IN THIS ISSUE

THE LWM-3 — PART II — CONSTRUCTIONAL DETAILS

By W. C. Louden, W8WFH, and A. F. Prescott, W8DLD

PART II of the LWM-3 transceiver article covers the complete mechanical and constructional details. Also described is the procedure for initial alignment of all circuits requiring it, and the tuneup for normal operation of the transceiver once alignment is completed.

The LWM-3 is described by W8WFH and W8DLD in a compact neat package of advanced electronic circuitry that is ideal for both mobile and home-station operation. Also, W8WFH’s model has a single main chassis plate; amateurs who duplicate the LWM-3 may prefer to utilize the various sections into subassemblies. This type of construction probably will result in a somewhat larger over-all size for the LWM-3, since extra space is needed where subassemblies join together. However, utilized construction is the option of the builder, the LWM-3 as described applies to the methods used by W8WFH in his model.

LAYOUT

In positioning parts on the chassis, thought must be given to orienting the sockets so that leads may be used to minimize stray coupling. Also, the tube sockets should be located to allow the arrangement of the circuit components about them. The socket locations shown in the chassis layout diagram, Fig. 7, are selected for these reasons and, also, as mentioned in Part I of this article, to allow the location of the chassis on the front panel of the car. The left side of the panel near the driver’s seat.

Those tubes such as the mixers which use common VFO and crystal RF voltages are mounted adjacent to one another. The GEE RF amplifier \( (V_c) \) is located so as to permit short leads to the slug-tuned coils \( (L_4 \) and \( L_5 \)). The first crystal oscillator tube \( (V_5) \) is located to minimize lead lengths to the crystal switching sections of the bandswitch \( (S_i) \). The same basic idea is carried throughout the entire chassis layout.

It is recommended that the given chassis layout be used as a minimum of stray coupling difficulties was encountered with this layout.

CHASSIS AND CABINET

CONSTRUCTION

The chassis was constructed of 8-inch thick aluminum to provide a rugged mounting for the parts. It is desirable to use this heavy material for two reasons: 1) It can be drilled and tapped for mounting parts; and 2) It will not flex to any great extent and thus deform the VFO and cause frequency shift.

Holes are punched in the chassis while it is still a flat sheet, using the chassis layout diagram, Fig. 7, as a guide. Although hand punches and drills can be used, a punching machine, if available, saves hours of building time. Flanges \( \frac{1}{4} \)-inch wide are then formed on all four sides with a sheet metal brake. The front and back edges were bent up and the two sides bent down.

The small edges were used rather than the standard chassis design to facilitate the mounting of the many small parts.

The builder may then work not only from the bottom of the chassis but also from the edges. (Continued on page 2)

MOUNTING RACK for mobile operation of the LWM-3 transceiver in W8WFH’s car. Hinged mounting arms \( \text{(open in top view)} \) slip into “packets,” on each side of LWM-3 cabinet, providing “slip in — slip out” removal of transceiver from car, and shock-resistant mounting. Arm fold \( \text{(lower view)} \) out of way of center passenger in front seat when LWM-3 is removed.

All power and control connections to LWM-3 are made through 24-pin jack in middle of rack, matching similar type plug on rear of cabinet. Meters and indicator lights above transceiver mounting rack show performance of 3-phase AC mobile power system.
BOTTOM VIEW OF THE LWM-3, showing the over-all assembly. Centered section contains coils L4 and L5, plus all of the kiloturn capacitors and bandswitch sections (S4 and S5). Associated with these tuned circuits in the RF amplifier/drive stage (V10), MODE SELECTOR switch (S3) is in upper right corner. Transmitter and SSB generator sections are at left. Audio and VFO section is in right front corner, and receiver section runs along rear of chassis. Most small components—except RF bypass capacitors, which are mounted directly on tube sockets—have been mounted on narrow terminal boards for maximum rigidity and compactness.

