section 3
principles of operation

3.1 GENERAL

The 30S-1 RF Linear Amplifier consists of a 1-stage linear amplifier and the necessary power supplies. It is capable of the maximum legal input power in the amateur bands between 3.5 and 29.7 MHz. It operates in either CW or SSB service with any exciter (such as KWM-1, KWM-2, or 32S-( )) capable of 80 watts pep output. In addition, the amplifier may be operated outside the amateur bands at any frequency between 3.4 and 30 MHz by retuning its input circuits.

3.2 BLOCK DIAGRAM

Figure 3-1 is a block diagram of the 30S-1 RF Linear Power Amplifier. The power amplifier stage is a single ceramic tetrode that is cathode driven. The control grid is grounded for rf by capacitor C104, and the screen grid is connected directly to ground. The plate power supply, the screen grid power supply, and the control grid bias supply are connected in series. The junction between the plate power supply and the screen grid power supply is grounded through the screen current meter shunt. This arrangement places the cathode at negative potential with respect to the screen grid. The bias supply is connected between the cathode and the control grid. Provisions are included for rf negative feedback to improve linearity and for automatic load control to prevent overdrive.

3.3 INPUT CIRCUITS

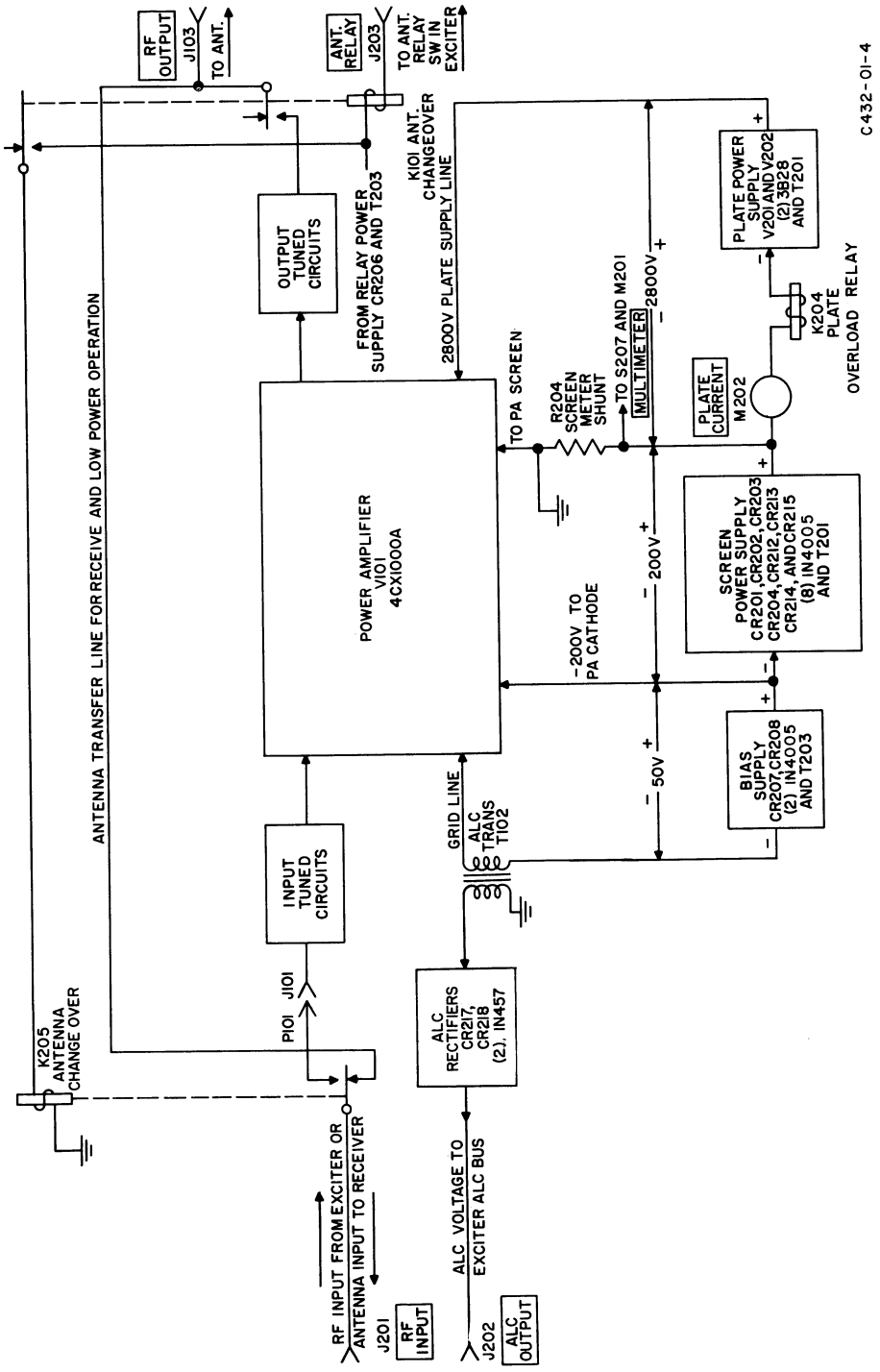
Refer to figures 3-1 and 7-1. Pi-network broad-tuned circuits and the interconnecting rf feedline match the 50-ohm input impedance to the cathode impedance, which is approximately 100 ohms. The 20.5-foot length of cable (furnished) is necessary between the 32S-1( ) (or KWM-2) driver and the 30S-1 input circuits. This is due to the necessity of having an even multiple of 180-degree phase shifts between driver plate and power amplifier grid. The cable length and the 30S-1 input circuits together accomplish this. An even multiple of 180-degree phase shifts is necessary because the varying drive intensity causes a change in the pa cathode impedance, which is translated to a shift in reactive impedance at the driver plate. The shift in reactive impedance, at the driver plate, results in phase modulation of the driver and increases the total overall distortion of the system. A 2.5-foot additional length of cable is required to bring the total interconnecting cable length to 23.0 feet for use with the KWM-1 as a driver. Drive power required for maximum legal input on SSB is 80 watts pep nominal.

