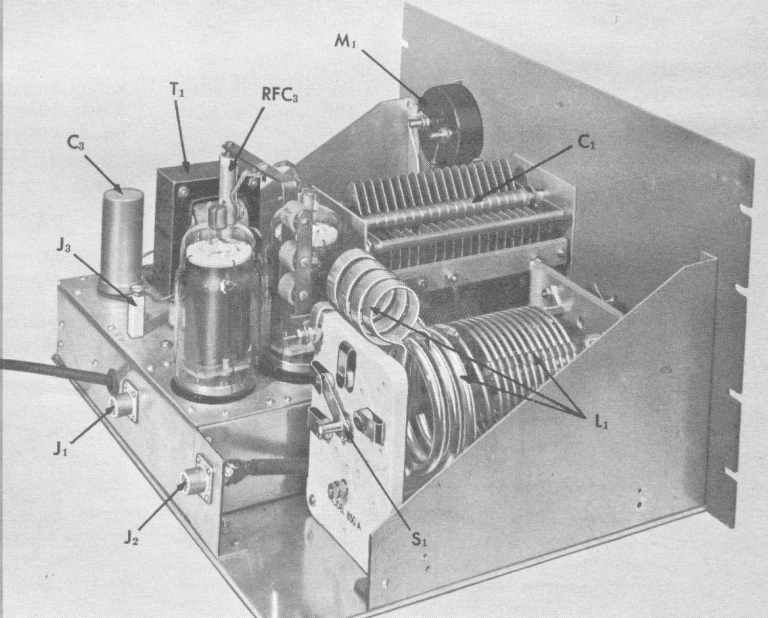
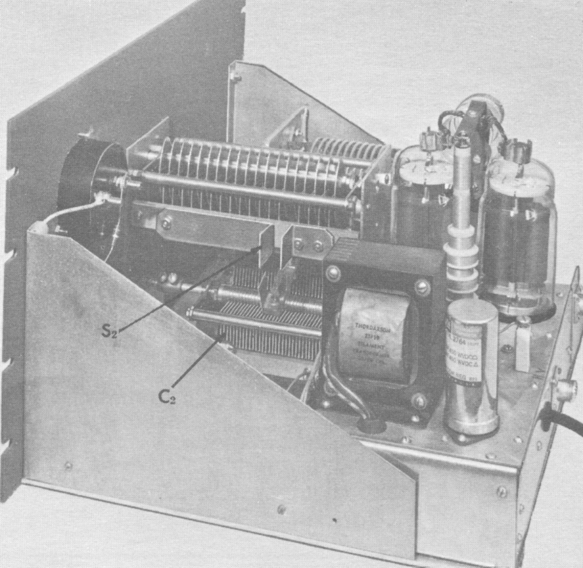
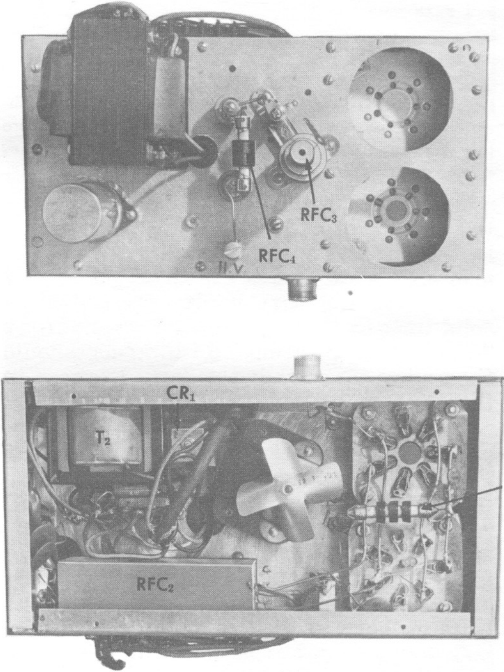

GROUNDED GRID LINEAR AMPLIFIER
0
20
40
60
80
100
D-C
MILLIAMPERES
GENERAL ELECTRIC
MINIMUM
XIMUM
TUNING
GRID
1x
PLATE
5x
METER SWITCH
14Mc
7.0Mc
21Mc
.5Mc
28Mc
BAND SELECTOR
DECREASE
EASE
ANTENNA LOADING
BIAS

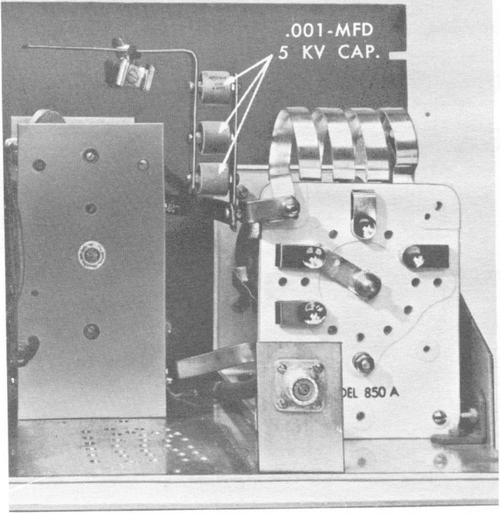
LEFT REAR VIEW of the linear amplifier. A ⅛-inch thick sheet of aluminum 13 x 17 inches in size forms the main chassis and is fastened to the panel with chassis support brackets. The plate circuit connections are made with $\frac{1}{16}$ x ½-inch copper strip, while the GL-813 plate leads are No. 10 braided copper wire.




S₂
C₂
THORDARSON
21F19
FILAMENT
TRANSFORMER



TOP AND BOTTOM VIEWS of the amplifier subchassis. The copper strip plate circuit connections have been removed from RFC$_3$ in the top view. Under-chassis wiring is insulated hookup wire, except for the filament leads, which are No. 12 tinned wire.



REAR VIEW of the amplifier plate circuit. Sub-chassis has been removed to show the holes in the aluminum plate through which cooling air is drawn into the chassis by the fan, and exhausted up through the chassis holes for the GL-813 tubes.