THE LWM-3 (Continued from page 1)

The sides, front and back panels are screwed to the chassis with 4-40 x 1/4-inch long machine screws. During preliminary debugging of the transceiver the sides and back were removed. A dummy front panel was used to support the controls. After the circuits are working properly, the sides, front and back panels are screwed into place.

The over-all size and constructional details of the cabinet are shown in Fig. 8. The curved shapes of the four corners of the perforated aluminum cabinet were formed by carefully bending the metal around a 1-inch wood dowel. The metal was clamped between the dowel and a wood bench top and bent first by hand. The curve was then smoothed with a plastic mallet.

The 9 x 1/4-inch aluminum strips which form the front and back lips of the cabinet were formed in the same manner. The strip was first cut longer than necessary and trimmed after forming without a gap at the junction of the two ends. Small aluminum angle strips were made from 1/4-inch sheet metal.
stock to fasten the strips to the front and back panels to provide an edge for fastening the perforated covers. A complete cabinet assembly was fastened together with Phillips head 4-40 x 1/4 inch long machine screws.

The front panel should next be fitted to the cabinet and then punched and drilled for the various controls as shown in Fig. 4. The panel frame and the cabinet frame should be cut with 1/4 inch diameter socket hole punches at the corners, then moving between these holes. A half-round file is used to smooth the edges.

The dial escutcheon is made from 1/4 inch thick aluminum, drilled and filed to shape as shown in Fig. 10. It was then painted with flat black lacquer. Assembly details of the dial plate and dial cover are shown in Fig. 2. A command set transmitter dial plate is cut down to 2 inches in diameter and a dial of 1/4 inch thick clear lucite plastic is riveted to it.

The dial cover also is of 1/4 inch clear plastic. Note in the dial detail photo on page 6 that the dial cover is fastened to the escutcheon with a 6-32 machine screw. A simple zero-adjustment is made by using a small "wire nut" as a knob on the front of the dial escutcheon. A 1/4 inch diameter rubber grommet is fastened into the wire nut with a flat-head machine screw. The grommet then drives the rim of the dial cover and thus moves the hairline.

CIRCUIT WIRING

Construction should begin with the packaged VFO unit. The VFO should oscillate with satisfactory frequency stability before proceeding further with construction. All frequency determining components, C19, C20 — are mounted directly on the frame of the oscillator tuning capacitor (C19), as shown in the top and bottom views. The command transmitter tuning capacitor selected was from a 2.1-3 kHz Navy TVH/ARC-5. The capacitor has the gear reduction and dial mechanism mounted on its frame. It had 16 rotor plates originally, but 6 plates were removed to allow the VFO to tune from 2.5 to 27 megacycles. Start by removing only 4 plates and additional plates may be removed as desired to cover the proper range. The capacitor is mounted with solid brackets to the chassis, one on each side. Each side is braced and is fastened with two 4-32 screws to the chassis at one end and two to the capacitor at the other end. Do not allow the tuning shaft to rub the panel, or any other intermittent grounds to occur, as this may cause the circuit to become unstable when the unit is subjected to vibration.

The RF amplifier (V3) and high frequency (V4) crystal oscillator are connected in series with the VFO unit. The circuit layout on the chassis board will depend upon the mechanism used to move the tuning slugs. The permeability tuning and pushbutton head from an old radio is used to move the tuning slugs in L4 and L6. This unit was from a Decca radio, vintage about 1932. However, other models are also used. All parts are removed except the bracket which contains the bearings and the bar and shaft which move the tuning slugs. The key feature of the pushbutton is that the appearance of the unit was the original mounting for the push buttons.

[Continued on page 4]

FIG. 7. CHASSIS LAYOUT DIAGRAM for the LW-3 transmitter as constructed by WB8WTH. Material is 3/16-inch thick sheet aluminum. Precise locations of the small trimmer capacitors will depend on the size of the slug mechanism. Positions of the knob on each tube socket is indicated by the arrow. A 9-pin miniature tube socket is required only for a Collins "7", type filter (right rear corner). Type "E", "F" and "Y" filters require other mounting means.
FIG. 8. CABINET ASSEMBLY DRAWING for a custom-mode cabinet.