3.4 OUTPUT CIRCUITS

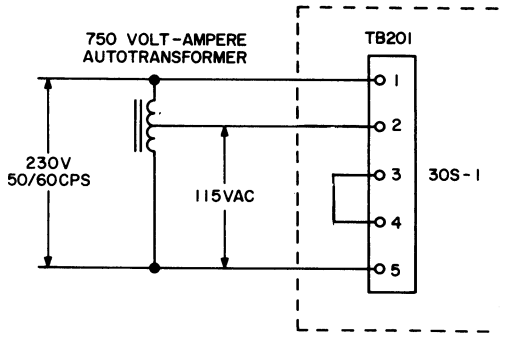
The plate circuit of the power amplifier is tuned by a pi network consisting of C120, L109, L104, C121, and C122. Capacitors C121 and C122 are ganged together and are adjusted by front panel control (LOADING) for matching the pi-network circuit to the impedance of the antenna and feed system in use. Capacitor C120 may be adjusted by the TUNING control on the front panel for resonating the tank circuit to the frequency in use. Output from the plate tank circuit is connected through the contacts of antenna changeover relay K101 to the antenna when the control circuits are switched to transmit function.

3.5 POWER SUPPLY CIRCUITS (Refer to figures 3-1, 3-2, 3-3, and 7-1.)

Separate plate, screen, and bias voltage sections and three ac heater sections are included in the 30S-1 power supply. The power supply may be connected to a 115-volt, single-phase or a 230-volt, 3-wire, single-phase source. The 230-volt, 3-wire, single-phase source. The 230-volt, 3-wire connection is recommended. When only a 2-wire 230-volt source is available, connect a 230- to 115-volt autotransformer rated at 750 volt-amperes as shown in figure 3-2. Always connect the 30S-1 to a low-resistance earth ground using the ground connection on the rear of the 30S-1. The high-voltage plate transformer, T201, has two primary windings that are connected in

