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KCS
COMPACTRON
AMATEUR BAND RECEIVER

Part I—Design and Electrical Circuitry
By Norman L. Morgan, W7KCS/9

Part II—Construction, alignment and operation, will appear in the Spring, 1963 Issue. Complete fabrication details for all home-made special parts will be included.

FEATURES
4 Compactrons perform 10 functions
Double-conversion superhetodyne
Crystal-controlled HF oscillator
Accurate tuning dial calibration
2-Kilocycle selectivity for 58

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 megacycles 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 COMPACTRONS in the receiver—as shown in the block diagram, Fig. 1—are: a 6D10 triple triode (V3) as cathode-follower and mixer, and crystal oscillator; a 6J11 twin pentode (V1) as a two stage IF amplifier; a 6AG11 twin-triode, twin diode (V4) as first audio amplifier, AGC gating stage, and AGC rectifier; and, a 6AL11 double pentode (V5) as audio power amplifier, and 100-kilocycle crystal calibration oscillator. The multi-function capability of compactrons thus contributes greatly to the simplicity of design and compact size of the receiver.

The four conventional tubes, and their functions are: a 6BZ6 RF pentode (V7) as a tuned RF amplifier, a 6UB-A triode-pentode (V6) as second mixer and tunable oscillator; a 6AL5 twin diode (V6) as the detector for amplitude-modulated (AM) signals; and, a 6J8B double-plate sheet beam tube (V6) as a product detector and IF carrier oscillator. The circuit was designed around those compactrons available at the time construction was started, but later additions to G-E's 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
tubes operate with a maximum of 180 plate volts and a very low 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. 3, the 6EZ6 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 coils.

Cross modulation from strong local signals on adjacent frequencies is minimized by using high-Q RF coils, and operating the 6EZ6 within the linear portion of its curve. The constant amplification enabled by the construction and feedback pentode 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 L5, and L14 to L19) were purchased with the secondaries prewound as standard items. The primaries were then wound on the coils by the author. With the possible exception of the universal-wound coils (L6, L10, L17, L20, and L21), the coils can be wound by the constructor on J. W. Miller type 42A0006CH1 coil forms (.4-inch diameter, 1 inch long) for L6 to L9, and type 4600 (.4-inch x .8-inch long) for L16 to L19.

The antenna input is a fixed impedance of 75-ohm transmission line; however, it can be adjusted with small limits by adjusting the slug tuning in the antenna coils. Although a lower capacitance could have been used for the tuned circuit, thus achieving higher L/C ratios and Q, the pickup of pictoroidal capacitor (C4) 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 C4 and C5, are compensated for by adjustment of L6. RF gain can be reduced by the RF gain control (R8) which increases the negative grid-cathode voltage by making the cathode voltage more positive. In order to limit the cathode-to-heater voltage gradient, R8 and R4 form a bridge which holds the cathode-to-heater voltage to below 100 volts. The remaining trimmer section of the 6DJ1 tube (V3C) is the grid controlled first conversion oscillator.

Very low mixing noise is achieved with a triode mixer, and the circuit allows to mixing in the absence of neutralization. Because of the mutual cathode resistor there is a certain amount of self-limiting when strong signals are received, making unnecessary AGC control of the RF amplifier stage to prevent overloading. In order to produce linear mixing in this circuit the value of the transconductance (Gm) of V2A should be large compared to the input impedance of the mixer. As a result of this, the supply voltage for V2A is approximately 140 volts while the supply voltage for V3A is reduced to approximately 40 volts. The advantages of the cathode-coupled mixer circuit can be utilized with this receiver with a single 6DJ1 triode compacton. If conventional tubes — say a triode push-pull, 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 is apparent in this view. Vernier scale on tuning knob has 100 divisions, but scale showing 25-kilocycle-per-knob-turn tuning rate can be added over it. Concentric type potentiometers are used on RF and AF gain controls. A "S" meter is standard General Electric DW-91 "Big Look" meter with hand-calibrated scale added by W7XCS/R.

the incoming signal on all tuning ranges, the resulting 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-overtone mode. If a matched set of crystals is obtained for Y1 to Y6, tuning dial 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 T2. The tracking circuit, composed of C6, C24A, C25, C26 and C22 together with the secondary of T3, tunes the variable IF frequency range of 3495 to 2995 kilocycles. The tunable oscillator (V3a) output voltage is applied to the cathode of the 6UR-A pentode section (V3a) second mixer. The 6UR-A tube is a good choice for this combination mixer-oscillator because of its inherent noise, good conversion gain characteristics, and low-grid-plate interelectrode capacitance. By using cathode injection, interaction between the signal and oscillator is minimized. The fixed cathode resistor (R4B) presents essentially a constant load on the VFO.