KILOWATT GROUNDED-GRID LINEAR AMPLIFIER

(*Radiotron HB*)

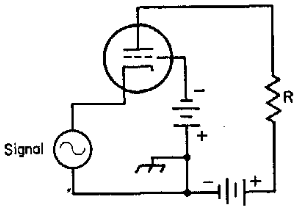
Grounded-grid amplifiers

The input voltage is applied to the cathode, the grid is earthed, and the output is taken from the plate, being in phase with the input. Driving power is required, so that it is not strictly a voltage amplifier.

(*ARRL HB)*

Grounded Grid Amplifier or, Grid Separation Circuit

The resistor *R* represents the load into which the amplifier works and may be a radio frequency tuned circuit.



GROUNDED–GRID AMPLIFIER

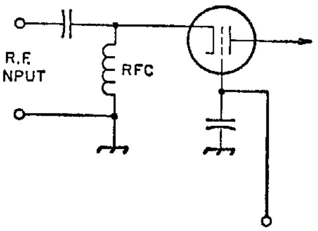
Grounded-Grid Amplifier

In the grounded-grid amplifier the input signal is applied between the cathode and grid, and the output is taken between the plate and grid. The grid is thus the common element. The ac component of the plate current has to flow through the signal source to reach the cathode. The source of signal is in series with the load through the plate-to-cathode resistance of the tube, so some of the power in the load is supplied by the signal source. In transmitting applications this fed-through power is of the order of 10 per cent of the total power output, using tubes suitable for grounded-grid service.

The input impedance of the grounded-grid amplifier consists of a capacitance in parallel with an equivalent resistance representing the power furnished by the driving source of the grid and to the load. This resistance is of the order of a few hundred ohms. The output impedance, neglecting the interelectrode capacitances, is equal to the plate resistance of the tube.

GROUNDED-GRID AMPLIFIERS

Figure *A* shows the input circuit of a grounded- grid triode amplifier.



(A)

The grid is at ground potential. An amplifier of this type is characterized by a comparatively low input impedance and a relatively high driver-power requirement. The additional driver power is not consumed in the amplifier but is ‘‘fed through’’ to the plate circuit where it combines with the normal plate output power. The total RF power output is the sum of the driver and amplifier output powers less the power normally required to drive the tube in a grounded-cathode circuit.

Effective bypassing and input-output isolation are the prime factors in keeping grounded grid amplifiers tame.

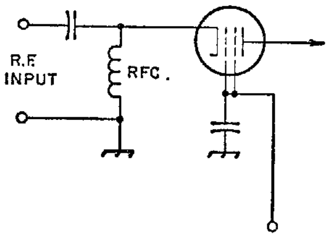
Positive feedback is from plate to cathode through the plate-cathode capacitance of the tube. Since the grounded grid is interposed between the plate and cathode, this capacitance is small, and neutralization usually is not necessary.

In the grounded circuit the cathode must be isolated for RF from ground. This presents a practical difficulty especially in the case of a filament-type tube whose filament current is large. In plate-modulated phone operation the driver power fed through to the output is not modulated

The chief application for grounded-grid amplifiers in amateur work below 30 Mc. is in the case where the available driving power far exceeds the power that can be used in driving a conventional grounded-cathode amplifier

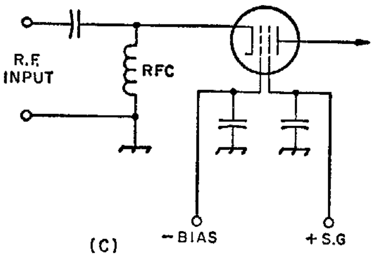
DC electrode voltages and currents in grounded-grid triode amplifier operation are the same as for grounded-cathode operation. Approximate values of driving power, driving impedance, and total power output in Class C operation can be calculated as follows, using information normally provided in tube data sheets. RMS values are of the fundamental components:

Screen-grid tubes are also used in grounded-grid amplifiers. The screen is simply connected in parallel with the grid, as in Figure *B*, and the tube operates as a high-mu triode.



(B)

In other cases, the screen is bypassed to ground and operated at the usual DC potential, as shown in Figure *C*.



(C)

Since the screen is still in parallel with the grid for RF, operation is very much like that of a triode except that the positive voltage on the screen reduces driver-power requirements. Since the information usually furnished in tube-data sheets does not apply to triode type operation, operating conditions are usually determined experimentally. In general, the bias is adjusted to produce maximum output (within the tube's dissipation rating) with the driving power available.

$$E_P = RMS\ value\ of\ RF\ plate\ voltage$$

$$= \frac{DC\ plate\ volts + DC\ bias\ volts - peak\ RF\ grid\ volts}{1.41}$$

$$I_P = RMS\ value\ of\ RF\ plate\ current$$

$$= \frac{rated\ power\ output\ watts}{E_P}$$

$$E_G = RMS\ value\ of\ grid\ driving\ voltage$$

$$= \frac{peak\ RF\ grid\ volts}{1.41}$$

$$I_G = RMS\ value\ of\ RF\ grid\ current$$

$$= \frac{rated\ driving\ power\ watts}{E_G}$$

$$Driving\ power\ (watts) = E_G(I_P + I_G)$$

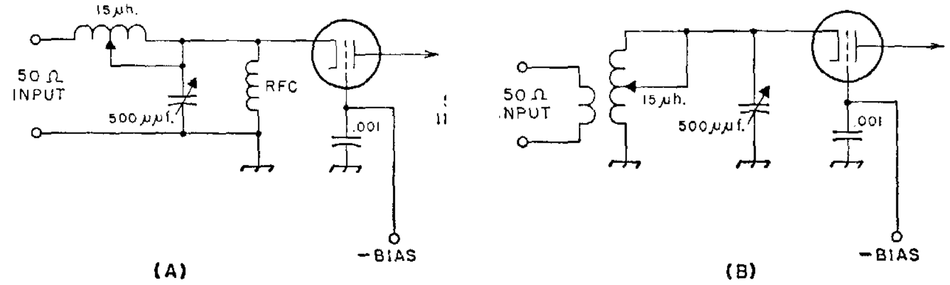
Then

$$Driving\ impedance\ (ohms) = \frac{E_G}{I_G + I_P}$$

$$Power\ fed\ through\ from\ driver\ stage\ (watts) = E_G I_P$$

$$Total\ output\ power\ (watts) = I_P(E_G + E_P)$$

The figure below shows two methods of coupling a grounded-grid amplifier to the 50-ohm output of an existing transmitter. At *A* an L network is used, while a conventional link-coupled tank is shown at *B*.