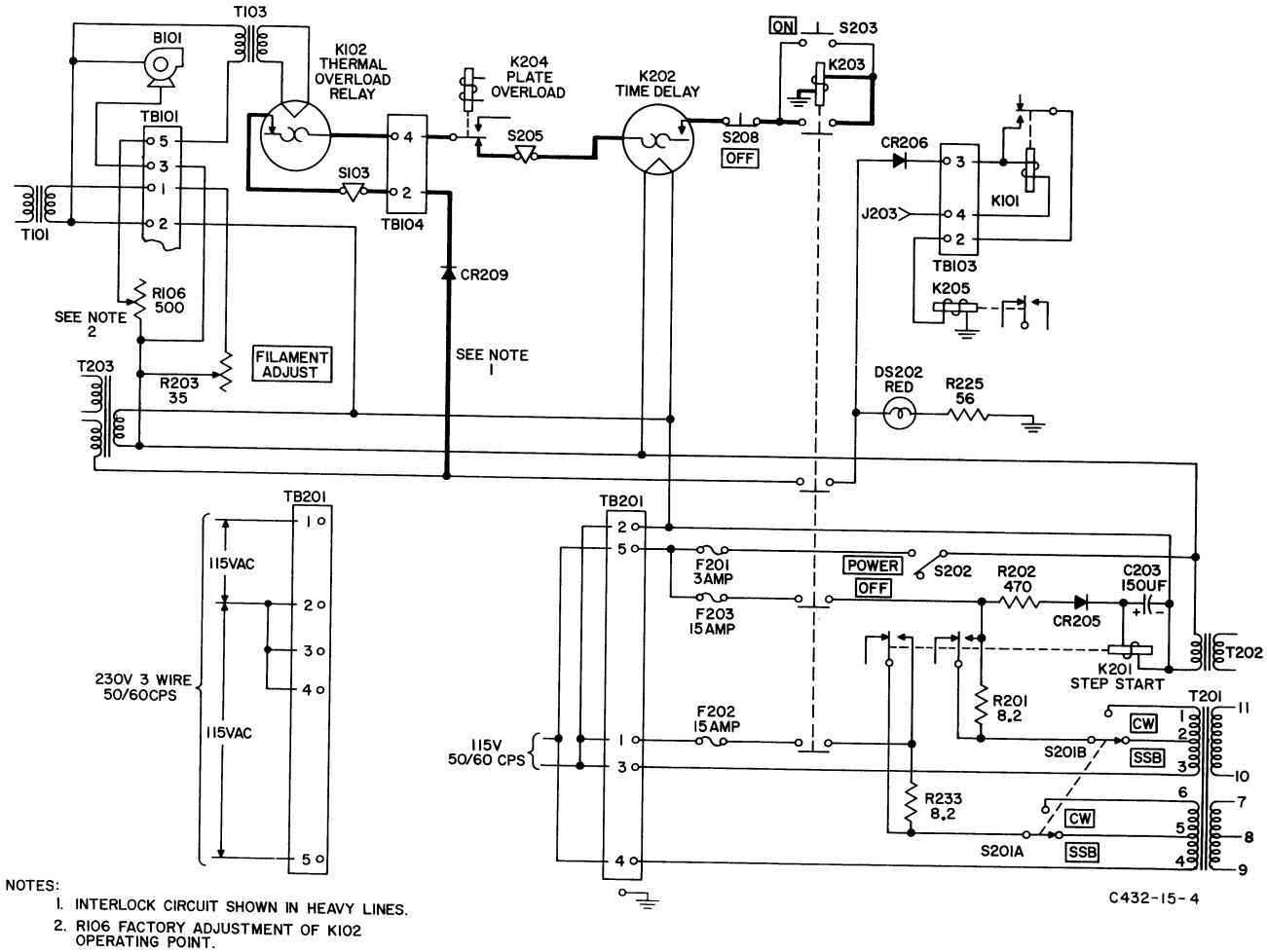


30S-1 Block Diagram
Figure 3-1



TP3-5301-019

Connections for 2-Wire, 230-Volt Operations
Figure 3-2



Control and Interlock Circuits, Simplified Schematic Diagram
Figure 3-3

parallel for 115-volt operation, and in series for 230-volt operation. The 12-volt ac winding of bias supply transformer T203 supplies current for the pilot lamps in the two meters and the pilot lamps which light the two dials. This transformer winding also supplies current to be rectified for dc relay power. The bias winding of T203 is connected to CR207 and CR208 in a full-wave rectifier circuit. This circuit provides grid bias voltage for the power amplifier. The heater of the 3-minute time-delay relay is supplied power from the 115-volt ac connections, which also furnish power to the high-voltage rectifier filament transformer, T202. Transformer T103 supplies ac power for the heater of the thermal overload relay, K102. Taps on the primary of the high-voltage plate transformer, T201, are switched to provide the different voltages necessary for the power amplifier in CW or SSB operation. Power amplifier bias voltage is taken from the bias supply bleeder resistors for CW or SSB operation. The screen supply rectifiers are eight type 1N4005 silicon diodes in a full-wave bridge circuit. Each rectifier diode is paralleled with a 0.001-μF capacitor to protect it from high transient voltages.

3.6 PROTECTIVE CIRCUITS (Refer to figure 3-3.)

3.6.1 Safety Interlock Circuits

The top cover and the power supply front door operate safety interlock switches for operator protection. When the top cover is opened, interlock switch S103 breaks the circuit to the coil of plate contactor K203. This removes all high voltages from the 30S-1. When the power supply compartment (lower) door is opened, interlock switch S205 breaks the same circuit and removes all high voltages. Both interlock switches are mechanically coupled to shorting switches which short out the high-voltage filter capacitors at the same time the interlock circuit opens. Rf compartment interlock switch S102 is mechanically coupled to shorting switch S101, and power supply compartment interlock switch S205 is mechanically coupled to shorting switch S206. This arrangement protects the operator from accidental contact with approximately 3000 volts dc, which is present in either compartment.

Warning

Do not block interlock switches. Voltages present in this equipment are dangerous to life. Be sure to press the OFF pushbutton before opening cabinet. Do not reach into lower cabinet unless the power cord is disconnected. Line voltage is present at relay K203 regardless of the position of the POWER-OFF switch. Accidental closing of K203 would apply line voltage to the plate transformer.

