

**THE COMPLETE BOOK
OF
SB-220 MODS**

Compiled By
Robert Kozlarek
WA2SQQ


Preface

Over the years certain pieces of equipment never seem to age. About eight years ago HEATH introduced the SB220. It then sold for \$349-by today's prices a great buy. About three years ago I made the decision that it was time to look for an amplifier, so plans were made to attend the Dayton Hamvention and find an amplifier. To my surprise there were none to be found! How could this be? Well, to make a long story short, it took me about a year. There were ads in QST, but I was always too late and the going price was always about \$400. Not a bad investment-buy an amp, use it for a few years and make a profit. Today's units do have more bells and whistles, more expensive tubes, and of course much higher price tags. This was also about the time I got involved in Packet radio on 2 meters. Then the idea hit me-why not use this new aspect of amateur radio to see what other 220 owners have done over the years to keep'em running. Within a month the info poured in and this collection began to take form. It made its debut at the 1987 Dayton Hamvention, where about 500 flyers were distributed. Ads in 73 and Ham Radio followed. Hams from 32 countries and 46 states have purchased this collection all of which have been satisfied. Many new ideas were also submitted, some of which were added to the collection. To promote new mods, I offer a one time 50% rebate for those who submit new ideas which are used. I also realized that you can't find parts as easy as you once could, so I found sources for the "hard to find items". To put the frosting on the cake, I also include two free updates- a total of six new mods which are sent as they become available.

Most of the mods have been installed in my SB220 with great results, but it must be noted that because installation techniques and ability will vary from person to person, no implied warranty is offered, nor shall I be responsible for damages to person or property of those who purchase it. The information presented is offered in good faith to promote the hobby of amateur radio. For your safety please follow these guidelines:

- *Disconnect power and antenna lines from the SB220.
- *Discharge the filter caps for several minutes prior to starting.
- *Remove the two 3-500Z's to avoid breaking them.
- *Never try operating the SB220 with the RF cage open or the case off.
- *If in doubt, ask a friend or drop me a line-(SASE please!)
- *Double check your work-haste makes waste!

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SECTION 2

EIMAC 3-500Z TECHNICAL DATA

HEATH SB-220

High Frequency Linear Amplifier[©]

Number:

-1-

Date:

March, 1987

Description of modification:

Submitted By:

IMPROVED PARASITIC CHOKES PC1,PC2), TO MINIMIZE ARCING WITHIN THE MAIN TUNING CAPACITOR (C55).

WA2SQC

List of required parts:

6ea. 100 ohm 2 watt carbon resistors
12" #18 copper wire

Procedure:

The Heath SB-220 is very prone to arcing within the main tuning capacitor (C55), especially while operating on the 80 and 40 meter band. This simple mod will in most cases eliminate or greatly reduce this from happening.

Start by taking two of the six resistors and space wind $3\frac{1}{2}$ turns of #18 copper on each of them.

Next take two of the remaining four resistors and put them in parallel with one of the two resistors prepared in the previous step.

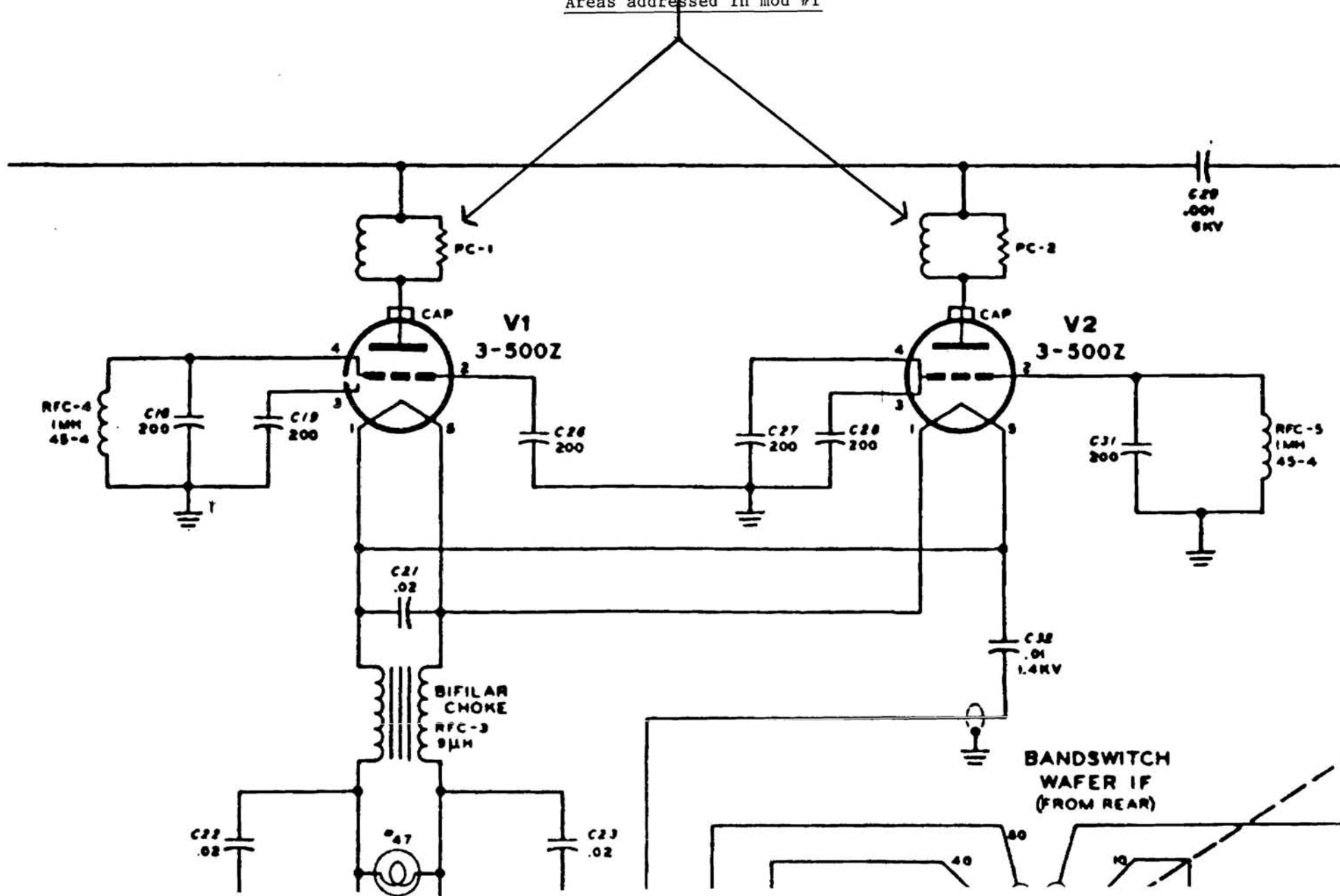
Repeat this procedure once again to fabricate the second completed choke. These two new units should be installed in place of the original PC1 and PC2. Position the chokes so that they are "tucked down" closer to the tube than the originals were. In Heath's original design, these were positioned away from the tube, but later changed to this position.

You may refer to the next page where a schematic has been provided to locate the components used in this modification.

REMEMBER THE VOLTAGE PRESENT WITHIN THIS SECTION IS DEADLY. DEATH IS A PERMANENT CONDITION. MAKE CERTAIN ALL POWER SOURCES HAVE BEEN DISCONNECTED AND ALL FILTER CAPS DISCHARGED FOR A MINIMUM OF 15 MINUTES.

Thats it!

Areas addressed in mod #1



HEATH SB-220[©]

High Frequency Linear Amplifier

Number:

-2-

Date:

January, 1987

Description of modification:

INCREASED RELIABILITY OF POWER SUPPLY.

COMP.

Submitted By:

WB2PAG

List of required parts:

14ea- 1000 PIV-2 amp silicon diodes

14ea- .01 1000vdc disc caps.

14ea- 470k $\frac{1}{2}$ watt carbon resistors

Procedure:

Probably the weakest area of the Heath SB-220 is the power supply. While normal use does not cause any problems, operation while using SSTV or RTTY has caused many a smoky shack. Heath in their design has chosen to use large "strings" of series diodes, and to add insult to injury, never provided any form of surge protection, or attempt to equalize the voltage across each diode. This is the foundation for this mod.

After carefully discharging the power supply for at least 15 minutes, carefully remove the power supply rectifier board. You may find it easier at this point to "pull" the front panel away to gain more access to the circuit board. Carefully remove all 14 diodes. Depending on the particular devices used, you may have to slightly enlarge each of the 28 holes used to mount the diodes. This would be a great time to use a solvent, such as FREON TF, and clean up all the old flux. Take special attention to get the polarity correct. A mistake here will spell the end once the power is applied. The next step is to install one 470k resistor, and one .01 capacitor across each diode. I found it best to mount the resistor on the foil side, and the cap. on the component side.

Lastly, using the manual's original instructions, reinstall the rectifier board ass'y back into the amplifier.

That's it!

REMEMBER THE VOLTAGE PRESENT WITHIN THIS SECTION IS DEADLY. DEATH IS A PERMANENT CONDITION. MAKE CERTAIN ALL POWER SOURCES HAVE BEEN DISCONNECTED AND ALL FILTER CAPS DISCHARGED FOR A MINIMUM OF 15 MINUTES.

Please refer to the following page where a schematic has been provided to aid you in this modification.

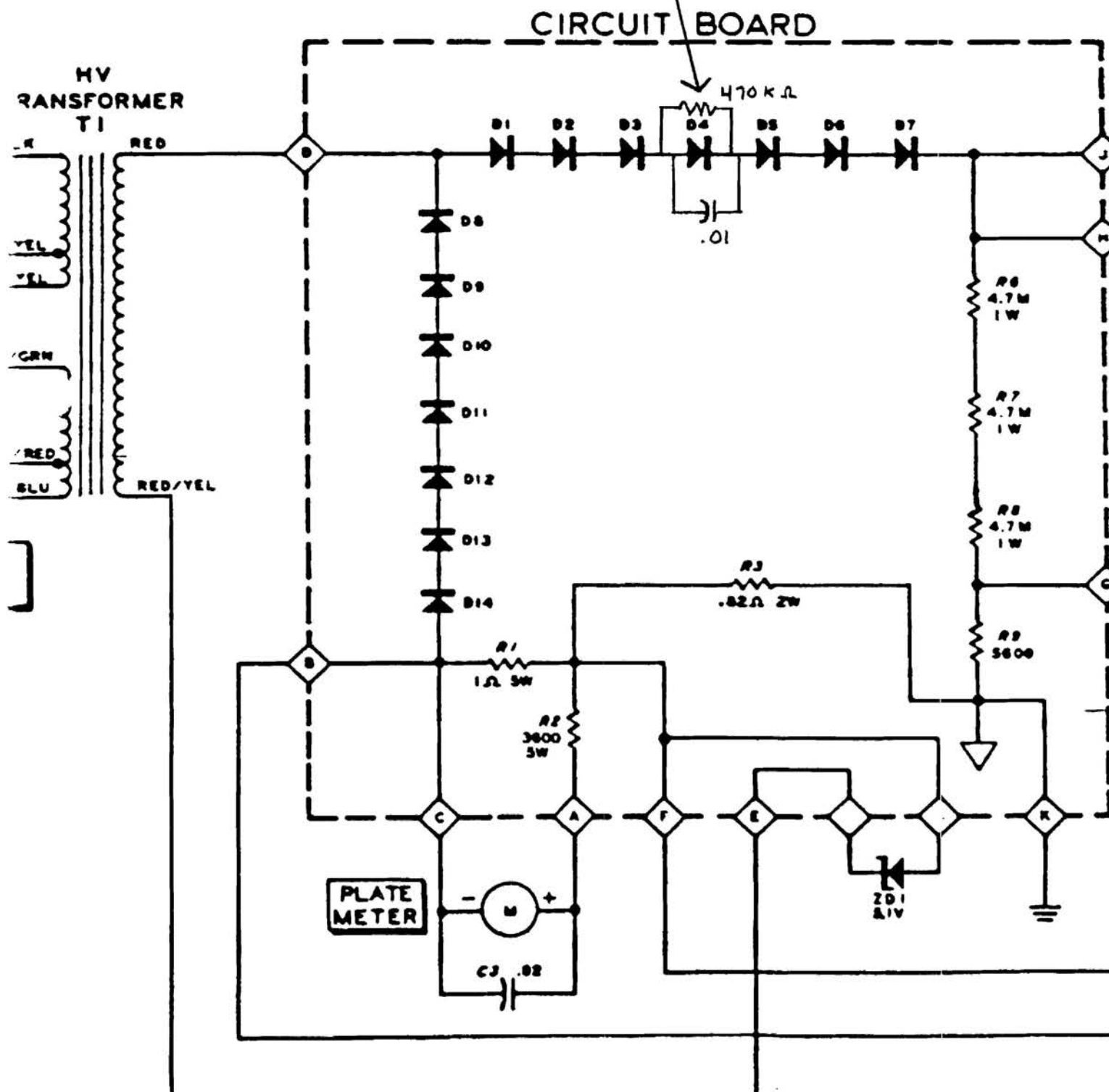
INDICATES A CONNECTION TO CIRCUIT BOARD

INDICATES A CONNECTION TO THE CIRCUIT BOARD.