A constant k filter with low pass characteristics is composed of L29, L30 and C28. This filter effectively attenuates harmonics of the VFO. The tracking of the mixer and VFO is accomplished by means of C24A, C25 and the associated capacitors, and is designed to track within 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 (R9 and C30) together with cathode bias (R4B) 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 a 6U8-A (V3b) 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 C28B. Additionally, all power consuming components (R18, R19 and R22) 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 it 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 to 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 OA2 150-volt regulator tube.

The second oscillator tunes back-wards. 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. Some of the 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. To minimize heat transfer to critical parts.

IF AMPLIFIERS — The output of the second mixer is fed directly into a Collins mechanical filter (FL1) which is tuned to the proper frequency on the input side by C25 and on the output side by C22, plus the input capacitance of V3A. If the receiver is to be used principally for SSB reception, a 2.1-kilocycle bandwidth filter (Collins F465J-21) is recommended. However, if good AM reception is important, then the 3.1-kilocycle bandwidth filter (Collins F465J-31) is recommended so that the AM carrier and sidebands 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 (V4A) — each section is similar to the 6F26 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 R20 and R21 together with capacitor C25 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 C18, C17 and decoupling circuit R20, C46 and R22.

Zener diode multipliers are used to produce the square-wave drive to the oscillators. A S meter is incorporated in the circuit to control the drive to the oscillator and VFO. The meter is driven from large plastic pulley on rear of chassis. Receiver is housed in a Bud SB-2140 "Shadow Cabinet," 14½ inches wide, 8 inches high, and 10 inches deep.

REAR VIEW of receiver in cabinet, showing positions of antenna jack, headphone jack, terminating board, fuse holder and AC power cord on rear of chassis. Receiver is housed in a Bud SB-2140 "Shadow Cabinet," 14½ inches wide, 8 inches high, and 10 inches deep. 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 C4J. Tunable oscillator (V3a) is in box between capocitor and power transformer (V3a). First oscillator coil (Y1 to L3) 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.
TABLE 1—PARTS LIST

