# The RCA AVA-126A Power Supply

## My Mission – A Fully Operational Power Supply

By Breckinridge S. Smith, K4CHE
104 Brookfield Drive
Dover, DE 19901

**Vibrator Ramblings:**
**Finding a substitute vibrator for my RCA AVA-126A power supply.**

I sat at the kitchen table staring at several 4 pin vibrators trying to **figure** out the manufacturer numbers printed on the cans. Louise walked by and picked up one of the cans and examined it closely. And then the "light bulb" illuminated and her expression changed to one of disbelief. . . Like she had discovered an old photograph in the upstairs closet. "I know what these are. They are vibrators. You used to replace them all the time in that radio in your old Packard." I love my wife as she remembers everything.

"Yes dear, as always you are correct." "But you don't have the 1950 Packard anymore." Ah, she had me now.

"I need to find a vibrator for my RCA aircraft set."

"Is that the set you sneaked down into the work shop last week? Does it smell musty?" She quickly picked up one of the vibrators and gave it a quick smell test and it obviously passed as it was returned to the table.

"No, the RCA does not smell. And it's not going to do anything unless I find the proper vibrator."

Fact: You need a vibrator for the AVA-126A and they are extremely rare. I don't know very much about vibrators and there is a recommended reading list at the end of this article. Actually, I despise vibrators. The little fiends sit there humming or buzzing and often varying in pitch and emitting strange "going to fail soon" sounds to warn you that they are they are going to stop any second. In my opinion, they were born to fail. When I had my old 1950 Packard, I absolutely hated going to Barney Miller's Radio Store in Lexington, Kentucky, and putting down a hard earned $3.25 for a vibrator. In the Mallory Vibrator Power Supply brochure it is stated "Vibrators themselves are subject to manufacturing tolerances, as well as certain changes during their life because of wear. All of these variations in combination must be considered in making a final design." In other words, I think they are trying to tell us that the vibrator is going to fail sooner or later.

I sat at the kitchen table and drifted for a moment and thought about the AN/ARN-6 ADF receiver that I depended on over the years in several different USAF and Navy aircraft. Why was there a spare secret vibrator installed in a clamp under the receiver lid? That should tell you something - why have a ready spare that the flight crew can change instantly in flight? I should have nightmares about going up those valleys between the mountains using the ARN-6 set for a bearing and depending on that vibrator power supply down underneath the flight deck with its humming and buzzing. The ARN-6 used a 100 cycle vibrator for the transformer in the inverter unit, which was used to power the loop and its indicators that were driven by autosyn (syncho) motors requiring an alternating current. Most all of the pages in the ARN-6 manual that reference trouble shooting the receiver refer to having the technician listening for a "buzzing sound." In flight you just put your hand on the lid and tried to differentiate between the vibrator and the vibrations from those round engines. When that buzzing stops the needles on the indicators freeze and the loop will not move. It's all over. But when the needles were frozen there was a procedure to turn the aircraft for an aural null – that was fun and another story. But anyway, enough ARN-6 rambling.

Today I am really beginning to dislike vibrators because they are now very scarce and expensive and they are utilized in several military radios that I operate including the AN/GRR-5, RS-6, BC-654, etc. And most importantly, at this moment I need a vibrator that will function in the RCA AVA-126A power supply to provide the high voltages for the receiver and transmitter. The problem

