THE LWM-3

A BANDSWITCHING SSB
MOBILE TRANSMITTER

PART II—MECHANICAL DETAILS

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Those tubes such as the mixers which use common VFO and crystal RF voltages are mounted adjacent to one another. The 6666 RF amplifier (Vc) is located m as to permit short leads to the slug-tuned coils (Lm and Lm). The first crystal oscillator tube (Vr) is located to minimize lead lengths to the crystal switching sections of the bandswitch (Sb). 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 it.

CHASSIS AND CABINET

CONSTRUCTION

The chassis was constructed of 0.08-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 ¼-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 a 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 11)

MOUNTING RACK for mobile operation of the LWM-3 transmitter in W3WPN's car. Flanged mounting arms (open in top view) slip into "pockets" on each side of LWM-3 cabinet, providing "slip in — slip out" removal of transmitter from car, and shock-resistance mounting. Arms hold (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 27-pin jack in middle of rack, matching similar type plug on rear of cabinet. Meters and indicator lights above transmitter mounting rack show performance of 2-phase AC mobile power system.

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

The LWM-3 as described by W3WPN and W3BDL is a compact neat package of advanced electronic circuitry that is ideal for both mobile and home-station operation. Also, W3WPN's model has a single main chassis plate, snubber which disposes the LWM-3 may prefer to utilize the various sections into subassemblies. The 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 simplest of the chassis, the LWM-3 as described applies to the methods used by W3WPN as to model.
stock to fasten the strips to the front and back panels and to provide an edge for fastening the perforated covers. The complete cabinet assembly was fastened together with Phillips head 4-40 x 5/8-inch long machine screws.

The cabinet was then painted and drilled for the various controls as shown in Fig. 7. The base, sides, and bottom are cut with 1/4-inch diameter socket hole punches at the corners, then scoring 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 dia of 3/8-inch thick clear burlite plaque is riveted to it.

The dial cover also is of 3/8-inch clear plastic. Note in the dial detail photo on page 2 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 to 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 of the oscillator, Cm, are mounted directly on the frame of the oscillator-tuning capacitor (Cm), as shown in the top and bottom views. The command transmitter tuning capacitor selected was from a 2.5-4.3 kc Navy TRB/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 2.7 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 brads to the chassis, one on each side. Each is 3 inches wide 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 a small frequency shift in the VFO when the unit is subjected to vibration.

The RF amplifier (V1) and high frequency (V2) crystal oscillator are completed next. The band switch and slug tuned coil layout will depend upon the mechanism used to move the tuning slug. The permeability tuning and pulldown control circuit for the radio is used to move the tuning slug up and down. One version was from a Delco radio, vintage about 1932. However, these mechanism which receivers have similar units. All parts were removed except the bracket which contains the bearings and the bar and shaft which move the slug. The line-up and appearance of the unit was the original mounting for the push buttons.

(Continued on page 4)
THE LWM-3 (Continued from page 3)

The small ceramic trimmer capacitors in the grid and plate circuits of V1, 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 5a to 5c. It is driven from switch shaft 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 10,000 ohm matching transformer is necessary with a controlled resistance microphone (see page 3 of Part I) 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 (K1) may be either tied closed, or the relay tube (V1a) 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 C10).

CONSTRUCTION HINTS

Subminax cable (Amphenol No. 21-028) 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. Tap-l 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

FOOTNOTES—LWM-3

1. The set is especially well suited to the 750-1650 band with the filters in the audio stages and 250-750 with the crystal microphones. A filter in the receiver front end is better than the crystal microphone for receiving QRM.

2. The filter is not shown in the schematic diagram since it is not part of the 750-1650 band circuit. A filter in the receiver front end is better than a crystal microphone for receiving QRM. A filter is not shown in the schematic diagram since it is not part of the 3000-7500 band circuit.

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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 Ablex Products Co. of 185
North Main Street, Brockton, Mass., and Lafayette Radio Electronica* 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; pigtales
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 fifth harmonic or higher
should be used to quickly detect drift or
frequency shift due to shock and
vibration.*

The VFO can be calibrated from
0 to 300 by using a separate monitoring
receiver and a 100-kilocycle crystal
calibrator. If a calibrator with a 10-
kilicycle divisions is available, the
5-kilocycle divisions can be marked on
the dial plate with a pencil, and the
5-kilocycle points added midway be-
tween them. By using harmonics of
the (Continued on page 6)

FIG. 9. PANEL LAYOUT DIAGRAM for the
(LM-3) transmitter. The panel should not be
drilled until locations of chassis components are
frozen to avoid errors. The 1-inch thick
delrin sheet can be left shiny, brushed, or etched to
give the desired finish.

