1.25.7 Air Exhaust

There isn't a simple way to exhaust the heated air from the plate compartment other than to provide the least restriction after it leaves the anode. I use an Eimac SK-1906 chimney (2 of them). Saw each chimney in half, bolt one half to the plate stripline and the other half to the cover over the plate compartment. Use a piece of 0.030" Teflon sheet rolled up and fastened with a couple of 1/8" rivets as the chimney between the two halves of the SK-1906

1.25.8 Construction

The anode compartment is 12" x 9" x 4-1/2" deep, the cathode compartment is 6-1/2" x 3-7/8" x 2" deep. Placement of the cathode compartment will depend on the relationship of the length of C2 plus the length of L1. C2 has to be mounted to the wall of the compartment with the height of the stator plate support rods matched to the height of L1. The cathode compartment should have at least 3 holes drilled somewhere around the sides to exhaust the air from the drilled aluminium blocks mentioned under "Cooling" A cover is required over the cathode compartment and one over the plate compartment. The plate compartment cover has to have screws spaced no more than 2-1/2" apart to hold it down and to provide good RF seal and air seal. The tube sockets are mounted 3" from the 9" end of the plate compartment, spaced 3-1/4" apart. The sockets require a 1" hole for each. The plate tuning flapper is mounted on a 1/2" x 1/2" aluminium bar, drilled on each end for 1/4" aluminium rod that will serve as pivots in Teflon 3/4" x 1-1/16" blocks. The aluminium bar is spaced 13/16" from the chassis. A piece of 0.005 brass shim is fastened to the bar and the chassis such that spring action afforded that will push the flapper up. The flapper is 2-5/16" x 6-9/16" and is made from aluminium. The actual tuning mechanism will have to be made up by the constructor, describing it is beyond the space available here.

1.25.9 Notes

If you tackle this project you will be pleasantly surprised at how easy the amplifier works, docile too! However, this amplifier will produce a surprisingly large amount of power, sufficient to melt many things, especially coax! Whatever high-voltage supply is used will have to supply at least 1+ Amperes readily. The supply B- has to be floating above ground and a B- lead run from the power supply to the amplifier along with a ground lead that is connected to the power supply chassis ground. Keying requires 12 VDC and the source should be capable of supplying 120 mA.

1.26 Hi-Power Hybrid

Tim Pettis KL7WE - May 1988

Would you like to run the legal power limit on the VHF and UHF bands without mortgaging your home? There IS a way to make the jump to higher power without starting all over. You need not rush out and buy a brand new 8877 or equivalent! You can use what you have and just add to it.

Using hybrid rings one can combine any two amplifiers having similar characteristics. A common amplifier on 144 MHz is the K2RIW using a pair of 4CX250's. It's output is a comfortable 750 W on CW. Two of these amplifiers can be connected by hybrid rings to produce the 1500 W legal limit. For less than $25.00 worth of parts (at new prices), one can produce a pair of hybrid rings. A venerable old RIW can be purchased with power supply for less than half the price of an 8877 tube alone. I have combined a pair of 432 MHz ARCOS amplifiers using Amperex DX393A's (Eimac 8930). The combination produces 1500 W output power.

1.26.1 Theory

The ring consists of 6 electrical quarter waves as shown in the diagram. A signal at port "A" will be equally divided between ports "B" and "C". Zero power will appear at port "D" The phase relationship at port "B" is -90° and port "C" is -270°. Power arriving at port "D" from port "A" via port "C" is -360° relative to port "A".

Power arriving at port "D" from port "A" via port "B" is only -180° relative to port "A". The result is that at port "D" the signals are 180° out of phase and cancel.

