

Figure 1-1. Collins KW-1 1000 Watt Amateur Transmitter

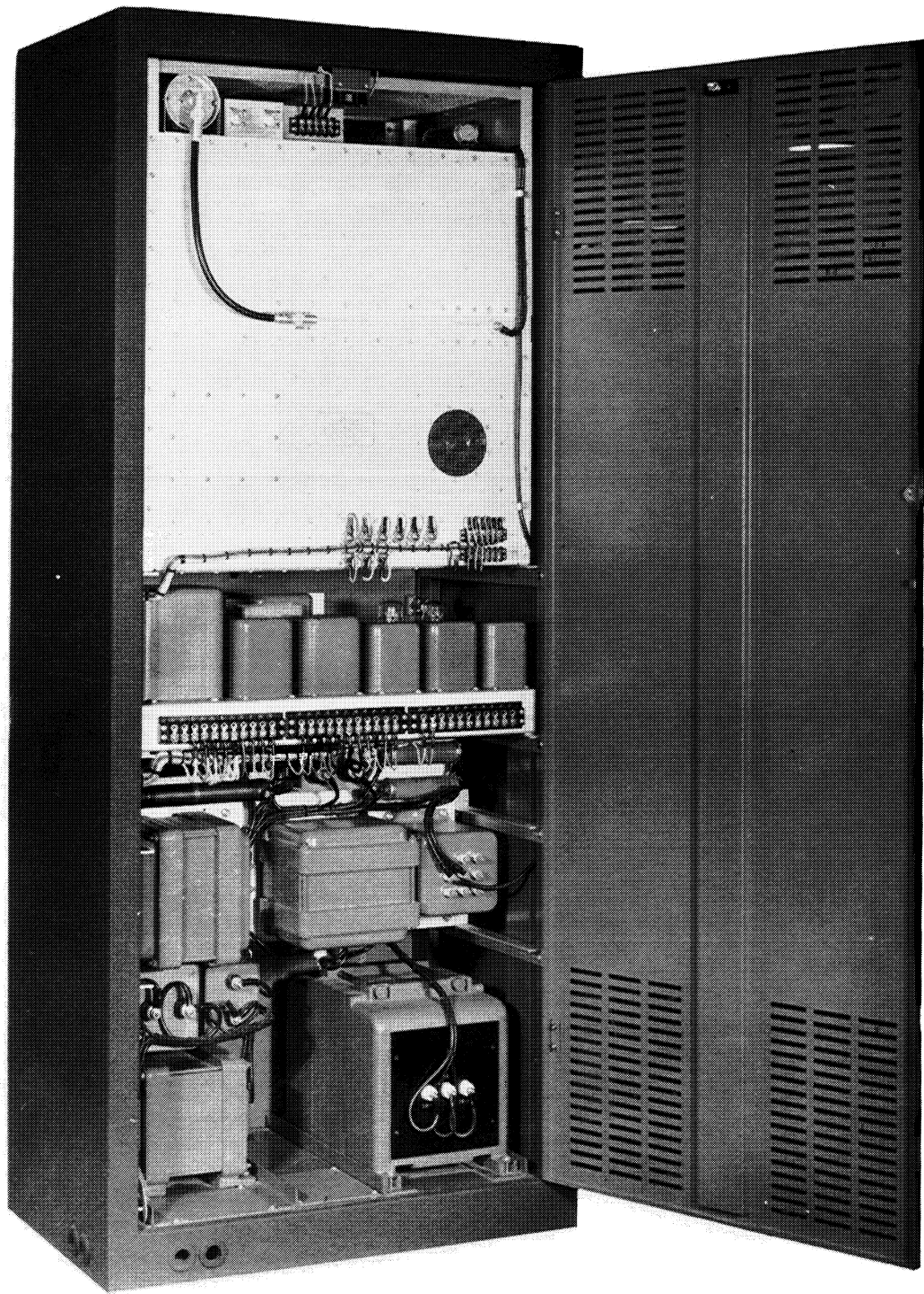


Figure 1-2. Collins KW-1 Transmitter, Rear View

SECTION I

GENERAL DESCRIPTION

1.1. GENERAL DESCRIPTION

The Collins KW-1 amateur transmitter is a vfo controlled, bandswitching, gang tuned, high power phone and cw transmitter. Power amplifier input is 1000 watts on the 80, 40, 20, 15, 11, and 10 meter bands, and 500 watts on the 160 meter band. Other features include TVI reduction, cw receiver muting for a 75A receiver, cw sidetone oscillator, a blower for additional cooling, door interlock switches, fuses, and an overload relay. Direct indication of frequency is provided on the accurately calibrated exciter tuning dial for all bands. Only the scale for the band in use is visible. The stable, hermetically sealed oscillator is followed by suitable buffer and multiplier stages to provide adequate excitation on all bands. The oscillator and multiplier stages are permeability tuned by powdered iron cores. The rf driver stage is tuned by a variable air capacitor. Tuning of the exciter is gauged on one control. When the frequency selector dial is tuned to any frequency, the entire rf section, with the exception of the power amplifier output circuit, is tuned for operation at that frequency. The pi-L output circuit is designed to work into an unbalanced resistive load of 52 ohms with maximum standing wave ratio of 2.5 to 1.

Either crystal or high impedance dynamic microphones may be used. A 600 ohm phone patch is incorporated in the speech amplifier. Increased side-band power without overmodulation is made possible by a speech clipper followed by low-level low-pass and high-level low-pass filters. The push-pull 810 modulator tubes fully modulate the power amplifier when running 1000 watts input.

The KW-1 transmitter is self-contained in a heavy gauge cabinet 28 inches wide, 18 inches deep, and 66-1/2 inches high. All that is needed to place the transmitter in operation is a 52 ohm antenna system, a power source, and a microphone or telegraph key.

The description and function of each part is included in the parts list in section 5 of this book. Section 3, operation, lists the function of all controls. Trimmer adjustment is included in maintenance, section 4.

