Gl-813 pentodes have been popular with radio amateurs for years. And their smooth adaptability to grounded-grid linear amplifier circuits should continue their well-earned reputation for versatility.

—Lighthouse Larry
7077's CERAMIC SISTERS...

The four new G-E ceramic receiving tube types pictured above — plus the 7077 high-mu triode (see G-E HAM NEWS, January-February, 1959, page 8) — form a team of ceramic tubes which are smaller in size, and unmatched in performance by any similar device that is on the market now or foreseeable in the near future.

While designed for the severe environment which military and commercial electronic equipment must frequently withstand, these tubes have many potential applications in amateur radio equipment.

Three of the types are high-mu triodes, and the other, the 7266, is a high frequency diode for detector, mixer or instrument probe circuits. The 7286 triode has a plate dissipation rating of 3.3 watts and a transconductance of 15,000 microhms. The 7402 is a printed board version of the 7077 and can be soldered or welded directly into the circuit. The 7486 triode has a 1.0-watt plate dissipation and can deliver 0.3 watts output in a class C amplifier at 450 megacycles.

The 7077 was in the final transmitting stage of the Pioneer IV sun satellite which last March established a record for long-distance point-to-point communication of 406,000 miles.

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KILOWATT GROUNDED-GRID LINEAR AMPLIFIER

Using only hand tools, an amateur can construct a high quality flexible linear amplifier in less time than it takes to round up the relatively few parts required.

The popularity of amateur transmitters in the 75- to 150-watt power class usually provides a ready-made unit 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 provided a satisfactory solution; and, experience indicates that the GL-813 operates efficiently in grounded grids. Also, this tube operates well as a high-ful 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 r.f. potential. The tubes run in class B at an efficiency of 60 to 70 percent, depending upon the plate voltage.

THE CIRCUIT, shown in the schematic diagram, Fig. 1, is quite simple, since no tuned grid circuit is required. The r.f. driving power is fed directly into the filaments of the two GL-813’s. A dual r.f. choke (RFC) in the filament circuit isolates the filament transformer.

High voltage is applied to the GL-813 plates, connected in parallel, through RFC’s. Three blocking capacitors in parallel keep high voltage from reaching the pi-network tuning plate circuit. A ready-made tapped coil (L1) and split-shunt 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 C1 is in the circuit on 14, 21, and 28 megacycles, when S2 is open. Both sections are in parallel on 3.5 and 7 megacycles, where greater maximum capacitance is required. S2, being closed by a linkage from the switch on L1.

A large variable capacitor (C2) — 1500 mmf 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 required. The output circuit will match impedances from 50- or 70-ohm unbalanced feedlines and loads.

THE CONTROL GRID on the GL-813 is bypassed to the chassis at each tube socket, receive from 0 to 100 volts of negative bias from the built-in bias supply, depending

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[Diagram of the amplifier with labels and connections]
FIG. 1. SCHEMATIC DIAGRAM of the GL-813 grounded-grid linear amplifier. The 5uf 001-mfd, 500 volt electrolytic capacitors are of the cylindrical ceramic type with silver terminals (Ceramica 800B1000, or equivalent). All other bypass capacitances are disk ceramic, 500 volt working. Resistors are 1/4-watt, with wattage ratings as specified. Resistors in the matching circuit are listed in TABLE I. No switches are shown in the 115-volt AC circuit, since it is controlled by external power switching circuits. All components to the left of the dotted line running down through the diagram are on the sub-chassis.

TABLE I — PARTS LIST

| R | 12 ohms, 1 watt, for 100-ma grid reading. |
| R1 | 3.4 ohms, 1 watt, for 500-ma plate reading. |
| W1 | 0.5-m, 200-mw r.f. choke (National B-300). |
| W2, W3 | 33-mega u.f. r.f. choke (National B-300). |
| W4, W5 | 300-ma r.f. choke (National B-300). |
| W6 | 25-ma r.f. choke (National B-300). |
| W7, W8 | 5-ma r.f. choke (National B-300). |
| W9 | 20-ma r.f. choke (National B-300). |
| W10 | 5-ma r.f. choke (National B-300). |
| W11 | 20-ma r.f. choke (National B-300). |
| W12 | 5-ma r.f. choke (National B-300). |
| W13 | 20-ma r.f. choke (National B-300). |
| W14 | 5-ma r.f. choke (National B-300). |
| W15 | 20-ma r.f. choke (National B-300). |
| W16 | 5-ma r.f. choke (National B-300). |

FIG. 2. SCHEMATIC DIAGRAM of an optional pi-network matching circuit. It will match the 400-ohm circuit of the GL-813 amplifier to the 50-ohm output circuit of high-ohm source which otherwise might not be loaded heavy enough to fully drive the linear amplifier.

