

50-Mc. S.S.B. with the Collins KWM-1

V.H.F. Service with All Original Operating Conveniences

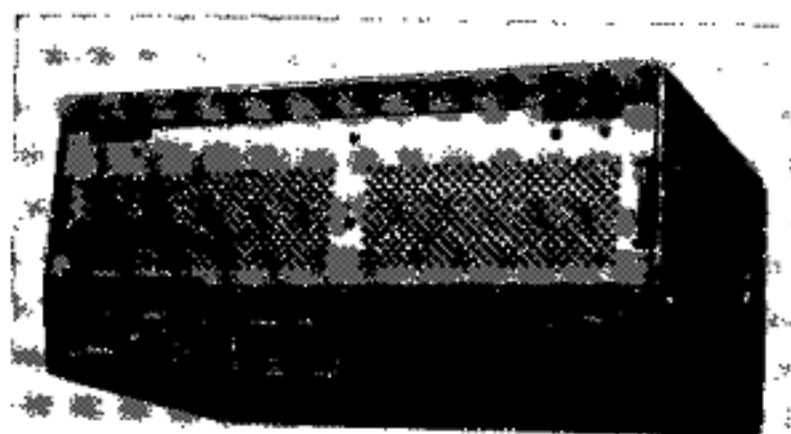
BY R. H. BAHNEY,* W8WM

CONVERSION of the Collins KWM-1 for s.s.b. reception and VOX transmission on 50 Mc. is entirely feasible. The method described here makes available the operating features of the KWM-1 on 50 Mc., and the modifications required are of such a minor nature that they have little effect on the original equipment.

External power may be used for the 50-Mc. accessories, or all but the heater current can be obtained from the KWM-1 supplies. When reasonable precautions are taken with the 50-Mc. outboard gear, the s.s.b. signal transmitted and the performance in receiving are comparable in every way to the admirable qualities of the original equipment on 10, 15 and 20 meters.

The block diagram, Fig. 1, shows how it is done. Built into a single outboard unit are a 50-Mc. converter for reception, and a mixer, driver and amplifier for 50-Mc. s.s.b. output. A crystal oscillator on 28.7 Mc. running continuously furnishes the heterodyning voltage for both transmission and reception at 50 Mc. The KWM-1 serves as a tunable i.f. on reception and as a source of s.s.b. excitation on transmitting, tuning 21.3 to 21.5 Mc. in both instances. This gives tracking coverage in the KWM-1 manner from 50.0 to 50.2 Mc. Other crystals can be obtained to increase this coverage, of course. When the dial reads zero the frequency is 50.0 Mc., and at 100 the frequency is 50.1. The receiving converter has a 6AG5 r.f. stage, and a 6U8 pentode mixer. The triode section of the 6U8 is the crystal oscillator. The transmitting mixer is a 6AG7. It is followed by another 6AG7 amplifier and a pair of 6146s in the final stage.

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Rear view of the KWM-1 showing the fitting added at the lower right, to take off the four connections for the 50-Mc. conversion unit.

When separate power supplies are used for the 50-Mc. unit no permanent modifications need be made in the KWM-1, though convenience is served if the four connections which must be made are brought out on a power fitting installed on the rear wall of the unit, as shown in the photograph. The points of connection are readily accessible when the bottom cover is removed and the relays involved can be identified by referring to the bottom view photograph (Fig. 5-1) in the KWM-1 instruction book.

Leads are bypassed with 0.001 capacitors at the power connector. They are as follows:

- 1 — Ground on Receive — 7th contact on Relay K_1 .
- 2 — 260 volts on Receive — 1st contact on Relay K_3 .
- 3 — 260 volts on Transmit — 3rd contact on Relay K_3 .
- 4 — 260 volts, Transmit and Receive — 2nd contact on Relay K_3 .