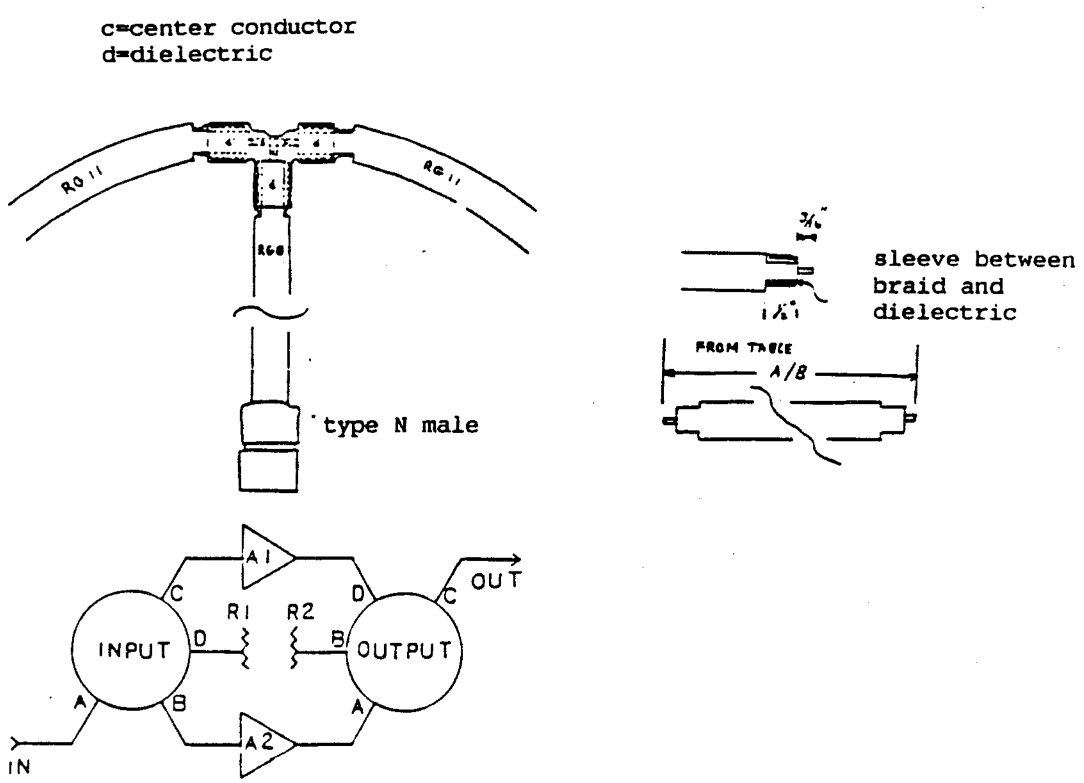
Power to the output ring is fed into port "A" and port "D". Power fed into port "A" arriving at port "D" via port "B" is 180° out of phase with that arriving via port "C". The net result is that power from one amplifier is not fed into the other. Power arrives at port "C" in phase as a result of the 180° phase difference that exists in the input ring.

The advantage of this method is that the input ports of the output ring are isolated from one another, preventing meltdown of one of the amplifiers should the other go dead.

In the event of an open at either input drive port of the output ring, one half of the drive will go to output port "C" and the other half will be sent to port "B".

For this reason the output ring termination must be capable of dissipating 50% of the power of either amplifier. That is to say that if you combine two amplifiers capable of producing 500 W each, the terminating resistor must be rated at 250 W. Port "D" of the input ring must be terminated in a load capable of dissipating 50% of the drive power. The ring itself is made of 75 ohm line. Each quarter wave section joined to the next provides a match to 50 ohm in just the same way that it is used to transform impedances in a two way power divider.

Figure 1–28: KL7WE Hi-Power Hybrid



1.26.2 Construction

The input ring can be made of high quality RG 59/U. The output ring can be made with conventional RG 11/U. The physical length of the lines can be calculated using the dielectric constant. The length for each band is given in Table 1–2. (This calculation is made for a velocity factor of 0.66.) The input ring can be constructed in a metal chassis box using BNC chassis connectors. Grounding is important! The braid should be joined as close to the end of the coax sections, and hence the connectors, as possible.

Table 1–2: Sizes for Hi-Power Hybrid

Band	Length A	Length B
432 MHz	4.5"	13.55"
220 MHz	8.86"	26.58"
144 MHz	13.50"	40.60"

Sizes are for a velocity factor of 0.66

A word of caution is in order. One might be tempted to try to construct the ring using coaxial T-connectors. **Don't do that !!** First, it is difficult to determine the velocity factor of that combination. Second, the impedance of most T-connectors I've found is unpredictable, and a good match is not possible, especially at 432 MHz . . .

It is necessary to get the phase relationships in the output ring as close as possible or there will be power transferred from one amplifier to the other. To join the 1/4 wave and 3/4 wave, RG11 sections of the ring to RG8 pigtails in a practical and repeatable manner took a little thought. The problem is solved by using copper water pipe T-connectors. 1/4 inch fittings have about the right inside diameter. The ring can therefore be connected to amplifiers antenna and termination without incurring extra losses. This is especially critical at 432 MHz and higher.