C1,...10—100-pF, per section, two-section straight-line variable (Hammond-MCD-100-S).
C2, C3, 2.5—13-pF, midgut ceramic trimmer, zero-temperature coefficient (Centralab 827-B2).
C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18, C19, C20, C21, C22, C23, C24, C25, C26
and C28—250-µF ceramic trimmer, zero-temperature coefficient (Centralab 827-D).
C27, C28, 3—12-pF, ceramic trimmer, zero-temperature coefficient C29—100-pF, per section, two-section midline type variable (Hammond-MCD-150-M).
C33, 12-pF, ceramic tubular, zero-temperature coefficient C34, C35, 1.8—8.7-pF, ceramic air trimmer (F. E. Johnson type M-140-104, 96111).
C36, 7—35-pF, ceramic trimmer (Centralab 827-D).
C37—420-pF, 1 percent 500-volt silvered mica (Elenco type CM-20).
C38—10—20-pF, air trimmer, zero-temperature coefficient C39—1.5-µF, 200-millimicrofarad filter choke (Stancor-C-22224).
P1—Mechanical bandpass filter, 455-kilocycle center frequency, 2.1-kilocycle bandwidth for SSB reception (Collins type F-455-J-21 filter used in this receiver).
P1—1-ampere midgut cartridge fuse, type 3AG, and holder.
CR to CR,...400-volt peak inverse, 750-millimicrofarad silicon rectifiers (G-E 1N1469).
J1—chassis type coaxial cable connector (SO-239).
J2—closed circuit type phone jack.
J3—135-µH universal wound coil, primary, J. W. Miller No. 42A135-
C81, secondary, 15 turns, No. 28 SE wire, random-wound 1/4-inch long and 3/4-inch spacing from primary.
J4—135-µH RF Choke, pi-wound coil (National B-13990B).
J5—455-kc. tapped oscillator coil, midgut type (Miller 5481-C).
M1—0—1.0-milliampere, 2½-inch square panel meter (General Electric DW-91, Cat. No. 573823).
P1—6.3-volt pilot lamp and socket.
R1—2,000-ohm control potentiometer for concentric shaft mounting on rear of R60 (IRC Snaptron rear section, right hand semi-log. taper, No. CR25 with 5816 shaft and DCl dust cover).
R2—100-ohm 1½-watt control potentiometer, screw-driver slot.
R3—1-megohm control potentiometer, left-hand audio taper (IRC Snaptron front section No. CF26 with SF12 shaft and BUS bushing).
R4—2,000-ohm, 1½-watt potentiometer, screw-driver slot.
S1,...6-pole, 6-position, 2-12 position steatite miniature, non-shorting rotary tap switch, stop set for 8 positions (Centralab PA-2025).
S2,...3-pole, 1-section, 3-position, 2-5-position steatite miniature, shorting rotary tap switch, stop set for 3 positions (Centralab PA-2000).
S3,...3-pole, 1-section, 4-position shorting rotary tap switch.
T1,...455-kilocycle IF input transformer (J. W. Miller 12-C1).
T2,...455-kilocycle IF output transformer (J. W. Miller 12-C2).
T3,...1500-kilocycle IF input transformer, modified (Miller 12-W1).
T4,...Power transformer, 115/135-volt secondary, 200 milliamperes; 6.3 volts at 5.5 amperes, 115-volt primary (Triad R-738).
T5,...Audio output transformer, 4,000-ohm primary, 3.2-ohm secondary, 3 watts (Stancor A-322B).
V1 to V6...General Electric receiving tubes, types as indicated in Fig. 2.
V7,...Quartz crystals; 84-234 type holders; see TABLE II—COIL DATA, for frequencies.
V8,...quartz crystal, FT-243 holder, 456.2 kilocycles, for lower side-band reception.
V9,...quartz crystal, FT-243 holder, 453.9 kilocycles, for upper side-band reception.
V10,...50-kilocycle standard frequency quartz crystal, HC-6/U holder (C-W MgF. Co. type HS-100).
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>Ant.</th>
<th>L &amp; L₁</th>
<th>L₂</th>
<th>Primary</th>
<th>Secondary</th>
<th>Oscillator</th>
<th>Crystal</th>
</tr>
</thead>
<tbody>
<tr>
<td>10A—29.2 — 29.7</td>
<td>L₁ &amp;</td>
<td>0.35</td>
<td>4</td>
<td>22</td>
<td>1.5  1/2</td>
<td>6  0.76</td>
<td>20  1/2</td>
</tr>
<tr>
<td>10B—28.7 — 29.2</td>
<td>L₁ &amp;</td>
<td>0.35</td>
<td>4</td>
<td>22</td>
<td>1.5  1/2</td>
<td>6  0.76</td>
<td>20  1/2</td>
</tr>
<tr>
<td>10C—28.2 — 28.7</td>
<td>L₁ &amp;</td>
<td>0.35</td>
<td>4</td>
<td>22</td>
<td>1.5  1/2</td>
<td>6  0.76</td>
<td>20  1/2</td>
</tr>
<tr>
<td>15—21.0 — 21.5</td>
<td>L₁ &amp;</td>
<td>0.44</td>
<td>5</td>
<td>22</td>
<td>1.5  1/2</td>
<td>6  1.1</td>
<td>20  1/2</td>
</tr>
<tr>
<td>20—14.0 — 14.5</td>
<td>L₁ &amp;</td>
<td>0.60</td>
<td>5</td>
<td>24</td>
<td>1.5  1/2</td>
<td>6  2.0</td>
<td>22  1/2</td>
</tr>
<tr>
<td>40—7.0 — 7.5</td>
<td>L₁ &amp;</td>
<td>1.2</td>
<td>7</td>
<td>28</td>
<td>1/4  1/2</td>
<td>6  6.5</td>
<td>21  1/4</td>
</tr>
<tr>
<td>80—3.5 — 4.0</td>
<td>L₁ &amp;</td>
<td>2.5</td>
<td>10</td>
<td>30</td>
<td>1/4  1/4</td>
<td>6  18.6</td>
<td>42A225CB₁</td>
</tr>
<tr>
<td>WWV—9.75</td>
<td>L₁ &amp;</td>
<td>1.0</td>
<td>6</td>
<td>28</td>
<td>1/4  1/4</td>
<td>6  3.6</td>
<td>24  1/4</td>
</tr>
</tbody>
</table>

