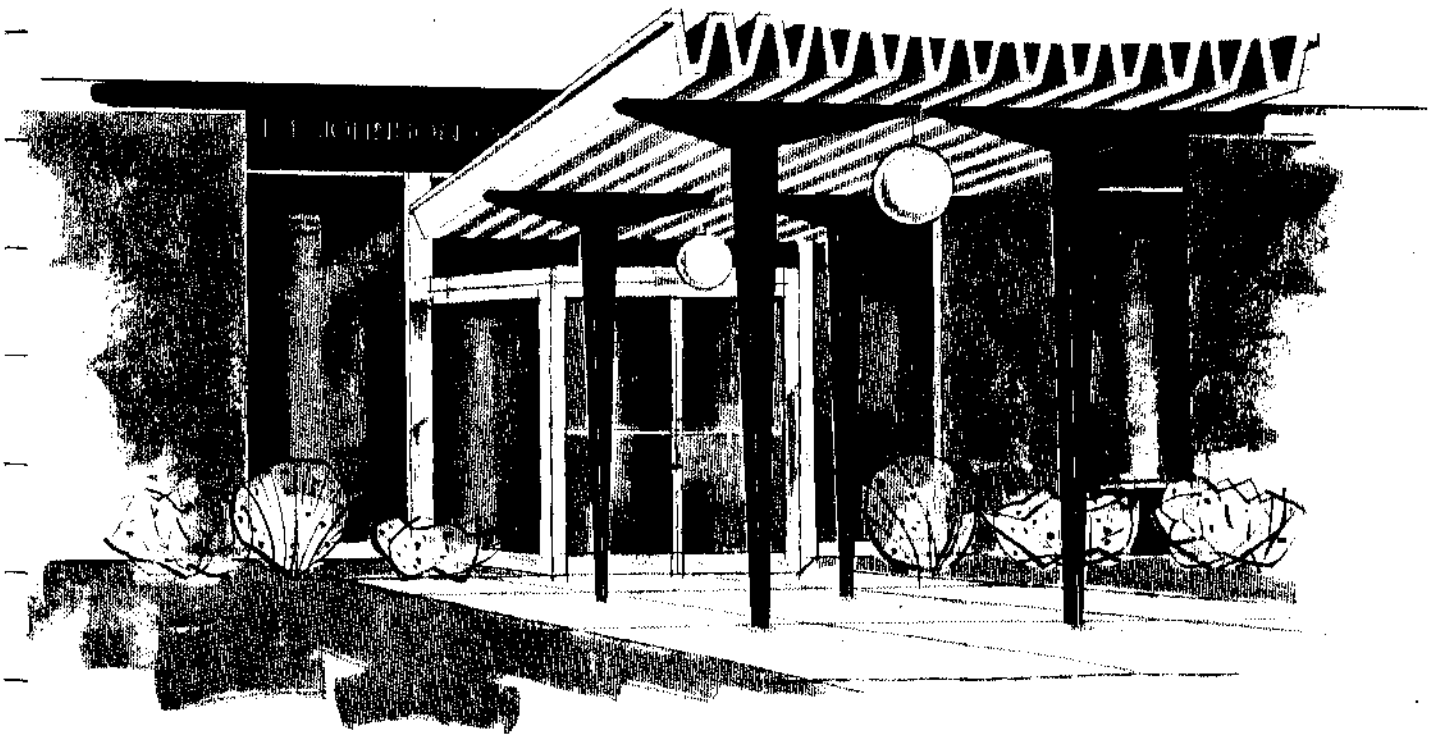
OPERATING MANUAL

VIKING THUNDERBOLT AMPLIFIER



E. F. JOHNSON COMPANY
WASECA, MINNESOTA, U. S. A.

JOHNSON VIKING THUNDERBOLT AMPLIFIER

OPERATING MANUAL CONTENTS

A. INTRODUCTION

The Viking Thunderbolt is a self contained radio frequency power amplifier capable of CW and AM, SSB or DSB linear operation over a continuous frequency range of 3.5 to 30 megacycles. The amplifier employs two Type PL175A pentode tubes in parallel, bridge neutralized, which permits power inputs of 2000 watts P.E.P. linear with suppressed carrier, 800 watts AM linear, and 1000 watts class C continuous wave. Drive requirements are approximately 10 watts from a well regulated exciter for class AB_2 linear (SSB and AM) operation and 20 watts for class C (CW) operation. TVI suppression, spurious filtering, rigorous shielding, and parasitic oscillation suppression are included in the amplifier design.

The complete Thunderbolt amplifier including high voltage, regulated screen and regulated bias power supplies is contained in a cabinet 21" wide x 11 5/8" high x 16 7/8" deep. The total weight is 120 pounds.

The Thunderbolt is fully protected by fuses and also by a series screen limiting resistor which limits the screen dissipation to a safe value even in the event of a complete bias failure.

B. INSTALLATION

1. Observe all packages for damage due to mishandling or abuse during shipment.

2. Open all packages and inspect contents for hidden damage or missing parts. Remove amplifier from cabinet.

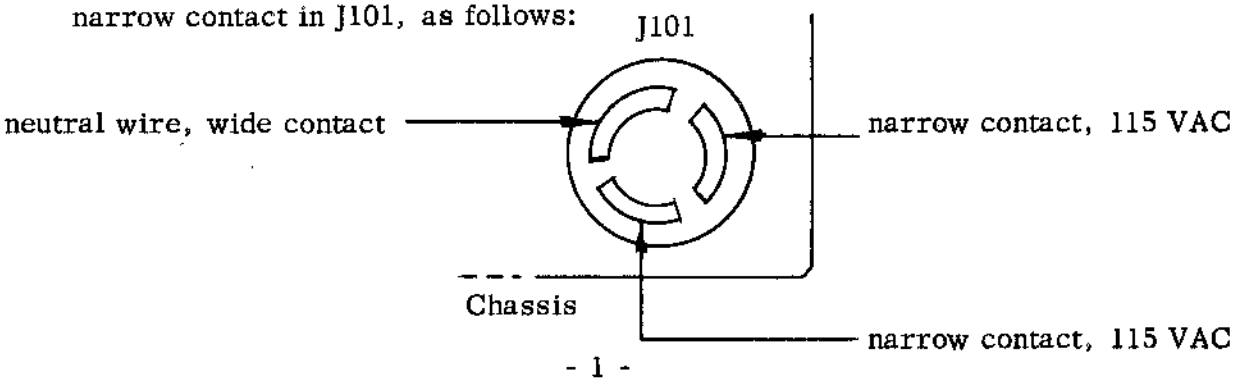
3. Report all claims for transportation damage immediately to the carrier and not to the E. F. Johnson Company.

4. Report any missing parts to the distributor.

5. Power Transformer Installation

   a. In wired units, the transformer was tested in the amplifier, removed, and shipped in a separate container to avoid shipping damage. All wired amplifiers are shipped wired for operation from a 3 wire, single phase 230 to 250 volt 50/60 cycle power source with a grounded neutral. It is preferable to operate this equipment from this type power source. If it is necessary to operate from a two wire, single phase 115 volt 50/60 cycle source, the amplifier may be converted from the 230 VAC circuit as described in section B5c.

   The three wire cable connecting the Thunderbolt to the 230 VAC power should be Underwriter Laboratory approved with current rating of 15 amperes. The grounded neutral wire of the cable must be connected to the power plug P101 so that it contacts the wide contact of J101. The two other wires of the cable should each connect to a narrow contact in J101, as follows:



b. Disconnect the leads of the 13 mfd capacitor board assembly and remove it from the unit. Install the power transformer in the rear left corner on the top of the chassis so the four mounting studs fit into the holes provided and the five leads feed through the 1 1/8" diameter hole near the back of the resistor boards as shown in Figure A. Secure the transformer to the chassis with a 1/4" lockwasher and a 1/4-20 hex nut on each stud. Make the following connections:

1. Connect the two yellow leads to the screw terminal on the capacitor board CH9 (Figure C).

2. Connect the black wire with green tracer to terminal 1 of TS1 (Figure B).

3. Connect the white wire to terminal 2 of TS1.

4. Connect the black wire to terminal 3 of TS1.

5. Connect the black wire with red tracer to terminal 4 of TS1.

c. Conversion to two wire 115 VAC operation is accomplished by making the following changes:

1. Disconnect the black wire with white tracer from terminal 1 of TS1 and connect this end to terminal 2 of TS1.

2. Remove the jumper wire (white wire with black tracer) from terminal 2 of TS1 and connect this end to terminal 1 of TS1.

3. Make two jumper wires like the one used above. Connect one jumper wire between terminals 2 and 4 of TS1. Connect the other jumper wire between terminal 1 of TS1 and the screw terminal at the end of TS1.

4. Connect the two narrow contacts of the power plug P101 together with a short length of No. 16 tinned wire (Be sure the power cord is completely disconnected from the power source.) The 115 volt power source has one lead at ground potential and the other lead 115 volts above ground and this polarity must be observed when connecting the power cord to P101. Connect the 115 volt power lead which is above ground to the two narrow contacts. Connect the grounded 115 volt power lead to the wide contact of P101.

d. Install the 13 mfd filter capacitor and reconnect the two leads.

e. The bias-screen transformer is normally wired for 115 VAC primary voltage. If the primary voltage is above 115 VAC, disconnect the black with yellow tracer wire from terminal 3 of TS3. Remove the black with red tracer wire from terminal 2 of TS3 and solder it to terminal 3 of TS3. Connect, but do not solder, the black with yellow tracer wire to terminal 2 of TS3. Be certain none of the terminals on TS3 are shorted to each other.

6. Tube Installation

Carefully install all vacuum tubes in the appropriate sockets as shown in Figures A and F. Slide amplifier into cabinet so HV shorting switch, SW105, opens.

Place the PLATE SWITCH at OFF, the FILAMENT SWITCH on ON, and allow the tubes to heat at least 1 minute before the initial application of high voltage on the tubes. This period is sufficient to allow the bias supply to reach full voltage and the tube filaments to reach the proper temperature.

7. Plate Suppressor Installation

After the wired unit had been completely tested, the plate suppressors, and plate connectors (including mounting hardware) were removed for shipment, utilizing separate packaging. The plate suppressors (E1 and E2) should be mounted on the neutralizing capacitor (C2) using the 6-32 x 1/4" binding head screw and #6 lockwasher (Figure A and F). The shorter suppressor goes to V1 (PL175A in the socket on the right side, viewed from the front) and the longer suppressor goes to V2 (PL175A on the left side). Place the plate connectors on the tube caps and adjust the suppressor assemblies so that the plate connectors do not impose undue stress on the tube caps. Carefully tighten the set screws on the plate connectors and then tighten the 6-32 screw on the neutralizing capacitor.

8. Neutralization

The wired amplifiers are shipped from the factory neutralized and need not be reneutralized.

Neutralization is adjusted with the amplifier operating in the CW mode with 20 ma. of grid current and a 450 ma. plate current loading on 14 megacycles (see Section D1 for tuning and loading procedure). At proper neutralization, the grid current should reduce when the tank is tuned off either side of resonance although a slight rise of 2 ma. or less of grid current is permissable on one side of tank resonance. If the grid current increases on the high frequency side of tank resonance, increase the neutralizing capacity by turning the neutralizing capacitor (C2) clockwise. If the grid current increases on the lower side of tank resonance, decrease the neutralization capacity. Proper neutralization is usually secured with the neutralizing capacitor set at approximately 14 turns from the minimum capacity stop position.

9. Ground Connections

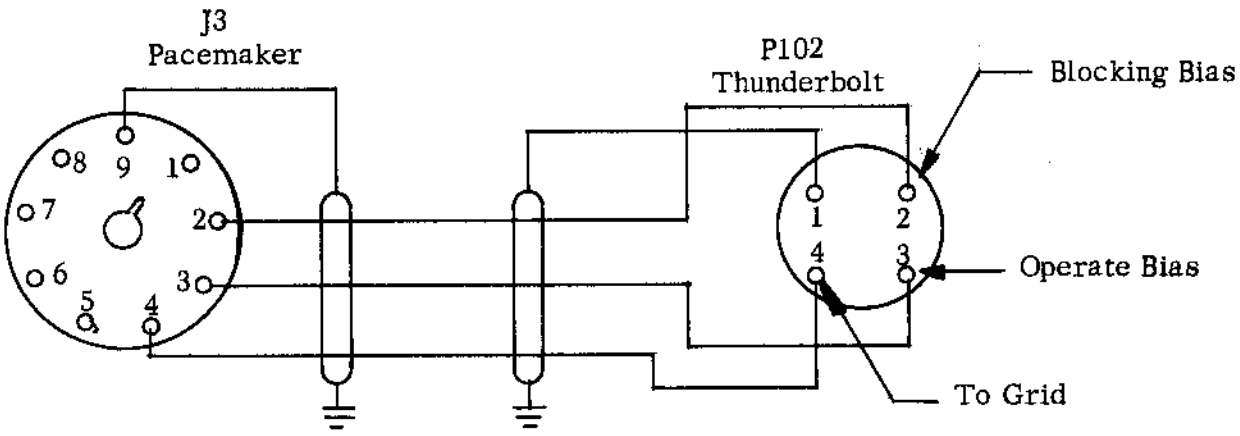
Both the Viking Thunderbolt and the exciter chassis should be bonded together by a heavy copper wire or strap. The same type wire or strap should be used to connect the chassis to an earth ground. The length of the ground wire should be as short as possible avoiding lengths which are a quarter wavelength long on any of the operating frequencies. If the ground lead must be long, it is desirable to make its length a 1/2 or full wave long on the operating frequencies. In some installations, it may be advisable to install more than one ground wire.