Begin construction by cutting 3 lengths of RG11 coax to dimension "A" and one end to dimension "B". Take care to blunt cut the end so that the strands of centre conductor remain together. Remove 3/16 inch of outer jacket, braid and dielectric from each end of the sections. Remove 1/2 inch outer jacket. Select a convenient length for the RG8 pigtails and cut 4 equal lengths. This should be not more than 18" at 432 MHz. Prepare one end as described above for the RG11. Install a type N male connector on the other end.

Cut 12 sleeves of 9/32 inch thin wall hobby shop brass tubing 1/2 inch long. Carefully slip the tubing between the braid and the dielectric. Smooth the braid down over the tubing and solder the braid to the brass. Be sure to use a low wattage iron for this purpose to avoid distorting the dielectric. Use of excess solder will prevent slipping the coax into the water pipe T-connector. Drill a 1/4 or 5/16 inch access hole in the top of the waterpipe T-connector. Be sure to deburr the inside of the hole. Slip two RG11 ring segments and a RG8 pigtail into the T-connector so that the 3 centre conductors meet exactly in the middle of the connector. Use the natural curvature of the coax to help form a ring. Use some means of holding the work in place. Heat the body of the T-connector allowing solder to flow inward around the circumference of the braid. You will find that the underlying brass sleeve will extend outside of the T-connector providing rigidity and a means of containing the solder. Solder the three centre conductors together. Make sure that you have a good connection here. Cover each joint with heat shrink tubing as you go. Repeat to complete the ring.

1.26.3 Testing

Each ring should be tested to insure symmetrical power division. This is best done with low power. Power division between ports "B" and "C" should equal and result in negligible loss of power. Next connect the rings together without the amplifiers. The total loss through the combined setup should also be negligible. For a 10 W signal, the total loss through both rings should be on the order of less than 0.05 W. Finally check the power of port "D" of each ring. Again more than 0.05 W out of the isolation port would indicate possible trouble. If you have access to a sweep generator, you can measure the symmetry and isolation of the hybrid by inserting a signal at port "A" and detecting the output at port "D". At the design frequency and only the design frequency, the power at this port should be in the order of 27 dB down. Multiple notches at this port indicate lack of symmetry (measure lengths carefully). For comparison the isolation of the input Combiner made of RG59 had better than 27 dB isolation from 400 to 440 MHz rising to 26 dB at 450 MHz.... The output ring exhibited similar characteristics.

When finally connecting the amplifiers, remember that the connecting lines between the amplifiers and both the input and output rings must be the same length. This assumes that both the internal input and output circuitry of the amplifiers is the same. Some amplifiers may use a short section of coaxial cable to connect from the RF input connector to the actual grid circuit, or equivalent. Especially in home-brew amplifiers this cable length may vary. This is not a problem. The internal lines can be made the same length, or the external lines can be made longer or shorter to compensate. All checks having been made, you are ready for final connection.

1.26.4 Final Thoughts

I had been reluctant to commit to the use of other than air dielectric line for the output ring for reasons of efficiency and possible component failure. However the temporary output ring has been in service for over 150 EME contacts during a 4 month period. Although there is some heating at the output port "C" after prolonged operation, it is not seemed serious enough to expect a failure at this junction. All others are cool. The caveat applied here is that the load (antenna) connected to the output of the ring be reasonable close to 50 ohm. I would also not expect one to use this ring for continuous service. SSB and CW provide no threat unless you are prone to lay a brick on the key to tune up. I suggest sending a series of 'dits' at 40 WPM.

1.27 A Bias Circuit for 7289 or 2C39 alikes

Rusty Holshouser K4QIF - June 1988

This circuit provides protection from thermal/detuning run away in terms of limiting the cathode current that may be drawn by any tube in the lineup. Also, cathode bias increases with drive cathode current. This will improve efficiency especially with high power CW operation. The circuit will have to be duplicated for each tube in the amplifier with the exception of the transmit enable relay and metering switch. The +25 V and 50 VDC supplies can also be common and do not have to be capable of much current. Q1 is the cathode current limiter. It is saturated until it becomes starved for base current at which level, its emitter to collector voltage increases and drives the cathode bias up. Q2 sets the bias level at the idle current.