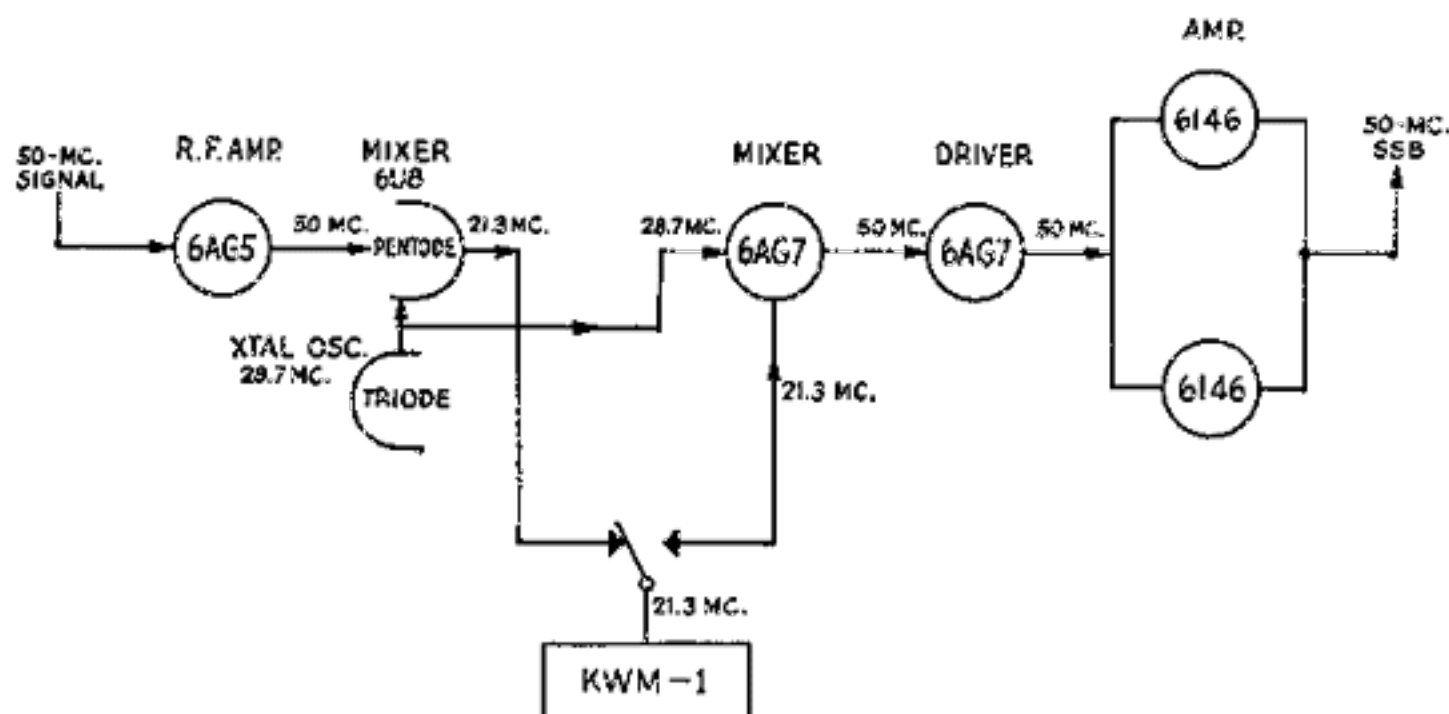


Fig. 1 — Block diagram of the outboard unit for 50-Mc. operation with the KWM-1. A continuously-running oscillator on 28.7 Mc. provides injection for both receiving and transmitting mixers.