Material is 1/16-inch perforated aluminum sheet. Front and rear lips are 3/4- x 1/32-inch thick aluminum strip. Do-it-yourself aluminum, available in hardware stores, was used.

THE LWM-3 (Continued from page 3)

The small ceramic trimmer capacitors in the grid and plate circuits of V4 are mounted in a compact grouping to minimize lead lengths and space required for the tuner. Extensive shielding is used between grid and plate sections of the switch and between the RF amplifier and other circuits. The crystal oscillator on one side and the final amplifier on the other. A 1/4-inch fibre shaft is filed down and substituted for the original metal shaft in switch sections S4 to S5. It is driven from switch S8 with a flexible coupling.

The remainder of the receiver is then wired and the receiver tested as a unit (see alignment and tune-up procedure).

The transmitter is started by wiring the audio amplifier and vox section. This unit may be tested separately through the use of the tone oscillator and, of course, with voice signals from a crystal microphone. A small 1000 to 200,000 ohm matching transformer is necessary with a controlled attenuator microphone (see page 1 of Part 1) to obtain sufficient voltage to drive the audio system.

The BFO isolation amplifier and balanced modulator can now be completed; and, to facilitate testing, the vox relay (K2) may either be tied closed, or the relay tube (Vox) biased to hold the relay closed.

The remainder of the transmitter circuits may be completed with the exception of the pi-network output capacitors (C9 to C13).

CONSTRUCTION HINTS

Subminax cable (AmpheNoil No. 21-598) was used to carry RF voltages around the chassis from tube to tube. This cable has good low loss insulation and is small in diameter. Lapel microphone shielded cable was used to carry the audio voltages to the various controls. Number 22 and 24 insulated hook-up wire is used for general circuit wiring. Small capacitors are essential to compact construction. Some circuits

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FOOTNOTES—LWM-3

The Collins 6210-12 mechanical filter used in this transmitter may be purchased at reduced prices from distributors at $87.50 each. Also available directly from Collins Radio are the FAS2-505 and FAS2-501 filters (termed "cage caps") with coaxial leads. Each 501 cage cap filter is a cage assembly with terminals on ends, used in "B" line and 501-32 can be obtained from the Collins Store. Each 501 cage cap filter costs $50.75.

The 501 cage cap filters are available in the following ranges. For orderers who order a 2- or 3-kilocycle band width, a FAS2-10 is available directly from Collins Radio at $35.00, F.O.S. Freight. For the 10-megacycle crystal oscillator a FAS2-15 is available from Collins Radio at $50.75.

Order FAS2-505, FAS2-501 and FAS2-511 filters from Collins Radio Company, Components Div., 2757 Grand Ave., Des Moines, Iowa. Include complete wire diagram in order. All information was supplied by Collins Radio Co. Prices and availability are subject to change without notice. Mail orders to Collins Radio Co., Plants and availability are subject to change without notice. Mail orders to Collins Radio Co., Des Moines, Iowa. All information was supplied by Collins Radio Co.

All components were obtained from Fundamentals of Single Sideband, by Collins Radio Company.
were rebuilt a number of times at smaller components became available.

The perforated circuit board was found to be one of the most convenient and compact methods of mounting parts. The Alden Products Co. of 185 North Main Street, Brockton, Mass., and Lafayette Radio Electronics both sell them. Small terminals for use with the boards may be purchased also; however, brass eyelets were set into the holes with a punch in a drill press. Some preliminary thought must be given to the layout of parts. However, all circuit soldering is done in the open.

Parts are mounted on one side and all wiring is done on the other; pigtails are provided on the board for connection to the tube sockets. It is a good idea to include a few extra terminals or eyelets on the board for last-minute changes, as it’s more difficult to insert these after the board is in place. Small boards made in this manner were used to hold small parts for the output RF voltmeter circuit parts, and the input circuit capacitors for the RF amplifier. These were mounted in place by a single 6-32 stud, as shown in the bottom detail views.

