VE3GK

HIGH RANGE HF LINEAR AMPLIFIER 160 THROUGH 10

BACK

THE TWO gk..4CX1000A AMP CAPER

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INTRODUCTION

The following is a brief description of a special 160 to 10 meter HF amplifier that I designed and constructed several years ago and redesigned and updated last winter. The amplifier originally covered from 80 through 10 meters and was very small in size for the power output. Actually, the unit is the same size as the old *Heath SB200 or Collins 30L1 amplifier*. The power supplies and remote blower are not included of course. New construction techniques were required to fit all the extra stuff in. I used two miniature vacuum relays to switch in extra capacitance for the input tuning. I also re-routed the PI network connections and relocated the band switch for a more efficient network. The

other new technique was inlay PC board on the old aluminum chassis which made for a more positive return ground anchor system.

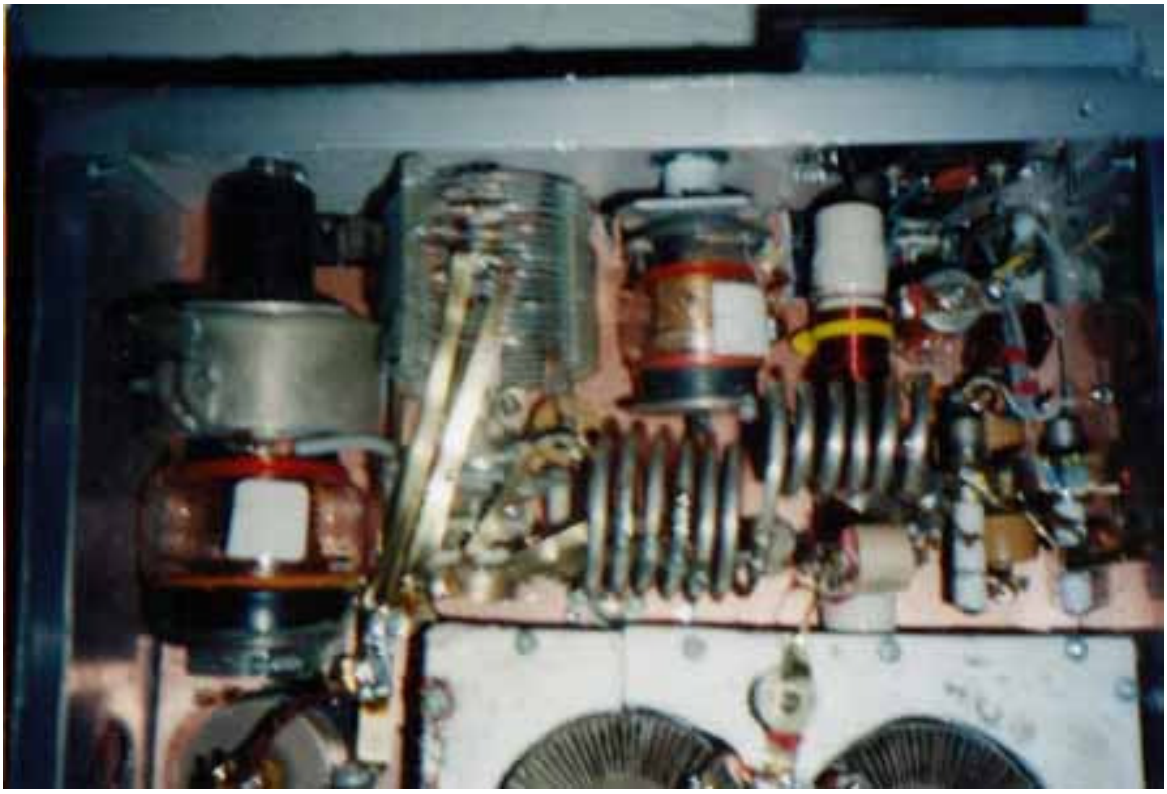
Remember, run the amplifier legal and be cool.

[VACUUM EVERYTHING]
Looking down into the amp.

THE VE3GK 20 DB HIGH FREQUENCY AMPLIFIER

With two 4cx1000a tetrodes tubes in parallel, there is lots of reserve power to generate a very clean signal. The tubes are ceramic-metal, with forced air cooling. Cooling consists of a remote positioned large blower on a long hose which make things very quiet. Each tube has a

plate dissipation of 1000 watts, for a total of 2000 watts in this amplifier. 4cx1000a tubes are designed for exceptionally low inter-modulation distortion in SSB service. This particular amplifier requires about 10 watts of drive power in practice for 1000 watts of output power with only 1200 volts on the plates which works out to a gain of 20 db. With slightly more drive power and with the rated 3000 volts on the plates the output power runs cool at the legal power limit.