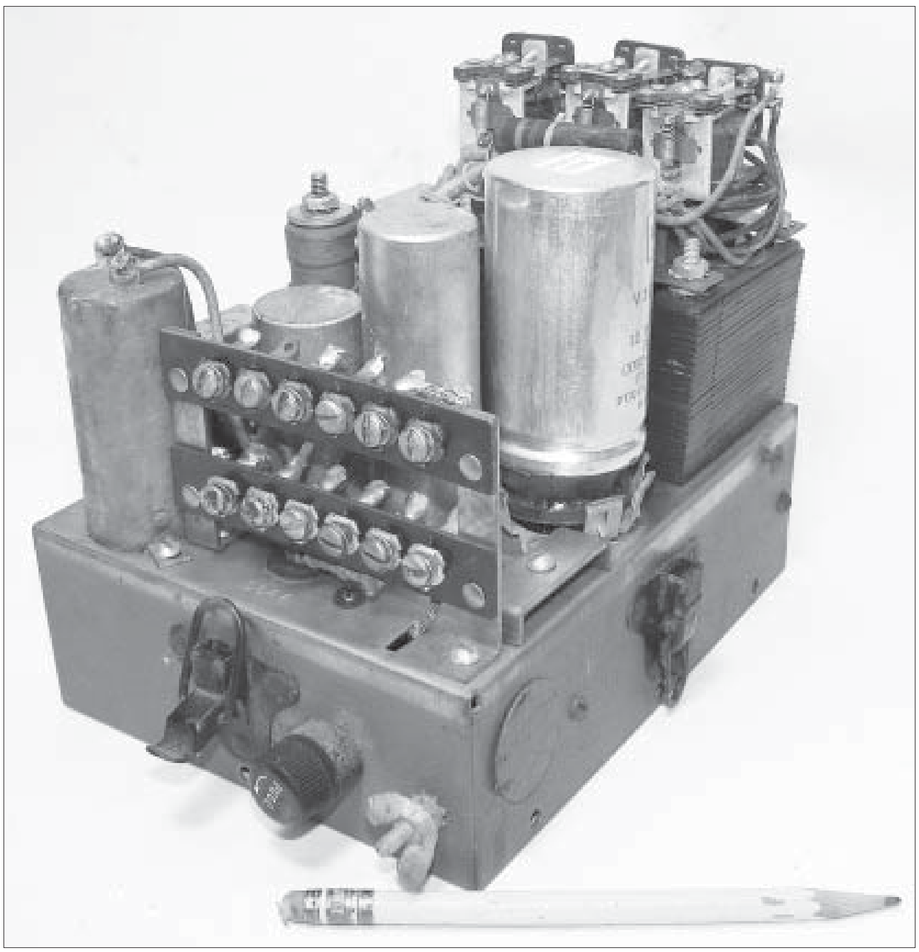

**Figure 1: The AVR-126A power supply, shown with its cover removed.**

is there are literally a thousand different vibrators that were made with hundreds of pin combinations and none of them will work in the RCA power supply – or will they? To further complicate matters the AVA-126A power supply vibrator has an 8 pin octal base. Yes, not 4 pins, not 5 or 6 but an 8 pin octal base. Perhaps improvise, rig, substitute? Perhaps I can wire up something that works in the AVA supply and get my set operational but will the substitute be reliable? See **figure 1**.

The decision was made to experiment and substitute a vibrator as I would probably never find the original and based on my past substitution and fabrication history, I knew that as soon as I **figure**d out a substitute vibrator and fabricated a plug, etc., then the "original" RCA vibrator will pop up or magically appear while I am "Hanzing" through those boxes underneath the tables at the hamfest. But even if I had the original vibrator the question is will it function after all these years? Probably not, but anyway I need a working vibrator and a ready spare.

The purpose of this article is to introduce testing and rejuvenation techniques for vibrators and to find a suitable substitute for the RCA AVA-126A power supply. Bench testing notes and comments on the famous "buffer" capacitors are included. I do not claim to have a perfect test procedure or rejuvenation process for vibrators and most of what I have presented here has been accomplished by others before me. Mr. Robert Downs (WA5CAB) was kind enough to offer some suggestions and comments and they have been included in parentheses.

**Some Typical Vibrator Types**

Before playing with the AVA-126A power supply I had to figure out a way to test and, if necessary, rejuvenate selected vibrators from my junk box. The work bench goal would be to eliminate the really bad units in the box and come up with several working units that could possible be used in the power supply. I had decided to power the entire transmitter-receiver system from 12 VDC so I began to sample the simpler 4 pin 12 VDC units from my box. The electrical mission objective was to get the coil energized so that it will pull-and-release the armature, resulting in a back-and-forth motion between the contacts, just like a buzzer. The oldest type vibrator is the "series" type shown in **figure** 3 but the simplest wiring for a vibrator is the "shunt"

