KCS COMPACTRON AMATEUR BAND RECEIVER

Part I—Design and Electrical Circuitry

By Harney L. Morgan, W7KCS/9

FEATURES —

4 Compactrons perform 10 functions
Double-conversion superhetodyne
Crystal-controlled RF oscillator
Accurate tuning dial calibration
2-Kilocycle selectivity for 588

THE KCS COMPACTRON amateur band receiver was developed to fill the need for a high-quality, high-performance receiver for the popular amateur bands that the experienced constructor could build using the usual home workshop hand tools. Only eight tubes are employed to perform a total of seventeen functions, including four of General Electric’s new compactron tubes which perform ten circuit functions. Four modern types of conventional tubes perform the other seven functions. The KCS covers the principal amateur bands from 3.5 to 29.5 megacycles, in seven 500-kilocycle tuning ranges, plus the range from 9.75 to 10.25 megacycles for reception of WWV on 10 megacycles. Design objectives of the receiver included: minimum cross modulation from strong signals on adjacent channels; high stability and low frequency drift; excellent usable sensitivity; sharp selectivity; low noise generated within the receiver; top-notch single sideband reception; a compact mechanical package; and, simplicity of adjustment and operation.

As can be seen from the panel views of the receiver, it is not a "knob-twister's delight." All the essential controls are on the panel; this simplifies operation. Only a signal generator, and a vacuum-tube voltmeter with an RF probe is needed for complete alignment. The critical circuits are aligned with adjustable capacitors and coils; however, an effort was made to eliminate all such adjustments where sufficiently precise fixed components could be used. A readily-available war-surplus worm and worm-gear drive mechanism was incorporated into a home-made slide rule type dial giving a professional appearance and "feel" to the receiver. The tuning rate is 25 kilocycles per revolution of the tuning knob, slow enough for easy tuning of single sideband signals. The tunable oscillator was designed to give a nearly linear tuning rate, so that frequency can be read directly from the vernier scale on the tuning knob to within a kilocycle or two. A modern-appearing standard cabinet, plus standard chassis and sub-chassis type construction, simplifies mechanical fabrication and assembly.

THE COMPACTORS in the receiver— as shown in the block diagram, Fig. 1—are: a 6D10 triple triode (V2) as cathode-follower and mixer, and crystal oscillator; a 4J11 twin pentode (V5) as a two stage IF amplifier; a 6AG11 triode, twin diode (V4) as first audio amplifier, AGC gating stage, and AGC rectifier; and, a 6AL11 double pentode (V6) as audio power amplifier, and 100-kilocycle crystal calibration oscillator. The multi-function capability of the compactors contributes greatly to the simplicity of design and compact size of the receiver.

The four conventional tubes, and their functions are: a 6H6Z RF pentode (V1) as a tuned RF amplifier, a 5U4-G triode-pentode (V3) as second mixer and tunable oscillator; a 6AL5 twin diode (V8) as the detector for amplitude-modulated (AM) signals; and, a 6H5 double-plate beam-beam tube (V7) as a product detector and IF carrier oscillator. The circuit was designed around those compactors available at the time construction was started, but later additions to G-E4 compactron line will make possible the further combining of functions. High-efficiency silicon rectifiers in a full-wave bridge type circuit are used in the high voltage power supply. All

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FIG. 1. BLOCK DIAGRAM showing the seventeen major circuit functions and the four cascade multipliers in the KCS receiver. Front-panel controls are identified with boxes around their function. The band and mode switches have sections ganged, and the preselector and tuning dial controls also drive ganged variable capacitors.

tubes operate with a maximum of 180 plate volts, and lower power dissipation, while still providing high gain and good stability. Even in the compact cabinet the receiver runs quite cool during extended periods of operation.

Design Considerations and Circuit —

Starting at the antenna input, the sensitivity, or signal-to-noise ratio, in a receiver can be made as high as practical by choosing low-noise RF amplifier and mixer circuits. Referring to the schematic diagram, Fig. 2, the 6Z6 semi-remote cut-off RF pentode (V1) was chosen for the RF amplifier stage because of its low noise resistance, high gain-bandwidth product, and high input and output resistances. The tube operates with a fixed gain of approximately 5. Additional voltage gain in this stage is provided by the step-up ratio of the RF input coil.

Cross modulation from strong local signals on adjacent frequencies is minimized by using high-Q RF coils, and operating the 6Z6 within the linear portion of its curve. The constant amplification and selectivity of the characteristic automatic gain control (AGC) of the control-grid circuit. Usually, AGC resistance in the grid acts as a shunting impedance, reducing the Q of the RF tuned circuit.