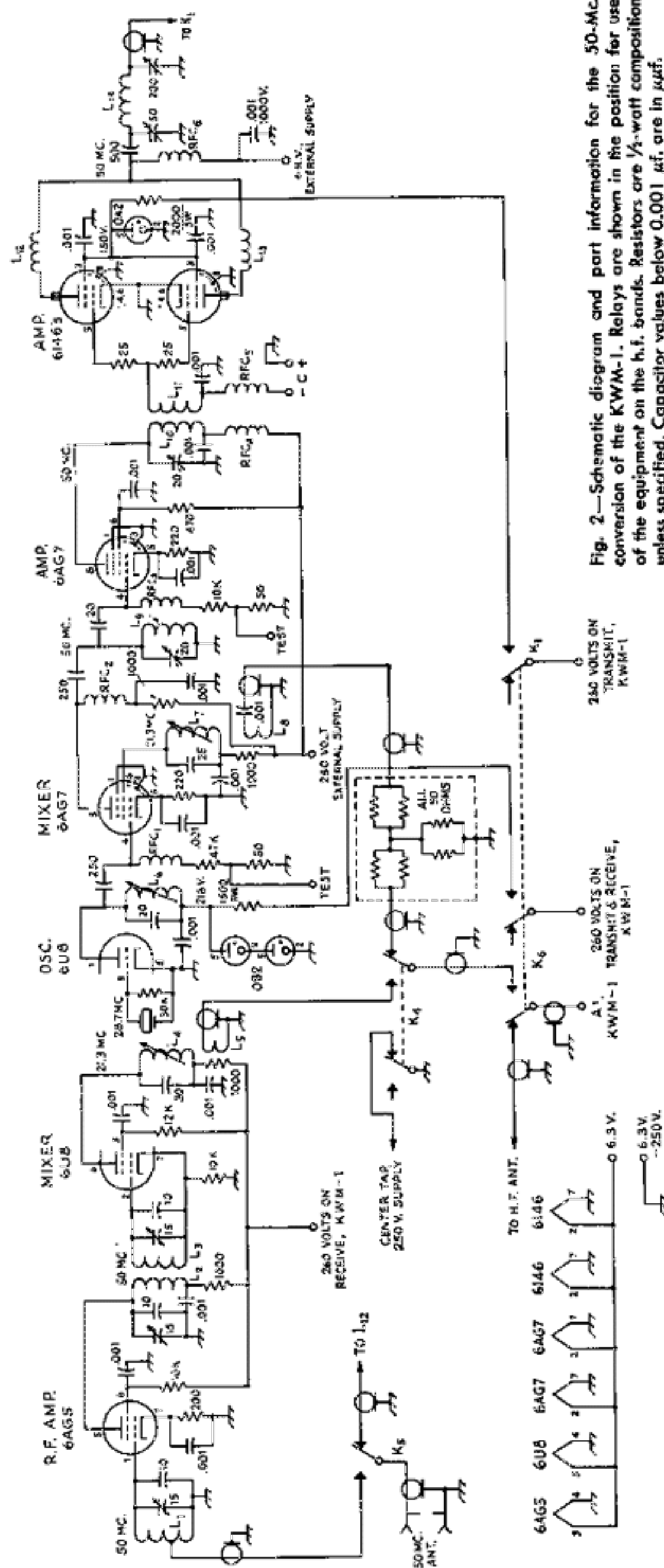


Fig. 2—Schematic diagram and part information for the 50-Mc. conversion of the KWM-1. Relays are shown in the position for use of the equipment on the h.f. bands. Resistors are $\frac{1}{2}$ -watt composition unless specified. Capacitor values below 0.001 μ f. are in μ mf.

K₁—D.p.d.t. a.c. relay; see text.

K₂—S.p.d.t. a.c. relay; see text.

K₃—Coaxial relay with 2 sets of auxiliary contacts.

L₁—6 turns No. 20 tinned, $\frac{1}{2}$ -inch diam., $\frac{3}{4}$ inch long. Tap at 2 turns.

L₂, L₃—8 turns like L₁, $\frac{3}{4}$ inch long.

L₄, L₇—10 turns No. 24 d.c.c., close-wound on $\frac{3}{8}$ -inch iron-slug form.

L₅—3 t. No. 24 d.c.c. at B-plus end of L₄

L₆—8 turns, like L₁

L₈—3 turns No. 24 d.c.c. at B-plus end of L₇.

L₉, L₁₀—7 turns like L₂.

L₁₁—2 turns No. 20 insulated, interwound in B-plus end of L₁₀.

L₁₂, L₁₃—5 turns No. 20 tinned, $\frac{1}{4}$ -inch diam., $\frac{3}{4}$ inch long.

RFC₁—RFC₂, ind.—7- μ h. solenoid r.f. choke (Ohmite Z-50).

RFC₃—21- μ h. solenoid choke (Ohmite Z-28).