3.6.2 Time Delay and Step-Start Circuits

When POWER-OFF switch S202 is closed, power is applied to the heater of the 3-minute time-delay relay, K202. After the power has been applied to its heater for approximately 3 minutes, the bimetallic contacts close. These contacts are in series with the interlock circuits and the coil of plate contactor K203. When the ON pushbutton is depressed, K203 is energized, and contacts of K203 close and apply power to step-start relay K201 through dc rectifier CR205. The large electrolytic capacitor across the coil terminals of K201 requires a fixed charging time to rise to a potential high enough to energize the relay. When this time has passed, K201 energizes and shorts out the step-start resistors. Until relay K201 has closed, all power applied to the transformer primary winding has been dropped through the two step-start resistors, R201 and R233. Thus, the high-voltage power supply starts at low primary voltage and, after the step-start cycle has elapsed, switches to full voltage. This allows time for partial charging of the large, high-voltage filter capacitors, C207 and C208, before the application of full secondary voltage to the rectifier plates. During this time, the rectifier tubes are protected from damaging peak currents.

3.6.3 Thermal and Overload Circuits

The thermal overload relay, K102, protects the power amplifier tube from overdissipation and loss of cooling air. Its bimetallic strip has contacts connected in series with the interlock system. The thermal overload switch is located in the airstream from V101. Current from transformer T103 is passed through the heater of

K102. This current keeps the temperature of K102 just below that necessary to open its contacts. If the airstream fails, the temperature of the bimetallic strip increases, opening the interlock circuit and removing voltages from the power amplifier. If overdissipation occurs in the plate of the power amplifier, the higher air temperature causes K102 to open and break the interlock circuit.

Caution

Adjustments for proper operating points of K102 are made at the factory. Do not adjust R106 or alter the contact spacing of K102. Loss of thermal protection of V101 may result..

3.6.4 Power Control Circuits

Refer to figure 3-3. When the POWER-OFF switch is operated to POWER position, 115-volt ac power is applied to the filament and control circuits. If the 3-minute time delay of K202 has passed, and if all interlock circuits are in proper operating condition, the plate contactor may be energized by pushing ON switch S203. When K203 contacts close, one set of them holds the electrical connection to the coil and keeps the relay closed after the ON pushbutton is released. Other contacts of K203 supply power to the antenna changeover relay circuit and to the primary winding of the high-voltage transformer, T201. Power to T201 is applied from K203 contacts through two step-start resistors. These resistors reduce the voltage applied to the transformer until capacitor C203 charges high enough that the voltage across it will energize step-start relay K201. When K201 closes, its contacts short out the step-start resistors and allow full voltage to be applied to the transformer winding.

3.7 ALC AND RF NEGATIVE FEEDBACK CIRCUITS

Automatic load control is a type of compressor circuit, operating at radio frequencies. The modulation envelope is detected by power amplifier grid rectification. This signal is filtered of rf by L108 and C140 and applied through transformer T102 to ALC rectifiers CR217 and CR218 to produce a negative control voltage which is a function of the drive level. The ALC rectifiers are connected as a voltage doubler. The negative control voltage produced by the ALC rectifiers is fed back to the ALC line of the exciter to produce 3 dB of override control.

The 3 dB of ALC override control produced in the 30S-1 reduces the exciter rf gain and keeps the drive level within required limits. Automatic load control helps to keep the drive level low enough to prevent driving the power amplifier into grid current and distortion.

A fixed amount of rf negative feedback, from the output circuit of the power amplifier to the input of the power amplifier, produces a high degree of linearity of the amplified signal. This feedback is accomplished by capacitor C103, which couples some of the plate energy back to the grid circuit. Although there is no phase inversion between the cathode and the plate circuits of a cathode-driven amplifier, there is a phase inversion between the cathode and the grid circuit, providing the grid is not bypassed completely at the rf frequency. Therefore, the feedback voltage is out of phase with the grid voltage. Capacitors C103 and C104 form a voltage divider circuit to maintain the proper amount of feedback voltage.

3.8 TUNING AND LOADING METER CIRCUIT

One section of the SSB-CW switch, S201, selects the proper output voltage from the tuning and loading bridge circuit for the TUNING & LOADING meter indication. This circuit and the power amplifier tube form a specialized bridge circuit. It consists of V101, CR101A, and CR101B, and the associated load resistors and filter networks. The bridge is balanced when the plate circuit TUNING and LOADING controls are set to present the proper load impedance to the power amplifier plate. The meter then will read zero at any power level, and the power amplifier tube will operate at the proper gain level for maximum efficiency and linearity.

3.9 DESCRIPTION OF CONTROLS AND INDICATORS (Refer to figure 1-7.)

a. POWER-OFF. This switch controls application of ac primary power to the 30S-1. When it is in OFF position, the 30S-1 is disabled. When it is in the POWER position, ac power is

applied to filament, control, and indicator circuits (except "plate on" indicator DS202).

b. ON. When this momentary push switch is pressed, power is applied to the coil of the plate contactor. The place contactor is held closed by one set of its contacts.

c. OFF. This momentary push switch opens the interlock circuit and deenergizes the plate contactor.

d. BANDSWITCH. This control selects the desired operating band.

e. MULTIMETER. This control selects the desired indication of the MULTIMETER. Refer to table 2-1 for description of switch positions.