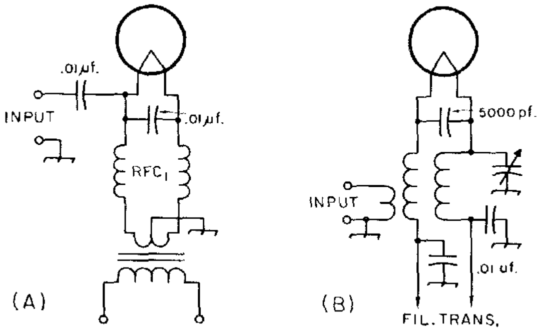


The values shown will be approximately correct for most triode amplifiers operating at 3.5 MHz. Values should he cut in half each time frequency is doubled, i.e., 250 pF and 7.5 pF for 7 MHz, etc.

Filament Isolation

In indirectly-heated cathode tubes, the low heater-to-cathode capacitance will often provide enough isolation to keep RF out of the heater transformer and the ac lines. If not, the heater voltage must he applied through RF chokes.

In a directly-heated cathode tube, the filament must be maintained above RF ground. This can be done by using a pair of filament chokes or by using the input tank circuit, as shown in the figure below.



In *A*, a double solenoid (often wound on a ferrite core) is generally used, although separate chokes can be used. When the tank circuit is used, at *B*, the tank inductor is wound from two (insulated) conductors in parallel or from an insulated conductor inside a tubing outer conductor.

GE Ham News Nov-Dec 1959

The popularity of amateur transmitters in the 75- to 150-watt power class usually provides a ready-made exciter when the time comes to add a more powerful final amplifier to the amateur station. Because pentodes have a low driving power requirement, a power-dissipating device must be employed when these tubes are driven from a 100-watt class rig.

A grounded-grid amplifier circuit provides a satisfactory solution; and, experience indicates that the GL-813 operates efficiently in grounded grid configuration. Also, this tube operates well as a high-mu triode, thus eliminating the need for a separate screen voltage supply.

To provide for a 1-kilowatt power capability as a linear amplifier, two GL-813 tubes are connected in parallel and operated in a grounded-grid circuit, with both the screen grids and beam forming plates at zero DC and RF potential. The tubes run in class B at an efficiency of 60 to 70 percent, depending upon the plate voltage. The plate circuit pi-network in the GL-

813 grounded-grid amplifier was designed for a 2,500-ohm plate load, working into a 50-ohm antenna load.

- *In the original GE Ham News there were several errors. A Supplement was later released correcting them and expanding the scope of the project. The schematic,* within this article that you are presently reading, *contains all the corrections published in this Supplemental Bulletin.*

- The circuit shown in the schematic diagram, Fig. 1, is quite simple, since no tuned grid circuit is required. *There is an error in the plate current metering circuit in the schematic diagram, Fig., 1. The contact on the meter switch, S3, labeled "PLATE", should be connected to ground, and not connected to the center tap of the filament transformer, T1.*
  The corrected circuit is shown as Fig. 1 in my article. The circuit as originally shown shorts out the meter in the "PLATE" position, resulting in practically no meter reading.

- The RF driving power is fed directly into the filaments of the two GL-813's.

- A dual RF choke (RFC*2*) in the filament circuit isolates the filament transformer.

- ***NOTE:*** INSTABILITY AT 28 MEGACYCLES - If instability is encountered in this amplifier at 28 megacycles, try connecting a 50 pF mica capacitor between the control grid and one side of the filament (pin 4 to pin 1) on *one* 813 tube socket. This should help stabilize the amplifier at this frequency.

- High voltage is applied to the GL-813 plates, connected in parallel, through RFC*3*.
- ***NOTE:*** PLATE CIRCUIT RF CHOKE - A B&W type 800 RF choke is recommended for RFC*3*, rather than the National R-175A choke shown in the model amplifier. The R-175A choke may have VHF resonances that could cause the choke to burn out.

- ***NOTE:*** RATING OF RFC*4* (1 mH National R300) - Although the rating of the RF choke in the plate voltage lead is only 300 milliamperes, the amplifier plate current swings up to 400 milliamperes only on peaks, thus the 300 milliampere RF choke is sufficient for the AVERAGE plate current drain.

- Three blocking capacitors in parallel keep high voltage from reaching the pi-network tuning plate circuit.

- A ready-made, tapped coil [(L*1*), B&W 850A] and split-stator tuning capacitor on the input side of the pi-network provide nearly optimum L/C ratios on all amateur bands from 3.5 to 30 megacycles. One section of C*1* is in the circuit on 14, 21 and 28 megacycles, when S*2* is open. Both sections are in parallel on 3.5 and 7 megacycles, where greater maximum capacitance is required, S*2* being closed by a linkage from the switch on L*1*.
- ***NOTE:*** POWER RATING OF TANK CIRCUIT - The B & W model 851 pi-network circuit is actually suitable for average power inputs of 800 watts in SSB service, as tests on the model amplifier have indicated.

OTHER PI-NETWORK INDUCTORS - The Air-Dux type 195-1 (500 watts) and 195-2 (1000 watts) inductors also may be used in this amplifier. A well-insulated tap switch capable of carrying 10 amperes of RF current is needed for the band switch, which is not a part of the Air-Dux inductors. Home-wound coils, and pi-network coils made up from ready-wound inductor stock, with a 28-megacycle coil wound from copper strip, also can be used for L*1*.
The same inductance values shown in TABLE 3 - P1-NETWORK CHART FOR 813 AMPLIFIER, should be used to design home-wound coils, or to prune ready-wound inductor stock. *Table 3 is included further down in this article.*
PLATE TANK CIRCUIT CONSTANTS - The plate circuit's pi-network for the GL-813 grounded-grid amplifier was designed for a 2,500-ohm plate load, working into a 50-ohm antenna load. A tabulation of the inductance and capacitance values required in the circuit for bands from 3.5 to 28

megacycles is given in TABLE 3 later in this article.

Note that the number of active turns in the circuit on each band is given for air-dux type 195-1 and 195-2 coils. The turns figures do not include the strip-wound 28 megacycle coil, and are given from where the strip coil joins the coil wound with wire. The inductance values *DO* include the strap inductor, which is 0.4 microhenries.