This area addressed in mod #2

lea, resistor and capacitor should be installed on each diode- D1 thru D14

C7
.001
5KV



HEATH SB-220[©]

High Frequency Linear Amplifier

Number:

-3-

Date:

January, 87

Description of modification:

Increased operating efficiency on 10 meters.

Submitted By:

WA2SQQ

NO

List of required parts:

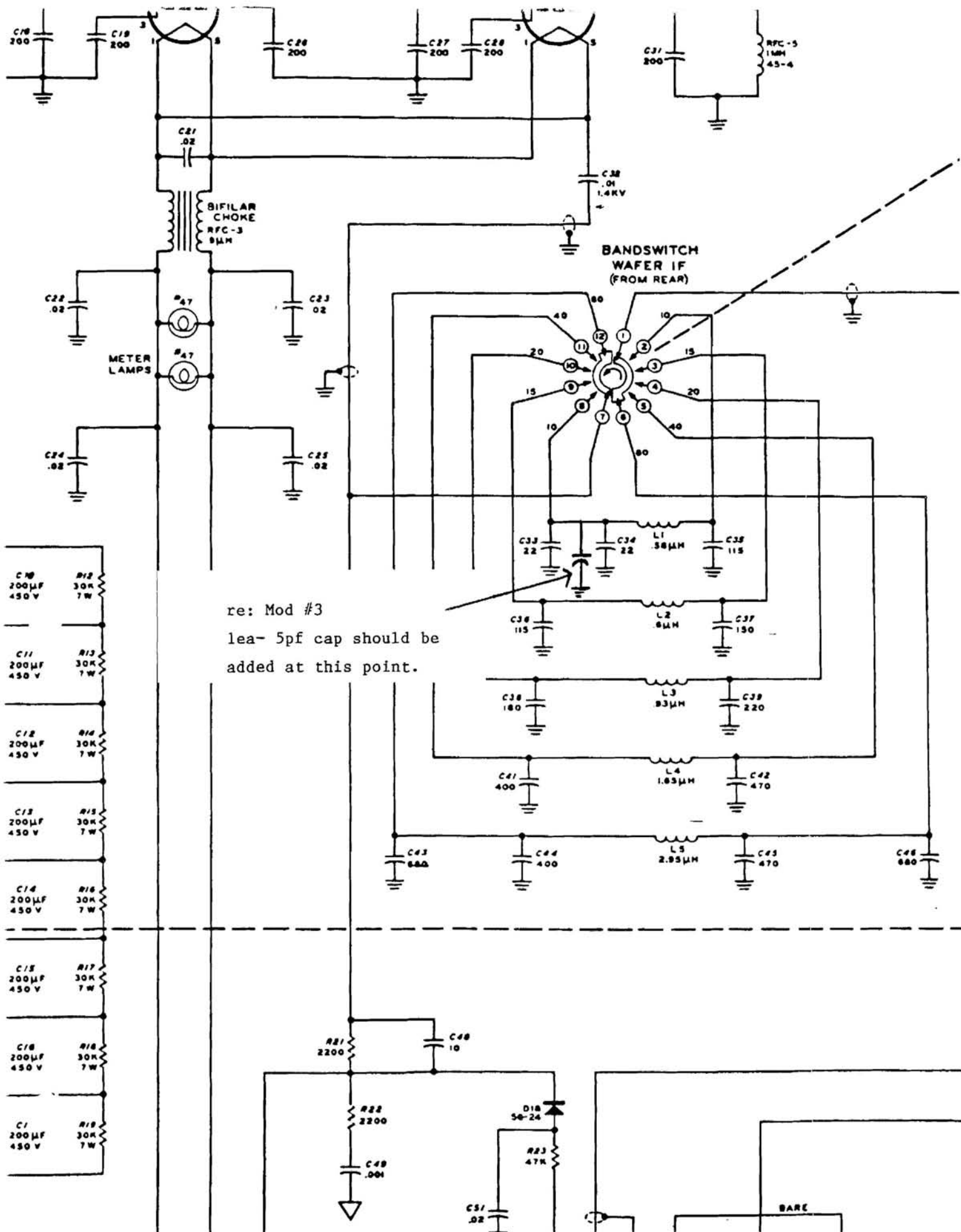
1ea- 5pf mica capacitor, min 500 vdc rating

Procedure:

When using the SB-220 with some of the older tube type rigs, output power as low as 250 watts has been noted. This has been traced to a high SWR between the exciter and the SB220. An input SWR of 3:1 for example, will reduce the output by about 24%. For the newer breed of radio, the problem is easily solved by the use of their built in antenna tuners. Owners of these older radios will appreciate the value as well as the performance of this mod.

After discharging and taking the SB-220 from its case, gently "pull away" the front panel to gain access to the input circuit coils. Locate the 10 meter coil, L1, and carefully install (solder) a 5pf capacitor accross the two capacitors which are connected accross this coil, C33 and C34. Reattach the front panel and fire it up. Measure the SWR between the exciter and the SB-220 to see if it is below 2:1. If it is, you are done, if its not, carefully adjust the 10 meter coil mentioned above a little at a time noting the results each time. I MUST INSIST THAT EACH TIME THE ADJUSTMENT IS DONE, THE POWER BE DISCONNECTED, THE POWER SUPPLY FILTER CAPS DISCHARGED, AND THAT EXTREME CAUTION BE EXERCISED. THE AREA THAT YOU ARE WORKING IN HAS VOLTAGES IN EXCESS OF 2000V, QUITE CAPABLE OF KILLING ANYONE. IT MIGHT TAKE YOU AN HOUR OR SO TO GET THIS RIGHT, BUT AT LEAST YOU WILL BE AROUND TO ENJOY IT!

Please refer to the schematic on the next page to assist you in the proper identification of components referred to in this mod.



HEATH SB-220[©]

High Frequency Linear Amplifier

Number:

-4-

Date:

March, 87

Description of modification:

Submitted By:

AA1U de QST

TOUCH UP PAINT FOR THE SB-220

List of required parts:

PACTRA "Namel" #X-38" model paint (green)

PACTRA "Namel" Black model paint

PACTRA "Namel" White model paint

Procedure:

Although Heath has never offered touch up paint, AA1U has been kind enough to share his formula with the amateur ranks.

Start by taking 2 parts of Pactra #X-38 and mixing it with one equal part of Pactra Black. This mixture should be mixed with 50 to 60 parts of Pactra white.

Varying the amount of white will allow you to adjust for color changes which have taken place with age. Use a fine grade of steel wool, such as "0000", to remove the gloss.

Pactra "Namel" is available in most hobby stores in bottles of 1 oz to cans of 1 pt. In most cases a n ample supply can be mixed up for about \$2.00.

Thanks to AA1U!

HEATH SB-220[©]

High Frequency Linear Amplifier

Number:

-5-

Date:

March, 87

Description of modification:

Submitted By:

WA2TSJ de QST

6 METER OPERATION WITH THE SB-220

NO

List of required parts:

1ea-10pf 500vdc disc cap

1ea-33pf 500vdc disc cap

Procedure:

For those who are brave enough to run several hundred watts on 6 meters, this ones for you!

After disconnecting the power, and discharging the power supply caps for at least 15 minutes, "pull away" the front panel to gain access to the tuned input coils.

Start by moving the 10 meter tap on the plate coil L6 to a point about 1 2/3 turns from the plate capacitor.

Next locate the 10 meter input coil L1 and unwind enough wire leaving only 2 3/4 turns.

Remove caps C33 and C34, replacing them with a single 10pf cap.

Remove cap. C35(115pf) and replace it with a single 33pf cap.

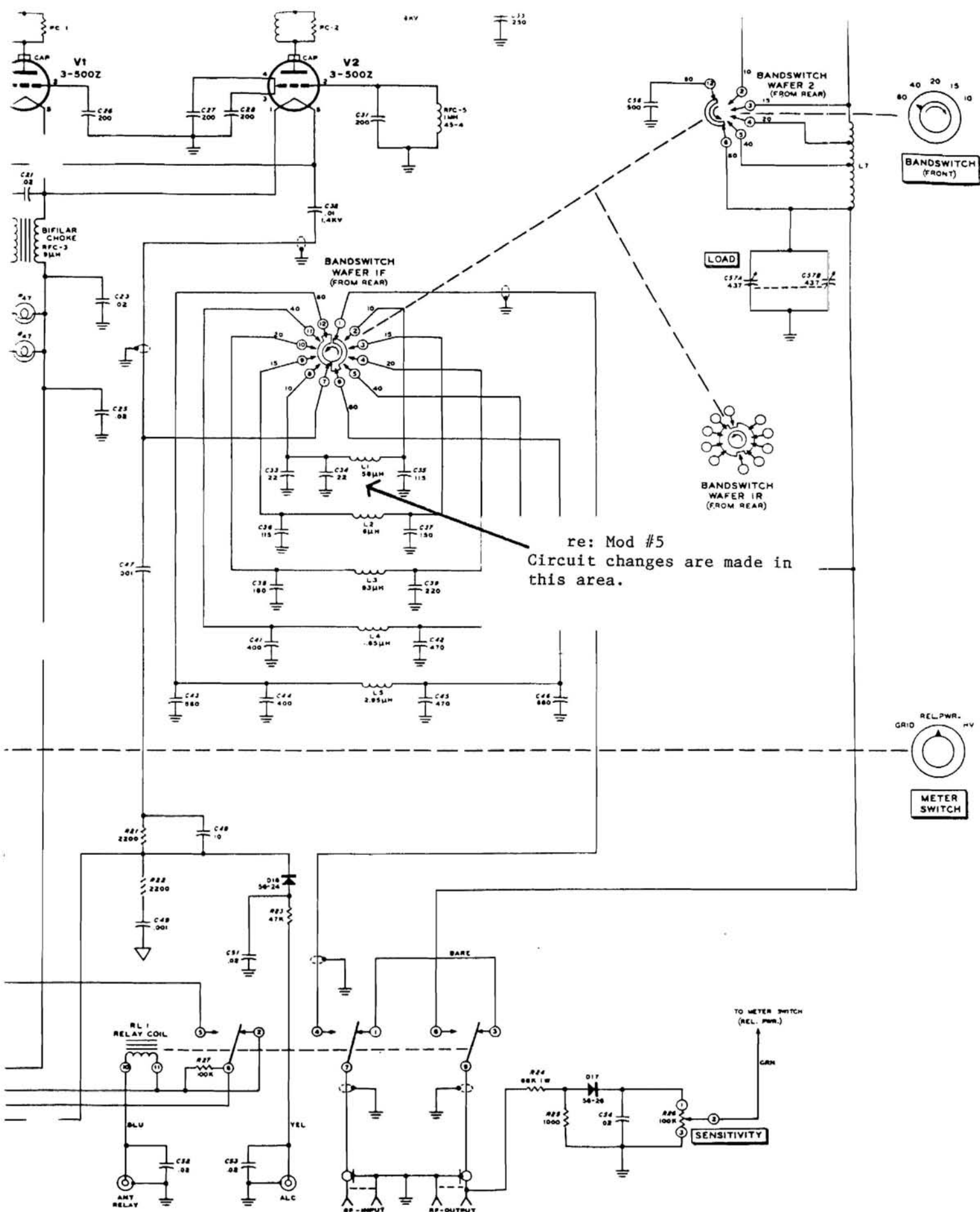
This completes the mod. A grid dip meter should be used to verify resonance before applying power.