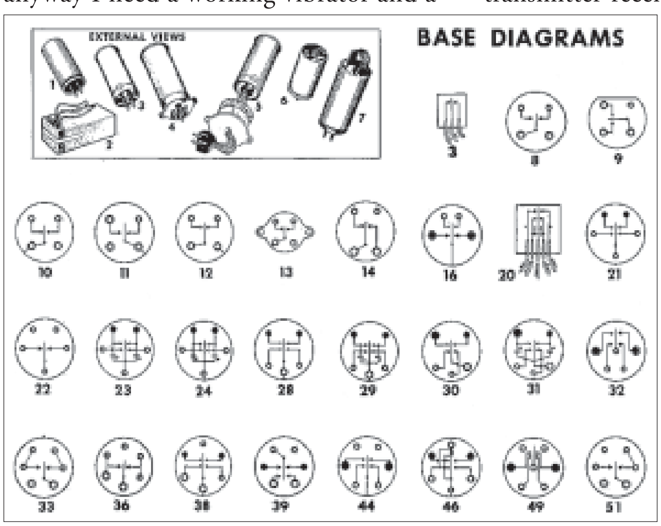


**Figure 1: Typical Vibrator Bases**

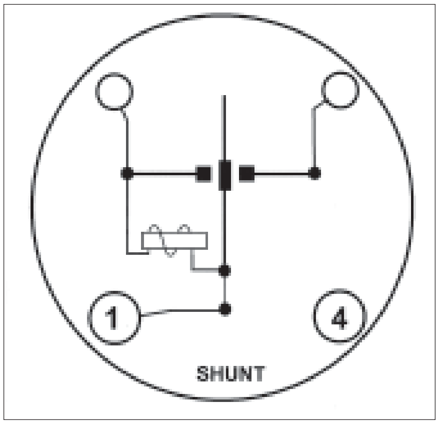

**Figure 2: Shunt Type Vibrator**

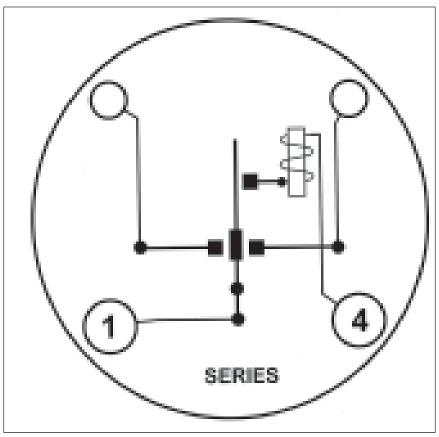

**Figure 3: Series Type Vibrator**

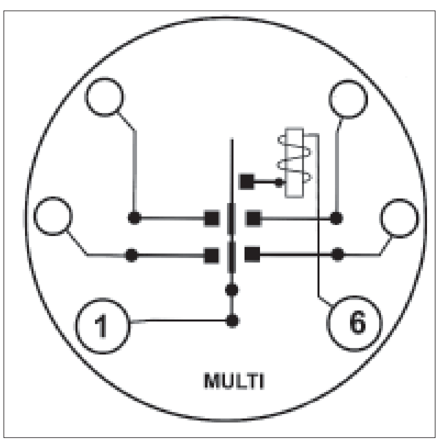

**Figure 4: Multi Type Vibrator**

type shown in **figure 2**, which utilizes 3 of the 4 pins. In the series type, all 4 pins are utilized as the coil receives voltage through the extra pin. In typical circuits, pin 1 would be grounded and positive voltage would be fed to pin 2 on the shunt type via one end of the transformer primary or sometimes a resistor voltage divider in the more complicated power supplies or with pin on 4 on the series type

**Figure** 4 is a typical multi-contact or synchronous vibrator sometimes used in power supplies in lieu of a rectifier tube. The other contacts are used in a self-rectifying circuit where the contacts are connected to the secondary to reverse the current flow. The result is rectification. At first I decided some simple ohm meter tests were in order. (Note that only the coil contact in the series type is NC (normally closed). All other contacts in both types are NO (normally open). If an ohmmeter check shows conduction through any contact other than the coil contact, the contact is probably welded. WA5CAB) Don't discard those multi-contact units as they might be used in older power supplies by only using one set of contacts. When checking with an ohmmeter, expect the coil resistance to be anywhere between 20 and several hundred ohms. (If the ohm meter check of a known "series" type shows open through the coil, most likely the coil contact is insulated by the sulfide layer. The lamp and line method will usually fix these. WA5CAB) And just for fun, some vibrators have resistors installed internally at different locations for hash reduction which results in some strange ohm meter readings.

**Testing and Rejuvenation**

LeRoy Parris (W7OUS) published a

circuit in *QST Hints and Kinks*, March 1957, which applies 115 VAC to the vibrator via a 40 watt light bulb. Per Robert Downs (WA5CAB), this circuit appeared earlier in a low distribution West Coast antique car collector newsletter. The articles were written before many automobile electrical systems had shifted to 12 VDC. Use the 40 watt lamp only on 6 volt and lower vibrators. Use a 25 watt bulb on 12 volt and a 12 or 15 watt bulb on 24 volt or higher coil voltage vibrators. The purpose of the lamp(s) is three-fold. First it limits the current to an amount safe for the coil, second it puts the full peak-to-peak line voltage across the insulating layer that has built up on the tungsten contacts, greatly increasing the probability of breaking through the layer, and third it gives an indication of activity.

Quoting from the W7OUS 1957 article, "The purpose of the procedure is to free the contacts of the film that develops after the vibrators have been through a period of inactivity. The mechanical beating and the voltage applied across the contacts (current limited by the lamp) will generally break down any film in one minute of operation."

Robert Downs also mentions that the W7OUS article was written 57 years ago. The longer the vibrator has been out of service, the longer it may take to clear the contacts. Standard procedure should be to not discard a vibrator – or relegate it to the "open-the-can" stack – until it has run with the lamp(s) connected for at least 12 hours. Also, shunt types with the contact internally connected across the coil typically take much longer than series types. If there is an internal resistor connected across the contact, the lamp and AC line method will not work.