NOTE: Be sure the four cabinet tie rods and 20 screws (with lockwashers) attaching the cabinet are tightened securely.

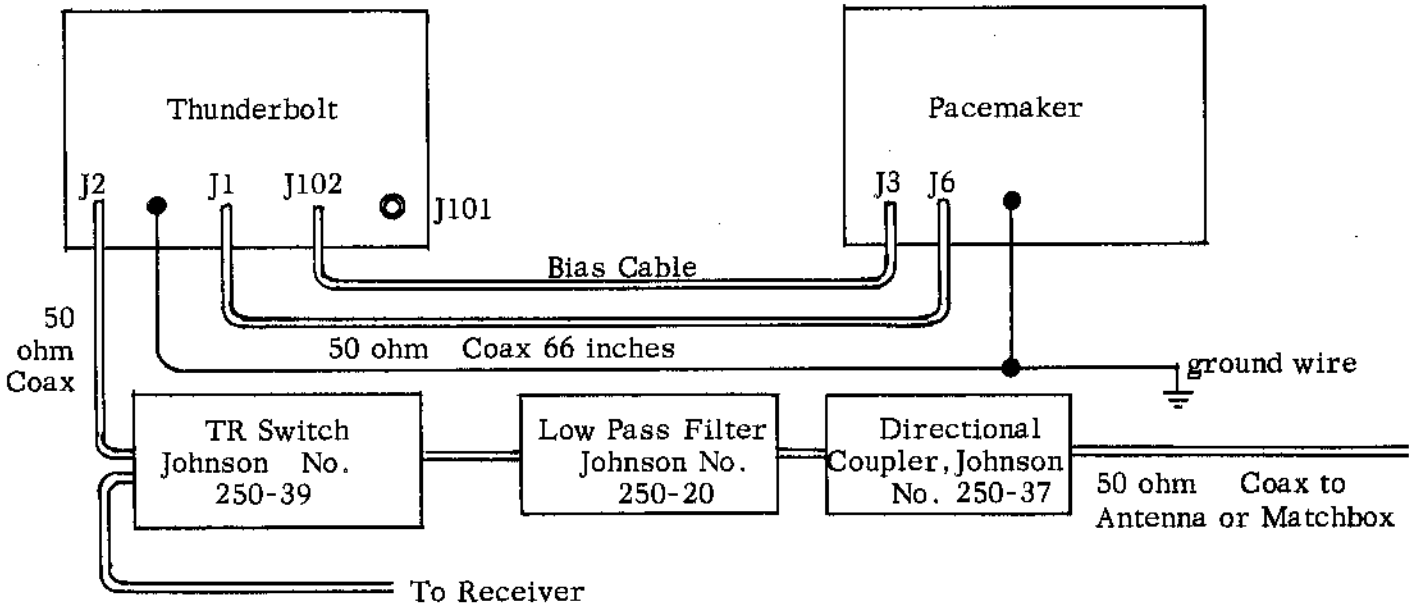
10. Exciter and Thunderbolt Interconnection.

a. Pacemaker - Thunderbolt Interconnection

Make up interconnecting cables for interconnection of the exciter and Thunderbolt amplifier as shown in the sketches that follow. Avoid excessive lengths of coaxial transmission lines.



Bias Switching Control Circuit Shielded Cable-three #22 or larger stranded wires.

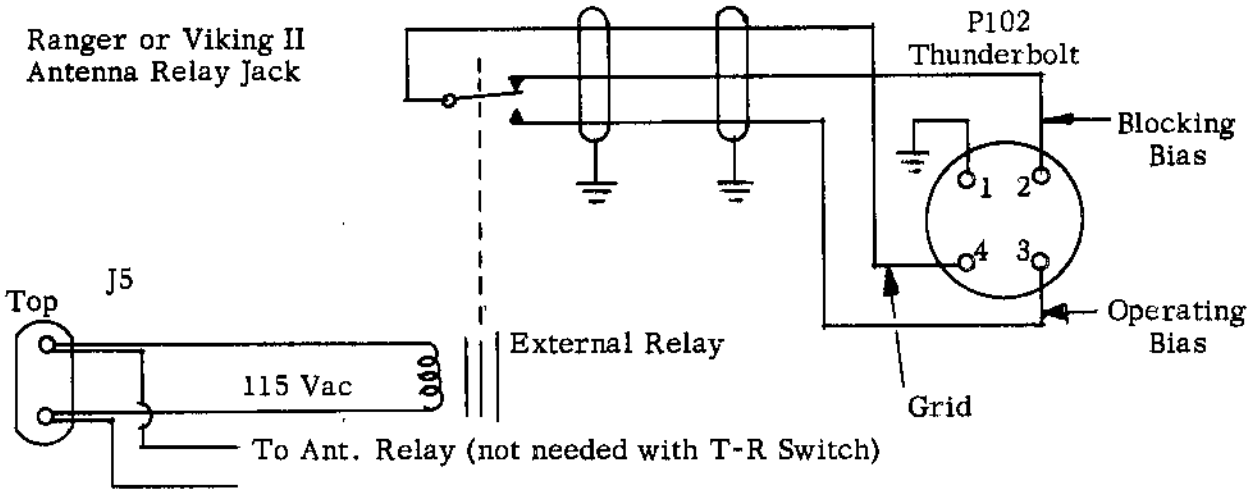


The output of the Pacemaker requires no external swamping for CW, SSB and AM linear operation. Proper loading for linear operation is provided by the 350 ohm grid loading resistor, R3, when the Thunderbolt grid switch is placed in the "RES" (resistive) position. This grid switch position requires no tuning of the grid circuit and is used for linear operation.

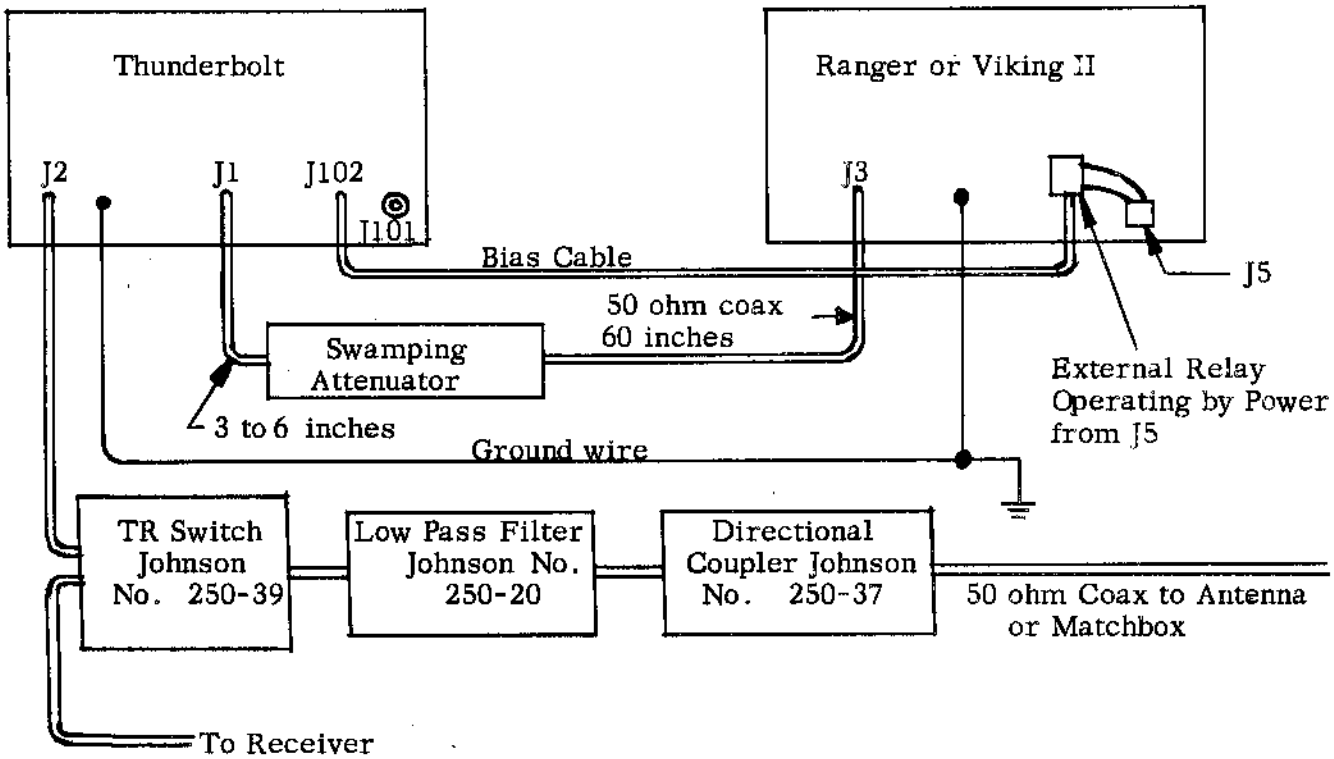
For CW operation the grid switch is turned to the operating frequency band, which switches the 350 ohm resistor out of the circuit.

b. Ranger, Viking II or Similar Exciters - Thunderbolt Interconnections.

Make up interconnecting cables for interconnection of the exciter and Thunderbolt amplifier as shown in the sketches below. Avoid excessive lengths of coaxial transmission lines.

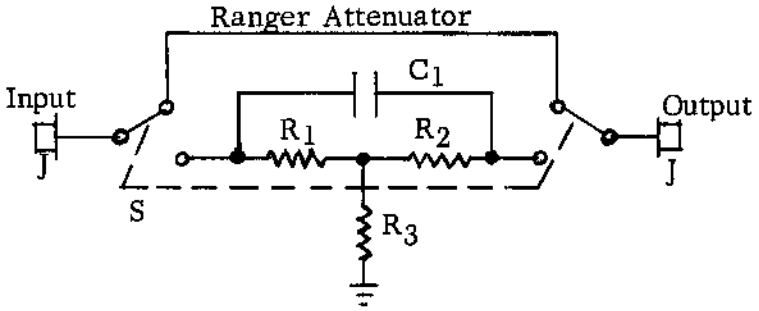


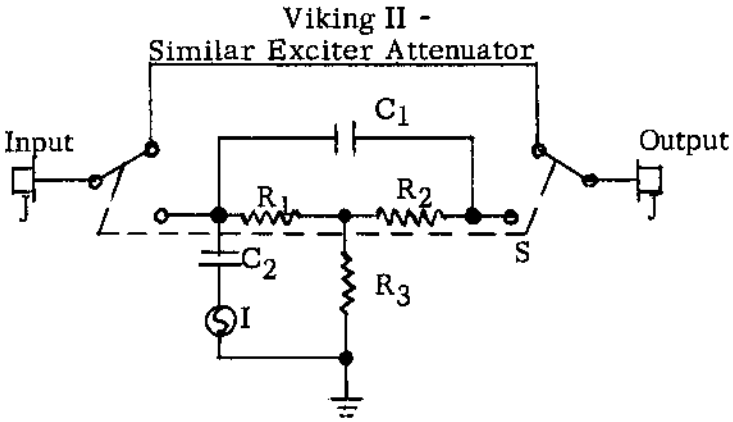
Bias Switching Control Circuit Shielded Cable - three #22 or larger stranded wires.



In AM linear operation, these exciters will require an external swamping attenuator in addition to the 350 ohm resistor provided in the Thunderbolt when the BAND switch is in the RES position. If the Thunderbolt is operated in the CW mode or TUNE position, the swamping attenuator must be switched out. A swamping attenuator, JOHNSON Part No. 250-42-1 should be used with the Ranger and the Viking II.

This 6db swamping attenuator may be constructed as shown in the diagram. The attenuator should be housed in a shielded enclosure to prevent radiation.





R_1 = ten 1200 ohm 2 watt non-inductive resistors in parallel.

R_2 = four 470 ohm 2 watt non-inductive resistors in parallel.

R_3 = ten 4700 ohm 2 watt non-inductive resistors in parallel.

C_1 = 47 mmfd 500 W.V. mica capacitor.

J = 83R-1 coaxial connector.

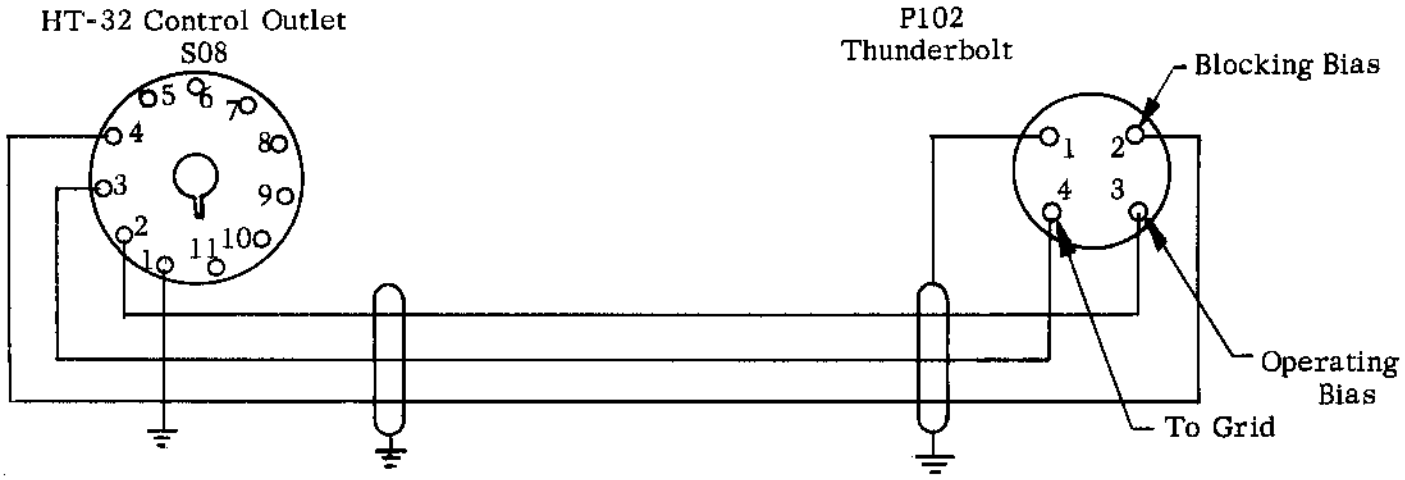
S = DPDT rotary switch.