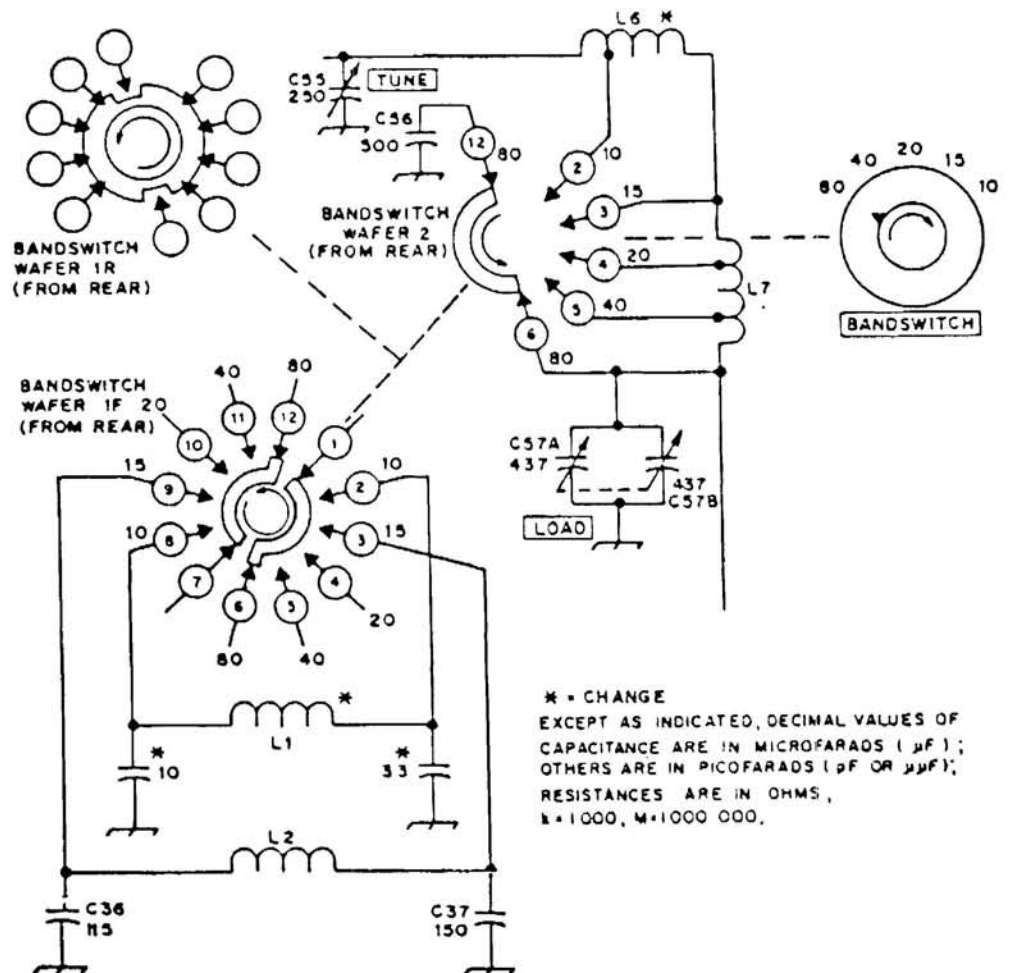
It should be noted that this mod will remove the normal 10 meter operation from the SB-220.

PLEASE REMEMBER THAT THE AREA IN WHICH YOU ARE WORKING HAS VOLTAGES IN EXCESS OF 2000V, QUITE CAPABLE OF KILLING YOU. EXERCISE CAUTION SO THAT YOU WILL BE AROUND TO ENJOY YOUR SB-220.

Please refer to the schematic on the next page to assist you in locating components refered to in this mod.

Thanks-WA2TSJ





SB-220 ON 6 METERS

The Heath SB-220 amplifier can be converted for use on the 6-meter band by changing only a few components. A partial view of the schematic diagram is shown in Fig. 1. The following modifications should be made:

- 1) Move the 10-meter tap on the plate coil (L6) to a point 1-2/3 turns from the plate-tune capacitor. A grid-dip oscillator can be used to check resonance at 50 MHz.
- 2) Unwind the 10-meter input coil (L1), leaving 2-3/4 turns.
- 3) Replace C33 and C34 by a single 10-pF mica capacitor.

4) Change C35 (115 pF) to a 33-pF mica capacitor. This change to my SB-220 has proved to be an excellent addition to the 6-meter setup. — John Roth, WA2TSJ

HEATH SB-220

High Frequency Linear Amplifier

Number:

-6-

Date:

February, 1987

Description of modification:

Submitted By:

Filament Inrush Current Protection.

W2UGM

COMP

List of required parts:

~~0-60 SECOND TIME DELAY RELAY 115vac-DDDT~~
~~30 watt wire wound resistor 130-180 ohms~~

TOGGLE SWITCH

~~3PDT~~ 3PST

150 ohm
25 WATT

Procedure:

If you have ever read the design specs EIMAC publishes on the 3-500z, you may have noticed that they suggest using some sort of Inrush current protection to limit the initial cold start up to a maximum of twice the normal "running" current. Also contained in this package is a copy of those specs which gives a step by step course in the proper care and feeding of the 3-500z. This Inrush circuit can be implemented by installing this mod. Please refer to the attached schematics on the following pages to aid you in its installation. Regarding the time delay relay, just about any TDR with a minimum contact rating of 3 amps should do fine. Heath's original design used what is known as a soft transformer where the transformer would not provide large amounts of current upon demand-however in spite of this, I have measured surges of up to three times the "running" current thus indicating the need for this mod. You might ask, "What if I don't limit the Inrush current, what can happen?" Well because the SB220 has no standby switch, repeated turn ons will result in a physical distortion of the filaments and eventually a premature failure of one or both tubes!

Step 1- Break the black wire of the filament transformer-T2 at the point indicated on the schematics supplied on the following pages.

Step 2- At the point where you just broke the circuit install the wire wound resistor listed above to bridge the gap.

Step 3- Wire one set of contacts from the TDR across the resistor. Use the info later in this mod to determine whether to use a normally open or closed contact.

Step 4-Next break the wire at the antenna relay-RL1- at the indicated point. And again wire another set of relay contacts across the break, thus putting them in series with the RL1 coil. Use the info given further on to determine normally open or closed.

Step 5- Once operational, set the relay for a delay of about 15-20 seconds.

NOTE: IF YOUR RELAY STAYS DEENERGIZED DURING THE SELECTED TIME DELAY, YOU SHOULD USE NORMALLY OPEN contacts.

IF YOUR RELAY STAYS ENERGIZED DURING THE SELECTED TIME DELAY, YOU SHOULD USE NORMALLY CLOSED contacts.

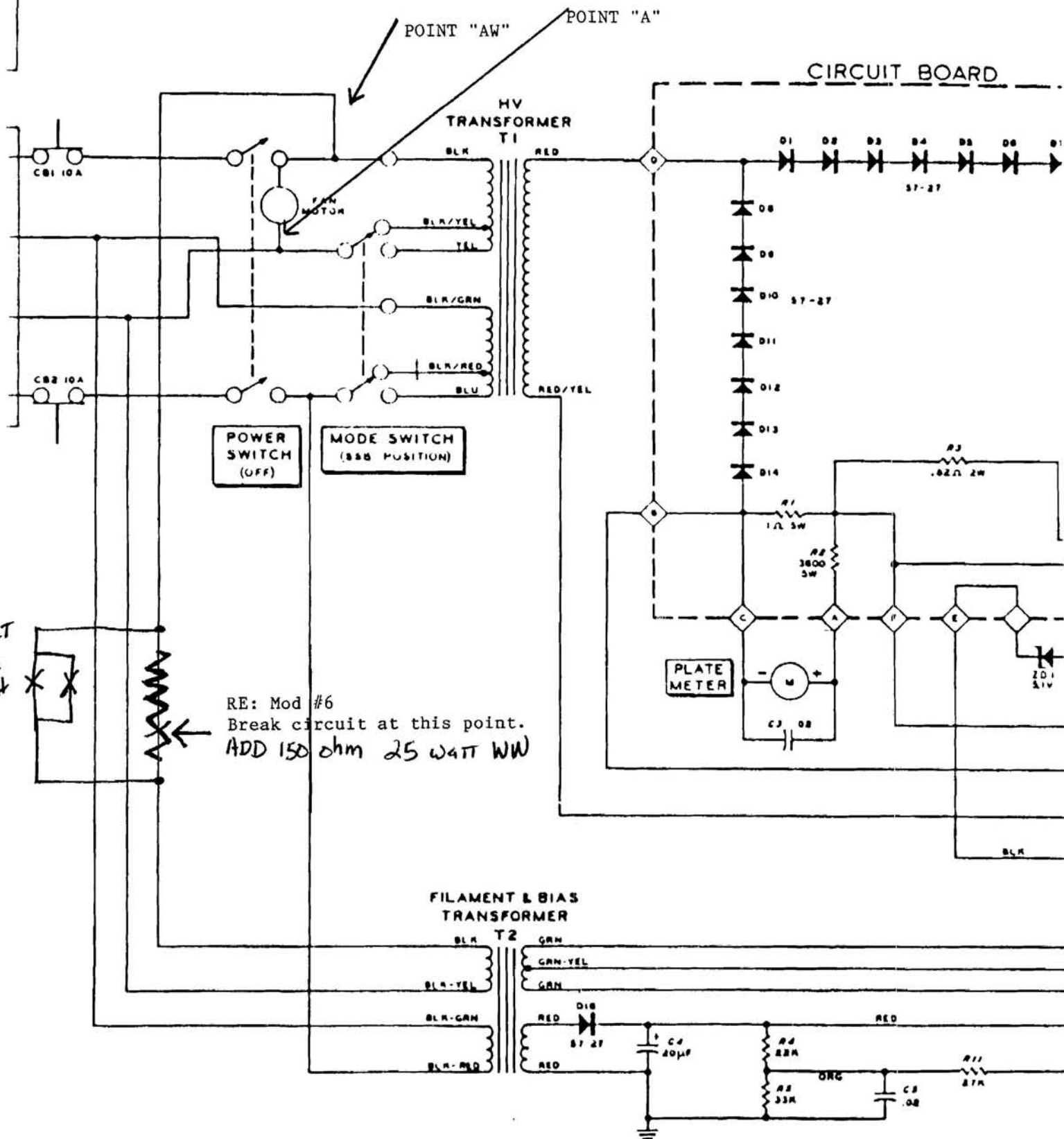
In theory its quite simple-The relay inserted in series with the filament transformer will limit the initial start up current, while the second set of contacts which were inserted in series with the antenna relay will not allow operation until after the tubes have been allowed to "warm up" fully. After the 15-20 second delay, the resistor is "jumped" out of the circuit and full current is applied to the 3-500z's.

PLEASE BE AWARE THAT THE SB220 HAS WITHIN IT VOLTAGES WITH enough VALUE TO KILL! AT LAST CHECK, DEATH IS A PERMANENT CONDITION-I DON'T WANT TO SEE YOUR NAME OR CALL IN SILENT KEYS.

PLEASE OBSERVE ALL SAFETY PRACTICES AND NEVER TRY TO DO ANY WORK ON THE SB220 WHILE THE POWER IS APPLIED

Thanks- W2UGM, Dick Marsino

PROTECT
TGGLE
SWITCH



HEATH SB-220[©]

High Frequency Linear Amplifier

Number:

-7-

Date:

February, 8

Description of modification:

Standby Switch/Dual Speed Blower

COMP.