f. SSB-CW. This switch selects plate and bias voltages for either SSB or CW operation. It also selects the proper output from the tuning and loading bridge circuit for application to the MULTIMETER.

g. TUNING. This control adjusts the plate tuning capacitor. The dial is calibrated in a logging scale.

h. LOADING. This control adjusts pi-network loading capacitors C121 and C122. The dial is calibrated in a logging scale.

i. CALIBRATION CHART. No calibration chart is provided on the front panel or in this instruction book. Such a chart must be derived for the conditions invlived in a particular antenna and feed system. The operator can make a chart for his particular system, using the logging scales on the TUNING and LOADING controls.

section 4
service instructions

Note

For additional service information on the 30S-1 RF Linear Amplifier, write or call Amateur Radio Marketing, Collins Radio Group, Rockwell International, Cedar Rapids, Iowa 52406; 319/395-4507.

4.1 GENERAL.

No special test equipment is required or adjustment of the input rf circuits if the station includes an rf wattmeter and directional coupler such as are included in the 312B-4 Station Control. If it is necessary to adjust the loading indication of the multimeter, required test equipment includes a 2500-watt, noninductive dummy load and a 2-tone audio oscillator (750 and 1900 Hz).

Caution

If any replacements are made in input circuits, be sure to retain the 6.1-foot coaxial lead between S102A and L110. This critical length of cable is part of the matching network.

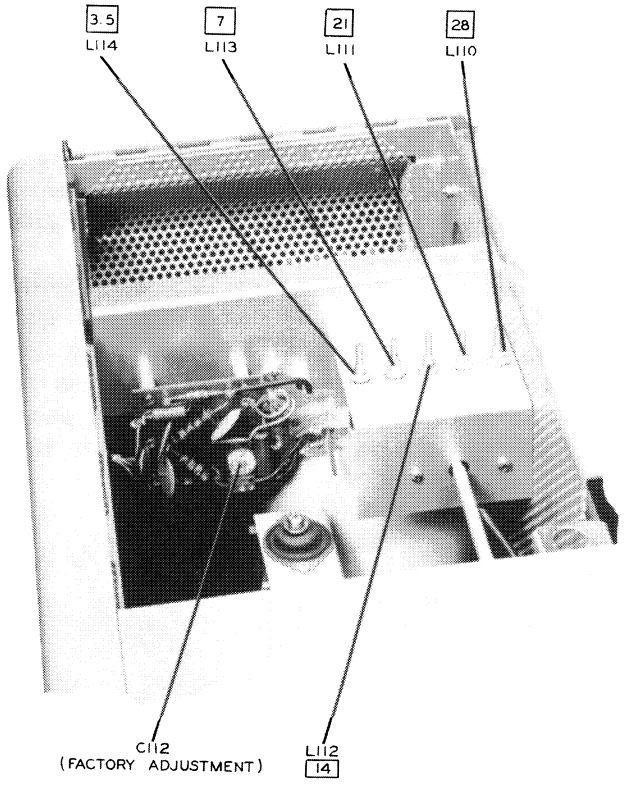
4.2 BLOWER LUBRICATION

The blower motor bearings are permanently lubricated and do not require oiling.

4.3 ALIGNMENT OF RF INPUT CIRCUITS

4.3.1 Amateur Bands

a. Connect a directional wattmeter (such as the type used in the 312B-4 Station Control or 302C-3 Directional Coupler) between the exciter output and RF INPUT jack J201 on the 30S-1. Connect a 2500-watt, noninductive 50-ohm dummy load to the output of the 30S-1.
b. With the 30S-1 plate power off, tune the exciter to 3.6 MHz (if CW operation only is anticipated), 3.8 (if both CW and phone operation is anticipated), or 3.9 MHz (if phone operation only is anticipated).
c. With the 30S-1 SSB-CW switch in the SSB position, press the ON pushbutton. Tune and load the 30S-1 into the dummy load. Retune and load the exciter output as necessary to maintain a 50-watt exciter power output.
d. Refer to figure 4-1. While monitoring the directional wattmeter installed in step a above, adjust L114 (accessible through one of the holes in the top cover of the rf compartment) for minimum reflected power (not to exceed 2 watts).
e. Repeat the above procedure at 7.2, 14.3, 21.3, and 28.6 MHz, adjusting L113, L112, L111, and L110 respectively. These adjustments are accessible through the holes in the top cover of the rf compartment. Do not raise the rf compartment cover for this procedure.



Input Tuned Circuit Adjustment Locations
Figure 4-1

4.3.2 *General Coverage*

Use the same procedure as given in paragraph 4.3.1, except set exciter to a frequency that is in the middle of the desired band. Useful bandwidth at the new alignment frequencies is approximately the same as that for the amateur bands. Do not attempt alignment to place the new operating bands outside the ranges given in table 4-1 for the BANDSWITCH positions listed. Also, do not attempt amateur-band operation on a BANDSWITCH position when the tuned circuits for that position have been realigned for out-of-band operation.