Resistors in attenuator—50-ohm, 1-watt, noninductive.

The Circuits

Referring to the schematic diagram, Fig. 2, the received 50-Mc. signal enters the 6AG5 amplifier through a tuned circuit, L₁. Inductive coupling, L₂L₃, transfers the amplified signal to the grid of the 6U8 pentode, the plate of which is tuned to 21.3 Mc., the intermediate frequency. Injection at 28.7 Mc. from the crystal oscillator in the triode portion is coupled through stray and inter-electrode capacitance. Output at 21.3 Mc. is inductively coupled to the "A1" terminal of the KWM-1. The amplifier and mixer circuits for receiving are powered from the 250-volt circuit of the KWM-1 that is hot only on receiving. The oscillator section takes its power from the KWM-1 lead that is hot on both transmit and receive. The oscillator voltage is maintained at 216 volts by two OB2 regulator tubes. This was found necessary to eliminate a slight change in voice pitch at the start of each period of transmission, when voice control is used.

In transmitting the 28.7-Mc. energy is capacitively coupled to the grid of the 6AG7 mixer. The 21.3-Mc. s.s.b. signal from the KWM-1 is link-coupled to the screen circuit, L₇. A simple attenuator having two 50-ohm carbon resistors in parallel in



Outboard unit for 50-Mc. operation with the KWM-1 designed by W8WM.

each leg is inserted in the line to the mixer, to put some load on the KWM-1, and still not overdrive the mixer screen. The KWM-1 gain is operated just barely open.

The 50-Mc. energy resulting from the mixing action in the 6AG7 is taken from the plate circuit and capacitively coupled to the grid of a second 6AG7, this one an amplifier. Its plate circuit is inductively coupled to the grids of the two 6146s in the final amplifier. Note that resistors are used in the grid leads and parasitic-suppression chokes in the plate leads of the 6146s. The value of the grid resistors was quite critical, and any lesser value allowed the amplifier to take off on its own.¹

Other circuits were tried for driving the final amplifier, but capacitive coupling turned out to be inefficient because of the high input capacitance of the tubes in parallel. Cathode injection was tried in the mixer, but better results were achieved with the screen injection shown.²

Plate voltage for the 6AG7s and the 6146s is taken from an external supply. The screen voltage for the 6146s is obtained from the KWM-1 at "200 volts on Transmit" and is reduced to 150 volts by an 6A2 regulator tube, as seen in Fig. 2. A 6.3-volt supply for the heaters and for relays K_4 and K_5 is shown in Fig. 3. The transformer center tap is also utilized for a variable bias supply for the 6146s, by means of a reversed filament transformer and a selenium rectifier.

Control Circuits and Relays

Switching the KWM-1 from 10-15-20 operation to 6 is accomplished with the coaxial relay, K_6 , in Figs. 2 and 3. This relay is energized when S_1 on the 6-meter equipment (Fig. 3) is closed. Auxiliary contacts on this relay also close the

¹ The builder has a choice here. He can neutralize the 6146 amplifier for complete stability (and probably eliminate the need for a 6AG7 amplifier stage) or he can lower the power sensitivity of the 6146s by inserting resistors in the grid circuit as shown. — Editor.

² In congested areas where TVI is likely to be encountered the builder of this equipment should check carefully for unwanted mixer products. The second harmonic of the KWM-1 output is on 42.6 Mc., in the i.f. range of most current TV sets. The second harmonic of the crystal-controlled oscillator is on 57.4 Mc., a sensitive spot in Channel 2. Unwanted products of the various harmonics may fall in other TV channels. If TVI from these sources appears the unwanted frequency causing the TVI can be trapped out most readily at the mixer plate or first amplifier grid circuit. — Editor.

"200 volts on Transmit" and "200 volts on Receive and Transmit" to the 6-meter rig. This was necessary to prevent the regulator tubes in the 6-meter unit from operating when the KWM-1 is used on its intended bands.