Submitted By:

WA2VIJ

List of required parts:

DPST Switch *

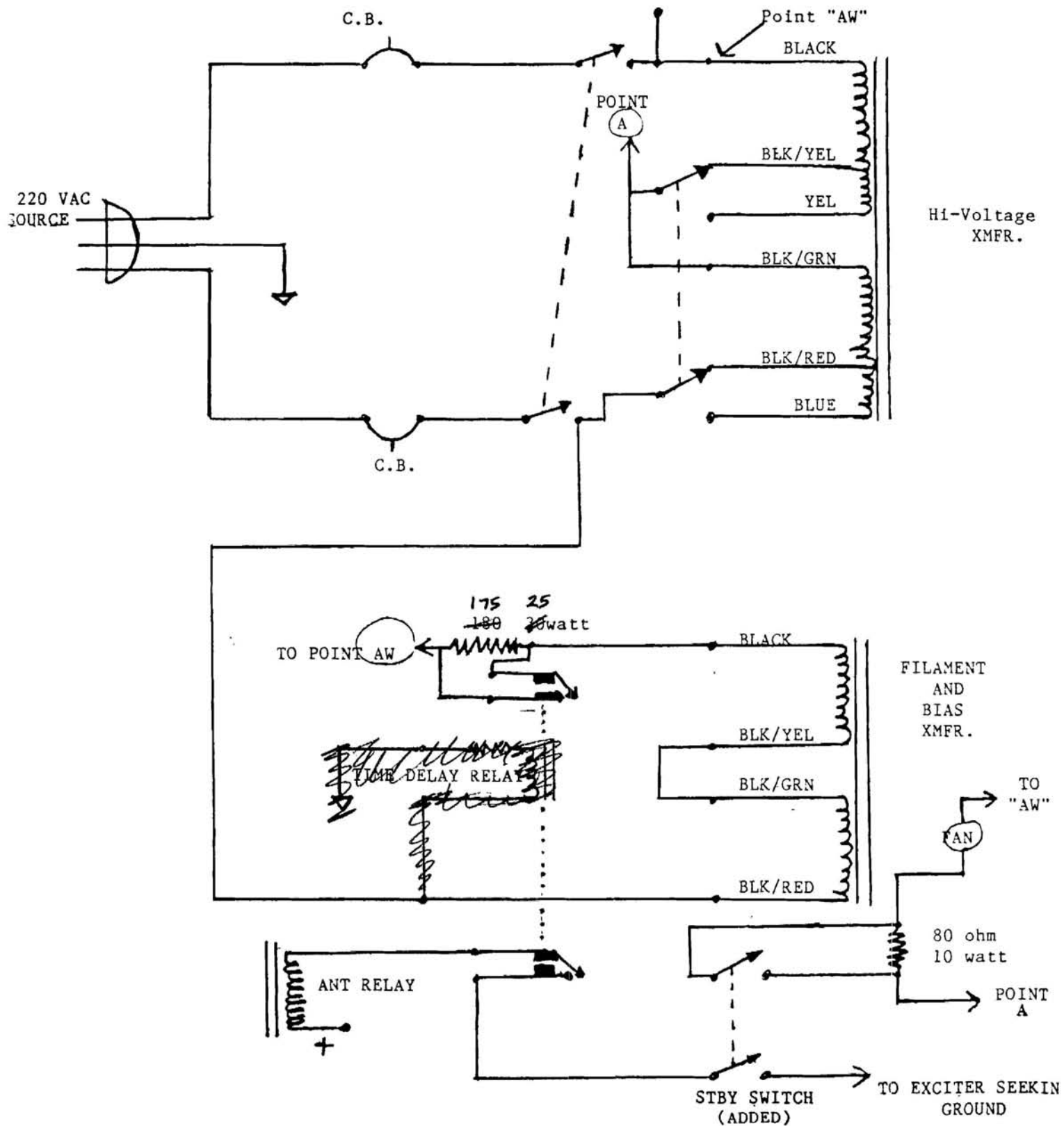
80 ohm 10 watt resistor

Procedure:

As popular as the Heath SB-220 is, Heath left out one of the most important features—a standby switch. Normal operation dictates that to run "barefoot" you must turn the main power off. This repeated "heating" of the 3-500Z's filaments will take its toll on their life. By adding one switch in series with the antenna relay coil, we can have the RF from your exciter go right through to the antenna.

By using a double pole switch, and one additional resistor, we can add a "low" speed to the blower so that while in standby mode, the speed of the fan can be reduced to cut down the ambient noise. Referring to the attached schematic, break the blower motor wire at the point indicated and wire in series to the blower an 80 ohm, 10 watt resistor. The switch which is added to serve as the stby switch will have one set of unused contacts. These are wired to bypass the resistor when the stby. switch is in the operate mode. For those who are "shy" about drilling holes in their equipment, you may want to consider using a new variable resistor, similar in value to the RF sensitivity control to replace the original. The new one should have a "push/pull type switch within it. These can usually be obtained from any vendor which stocks TV parts, as these are usually used for the volume controls on today's TV's. Should you not wish the additional speed on the blower, a SPST switch will do.

Thanks-WA2VIJ



HEATH SB-220[©]

High Frequency Linear Amplifier

Number:

-8-

Date:

February, 87

Description of modification:

Submitted By:

Noisy Fan Cure

WA2SQQ

List of required parts:

2ea- Rubber Gromets

4ea-"Fender Washers"

Procedure:

Early Heath SB-220's used a different fan which ran quite a bit louder than we would like. For a while Heath was replacing them with a quieter version at no charge. When the "free lunch" ended, they applied a 26.00 price tag to the new one. While the price has probably gone up, you may opt to do this mod which will do a nice job of keeping the noise acceptable.

1) Using a tapered reamer carefully enlarge the mounting holes used by the blower assembly to allow insertion of a rubber gromet just large enough to accomodate the screw size used to mount the blower assembly.

2) Install 2 rubber gromets in these newly enlarged holes. Make sure they fit snug.

3) Reinstall the fan, with the addition of two "fender washers per mounting screw. These are placed one on either side of the gromet, and will provide a solid surface for which to tighten upon.

For those who are less than familiar with the term "fender washer", this type of washer has a hole just large enough to accomodate the screw which it will be used with, but in addition will have an overall outer diameter much larger than a normal washer. For a #8 or #10 screw, the overall outer diameter is usually about 3/4".

Take special care not to overream the mounting holes described in step #1. Once you enlarge them, you can't make them smaller!

When this mod is added to mod # 7, you can expect an overall decrease in "shack noise" by about 60%.

Good luck.

HEATH SB-220

High Frequency Linear Amplifier

Number:

- 9 -

Date:

JANUARY, 1987

*These parts are available from the source listed within this manual.

Description of modification:

Adding 160 meter operation to the Heath SB-220 while not giving up any other of the existing features. To make this modification compatible to today's solid state transmitters, this mod will maintain a tuned input circuit. It will also require only a minimal amount of modification with no defacing of the front panel, making the mod virtually undetectable, thus not hurting the resale value.

Submitted By:

K6QAY/WA2SQQ

List of required parts:

*Filament Choke B&W FC-30 or equivalent	3PDT relay-115 vac coil
*Plate Choke-National R175 or equivalent	mini spst toggle switch
.15 600vdc ceramic disc cap.-2pcs required	
B&W miniductor #3907-1 (see text)	
150 pf 2.5kv ceramic disc cap	
750 pf 2.5kv ceramic disc cap	

Procedure:

Since the FCC saw fit to allow higher power to be used on 160 meters, the need for linear amplifiers that cover this band has sharply risen. While this mod is not simple, it can be installed in just a few hours and will enhance the operation of the SB220.

Theory of operation:

To enable the SB220 to operate on 160 meters, the following must be done.

The values of RFC 1 and RFC 3 must be increased to accommodate the lower frequency. The resonant frequency of the 80 meter tuned input stage must be lowered in such a way so that both 80 and 160 meter operation can be obtained.

Step 1: Replace the filament choke RFC 3 with the part listed above.

Step 2: Replace the plate choke RFC 1 with the part listed above.

Step 3: Install 1ea, .15 disc cap across C22 & C23 located near the filament choke.

Step 4: Cut the wire from inductor L7 which goes to capacitor C57. See the schematic for this mod to identify the correct point at which the circuit should be cut.

Step 5: Prepare a 2½" piece of the B&W "miniductor". You will need a total of 24 turns. Once prepared, it should be mounted on the side of the RF cage just above capacitors C55 & C57. I have found the best way to accomplish this is to fabricate two "L" brackets out of a small piece of lexan or plexiglass. The miniductor can be attached to the miniductor using silicon rubber. Make sure it is firmly mounted. Should it come loose, this could cause some real damage to your SB220.

Step 6: Connect one lead of the 150pf disc capacitor to the RH tie bolt of the tuning capacitor C53 located on the front panel. This is the one which on the front panel is marked "TUNE".

Step 7: Connect one lead of the 750pf disc capacitor to the LH tie bolt of capacitor C57 located on the front panel. This is the one which on the front panel is marked "LOAD".

Step 8: Install the 3PDT relay in the front left area of the SB220. Using the holes on the screening will permit easy mounting in a variety of places.

Step 9: Begin the wiring of the relay by first strapping two of the three normally open contacts together using a piece of no less than 18AWG solid wire. The free end of this wire should be connected to the closest ground point available. In my SB220, I drilled a small hole to accommodate a small screw and attached it direct to the cabinet.

NOTE: TO MINIMIZE THE LEAD LENGTH AND INTERACTION WITH 80 METER OPERATION, THE GROUND SIDE OF THESE ADDITIONAL CIRCUITS WILL BE BROKEN WHEN THE NEWLY INSTALLED 160 METER PORTION IS NOT BEING USED.

Step 10: Connect the remaining lead of the 150pf disc capacitor mentioned in step 6, to the wiper of the first normally open contact mentioned in Step 9.

Step 11: Connect the remaining lead from the 750pf disc capacitor mentioned in Step 7, to the second normally open contact mentioned in Step 9.

Step 12: Using a piece of solid wire similar to that used in Step 9, connect the third of contacts of the relay mentioned in Step 8, across the B&W miniductor which was mentioned in Step 5. This wiring will now allow the miniductor to be jumped out of the circuit during 80 meter operation.

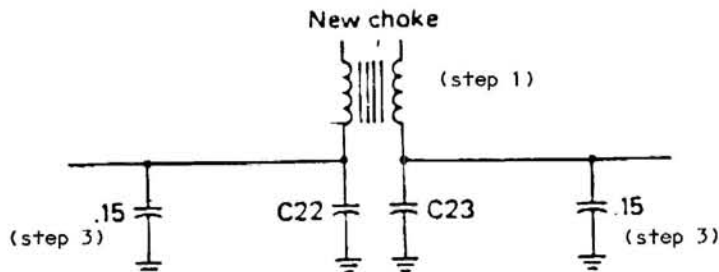
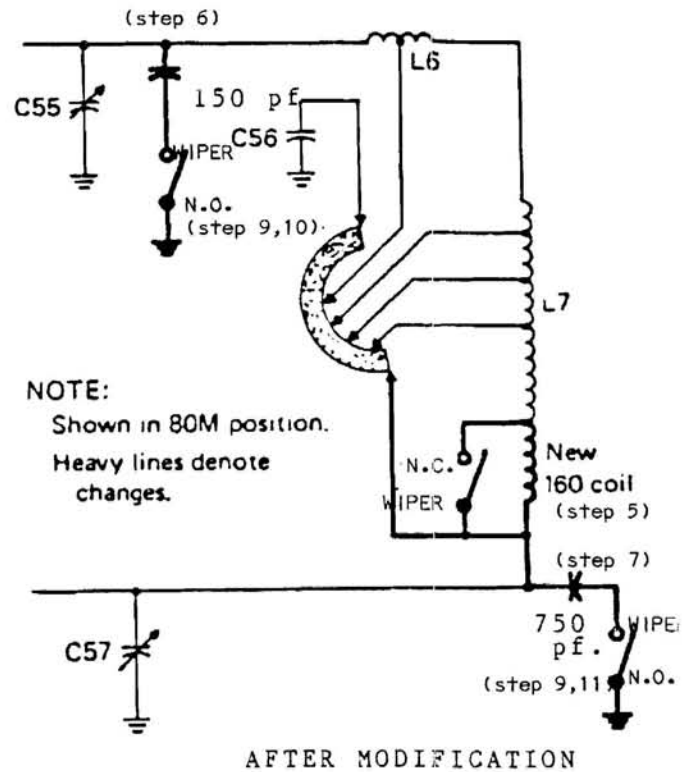
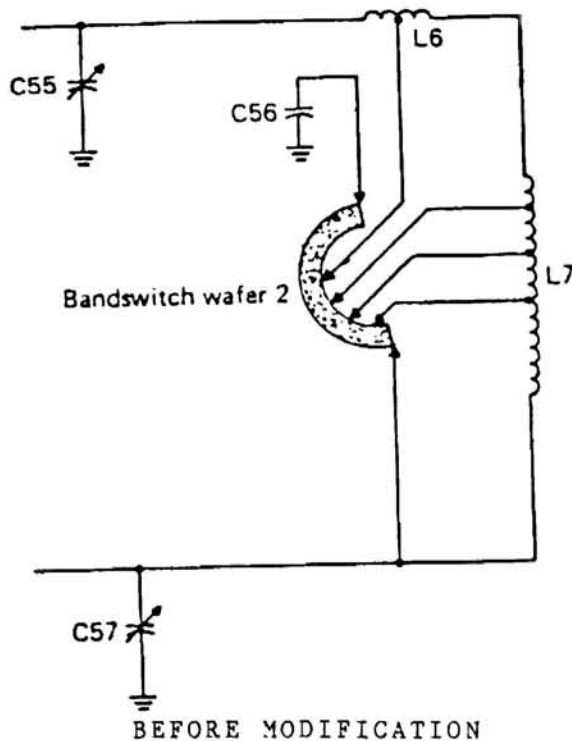
Step 13: Cut the wire from the 80 meter inductor L7 going to the output line and variable cap C57. The B&W miniductor should be added in series with L7. You may refer to the schematic on the next page for further clarification.

cont'd

Step 14: Lastly, you should mount a small spst switch in the location of your choice. Power to energize the relay may be obtained of of the fan motor circuit.