All RF coils (L1 to L6 and L7 to L9) were purchased with the secondaries wound as standard items. The primary were then wound on the coils by the author. With the possible exception of the universal-wound coils (L8, L10, L11, and L12), the coils can be wound by the constructor on J. W. Miller type 42A000CH1 coil forms (14-inch diameter, 1 inch long) for L4 to L6, and type 4600 (3/8-inch x 3/8-inch long) for L10 to L12.

The antenna input is a fixed impedance for 75-ohm transmission lines; however, it can be adjusted between the limits by adjusting the slug tuning in the antenna coil. Although a lower capacitance could have been used for the tuned circuit, thus achieving higher L/C ratios and Q, the 7 to 100-picofarad capacitor (C2) provides easy coverage of all bands on the PRE-SELECT knob.

Both the input and output of the RF amplifier stage are tuned to the same frequency and use identical inductors so that tracking between the input and output is easily accomplished. Small errors in coils, and between sections of C1A and C1B, are compensated for Q and C0. RF gain can be reduced by the RF gain control (R0) which increases the negative grid-cathode voltage by making the cathode voltage more positive. In order to limit the cathode-to-heater voltage gradient, R4 and R5 form a bridge which holds the cathode-to-heater voltage to below 100 volts.

The type 6BZ6 pentode is a relatively quiet tube and probably represents the highest noise level in the receiver. The 6BZ6 is in contrast to the 6Z6 because in that the maximum amount of noise is generally generated by the mixer stage. A lower noise RF amplifier tube such as a General Electric 6FG5 shadow grid beam pentode could have been used, but this did not seem worthwhile at the frequencies at which this receiver operates. The 6FG5 produces less noise than the 6BZ6 tube and would be an excellent choice for a receiver operating on the 50- or 144-megacycle amateur bands. Even with the 6BZ6 tube the KCS receiver has such low noise that it is difficult to realize that it is operating until a signal is tuned in. The first mixer. — The first mixer stage uses a rather unusual cathode-coupled circuit. The first section of the 6D10 triode triplet (V3A) acts as a cathode follower, isolating the signal input from the crystal oscillator injection signal. Signal voltage is coupled into the cathode of V3A via a common cathode resistor (R8). The second section, V3B, acts as a mixing triode with the local oscillator signal being injected into its grid. The voltage from the oscillator for the 6D10 tube (V3C) is the crystal controlled first conversion oscillator.

Very low mixing noise is achieved with a triode mixer, and the circuit allows a complete range of neutralization. Because of the mutual cathode resistor there is a certain amount of distortion when strong signals are received, making unnecessary AGC control of the mixer-amplifier stage to prevent overloading. In order to produce linear mixing in this circuit the value of the transconductance (Gm) of V3A should be large compared to the grid-cathode conductance of V3B. Consequently, the supply voltage for V3A is approximately 140 volts while the supply voltage for V3B is reduced to approximately 40 volts. The advantages of the cathode-coupled mixer circuit can be utilized in this receiver with a single 6D10 triode triplet. Conventional tubes — say a twin triode, plus a single triode — were used in this circuit, two tubes are necessary and a large chassis area for the mixer circuit is required.

Since the crystal controlled first oscillator operates higher in frequency than
NEATNESS AND SIMPLICITY of front panel of the receiver are apparent in this view. Vturtle scale on tuning knob has 100 divisions, but scale showing 25-kilocycle-per-knob-turn tuning rate can be applied over it. Concentric type potentiometers are used on RF and AGC gain controls.

"S" meter is standard General Electric DW-91 "Big Look" meter with hand-calibrated scale added by W7XCS/9.

TOP VIEW of the receiver chassis. Home-made slide-rule type dial scale is driven from large plastic pulley mounted on upper end of shaft of C42. Tunable oscillator (V2) is in box between capacitor and power transformer (T1). First oscillator coils (R1 to L1) are all housed in the small box behind the meter. Chassis layout diagram will appear in Part II of this article in the next issue.

the incoming signal on all tuning ranges, the resultant subtraction in the mixer produces a first IF signal in the 3-megacycle region. The crystals for the 3.5- and 7-megacycle bands operate in the fundamental mode, while the six crystals for the higher-frequency ranges operate in the third-overone mode. If a matched set of crystals is obtained for V1 to V6, tuning calibrations will remain virtually the same for all bands. The crystal-controlled first oscillator provides the advantage of high stability over a tunable first oscillator on the bands above 14 megacycles where it is needed.