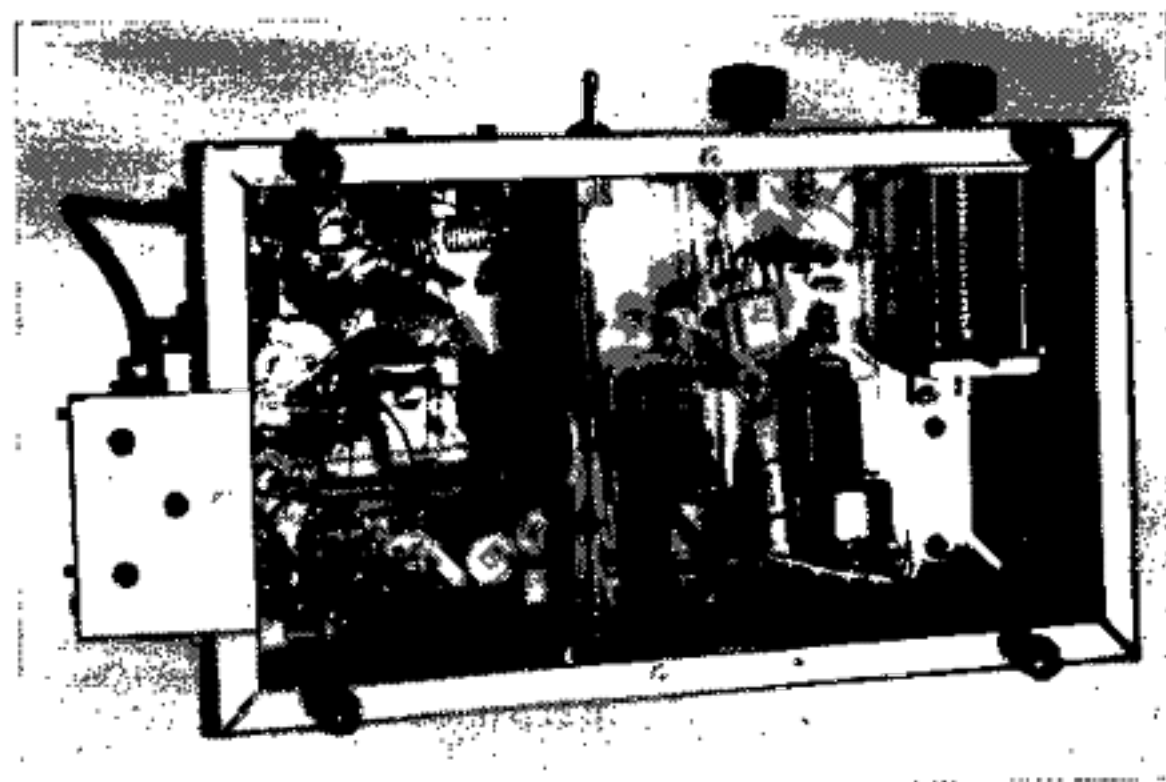
Relay K_4 (Fig. 2) switches the coax attached to "A1" on the KWM-1 from converter output to transmitter input, as well as closing the center tap of the 250-volt power supply to ground on transmit. Relay K_5 throws the 6-meter antenna from converter input to transmitter output. Relays K_4 and K_5 are in series across the 6 volts d.c., and are energized on receive by the "Ground on Receive" contact on the VOX-operated relay, K_1 , in the KWM-1. These low-voltage relays were placed in series in preference to using one double-pole double-throw relay, to simplify wiring and cut down losses due to long coaxial leads inside the chassis. Further, on VOX operation, time is required for sequence operation of two relays, and we desired the least possible additional delay in voice-control work. Relays K_4 and K_5 can be any small relays that will work on low-voltage a.c. Their coils can be wired in series or parallel, depending on their voltage ratings.

With this method no trouble has been experienced, even on one-word breaks. The bias and plate voltage remain on the final during reception, and the screen voltage is applied on transmitting by relay K_3 in the KWM-1.