HEAVY-DUTY BANDSWITCH REQUIRED FOR S*1*

The G-E HAM NEWS lab has used Ohmite type 111-5, 5-position, single section rotary tap switches with Air-Dux coils in other amplifiers and has found them capable of holding up in RF band switching service. They are rated at 10 amperes in 115-volt, 60 cycle AC switching service, and have a rotor contact insulated from the shaft for about 600 volts AC. However, we recommend mounting the switch on an insulated bracket, and using an insulated coupling on the shaft for RF service, especially in circuits having a plate voltage of 2000 or more.

- ***NOTE:*** CAPACITOR C*1* - This capacitor is a Cardwell type P-8359, *not P-8060*, as originally specified in the TABLE I PARTS LIST of the initial printing of the bulletin.
- If 2,000 volts or less will be run on the plates of the GL-813’s, a capacitor for C*1* with 0.100-inch air gap will be suitable. The 0.125-inch air gap specified is suitable for up 3,500 plate volts.

- A large variable capacitor (C*2*),1500 pF maximum - across the output side of the pi-network eliminates the need for several fixed capacitors, and a tap switch to add them to the circuit as needed.
- ***NOTE:*** AVAILABILITY OF CARDWELL CAPACITORS - Some persons have reported difficulty in obtaining the Cardwell type P-8359 (C*1* about $33.00 amateur net) and P-8013 (C*2* - $19.50 amateur net) variable capacitors. We have been advised that these capacitors are currently available

through electronic parts distributors. If these capacitors are not in stock, the distributor can order from the Cardwell Condenser Corporation, 80 East Montauk Highway, Lindenhurst, Long Island, New York.

SUBSTITUTE FOR C*1* - A conventional split-stator variable capacitor of suitable capacitance and voltage rating can be substituted for the Cardwell unit. The Johnson type 100ED45, Cat. No. 154-3, having 15-l00 pF per section, and a 0.l25-inch air gap, is recommended. Install the switch between the stators of C*1* on the studs supporting the stator plates at the middle of the capacitor. Change the linkage running from S*1* to the shorting bracket on S*2* to suit the parts layout of your particular amplifier.

SUBSTITUTE FOR C*2* - Although the high maximum capacitance range of the Cardwell P-80l3 capacitor (l50-l500 pF) makes it ideal for pi-network output circuits, a smaller variable capacitor and a tap switch to add fixed mica capacitors across the pi-network output can be substituted. The circuit shown in the COMPACT TRIODE KILOWATT (See *G-E HAM NEWS*, September-October, 1959; Fig. I, page 4, for details) is suitable. *This circuit is shown further down in this article.*

- The output circuit will match impedances from 50-or 70-ohm unbalanced feed line and loads.

- THE CONTROL GRIDS on the GL-813’s, bypassed to the chassis at each tube socket, receive from 0 to 100 volts of negative bias from the built-in bias supply, depending on the setting of R*1*.
- ***NOTE:*** **WATTAGE RATING FOR POTENTIOMETER R*1*** - This rating, originally given as 2 watts, actually should be 25 watts.

The low resistance of this potentiometer across the bias voltage supply stabilizes the bias, thus a high-wattage potentiometer is required at this point. *Consider a possible solid-state negative adjustable voltage regulator circuit.*

- When no connection is made between terminals 1 and 2 on the terminal strip, the tubes are biased to cut off plate current flow.
  Jumpering these terminals reduces the bias to the value selected by R*1*.
  Leads should be run from these terminals to a switch, or relay contacts which close while transmitting.

- Separate metering of current in the grid and plate circuits is accomplished by switching a single meter (M*1*) across shunting resistors, R*2* and R*4,* respectively.
  Only plate current is read in the PLATE position of S*2*, since the grid circuit is returned directly to the center tap on the filament transformer (T*1*).

MOST EXCITERS will have a wide enough range in output impedance to match to the cathode circuit of the GL-813’s (about 150 to 200 ohms, depending upon frequency).

In case the exciter will only match into a 50- to 70-ohm load and will not drive the grounded grid amplifier hard enough, a pi network matching circuit can be inserted between the exciter and amplifier.

The suggested circuit for this network is shown in Fig. 2.

The parts values shown should have sufficient flexibility for most matching requirements.

All components for the matching network were housed in a 4 x 5 x 6-inch Minibox (Bud CU-3007). Lengths of coaxial cable for the input and output were cut to the proper dimensions to run to the exciter and final amplifier.

- ***NOTE:*** *The following applies to the separate circuit for signal input and is shown as C1 in Figure **2** and refers to the Table **II** Parts List.*
  The plate spacing of C*1*, the 15-300 pF variable capacitor in the pi-network cathode input coupler diagram, Fig. 2, should be 0.0245 inches, not 0.224 inches, as given in TABLE II - PARTS LIST, CATHODE COUPLER.

- ***NOTE:*** CAPACITANCES IN PI-NETWORK CATHODE COUPLER - The listings for capacitors C*1* and C*2* in the pi-network cathode coupler (Fig. 2) were reversed in the original

bulletin. C*1* should be the 3-section broadcast receiver capacitor; and, C*2* should be the 12-325-mmf capacitor to match into the cathodes of the 813 tubes.
The corrected values are contained in Fig. 2 of this article.

CONSTRUCTION is quite simple, due to the utilization of standard, readily available components throughout the amplifier.

- ***NOTE:*** The size of the main chassis plate, given originally as 13 inches deep x 17 inches wide, should be 14 1/2 inches deep, in order to accommodate both the capacitor mounting, which occupies 8 1/2 inches of depth, and the 6-inch depth of the subchassis on which the tubes are mounted.
- The main chassis is fastened with its bottom surface 1/8-inch above the lower edge of a 10.5 x 19-inch aluminum relay rack panel.
- Only the pi-network components, meter and meter switch are on the main chassis.
- The remaining components are assembled on the 6 x 11 x 2.5-inch sub-chassis.

The photographs and drawings illustrate the placement of the major components (Figs. 3 and 4).

- Either a 3½ or 2½-inch meter may be used for M*1*.