ALIGNMENT AND TUNE-UP PROCEDURE

When preliminary work is being done on the VFO its output can be monitored using a separate receiver. For stability checks the 5th harmonic or higher should be used to quickly detect drift or frequency shift due to shock and vibration." The VFO dial can be calibrated from 0 to 200 by using a separate monitoring receiver and a 100-kilocycle crystal calibrator. If a calibrator with a 10-kilocycle divider is available, the 10-kilocycle divisions can be marked on the dial plate with a pencil, and the 5-kilocycle points added midway between them. By using harmonics of the

FIG. 10. DIAL ESCUTCHEON drawing for the LWM-3. Corners and dial opening are rounded with a file to desired contours before painting. The three mounting holes are counterbored to allow flat head machine screws to be flush with the surface.
to arrive at the proper coil and capacitance settings in the oscillator tuned plate circuit, especially when using the 2nd harmonic of the frequency for 14, 21 and 28 megacycles.

When the receiver wiring is completed a 450-kilocycle signal is connected to pin 1 of V4, a bias battery of -3V is connected from ground to the junction of C22 and R30, and the IF transformers T1 and T3, roughly tuned to provide maximum output. The signal generator in turn then connected to the plate of V4, and adjusted until some signal can be heard through the IF strip. At this frequency T2, and T4, are readjusted to give maximum output.

The signal generator is then connected to pin 5 of V4, and set for 3 megacycles. Transformer T2 is adjusted roughly for maximum output. The input is then changed to both 2.96 and 3.15 megacycles, and T4, is adjusted to give a uniform response over this frequency band.

Next, select the desired 280-kilocycle tuning range from TABLE III CRITICAL CHART. Obtain crystals of the specified frequencies and plug them into the proper crystal sockets as indicated in the chart. Connect the signal generator to the antenna RF jack (J4), and tune the VFO dial to 150.

Start with the highest frequency range, say 29.5 to 29.7 megacycles — insert the 5.69275-megacycle crystal into the socket for position 11 of the bandswitch (S4). Set the signal generator to about 29.6 megacycles so that its signal is heard in the LW-M-3. Rotate the EXCITER TUNE control to maximum signal strength. Next, adjust the tuning slugs in position 10 until a signal peak is heard with the slugs nearly out of the tuner. Repeat this adjustment for each position.

The adjustment assures close tracking of these circuits over 28.0 to 29.7-megacycle range (positions 0 to 8).

Next, set the bandswitch to position 6 or 7, and the tuning dial and signal generator to 21.3 megacycles. Adjust trimmer C22 or C30 for maximum signal after first peaking the signal with the EXCITER TUNE control. Then turn to position 4, and set the VFO and signal generator to 600-700 megacycles. Peak the EXCITER TUNE control and trimmers C22 and C30. Repeat this procedure in position 5. At 7.3 megacycles, peaking EXCITER TUNE and C22 or C30. Finally, align these circuits in position 2, 5, 6 and 7 megacycles, using EXCITER TUNE, and C22 or C30.

The received signal is maintained at the same dial calibration point, when switching from lower sidetone to upper, by switching the VFO frequency through the use of diode CR5, and capacitor C30, at the same time the RF frequency is switched. Pick up an AM signal near the center of the dial, and tune so that the carrier is no longer heard. Switch S3 is then changed from LSB to USB and C30 is adjusted until either sideband can be heard without the carrier frequency shift. The calibration of the VFO may be re-adjusted slightly with C30 to compensate for the slight change caused by the adjustment of C30.

The transmitter completed S, may be tuned to "tune" and, with microphone gain at zero and the vox gain at maximum, the transmitter will be keyed on but with no modulation. The vox gain and the output capacitance are then adjusted with a separate receiver which has an 8 meter. Avoiding overloading the receiver, R4 and C4, are then adjusted to roll out the carrier. If everything is working properly, the separate receiver can be connected to the transmitter output and, with maximum receiver gain, adjust R4 and C4, until the 8 meter reading is 5-4-8 units. At this point if the separate receiver is tuned through the signal there will be no well-defined signal, just some noise.