SECOND MIXER — The output of the first mixer is fed into T5. The tracking circuit, composed of C58, C64, C65, C61, and C62 together with the secondary of T15, tunes the variable IF frequency range of 3895 to 2965 kilocycles. The tunable oscillator (V158) output voltage is applied to the cathode of the 6UG-A pentode section (V158) second mixer. The 6UG-A tube is a good choice for this combination mixer-oscillator because of its negligible phase noise, good conversion gain characteristics, and grid-plate interelectrode capacitance. By using cathode injection, interaction between the signal and oscillator is minimized. The fixed cathode resistor (R41) presents essentially a constant load on the VFO.

A constant k filter with low pass characteristics is composed of L20, L29, and C48. Effectively it acts as a constant-k filter, and thereby eliminates distortion of the harmonics of the VFO. The tuning of the mixer and VFO is accomplished by means of C44, C48, and the associated capacitors, and is designed to track with several kilocycles throughout the band. By proper choice of these components the tuning is nearly linear throughout the useful range. By using a combination of grid leak bias (R95 and C111) together with cathode bias (R108) on the mixer, a reasonable flat conversion gain can be achieved with moderate changes in the oscillator injection voltage.

TUNABLE OSCILLATOR — The triode section of the 6UG-A (V158) in a tuned-grid circuit is used for the tunable oscillator. It delivers good stability and an easy method of obtaining oscillation without putting plate voltage across C48. Additionally, all power consuming components (R18, R68, and R108) are mounted below the chassis so that the heat does not dissipate into the VFO-mixer compartment.

 Provision was originally made for a voltage regulator tube for the oscillator plate voltage, but this was not necessary for moderate changes in line voltage. A check showed a frequency change of approximately 250 cycles for a voltage change between 105 and 125 volts. In locations where this voltage range might be greater, or where very low line voltage is encountered, it might be wise to add an 6AQ 150-volt regulator tube.

The second oscillator tunes backward. For example, on the 3.5- to 4.0-megacycle range the oscillator tunes from 3.04- to 2.54-megacycles respectively. The combination of the crystal first oscillator and tunable second oscillator frequencies were chosen to minimize spurious beat frequencies. By use of the frequency combinations the lowest spurious frequency occurs on 7 megacycles with the fourth harmonic of the tunable oscillator and the first harmonic of the crystal oscillator. Since the attenuating filter network effectively minimizes the fourth harmonic of the local oscillator this signal is extremely weak.

Ceramic tube sockets and low drift capacitors are used in the tunable oscillator which is built into a rigid compartment of its own. Heat dissipating components of this stage are mounted below the chassis and out of the compartment, thus minimizing heat transfer to critical parts.

IF AMPLIFIERS — The output of the second mixer is fed directly into a Collins mechanical filter (FL3) which is tuned by capacitors on the input side by C58 and C61, and on the output side by C69, plus the input capacitance of V159. If the receiver is to be used principally for SSB reception, a 2.1-kilocycle bandwidth filter (Collins F4532-S1) is recommended. However, if good AM reception is important, then the 3.1-kilocycle bandwidth filter (Collins F4533-S1) is recommended so that the AM carrier and sideband will pass through the filter. Other types of mechanical filters — the Collins "Y," or new low-cost "FA" series filters — also are suitable, but will require different mounting than the 9-pin socket used on the "J" type filter.

A 6J11 twin pentode compactron (V4) — each section is similar to a 6F9G miniature pentode — operates as a two-stage IF amplifier. The 6J11 is ideal for this application, since it has high gain, and saves considerable space over two separate tubes. It is the only tube controlled by the negative AGC bias voltage in the receiver, since all previous stages have constant gain.

Resistors R49 and R53 together with capacitor C80 provide effective decoupling in the AGC circuit between the controls grids of the first and second IF amplifier stages. Because of the extremely high gain of these tubes (GM = 14,000) a neutralizing circuit was included. It consists of C82, C71, and decoupling circuit R56, C84, and R25.

The S meter circuit monitors the cathode voltage of V158 and compares it against a constant voltage across R45. By using the S meter in the cathode circuit of the second IF stage, low voltage operation results which cuts down on the wattage rating of R46 and the zero set potentiometer (R40). The S meter therefore reads the complete tube current of the second IF amplifier as AGC is applied to its control grid in a value which changes in proportion to the signal strength. On single side band and CW operation the AGC circuit is taken from the first audio amplifier so that the S meter follows the audio strength rather than the RF strength, as is the case with AM reception.

