adjust R23 for 14 volts at point A; the lamp should still glow brightly.

Apply a 0.5-volt pp 1-kHz sine wave to J1 and adjust R24 until 100% modulation is obtained (see Fig. 7). The bulb will brighten with modulation. Adjust R23 for the best possible modulation symmetry.

Switch S1 back to FM and re-check the waveforms shown in Fig. 7; adjust R5 if required. Finally, run the transmitter into either the light bulb or the 10-ohm, 2-watt resistor for an hour or so to check for overheating; Q3, Q6, and Q7 should not get too to touch them.

That completes the construction, alignment, and testing of the transmitter. In our next installment, we will show you how to build AM and FM line-carrier receivers. **R-E**