It is strongly urged that prior to energizing the SB220, you use a grid dip meter to verify resonance of the tank circuit. With the power off, manually close the relay contacts and make certain the tank circuit will resonate at 160 meters. If it doesn't, go back over you wiring step by step to find your error. Operation is the same as it would be on any band, with the addition that for 160 meter operation the relay must be turned on using the SPST switch you installed. Installation on most of the components locations is left up to each individuals preference. All leads should be kept as short as possible to minimize any interaction which might take place.

GOOD DX



HEATH SB-220[©]

High Frequency Linear Amplifier

Number:
-10-

Date:
February, 87

Description of modification:

Adding "QSK" or full break-in operation to the SB-220.

Submitted By:

K5PC de QST 1/80

List of requ

1ea 100pf 1kv disc.cap.	2ea 1N918 diode or equiv.
1ea .01uf 1kv disc. cap.	2ea 2N5184 transistor or ECG-195A (Sylvania)
1ea 10k ohm 1 watt res.	Misc item: 2" X 2" perf board
1ea 5.6k ohm 5 watt res.	15" RG-174u coax
	standoff insulator (circuit board mount

Procedure:

Heath's original design of the SB-220 did not allow for operation in the "QSK" or full break in mode. With today's new generation of solid state transceivers, most will allow QSK operation. For a few dollars and about two hours of your time, you can not only add this option to your SB-220, but also substantially cut down on the operating temperature. Because the quiescent plate dissipation adds up to almost 400 watts !!, the addition of this mod will also add to the life of your SB-220 and save you a few bucks a year in monthly power bills. The first step is to build the circuit shown on the next page. Probably the easiest way is on a piece of pery board.

After you've got this far, proceed to step one below.

1-Decide on a convenient place to mount the board, and do so.

2- The original anode connection of diode ZD-1 in the SB-220 should be unsoldered at the diode.

3-The collector of Q1 should be connected to the anode of ZD1.

4-The emitter lead from Q2 should be connected to the point on the power supply rectifier board where the anode of ZD1 was originally connected.

5- Carefully route a piece of RG-174u coax from your board to relay RL1. The center conductor should be connected to lug4 of RL1.(See next page)

6-At the circuit board connect the other end of the coax to the free end of capacitor C2.(See schematic on next page).

7-Refering to the schematic on the next page, connect a 1N4004 diode from point "C" on the power supply board to ground as per the diagram. This diode will serve as a clamp to prevent that point from going negative should the bias supply fail. Should any of the added circuits fail, the amplifier will go into a cutoff condition..

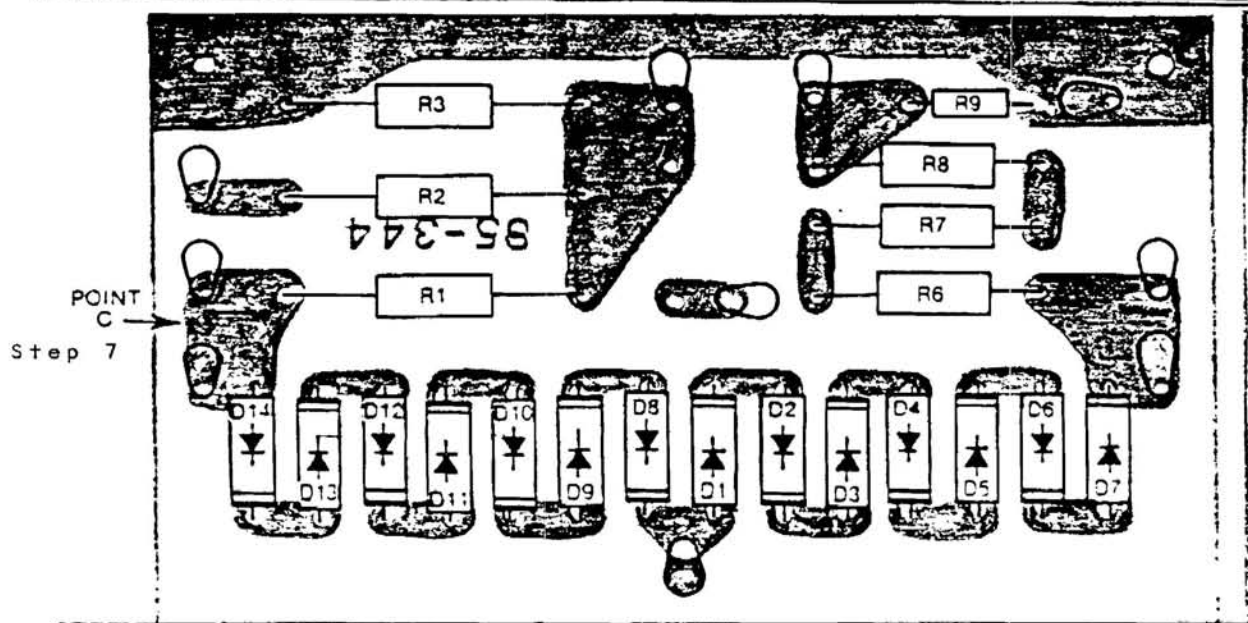
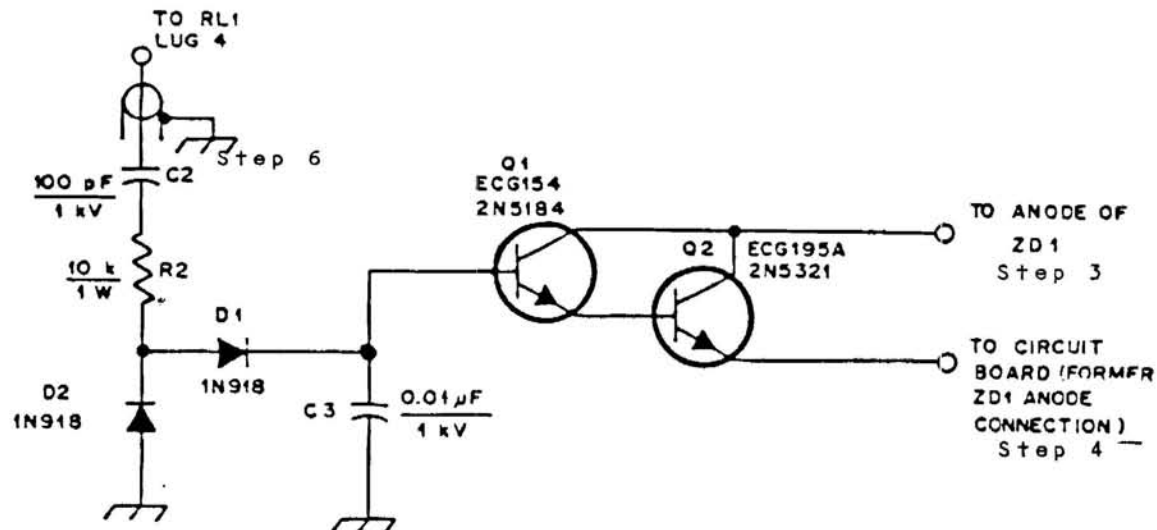
8- Next install a 5.6k ohm,5watt resistor from lug 9 to lug 11 on relay RL1. This will act as a current limiter for the bias supply.

9-Remove and discard resistor R27-100k ½watt which was part of the original SB-220 circuit. This resistor is located at lug 9 of relay RL1.

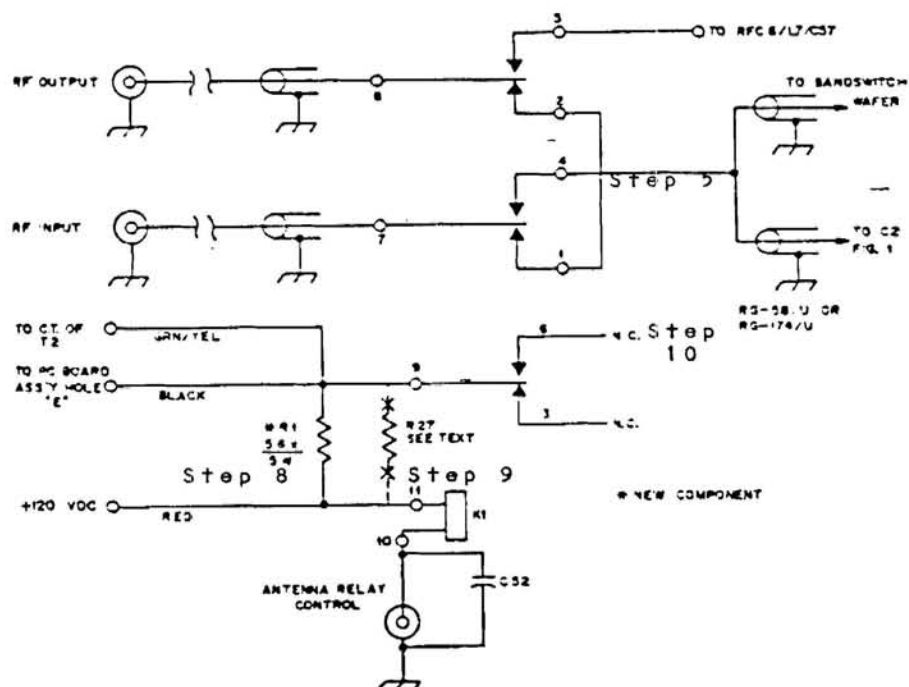
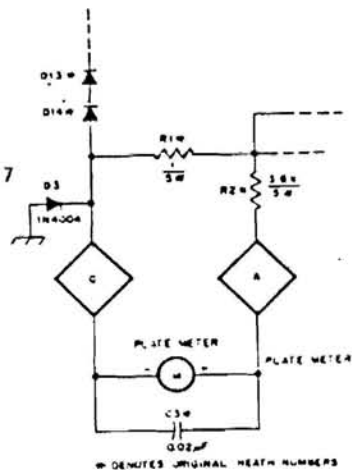
10- Next remove the black lead from lug 6 of RL1 and connect it to lug 9 of the same relay.The relay will now function as a simple amplifier in/out. RL1 may be operated remotely through the relay jack, or via a front panel switch. With this complete, the amplifier will allow straight through operation with the unit turned off.

Please refer to the next page where the individual steps have been noted at each point on the schematics.

Step 1-



Step 7



HEATH SB-220

High Frequency Linear Amplifier

Number:

-11-

Date:

April, 87

Description of modification:

Increased operating duty cycle using a "Hipersil" type plate xmfr.

Submitted By:

WA2SQQ

List of required parts:

See text...