C_2 = 150 mmfd 500 W.V. mica capacitor.

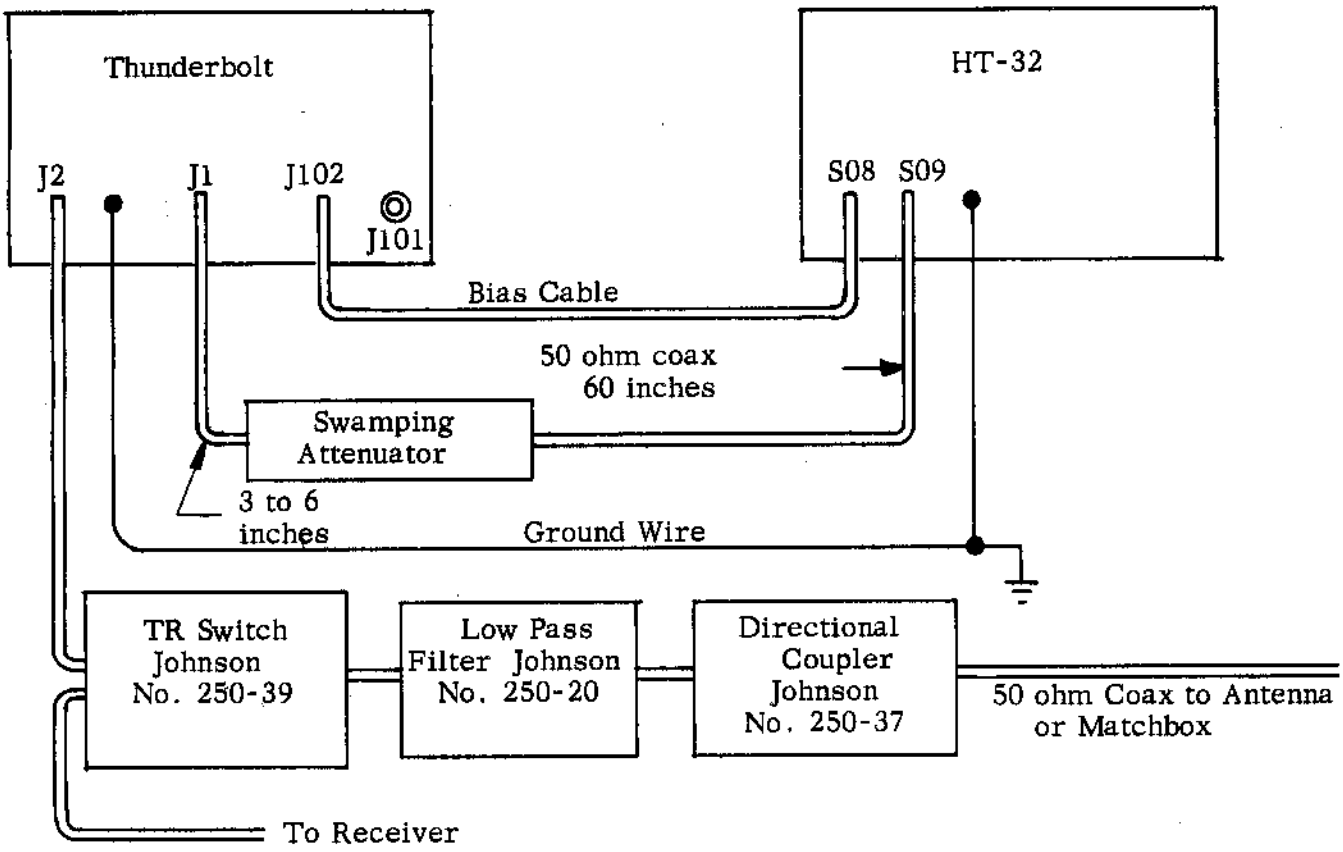
I = 75 watt 115 VAC light bulb.

c. Thunderbolt - HT-32 Exciter Interconnections.

Make up interconnecting cables for interconnection of the exciter and Thunderbolt amplifier as shown in the sketches below. Avoid excessive lengths of coaxial transmission lines.

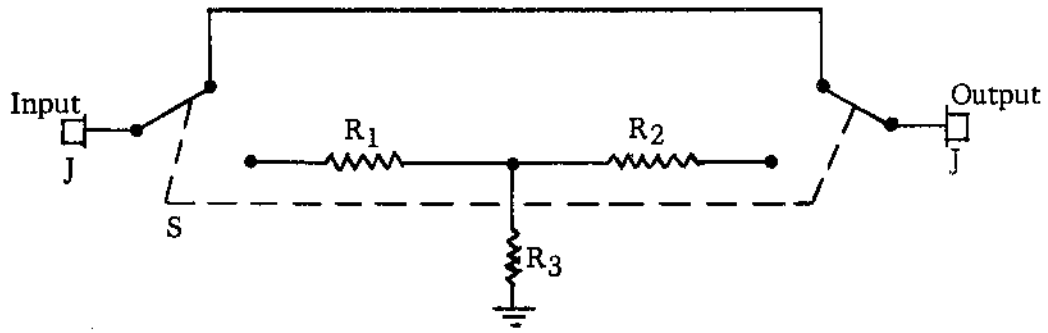


Bias Switching Control Circuit
Shielded Cable - three #22 or larger stranded wires



When an HT-32 exciter is used, the Thunderbolt bias leads in the above circuit should be connected to pins 2, 3 and 4 of SO8 in the HT-32. A swamping attenuator (JOHNSON Part No. 250-42-3) should be used on the RF output of the HT-32 and should be switched out when driving the Thunderbolt in CW operation.

This 6db swamping attenuator may be constructed as shown in the diagram. The attenuator should be housed in a shielded enclosure to prevent radiation.



R_1 = Twelve 220 ohm 2 watt non-inductive resistors in parallel.

R_2 = Four 68 ohm 2 watt non-inductive resistors in parallel.

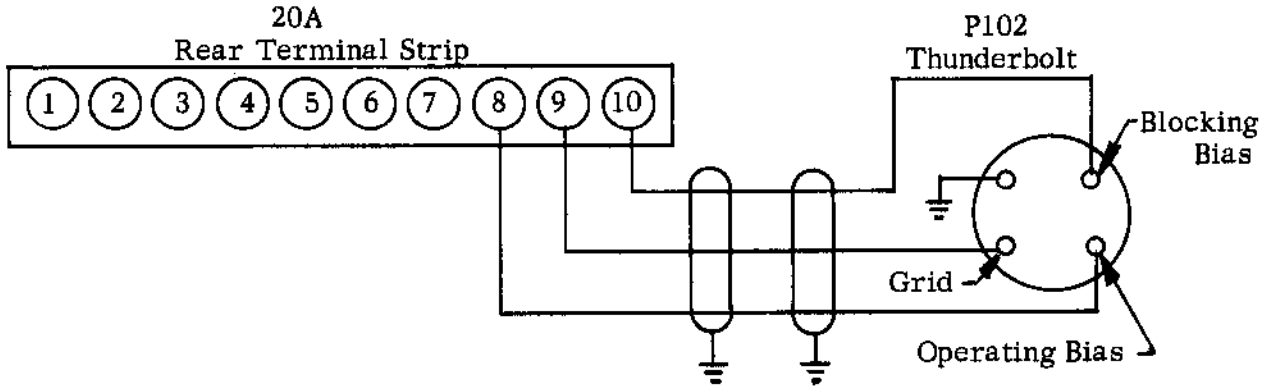
R_3 = Twelve 820 ohm 2 watt non-inductive resistors in parallel.

J = 82R-1 coaxial connector.

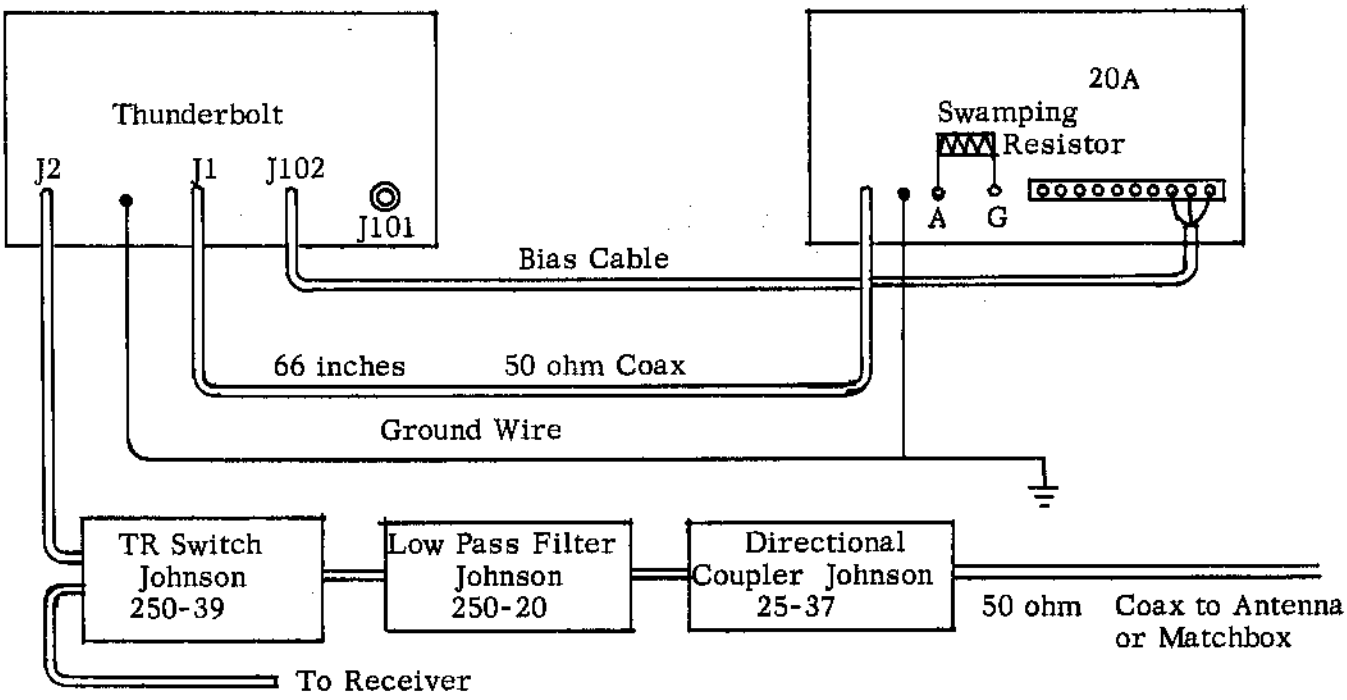
S = DPDT rotary switch.

d. Thunderbolt - 20A Exciter Interconnections.

Make up interconnecting cables for interconnection of the exciter and the Thunderbolt amplifier as shown in the sketches below. Avoid excessive lengths of coaxial transmission lines.



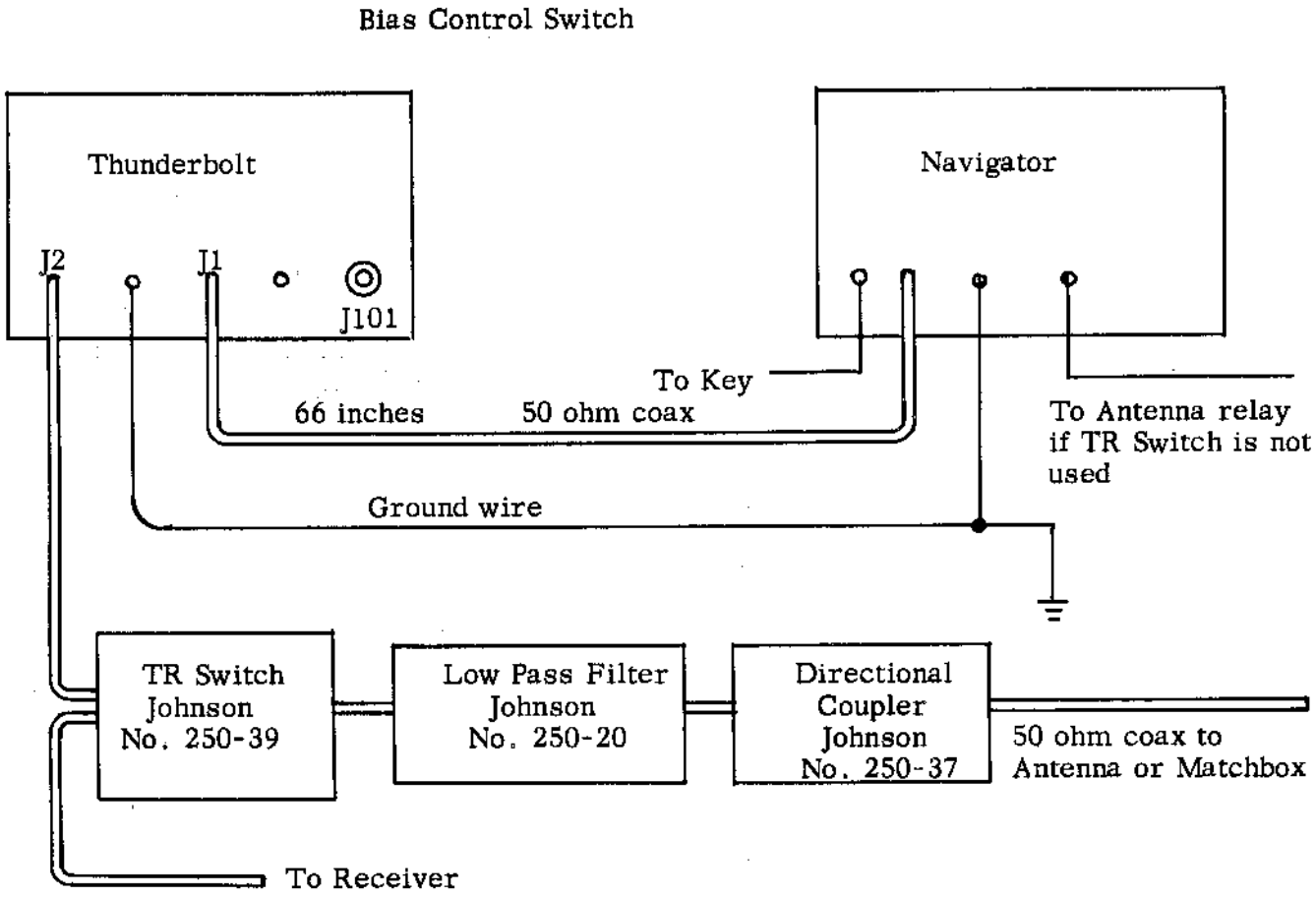
Bias Switching Control Circuit Shielded Cable - three #22 or larger stranded wire.