- The front and back plates of C*1* and C*2* are fastened to 1/8-inch thick sheet aluminum brackets 7 inches high and 4 inches wide.

- The shaft on which the linkage for switch S*2* is supported also runs between these plates. The parts in this linkage, and assembly details, are shown in Fig. 5.

- A U-shaped clip, made from spring brass or phosphor bronze, completes the connection between copper angle brackets fastened to the two stator sections on C*1*, when L*1*/S*1* is in the 3.5 and 7-megacycle positions.

- The arm on the L*1*/C*1* shaft is adjusted so that it engages the forked arm, as shown in solid lines on the sketch, when S*1* is in the 7-megacycle position. Both arms should then move up so that the forked arm is in the position indicated by dotted lines when S*1* is in the 14-megacycle position.

- Under-chassis wiring, except for the No. 12 tinned wire filament leads, is run with No. 18 insulated wire.

- The plate circuit connections were made with 1/16 x 1/2-inch copper strip, as shown in the photos.

- A small 115-volt phonograph motor with a 3-inch diameter, 4-blade fan draws air up through holes in the aluminum base plate and out through the holes in the sub-chassis for the 813 tubes.

Once construction is finished, check the filament and bias voltage circuits before connecting the high voltage power supply to J*3*.

A power supply with provision for reducing the output voltage to about one-half or two-thirds of full voltage is recommended, especially if the full output is 2,000 volts or higher.

Connect an antenna or dummy load to J*2*.

TUNEUP FOR SSB operation consists simply of:

1. Applying full plate voltage and, with terminals *1* and *2* on the power strip shorted, setting R*1* for 40 milliamperes of plate current with S*3* in the PLATE position.
2. Turn S*1* to the same band on which the driving exciter is operating and apply driving power to the amplifier by injecting carrier on the SSB exciter.
3. Adjust the exciter loading for a full-scale reading on M*1* with *S3* in the GRID position.

4. Turn C*2* to maximum capacitance, *S3* to the PLATE position and adjust C*1* for minimum plate current.

5. Turn on partial high voltage and decrease the capacitance of C*2* for a plate current reading of 200 milliamperes, readjusting C*1* for minimum plate current, as necessary.

6. Apply full plate voltage and adjust C*2* for about 400 milliamperes plate current.

7. The grid current should read 100 milliamperes.

8. Switch the exciter to deliver SSB output and adjust its operation for the audio gain for normal RF power output. With speech, the 813 linear amplifier should swing up to about 150 milliamperes plate current; while with a steady whistle the plate current should reach 400 milliamperes. The amplifier is now tuned up.

TUNEUP FOR CW operation is similar, except that:

1. The bias voltage is adjusted initially for almost zero plate current.
2. The exciter is adjusted to deliver 100 milliamperes of grid current into the amplifier without plate voltage.
3. After applying partial plate voltage, load the amplifier to about 180 milliamperes plate current.
4. With full plate voltage, the plate current should be about 350 milliamperes.

TUNEUP FOR AM by a conventional amplitude modulated transmitter:

1. The plate current is adjusted to 40 milliamperes at full plate voltage, the same as for SSB operation (with terminals *1* and *2* on the power strip shorted, setting R*1* for 40 milliamperes of plate current with S*3* in the PLATE position).
2. Adjust the exciter for 90 to 100 milliamperes of amplifier grid current.
3. Apply partial plate voltage and load the amplifier to about 150 milliamperes plate current.
4. Next, apply full plate voltage and adjust for 300 milliamperes plate current.

5. Now, reduce the driving power from the exciter until the amplifier plate current reads 150 milliamperes.

6. When the exciter is amplitude modulated 100 percent, the amplifier's plate current should rise not more than 5 percent, otherwise distortion of the output signal will result.

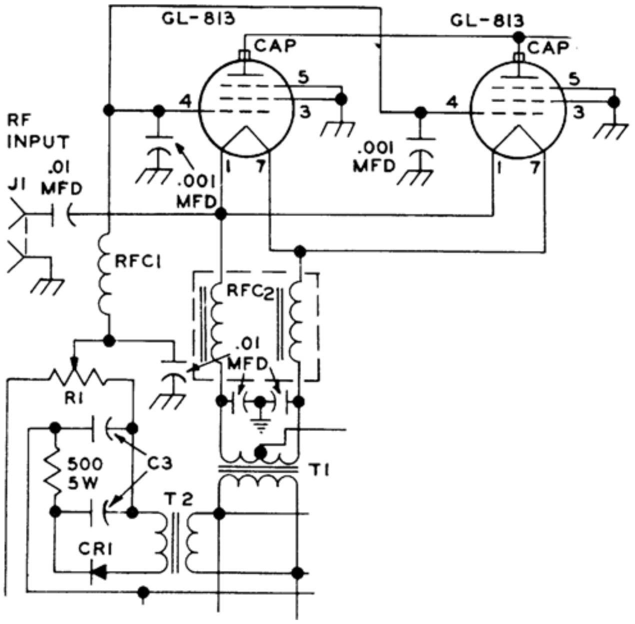
It's a good idea to check the operation of this amplifier with an oscilloscope during initial adjustment and also periodically to ensure linearity of the output signal. The model amplifier constructed for this article has been operated on all bands for over a year at W2GFH without a failure for any reason. It is stable, easy to adjust and provides a really potent signal.

-30-

(Dr. Greg Latta’s *Wingfoot 813* webpage)
http://faculty.frostburg.edu/phys/latta/ee/wing813amp/813schematic.html

Circuit Descriptions and Sub-Schematics

Amplifier Input and Filament Supply Circuit:
With a directly heated-cathode, the grounded-grid circuit has to allow both the input RF and the filament power to reach the filament/cathode without interfering with each other.