AM DETECTOR — The output of the IF transformer (V2) is fed into an integrating diode AM detector and also into the single side band audio detector circuit.

The integrating diode detector, consisting of both sections of a 6AL5 twin diode tube (V4) reduces distortion by presenting a capacitance load to the input, thereby reducing back feed on both the positive and negative AGC signal peaks. With positive peaks the output...
TABLE I—PARTS LIST

<table>
<thead>
<tr>
<th>Part</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.1</td>
<td>0.1-milliampere, 7/8-inch square panel meter (General Electric DH-91) Cat. No. 551623</td>
</tr>
<tr>
<td>P.1</td>
<td>6.3-volt pilot lamp and socket</td>
</tr>
<tr>
<td>R.1</td>
<td>2,000-ohm control potentiometer for concentric shaft mounting on rear of R.2 (IRC Snaptral rear section, right-hand semi-log taper, No. CR25 with 5615 shaft and DC1 dust cover)</td>
</tr>
<tr>
<td>R.10</td>
<td>30,000-ohm 1/2-watt control potentiometer, screw-driver slot</td>
</tr>
<tr>
<td>R.2</td>
<td>1/10-miliampere control potentiometer, left-hand audio taper (IRC Snaptral front section No. CF26 with 5F12 shaft and BUS bushing)</td>
</tr>
<tr>
<td>R.3</td>
<td>2,000-ohm, 1/2-watt potentiometer, screw-driver slot</td>
</tr>
<tr>
<td>S.1</td>
<td>6-pole, 6-section, 2112 position shaftless miniature, non-shunting rotary tap switch, step set for 8 positions (Centralab PA-2025)</td>
</tr>
<tr>
<td>S.2</td>
<td>3-pole, 1-section, 3-position, 2.5-position shaftless miniature, shorting rotary tap switch, step set for 3 positions (Centralab PA-2035)</td>
</tr>
<tr>
<td>S.3</td>
<td>3-pole, 1-section, 4-position shorting rotary tap switch</td>
</tr>
<tr>
<td>T.1</td>
<td>450-kilocycle IF input transformer (J. W. Miller 12-C1)</td>
</tr>
<tr>
<td>T.2</td>
<td>450-kilocycle IF output transformer (J. W. Miller 12-C2)</td>
</tr>
<tr>
<td>T.3</td>
<td>1500-kilocycle IF input transformer, modified (Miller 12-W1)</td>
</tr>
<tr>
<td>T.4</td>
<td>Power transformer, 115/155-volt secondary, 200 milliamperes; 6.3 volts at 0.5 amperes, 15-volt primary (Tried R-738)</td>
</tr>
<tr>
<td>T.5</td>
<td>Audio output transformer, 4,000-ohm primary, 3.2-ohm secondary, 3 watts (Stanvac A-3226)</td>
</tr>
<tr>
<td>Y.c</td>
<td>To Y.c—General Electric receiving tube, types as indicated in Fig. 2.</td>
</tr>
<tr>
<td>Y.d</td>
<td>Quartz crystals, 87-243 type holders; see TABLE II—COIL DATA, for frequencies.</td>
</tr>
<tr>
<td>Y.e</td>
<td>Quartz crystal, FT-243 holder, 456.2 kilocycles, for lower side-band reception</td>
</tr>
<tr>
<td>Y.f</td>
<td>Quartz crystal, FT-243 holder, 453.9 kilocycles, for upper side-band reception</td>
</tr>
<tr>
<td>Y.i</td>
<td>100-kilocycle standard frequency quartz crystal, HC-6/U holder (C-W Mfg. Co. type HH-100)</td>
</tr>
</tbody>
</table>
FIG. 2. MAIN SCHEMATIC DIAGRAM of the KCS receiver. Parts requiring additional explanation are described in TABLE I—PARTS LIST, or TABLE II—COIL DATA. Resistances are given in ohms, 1/2-watt rating, unless marked for higher wattage. Capacitances are in picofarads (pF), or in microfarads (µF), as marked. Capacitors with polarity signs are electrolytic types of the capacitance and voltage rating specified.