THE TWO SMALL VACUUM RELAYS (WHITE) THAT SWITCH IN THE EXTRA INPUT CAP ARE JUST ABOVE THE RIGHT 4CX1000A IN THE ABOVE IMAGE. THE HIGH POWER VACUUM RELAY IS LOCATED JUST BELOW THE LARGE 1000 PF VACUUM OUTPUT PI NET CAP. THE LARGE COILS ARE SILVER PLATED. THE BAND SWITCH IS LOCATED JUST ABOVE

THE LEFT CORNER OF THE TEFLON TUBE COVER FOR MORE EFFICIENT CIRCUIT PATHS ABOVE 80 METERS.

The ceramic band switch is positioned to the back of the output vacuum variable so that there is a short path on the bands above 40 meters. Strapping is also used for the switch connections rather than wire.

GENERAL INFORMATION

The control grids are driven in the passive mode, across a 50 ohm, 40 watt non-inductive resistor network, consisting of 20, 1000 ohm 2 watt carbon resistors in parallel.

Two, re-modeled Eimac SK600A tube sockets were used to allow the tubes to be mounted closer together. The PI network design uses two vacuum capacitors in the PI network and a vacuum relay to switch the output power. The tank coils are silver plated

above 30 meters for greater conductivity. The screen voltage is relay controlled and is switched out in the stand-by mode. Switching off the plate supply releases control of the relay voltage and the amplifier is by-passed out of the circuit for bare-foot operation. The screens of the tubes are physically connected to the chassis and the cathodes [filaments] are isolated 300 volts below the chassis reference. The isolated cathode point [the filament] is the anchor point for the plate negative lead, the screen negative lead and the control grid positive lead. In effect the output cavity is isolated from the input cavity so the amplifier is very stable. The filament circuit uses an auto transformer so that the filament voltage can be adjusted for the lowest operating current. The ALC circuit consists of two miniature audio transformers, one in each grid bias line. These transformers raise the voltage derived from any fluctuating grid current. This voltage is rectified, and connected in series to form the ALC source voltage. Both the negative and the positive leads are isolated and brought out of the amp. They also are connected to the front panel meter on one of the switch positions to observe any over-drive condition.

The amplifier covers all of the HF bands including top band, 160 meters. To achieve this, I used two miniature vacuum relays to remotely switch two 5kv, 500 pf door knob capacitors in series to ground in the input of the PI network. One relay switches in the series value of 250 PF and the other connects only one of them for a total of 500 PF. The

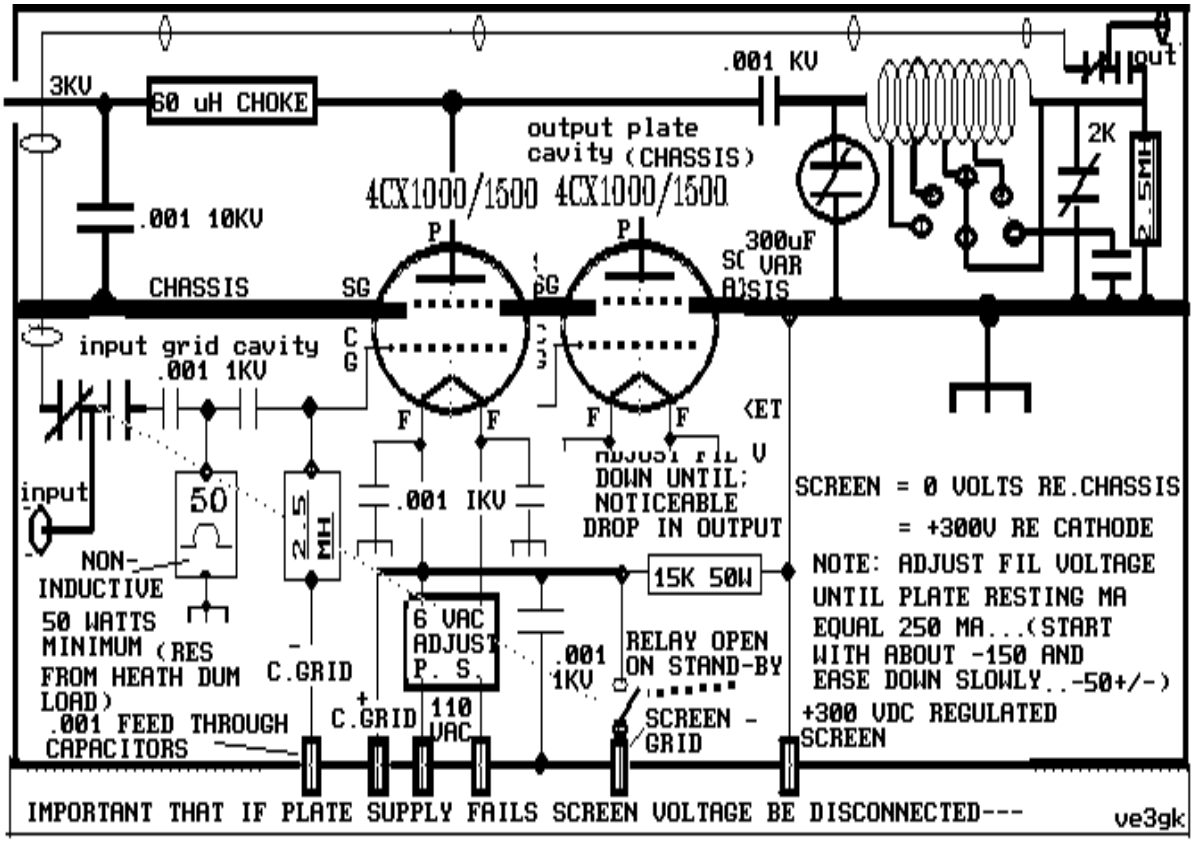
input vacuum variable has a value of 250 PF so I now have a choice input capacitance of a, minimum to 250 PF b, 250 PF to 500 PF and c, 500 PF to 750 PF. The output has available, three sets of output PI network capacitance: a, the 1000 PF from the vacuum variable b, "a" plus 500 PF door knob for a total of 1500 PF and c, "a" plus two 500 PF in parallel for a total of 1000 PF and a grand total of 2000 PF. This extra capacitance allows me to cover all of top band.