The Thunderbolt bias switching leads should be connected to terminals 8, 9, and 10 at the 20A exciter as shown in the above circuit. The output of the 20A should be swamped with 100 ohms of resistance (three 330 ohm, 2 watt non-inductive resistors in parallel). Due to the reduced output of the 20A on the 15, 11 and 10 meter bands, the exciter may not be capable of driving the Thunderbolt to full power on these bands. The swamping resistor will have to be removed to drive the Thunderbolt in CW operation.

e. Navigator - Thunderbolt Interconnection.

Make up interconnecting cables for interconnection of the exciter and the Thunderbolt amplifier as shown in the sketches below. Avoid excessive lengths of coaxial transmission lines.



No swamping resistance load is required on the Navigator since it is only capable of CW operation. The tuning procedure is the same as described in section D1.

C. METERS, CONTROL AND FUSES

Refer to Figure K, Control Familiarization Chart.

1. PLATE CURRENT-POWER meter (M2) indicates the plate current of the amplifier and the power input for plate voltage of 2000 volts. If the plate voltage is other than 2000 volts, multiply plate current and plate voltage to obtain watts input.

2. The MULTI-METER (M1) indicates the grid current, screen current, and plate voltage as selected by the meter switch located below the meter. The top scale reads the grid current directly and the screen current when the scale is multiplied by 5. The plate voltage is read by the bottom scale and is in kilovolts.

3. The FILAMENT SWITCH controls the filament, bias and screen voltages. The filament switch must be turned on only when the plate switch is in the off position. Sufficient time must be allowed for heating of the 3B28 filaments and the bias and screen voltages to come up to value before the plate switch is placed in the ON position. One minute is sufficient.

4. The PLATE SWITCH controls the high voltage. It must be in the OFF position when the filament switch is turned on or whenever the mode or coupling switches are changed.

5. The MODE SWITCH selects the proper bias and screen voltage for CW, TUNE and LINEAR operation. The CW position is used for Class C operation of the Thunderbolt amplifier. The TUNE position is used only for the tuning and loading of the amplifier for linear operation. The LINEAR position is used for AM, SSB and DSB operation of the amplifier.

6. The BAND SWITCH selects the input coupling coil and grid tuning inductance for continuous coverage from 3.5 to 30 megacycles. The RES (resistance) position disconnects the tuned grid circuit and places a 350 ohm swamping resistor across the grid circuit of the PL175A tubes. The RES position may be used with the PACEMAKER (AM and SSB operation), the Ranger and Viking II (AM operation) or any similar exciter whose output circuit will load into 350 ohms. For CW operation, the BAND SWITCH must always be in tuned circuit position for the desired operating band and not in RES position.

7. The GRID dial controls the grid circuit tuning capacitor.

8. The PLATE TUNING control provides single knob tuning of the plate circuit inductor and capacitor from 3.5 to 30 megacycles. The PLATE TUNING control also drives the slide rule type indicator.

9. The COUPLING controls provide switching of the fixed loading capacitors and adjustment of the variable loading capacitor to obtain the desired plate current (loading).

10. The Thunderbolt has three fuses (F101, F102, F103) located at the rear of the amplifier chassis. The fuses protect the following circuits.

    a. F101 protects all AC power primaries.

    b. F102 protects the high voltage transformer primary.

    c. F103 protects the filament and low voltage transformer primaries.

11. J102, the four pin socket on the rear of the chassis, provides control of blocking and operating bias. An external set of SPDT relay contacts (usually available in the exciter) transfers the bias from blocking to operate (See Section B10). Blocking bias is used during standby periods to cut off the amplifier thus reducing power consumption and plate dissipation and eliminating diode noise in the receiver.

D. ADJUSTMENT AND OPERATION

1. CW Class C Operation

The Thunderbolt Amplifier is operated as a Class C amplifier for CW by switching the MODE SWITCH to the CW position which selects the proper bias and screen voltages. For this type of operation, the BAND SWITCH must be placed in the operating frequency position and the GRID capacitor adjusted for resonance. The maximum permissible loading of the Thunderbolt is secured when the plate power input, at resonance, is 1000 watts (plate current x plate voltage) with 20 ma. of grid current drive. The Thunderbolt may be adjusted to a lower power input by reducing the load coupling.

The Thunderbolt is adjusted for CW operation in the following manner.

a. Place the Thunderbolt PLATE at OFF, FILAMENT at ON, METER at GRID, MODE at CW, and BAND at the operating frequency.

b. Set the Thunderbolt dial positions to those given in Figure I.

c. Adjust the exciter and the Thunderbolt grid circuit to resonance (tune GRID for maximum grid current). Adjust the exciter output for 10 ma. of grid current in the Thunderbolt.

d. Place Thunderbolt PLATE at ON and adjust the PLATE TUNING for resonance, minimum plate current (dip).

e. Increase the output of the exciter (keeping the exciter final in resonance) for 20 ma. of Thunderbolt grid current. Adjust the COUPLING and PLATE TUNING until 1000 watts input is secured at resonance. After each incremental adjustment of the COUPLING controls (coupling is increased with increasing dial numbers), the PLATE TUNING is adjusted for minimum plate current (dip). Tuning for dip should always be the last adjustment.

f. Keying of the exciter will operate the amplifier. Since blocking bias is provided on the grids of the PL175A tubes, the plate current will be cut off during key up condition.

2. Linear Operation

General

The Johnson Viking Thunderbolt uses voltage regulated bias and screen supplies and a well regulated plate voltage supply to assure good linearity and low distortion. Although the Thunderbolt is very "clean", the on-the-air signal can be no better than the signal supplied by the exciter. For example, a popular 20 watt exciter produces relatively high distortion at the rated output of 20 watts and, although it may be tolerable "barefooted", it may cause excessive splatter when the signal is of much greater intensity due to the use of a high-powered amplifier (The Thunderbolt gives a power increase of 60 times in this case!).

A SSB exciter should be loaded to rated input when it is used to drive a linear amplifier in order that the inherent signal-to-noise and suppression characteristics of the exciter be fully realized. This requires an attenuator or "swamping" load to absorb excessive power when the exciter produces more output than needed to excite the linear amplifier. The Thunderbolt operates in Class AB1 (zero grid current) up to a peak envelope power input of 1400 watts and is driven into the grid current region, Class AB2, to obtain the maximum rated power of 2000 watts. When grid current starts to flow, the Thunderbolt grid impedance drops thus presenting a variable load to the exciter. The exciter should be heavily loaded so that the changing grid load has relatively little effect upon the exciter. An exciter should have, preferably, an output of 40 watts or more, swamped down, when

driving into the Class AB2 region. When in doubt, do not drive into the grid current region (limit audio level to the point where grid current just starts to flick upward) until careful checks are made to assure that there is no splatter.

AM linear operation requires that the exciter be loaded reasonably close to its normal operating level with the output then attenuated to prevent overdriving the Thunderbolt.

Appropriate attenuators for typical exciters are shown in Section B10.

a. Loading Point

The linearity of any linear amplifier is largely dependent upon the loading and it is important, therefore, that a linear amplifier be properly loaded. The Viking Thunderbolt utilizes a unique loading procedure which compensates for differences in vacuum tubes and permits optimum loading without the use of an oscilloscope.

With exciter interconnections properly made (See Section B10), temporarily disconnect the coaxial cable from the input coaxial fitting, J1, on the Thunderbolt. Place Thunderbolt MODE switch in LINEAR position, PLATE OFF, FILAMENT ON. Turn on exciter, turn Thunderbolt PLATE ON and record the plate current, ___ ma (should be between 200 and 300 ma). This value is the static plate current and will now be used to determine the proper plate current loading point per the following chart:

Static Plate Current	Loading Point, MA
200	325
220	340
235	350
250	360
275	375
300	390

Pick the loading point nearest the static plate current previously recorded. Henceforth, this loading point plate current will serve on all bands as the proper loading point for linear operation. For example, a static plate current value of 250 ma calls for a loading point value of 360 ma.

b. Linear Operation Loading Procedure

The loading procedure for linear operation of the Viking Thunderbolt is simply this: In the TUNE position and with four (4) ma grid current, adjust the PLATE TUNING and COUPLING controls to obtain the proper load point current (360 ma in the example above). This establishes the proper load point and the amplifier can now be switched to LINEAR mode and linear operation commenced.

For the purpose of initial familiarization, a detailed step-by-step loading procedure is listed below:

(1). With exciter interconnections properly made (See Section B10), set the Thunderbolt controls

MODE to	TUNE
PLATE	OFF
FILAMENT	ON
METER	GRID
BAND	RES for Pacemaker, Ranger, Viking II and similar units. Appropriate band for HT-32, 20A and others.

PLATE TUNING COUPLING	Set per Figure I, Approximate Dial Positions
GRID	Tune for peak grid current in following step if RES position is not used.

(2). Turn on exciter and adjust exciter output for four (4) ma. grid current on Thunderbolt. During following adjustments, readjust exciter as necessary to maintain 4 ma. grid current.

(3). Turn PLATE ON and adjust PLATE TUNING for minimum plate current (dip) on upper meter.

(4). Adjust coarse and fine COUPLING controls to increase plate current reading (clockwise adjustment increases reading) to desired load point current (See D2a, above). After each incremental adjustment of COUPLING, the PLATE TUNING should be adjusted for dip. Adjustment for dip should always be the last adjustment.

(5). When loading for linear operation, there should always be a 25 to 35 ma. plate current dip when the Thunderbolt is fully loaded. In the example given, the load point current is 360 ma. If the 360 ma. current is obtained but a 25 to 35 ma. "dip" (25 to 35 ma. difference between out-of-resonance plate current and dipped plate current) is not possible, decrease the coupling to the point where this amount of dip is present. Instead of 360 ma., the dipped plate current will be some lower value.

In other words, load to the specified plate current loading point whenever possible but in all cases decrease the loading (coupling) to secure a 25 to 35 ma dip whenever such dip is not present.

Excessive loading decreases the power output in the Thunderbolt or any other linear amplifier.

(6). This completes the loading procedure. Reloading will only be necessary if bands are changed, if frequency is changed appreciably within a band, or different antenna systems used.

(7). Turn PLATE OFF, switch MODE to LINEAR. Operation in the linear mode may now be commenced by placing exciter in proper mode and placing PLATE in ON position. In SSB operation, the peak plate current meter swing should not exceed a value which times the voltage equals 1000 watts (for example, 455 ma if plate voltage is 2200 volts) as 1000 watts meter reading is the maximum legal power permitted in the Amateur Service by the FCC. With average voices, and due to the fact that the inertia of the meter needle results in a reading considerably below the true plate current, the peak envelope power input will be 2000 watts. The plate current meter has a time constant of 1/4 second as required by the FCC.

c. Exciter Tuning

(1). Johnson Viking Pacemaker

The Pacemaker exciter is fed directly into the Thunderbolt with the BAND switch in the RES position and no GRID tuning or external swamping is required on any band, SSB or AM (See Section B10a). Set Pacemaker controls:

VFO and BAND	desired band and frequency
MODE	AM-HI
CARRIER INSERT	0
OPERATE	STANDBY
AUDIO	0

Set Thunderbolt controls:

METER	VOLTAGE (This position is used to avoid pinning the meter in GRID position during Pacemaker tuneup.)
MODE	TUNE
BAND	RES
PLATE	OFF
FILAMENT	ON
PLATE TUNING, COUPLING	Set per Figure I, Approximate Dial Settings.

(a). Turn on Pacemaker and load it according to Pacemaker tuning instructions to 0.2 ma grid current and 115 ma plate current. Be sure that BALANCE MOD and EXCITER are tuned for maximum Pacemaker grid current.

(b). Turn CARRIER INSERT to 0, Thunderbolt METER to GRID. Adjust CARRIER INSERT for Thunderbolt GRID current of four (4) ma. (If grid current is above four ma. with carrier insert at 0, adjust CARRIER BALANCE controls to bring current down within range of insert control).