Procedure:

PLEASE NOTE: BEFORE ATTEMPTING THIS MOD, IT IS HIGHLY SUGGESTED THAT THE MODIFICATION IN THIS BOOK WHICH ADDRESSES INCREASED RELIABILITY OF THE POWER SUPPLY BE DONE. THE ORIGINAL DESIGN WILL NOT TOLERATE THE ADDITIONAL PLATE VOLTAGE AND CURRENT THAT WILL BE PRESENT.

For those who enjoy running AM, RTTY, or SSTV, this ones for you. While the original plate transformer does an adequate job on SSB and CW, it really can't handle the increased power required to facilitate a "CCS" type operation.

The PETER W DAHL CO now offers three replacement transformers for the SB-220 which are heavy duty substitutes. Type #1 will mount within the SB-220, while types 2 and 3 will require external mounting. They also offer better voltage regulation and reduced operating temperature. Listed below is a comparison chart for these units. Peter W Dahl also offers a broad range of heavy duty power supply components for the do-it your selfer. They may be contacted at:

PETER W DAHL CO.
5869 Waycross Ave
El Paso TX 79924

915 751 2300

	Primary	Secondary	Dimension	Weight	Price
Type 1	117/234	860/1171@1A	6½x5½x6	21.7	\$150ea.
Type 2	117/234	925/1175@2.13A	8½x81/8x7½	41 lbs	\$215 ea
Type 3	117/234	925/1175@3.5A	10x9½x9	60 lbs	\$265 ea

NOTE: All prices are + shipping; All current ratings are CCS

HEATH SB-220

High Frequency Linear Amplifier

Number:

12

Date:

Nov, 87

Description of modification:

Universal ALC

COMP.

Submitted By:

W2AXU

List of required parts:

100K ohm 1watt pot.

Procedure:

The SB220's original design centered on the popular "SB" line which Heath marketed for several years, as well as some of the than popular HF transeivers such as Swan, Drake and National. As far as todays solid state equiptment, the ALC portion is not user friendly. This modification will allow you to use the ALC feature with a minimum amount of effort, not to mention that this is your contribution to less splatter on the air!

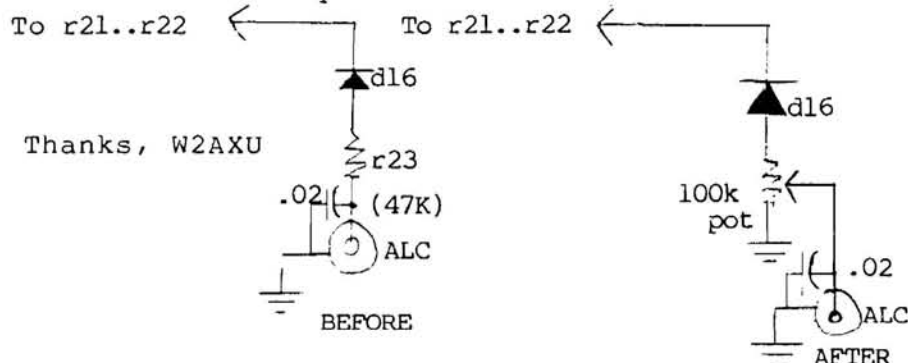
Step 1 Replace R23 (47K $\frac{1}{2}$ W) with a 100K pot as shown below.

Step 2 The center of the pot is then wired to the ALC connector as shown below.

Mount the pot in any location which you see fit. In my SB220, I chose to use a dab of GE silicon rubber and mount the back of the pot to the underside of the SB220, next to the antenna relay.

Step 3 The final step is to adjust the 100K pot to the ALC level which your radio wants to see. Once set, you should not have to readjust it.

As with this mod and all others, never attempt to work on the SB220 with the power connected. Its also a good idea to remove the 3-500z's so you don't break them.



HEATH SB-220

High Frequency Linear Amplifier

Number:
-13-

Date:
Dec, 1987

Description of modification:

Meter Protection on your SB220 or SB221

COMP.

Submitted By:

R.G. Affel
W4TDW

List of required parts:

2- Diode: 1amp 600 p.i.v. 1N40XX

Procedure:

One of the possible side effects of an amplifier suffering from parasitic oscillation is watching the meters bounce or the stop once to often. In most cases, after a few times, the meter movement opens up and requires you to replace the meter.

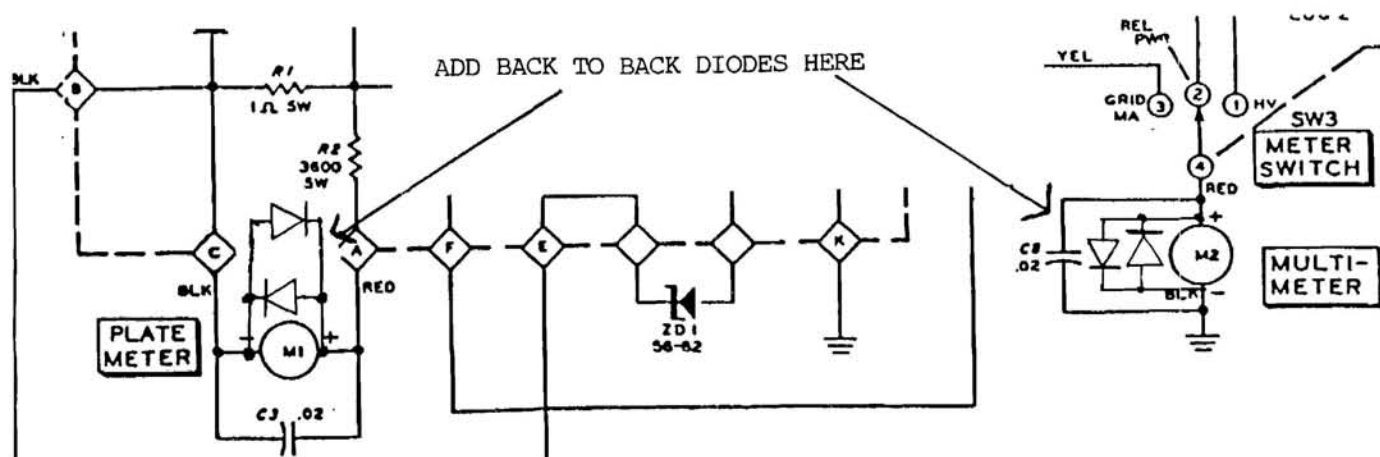
A very simple cure is to install a pair of back to back diodes across each meter. Just about any of the popular 1N4000 series will do just fine.

This is like an insurance policy with a one time price of about "half a buck". For those of you not familiar with this installation, please refer to the diagram below.

As always, NEVER work on the SB220 with the power or the rig connected. Its also a good idea to remove the 3-500Z's to guard against accidental breakage.

Thanks,

W4TDW



HEATH SB-220

High Frequency Linear Amplifier

Number:

-14-

Date:

December, 198

Description of modification:

Curing parasitics in the SB220

Submitted By:

April, 86 Ham Radio
AG6K

List of required parts:

3ea 10 ohm 2 watt metal film resistors (NONINDUCTIVE)

Procedure:

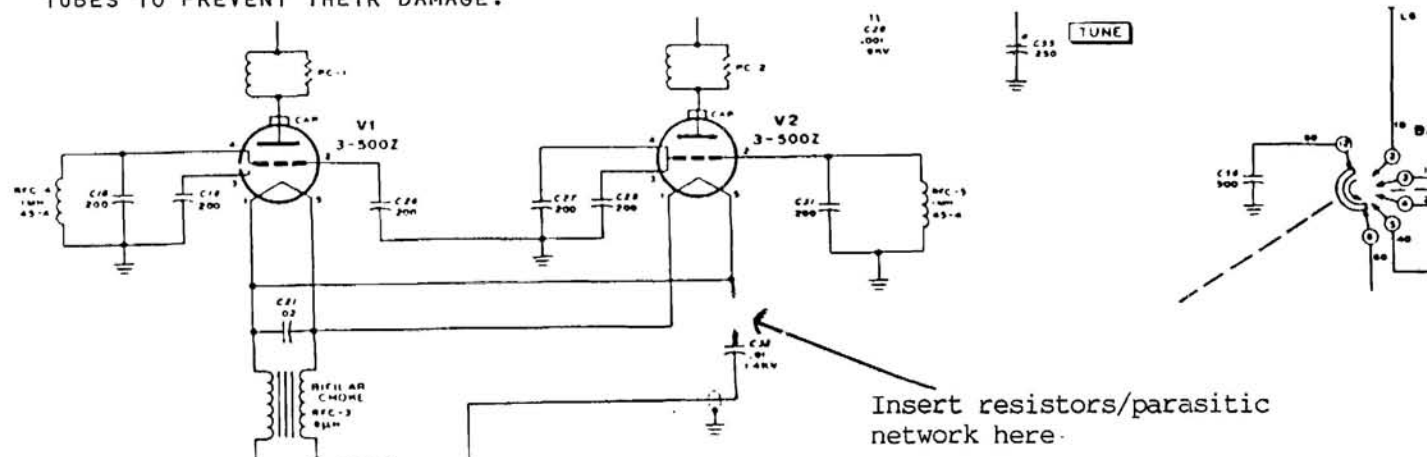
Chronic "splitting" or arcing at the plate caps, perhaps a burnt plate parasitic suppressor, the smell of a burnt resistor—Sound familiar? These are all the symptoms of a grounded grid amplifier suffering from parasitics. Left untreated, it can destroy the tubes, the meters and their shunts, bias supplies, and in severe cases have been known to destroy the filament transformer. Some people place the blame on a pair of soft tubes. The problem usually gets more severe with new tubes as they will have higher gain. The solution, contrary to what you are probably thinking is quite simple. The insertion of a small amount of noninductive resistance in the cathode circuit, which generates negative feedback, will usually cure the problem. Depending on the amount of resistance, the amplifier might become slightly harder to drive, but the difference in actual output power would never be seen on the air.

For the SB220, three 10 ohm 2 watt metal film resistors in parallel, with space between them seems to work best. Referring to the diagram, they should be installed between the RF drive coupling cap C32, and the filament lead where C32 was originally connected. If you notice a slight increase in the input SWR on 10 & 15 meters, a slight touch-up of coils L1 and L2 should bring things back to normal.

For minor cases of parasitic oscillation, a 47 ohm 2 watt resistor with 4 turns of #16 wire on it can be substituted in lieu of the 3 resistors mentioned above. Although this method will not improve the linearity of the SB220, it will reduce the overall VHF gain of the circuit and improve stability. IN EITHER CASE ONLY NONINDUCTIVE TYPE RESISTORS MUST BE USED.

For a better understanding of parasitic oscillation, I highly suggest reading AG6K's article from the April, 1986 HAM RADIO, titled "Grounded Grid Amplifier Parasitics" from which information for this mod was obtained.

DO NOT ATTEMPT TO WORK ON THE SB220 WITH POWER CONNECTED. YOU SHOULD ALSO REMOVE THE TUBES TO PREVENT THEIR DAMAGE.



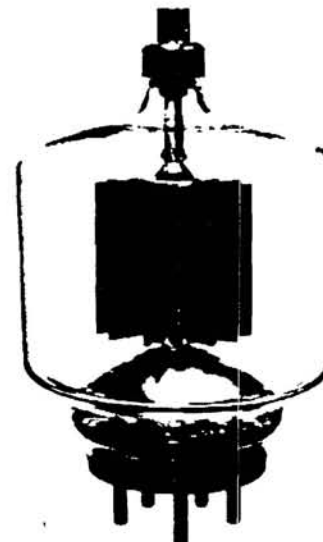


TECHNICAL DATA

3-500Z

HIGH-MU
POWER TRIODE

The EIMAC 3-500Z is a compact power triode intended to be used as a zero-bias Class AB₂ amplifier in audio or radio-frequency applications. Operation with zero grid bias simplifies associated circuitry by eliminating the bias supply. In addition, grounded-grid operation is attractive since power gain as high as twenty times can be obtained with the 3-500Z in a cathode-driven circuit.



GENERAL CHARACTERISTICS¹

ELECTRICAL

Filament: Thoriated Tungsten

Voltage	5.0 ± 0.25 Volts
Current @ 5.0 Volts	14.6 Amperes
Amplification Factor (Average):	130

Direct Interelectrode Capacitance (Grounded Filament)²

Cin	8.3 pF
Cout	0.07 pF
Cgp	4.7 pF

Direct Interelectrode Capacitance (Grounded Grid)²

Cin	8.3 pF
Cout	4.7 pF
Cgp	0.07 pF

Frequency of Maximum Rating (CW) 110 MHz

¹Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. Varian EIMAC should be consulted before using this information for final equipment design.