1.2. GENERAL DESCRIPTION OF RF SECTION

The 70E-14 oscillator unit, shown in figure 6-10, consists of a 6BA6 oscillator, V-001, and a 6BA6 isolation stage, V-002. The oscillator was baked

dry before sealing and should not be opened. If service other than tube replacement is required, it should be removed from the transmitter and returned to the factory as outlined in the maintenance section of this book. High oscillator stability is made possible through regulation of the filament voltage as well as the plate voltage. 0C3/VR105 gas type regulator tubes, V-202 and V-203, control the oscillator plate supply voltage. A 6A10 current regulator tube, V-201, is used in series with the filaments.

The 6BA6 oscillator tube, V-001, the 6BA6 isolation stage, V-002, and the 6AK6 buffer, V-301, always operate on 160 meters. The 6AQ5 first multiplier operates either straight through on 160 meters or as a doubler to 80 meters. The 6AQ5 second multiplier, V-303, is used only as a 40 meter doubler. The 6AQ5 third multiplier doubles to 20 or triples to 15 meters. The 6AQ5 fourth multiplier doubles to 10 meters. Double tuned circuits are used in the frequency multiplier stages to provide the necessary sub-harmonic and higher-harmonic attenuation.

Output from the proper multiplier stage is selected by S-301G to drive the 807 rf driver stage, V-204. This stage is always operated as a straight amplifier to drive the 4-250A power amplifier grids.

V-101 and V-102, the parallel 4-250A power amplifier tubes, operate at inputs up to 1000 watts on all bands except 160 meters. On the 160 meter band the power amplifier is designed for inputs up to 500 watts. A pi section followed by an L section forms the power amplifier output circuit. A high voltage gap is provided to ground from the output of each section. L-117 is a static drain choke. A variable, high vacuum capacitor is used for plate tuning in the pi network output circuit. This network matches between the power amplifier plate impedance and the input impedance of the L matching section. The matching section output impedance is 52 ohms and is designed to feed a standard 52 ohm transmission line such as RG-8/U. Use of the L section in addition to the pi section aids in decreasing the amplitude of the higher harmonics to a very low value. A gear-driven band switch ganged with the band switches of the exciter selects the proper value of inductance in the L and pi sections. While the pi-L network used in this application will match into a wide range of load impedances, for reasons of harmonic attenuation and high voltages the standing-wave ratio must be held to 2-1/2 or 1 or less. Use of RG-8/U coaxial line is recommended for all transmission lines within the building.

Power and control leads from the exciter and power amplifier TVI shield are brought out through low-pass filters, thus reducing radiation of undesired signals from these leads. All controls normally operated for transmission and reception are available on the front panel.

During open key conditions with cw emission, a blocking bias is applied through a wave shaping filter to overcome the excitation voltage and cut off the plate current on buffer V-301 and first multiplier V-302. Plate current to the remaining doubler stages, the rf driver and the power amplifier is reduced to a safe value by fixed bias voltage.

1.3. GENERAL DESCRIPTION OF AUDIO SECTION.

The speech amplifier may be used with either crystal or high-impedance dynamic microphones. Suitable filtering is used at the input of the speech amplifier to keep rf voltages out of the first audio grid. The microphone input, J-401, incorporates provisions for push-to-talk operation. A 600 ohm phone patch input, J-402, is included in the second audio stage input circuit. When used with a remote line, an isolation transformer must be used to separate the dc voltages involved.

A peak clipper consisting of a series diode gate limits the amplitude of the input signal to a predetermined value so as to provide a high average level of modulation without danger of overmodulation. The output of the second audio stage is coupled to the series clipper, V-402, through C-407. R-408 and R-411 serve as clipper input and output resistors. The clipper plates are connected together and tie to the clipping level control, R-410, through series resistor R-409. R-410 acts as a voltage divider between the B+line and ground. The exact point at which clipping will occur is set by R-410 which controls the positive potential applied to the plates of V-402.

Under static conditions a dc voltage is tapped off on voltage divider R-410 and applied through R-409 to both plates of V-402. Current flows from the power supply through voltage divider R-410 and the 330,000 ohm series resistor R-409. The current then divides through the diode sections of V-402 and their 220,000 ohm load resistors, R-408 and R-411. Under static conditions, the dc voltage drop maintains all parts of the clipper circuit at a positive potential above ground. The voltage drop between the plate and cathode of each diode section of V-402 is very small compared to the drop across 330,000 ohm resistor R-409 in series with the plates. Each diode's plate and cathode are therefore maintained at approximately equal potentials as long as there is current flow between them. Clipping does not occur until the peak audio input voltage reaches a value greater than the static voltage at the plates of the diodes.

Assume that voltage divider R-410 has been set to a point that will give 4 volts at the plates of V-402. When the peak audio input voltage is less than 4 volts, both halves of V-402 conduct at all times. As long as V-402 conducts, its resistance is very low compared with the 330,000 ohm resistor, R-409, in

series with the plates. Whenever a voltage change occurs across input resistor R-408, the voltage at all of the tube elements increases or decreases by the same amount as the input voltage change, and the voltage drop across R-409 changes by an equal amount. This action permits all of the tube elements to be at the same dc level above ground. As long as the peak input voltage does not exceed the value of 4 volts to which the plates were assumed to have been set by R-410, V-402 acts merely as a conductor and the output cathode is permitted to faithfully follow all voltage changes at the input cathode.

If under static conditions 4 volts appears at the diode plates, then twice this voltage or 8 volts will appear if one of the diode circuits is opened so as to interrupt its current flow and remove its dc load from the circuit. As long as one of the diode sections continues to conduct, as is always the case with a clipper of this type, the voltage at the diode plates cannot rise above twice the voltage to which it was set by R-410. In our example this voltage cannot rise above 8 volts. If the audio input voltage through C-407 is increased to any peak value between zero and plus 4 volts, the first cathode of V-402 will increase by the same amount to the proper value between 4 and 8 volts. The remaining tube elements will assume the same value as the first cathode. However, the plates of V-402 cannot increase more than 4 volts above their 4 volt static level. When the input voltage through C-407 increases to more than plus 4 volts, the input cathode potential increases to more than 8 volts and the plates and output cathode increase to 8 volts and remain there until the input voltage through C-407 drops below 4 volts.