Construction

Front and bottom views of the outboard 6-meter unit are shown in the photographs. The chassis is 3 by 7 by 12 inches. The two 6AG7s are side by side at the left rear. They tend to look like one large tube in the picture. The 6AG5 and 6U8 are at the left front. The crystal is on the front of the chassis, with the regulator tubes on a raised portion in back of it. The T-pad attenuator is in a separate ventilated aluminum box on the left end of the chassis, with the coax for the 21.3-Mc. energy from relay K_4 running into it. The coaxial antenna socket is just in back of the upper end of the coax. From left to right on the front wall are the tuning adjustments (screw-driver-type trimmers) for the antenna, r.f. and mixer circuits in the converter. The toggle switch is S_1 , and the two knobs are for the tuning and loading capacitors in the amplifier.

Bottom view of the 50-Mc. conversion unit. Ventilated compartment at the left contains the attenuator for the 21-Mc. s.s.b. signal from the KWM-1.



The bottom view shows the unit tipped back from the front-view position. The 6146s and associated components are in the large compartment at the right, with a shield running the full width of the chassis to isolate them from the rest of the layout. The mixer and r.f. amplifier components can be seen at the upper left, with the oscillator slug-tuned coil just below the converter antenna coil, at the left. In the lower right corner of the smaller compartment are the rectifier and electrolytic capacitors of the bias supply, and the transmitter mixer coil. The driver coil, L_{10} , is at the left edge of the smaller compartment just below the center.

The original intention was to boost the output of the crystal oscillator with a 6AG7 amplifier, but tests showed the output of the 6L8 triode to be adequate. The 6AG7 was then put to work as a 50-Mc. driver, which was definitely needed with the amplifier design as shown.¹ This explains the unconventional location of the driver. The writer suggests that the mixer and driver positions be interchanged, thus allowing a shorter lead from L_{11} to the final grids.

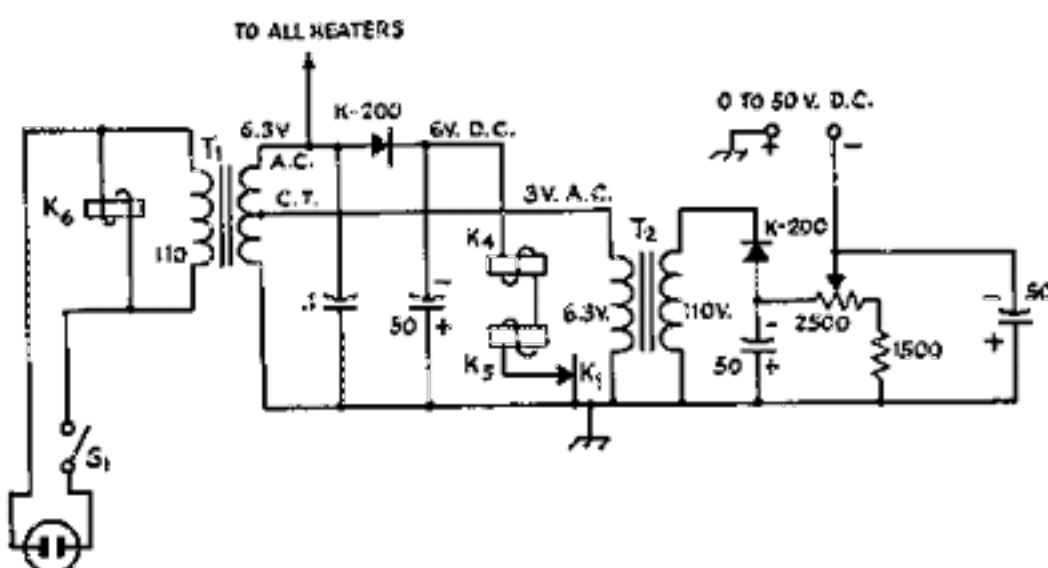
Adjustment

The receiving converter should be set up for use by first resonating the oscillator plate coil, L_6 , at 28.7 Mc. and the mixer plate coil at 21.3

Mc. with the aid of a grid-dip meter. Make sure that the crystal oscillator is working by listening for its note at 28.7 Mc. on a communications receiver. If it is working it should now be possible to hear signals on 50 Mc. The tuned circuits should be peaked for best reception. As the tuning range is limited to 200 kc. there is no problem in getting uniform response, so the stages may be peaked for maximum gain. If other crystals are to be used, and uniform response across more than 200 kc. is desired, a flat-topped response may be obtained by stagger-tuning the coils L_2 , L_3 and L_4 . L_1 should be adjusted for best signal-to-noise ratio, rather than maximum gain. The crystal frequency should be exactly right, if the calibration accuracy of the KWM-1 is to be preserved on 50 Mc.