***SAFETY WARNING:*** Be aware that there have been vibrators manufactured that have the outer case connected to one of the pins which can be exciting. Play it safe when you wire up a rejuvenator/tester. Use only a 3-pole AC line plug and cord, accurately identify the neutral in the wall socket, and connect it only to the common pin.

Notice in **figure 5** that W7OUS conects all of the contacts to the lamp and the lamp to the "high" side of the line. This would cover all the configurations. What I recommend is that you connect one lamp to just the coil and coil contact and connect at least one more lamp to the second and higher number contacts to check for contact activity. Most of us in the past have rigged up a vibrator test jig using a simple "suicide cord" with alligator clips and a single lamp and

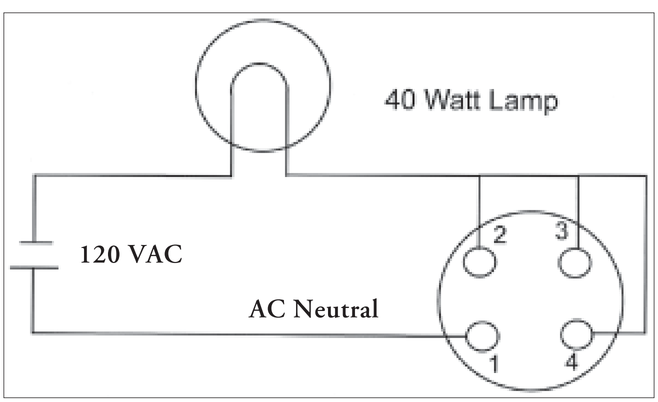


**Figure 5: Vibrator Contact Cleaning Circuit**

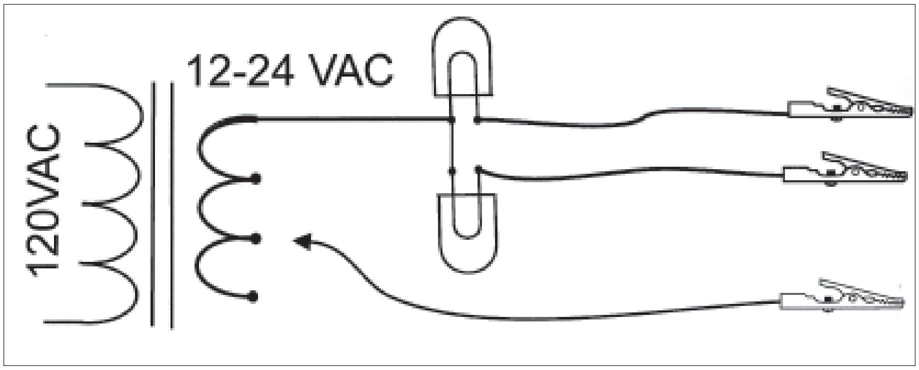


**Figure 6: Homebrew Simple Vibrator Tester**

plugged the cord into the wall and closed our eyes and hope that the vibrator will start humming and then wait for a couple of minutes and then pull the plug. Does it work? Sometimes, but it is somewhat dangerous.

The choice of lamps as previous mentioned should be 40 watts for 6 volts units then decrease the wattage and use 25 watts for 12 volt units, for 24 volt units try a 15 watt bulb. Also, there is no benefit to using anything larger than 12/15 watt lamps on any contact that is not switching the coil.

Sencore developed a unique unit to test vibrators. They made a small adaptor called the "Vibra-dapter" that had an octal-plug base that was inserted into the tube tester octal socket and the appropriate filament voltage was selected for power. The Sencore unit had two lamps. During testing, if both lamps glowed equally, you had a good vibrator.

I copied the circuit but used a tapped low voltage transformer to vary the voltage, 12 volts for testing and 24 volts for rejuvenation. 12 volt bayonet base lamps were used for the indicators. A typical test set up would be to use the bottom (tap) lead on pin 1 of a shunt vibrator unit (usually pin 1 the large pin) and attach the lamp leads to the contact pins 2 and 3 (smaller pins). Be sure and use the same voltage and type of bulb for each lamp. When testing a series vibrator you can add an extra lamp lead to feed the coil.

When using 60 CPS AC you can expect some detectable flashing of the lamps as the 60 CPS AC from the transformer or wall outlet is out of synch with the vibrator frequency which is typically 90, 100, or 115 CPS, so the lamps will flash at a rate in relation to the difference in frequencies. (The resulting mechanical vibrations and voltage across the contact helps clean the sulphate or sulfide from the contacts. I have found that playing with a vibrator at this low voltage often gets it started and then I let it run for 15-30 minutes. Some stubborn cases can take several hours. Then as a final check you can disconnect the test circuits from AC and feed the lamp inputs with DC to make sure all is OK and at the same time check the vibrator frequency with a scope across the feed point and one of the contacts.