²Capacitance values are for a cold tube as measured in a special shielded fixture.

(Effective 4/1/86)

MECHANICAL**Maximum Overall Dimensions:**

Length 6.10 in; 154.94 mm
 Diameter 3.44 in; 87.33 mm
 Net Weight 7 oz; 198.5 gm
 Operating Position Vertical, base up or down

Maximum Operating Temperature:

Plate Seals 225°C
 Base Seals 200°C
 Cooling Radiation and Forced Air
 Base 5 Pin Special
 Recommended Socket EIMAC SK-410
 Recommended Chimney EIMAC SK-406
 Recommended Heat-Dissipating Connector:
 Plate HR-6

**RADIO FREQUENCY LINEAR AMPLIFIER
 CATHODE DRIVEN**

(Frequencies to 110 MHz)

Class AB₂**MAXIMUM RATINGS**

DC PLATE VOLTAGE 4000 VOLTS
 DC PLATE CURRENT 0.4 AMPERE
 PLATE DISSIPATION 500 WATTS
 GRID DISSIPATION 20 WATTS

- 1 Zener diode positive bias used at plate potentials of 3 kV and above.
- 2 Approximate value.
- 3 Currents listed correspond to SSB, or "Two-tone" average current at peak of signal envelope.
- 4 Single-tone current for 3500 Vdc operation may reach this value during short periods of circuit adjustment only
- 5 Intermodulation distortion products are referenced against one tone of a two tone signal

TYPICAL OPERATIONClass AB₂ Peak Envelope or Modulation Crest Conditions

	1500	2000	2500	3000	3500	Vdc
Plate Voltage	1500	2000	2500	3000	3500	Vdc
Cathode Voltage	0	0	0	-10	-15	Vdc
Zero Signal Plate Current ¹	65	95	130	62	53	mAdc
Single-Tone Plate Current CW ¹	400	400	400	400	400	mAdc
Two-Tone Plate Current	260	270	280	268	262	mAdc
Single-Tone Grid Current ²	130	130	120	108	108	mAdc
Two-Tone Grid Current ²	80	80	70	60	58	mAdc
Single-Tone Power Input	600	800	1000	1200	1400	W
Useful Output Power CW or PEP	330	500	600	740	890	W
Resonant Load Impedance	1600	2750	3450	4200	5000	Ω
Intermodulation Distortion Products ⁵						
3rd Order	-46	-38	-33	-40	-40	db
5th Order	---	---	---	-46	-45	db
Driving Impedance	94	102	100	115	115	Ω
Maximum Signal Driving Power	49	49	46	46	46	W

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR GRID DRIVEN, CATHODE DRIVEN

Class AB₂ and C Telephony or FM
(Key-Down Conditions)
(Frequencies to 110 MHz)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	4000 VOLTS
DC PLATE CURRENT	0.35 AMPERE
PLATE DISSIPATION	500 WATTS
GRID DISSIPATION	20 WATTS

TYPICAL OPERATION

	Grid Driven		Cathode Driven		
Plate Voltage	3000	3500	3000	3500	Vdc
Grid Voltage	-10	-75	-10	-75	Vdc
Plate Current	350	300	333	350	mAdc
Grid Current	115	115	108	118	mAdc
Peak rf (Cathode) (Grid) Voltage	110	187	95	200	v
Approx. Driving Power	14	22	35	81	W
Plate Input Power	1050	1050	1000	1225	W
Plate Dissipation	330	200	300	305	W
Useful Output Power	720	850	700	920	W
Resonant Load Impedance	4200	5700	4800	5500	Ω

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN

Class C Telephony (Carrier Conditions)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	3000 VOLTS
DC PLATE CURRENT	0.275 AMPERE
PLATE DISSIPATION ¹	330 WATTS
GRID DISSIPATION ²	20 WATTS

1 Corresponds to 500 watts at 100% sine-wave modulation.

2 Average, with or without modulation

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	3000 Vdc
Grid Voltage	-100 Vdc
Plate Current	275 mAdc
Grid Current ¹	120 mAdc
Peak rf Grid Voltage ¹	200 v
Calculated Driving Power	25 W
Plate Input Power	825 W
Plate Dissipation	185 W
Plate Output Power	640 W

1 Approximate value.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB₂, Grid Driven (Sinusoidal Wave)

MAXIMUM RATINGS (Per Tube):

DC PLATE VOLTAGE ¹	4000 VOLTS
DC PLATE CURRENT	0.4 AMPERE
PLATE DISSIPATION	500 WATTS
GRID DISSIPATION	20 WATTS

1 See zero-bias operation in Application Section.

2 Approximate value.

3 Per tube.

4 Nominal drive power is one-half peak power.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	3000 Vdc
Grid Voltage	0 Vdc
Zero-Signal Plate Current ²	300 mAdc
Max. Signal Plate Current	770 mAdc
Max. Signal Grid Current ²	244 mAdc
Peak af Grid Voltage ³	100 v
Peak Driving Power ⁴	25 w
Plate Input Power	2310 W
Max. Signal Plate Dissipation	890 W
Plate Output Power	1420 W
Load Resistance (plate to plate)	8600 Ω

HIGH-LEVEL MODULATED RADIO- FREQUENCY AMPLIFIER PULSE-WIDTH MODULATION - Grid Driven

ABSOLUTE MAXIMUM RATINGS:

	RF Amplifier	Switching Modulator	
DC Plate Voltage.....	4	10	KILOVOLTS
DC Plate Current.....	0.4	0.4	AMPERES
DC Grid Voltage	-200	-200	VOLTS
Plate Dissipation.....	500	500	WATTS
Grid Dissipation.....	20	20	WATTS

TYPICAL OPERATION (Carrier Conditions)¹

	RF Amplifier	Switching Modulator	
Plate Voltage.....	3.0	9.0	kVdc
Plate Current.....	250	180	mAdc
Grid Voltage.....	-85	-120	Vdc
Grid Current ²	170	125	mAdc
Useful Power Output ² ...	550	1500	W

1. These conditions assume rectangular drive waveform and a third harmonic, high-efficiency "Tyler" circuit.

2. Approximate value.

NOTE TYPICAL OPERATION data are obtained by calculation from published characteristic curves or actual measurement. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid current. The grid current which results when the desired plate current is obtained is incidental and varies from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUE FOR EQUIPMENT DESIGN

	<u>Min.</u>	<u>Max.</u>	
Filament: Current at 5.0 Volts	13.8	15.0	Amperes
Interelectrode Capacitance ¹ (Grounded Filament Connection)			
Input	6.5	10.0	pF
Output	---	0.18	pF
Feedback	4.2	5.2	pF
Interelectrode Capacitance ¹ (Grounded Grid Connection)			
Input	6.5	10.5	pF
Output	4.2	5.2	pF
Feedback	---	0.18	pF
Zero Signal Plate Current:			
(Ec = 0 Vdc Eb = 2500 Vdc)	90	180	mAdc

¹In shielded fixture.

APPLICATION

MECHANICAL

MOUNTING - The 3-500Z must be operated vertically, base up or down. A flexible connecting strap should be provided between the heat dissipating plate connector and the external plate circuit. The tube must be protected from severe vibration and shock.

SOCKET - The EIMAC SK-410 air system socket and the SK-406 chimney are recommended for use with the 3-500Z. When a socket other than the SK-410 is used, provisions must be made for equivalent cooling of the base, the envelope, and the plate lead.

If a socket other than the EIMAC SK-410 is employed, the user should assure himself that strong lateral pressure is not applied to the tube base pins. Otherwise, even though the base of the tube is reinforced, damage to the base seals may result.

CAUTION-GLASS IMPLOSION - The EIMAC 3-500Z is pumped to a very high vacuum, which is contained by a glass envelope. When handling a glass tube, remember that glass is a relatively fragile material, and accidental breakage can result at any time. Breakage will result in flying glass fragments, so safety glasses, heavy clothing, and leather gloves are recommended for protection.

COOLING - Forced-air cooling is required to maintain the base seals at a temperature below 200°C. Air flow requirements to maintain the above maximum temperatures are tabulated below. (For operation below 30 MHz)

Base-to-Anode Air Flow		
Anode Dissipation (Watts)	Air Flow (CFM)	Pressure Drop (inches-H ₂ O)
300	6.6	0.023
400	10.3	052
500	13.0	082

The anode of the 3-500Z operates at a visibly red color at its maximum rated dissipation of 500 Watts.

In all cases, air flow rates in excess of the minimum requirements will prolong tube life. NOTE: Two 3-500Z tubes in a single amplifier, chassis mounted, may be adequately cooled by use of a fan so mounted as to pressurize the space below the sockets. Fans suitable for use at or near sea level are Pamotor Model 2000, or Model 6500. The Rotron "Spartan" fan (3200 rpm) is also suitable, as is a #3, 3 inch squirrel cage blower (3100 rpm).

In all cases, the only criteria of proper cooling is the temperature of the tube seals. Tube temperatures may be measured with the aid of temperature sensitive paint, spray, or crayon.

Suitable products are manufactured by the Tempil Division, Big Three Industrial Gas & Equipment Co., Hamilton Blvd., SO. Plainfield, New Jersey 07080.

ELECTRICAL

FILAMENT OPERATION - The rated filament voltage for the 3-500Z is 5.0 Volts. Filament voltage, as measured at the socket, should be maintained within the range of 4.75 to 5.25 Volts to obtain maximum tube life.

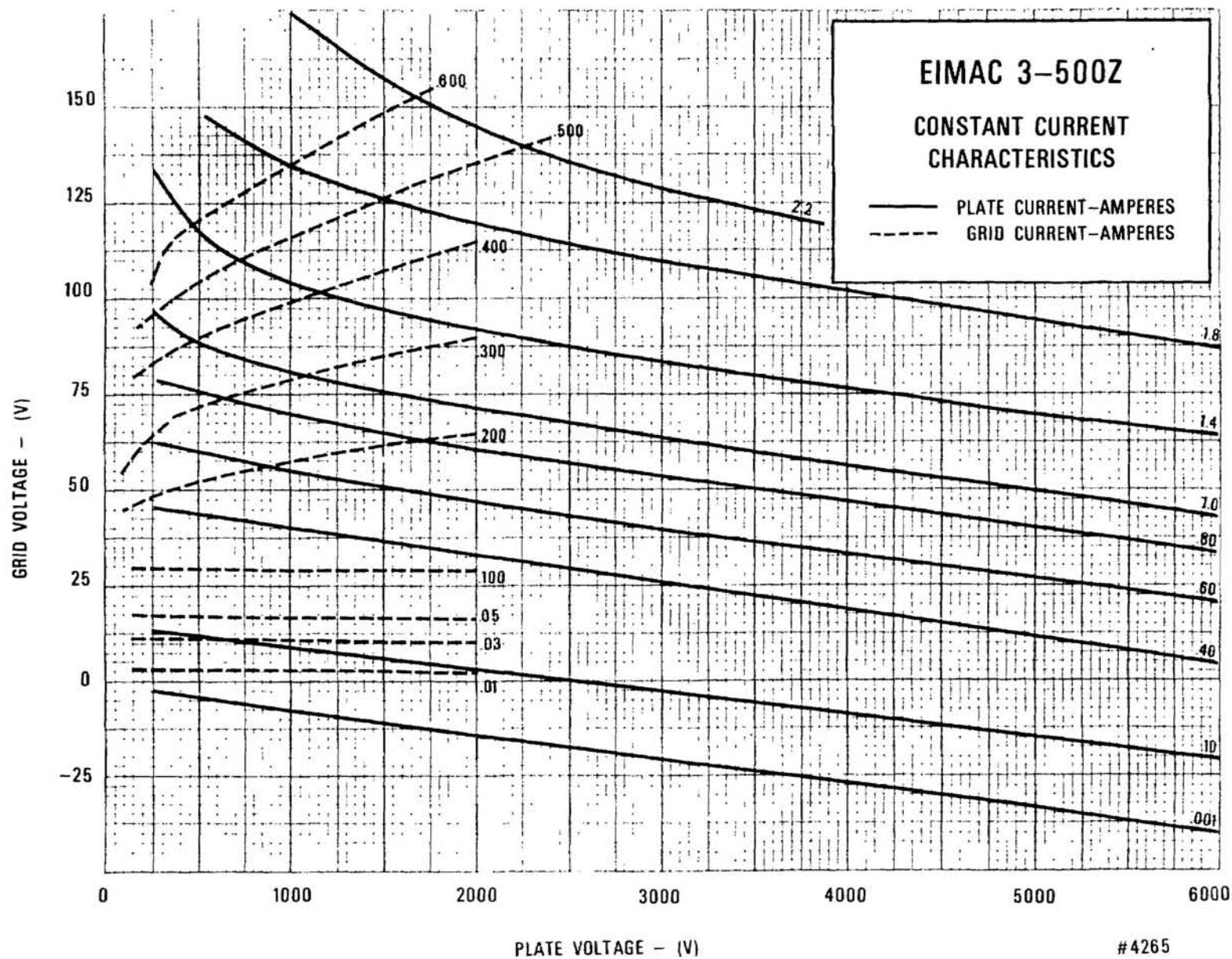
For best tube life, the inrush current to the filament should be limited to two times normal current during turn-on. This will minimize thermal stress on the thoriated-tungsten filament wire, which can cause internal tube geometry changes with repeated cycling.