The transmitter adjustment should start with no plate voltage on the final. Put the KWM-1 in the tune position, at 21.3 Mc. With the VOX gain full counterclockwise, (PTT on) advance the microphone gain to obtain a reading of S3 with the meter switch in the P.A. position. Couple a grid-dip meter (in the power-indicating position) to the 6AG7 mixer screen coil, L_7 , and tune L_7 for maximum indication at 21.3 Mc. With voltage on the 6AG7s, 50-Mc. power should be available at L_9 . Tune L_9 and L_{10} for maximum 50-Mc. indication.

Fig. 3—Heater and bias supply and relay circuits for the 50-Mc. conversion. Relay contact marked K_1 is the ground-receive contact (contact No. 7) on the KWM-1 relay, K_1 .



Next place the KWM-1 in the off position. Connect a dummy load to the final amplifier output (a 50-ohm carbon resistor will do) and adjust the final plate circuit to resonance at 50 Mc. with the aid of a grid-dip meter. Now put the KWM-1 on s.s.b., and with the VOX gain at 12 o'clock adjust the bias supply resistor to give about 40 volts at the grid of the final. Voltage can be applied to the final plates at this point, and there should be no plate current, as the screen voltage is not on. Turning the VOX gain full counterclockwise will apply screen voltage, and less than 50 ma. should appear in the plate circuit of the final. Adjust the bias resistor to obtain a reading of 30 ma.

The tune position of the KWM-1 can now be tried and the microphone gain advanced for an increase in the final plate current. All tuned circuits should be given a final repeaking at this point. Next, remove plate and screen voltage from the final and check for r.f. feedthrough at the final plate coil, L_{12} . Should there be appreciable feedthrough of r.f., neutralization may be necessary, though an increase in the value of the grid resistors may prevent instability by lowering the amplifier's power sensitivity.¹

The transmitter may now be operated by placing the KWM-1 in the s.s.b. position, setting the VOX gain at 12 o'clock and advancing the microphone gain to obtain about 200 ma. on the final plate meter on voice peaks.

Using the KWM-1 Power

For those who wish to delve deeper into the labyrinth of the KWM-1, the method outlined below requires only a 6.3-volt heater supply. All

other power is supplied by the KWM-1. The writer suggests, however, that the 50-Mc. outboard gear be first adjusted with external power supplies, as described previously. To use the KWM-1 power entirely, proceed as follows:

1) Remove the 0A2 regulator tube from the outboard unit, and short out the 2000-ohm resistor in the final screen lead.

2) Disconnect the bias supply, and connect to the minus 65-volt bias supply in the KWM-1.

3) Connect the "260 volts on Transmit" to the plate and screen leads of the 6AG7s, in place of the external 250-volt supply.

4) Bring out the high-voltage lead from the KWM-1 and use it in place of the 500-volt external supply.

Below are tabulated readings for the KWM-1 in normal service and with the 50-Mc. outboard unit, for operation with the KWM-1 supplies and from external power. Readings are for the 6146s at peak load.

	Plate Volts	Plate Ma.	Screen Volts	Bias Volts
KWM-1 on 21 Mc.	750	40-200	200	60
Using external power:				
KWM-1	820	40-60	250	60
50-Mc. outboard unit	500	30-200	150	40
Using KWM-1 power:				
KWM-1	680	35-55	240	60
50-Mc. outboard unit:	680	40-200	240	60

It can be seen that when the KWM-1 power is used the voltage on the 6146 plates drops to 680 and the screen voltage to 240. In practice this ratio seems to work out well. As this was being written the 50-Mc. s.s.b. unit had been in daily use for some time, with no adverse effects on it or the KWM-1.

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