(c). Load Thunderbolt as described in preceding section, D2b. Turn PLATE switch OFF, MODE to LINEAR.

(d). Turn Pacemaker MODE switch to desired sideband for SSB OPERATION AND ADJUST CARRIER BALANCE controls for minimum plate current on Pacemaker. Turn PLATE ON and advance AUDIO control while speaking into microphone. Maximum legal power is obtained when plate current meter peaks reach approximately 455 ma. The Thunderbolt plate current may serve as a more sensitive indicator for CARRIER BALANCE adjustment.

(e). For AM OPERATION tune up as in preceding steps. With CARRIER INSERT at 0, turn Pacemaker MODE switch to AM-LO. With PLATE ON, advance CARRIER INSERT until the Thunderbolt plate current is 375 ma. Advance AUDIO control, while speaking into microphone until the plate current kicks upward slightly (approximately 25 ma.). Monitoring the signal and reports will indicate proper audio setting.

(f). For CW OPERATION, the RES position is not used and the BAND and GRID are adjusted to the proper frequency. Load the Pacemaker to a minimum of 50 ma. plate current (with .2 ma. grid current) and then reduce the CARRIER INSERT to obtain 20 ma. grid current on the Thunderbolt as described in section D1.

(2). AM Linear Operation with Ranger, Viking II or Similar Exciters

Interconnect the exciter and Thunderbolt as shown in Section B10b. Set exciter on desired band with attenuator switched out (no attenuation). Set Thunderbolt controls.

METER	GRID
MODE	TUNE
BAND	RES
PLATE	OFF
FILAMENT	ON
PLATE TUNING, COUPLING	Set per Figure I, Approximate Dial Settings

(a). With normal grid current on the exciter and with its output decoupled to avoid overdriving the Thunderbolt, increase the exciter coupling to obtain four (4) ma. Thunderbolt GRID current. During following adjustments, readjust exciter as necessary to maintain 4 ma. grid current.

(b). Turn Thunderbolt PLATE ON and load as described in Section D2b. Turn PLATE OFF. Turn MODE to LINEAR.

(c). Switch the attenuator into the circuit and increase the exciter loading to where the Thunderbolt plate current is 375 ma (Thunderbolt PLATE ON, MODE in LINEAR). Advance the audio gain while speaking into the microphone until the Thunderbolt plate current kicks upward slightly.

The exciter grid current should always be maintained at the normal operating value. Using the specified attenuator, the Ranger plate current will be approximately 75 to 90 ma. and the Viking II 100 to 190 ma. when properly loaded. Although these figures are below the normal loading for AM operation, the loading is still adequate and the waveform very satisfactory.

(3). HT-32 Exciter

Interconnect the HT-32 and Thunderbolt as shown in Section B10c.

Set HT-32 controls.

BAND and FREQUENCY	desired band and frequency
OPERATION	STANDBY
FUNCTION	DSB
RF LEVEL	0
METER COMPRESSION	1
AUDIO LEVEL	0

Set Thunderbolt controls.

METER	GRID
MODE	TUNE
BAND	desired frequency range
PLATE	OFF
FILAMENT	ON
PLATE TUNING, COUPLING	Set per Figure I, Approximate Dial Settings

For SSB Operation

(a). Turn HT-32 OPERATION switch to MOX, advance RF LEVEL slightly and tune DRIVER TUNE and FINAL TUNE for peak meter reading.

(b). Adjust Thunderbolt GRID tuning for maximum Thunderbolt grid current. Repeak HT-32 FINAL TUNE and adjust RF LEVEL for four (4) ma. grid current on Thunderbolt. Maintain 4 ma. in following loading steps.

(c). Turn Thunderbolt PLATE ON and load as described in Section D2b. Turn PLATE OFF. This completes the loading of the Thunderbolt.

(d). Turn METER to VOLTAGE on Thunderbolt to prevent pinning meter on the grid range during following HT-32 loading adjustment.

(e). Adjust RF LEVEL, DRIVER TUNE and FINAL TUNE on the HT-32 for just under maximum output (peak on meter) and adjust METER COMPRESSION as described in HT-32 Operating Manual.

(f). Switch FUNCTION to desired sideband, upper or lower, Thunderbolt MODE to LINEAR, METER to GRID, PLATE ON.

(g). Advance AUDIO LEVEL, while speaking into the microphone, until Thunderbolt plate current meter peaks reach approximately 455 ma. The HT-32 OPERATE switch may be placed in the VOX position for voice-operate or used between STANDBY and MOX for manual operation.

(3). For AM (DSB) Operation

(a). Follow procedure as detailed above for SSB Operation, steps a through e.

(b). Turn RF LEVEL to 0, Thunderbolt METER to GRID, MODE to LINEAR, PLATE ON.

(c). Turn up RF LEVEL so that Thunderbolt plate current reads 375 ma.

(d). Advance AUDIO LEVEL, while speaking into microphone, until a very slight upward kick of the Thunderbolt plate current is observed. Either VOX or MOX operation may be used.

For CW Operation

The attenuator should be switched out of the circuit and loading accomplished as described in Section D1.

(4). 20A Exciter

Interconnect the 20A and the Thunderbolt as shown in Section B10d.

For SSB Operation

Set 20A for AM Operation on desired band, SPEECH LEVEL at 0. Set Thunderbolt controls.

METER	GRID
MODE	TUNE
BAND	desired frequency range
PLATE	OFF
PLATE TUNING, COUPLING	Set per Figure I, Approximate Dial Settings
FILAMENT	ON

(a). Turn on 20A and tune MIXER and AMPLIFIER for maximum output.

(b). Tune Thunderbolt GRID for maximum grid current, retune AMPLIFIER for maximum Thunderbolt grid current. Adjust CARRIER control for four (4) ma Thunderbolt grid current. Maintain 4 ma in following loading steps.

(c). Turn Thunderbolt PLATE ON and load as described in Section D2b. Turn PLATE OFF.

(d). Adjust 20A for SSB operation per 20A Instruction Manual. Turn Thunderbolt MODE to LINEAR, PLATE ON.

(e). Advance SPEECH LEVEL, while talking into the microphone, until Thunderbolt plate current meter peaks reach approximately 455 ma. Either VOX or MANUAL operation may be used.

NOTE: The power output of the 20A falls off on the higher bands making it difficult to drive the Thunderbolt to full output. It should be possible to drive to the maximum Class AB1 (zero grid current) power of 1400 watts on all bands. In fact, on any band the 20A distortion should be checked when driving the Thunderbolt to 2000 watts or in the grid current region.

For AM Operation

(a). Follow procedure as detailed above for SSB operation, steps a through c.

(b). Turn Thunderbolt MODE to LINEAR, PLATE ON. Adjust CARRIER control for 375 ma plate current on Thunderbolt.

(c). Advance SPEECH LEVEL control, while speaking into the microphone, until a very slight upward kick of the Thunderbolt plate meter is observed. VOX or MANUAL operation may be used.

For CW Operation

The swamping resistor should be removed from the 20A and tuning accomplished as described in Section D1.

VIKING THUNDERBOLT AMPLIFIER

Parts List

Part No. or Drawing No.	Item No.	Qty.	Description
22.1079	B102	2	Motor, 115V, 60 cycles AC
22.1358	B103	1	Blade, 4" fan
22.1439	B104	1	Blade, 5" fan
16.1343	BKT1	1	Bracket, final tank and loading switch
17.754-11	BKT2	1	Bracket, final tuning capacitor mounting
16.1001-11	BKT3	1	Bracket, component, 1 3/16"
16.1001-12	BKT4	1	Bracket, component, 1 7/8"
16.1001-13	BKT6	1	Bracket, 2 7/32" component mounting
16.82-27	BKT7	1	Bracket, 3 7/8" panel support
16.1346	BKT8	1	Bracket, blower and resistor board mounting
16.82-29	BKT9	2	Bracket, H.V. shorting switch
167-4	C1	1	Capacitor, variable, 75L15
159-125-3	C2	1	Capacitor, neutralizing
154-38-2	C3	1	Capacitor, 320E30 variable
22.1458	C4	2	Capacitor, 300 mmfd 2500 WV
22.1427	C5, 6, 7	3	Capacitor, 620 mmf 2500 WV
22.1112	C8, 19, 20	3	Capacitor, 500 mmf, 20 KV ceramic
154-39-2	C9	1	Capacitor, variable 675E20
22.827	C11, 15, 16, 17, 18, 106, 108, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123	21	Capacitor, .005 mf ceramic disc
22.828	C13, 14, 12, 22, 23, 24, 25	7	Capacitor, 1000 mmf, 1500 VW disc ceramic
22.1048	C10	1	Capacitor, .001 mf mica
23.1359-1	C101	1	Capacitor, assembly, 13 mf, 2700 WVDC
22.860	C21	1	Capacitor, 500 mmfd 500 VW
22.962-2	C102, 103, 104	3	Capacitor, 30 mfd, 450 VW
22.955-1	C26	1	Capacitor, .002 mf mica
23.1301	CH1	1	Chassis
23.1128-2	CH2	1	Cabinet
17.853-2	CH3	2	Chassis rail
23.1127-6	CH4	1	Panel
17.1038	CH5	1	Sub chassis, VR tube
17.1039	CH6	1	Shield, VR tube chassis
22.1182-2	CH7	2	Bracket, meter shield
22.1181-2	CH8	2	Shield, meter
23.1290	CH9	1	Filter capacitor board assembly
23.1291	CH10	1	Mounting board assembly
18.750	CH11	1	Mounting board, resistor, transite
23.1298	CH12	1	Plate, grid compartment bottom assembly
32.64-4	D1	1	Escutcheon, dial
23.1122-2	D2	1	Back plate and bracket assembly
23.1120-1	D3	1	Pulley, 3" diameter
23.909-1	D4	1	Pulley, outside hub, 1 3/4" diameter
22.1137-2	D5	1	Pointer, dial
115-256-15	D6	1	Bearing and shaft assembly
22.1136-2	D7	2	Pulley
22.1097	C105	1	Capacitor, .01 mf. ceramic

VIKING THUNDERBOLT AMPLIFIER

Parts List

Part No. or Drawing No.	Item No.	Qty.	Description
23.1246-1	D8	3	Knob, 1 5/8" diameter
23.907-12	D9	2	Knob, 100-0 skirted, 180°
23.907-14	D10	1	Knob, line indicator
13.123-12	D11	6	Bearing, panel, 3/8-32
104-250	D12	1	Shaft coupling, flexible
14.139-2	D13	1	Shaft, 1/4" dia. 6 7/16" long, N.P. steel
14.139-9	D14	1	Shaft, 1/4" dia. 6 1/4" long, N.P. steel
14.139-10	D15	1	Shaft, 1/4" dia. 6 7/8" long, N.P. steel
18.751-1	D16	1	Rod, 1/4" dia. phenolic
14.568-1	D17	1	Rod, 1/4" dia. aluminum
23.900-1	D18	1	Gear ass'y, final tank
104-252	D19	1	Coupling, insulated shaft
104-264-2	D20	1	Coupling, insulated shaft
13.760-2	D21	2	Coupling, rigid metal shaft
23.910-2	D22	1	Knob, spinner, 2 3/8" dia.
23.544-2	D24	1	Jewel assembly, red
23.909-2	D25	1	Pulley, inside hub, 1 3/4" dia.
42.49-148	D26	5 ft.	Cord, dial, .040 nylon
23.1292-1	E1	1	Suppressor, plate assembly
23.1292-2	E2	1	Suppressor, plate assembly
23.1299	E3	1	Suppressor, grid
23.1084	E4, 5	2	Suppressor, screen
22.747	E6	2	Hood, coax, 83-1H
22.1309	E7	1	Hood, coax, UG177U
10.19-1	E8	2	Insulator, 1" cone
16.1347	E10	1	Strap, grid connecting
16.1348	E11	1	Strap, filament grounding
16.51-5	E12	2	Cap, plate (866A)
16.313-4	E13	1	Strap, loading capacitor connecting
10.19-5	E14	1	Insulator, 5/8" cone
16.313-3	E15	1	Strap, blocking capacitor
16.1352	E16	1	Strap, blocking capacitor
22.1397-10	F101	1	Fuse, 10 ampere, Buss MDL10
22.742	F103	1	Fuse, 5 ampere, Buss MTH5
22.1397-10	F102	1	Fuse, 10 ampere, Buss MDL10
22.739-2	FH101, 102, 103	3	Post, fuse extractor
22.113-1	G1, 2, 3, 4	4	Grommet, 9/16" rubber
22.113-5	G5, 6, 7, 14	4	Grommet, 5/16" rubber
71.43-097	G8	65"	Gasket, 3/16" round metaltex
22.1475-2	G9, 10, 11, 12	4	Button, polyethylene, rest
22.994-2	G13	1	Gasket rubber
23.1293	H	1	Harness, cable
16.895-2	HW	1	Spring, shorting switch
22.1272	HW	4	Spring, dial cord
22.21	I101	1	Lamp, 120 V., candelabra base #6S6 pilot
22.375	I102, 103	2	Lamp, 6.3 V., #44 pilot
22.746	J1, 2	2	Connector, 83R-1 coax.
22.1429-1	J101	1	10 amp. 3-wire male flush base
22.1191	J102	1	Jack, 4 terminal
23.1294	L1	1	Inductor, 10 meter grid and link