INTERMODULATION DISTORTION - Typical operating conditions with distortion values included are the result of data taken during actual operation at 2 MHz. Intermodulation values listed are those measured at the full peak envelope power noted.

INPUT CIRCUIT - When the 3-500Z is operated as a grounded-grid rf amplifier, the use of a resonant tank in the cathode circuit is recommended in order to obtain greatest linearity and power output. For best results with a single-ended amplifier, it is suggested that the cathode tank circuit operate at a Q of two or more.

SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions different from those given here, write to the Power Grid Tube Marketing Department, Varian EIMAC, 1678 South Pioneer Road, Salt Lake City, UT 84104, for information and recommendations.

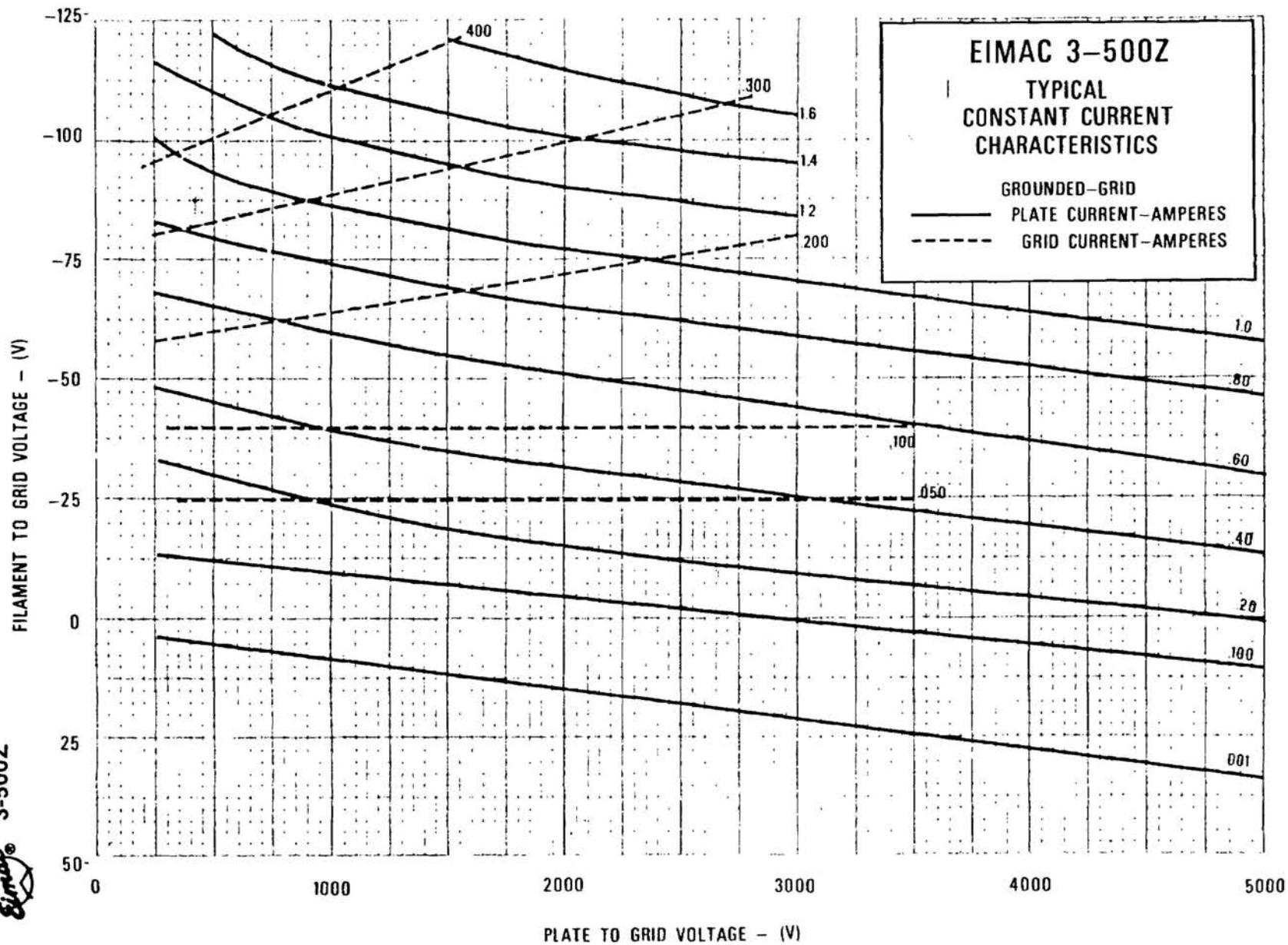
CAUTION-HIGH VOLTAGE - Operating voltage for this tube can be deadly, so the equipment must be designed properly and operating precautions must be followed. Design equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high voltage circuits and terminals, with interlock switches to open the primary circuits of the power supply and to discharge high voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL. -



3-500Z



#4265



HEATH SB-220

High Frequency Linear Amplifier

Number:

15

Date:

SEPT, 1988

Description of modification:

SB220 Tuning Aid to achieve better linearity

Submitted By:

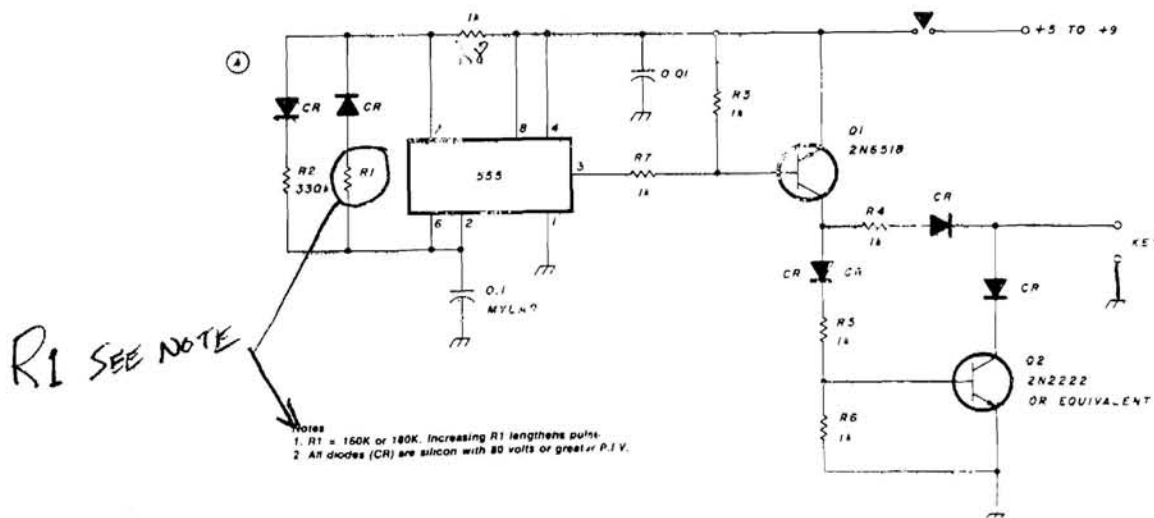
de AG6K
9/85 HAM RADIO

List of required parts:

NE555 timer IC	R5-1k,	Caps-disc type .01 & .1
CR- silicon diode 80PIV or greater	R6-1K-	Q1 2N6518
R1-160K	R7-1K	Q2 2N2222 or equiv.
R2-330K	R7-1K	
R3-1K	R8-1k	
R4-1K		

Procedure:

Although this mod can be used with any linear amplifier, I thought it especially suitable for the SB220, and a great addition to any shack. One of the more common causes of splatter is a misadjusted amplifier. Because of the tuning method most people use, it's much easier to operate this "linear" amplifiers in a non linear state. While the handbook tells us that we should use "two tone" method, most people do not because an RF scope and two tone generator are no longer part of the average shack. The newer solid state self tuning rigs usually lead to the assumption that they are no longer needed, and jointly these two items could cost several hundred dollars. The most common method is to use "tune" position. After all, why would the manufacturer call it this if it wouldn't do the job? The problem with this approach is that it will apply maximum output to the amplifier. After a few seconds, this has led to the failure of the SB220's "stock" power supply. So you say, "I'll just drop the carrier level down a bit and all will be well!"--right? WRONG!! This will result in a reduction of peak plate current and AC plate voltage - two factors used in determining the plate load impedance. Altering one upsets the other. The result is that the amplifier is tuned for an input which does not resemble the duty cycle of the human voice- about 33%. It also leads to excessive grid current which could damage the tubes, not to mention the creation of splatter. The solution? It's easy. Build the circuit shown below. It will produce a keyed waveform which will imitate the human voice. It can be built into a small box, and powered from a small 9v battery for quite a while. The result will be a cleaner signal with longer tube life. Shielded wire and a metal enclosure should be used. Using the pulser is simple. Put the SB220 in the SSB position and your rig to the CW position. Dial in enough carrier to produce an ALC reading. With the transmitter keyed, adjust the SB220 for maximum output. If your rig requires tuning, use it to tune the rig. You should note that the indicated plate current will be about one third the normal reading- this is normal and indicates that all is well. I suggest reading the September 1985 article in HAM RADIO by AG6K titled "Adjusting SSB amplifiers" from which this mod was taken. Mr Measures seems to be on the ball as usual!



HEATH SB-220

High Frequency Linear Amplifier

Number .

16

Date:

April, 1938

Description of modification:

Submitted By:

Mike Rhodes-W8DN

Filament Inrush current protection-Version 2

NO

List of required parts:

1ea Terminal lug strip (4 ungrounded lugs)

2ea Global Thermistors (*see text)

Procedure:

The purpose of this mod is to limit the initial current which the 3-500Z's filament will draw. While another mod in this book offers a much more elaborate method, this is a much easier method in doing the same job. This method does not offer any means of preventing RF from being applied to the SB220 before the tube has come up to operating temperature. Total warm up time should be about 5 seconds. This mod is not recommended for those SB220's running @120 vac, as the line voltage may dip too low, which would result in a filament voltage less than 5.0 volts. Typical installations have noted a voltage drop of about .2v.

1. Using the drawing below, mount a terminal lug strip to the mounting lug directly to the rear of the lug that terminal strip "BT" is attached to. Position the new strip at right angles to terminal strip "BT", as shown.
2. Attach the thermistors to the ungrounded lugs in such a way that they are opposite each other.
3. Remove the black filament xmfr primary lead from lug "AW", soldering an extension wire to it, then connecting it to one side of the thermistor. Next attach a wire from the other side of this first thermistor to lug "AW" so that the thermistor is now in series with the xmfr. Repeat this procedure for the black/yellow wire located on lug 3 of switch "AN".

Sources: KEYSTONE #CL90 Current Limiter

Sintec Co, Box 410, 28 8th Street, Frenchtown, NJ 08825

p/n14442 @1.21 ea

MCM# 33-650 @1.25 ea

MCM ELECTRONICS, 858 E Congress Park Dr, Centerville, OH 45459