### Finding the correct Vibrator for the AVA-126A power supply

The schematic of the AVA-126A power supply, with 7 leads of the primary going to the standard 8 pin octal socket, is very daunting and the confusion is the result of RCA using the power supply for different voltages. Jumpers in the base of the vibrator selected the proper windings for the voltage of the vibrator. You could solder jumpers underneath the chassis on the 8 pin octal plug, but I recommend putting the jumpers on your octal plug that you mount your replacement vibrator on and leave the power supply wiring original.

The original vibrator for 12 volt operation was a series type with an 8 pin octal base. The low voltage was fed to pin 4 to supply current to the vibrator coil. Pin 8, the vibrating reed or armature, was grounded. The switched outputs were on pins 1 and 7 and fed the primary windings of the transformer. As mentioned previously, the primary windings of the transformer are selected via jumpers contained in the vibrator base. See **figure 7** with an enlarged jumper diagram, and **figure 8**, the AVA-126A schematic.

Most of my vibrators that survived testing and rejuvenation were of the "shunt" variety and use only 3 of the 4 pins. The newer cans were slightly larger in diameter and height than the original. One pin (pin 1, one of the large pins) is for the flexible reed or armature and the other two pins are used for the two switch contacts that the armature comes into contact with as it vibrates back and forth. My most common vibrator speed in my junk box was 115 cps and there were several older models at 90 and 100 cps. I choose the newer 115 cps versions for the majority of my bench testing.

Note: Bench primary 12 volt power to turn on the vibrator circuit and hopefully produce the B plus high voltage can be activated by 3 separate circuits assuming that you have provided primary power to Board A (bottom) terminal 5 and ground. Any one of the 3 circuits below can be used to test the power supply. Detailed discussion of each terminal board is located at the end of this article. See figure 7.

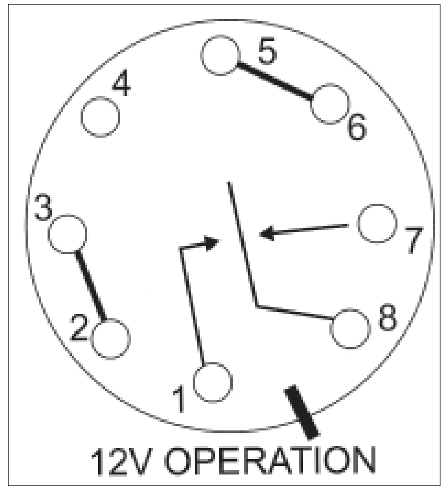


**Figure 7: Vibrator Base Diagram with 12 Volt Jumpers**

A. Board B (top) ground terminal 4. This is the remote control terminal and a relay should close.

B. Board A(bottom) ground terminal 4. This is the PTT terminal. Two relays should close.

C. Board B (top) provide 12 volts primary power to terminal 1. This will power the vibrator circuit. This 12 volts is normally supplied through the receiver ON/OFF switch when the receiver is powered from the power supply. No relays will close.

Important: Before you experiment with the AVA power supply, change the buffer capacitor that is shown as "C4" on the schematic. I repeat: Change the buffer, or as I prefer to call it, a timing capacitor. A good starting value is .02 µF at 1600