When the input voltage swings in a negative direction, it will subtract from the 4 volt drop across R-408 and decrease the voltage on the input cathode by an amount equal to the input voltage. The plates and output cathode will follow the voltage level at the input cathode as long as the input voltage does not swing more than 4 volts negative. If the input voltage changes more than 4 volts in a negative direction, the plates will also become negative. The potential at the output cathode will follow the voltage at the input cathode and decrease from its normal value of 4 volts positive until it reaches zero potential. As the input cathode voltage decreases to less than zero, the plates will follow. However, the output cathode, which is connected to ground through R-411, will stop at zero potential as the plate becomes negative. Conduction is impossible under these conditions. The output cathode remains at zero potential until the voltage at the input cathode swings back up to zero.

The voltage across output resistor R-411 follows the voltage variations across input resistor R-408 as long as the input voltage does not swing to a peak value greater than the static voltage at which the plates are set by voltage divider R-410. When the static plate voltage is set at 4 volts, input voltage peaks

greater than 4 volts in either direction cause the output voltage to swing 4 volts in the direction of the peak and remain at that level during the time the peak is above 4 volts. Effective clipping may thus be obtained at any desired level.

The square topped audio waves generated by the clipper are high in harmonic content, but these higher order harmonics are greatly reduced in amplitude by a low-level speech filter consisting of C-409, L-401, and C-410, which attenuates all audio frequencies above 3000 cycles. A 12AU7 phase inverter follows the speech filter and excites a pair of 6B4G tubes used as a driver stage. The driver provides sufficient grid swing for the push-pull 810 tubes in the class B modulator. A second low pass filter, C-503, L-503, and C-504, at the output of the modulation transformer further attenuates the high frequencies caused by the speech clipper and eliminates distortion products generated in the speech amplifier subsequent to the low-level speech filter. The modulator provides sufficient power to fully modulate 1000 watts input to the power amplifier.

When the transmitter is keyed on cw, a sidetone oscillator, V-406, is also keyed to provide an audio sidetone signal that may be used for monitoring purposes as described in paragraph 2.14. Each time the key is pressed, the voltage drop across the cathode of V-406B is made available for receiver muting as described in paragraph 2.13.

1.4. GENERAL DESCRIPTION OF POWER SUPPLIES

The bias and plate power required by the transmitter is furnished by a bias supply, two low voltage supplies, and a high voltage supply. Improved voltage regulation in the high voltage supply has been obtained by connecting a 0.15 mfd capacitor across the input choke. This capacitor resonates with the choke at approximately 120 cycles at no-load conditions. The resulting parallel tuned circuit presents a high impedance to the lowest (120 cycle) ripple frequency and aids in limiting the no-load voltage. In the interest of safety, electrical interlocks are used to disable the 2500 volt and 500 volt supplies when the rear door, upper front panel, or lower front panel is opened. As shown in figures 6-2, 6-3, and 7-2, high voltage shorting switches, S-501 and S-502, are provided to mechanically short circuit the high voltage filter capacitors after the electrical interlocks have operated. This protection is in addition to the usual bleeder resistor. By making the proper connections, as outlined in paragraph 2.6, the transmitter can be operated from a source of either 115 or 230 volts. Overload protection is assured by the use of an overload relay in the power amplifier filament center tap and fuses in the bias and low voltage supplies as well as the ac line. Power for the control circuit is furnished by the bias supply, making operation of the transmitter impossible unless bias voltage is present. The bias supply rectifier is a slow-heating type and acts as

a time delay device to prevent operation of the control circuit and application of plate voltage to the 872A mercury vapor rectifiers before they have reached operating temperature. When 872A tubes are first placed in the transmitter, they must be operated with only the filaments energized for 10 minutes to allow the mercury to condense to the bottom of the tube envelope.

1. 5. KW-1 SPECIFICATIONS

Power Amplifier Input	1000 watts (500 watts on 160 meters)
RF Output Impedance	52 ohms
Maximum Permissible Standing Wave Ratio	2.5 to 1
Amateur Bands Covered	160, 80, 40, 20, 15, 11, 10 meters
Frequency Range	1800-2000 Kc 3500-4000 Kc 7000-7300 Kc 14000-14400 Kc 21000-21450 Kc 26960-29700 Kc
Emission	Voice or cw
Frequency Control	70E-14 Master Oscillator, 1675 to 2050 Kc
Microphone	High impedance crystal or dynamic
Phone Patch Impedance	600 ohms, unbalanced to ground
Weight	600 pounds
Dimensions	66-1/2" high, 28" wide, 18" deep
Circuit Protection	Overload relay, fuses, high voltage arc gaps
Tuning Controls	Bandswitching, frequency selector, PA tuning, PA loading

Other Controls

Filament switch, filament voltage adjustment, plate switch, overload reset switch, overload relay adjustment, send-standby-calibrate switch, emission selector switch, tune-operate switch, meter switch, power amplifier excitation control, modulator bias control, audio driver bias control, clipping level, audio gain control, bandspread adjustment.

Accessories Required

High impedance microphone, telegraph key, 52 ohm antenna, wiring to power source.

Power Source

230 v, 3 wire, 50/60 cycle, single phase, grounded neutral; or 115 v, 2 wire 50/60 cycle, single phase.

Typical Power Demand,
CW

Key closed	2000 w
Key open	800 w
Calibrate, key closed	660 w
Standby	500 w

Typical Power Demand,
Phone

100% sine wave mod.	3100 w
No modulation	2280 w
Calibrate	780 w
Standby	600 w

Tube Complement:

See following page.

Tube Complement:

V-001	6BA6	Oscillator
V-002	6BA6	RF Isolation Stage
V-101	4-250A	Power Amplifier
V-102	4-250A	Power Amplifier
V-201	6A10	Filament Regulator
V-202	OC3/VR-105	Voltage Regulator
V-203	OC3/VR-105	Voltage Regulator
V-204	807	RF Driver
V-301	6AK6	RF Buffer
V-302	6AQ5	{ 160 Meter Buffer,
		{ 80 Meter Doubler
V-303	6AQ5	40 Meter Doubler
V-304	6AQ5	{ 20 Meter Doubler,
		{ 15 Meter Tripler
V-305	6AQ5	10 Meter Doubler
V-401	12AX7	Audio Amplifier
V-402	6AL5	Audio Clipper
V-403	12AU7	Phase Inverter
V-404	6B4G	Audio Driver
V-405	6B4G	Audio Driver
V-406	12AU7	Sidetone Oscillator
V-407	5V4G	Bias Rectifier
V-408	5V4G	300 Volt Rectifier
V-409	5V4G	300 Volt Rectifier
V-410	5R4GY	500 Volt Rectifier
V-501	872A	2500 Volt Rectifier
V-502	872A	2500 Volt Rectifier
V-503	810	Modulator
V-504	810	Modulator

SINCE PUBLICATION OF THIS BOOK, THE
6AK6 TUBE USED IN THE RF BUFFER STAGE,
V-301, HAS BEEN REPLACED BY A 6BA6 TUBE.