Table 4-1. Frequency Coverage Allowable by Realignment.

BANDSWITCH SETTING	LOWER LIMIT (MHz)	UPPER LIMIT (MHz)
3.5	3.4	6.0
7	6.0	10.0
14	10.0	15.0
21	15.0	22.0
28	22.0	30.0

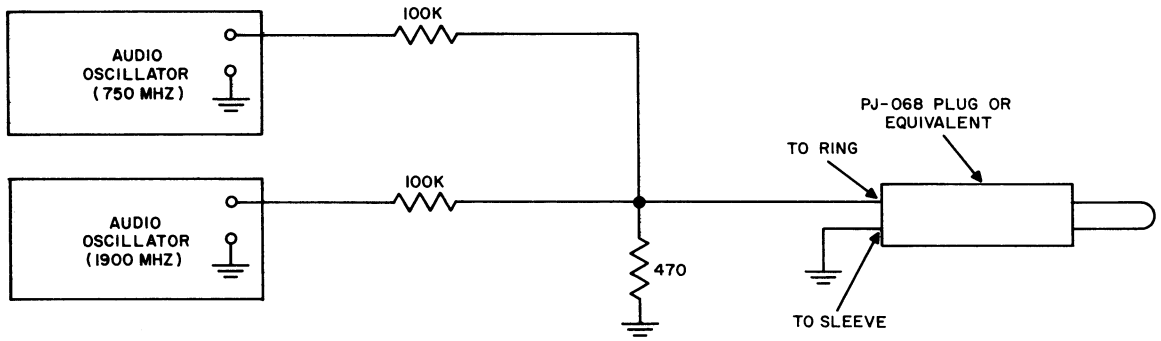
4.4 BIAS AND FILAMENT VOLTAGE ADJUSTMENT

Occasionally check the FILAMENT VOLTAGE reading on the MULTIMETER and the no-signal plate current on the PLATE CURRENT meter. If these readings are not 6.0 volts ac and 200 mA dc, respectively, adjust as in paragraph 1.2.2.

4.5 LOADING INDICATOR ADJUSTMENT

The loading indicator circuit may be checked for accuracy as follows:

a. Connect a 50-ohm, 2500-watt, noninductive dummy load to RF OUTPUT connector J103 on the rear of the 30S-1.
b. Tune and load the 30S-1 at 14.3 MHz (SSB).
c. Introduce a 2-tone input signal (750 and 1900 Hz) to the exciter input. When using the KWM-2/2A or S-line equipment, this can be done as shown in figure 4-2, where one audio oscillator is generating a 750-Hz, 1-volt rms signal and the other is generating a 1900-Hz, 1-volt rms signal.
d. Adjust the exciter for a USB signal of approximately 30 watts rf output using the 2-tone signal for the exciter drive. When using the KWM-2/2A or S-line equipment, this is done by positioning the METER switch to the ALC position and turning the MIC GAIN control clockwise until an indication of 6 dB is indicated on the meter.
e. Set the 30S-1 MULTIMETER switch to the TUNING & LOADING position. Adjust the 30S-1 TUNING and LOADING controls for maximum power output. If the meter indication is not 0, adjust C112 until the meter indication is 0.
f. Remove the drive to the 30S-1 (when using the KWM-2/2A or S-line equipment, merely turn the MIC GAIN control fully counterclockwise) and push the OFF pushbutton on the 30S-1. Remove the 2-tone input signal. Set the 30S-1 multimeter switch to the GRID position. Increase the exciter drive level to produce a



2-Tone Test Setup
Figure 4-2

30S-1 current indication of 0.2 mA (when using the KWM-2/2A or S-line equipment, increase the drive by positioning the mode selector to the LOCK KEY position and then positioning the MIC GAIN control clockwise to the desired drive level).

g. Set the 30S-1 MULTIMETER switch to the TUNING & LOADING position. Adjust the TUNING control to produce a dip in the multimeter indication. Adjust the LOADING control for a peak PLATE CURRENT meter indication. Continue adjusting the TUNING control for a multimeter dip and the LOADING CONTROL for a PLATE CURRENT meter peak until the PLATE CURRENT meter indicates 480 mA and the MULITMETER indicates 0.
h. If the multimeter indication in step g is not satisfactory, adjust R105 until the MULTIMETER indication is 0.

4.6 POWER OUTPUT CHECK

a. Connect a 50-ohm, 2500-watt noninductive dummy load to RF OUTPUT connector J103 on the rear of the 30S-1.
b. Connect an rf vacuum-tube voltmeter across the dummy load, setting the range scale on the meter to read approximately 300 volts of rf.
c. Tune and load the 30S-1 on any frequency in the CW mode, The rf vtvm across the dummy load should indicate at least 173 volts.

Caution

During the above procedure, do not keep the 30S-1 operating at output power levels higher than 600 watts for long periods of time. The power supply is not designed for continuous high power operation.