NOTES

All coils wound on J. W. Miller ceramic slug-tuned coil forms, Part No. 45A000CB₁, 1/8-inch diameter, 1 inch long.

Inductance values given are those actually in circuit. All coils closewound unless specified.

Enamel wire used on all coils unless otherwise specified. DCC—Double Cotton-covered wire. SE=Silk-enamelled covered wire.
transformer load is essentially C50, while on negative peaks, the output load sees the capacitive reactance of C55 in parallel with the AGC resistors. Audio filtering is provided by R90 and R91, while R72 and C55 form the charge time constant network. During discharge of the AGC circuit, C55, R90 and R91 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 6AL5 tube. This delay application of AGC voltage until a signal of approximately 20 microvolts is received.

The 6AL5 tube could be replaced by two 1N54 diodes directly with no changes in 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 unbalanced detector-circuit of General Electric 6J8 double-plate beam tube (V4) is utilized in an excellent performing product detector circuit. The good separation possible with this tube makes it ideally suited for single sideband product detector applications. It requires low oscillator injection voltage, and has freedom from spacecharge coupling effects which are present in dual-control pentodes and triodes. It delivers relatively linear output voltages, 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 R93 and R94. The audio output signal emerges from one plate through the filtering resistor R90. The oscillator which is crystal controlled by Z4 or Z4B 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 trimer capacitor, C6 is specified as a plus minus 1 percent value. A 1N54 diode (C6B) protects the sheet beam tube from positive grid bias by shutting positive voltages to ground.

**AUDIO AMPLIFIERS** — Audio output from the AM or single sideband detector is first amplified in a conventional triode audio amplifier (V6A). The 1/2 6AL1 audio output tube (V6A) provides about 2/3 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 R90 provides some additional attenuation of the low frequencies so that the audio output has a crisp, sharp, rather pleasant quality that is superior to high output or excessive humpiness.

The use of the 6AL111 cathode follower (V7), which is essentially a 6J76 combined with a 6AG5, allows the 100-kilocycle crystal calibration oscillator to be put into the same envelope. The oscillator which 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 every 100 cycles across the tuning range.

Audio voltage from both AM and SSB detectors is also applied to the single sideband automatic gain control triode tube (V8). This is the second section of the audio amplifier tube — a 6AG11 four-section compactor — essentially a 12AT7 triode tube, plus 6BQ8 diodes with separate cathodes. AGC voltage then runs through the AGC diode (C55A) and one diode section of V7C. The resulting DC voltage is applied across the charging time constant consisting of the forward resistance of V7C and C6B. This provides a very fast attack voltage for the AGC. The release voltage time constant is provided by R44, C53 and the back resistance of V7C.

This network provides a release time of approximately 5 seconds. The single side band AGC voltage follows audio signal strength; however, because of the time constant of the grid it does not rapidly fluctuate with instantaneous changes of audio level. Since only one of the 6AG11 compactor diodes is used in this receiver, it would be possible to use such 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 1N1695 750-milliampere silicon rectifiers. The semiconductor rectifiers minimize space requirements in the power supply compartment. The diode rectifiers and filtering components (G14A, G15B, and CH1) 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 for a current of 80 milliamperes, a filter (R50) was provided to limit current through the diodes during the first charging cycle.

Note that all tube heaters are connected together by means of twisted wire and are grounded at only two points. There is a ground at the power transformer (T1), and also on pin 5 of the 6J8S tube (V6). In order to reduce hum in the circuit, the filament and 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. Resistance is used rather than a single heat 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 S8 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

**FOOTNOTES**

1. Those persons who are interested in the details of the schematic diagram would find Paul W. E. Vinter’s Conception Design of Active Circuits, by Kents. A. Riddle, TMSF, No. 455-221, 1958, useful.