TABLE II

| C | 225-mef variable, 0.224-inch air gap (Thornefield MC-225-AF). |
| C1 | 450-1250 muf variable (section broadest motion, variable). 0.120- to 0.220-inch per section, all caps in parallel. |
| L1 | 40, 5 turns, No. 14 stranded wire, 1 1/2 inches in diameter, 2 inches long, space wound. 5 turns per inch, tapped 1 1/4 inch, 4 (14 M.G.), and 10 (3 M.G.) turns from No. 14. |
| L2 | 1 1/2 inch, 5 turns, No. 14 stranded wire, 1 inch in diameter, 1 inch long, space wound 5 turns per inch, self-supporting. |
| L3 | 5 ohms, 5 turn top wind, terminal inscription (Ceramica No. 2500, or equivalent). |

Shielding: 4 x 6 x 6-inch Minibas (Rad CU-3007), or 3 x 5 x 7-inch Minibas (Rad CU-3008).
on the setting of $R$. 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 $R$. Leads should be run from these terminals to a switch, or relay contacts which close while transmitting.

Separate excitation of current in the grid and plate circuits is accomplished by switching a single meter ($M$), across shunting resistors, $R_s$ and $R_p$, respectively. Only plate current is read in the FLATE position of $S$, since the grid circuit is returned directly to the center tap on the filament transformer ($T$).

**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 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 CL-307). Lengths of coaxial cable for the input and output were cut to the proper dimensions to run to the exciter and final amplifier.

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

The main chassis is a 13 x 17 x 1/4-inch thick sheet of aluminum fastened with its bottom surface 1/4 of an inch above the lower edge of a 10 x 12-inch aluminum relay rack panel. Only the parts in the components, meter and meter switch are on the main chassis, the remaining components being assembled on the 6 x 11 x 21/2-inch sub-chassis.

The photographs and drawings illustrate the placement of the major components (Figs. 3 and 4). Either a 3/8 or 21/2-inch meter may be used for $M$.

The front and back plates of $C_1$ and $C_2$ are fastened to 1/4-inch thick sheet aluminum brackets 2 inches high and 4 inches wide. The shaft on which the linkage for switch $S$ is supported also runs between these plates. The parts in the linkages 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

(continued on page 6)
the two stator sections on C5, when L-2 is in the 3.5 and 7-megacycle positions. The arm on the L5/C5 shaft is adjusted so that it engages the forked arm, as shown in solid lines on the sketch, when S5 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 S5 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 3/8-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. 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.

TUNEUP FOR SSB operation consists simply of applying full plate voltage and, with terminals 1 and 2 on the power strip shorted, setting R4 for 40 milliamperes of plate current with S5 in the PLATE position. Turn S5 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. Adjust the exciter loading for a full-scale reading on M. With S5 in the GRID position, turn C5 to maximum capacitance, B5 to the PLATE position and adjust C5 for minimum plate current. Turn on partial high voltage and decrease the capacitance of C5 for a plate current reading of 200 milliamperes, readjusting C5 for minimum plate current, as necessary. Apply full plate voltage and adjust C5 for about 400 milliamperes plate current. The grid current should read 100 milliamperes.

Switch the exciter to deliver SSB output and adjust its operation for the audio gain for normal r.f. 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 the plate bias voltage is adjusted initially for almost zero plate current. The exciter is adjusted to deliver 100 milliamperes of grid current in the amplifier without plate voltage. After applying partial plate voltage, load the amplifier to about 180 milliamperes plate current. With full plate voltage, the plate current should be about 500 milliamperes.
This amplifier also may be driven by a conventional amplitude modulated transmitter. The plate current is adjusted to 60 milliamperes at full plate voltage, the same as for SSR operation. Adjust the exciter for 90 to 100 milliamperes of amplifier grid current. Apply partial plate voltage and load the amplifier to about 150 milliamperes plate current. Next, apply full plate voltage and adjust for 300 milliamperes plate current.

Now, reduce the driving power from the exciter until the amplifier plate current reads 150 milliamperes. When the exciter is amplitude modulated 100 percent, the 813 amplifier plate current should rise not more than 6 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 W5GFH without a failure for any reason. It is stable, easy to adjust and provides a really potent signal.
TECHNICAL INFORMATION — 12FQ8

Miniature twin double plate triode

Radio amateurs undoubtedly will doodle plenty of prospective circuits around this new and unique "signal-splitting" twin triode receiving tube with four plates — each brought out to separate base pins — instead of the usual two. The double plates make it possible to obtain two well-isolated output signals from each section.

The 12FQ8 can be used profitably to reduce the number of tubes in circuitry of instruments and other equipment where it is essential to economically reduce to a minimum the interaction between two outputs of one stage. Complete technical data and characteristic curves are available on request from the G-E HAM NEWS office.

ELECTRICAL DATA

Cathode — Coated Unipotential
Heater Voltage, AC or DC.............. 12.6 Volts
Heater Current.................................. 0.15 Amperes
Maximum plate dissipation, each section........... 0.5 Watts

AVERAGE CHARACTERISTICS, EACH SECTION

Plate Voltage ...................................... 250 Volts
Grid Voltage......................................... — 1.5 Volts
Amplification Factor, Grid to Each Plate........... 95
Plate Resistance, approximate, Each Plate....... 7600 ohms
Transconductance, Grid to Each Plate........... 1250 Microhm
Plate Current, Each Plate....................... 1.5 ma

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