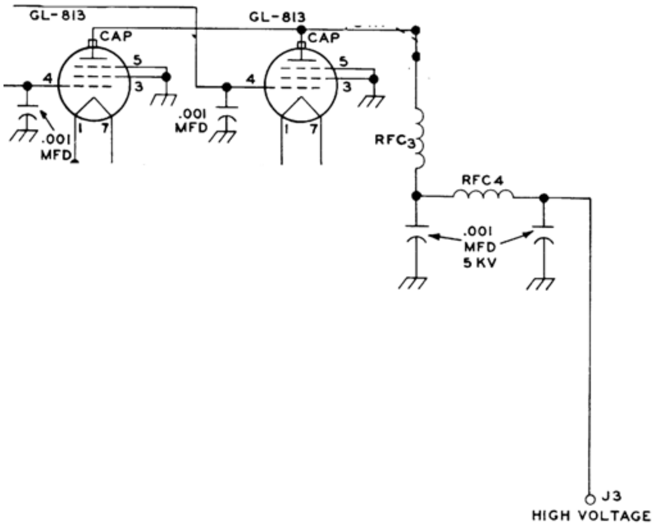


In the cathode/filament circuit the 0.01 mF capacitor permits the input RF to reach the filaments of each tube, while preventing the much lower frequency filament AC from flowing back through the input circuit (X_C at 3.5 MHz is 4.5 ohms and at 60 Hz it is 265 Kohms).

At the same time, it is important to keep the input RF from flowing into the filament power transformer. This is accomplished with a pair of heavy duty RF chokes that are actually wound on the same core (the B&W FC-15). These allow the low frequency heater AC to pass through while blocking the much higher frequency RF.

Any residual RF that might have passed through the RF chokes is shorted to ground through the two 0.01 mF capacitors. The filament transformer provides 10 volts AC at 5 amperes to heat the 813 filaments.

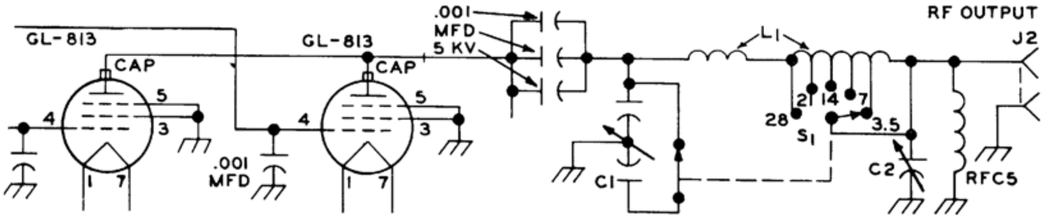
Amplifier Plate Feed Circuit:



In an RF amplifier it is necessary to supply DC plate voltage to the tube (about 2000 volts in this case) and at the same time extract the amplified RF that appears at the plate of the tube. RFC*3*, the National R-175A plate RF choke allows the direct current from the plate supply (B+) to pass through it, while preventing the RF on the plate of the tube from flowing back through the plate supply.

The [0.001 mF capacitor/RFC*4* (1 mH)/0.001 mF] capacitor circuit short circuits any residual RF that might have gotten through the plate choke and prevents it from reaching the plate supply.

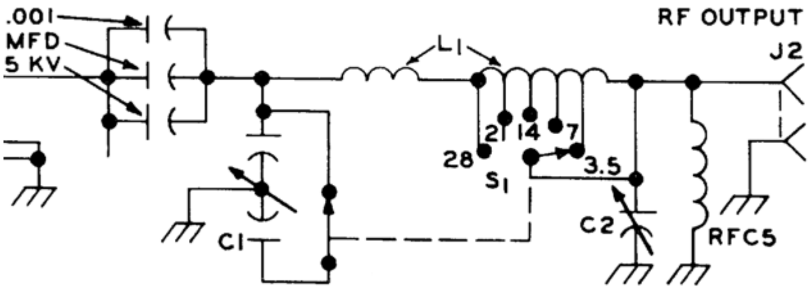
At the same time, the three paralleled 0.001 mF 5KV plate-coupling capacitors permits the RF on the plate to flow though to the output tank circuit while blocking the DC plate voltage.



Not shown in this schematic, but to be included is a coil in series with the plate lead used as a parasitic suppressor, which helps prevent unwanted oscillations. Although reportedly not needed for 80 and 40 meters, the amplifier will probably be used through its full frequency output range and parasitic suppressors are probably essential.

Amplifier Plate Tank Circuit:

The plate tank circuit is a pi-network that matches the high impedance of the plate to the low impedance of the antenna.



At the same time the circuit filters out undesired harmonics from the output signal.

The signal from the plate enters through the three paralleled 0.001 mF plate coupling capacitors at the upper left in the schematic.

The B&W 850A coil assembly (L*1*) and a split-stator tuning capacitor (C*1*) on the input side of the pi-network provide nearly optimum L/C ratios on all amateur bands from 3.5 to 30 megacycles. One section of C*1* is in the circuit on 14, 21 and 28 megacycles. Both sections are in parallel on 3.5 and 7 megacycles, where greater maximum capacitance is required.

The band switch on L*1* varies the inductance of the tank coil, and the 1500 pF load capacitor (C*2*) adjusts the network for the best impedance match.

The 2.5 mH RF choke performs two important functions: If the plate coupling capacitor should fail and short, the RF choke will short circuit the plate supply, hopefully blowing the fuse. This will prevent the plate voltage from appearing on the antenna, a very dangerous situation. The choke also prevents any DC voltage from appearing across the load capacitor, thus lowering the voltage it is required to handle and allowing for a physically smaller capacitor to be used.

The output circuit will match impedances to 50-or 70-ohm unbalanced feed line and loads.

Amplifier Grid Metering Circuits:

Metering the DC grid currents of an RF amplifier is an important method of monitoring amplifier operation. In this amplifier, the control grid and screen grid are connected in parallel for RF, effectively creating a "super" control grid. (The so called "triode connection"). Though each grid is in parallel for RF, the DC current from each is measured separately.

Using the *Wingfoot* schematic, the screen grid and control grid metering circuits are identical. Each meter is shunted with a 100-ohm resistor to permit operation without the meter actually being in the circuit. The 0.1 mF capacitor grounds the grid for RF right at the tube socket, and the 2.5 mH RF choke and 0.001 mF capacitor make sure that no residual RF finds it way to the meter.

In the *GE Ham News* schematic, the grid circuit is returned directly to the center tap on the filament transformer (T*1*).

Plate current is to be measured by a separate meter on the POWER SUPPLY PANEL. Thus separate meters are then available on the RF PANEL to measure both the CONTROL and SCREEN GRID currents per the *Wingfoot* schematic.