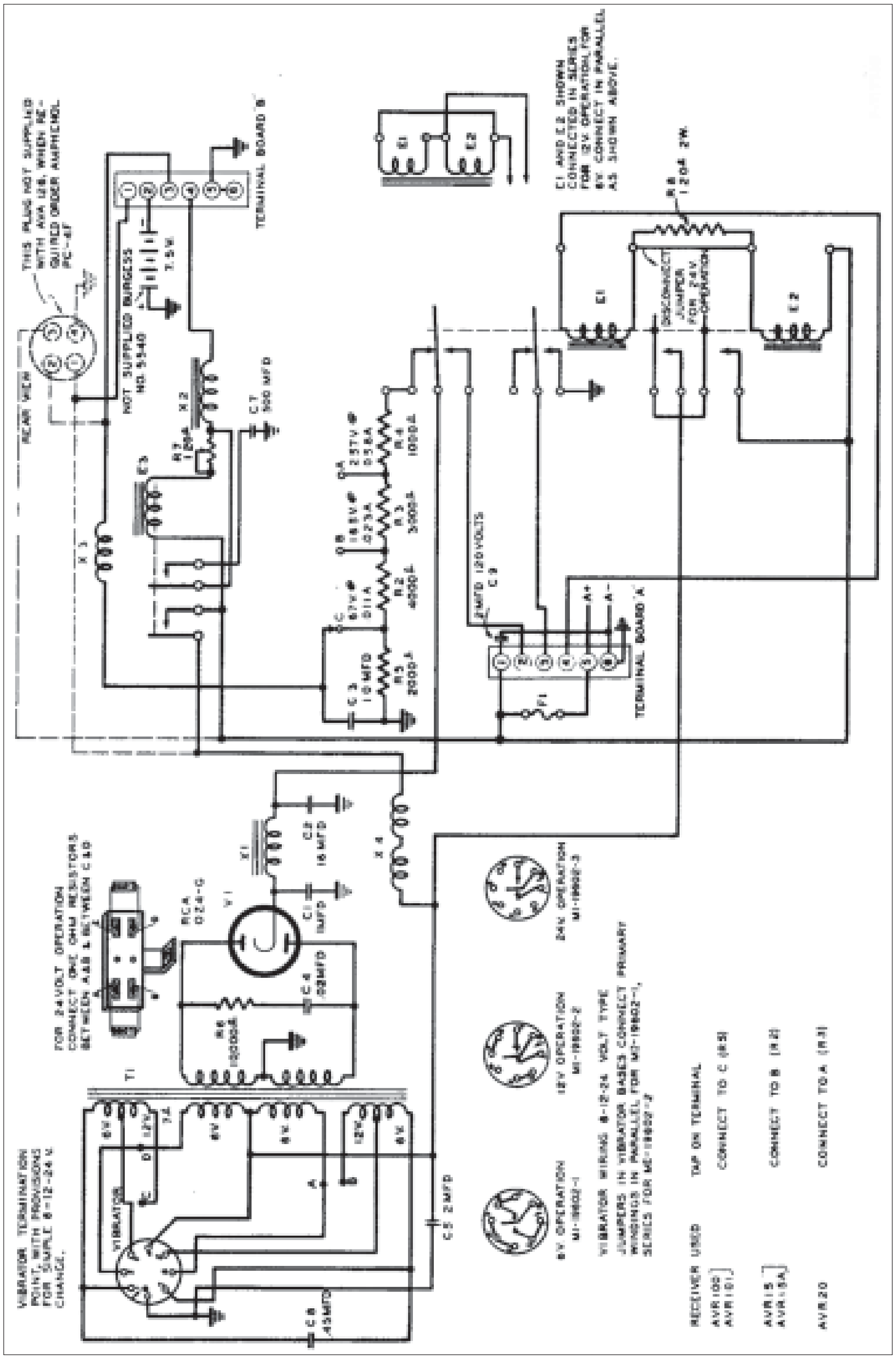

**Figure 8: Complete AVA-126A Schematic**

volts as shown on the schematic. Note: Power and connections to the terminal's boards are at the end of this article. Without a proper working timing capacitor, the vibrator's contact life and overall operation will be affected.

Once you have a working vibrator then you can fine tune the timing. With an oscilloscope, check "across" the primary and look for a smooth transition from square wave to square wave without any intermediate steps. Try monitoring the total DC input current without any load on the HV output of the power supply by pulling the rectifier tube, which will disconnect the filter capacitors as well as any load on the output. I personally prefer just to use total current consumption as a guide and ignore the oscilloscope patterns and adjust the timing capacitor for minimum current.

When fine tuning a power supply that uses the multi-contact, self-rectifying system you will not have a rectifier tube to pull to remove the entire load, in this case you will have to physically disconnect the filter capacitors and bleeder resistors, or the voltage dividers. By the way, when working on multi-contact type power supplies and substituting vibrators, you can always install silicon diodes as rectifiers and eliminate one set of contacts and use a simpler vibrator. Some technicians in the past, when installing buffer capacitors, used a decade type of test box that would select different capacitor values in calibrated steps for determining the correct value. Beware of the high voltages present.

After you have changed the buffer capacitor (You did change it, didn't you?), start your experiments with the AVA supply by making an octal plug for your test circuit with 3 leads terminating in alligator clips for shunt type vibrators or use 4 leads for series units. Don't forget to configure the primary winding jumpers on the test jig's octal plug, and then hook up the insulated leads with the alligator clips to the vibrator pins. Go back and look at figure 8. Note that on the schematic "CD" and "AB" are only used for 24 volt operations. During my testing, I tested both shunt and series vibrators and could not notice any difference in voltage output, ripple, or waveform. It is interesting to note that many military power supplies were designed to use both series and shunt vibrators.

Now comes the fun part. See **figures 9 and 10**. Take your newly tested vibrator and apply heat to the pins and shake the solder out. Then, gently break off the pins so they are flush with the base, leaving the internal leads exposed. Solder additional connecting wires from the vibrator to the octal plug. After testing the wired unit in the power supply, attach the connector to the bottom of the vibrator with a liberal amount of "Goop" that serves as both a mounting cement and an insulator. Let the Goop cure for 24 hours. Don't use Goop in the kitchen and go outdoors for curing due to the smell. "I do love the smell of Goop in the morning."