SECTION II

INSTALLATION

2.1. UNPACKING

Each KW-1 transmitter is partially disassembled before shipment. The parts are packed in a number of wooden crates. To avoid damaging the equipment while opening the crates, use a nail puller rather than a hammer or bar. Remove the packing material and carefully lift the units out of their cases. Search all of the packing material for small packages. Inspect each unit for loose screws or bolts and be certain that all controls such as switches and dials are in good mechanical order. All claims for damages should be filed promptly with the transportation company. If a claim is to be filed, the original packing cases and material should be preserved.

2.2. LOCATION OF THE TRANSMITTER

When deciding on a location for the transmitter, give consideration to its 600 pound weight and to the location of power, antenna, and ground connections. There should be a clearance of approximately four feet behind the transmitter to allow room for installation of units and their removal for servicing. Entrance of external wiring is discussed in paragraph 2.4.

2.3. REPLACEMENT OF UNITS REMOVED FOR SHIPPING.

The rf unit, figure 6-4, the speech amplifier chassis, figure 6-11, and all tubes except those with metal shields, have been removed from the transmitter and packed separately for safety in shipping. The cabling diagram, figure 7-3, and the photographic illustrations will be of assistance when replacing and connecting these components in the transmitter. Wires and cables that were removed from the units to which they connect were tagged before shipment. Should any of these tags become lost, refer to the cabling diagram, figure 7-3, for assistance in identifying the leads.

The following installation procedure is recommended:

- a. Place the transmitter cabinet in its permanent location.
- b. Remove all cords, tape, and wooden blocks that were installed to hold the transmitter parts in place for shipment.
- c. Remove the upper front panel (the one with handles) from the rf unit by pulling straight out on the two handles. Do not remove any screws

on this panel. Slide the rf unit, figure 6-4, into position from the front of the transmitter. Do to the bulk of this unit, two men will be required to lift it into position. Figure 6-2 and 6-3 show the rf unit in place. Line up the tapped holes in the rf unit with the holes in the mounting rails. Insert the proper screws through the rails and into the tapped holes in the rf unit.

d. Replace the two 4-250A power amplifier tubes, V-101 and V-102 and the neutralizing capacitor, C-106, in their proper positions as shown in figure 6-5. Replace the metal strap that connects to the 4-250A plate terminals the top of C-106, and one end of C-105 as shown in figure 6-5. Replace the metal screen in front of the 4-250A tubes and tighten the 18 mounting screws to hold it in position as shown in figure 6-2.

e. The 807, 6A10, and two OC3/VR105 tubes have been removed from the exciter chassis. Refer to figure 6-7 and replace these tubes in their sockets through the inspection hole to the left of the name plate. The 807 plate lead has been tied underneath the power amplifier chassis for safety in shipping. After the tubes have been installed, replace the inspection plate and tighten the 10 screws as shown in figure 6-4.

f. A 5R4GY, two 6B4G and three 5V4G tubes have been removed from the speech amplifier chassis, figure 6-11. Replace these tubes in their sockets. Open the cabinet door wide and slide the speech amplifier chassis, figure 6-11, into position from the rear of the cabinet. Figures 6-2 and 6-3 show the chassis in place. Position the chassis on its mounting rails so the holes in the rails line up with the holes in the lower lip of the chassis. Insert the proper bolts up through the mounting rails and the chassis lip. Secure the bolts on the inside of the chassis with the nuts provided for this purpose.

g. Install two 872A rectifier tubes and two 810 modulator tubes behind the lower front panel as shown in figure 6-2.

h. Refer to the illustrations as well as to the tags on the cables in order to make all connections between units. There are four connections to be made to E-110 at the top of the rf unit as shown in figure 6-3. The long black wire taped in the rear of the rf unit should be run down the side of the cabinet between the cabinet and the mounting rails. Connect the end of this wire to terminal 7 on L-503 as shown in figure 6-3. On early models of the KW-1 it will be necessary to connect two wires to interlock S-602. This interlock is shown in figure 6-2. The two wires originate under the speech amplifier chassis. Slide the tinned end of one wire into each of the two holes at the rear of S-602. Tighten the two screws at the side of the interlock to hold the wires in place. Similar interlocks are used on the rear door and the upper front panel.

i. Shorting bar S-502 at the rear of the transmitter cabinet, figure 6-3, has been removed for shipment. Shorting bar S-501, figure 6-2, has not been removed and should be referred to when installing S-502. The free end of each bar should rest against the secondary terminals of the modulation transformer. If a shorting bar rests on the cabinet floor, loosen the single bolt holding the bar so that it may be moved to its proper position. Tighten the mounting bolt. When either the rear door or lower front panel is opened, the electrical door interlocks operate and turn off the 500 volt and 2500 volt power supplies as shown in figure 7-2. A shorting bar then falls against the modulation transformer secondary terminals and shorts the 2500 volt wiring to ground.

2.4. EXTERNAL CONNECTIONS

The external connections described below may be brought into the transmitter through any of the large grommets in the cabinet base or through a hole in the floor beneath the transmitter. The two access plates illustrated in figure 6-3 may be removed to provide admittance to the cabinet base. All external wiring is connected to the transmitter on or above the speech amplifier chassis. Two wiring channels are provided to conduct the wiring from the cabinet base to the vicinity of this chassis. The wiring channels, one of which may be seen in figure 1-2, are located between the chassis supports and the cabinet wall at either side of the rear door. All wiring that is brought into the cabinet base should be routed upward through these channels. A rubber grommet is provided in the cabinet wall near the microphone and phone patch connectors. Two large grommets are located in the cabinet roof directly above the coaxial antenna terminals. Microphone and antenna connections may be brought in through the grommets or through the cabinet base.