Amplifier Plate Metering Circuit:

Metering the plate current of an RF amplifier is even more important than metering the grid current. In the *Wingfoot* amplifier, the plate current meter is placed in the negative lead of the plate supply. This keeps the meter near ground potential and keeps high voltages off of the meter. This is the scheme that is used in my version on the POWER SUPPLY PANEL B+ meter.

Amplifier Bias Circuit:

The amplifier bias circuit applies adjustable bias to the 813 control and screen grids wired to run in a paralleled "triode connection". In "Standby" mode the full output of the bias supply to the 813 grids cuts the tube off. During "Operate" mode the bias is set to the value selected by the bias adjust potentiometer.

THE CONTROL GRIDS on the GL-813’s are bypassed to the chassis at each tube socket and receive from 0 to 100 volts of negative bias from the built-in bias supply, depending on the setting of R*1*.

When no connection is made between terminals 1 and 2 on the terminal strip, the tubes are biased to cut off plate current flow.

Jumpering these terminals reduces the bias to the value selected by R*1*.

Leads should be run from these terminals to a switch, or relay contacts which close while transmitting.

-30-

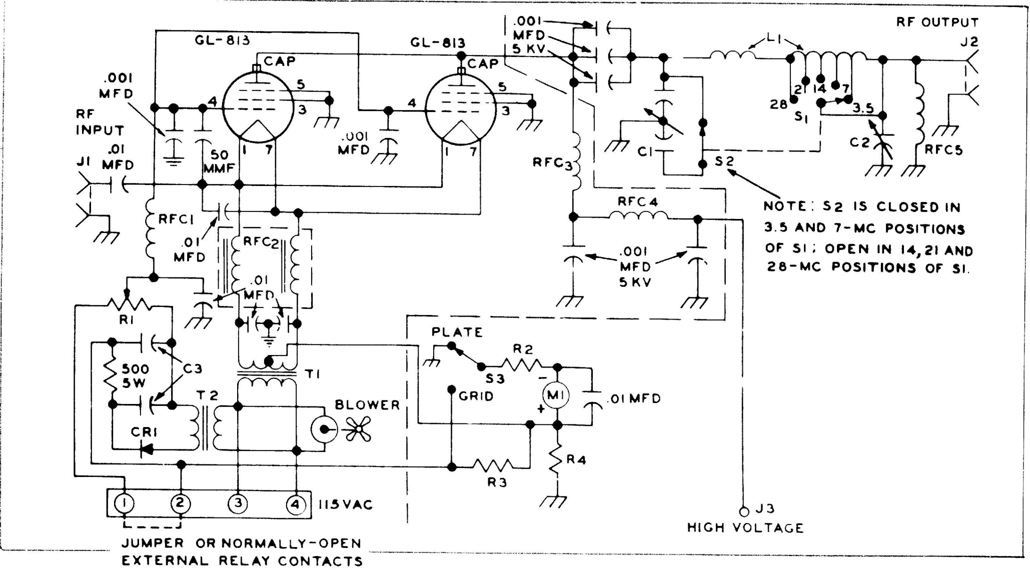


FIG. 1. SCHEMATIC DIAGRAM of the GL-813 grounded-grid linear amplifier. The five .001-mfd, 5KV fixed capacitors are of the cylindrical ceramic type with screw terminals (Centralab 8508-1000, or equivalent). All other bypass capacitances are disc ceramic, 500 volts working. Resistances are in ohms, with wattage ratings as specified. Resistances in the metering circuit are listed in **TABLE I.** No switch is shown in the 115-volt AC circuit, since it is controlled by external power switching circuits. All components to the left of the dashed line running down through the diagram are on the sub-chassis.

TABLE I — PARTS LIST

C_1	Split-Stator variable capacitor; front section, 28—160 mmf; rear section, 7-50 mmf; 0.125-inch air gap (Cardwell P-8359, or equivalent).
C_2	50—1500 mmf variable capacitor, 0.030-inch air gap (Cardwell P-8013, or equivalent).
C_3	2-section electrolytic capacitor, 40-mfd. 150 volts per section (Sprague TVL-2428).
CR$_1$	130-volt, 75 ma. selenium rectifier.
J_1, J_2	Chassis type coaxial cable connectors (Amphenol 83-1H hood on J_2).
J_3	1½ inch high standoff insulator.
L_1	10 uh pi-network band switching inductor (B & W 851 for up to 600 watts; B & W 850A for over 600 watts).
M_1	DC milliameter, 0-1 ma., full scale.
R_1	500-ohm, 25 watt potentiometer.
R_2	Series resistance for M_1; 1200 ohms, 1 watt.
R_3	12 ohms, 1 watt, for 100-ma grid reading.
R_4	2.4 ohms, 1 watt, for 500-ma plate reading.
RFC$_1$	0.5-mh, 300-ma r.f. choke (National R-300).
RFC$_2$	15-ampere dual choke (B & W No. FC-15).
RFC$_3$	200 uh, 500-ma r.f. choke (National R-175A, or B & W No. 800).
RFC$_4$, RFC$_5$	1 mh, 300-ma r.f. chokes (Nat. R-300).
S_1	5 position single section tap switch; part of L_1 pi-network coil.
S_2	Special 2-position, single section switch; see FIGS. 4 and 5 for details.
S_3	2 position, single section tap switch.
T_1	10-volt, 10-ampere filament transformer.
T_2	115-volt, 30-ma power transformer.
V_1, V_2	GL-813 power beam pentode tubes.

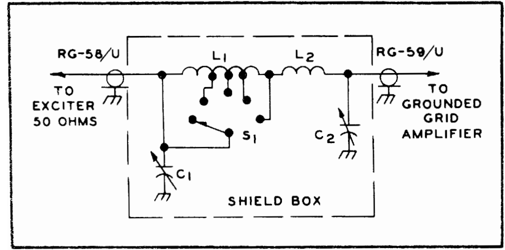


FIG. 2. SCHEMATIC DIAGRAM of an optional pi-network matching circuit. It will match the cathode circuit of the GL-813 amplifier to the 50-ohm output circuit of those exciters which otherwise might not be loaded heavy enough to fully drive the linear amplifier.