By this time you have probably decide to fabricate an adapter, for example, a 4 pin socket to an 8 pin plug. However, there is not probably not enough vertical room for the adapter and the vibrator in the power supply, especially if you have a newer type of vibrator that is slightly longer than the original. The power supply's outer case will accommodate the height of the newer vibrator if care is taken in construction of the base and your application of the Goop. After

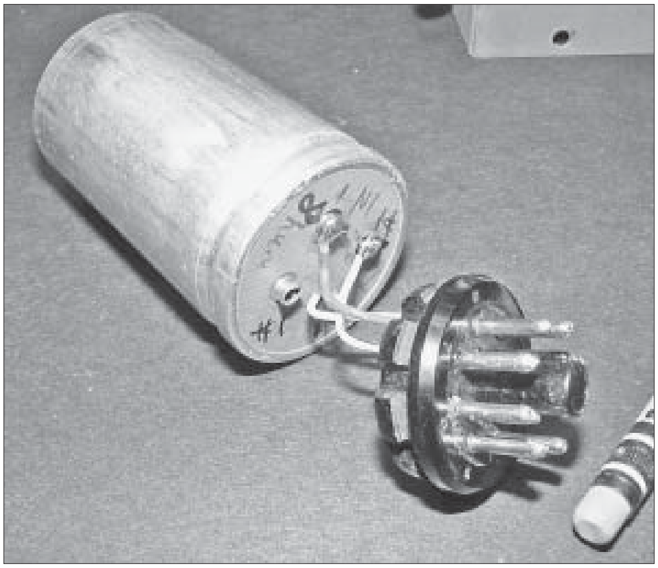

**Figure 9: Vibrator with Pins Sheared and Wired to Plug**

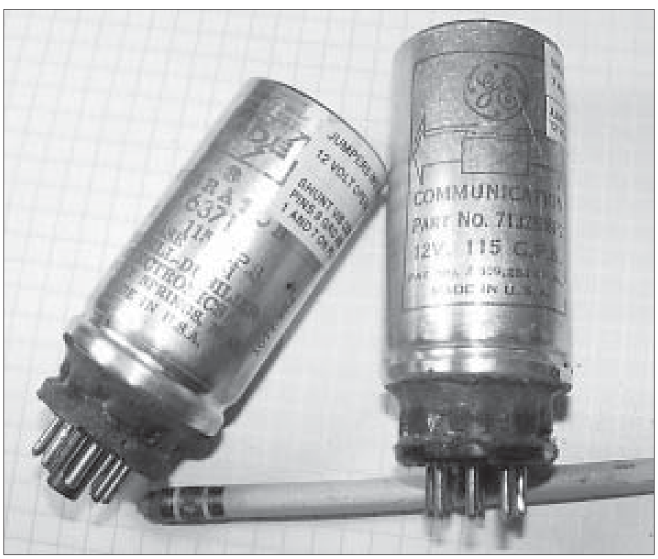

**Figure 10: "Goop" Adhesive Applied To Vibrator and Plug**

applying the Goop, try to compress the space between the bottom of the vibrator and the 8 pin plug.

Note: In most cases, your substitute vibrator will not be grounded via the chassis clamps and it may be necessary to attach a ground wire to the vibrator case to help with hash elimination. A simple hose clamp can be used for the ground wire attachment. When bench testing with the cover off of the power supply expect to have the hash noise level above normal.

**Final Power Supply Tests**

My power supply worked very well with the substitute vibrators. After replacing the timing (buffer) capacitor and several of the filter caps the supply started easily, even on lower voltages of 6 to 7 volts. Best of all, the supply now makes that nice humming sound and whole work bench vibrates just like that bed in the motel. After connecting the AVT-112A transmitter and the AVR-20-A receiver I ran several bench tests and found that my power supply's performance measurements were very close to published specifications. Initial voltage input to the power supply was 12.0 volts measured at the terminal strip. Use fairly large wire for your primary input to avoid input voltage loss due to resistance. In the "Stand By" position with the vibrator running and no load on the high voltage outputs the input current was slightly less than 1 amp.

A no-load transmit voltage with transmit PTT relay closed was 350 volts. When transmitting with the AVT-112A the input drain was 7.4 amps and AVT-112A transmitter power output was 6 to 7 watts on 3885 kcs, which agreed with published specifications in the manual. An additional bonus is that the newer vibrators are much quieter than the older ones.

**Modifications**

The only modification I made was to add a 100 µF capacitor to the output of the rectifier, just prior to the choke X1. This reduced my peak-to-peak ripple voltage from 3 to 4 volts, down to less than one-half (.5) volt. The OZ4 cold cathode rectifier tube comes in several versions. The metal case version may require that you loosen the nut holding the large power resistor (R7) and move it slightly to accommodate the base of the OZ4. The OZ4 can be removed and two 1000 PIV diodes inserted in its place and you will gain an additional 15 volts on the high voltage output.