### TABLE II—COIL DATA

<table>
<thead>
<tr>
<th>Band &amp; Freq. in MC</th>
<th>PRIMARY</th>
<th>SECONDARY</th>
<th>OSCILLATOR</th>
<th>CRYSTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L &amp; L&lt;sub&gt;1&lt;/sub&gt;</td>
<td>Wire Length &amp; Size</td>
<td>L &amp; L&lt;sub&gt;2&lt;/sub&gt;</td>
<td>Wire Length &amp; Size</td>
</tr>
<tr>
<td>10A—29.2—29.7</td>
<td>0.35 4 22 1/2 1/2 0.76 8 20 DCC</td>
<td>42A106C81 L&lt;sub&gt;12&lt;/sub&gt;</td>
<td>2.3 17 28 1/2 4503 Y&lt;sub&gt;1&lt;/sub&gt;</td>
<td>32,695</td>
</tr>
<tr>
<td>10B—28.7—29.2</td>
<td>0.35 4 22 1/2 1/2 0.76 8 20 DCC</td>
<td>42A106C81 L&lt;sub&gt;14&lt;/sub&gt;</td>
<td>2.4 17 28 1/2 4503 Y&lt;sub&gt;1&lt;/sub&gt;</td>
<td>32,195</td>
</tr>
<tr>
<td>10C—28.2—28.7</td>
<td>0.35 4 22 1/2 1/2 0.76 8 20 DCC</td>
<td>42A106C81 L&lt;sub&gt;15&lt;/sub&gt;</td>
<td>2.5 17 28 1/2 4503 Y&lt;sub&gt;1&lt;/sub&gt;</td>
<td>31,695</td>
</tr>
<tr>
<td>15—21.0—21.5</td>
<td>0.44 5 22 1/2 1/2 1.1 8 20 DCC</td>
<td>42A106C81 L&lt;sub&gt;18&lt;/sub&gt;</td>
<td>3.5 23 30 1/2 4504 Y&lt;sub&gt;1&lt;/sub&gt;</td>
<td>24,495</td>
</tr>
<tr>
<td>20—14.0—14.5</td>
<td>0.60 5 24 1/2 1/2 2.0 12 22 DCC</td>
<td>42A226C81 L&lt;sub&gt;17&lt;/sub&gt;</td>
<td>4.3 23 30 1/2 4505 Y&lt;sub&gt;1&lt;/sub&gt;</td>
<td>17,495</td>
</tr>
<tr>
<td>40—7.0—7.5</td>
<td>1.2 7 28 1/2 1/2 6.5 21 28 LITZ</td>
<td>42A666C81 L&lt;sub&gt;16&lt;/sub&gt;</td>
<td>7.0 33 33 1/2 4505 Y&lt;sub&gt;1&lt;/sub&gt;</td>
<td>10,495</td>
</tr>
<tr>
<td>80—3.5—4.0</td>
<td>2.5 10 30 1/2 1/2 18.6 UNIVERSAL WOUND</td>
<td>42A226C81 L&lt;sub&gt;18&lt;/sub&gt;</td>
<td>11.0 40 36 1/2 4506 Y&lt;sub&gt;1&lt;/sub&gt;</td>
<td>6,995</td>
</tr>
<tr>
<td>WWY—975—10.25</td>
<td>1.0 6 28 1/2 1/2 9.6 16 24 DCC</td>
<td>42A336C81 L&lt;sub&gt;20&lt;/sub&gt;</td>
<td>9.4 33 33 1/2 UNIVERSAL WOUND</td>
<td>4399 Y&lt;sub&gt;1&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

**NOTES**

- All coils wound on J. W. Miller ceramic slug-tuned coil forms, Part No. 42A000C81, 1/2-inch diameter, 1 inch long.
- Inductance values given are those actually in circuit.
- All coils chosen wound unless specified.
- Enamelled wire used on all coils unless otherwise specified.
- DCC=Double Cotton-covered wire.
- SE=Silk-enamelled covered wire.
transformer load is essentially C30, while on negative peaks, the output load sees the reactive component of C30 in parallel with the AGC resistors. Audio filtering is provided by R30 and R30, while R7 and C6 form the charging time constant network. During discharge of the AGC circuit, C30, R30 and R30 provide a charge time constant of 0.12 seconds and a discharge time constant of 0.18 seconds. A slight delay voltage is applied to the AGC line due to contact potential in the 6AK7 tube. This delay applies a voltage to AGC until a signal of approximately 20 microvolts is received.

The 6AL5 tube could be replaced by two 1N34 diodes directly with no changes to the circuit. This would reduce the receiver complement to seven tubes; however, the diodes would provide no delay and result in slightly more distortion and less gain than the tube equivalent.

**SINGLE SIDE BAND PRODUCT DETECTOR** - The usual sideband detector is the General Electric 6J88 double-plate sheet beam tube (Y8) or is utilized in an excellent performing product detector circuit. The good separation possible with this tube makes it ideally suited for single side band product detector applications. It requires low oscillator injection voltage, and has freedom from spacecharge coupling effects which are present in dual-control pentodes and heptodes. It delivers relatively linear output voltage and is relatively insensitive to a wide range of variation in oscillator amplitude.