With the carrier nulled out the micro-

phone gain is increased slightly to pro-

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MOBILE MOUNTING RACK used by WEFWH for his LWM-3 transceiver. Vertical brackets and cross member are sheet aluminum of least 0.032 of an inch thick. Mounting area is 3/4-inch thick aluminum 10 1/2 inches long and 1 3/8 inches wide. Standard 2 1/2-inch butt type hinges are used to allow the mounting area to fold flat when the mount is not in use (see photos on page 1).

OPERATION
The hand switch is set to the desired 200-kilocycle segment of the band. The EXCITER TUNE control is rotated to provide maximum received signal as indicated by the S Meter. The switch S may be turned to the CAL position to check 100-kilocycle points from the crystal calibrator. Before transmitting turn S to TUNE and the meter switch to OUTPUT. Adjust the FINAL TUNE capacitor for maximum meter indication and you are ready to call on your favorite frequency. WEFWH has a switch on the dash of the mobile that allows this tuning to be done with the linear amplifier plate voltage off. In this manner no QRM is caused on the frequency before the LWM-3 is ready to operate.

The LWM-3 can also be connected directly to the antenna through a separate transfer switch. At one watt into the antenna WEFWH has been able to maintain a contact from Chicago to New York on 7200 kilocycles. The main advantage of the low power, however, is to talk over very short distances, mobile to mobile, with no receiver overload difficulties, or unnecessary QRM.

WEFWH devoted over a year and a half to designing, constructing and thoroughly testing his model of the LWM-3 before considering it complete. The experienced constructor should be able to duplicate it in from one to three months, depending upon the amount of 'spare time' which can be devoted to this project.

However, the completed LWM-3 transceiver delivers performance comparable to fine commercial equipment costing several times the $100.00 to $250.00 in parts (depending on the extentiveness of your junk box) required. Moreover, the LWM-3 is a literal "gold mine" of design, circuit, mechanical and construction ideas.

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"SIDE POCKETS" on LWM-3 cabinet for mobile rack mounting area (see Fig. 13 and photos on page 1) are made by sandblasting two spacer strips of 3/8 x 1 1/4-inch bar aluminum 9 inches long between 3/4-inch thick aluminum plates 8 inches long and 2 inches wide. Position spacers and add this shoe so that mounting arms in rack slide freely into pockets without binding. Assemble pieces with 4-40 machine screws.

Nearly every amateur will find some feature that he can apply to his own equipment.

The packaged VFO unit, especially, utilizes the excellent tuning capacitor; warm gear knob shaft drive, and split-gear tuning dial drive from the command set transmitter. It can be adapted to practically any VFO circuit design — series and parallel-tuned high-C Colpitts, Hartley, Franklin, Vacker, etc. — and all popular amateur band tuning ranges.

Finally, the LWM-3 offers conclusive proof that the technology of home-constructing amateur radio equipment is keeping pace with commercial equipment, and is not a "dying" art!
CONSENSUS SPECIFICATIONS OF CURRENT G-E COMPACTRON® DEVICES

**TYPE**

**DESCRIPTION**

**CHARACTERISTICS SIMILAR TO**

**BASE**

**HEATER**

**DIMENSIONS IN INCHES**

**DIAM.** **HEIGHT **

1AG1 Twin Triode

6AG1

6A11

12AX7 Triode

6D01

6F01

6G01

12B4 Triode

6H01

6J01

12C8 Triode

** Cleared for use by the Electronic Industries Association.**

*Types available from G-E Tube distributors immediately; other types are in production and will be available shortly.*

**12-PIN SOCKETS for G-E Compactron devices are now available — two in a plastic bag, at nominal cost — from G-E Tube distributors.**

**They fit a 1 1/4-inch chassis hole, with mounting holes spaced 1 1/2 inches. Ask for ETB-2976 at your G-E distributor.**

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**Available FREE from your G-E Tube Distributor**

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