VIKING THUNDERBOLT AMPLIFIER

Parts List

Part No. or Drawing No.	Item No.	Qty.	Description
16.1350-1	L2	1	Inductor, 15 meter grid
23.1088-2	L3	1	Inductor, low freq. grid
229-204	L4	1	Inductor, rotary
23.1295	L5	1	Inductor, 10 meter final tank
102-752-4	L6	1	Choke, R.F., static drain (without BKT)
23.1085-3	L7	1	Choke, R.F., plate
23.1000	L106, 107, 108	3	Choke, 4.7 uh R.F.
22.951	L8, 9, 10	3	Choke, 2.5 mh R.F.
16.1181-5	L104, 105	2	Choke, R.F. line filter
16.1181-3	L109, 110, 111, 112	4	Choke, R.F. filter
542.5001-001	L101	1	Choke, 5-25 HY H.V. filter
22.749	L102, 103	2	Choke, .095 amp., 15 HY L.V. filter
22.1400	M1	1	Meter, grid current - voltmeter
22.1399	M2	1	Meter, plate current, watts
22.1430-1	P101	1	Connector body, 10 amp. 3 wire female
22.1190	P102	1	Plug, 4 terminal
22.7077-10	R1, 2	2	Resistor, 15 K 2 watt composition
22.1665	R3, 4, 5	3	Resistor, 1000 ohm non-inductive
22.1593	R101, 102, 103, 104, 105, 106	6	Resistor, 5000 ohms 50 watt
22.1442-1	R107, 108	2	Resistor, 1.5 meg. 2 watt ± 1%
22.1432	R111	1	Resistor, 20 K ohms 50 watt
22.9594-10	R110	1	Resistor, 4 K ohms 10 watt
22.1431	R115	1	Resistor, 4000 ohms 50 watt
22.7067-10	R116	1	Resistor, 5600 ohms 2 watt
22.1467	R117	1	Resistor, 1.724 ohms meter shunt ± 1% tol. 1/2 watt wire wound
22.8013-5	R119	1	Resistor, 0.33 ohm meter shunt 1/2 watt wire wound
22.7097-10	R113, 114	2	Resistor, 100 K ohms 2 watt
22.6073-10	R109	1	Resistor, 10 K ohms 1 watt
22.1434	SW1	1	Switch, grid band
23.1297	SW2	1	Switch, coupling
22.1435	SW101	1	Switch, SPST
22.1455	SW102	1	Switch, DPST
22.1436	SW103, 104	2	Switch, 3 pole 3 position
22.1466	T101	1	Transformer, H.V. power
22.1422	T102	1	Transformer, filament
22.1421	T103	1	Transformer, L.V. power
22.789-1	TS1	1	Terminal strip, 4 terminal barrier
22.740-3	TS2, 3, 4, 5, 6	5	Terminal strip, 3 point
22.837	TS7	1	Terminal strip, 2 point
22.740-4	TS8	1	Terminal strip, 4 point
22.790-1	TS9	1	Marker strip, terminal
22.1401-1	TS10	1	Terminal strip, 3 point, single hole mounting
22.1751	V1, 2	2	Tube, PL175A
595.4001-001	V101, 102	2	Tube, 3B28
22.1104	V103	1	Tube, 5U4G
22.5107-10	R118	1	Resistor, 270K ohms, 1/2 watt

VIKING THUNDERBOLT AMPLIFIER

Parts List

Part No. or Drawing No.	Item No.	Qty.	Description
22.1332	V104	1	Tube, 6BY5GA
22.1109	V105, 106	2	Tube, VR150-OD3
22.1110	V107, 108	2	Tube, VR105-OC3
22.1464	V109	1	Tube, VR90-OB3
71.32-170	W1	11 7/16"	Cable, RG8U-coax
71.32-178	W2	10 1/2"	Cable, RG59U-coax
42.24-107	W3	3"	Tubing, plastic, .133 I.D.
42.24-112	W4	12"	Tubing, plastic, .187" I.D.
23.546-2	XI101	1	Bracket, dial light, 115 V. candelabra base
23.1047	XI102, 103	2	Pilot light, snap-in type
122-224-1	XV101, 102	2	Socket, 4 prong steatite
22.1274	XV103, 104, 105, 106, 107, 108, 109	7	Socket, molded octal
122-275	XV1, 2	2	Socket, 5 prong jumbo for PL175A

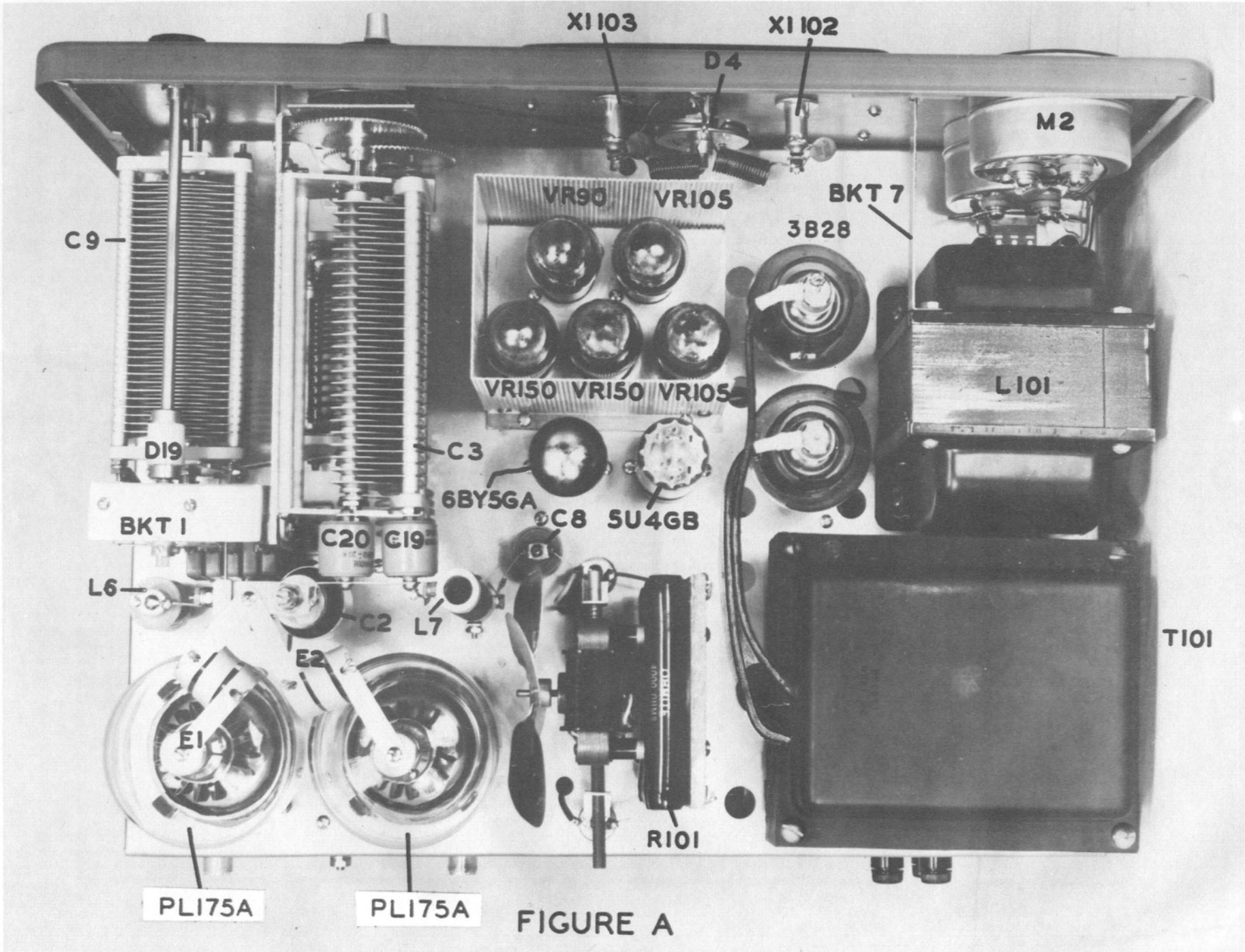

X1103
X1102
D4
M2
VR90
VR105
BKT 7
3B28
C9
VR150
VR150
VR105
L101
D19
C3
6BY5GA
5U4GB
C8
BKT 1
C20
C19
L6
C2
L7
T101
E2
E1
R101
PL175A
PL175A