The circuit makes use of a single ended balanced design, with the balancing voltage on the deflectors provided by the resistance bridge R30 and R30. The audio output signal emerges from one plate through the filtering resistor R30. The oscilator which is crystal controlled by Y3 or Y3 for lower side band or upper side band, respectively, injects its voltage between the control grid and cathode of the tube. In order to eliminate a trimmer capacitor, C30 is specified as a plus or minus 1 percent value. A 1N54 diode (CR3) protects the sheet beam tube from positive grid bias by clamping positive voltages to ground.

**AUDIO AMPLIFIERS** - Audio output from the AM or single sideband detector is first amplified in a conventional triode audio amplifier (Y4A). The 6AL5 tube audio output tube (Y3A) provides about 2½ watts of useful output power. The coupling networks between the two audio stages tend to produce slightly higher cutoff frequencies than might normally be expected when using a mechanical filter. Resistor R30 provides additional attenuation of the low frequencies so that the audio output has a crisp, sharp, rather pleasant quality which is quite different from that of a conventional exemptive bass tube.

The use of the 6AL51 compacton (Y7), which is essentially a 6DT6 combined with a 6AG5, allows the 100-kilocycle crystal calibration oscillator to be put into the same envelope. The oscillator is on only when the function switch (S4) is turned to calibrate. The output of the crystal oscillator is fed directly into the antenna to give a signal over 100 kilocycles across the tuning range.

Audio voltage from both AM and SSB detectors is also applied to the single side band automatic gain control gate triode tube (Y64). This is the second section of the audio amplifier tube — a 6AG11 four-section compacton — essentially a 12AT7 twin triode, plus

6BWS diodes with separate cathodes. AGC voltage then runs through the AGC diode (CR2) and one diode section of V4C. The resulting DC voltage is applied across the charging time constant capacitor composed of the forward resistance of V4C and C30. This provides a very fast attack voltage for the AGC. The release voltage time constant is provided by R44, C66 and the back resistance of V60 and B4. However, because of the discharge constant of the capacitor C30, the AGC signal does not rapidly fluctuate with instantaneous changes of audio level. Since only one of the 6AG1 compactons is used in this receiver, it would be possible to use the Schmitt trigger as a noise limiter if the constructor felt it desirable.

**POWER SUPPLY** - The power supply consists of a full wave bridge rectifier system using General Electric type 1N1896 750-miliampere silicon rectifiers. The semiconductor rectifiers minimize space requirements in the power supply compartment. The combination of filtering components (C16A, C16B and C16C) were chosen to result in a very low ripple voltage of 0.01 percent, which is barely discernible with the audio volume control wide open. Because of the high capacitance of the input capacitor a current limiting resistor (R30) was provided to limit current through the diodes during the first charging cycle.

Note that all tub heaters are connected together by means of twisted wire and are grounded at two points. There is a ground at the power transformer (Y5), and also on pin 5 of the 6J88 tube (Y8). In order to reduce hum in the single stage product detector it was necessary to ground pin 5 directly to the chassis. This pin is also connected to the internal shield and focusing electrodes of this tube. Rather than a single heater wire and a direct chassis ground for the other side of the heater circuit, the twisted pair of wires reduces any tendency of hum pickup in the audio output. This extreme may not be necessary; however, other methods were not tried to determine its superiority.

Note that switch S4 is a shorting switch or make-before-break type rotary switch which allows the next circuit to be energized before the previous circuit is disconnected. This prevents transient voltages from being

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**FOOTNOTES**

1. These persons who are interested in the details of the new triode compact are invited to send their mail to the Conductive Design of Active Circuits, by Keith A. Fuller, 1140 Pacific Ave., San Francisco, Calif.

2. A new type of fully automatic frequency controller, a new TV type of filter, and a new 2.1-kilocycle bandwidh, Model No. 74/35, have been announced. These devices are designed for high-speed reception and are of great interest to the ham radio operator.

3. The military type of filter used in the 2.1-kilocycle bandwidh, Model No. 74/35, has been developed for use in the short wave band for SSB receivers. The filter is designed to provide a sharp filter characteristic with a bandwidth of 2.1 kilocycles.