2.5. GROUND CONNECTIONS

A ground connection must be provided on the KW-1 transmitter. Bring a number 12 or larger wire into the transmitter from a good ground such as a cold water pipe. Run the wire up the right-hand wiring channel, as viewed from the rear, and connect it to the stud just to the left of terminal board E-202 on the back of the rf unit. This stud is identified in figure 6-3.

2.6. POWER INPUT CONNECTIONS

A 50/60 cycle 115 volt two-wire system or a 50/60 cycle 115/230 volt three-wire single-phase system may be used to power the KW-1. In most installations, regulation of the input voltage will be better when a 115/230 volt source is used. All KW-1 transmitters are wired at the factory for 230 volt operation. The transmitter draws 3100 watts at 100% sine wave modulation.

The primary connections should go from the service outlet directly to the transmitter. Bring the wiring into the cabinet base and up through the wiring channel near terminal board E-401, the terminal board to the left on the rear of the speech amplifier chassis. Make sure plate switch S-401 is in the off position before connecting power to the transmitter.

For 230 volt operation use three number 8 wires. Connect them to terminal board E-401 as shown in figures 7-2 and 7-3. Connect one hot wire to terminal 1 and the other hot wire to terminal 2. The neutral wire goes to terminal 7. The high voltage power transformer, T-503, must be connected for 230 volt operation as shown in figure 7-3. Connect the orange wire to terminal 1, the white-orange wire to terminal 4, the white wire that comes out the end of the cable to terminal 3, and the two white wires that come out the side of the cable to terminal 2. These connections are for 230 volt operation.

For 115 volt operation, use two number 6 wires. Connect them to terminal board E-401 as shown in figures 7-2 and 7-3. Terminals 1 and 2 on E-401 connect together and to the hot wire. Connect the neutral wire to terminal 7. Connect the high voltage power transformer, T-503, for 115 volt operation as shown in figure 7-3. When shipped from the factory the wires to T-503 are tagged for 230 volt operation. Connect the orange wire to terminal 1, the white-orange wire to terminal 3, the white wire that comes out the end of the cable to terminal 4, and the two remaining white wires to terminal 2. These connections are for 115 volt operation.

2.7. ANTENNA CONNECTIONS

Antenna connector E-108 is located on a bracket at the top of the rf unit as shown in figure 6-3. A right angle mating plug for E-108 is included with the transmitter. An additional plug is included for the other end of the cable. Bring a piece of RG-8/U coaxial cable through a grommet on the cabinet roof or in through the base of the cabinet and up the left-hand wiring channel as seen from the rear. Connect the coaxial cable to the E-108 mating plug. Use of RG-8/U coaxial cable is recommended for all transmission lines within the building.

The pi-L output circuit is designed to work into a 52 ohm resistive load. The standing wave ratio must be held to a maximum of 2.5 to 1. Do not attempt to use any antenna or feed system that will result in a standing wave ratio larger than 2.5 to 1. The transmission line must incorporate some method of line balancing in order to match between the unbalanced pi-L output circuit and a balanced antenna system. Section 7 of this book shows some antennas that may be used with this transmitter. The American Radio Relay League Antenna Book contains information on matching coaxial cable feed-lines to balanced antenna systems. The tuned antenna couplers shown in the ARRL Antenna Book

may also be used for coupling to a feed line or antenna; however a method of checking standing wave ratios must be available.

2.8. RECEIVER ANTENNA CONNECTIONS

Receiver antenna connector E-107 is located on a bracket at the top of the rf unit as shown in figure 6-3. A right angle mating plug for E-107 is included with the transmitter. An additional plug is included for the other end of the cable. Bring a piece of RG-8/U or RG-58/U coaxial cable in through the cabinet roof or through the base of the cabinet and up the left-hand wiring channel, as seen from the rear. Connect the coaxial cable to the E-107 mating plug. The other end of the coaxial cable goes to the antenna connections on the receiver. The antenna changeover relay connects the transmitting antenna to the receiver when send-standby-calibrate switch S-204 is in the standby or calibrate positions and to the transmitter when this switch is in the send position.

2.9. MICROPHONE AND PUSH-TO-TALK CONNECTIONS

The microphone and push-to-talk connector, J-401, is located on top of the speech amplifier chassis as shown in figure 6-11. Terminal 1 of J-401 is the audio input. Terminal 2 is the push-to-talk line. If a push-to-talk switch is not available on the microphone, terminal 2 may be disregarded and send-standby-calibrate switch S-204 used to control the transmitter. **TERMINAL 1 IS AUDIO; TERMINAL 2 IS PUSH TO TALK. IF THESE TERMINALS ARE REVERSED WHEN ASSEMBLING THE MICROPHONE PLUG, THE MICROPHONE MAY BE DESTROYED.** The cable that connects to J-401 can be brought into the cabinet through the large rubber grommet near the speech amplifier chassis or through the cabinet base. A mating plug for J-401 is included with the transmitter. Either crystal or high impedance dynamic microphones may be used.

2.10. PHONE PATCH CONNECTIONS.

Phone patch connector J-402 is located on top of the speech amplifier chassis as shown in figure 6-11. Terminal 1 of J-402 is the audio input. Terminal 2 is ground. Bring a twisted pair into the transmitter as outlined in paragraph 2.4. A mating plug for J-402 is included with the transmitter. A 600 ohm load is presented by the phone patch circuit. In order to isolate the dc voltages involved, a 500 ohm or 600 ohm 1 to 1 ratio line to line transformer such as the Stancor A-4407 must be connected between the remote line and phone patch connector J-402. Connect the primary of the transformer across the remote line. Connect the secondary between terminals 1 and 2 of J-402.

2. 11. KEY CONNECTIONS.