HOLE SIZE CHART

- 1/8-drill-1/32-inch diameter.
- 7/32-drill-1/8-inch diameter.
- 1/8-pocket punch-1/8-inch diameter for 7-pin miniature tube socket.
- 1/16-pocket punch-1/32-inch diameter for 8-pin miniature tube socket.

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.

FIG. 11. DETAIL DRAWING of the dial cover and dial plate. The plate is made from a
Command Set transmitter dial plate cut down to 3 inches in diameter to form a hub.

* VFO and monitoring them at higher
frequency, say 25 to 27 megacycles,
1-kilocycle calibration lines can be ob-
tained. Five-kilocycle dial markings
were found to be adequate on this model.
Accurate initial calibration of the VFO dial will pay off later in good
frequency reproducibility.

After marking the calibration lines
on the dial plate, they can be scribed in
and filled with black ink. Or, "Chart-
Pak" cellulose tape may be used for
the lines. Black dabs are used for the
numbers. After the dial plate is com-
pletely, spray it with a coat of clear lacquer to preserve the calibrations.

If a Colkine "BP" line receiver or trans-
mitter, or LWM-2 transmitter, is avail-
able, the VFO in it can be used as a
calibration source for the VFO in the
LWM-3. Simply set the Colkine gear
dial to the 6-kilocycle intervals, starting
at 1.25 megacycles, pick up the signal
in a monitoring receiver, set the LWM-3
VFO to zero beat with it, and mark the
calibrations on the dial.

The crystal oscillator can also be
checked in the same manner as the
VFO. A grid dip meter was used first.
THE LWM-3 (Continued from page 5)

to arrive at the proper coil and capacitor settings in the oscillator tuned plate circuits, especially when using the 2nd harmonic of the crystal frequency for 14, 21 and 28 megacycles.

When the receiver wiring is completed a 455-kilocycle signal is connected to pin 7 of V4A, a bias battery of -3V is connected from ground to the junction of C12 and R12, and the IF transformers T1 and T2, roughly tuned to provide maximum output. The signal generator is then connected to the plate of V4A and adjusted until some signal can be heard through the IF strip. At this frequency T1 and T2 are readjusted to give maximum output.

The signal generator is then connected to pin 7 of V4A and set for 3 megacycles. Transformer T1 is adjusted roughly for maximum output. The input is then changed to both 2.96 and 3.15 megacycles, and T1 is adjusted to give a uniform response over this frequency band.

Now, select the desired 950-kilocycle tuning range from table III CRYSTAL 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 unloading input jack (J1) and tune the VFO dial to 150.

Start with the highest frequency range of 295 to 297 megacycles — insert the 295- to 297-megacycle crystal into the socket for megacycle crystal, turn on the oscillator and adjust the signal generator to yield 295-3 megacycles so that its signal is heard in the LWM-3. Rotate the EXCITER TUNE control to maximum signal strength. Next, adjust the tuning stage to obtain Lo1 and Lo2 until a signal peak is heard with the slug pulled nearly out of the click to a maximum of the local oscillator mechanism. This adjustment assures close tracking of these circuits over 28.0 to 28.7-megacycle range (positions 8 to 11).

Next, set the bandwidth to position 6 or 7 and the tuning dial and signal generator to 21.3 megacycles. Adjust trimmer C40 and C50 for maximum signal after first junking the signal with the EXCITER TUNE control. Then turn to position 9 and set the VFO and signal generator to 28.7 megacycle. Peak the EXCITER TUNE control and trimmers C50 and C51. Repeat the procedures in position 11 of the megacycles and C45 and C50. Finally, align these circuits in positions 8 to 11 of the megacycles, using EXCITER TUNE, and C40 and C50.

The received signal is maintained at the same dial calibration points, when switching from lower band to upper, by switching the VFO frequency through the use of diode C45 and capacitor C50 at the same time the IF frequency is switched. Hook up an AM and near the center of the dial range the AM will be present even with no longer heard. Switch B5 is then changed to switch B1 and receive the line or carrier is adjusted until either sideband can be heard with the signal generator on click to a maximum of the local oscillator mechanism. The calibration of the VFO may be repeated with C40 to compensate for the slight change caused by the adjustment of C40.