4. The circuit shown in the schematic diagram of the AGC receiver is a modification of the circuit shown in the previous issue of the magazine. The modification is made by using a different type of filter and by changing the values of some of the components. The new circuit is designed to provide a much higher gain than the previous circuit.
THE LOADBOX — A POWER-INDICATING
DUMMY ANTENNA

By Philip E. Haifield, WDQPS* 

HIGH-QUALITY SIGNALS from amateur
transmitters are more important today
than ever before, but with today’s
crowded amateur band conditions, on-
the-air testing is frowned upon. Thus,
a dummy-antenna load is a necessity in
the amateur station.

The LOADBOX is a modernized ver-
tion of one of the dummy loads de-
scribed in an earlier issue of G-E HAM
NEWS. It features complete shielding
to reduce radiation and an internally
mounted RF ammeter to allow compar-
ative power readings.

It is built in a 4x5x6-inch aluminum
utility box. An unpainted box was used,
since good contact between the body of
the box and the covers will decrease un-
wanted radiation. The covers furnished
with the box were replaced by covers cut
from perforated aluminum sheet (Reynolds
Home Aluminum) to assist in cooling the
resistor assembly. Additional sheet-metal
screws were used to assure good contact be-
 tween the covers and the body of the box.

The resistor assembly consists of ten,
non-inductive, wirewound, 500-ohm, 10-
watt resistors connected in parallel to
give a nominal resistance of 50 ohms.
Two copper disks (see photos) were
used to parallel the resistors. Copper
connection straps were fastened to the
center of the disks with machine screws
and solder before the resistor assembly
was made. The resistor leads were
slipped through the holes around the
edge of the disks, soldered, and clipped.
One strap was used to connect the re-
sistor assembly to the bottom of the
aluminum box and the other to connect
to the RF ammeter, as shown in the
schematic diagram.

The RF ammeter is mounted on sup-
ports inside the box with the face visible
through the screened hole on the
front of the box. The meter used in this
model has a 0–1–5-ampere range, which
allows power inputs up to approximately
110 watts.

The front of the box also carries the
input coaxial connector and the vari-
able capacitor used to compensate for
the reactance of the resistor assembly.

The resistor assembly may be com-

pensated by connecting the Loadbox,
through a SWR bridge, to a source of
RF and adjusting the variable capaci-
tor on the front of the box for a null
indication on the SWR bridge at the
center of each band on which the Load-
box is to be used. Marks may be made
on the front of the box to allow reset-
ing of the capacitor.

For operation, approximate power
being dissipated in the load may be
calculated by squaring the reading of
the RF ammeter and multiplying by 50.
However, the Loadbox is most useful for
determining whether changes in a
piece of equipment increase or decrease
the power output. This is difficult to do
with a light bulb as most of us are
unable to “remember” the intensity of
a light bulb between tests.

The resistance of the model illus-
trated was measured from 1 to 50 Mc.
The results are shown on the curve.
From this it can be seen that some
error in calculated power output will
prevail at all frequencies if a resistance
of 50 ohms is assumed, but that the
error will increase sharply above 30
megacycles. However, this does not
affect the usefulness of the Loadbox as
an indicator of relative power at a
given frequency.

Although the nominal rating of the
resistor assembly is 100 watts, powers
as high as 500 watts may be dissipated
for short intervals. However, if this is
done the RF ammeter must have the
proper range and the overload should
not be applied for more than one
minute, followed by a fifteen minute
cooling-off period. Cooling may be
assisted by using a fan or blower to
move air through the perforated covers
of the box.

For maximum convenience, the Load-
box may be connected to the transmit-
ter through one position of a coaxial
selector switch (B&K Model 550A, or
Waters Mfg. Co. Model 335) which
also selects the “free” antennas.
So, whenever you test out your trans-
mitter — even for only a minute or
two — connect it to the Loadbox and
prevent needless interference to other
stations.

FOOTNOTES

*See “Technical Trifles — Using Resistors as RF
Load,” G-E HAM NEWS, January-February, 1951
(Vol. 6, No. 1), for details.

WDQPS is a technical data engineer with General
Electric’s Research Tube Department, Schenectady, 
New York. He is author of a number of articles in G-E,
Funiculare Electronique, Elektronic World, and G-E HAM
NEWS.

PARTS LIST — LOADBOX

A. 0–1–5-ampere RF ammeter, internal ther-
mostat type.
B. J-50-micron miniature variable (Hammarlund
HF-50, or equivalent). 
C. 50-ohm coaxial cable (Belden 029).
D. 50-ohm non-inductive resistors
(Sprague 10-N41). 
E. 10-500-ohm, 50-watt RF ammeter.
Box — Aluminum utility box, 4x5x6 inches, covers
on 4-inch sides (Bud AU-1029).