Terminals 25 and 26 of terminal board E-403 are used for key connection. This terminal board may be seen in figures 6-3. Bring a twisted pair into the cabinet base and up through a wiring channel. Terminal 25 is ground and should be connected to the base of the key. In order to prevent higher than normal grid currents in the first multiplier and rf buffer stages, do not close the key when operating on phone. The slight spark that occurs at the key may cause clicks in receivers within a few feet of the operating position. This may be prevented by connecting a 2.5 millihenry rf choke in each lead at the key terminals. The rf chokes are used only to prevent local radiation from the key leads and will have no effect on the transmitted signal. Wave shaping of the keyed signals is controlled by keying circuits within the transmitter and will not be effected by the rf chokes.

2. 12. RECEIVER DISABLING CONNECTIONS

The receiver disabling connections, terminals 27 and 28 on terminal board E-403, are connected only to a pair of contacts on the send-receive relay, K-403. When K-403 is in the receive position, these contacts are closed and terminals 27 and 28 on terminal board E-403 are shorted together. Most receivers have a pair of terminals at the rear connected by a jumper that may be opened to disable the receiver. If it is desired to automatically disable the receiver whenever the transmitter carrier is turned on, remove the jumper from the rear of the receiver, bring a twisted pair from the receiver terminals into the transmitter, and connect to terminals 27 and 28 on E-403. Do not attempt to break currents larger than four amperes with this relay.

2. 13. RECEIVER MUTING CONNECTIONS

Collins 75A receivers have provisions for muting the receiver audio system whenever the transmitter key is closed. A small positive voltage is required from the transmitter to silence the receiver. In the KW-1 transmitter this voltage is available between terminals 29 and 30 on terminal board E-403. Terminal 30 is ground. Terminal 29 is at zero potential when the key is open, and approximately 20 volts above ground when the key is closed. If receiver muting is desired, bring a twisted pair from the rear of the receiver into the transmitter and connect to terminals 29 and 30, being careful to observe that terminal 30 is ground.

2. 14. SIDETONE OUTPUT

A sidetone oscillator, V-406, is included in the KW-1 transmitter to provide a keyed audio signal for cw monitoring. Sidetone output connections

are provided on terminal board E-403 located on the rear of the speech amplifier chassis. When the sidetone output is to be used with a Collins 75A receiver, connect terminal 31 (ground) on terminal board E-403 to the ground terminal on the receiver audio terminal strip. Connect terminal 32 on terminal board E-403 to the 500 ohm terminal on the receiver's audio terminal strip. A twisted pair for making these connections may be brought into the transmitter base and through a wiring channel to terminal board E-403. Sidetone output will now be heard from the receiver speaker or earphones whenever the transmitter is keyed. Muting or disabling the receiver during transmitting periods will not prevent the side-tone from being heard.

If it is desired to match the sidetone output into a high impedance source such as the output transformer associated with a small speaker, connect terminals 31 and 32 together. The sidetone output may then be taken from between terminals 32 and 33.

SECTION III

OPERATION

Capital letters are used in this section of the book to indicate lettering that appears on the transmitter panels or chassis.

3.1. FILAMENT SWITCH. See figures 6-1 and 7-2.

As shown in the primary control circuit diagram, figure 7-2, operation of FILAMENT switch S-404 energizes the filament pilot light, the dial lights, all filaments except the modulator tubes (the modulator filaments will be energized if AM-CW switch S-203 is in the AM position), the blower, bias supply, 300 volt supply, and FILAMENT PRIMARY VOLTAGE meter, M-101. The 6A10 filament regulator tube, V-206, holds down the starting current through the filaments of the two 6BA6 tubes in the 70E-14 oscillator unit. The oscillator will begin operation about 40 seconds after the FILAMENT switch is turned on.

3.2. FILAMENT VOLTAGE ADJUSTMENT. See figures 6-1 and 7-2.

The proper tap on auto transformer T-405 can be selected by FILAMENT VOLTAGE control S-403 to apply the correct voltage to the filaments of the power amplifier, high voltage rectifier, exciter, and oscillator tubes. FILAMENT PRIMARY VOLTAGE meter M-101 is connected across the auto transformer output. Whenever the voltage read by this meter is adjusted to 120 volts $\pm 5\%$, the correct filament voltage will be applied. For convenience in wiring, blower B-101 and cw-phone relay K-501 are operated from the auto transformer. When FILAMENT VOLTAGE switch S-403 is in position 3, the auto transformer output voltage is the same as the input voltage. FILAMENT PRIMARY VOLTAGE meter M-101 then reads the line voltage.

3.3. TIME DELAY CIRCUIT.

When the transmitter is first placed in operation or when new 872A mercury vapor rectifier tubes are installed, the filaments should be operated for 10 minutes to condense the mercury to the bottom of the tubes before application of plate voltage. After this initial period, the proper time delay is automatically provided by the slow heating 5V4G rectifier tube used in the bias supply. Send-receive relay K-403 is inoperative in the absence of bias voltage. Plate power cannot be applied until the bias rectifier tube reaches operating temperature and makes bias voltage available for operation of the relay. This method of time delay has the additional feature that the delay period is very short following a momentary power interruption.

3.4. PLATE SWITCH. See figures 6-1 and 7-2.

PLATE SWITCH S-401, located on the transmitter front panel, is in series with the control circuit consisting of the door interlocks, overload relay contacts, and a parallel combination consisting of the microphone push-to-talk switch and a set of contacts that close when the SEND-STANDBY-CALIBRATE switch is in the SEND position. When the PLATE switch and the switches and interlocks in series with it are closed, power is applied to the coil of send-receive relay K-403. In the send (operated) position of send-receive relay K-403, a potential of 300 volts is applied to the exciter, plate contactor K-402 and antenna relay K-101 are closed, the 500 volt power supply is energized, and the receiver disabling contacts are opened. Contacts on the SEND-STANDBY-CALIBRATE switch are connected in parallel with certain send-receive relay contacts in order to apply 300 volts to the exciter and energize the 500 volt power supply for calibration purposes.

3.5. OVERLOAD RESET SWITCH. See figure 6-1 and 7-2.

OVERLOAD RESET S-405 is a momentary-contact switch located on the front panel. When closed, it energizes the reset coil on overload relay K-401 and, if the overload no longer exists, returns the relay to the normal operating position.