FIGURE A

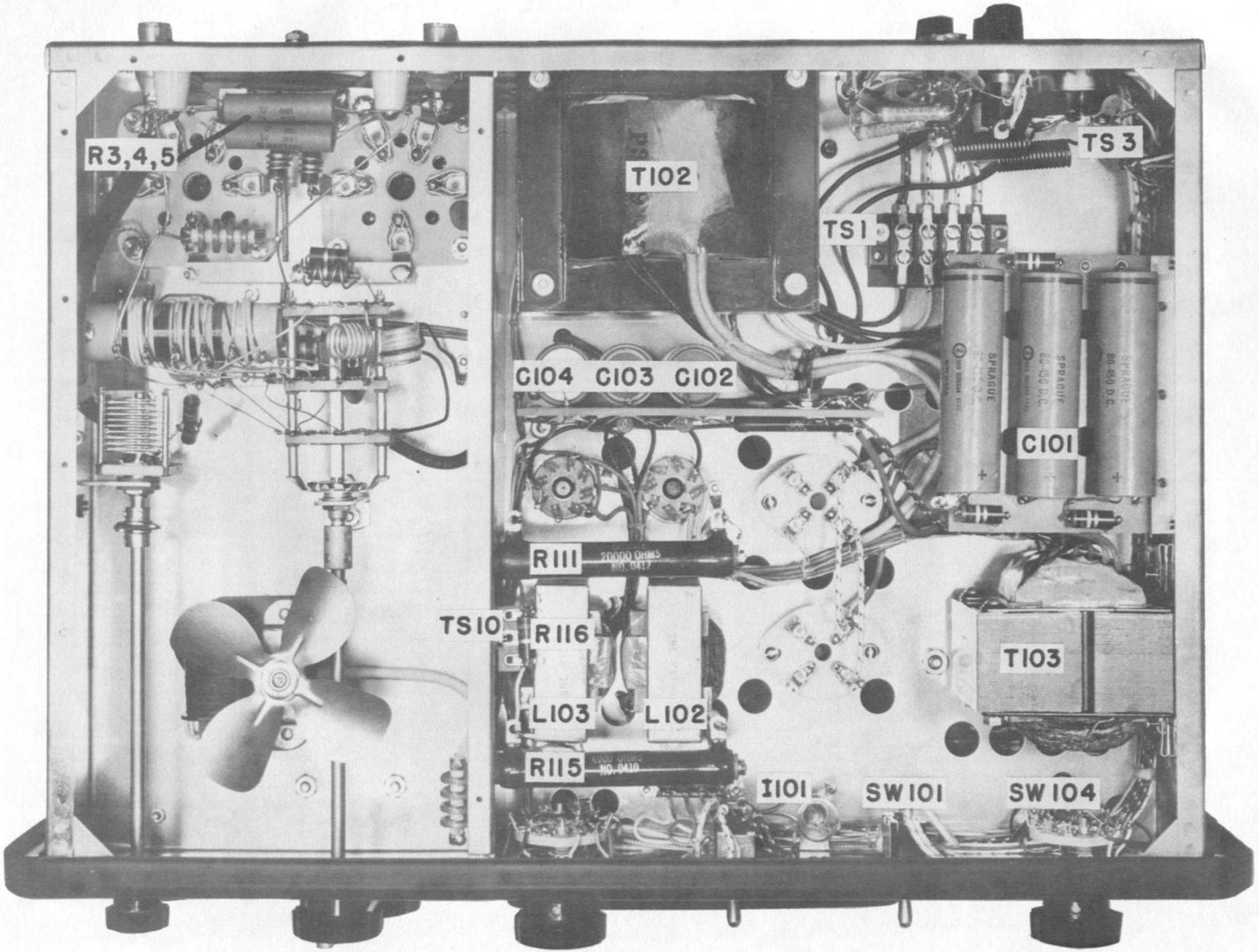

R3,4,5
T102
TS 3
TS1
C104 C103 C102
C101
R111
20000 OHMS
TS10
R116
T103
L103
L102
R115
I101
SW101
SW104

FIGURE B

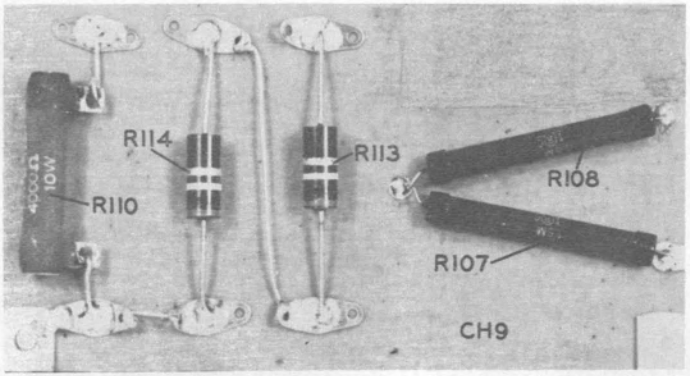


FIGURE C-A

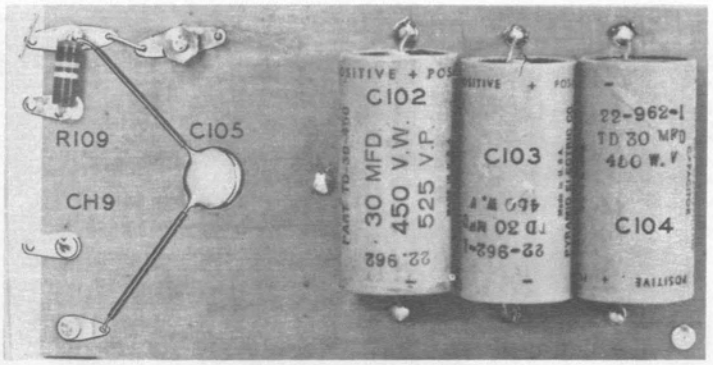
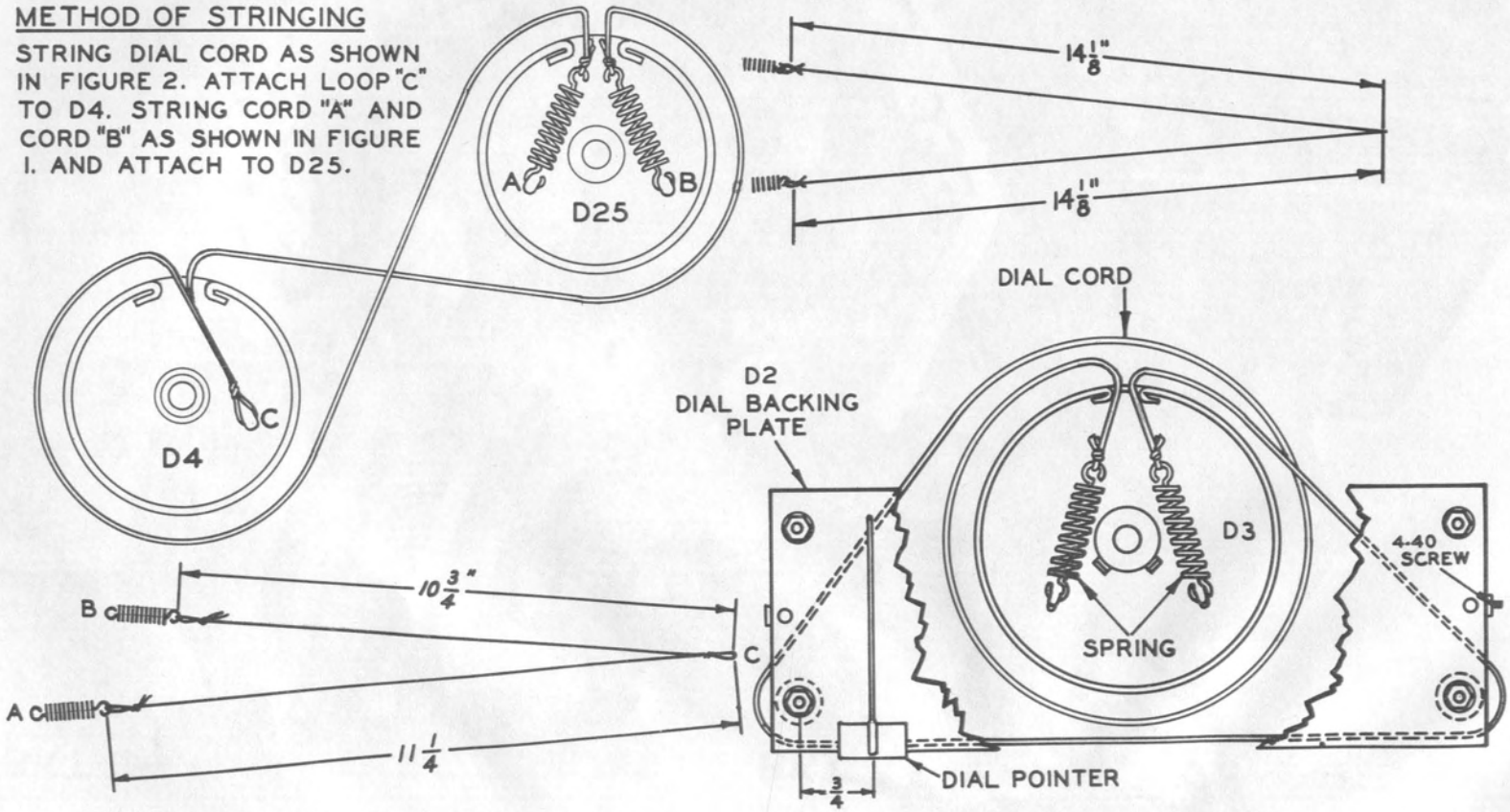


FIGURE C-B

METHOD OF STRINGING

STRING DIAL CORD AS SHOWN IN FIGURE 2. ATTACH LOOP "C" TO D4. STRING CORD "A" AND CORD "B" AS SHOWN IN FIGURE 1. AND ATTACH TO D25.



DRIVE CABLE FOR DIAL MECHANISM.
FIGURE "D"

DIAL DRIVE ASSEMBLY
FIGURE "E"

FIGURE H

APPROXIMATE OPERATING VALUES

	CW		AM LINEAR		TUNE	SSB or DSB	
	Trans.	No. Excit.	Trans.	With Block Bias	Trans.	Trans.	With Block Bias
Plate Voltage	2200	2350	2200	2350	2200	2200	2350
Screen Voltage	400	510	510	510	360	510	510
Bias Voltage	-165	-165	-90	-142	-90	-90	-142
Plate Current	455	0	375	0	360	250➔455	0
Screen Current	50	0	0➔ 5	0	5	0➔ 2	0
Grid Current	20	0	0➔ 0.5	0	4	0➔ 3	0

FIGURE I

APPROXIMATE DIAL POSITIONS, CW MODE

50 OHM LOAD

FREQUENCY, MCS.	4.0	7.3	14.25	21.25	27	29
Plate Tuning Dial	18	53	76	86	92	94
Coupling Capacitor	75	76	49	58	42	47
Coupling Switch	3	4	5	5	5	5
Grid Capacitor	75	58	60	65	68	79
Band Switch	3.5-4.7	6.5-8.5	11.5-17	17-24	24-30	24-30

FIGURE J

VOLTAGE AND RESISTANCE CHECK LIST

1. Resistance Values, may be useful in trouble shooting.

All resistance measurements are to ground, unless otherwise noted, and may vary ±10% in value. Power plug P101 and bias control plug P102 removed from sockets. Refer to Figures A, B, F and G for location of measurement points.

C102 (terminal nearest viewer)	20,000 ohms
C104 (terminal nearest viewer)	4,000 ohms
Terminal 2 of Mode Switch SW103	24,000 ohms.
L7 Choke (H.V. shorting switch closed)	0 ohms
L7 Choke (H.V. shorting switch open)	30,000 ohms
PA Grid (terminal 3 of PL175A socket)	
Mode switch in CW	4,000 ohms
Mode switch in LINEAR	Infinite ohms
PA Screen Grid (terminal 2 of PL175A socket)	
Mode switch in CW or LINEAR	24,000 ohms
Bias Control plug socket, J102	
Terminal 1, at all mode positions	0 ohms
Terminal 2, at all mode positions	4,000 ohms
Terminal 3, mode switch on CW	Infinite ohms
Terminal 3, mode switch on TUNE or LINEAR	9,600 ohms
Terminal 4, at all mode positions	Infinite ohms
High Voltage Transformer, T101	
Black wire to black-red wire	.6 ohms
White wire to black-green wire	.6 ohms
Yellow wire to red wire	120 ohms
Yellow wire to red wire	120 ohms
High Voltage Filter Choke, L101	
Between two leads, max.	30 ohms
Low Voltage Transformer, T103	
Green to green wire	
Yellow to yellow wire	Practically zero ohms
Blue to blue wire	140 ohms
Red to red-yellow wire	350 ohms
Red to red-yellow wire	350 ohms
Black to black wire	2.2 ohms
Low Voltage Chokes, L102 and L103	
Black to black wire, +15%	290 ohms
Filament Transformer, T102	
Brown to brown wire Green to green wire Yellow to yellow wire	Practically zero ohms
Black to black wire	1.2 ohms

2. Voltage Values

WARNING! The voltages encountered in this equipment are high enough to cause fatal injury. Exercise extreme caution when making the following checks. Place a grounding hook, with an insulated handle, on the rectifier tube caps whenever working inside the cabinet with the primary power plug in its socket and the PLATE switch OFF. All measurements are with respect to chassis ground, without grid drive or plate voltage, and may vary plus or minus 10 percent.

Remove F102, H. V. primary fuse, place power plug P101 in socket J101, turn PLATE switch OFF and FILAMENT switch to ON. Plug P102 not inserted into J102.

C104 (terminal nearest viewer)	-150 volts
C102 (terminal nearest viewer)	+600 volts
PA Screen grid (terminal 2 of PL175A socket)	
Mode Switch on CW	+510 volts
Mode Switch on TUNE	+360 volts

Insert P102 into J102 so bias may be switched from operating to blocking.

PA Screen grid (terminal 2 of PL175A socket)	
Mode switch on LINEAR and blocking bias on grid (pins 4 and 2 of J102 connected)	+510 volts
PA grid (terminal 3 of PL175A socket)	
Mode switch on CW	-150 volts
Mode switch on TUNE	- 90 volts
Mode switch on LINEAR and blocking bias on grid (pins 4 and 2 of J102 connected)	-150 volts
Mode switch on LINEAR and operating bias on grid (pins 4 and 3 of J102 connected)	-90 volts

Plate voltage: Place unit in the cabinet and make all connections. With the amplifier operating in the CW mode (20 ma. grid current and 1000 watts input) the plate voltage should read 2000 to 2300 volts depending upon the line voltage.

CALIBRATION CHART

AM, SSB AND DSB OPERATION

Static Plate Current _____

Frequency						
Plate Tuning Dial						
Coupling Capacitor						
Coupling Switch						
Grid Capacitor						
Band Switch						

CW CLASS C OPERATION

Frequency						
Plate Tuning Dial						
Coupling Capacitor						
Coupling Switch						
Grid Capacitor						
Band Switch						

CALIBRATION CHART

AM, SSB AND DSB OPERATION

Static Plate Current _____

Frequency						
Plate Tuning Dial						
Coupling Capacitor						
Coupling Switch						
Grid Capacitor						
Band Switch						

CW CLASS C OPERATION

Frequency						
Plate Tuning Dial						
Coupling Capacitor						
Coupling Switch						
Grid Capacitor						
Band Switch						