1 See “Technical Trifles — Using Resistors as RF
Load,” G-E HAM NEWS, January-February, 1951
(Vol. 6, No. 1), for details.

2 WDQPS is a technical data engineer with General
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York. He is author of a number of articles in G-E, FuniculareElectronique, Elektronik World, and G-E HAM
NEWS.
NEW MOBILE transmitting tubes by General Electric are: (left to right) 8156 21-watt beam pentode compacton; 8106 beam pentode multiplifier-driver; 8102 triode-pentode for tripping and modulating; and the type 7984 compacton 46-watt beam power amplifier. Designed specifically for reliable and economical equipment in the 175 Mc. range of commercial communications, the 7984 and 8156 feature high power output at moderate plate voltage, compact size, short internal leads, multiple base-pin connections for positive RF grounding of cathode and screen-grid elements, and 12.5-volt heaters which operate directly from 12-volt automobile electrical systems.

RADIO AMATEURS who are planning to build new mobile equipment will find two new compactons, and two 9-pin miniature tubes ideal for transmitter circuits. All four new tubes—pictured at the left—have been designed specifically for reliable and economical mobile communications at frequencies up to 175 megacycles.

The popular 6146 transmitting tube has been compactonized in such fashion that it delivers more power output in the VHF range (at 175 megacycles) but at the same time requires less driving power. It bears the EIA designation of type 7984, and is rated for 46 watts output, as compared with the rated 38 watts of the 6146 under similar conditions.

Seated height is only 2.5 inches, as compared with the 3.25-inch seated height of the 6146. The saving in gain because the 7984 has neither a composition base, nor a top cap. Eliminating the top cap for the plate connection in mobile equipment is advantageous because it eliminates a long loose wire lead which is difficult to keep from vibrating or otherwise moving about. Maximum ratings of the 7984 in intermittent mobile RF service, class C telegraphy and FM telephony, are: DC plate voltage, 750 v.; DC screen-grid voltage, 250 v.; DC grid No. 1. 4.0 ma.; and plate dissipation 35 watts. Typical operation as amplifier at 175 megacycles: plate voltage, 460 v.; screen-grid, 145 v.; grid No. 1. 60 v.; plate current, 180 ma.; screen-grid current, 12 ma.; grid No. 1 current. 2.5 ma.; driving power, 2 watts; and power output. 46 watts.

Another new compacton, type 8106, is a medium power tube with 15 watts plate dissipation. A new multiplier-driver tube, the 8106, is rated at 6 watts plate dissipation. The 8106 can double and drive the 7984, can drive two 7984's in push-pull, or can double and drive a pair of 8106's. For frequency tripling and FM modulator, the node-pentode 8102 miniature tube is available.

Other significant characteristics are:

8106—This beam pentode compacton has four pins for connecting to the cathode and beam plates, three plate pins, and two screen-grid pins. Ratings are: 600 volts maximum DC plate, 250 volts screen grid, 100 ma. plate current, 5 ma. control-grid current, 15 watts plate dissipation, and 2.5 watts screen-grid dissipation. In typical operation at 175 megacycles with 400 plate volts, 170 screen-grid volts, and minus 60 control-grid volts, the tube draws 90 ma. plate current, 10 ma. screen-grid current, and 3 ma. grid current. With 1.0 watt of driving power, the useful output is 21 watts.

8106—a 9-pin miniature beam pentode, the tube features three cathode-beam plate pins, and two screen-grid pins. Maximum ratings are: 380 plate volts, 300 screen-grid volts, 6.0 watts plate dissipation, and 40 ma. DC cathode current.

8102—a 9-pin miniature triode-pentode, the tube has a large cathode cross section, and the pentode section is rated to carry 20 ma. cathode current. Both plates are rated at 330 volts maximum, and 2.5 watts dissipation. In typical operation at 125 volts, the plates draw 12 and 13.5 ma., respectively.

These new types will bring new efficiencies to amateur radio mobile equipment, as they are doing for commercial VHF two-way radio.

Available FREE from your G-E Tube Distributor

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Lighthouse Larry

 While the KCS Compton receiver is admittedly an ambitious project, the construction and alignment are well within the capabilities of the experienced radio amateur. It enables amateurs with a good supply of parts on hand to "step-up" to a higher-performance receiver at low cost. The KCS receiver also is a "guide" of circuit and constructional ideas for thousands of other amateurs, who may not construct a complete receiver, but who can use these ideas in equipment they now have, or are constructing.

OTTIS C. SMITH W05PN DUNLAP ROUTE HEMINGFORD, NEBRASKA

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