3.6. OVERLOAD RELAY ADJUSTMENT. See figures 6-2 and 7-2.

Overload adjustment R-433 is a screwdriver adjustment on overload relay K-401. This relay is located on the speech amplifier chassis behind the lower front panel. Turning the control clockwise will increase the amount of power amplifier cathode current required to open the overload relay. The relay has been set at the factory to open at 600 milliamperes.

3.7. SEND-STANDBY-CALIBRATE SWITCH. See figures 6-1 and 7-2.

The three position SEND-STANDBY-CALIBRATE switch, S-204, is located on the front panel. In the send position a pair of contacts short the microphone push-to-talk switch and another pair of contacts connect the side-tone plate circuit to the 300 volt line, provided that EMISSION switch S-203 is in the CW position. In the CALIBRATE position the exciter 300 volt circuit is completed and the 500 volt power supply is energized. In the STANDBY position all switch contacts are open.

3.8. CW-AM EMISSION SELECTOR SWITCH. See figures 6-1 and 7-2.

All circuit modifications required to change from cw to phone emission are performed by EMISSION switch S-203 located on the front panel. Section

S-203A is not used. Section S-203B connects the keying line to ground through a 10,000 ohm resistor for phone operation. S-203C energizes phone-cw relay K-501 for phone operation. This relay shorts the modulation transformer secondary for cw operation. In the phone (energized) position of K-501 the short is removed from the modulation transformer secondary and the modulator tube filaments are lighted. Switch section S-203D applies 300 volts to the sidetone oscillator in the CW position, provided that SEND-STANDBY-CALIBRATE switch S-204 is in the SEND position. Switch section S-203E connects a 47 ohm resistor in parallel with power amplifier audio screen choke L-201 in the CW position. In order to prevent higher than normal grid currents in the first multiplier and rf buffer stages, do not close the key while EMISSION switch S-203 is in the AM position.

3.9. FREQUENCY SELECTOR CONTROL. See figures 6-1 and 7-3.

The frequency selector control tunes the 70E-14 oscillator unit, all doubler stages, and the 807 rf driver stage. Only the band in use is visible on the main frequency indicating dial. A red pointer on the band-spread dial, located just below the main dial, subdivides the large divisions of the main frequency indicating dial by means of a mechanical bandspread arrangement. If any difficulty is encountered in combining the two dial readings, start at the low end of an amateur band (with the transmitter turned off) and tune slowly up the band. Notice the correlation between the two dials. Stop at the 50 or 100 kilocycle points and read the two dials, noticing how the bandspread dial interpolates between the divisions of the main tuning dial. The bandspread calibration may be adjusted as outlined in the maintenance section of this book.

3.10. TUNE-OPERATE SWITCH. See figures 6-1 and 7-2.

TUNE-OPERATE switch S-202 on the front panel connects the 500 volt line to power amplifier screen resistor R-102 in the OPERATE position. In the TUNE position 20,000 ohm resistor R-220 and 5,000 ohm resistor R-219 are connected in series to form a bleeder resistor. The power amplifier screen circuit connects to the junction of the two resistors. Under these conditions the screen voltage is reduced to about 50 volts under key-down conditions and the power amplifier plate current is limited to a safe value.

3.11. METER SWITCH. See figures 6-1 and 7-3.

METER SWITCH S-201 and 0-1 milliampere CURRENT-VOLTAGE METER M-102 may be used to check any one of the following circuits:

<u>Switch Position</u>	<u>Full Scale Meter Reading</u>	<u>Normal Reading</u>
300 V	500 V	280 V
500 V	1000 V	540 V
807 Grid	5 Ma	2 to 5 Ma
807 Plate	100 Ma	20 to 80 Ma
PA Grid	50 Ma	18 to 22 Ma

3.12. PA EXCITATION CONTROL. See figures 6-1 and 7-3.

Power amplifier excitation may be changed by varying the screen voltage applied to the 807 rf driver stage, V-204. PA EXCITATION control R-226 on the transmitter front panel acts as a voltage divider to increase or decrease the rf driver screen voltage and thereby change the rf power applied to the power amplifier grid circuit. Normal power amplifier grid current is 22 milliamperes. This may be reduced to 18 milliamperes for CW operation.

3.13. MODULATOR BIAS CONTROL. See figures 6-2 and 7-3.

MODULATOR BIAS control R-427 located on the speech amplifier chassis is one of four series resistors used as the bias supply bleeder. This screwdriver adjustment has been set at the factory to bias the modulator grids to approximately -65 volts. The bias is adjusted to give 50 milliamperes modulator static plate current.

3.14. AUDIO DRIVER BIAS CONTROL. See figures 6-2 and 7-3.

AUDIO DRIVER BIAS CONTROL R-428 located on the speech amplifier chassis is one of four series resistors used as the bias supply bleeder. This screwdriver adjustment has been set at the factory to bias the audio driver grids to -60 volts.

3.15. CLIPPING LEVEL. See figures 6-2 and 7-3.

Speech clipping level is adjusted by CLIPPING LEVEL control R-410 on the speech amplifier chassis. This resistor controls the positive voltage applied to the plates of V-402. The screwdriver CLIPPING LEVEL control is adjusted at the factory to clip at 100% voice modulation. If this control is to be adjusted, an oscilloscope must be available for checking modulation percentage. Clipping level is controlled by CLIPPING LEVEL CONTROL R-410 but the amount of clipping is controlled by the AUDIO GAIN control as outlined in paragraph 3.16. CLIPPING LEVEL control R-410 may be adjusted as

follows: Modulate the transmitter with a sine wave of about 1000 cycles and observe the modulation percentage on an oscilloscope. Vary the AUDIO GAIN control until the oscilloscope indicates approximately 90% sine wave modulation. CLIPPING LEVEL control R-410 should then be adjusted until a barely noticeable flattening of the peaks occurs. The CLIPPING LEVEL is now set to clip at 90% sine wave modulation. This setting will cause clipping at approximately 100% modulation when speech is used.