Because the control grid in the 4CX1000a is located very close to the heater/cathode, if more volts on the filaments are used than required, the grid usually starts to act like a second cathode and emit electrons. This condition shows up as negative grid current. To compensate for this, the applied filament voltage should be lowered and, in turn, the applied heat can be reduced. The technical term for this is called "poisoning of the control grid". In my case I found that 5.7 volts is all I require on my particular tube filaments to achieve stability and eliminate negative grid current. Remember, the filament wattage or heat varies as the square of the applied volts. In practice if you reduce the volts by 3 percent, the wattage or heat is reduced by 9 percent. I arrived at this [5.7v] amount by observing the output power on my Bird 43 wattmeter while reducing the filament volts, and when the power output starts to fall off I raise the volts slightly to achieve a stable output.

Missing or additional circuitry can be found in any of the amplifier hand books or by E mailing me at; ve3gk@rogers.com .

As you can tell I used Adobe Photoshop to drop in another tube in the diagram below. Just hook up the filaments in series or parallel and connect the plates together with the proper parasitic suppressors. Missing are the two variable voltage power supply for the grid bias, actually one power supply with two voltage dividers. This dual voltage control is essential so that each tube can be set up to obtain 250 ma resting current for a total of 500ma for class AB1 operation. This is accomplished by varying the applied control grid bias negative voltage. Start out with about -150 volts negative, which will bias the tube so the plate current is cut off. Now, very slowly decrease the amount of negative bias until the plate current reaches 250 ma. Because the grid voltage ratio to plate current cur4ve3 is so steep here the rise in plate current is dramatic. That is the reason the tube has such a high gain factor. With 5 watts of drive power across a 50 ohm load with only 2000 volts on the plate the output power in this amplifier is 1000 watts for a gain factor of about 22 dbp. This amplifier has 14 pi network coil switch positions so I didn't worry that much about the new plate circuit configuration, I just selected the position that resulted in the best output signal and recorded the switch position. I also reduced the resistance value of the 15K 50W connected from the screen grid positive lead connected to the chassis to the common return, the filament to 2k ohms at 50 watts for better stability. You have to have a regulated screen supply to accommodate the extra power drain.

SINGLE 4CX1000A AMPLIFIER DIAGRAM SHOWING THE SCREEN GRID CHASSIS CONNECTION WHICH PROVIDES MAXIMUM ISOLATION BETWEEN THE OUTPUT PLATE CAVITY FROM THE INPUT CONTROL GRID CAVITY . THE HEAVY LINE REPRESENTS THE CHASSIS


3KV
60 uH CHOKE
.001 KV
out
output plate
cavity (CHASSIS)
4CX1000/1500 4CX1000/1500
2K
2.5MH
.001 10KV
P
P
300uF
VAR
CHASSIS
SG
SG
input grid cavity
.001 1KV
C
G
F
F
F
F
input
50
2.5 MH
.001 IKV
DOWN UNTIL:
NOTICEABLE
DROP IN OUTPUT
SCREEN = 0 VOLTS RE.CHASSIS
= +300V RE CATHODE
NON-
INDUCTIVE
50 WATTS
MINIMUM (RES
FROM HEATH DUM
LOAD)
15K 50W
NOTE: ADJUST FIL VOLTAGE
UNTIL PLATE RESTING MA
EQUAL 250 MA...(START
WITH ABOUT -150 AND
EASE DOWN SLOWLY..-50+/-)
6 VAC
ADJUST
P. S.
.001
1KV
RELAY OPEN
ON STAND-BY
C.GRID
C.GRID
110
VAC
SCREEN -
GRID
+300 VDC REGULATED
SCREEN
.001 FEED THROUGH
CAPACITORS
IMPORTANT THAT IF PLATE SUPPLY FAILS SCREEN VOLTAGE BE DISCONNECTED---
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Stay tuned for more information as I still have to gather all the pages of notes and schematics together in a more presentable clear format. The power supply re-fit is next on the winter schedule and I hope to have images of all the individual supplies so

Very 73

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