2. Reals in Audio Company, Components Division, 19700 San Joaquin Road, Newport Beach, Calif., has recently announced the availability of a new low-cost mechanical filter for very low cost. It is a 2.1-kilocycle bandwidth, Model No. F453 F4-21. It is housed in a "puff-rib" type case, 7½ inches long, with connections on the bottom side. It can be mounted on the chassis of the 6J8 receiver and can be placed in the filter socket shown in this model, with connection brought down under the chassis and socket. The filter is listed as $6.50 for the low frequency side, or $7.50 for the high frequency side, and a "bottom view". Retail price is $24.95.

3. A 200 ohm set of matching coils, 15 K63B rectifier tubes, which includes all crystals for a 105.51515 microfarad, is available from the Magnetic Co., P.O. Box 2045, El Monte, Calif., for approximately $26.50.
THE LOADBOX — A POWER-INDICATING DUMMY ANTENNA

By Philip E. Hatfield, WQGFS

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 version of one of the dummy loads described in an earlier issue of Q-G E HAM NEWS. It features complete shielding to reduce radiation and an internally mounted RF ammeter to allow comparative 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 unwanted radiation. The corners of 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 between 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 resistor leads by means of clamps from the aluminum box and the other to connect to the RF ammeter, as shown in the schematic diagram.

The RF ammeter is mounted on supports 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 variable capacitor used to compensate for the reactance of the resistor assembly.

The resistor assembly may be compensated by connecting the Loadbox, through an SWR bridge, to a source of RF and adjusting the variable capacitor on the front of the box for a null indication on the SWR bridge at the center of each band on which the Loadbox is to be used. Marks may be made on the front of the box to allow resetting of the capacitor.

During 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 illustrated was measured from 1.7 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 300 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 Loadbox may be connected to the transceiver through one position of the coaxial cable selector switch (B&W Model 550A, or Waters Mfg. Co. Model 335) which also selects the "live" antennas. So, whenever you test out your transmitter even for only a minute or two—connect it to the Loadbox and prevent needless interference to other stations.

FOOTNOTES
2WQGFS is a technical data engineer with General Electric's Receiving Tube Department, Schenectady, New York. He is author of a number of articles in GIST, Popular Electronics, Electronics World, and G-E HAM NEWS.

SIDE VIEW of the Loadbox, showing how the bank of resistors is connected in parallel, and the copper strip leads between components.

PARTS LIST—LOADBOX

A...0—1.5-ampere RF ammeter, internal thermocouple type.
C...50-ohm, 50-pf. miniature variable (Hammarlund HF50, or equivalent).
J...Common-type coaxial cable jack (SO-239).
R...Ten 500-ohm, 50-watt non-inductive resistors (Sprague 10-NT).
Box...Aluminum utility box, 4x5x6 inches, covers on 4-inch sides (Bud AU-1029).

TERMINAL BOARD

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applied onto the primary of T3 and thus producing excessive transient voltages on the 1N1696 diodes in the bridge rectifier.

The headphone jack (J2) cuts off the internal speaker—mounted inside the top of the cabinet—when headphones are plugged in. Provision is made for an external speaker to be connected to terminals 1 and 2 on the terminal board, and thus biasing the J626 RF amplifier tube to cutoff by applying high positive voltage on the cathode.

MECHANICAL DETAILS—The construction, alignment and operation of the KCS COMPACTRON amateur band receiver will be covered in detail in the following issue of G-E HAM NEWS, Spring, 1963 (Vol. 18 No. 1).
We feel that with articles like the KCS receiver and LWM-3 transmitter, we are helping to advance the "state of the art" in home-constructed amateur radio equipment. We have shown that the equivalent of fine commercial equipment can be constructed at home. And, we estimate from mail received that at least 400 to 600 SSB transceivers similar to the LWM-3 are being constructed, and many more SSB excitors are being converted to include transceive operation. However, for those who like simple projects, we publish shorter articles too, like the LOADBOX in this issue, and thus provide a balanced "diet" of articles. (See November-December, 1961, and January-February, 1962 issues.)

---Lighthouse Larry

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