3.16. AUDIO GAIN CONTROL. See figure 6-1 and 7-3.

AUDIO GAIN control R-404 controls the amount of grid swing applied to the second audio amplifier, V-401B. R-404 will control the modulation percentage up to the point where clipping occurs. When the audio level is high enough to cause clipping, an increase in the AUDIO GAIN control setting cannot increase the modulation percentage but will increase the amount of clipping and the sideband power. Since heavy clipping results in less desirable quality, even though the intelligibility may be better for working through interference, the signal should be monitored and the AUDIO GAIN control adjusted to the point which produces a balance between more audio power and good quality.

3.17. BAND SWITCH. See figures 6-1 and 7.3.

Only the front panel BAND SWITCH need be operated to change bands. Switch sections S-301A through S-301F connect the required multipliers into the circuit. S-301G selects output from the proper multiplier stage to drive the 807 stage, V-204. Switch section S-301H parallels a portion of the 807 screen voltage circuit with resistors to reduce the input and output of this stage on all bands except 15 and 10 meters. Switch section S-102A parallels the 807 plate tuning capacitor, C-126B, with capacitor C-126A on the 80 and 160 meter bands. S-102B selects the proper 807 plate coil and padding capacitor for the band in use. The proper L section inductance is selected by switch section S-101A while S-101B selects the required pi section inductance and switches in the required number of antenna loading capacitor sections.

3.18. POWER AMPLIFIER PLATE TUNING AND ANTENNA LOADING CONTROLS. See figures 6-1 and 7-4.

The power amplifier is tuned to resonance by POWER AMPLIFIER PLATE TUNING control C-103. There are 1400 dial divisions on this control. Antenna loading is increased by increasing the dial reading of the ANTENNA LOADING CONTROL, thereby decreasing the capacitance of antenna loading capacitor C-101/C-102. With a pi-L output network of the type used in the KW-1 transmitter, any adjustment of the POWER AMPLIFIER LOADING CONTROL will detune the output network and cause the power amplifier

plate current to soar. Care must be exercised to keep the power amplifier tuned to resonance whenever the ANTENNA LOADING control is adjusted. If any extensive tuning is to be done, turn the TUNE-OPERATE switch to the TUNE position. This does not reduce the power amplifier plate voltage but reduces the screen voltage and limits the plate current to a safe value. If the power amplifier is loaded to approximately 120 milliamperes while the TUNE-OPERATE switch is in the TUNE position, the power amplifier plate current will be approximately 400 milliamperes when the TUNE-OPERATE switch is turned to the OPERATE position. The ANTENNA LOADING control should be set at half scale when the tuning-loading operation is started. Do not load the power amplifier to more than 200 milliamperes on the 160 meter band.

High voltage gaps are provided between the output network and ground. An arc-over across one of these gaps probably indicates that the antenna system is not presenting the proper load to the transmitter. To prevent arc-over, the standing wave ratio must be held to less than 2.5 to 1. Do not increase the settings of the arc gaps above the values recommended in the maintenance section of this book.

3.19. STARTING THE EQUIPMENT. See figures 6-1 and 7-2.

- a. Turn PLATE SWITCH S-401 to OFF.
- b. Close the transmitter rear door and front panels.
- c. Turn TUNE-OPERATE switch S-202 to the TUNE position.
- d. Turn on FILAMENT switch S-404.
- e. Turn FILAMENT VOLTAGE switch S-403 to the position that causes FILAMENT PRIMARY VOLTAGE meter M-101 to read 120 volts $\pm 5\%$.
- f. Operate the BAND SWITCH to the desired band.
- g. Operate the frequency selector to the desired frequency.
- h. Select the desired type of emission with EMISSION switch S-203.
- i. Operate METER SWITCH S-201 to the PA GRID position, causing CURRENT OR VOLTAGE meter M-102 to read power amplifier grid current.
- j. Operate SEND-STANDBY-CALIBRATE switch S-204 to the CALIBRATE position.

k. Adjust PA EXCITATION control R-226 to give 22 milliamperes grid current on M-102.

l. Operate SEND-STANDBY-CALIBRATE switch S-204 to the SEND position.

m. Turn PLATE SWITCH S-401 ON.

n. Operate the POWER AMPLIFIER PLATE TUNING and ANTENNA LOADING controls as outlined in paragraph 3.18 to give approximately 120 milliamperes power amplifier plate current at resonance, (60 MA on 160).

o. Turn TUNE-OPERATE switch S-202 to the OPERATE position.

p. Adjust power amplifier plate current to 400 milliamperes (200 MA for 160 meters) and grid current to 22 milliamperes.

q. The transmitter is now tuned up and operating at full power. If a microphone push-to-talk switch is available, it may be used to energize the transmitter when the PLATE switch is ON and the SEND-STANDBY-CALIBRATE switch is in the STANDBY position. When the microphone push-to-talk switch is not used, the transmitter will normally be controlled by SEND-STANDBY-CALIBRATE switch S-204.

3.20 TELEVISION INTERFERENCE

The design of the KW-1 transmitter is such that spurious radiation has been reduced to a very low value, particularly on television frequencies.

The rf unit is completely shielded in a metal box inside the main cabinet. All circuits passing through this shield are well filtered for attenuation at television frequencies. These features minimize direct radiation from the cabinet and external leads.

Spurious radiation from the antenna is attenuated by careful design of the rf circuits. There are always three or more tuned circuits at the carrier frequency. The variable vacuum capacitor used for power amplifier plate tuning provides a low-impedance circuit to ground at television frequencies.

In the power amplifier the use of a pi section followed by a L section is very effective in reducing harmonics of the carrier frequency. To this is added the attenuation of the 35C-2 low pass filter. Use of a coaxial

transmission line from the transmitter to the transmitting antenna is recommended.

However, when a television receiver is operated within a few hundred feet of a powerful transmitter, even though the transmitter does not radiate an interfering signal on the TV channel, it is to be expected that interference may be caused by lack of enough selectivity in the television receiver input circuit.

In such cases, improve the receiver selectivity by installing a high pass filter at the receiver antenna terminals. If a booster is used at the television receiver, install the high pass filter at the antenna input terminals of the booster and use very short leads between the booster output and the television receiver input.

The following publications contain information on the elimination of television interference at the receiver: The Radio Amateur's Handbook, published by The American Radio Relay League, West Hartford, Connecticut; and Television Interference, published by Remington Rand Laboratory of Advanced Research, South Norwalk, Connecticut.