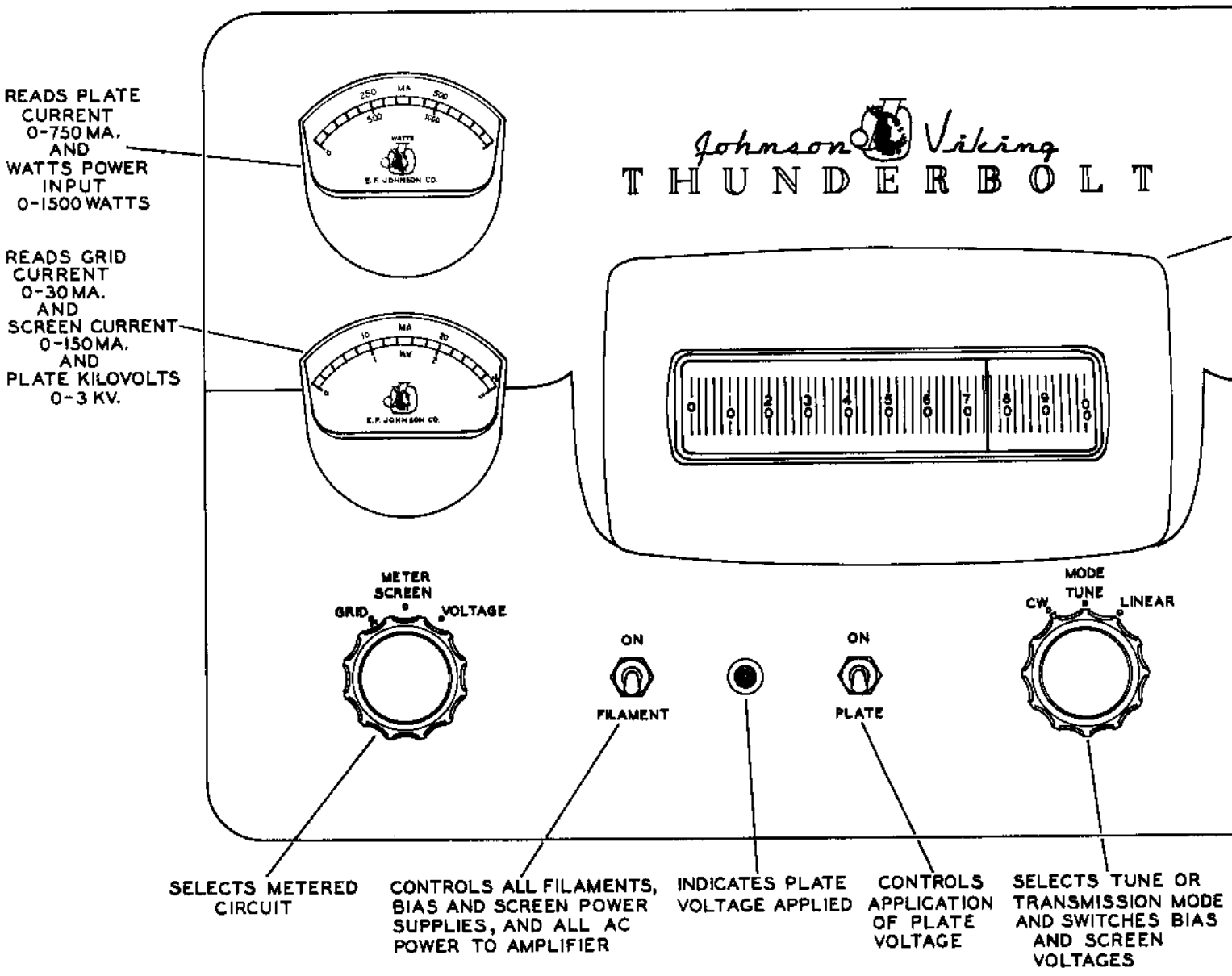


FIGURE K

CONTROL FAMILIARIZATION CHAR

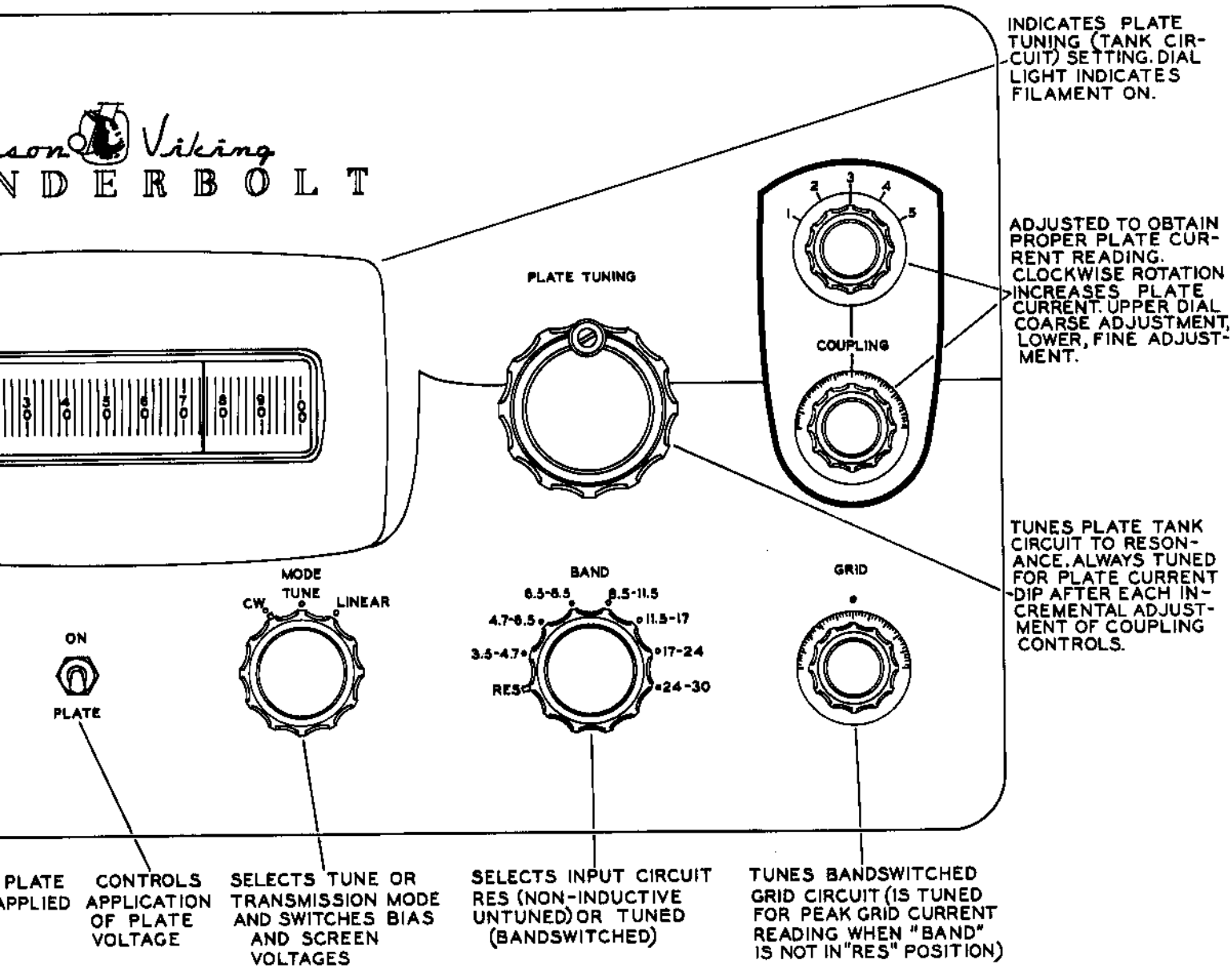


FIGURE K

CONTROL FAMILIARIZATION CHART

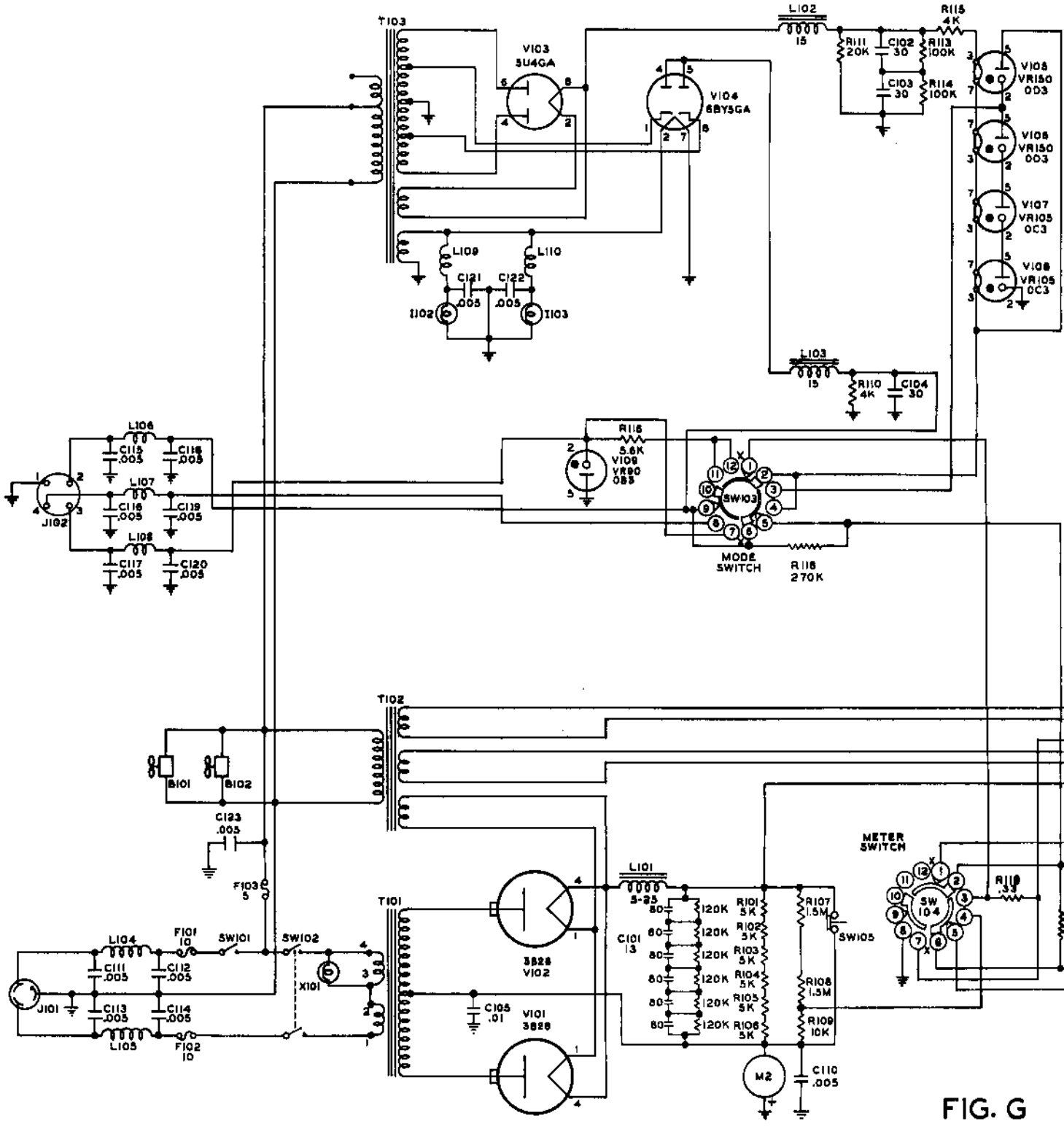
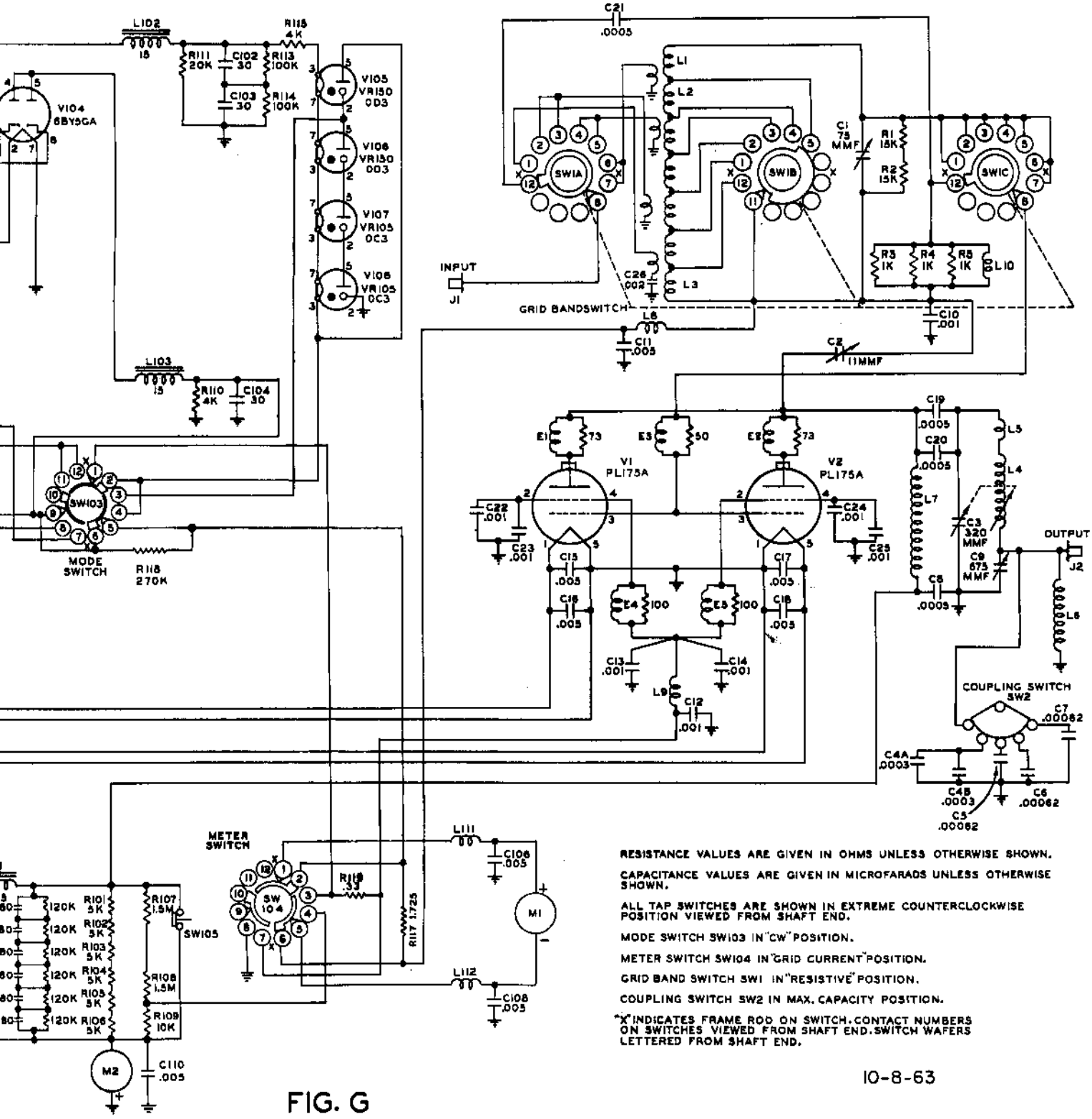

T103
V103 5U4GA
V104 6BY5GA
L102
15
R111 20K
C102 30
C103 30
R113 100K
R114 100K
R115 4K
V105 VR150 003
V106 VR150 003
V107 VR105 003
V108 VR105 003
L109
L110
C121 .005
C122 .005
I102
I103
L103
15
R110 4K
C104 30
L106
C115 .005
C116 .005
L107
C118 .005
C119 .005
L108
C117 .005
C120 .005
J102
R116 5.6K
V109 VR90 053
SW103
MODE SWITCH
R118 270K
T102
B101
B102
C123 .005
F103 5
T101
L104
F101 10
SW101
SW102
C111 .005
C112 .005
C113 .005
C114 .005
L105
F102 10
J101
X101
3828 V102
V101 3828
C105 .01
L101
S-25
C101 13
120K
R101 5K
R102 5K
R103 5K
R104 5K
R105 5K
R106 5K
R107 1.5M
SW105
R108 1.5M
R109 10K
M2
C110 .005
METER SWITCH
SW 104
R110 .33

FIG. G



RESISTANCE VALUES ARE GIVEN IN OHMS UNLESS OTHERWISE SHOWN.

CAPACITANCE VALUES ARE GIVEN IN MICROFARADS UNLESS OTHERWISE SHOWN.

ALL TAP SWITCHES ARE SHOWN IN EXTREME COUNTERCLOCKWISE POSITION VIEWED FROM SHAFT END.

MODE SWITCH SW103 IN "CW" POSITION.

METER SWITCH SW104 IN "GRID CURRENT" POSITION.

GRID BAND SWITCH SW1 IN "RESISTIVE" POSITION.

COUPLING SWITCH SW2 IN MAX. CAPACITY POSITION.

"X" INDICATES FRAME ROD ON SWITCH. CONTACT NUMBERS ON SWITCHES VIEWED FROM SHAFT END. SWITCH WAFERS LETTERED FROM SHAFT END.

10-8-63

FIG. G

K4XL's  BAMA

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