For SSB operation, the average voice has a peak-to-average power ratio of approximately 15 dB. The ALC circuits of the equipment reduce this ratio to approximately 10 dB for the average operator. This means that the average power read on the wattmeter is about 10 percent of the peak power output. If the operator's voice is low pitched, the average power indicated on the wattmeter will be higher. However, since the ALC circuits of the equipment reduce the drive power when the amplifier reaches 2-kW plate power input, indication of ALC voltage on voice peaks means that the 30S-1 is operating at its optimum power output level.

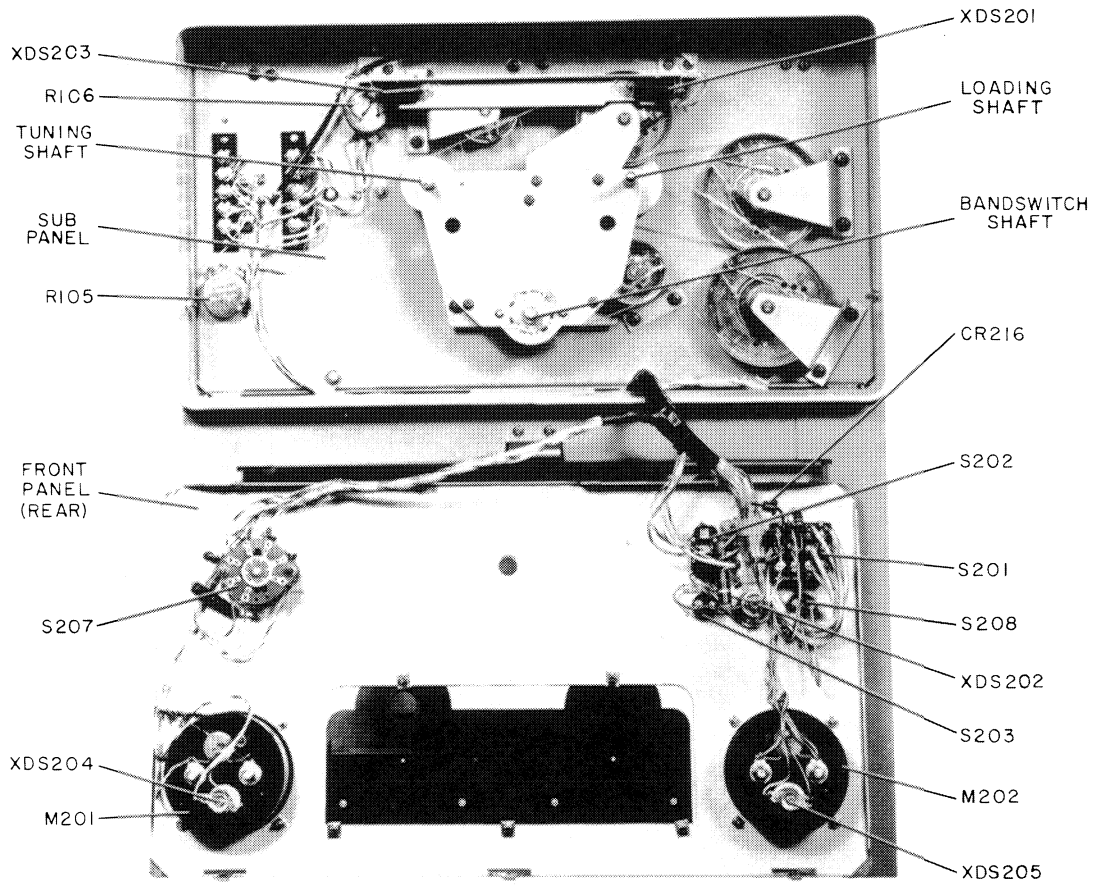
4.7 DIAL CORD REPLACEMENT

Refer to figures 4-3 and 4-4. Remove all control knobs. Remove the flathead screws securing the front panel to the cabinet. These screws are arranged across the top front and bottom front edges of the cabinet. The power supply front cover must be removed to gain access to the bottom screws. Do not loosen the screws at the sides of the cabinet. Remove the front panel from the cabinet, exposing subpanel and dial drive assemblies. Remove the broken or defective dial cord, and replace with the proper length of the new cord (Collins part number 432-1009-00). When ordering dial cord, be sure to state the desired length in feet. If possible, measure the required length of the new cord to be cut by the length of the old cord removed. Note that switch drive cords are not under spring tension. These cords are pulled and tied tight in order to bring switches into positive detent. Replace front panel and knobs. If switches are not aligned to same relative positions after the dial cord replacement, loosen the shaft couplers and align switches and knobs for proper positions. Retighten couplers.