TABLE II
PARTS LIST, CATHODE COUPLER

C_1	45—1260 mmf variable (3-section broadcast receiver variable, 15—420-mmf per section, all sections in parallel).
C_2	12 — 325-mmf variable, 0.024-inch air gap (Hammarlund MC-325-M).
L_1	4.2 uh, 17 turns, No. 16 tinned wire, 1¼ inches in diameter, 2⅛ inches long, spacewound 8 turns per inch, tapped 2 (21 MC, 4 (14 MC), and 10 (7 MC) turns from L_2 end of coil. (B & W No. 3018).
L_2	0.44 uh, 5 turns, No. 12 tinned wire, 1 inch in diameter, 1 inch long, spacewound 5 turns per inch, self-supporting.
S_1	1 pole, 5 position tap switch, ceramic insulation (Centralab No. 2500, or equivalent).
Shield Box	4 x 5 x 6-inch Minibox (Bud CU-3007), or 3 x 5 x 7-inch Minibox (Bud CU-3008).

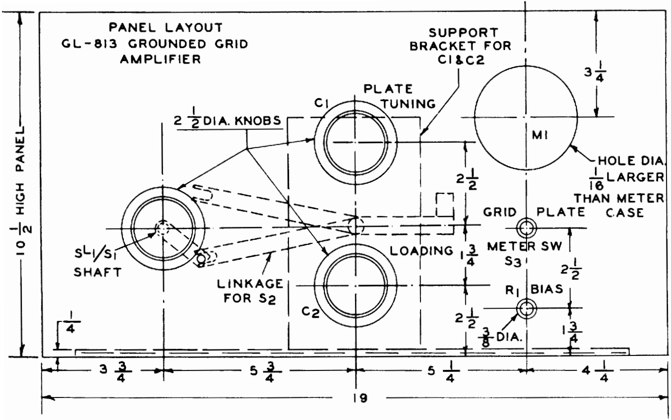


FIG. 4. PANEL LAYOUT DIAGRAM for the GL-813 linear amplifier. The linkage for S_2 pivots on the shaft located between C_1 and C_2. Drill ⅜-inch diameter panel holes for this shaft, and the shafts on C_1, C_2, L_1 and the meter switch, S_3. The aluminum chassis deck is positioned ⅛ of an inch above the bottom edge of the panel.

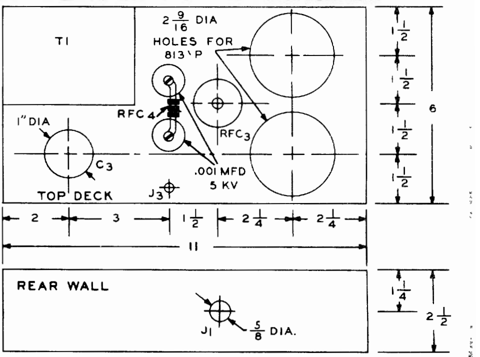
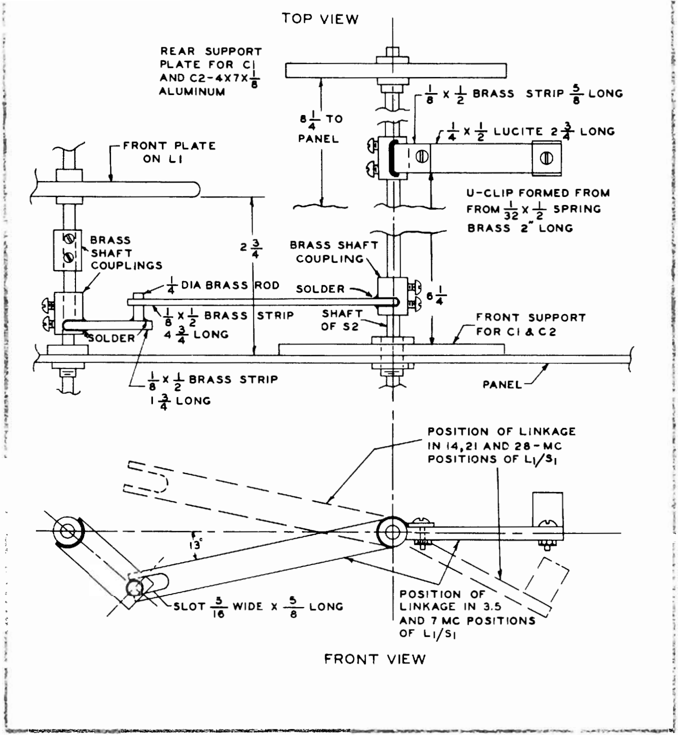


FIG. 3. LAYOUT DIAGRAM for the amplifier subchassis. Holes for the machine screws which secure the components in place are located from the holes on those components.

FIG. 5. DETAIL DRAWING of the linkage which actuates S_2 from the shaft driving the bandswitch (S_1) on L_1. Three ⅛ x ½-inch brass strips, soldered to brass shaft couplings, are the linkage arms. U-shaped clip-on plastic arm closes circuit between copper angle brackets on C_1 in the 3.5 and 7-megacycle positions of L_1.



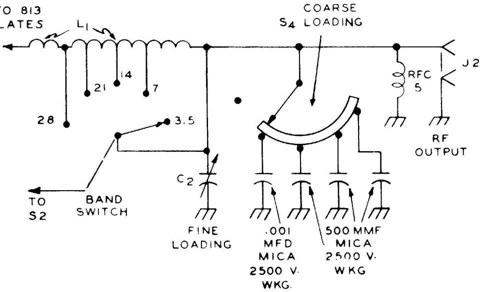

TO 813
PLATES
L1
28
21
14
7
3.5
BAND
SWITCH
TO
S2
C2
FINE
LOADING
COARSE
S4 LOADING
.001
MFD
MICA
2500 V.
WKG.
500 MMF
MICA
2500 V.
WKG
RFC
5
J2
RF
OUTPUT

TABLE 3

TABLE 3 - PI-NETWORK CHART FOR 813 AMPLIFIER

LOAD IMPEDANCE (ohms)	BAND (MC)	C_1 (mmf)	L_1 (uh)	ACTIVE TURNS (see text)
2,500	3.5	210	10.5	15
2,500	7	105	5.2	8.5
2,500	14	52	2.6	5
2,500	21	35	2.6	3
2,500	28	26	1.28	1