With the transmitter completed B5 may be turned to "tune" and, with microphone gain at zero and the voltmeter at maximum, the diode will key up. If any modulation is heard the 0-200 dial on the plate meter should be adjusted. This is done by adjusting G2, the grid current control, driven by the edge of the dial plate. Adjustment of calibration points.

DIAL PLATE and chassis details are shown in this view. Dial plate rotates about 330 degrees for 140-degree rotation of tuning capacitor. Black dots are used to mark 0-200 on the dial plate, identification of panel controls and their positions. Rubber grommet driver the edge of dial plastic cover for adjustment of calibration line of 100-kilocycle calibration points.
MOBILE MOUNTING RACK used by WEWFIH for his LWM-3 transceiver. Vertical brackets and cross member are sheet aluminum of facial/1/2 of an inch thick. Mounting area is 4 3/16-inch thick aluminum 10 1/2 inches long and 1 3/4 inches wide. Standard 3 1/4-inch butt type lugs 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 B, 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. WEWFIH 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 WEWFIH has been able to maintain a contact from Chicago to New York on 7700 kilocycles. The main advantage of the low power, however, is in talking over very short distances, mobile to mobile, with no receiver overload difficulties, or unnecessary QRM.  

WEWFIH 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 the project.  

However, the completed LWM-3 transceiver delivers performance comparable to line commercial equipment; costing several times the $150 to $250 in parts (depending on the exactness of your junk box) required. Moreover, the LWM-3 is a literal "gold mine" of design, circuit, mechanical, and constructional ideas.
SIXTEEN TYPES of General Electric’s COMPACTRON multi-function de-
vices are now being supplied to man-
ufacturers of electronic equipment.
They are appearing in new television and home radio receivers, Hi-Fi ampli-
fiers, and even in amateur radio gear.
The new Hammond RX-96 SSB exci-
ter has 6G10 and 6G11 tubes in it.
A typical short wave receiver re-
quires about one-third fourth of the
versatile Compactron devices than con-
ventional receiving tubes. In addition,
they cost less per function.

Basic specifications of the sixteen
types are given below. Note that up to
four circuit functions can be performed
by Compactron devices having com-
linations of diodes, triodes and pen-
toids. G-E HAM NEWS will publish
additional data — and circuits too —
as more Compactron devices become
available.

| CONDENSED SPECIFICATIONS OF CURRENT G-E COMPACTRON* DEVICES |
| --- | --- | --- | --- |
| TYPE | DESCRIPTION | CHARACTERISTICS SIMILAR TO | BASE | HEAT |
| 1A20 | HV Diode | 12J2 High-Voltage Rectifier | 12DD | 1.25V 0.2A | 1.9 3 |
| 2A42* | HV Diode | 3A3 High-Voltage Rectifier | 12DG | 2.3V 0.2A | 1.9 3 |
| 6AG11 | Diode-Base-Triode Twin Triode | 6AG8 Triode Section plus 6A28 Triode-Pentode | 12A8 | 0.15V 0.15A | 1.9 3 |
| 6A31 | Diode-Triode-Triode Pentode | 6A80 Triode Section plus 468X Triode-Pentode | 12AP | 0.1V 0.15A | 3 2.25 |
| 6BR1 | Triple Triode | 12A50 Triode Sections | 12BY | 0.18V 0.2A | 1.9 3 |
| 6BR3 | TV Gating Diode | 6A44-D5B TV Gating Diode | 12BL | 0.15V 0.15A | 1.9 3 |
| 6BR7 | Single Diode | 12A50 Triode Sections | 12BP | 0.18V 0.2A | 1.9 3 |
| 6C10* | Triode-Pentode | 12A50 Triode Sections | 12CQ | 0.50V 0.50A | 1.9 3 |
| 6C12* | Triode | 6A30 Triode Section | 12CY | 0.18V 0.2A | 1.9 3 |
| 6C17 | Diode-Triode-Triode | 6A30 Triode Section | 12B4 | 0.18V 0.2A | 1.9 3 |
| 6C11 | Single Diode Pentode | 6A30 Triode Section | 12B5 | 0.18V 0.2A | 1.9 3 |
| 6C55 | Beam Power Pentode | 6A30 Triode Section | 12B4 | 0.18V 0.2A | 1.9 3 |
| 6G7* | 8610-E High-Gain Preamplifier | 6A30 Triode Section | 12B4 | 0.18V 0.2A | 1.9 3 |
| 6H11 | Triode Section Preamplifier | 6A30 Triode Section | 12B4 | 0.18V 0.2A | 1.9 3 |

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

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