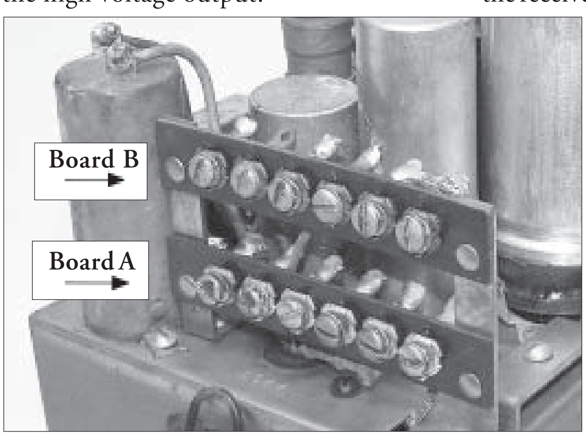

**Figure 11: Close-Up View of the Terminal Board**

**Power Supply Terminal Connections and Power**

There are two terminal boards. B is the top board and A is the bottom board, just the opposite of what you would think. (A would be on the top and B on the bottom.) But, I am easily confused.

The following information on the terminal boards A (bottom) and B (top) is provided. Each terminal board has 6 connections and is numbered. The reference is to figure 8, the AVR-126A schematic. Also see **figure 11**.

**Board A (Bottom) Terminals 3-6**

1. Provides primary 12 volt power to transmitter (pin 7) and receiver (pin 3) via fuse F1. This prevents the filaments from being on all the time.

2. Supplies high voltage to transmitter (pin 9).

3. Side tone control for transmitter (pin 5) Used when transmitter is put into interphone (ICS) mode.

4. Push-to-talk line receives PTT ground from transmitter (pin 8) to activate relay E1 and E2. Relay E2 can provide primary power to the vibrator circuit. E1 switches the high voltage from the receiver to the transmitter and another set of contacts on E1 provides a ground for the sidetone circuit when interphone mode has been selected on the transmitter and terminal 3 is used to switch the audio on and off. Confused yet?

5. This is positive 12 volts primary power input for the power supply vibrator circuit and receiver/transmitter filaments and relays. It is fused

via F1.

6. Ground and Minus 12 Volts (Chassis is ground.)

### Terminal Board B (Top) Terminals 1-6

1. Connected to receiver (pin 1) and provides power from the receiver to power the vibrator circuit. When receiver "ON/OFF" switch is turned on the filaments are powered and the supply vibrator circuit is activated.

2. Bias Battery Connection: Is not used for the AVR-15(low frequency) or AVR-20-A (high frequency) receiver and is used for the AVR-100 series.

3. Provides high voltage to receiver (pin 1). Voltage is determined by resistor taps. See the figure 7 schematic.

4. Provides remote control of the power supply, when grounded it will activate vibrator circuit via relay E3. Note: This is for remote control of the power supply normally the power supply is activated by turning the receiver to "ON," which provides 12 volts to terminal 1 of board (B).

5. Ground: Rreceiver Ground (pin 4).

6. Ground

### Conclusion

My discovery that you can use either "shunt" or "series" vibrators in the RCA AVA-126A power supply allowed me to expand my search and find several vibrators that performed very well and I now have a complete functional supply that hums and buzzes happily. I now have more vibrators spares than I will ever use. My vibrator quest has been interesting and perhaps my vibrator phobia is slowly fading away as a result of my bench therapy, and as a bonus I have added the ability to determine the exact frequency of a vibrator by feel or sound to my personal skill set. Now, if only I had that 1950 Packard!

### Thank You

A special "thank you" goes to my good friend, Mr. Robert Downs (WA5CAB), a military radio collector and aficionado. Robert has repaired more military radios and vibrators than any one on this planet and has assisted hundreds of radio amateurs and military vehicle owners. He is a collector, historian, and electrical/radio engineer with superb bench skills and shares his knowledge and time without hesitation. He can provide the best and most professional reprints of military manuals and technical orders and, as my wife can attest to, they do not smell musty! Robert provided many of the technical details of this article and edited portions thereof, but is not responsible for my grammar and my 8th grade writing skills.

<u>Reading List</u>:

1. P.R. Mallory & Co, <u>Vibrator Power Supplies, Fundamental Principles</u>, Date Unknown

2. Bryan Goodman, <u>Vibrator Power Supplies</u>, QST, Nov 1941

3. Bryan Goodman, <u>Vibrator Power Supplies, The Mobile Manual</u>, ARRL 1962

4. LeRoy Parris, W7OUS, <u>Cleaning Vibrator Contacts</u>, QST, March 1957

4. AN 16-30ARN6-3 or T.O. 12R5-3ARN6-2, <u>Handbook of Maintenance Instructions, Radio Compass AN/ARN-6</u>

***ER***