4.8 PA TUBE REPLACEMENT

If it is necessary to replace the power amplifier tube, V101, proceed carefully as follows:

a. Move K102 aside as shown on 30S-1 lid so it will not interfere in tube removal or replacement.
b. Loosen the clamp around the tube plate cooling fins. Do not move the tube clamp out of position.
c. Grasp the tube by the plate cooling fins, and gently rotate tube one-third turn counterclockwise. Pull the tube straight out from its socket. Do not force at any time, but feel for binding or interference as the tube is withdrawn. Inspect the connector tabs inside the socket to make sure they were not deformed in tube removal.
d. Remove the new tube from its carton. Inspect it to be certain that the base contacts have not been damaged in shipping. These contacts are the thin metal tabs that extend radially from the ceramic lower portion of the tube.



30S-1, Front Panel Lowered and Subpanel Exposed
Figure 4-3

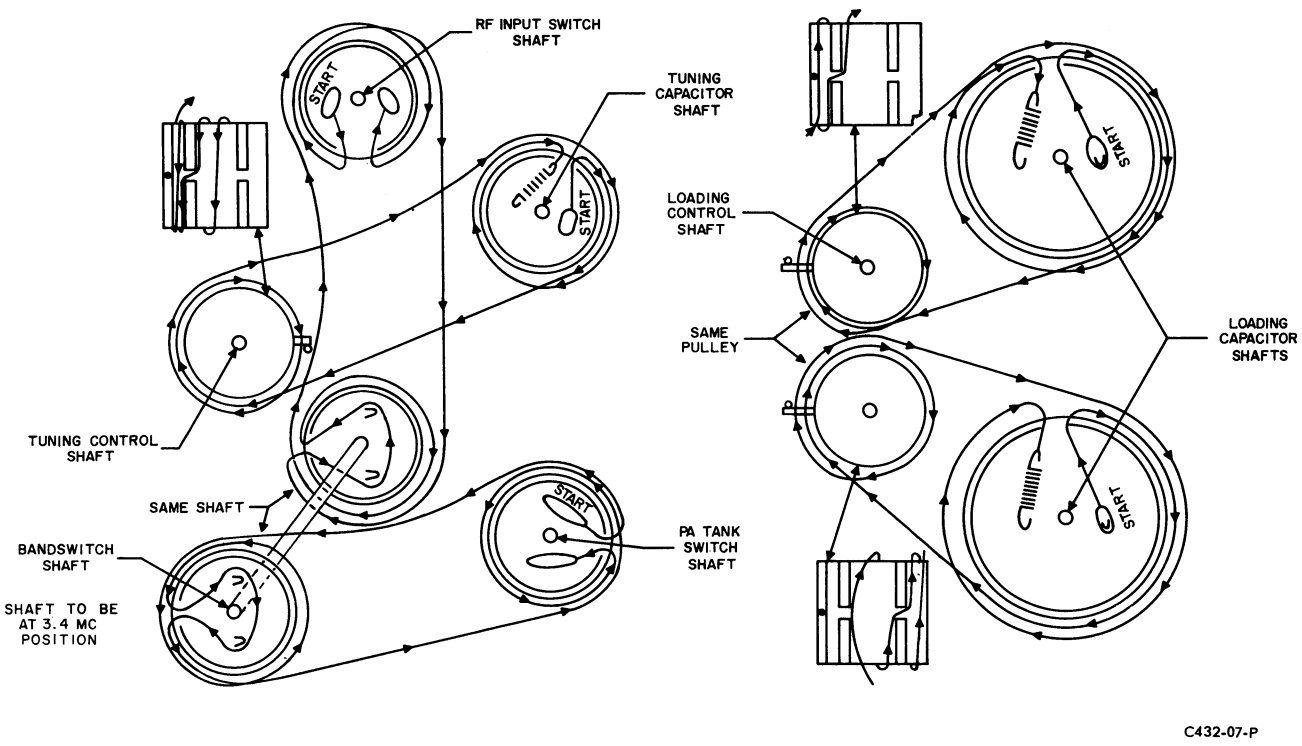
e. Insert the tube gently into its socket, making certain the tube base contacts are not jammed or bent in the process. In order to do this, start the socket key into the keyway inside the tube and lower the tube gently, feeling for any binding between socket key and tube keyway. If binding occurs, withdraw the tube, rotate it one-third turn and try again. In two of the three possible positions, the tube may bind in entering the socket. This is due to the fact that the tube keyway and the socket key are slightly off center. Find the orientation that does not bind, and insets the tube all the way into the socket so that the bottom portion of the tube plate cooling fins is inside the black cooling chimney.

f. Check that the top of the tube plate cooling fins is approximately seven-eights of an inch above the top edge of the black cooling chimney. Turn the tube clockwise (viewed from 30S-1 rear) against the stop to tighten the tube base contacts under the socket contacts. Do not force.

Caution

If an attempt is made to force the tube into its contacts when the tube is not properly seated in its socket, both tube and socket may be damaged. The warranty for tube and socket is void for damage caused by improper handling or installation.

g. Tighten the clamp around the tube plate cooling fins. This makes electrical connection to the plate of the tube.



Dial Cord Replacement Diagram
Figure 4-4

h. Place thermal relay K102 so that is detent is engaged, and it will be in the airstream flowing through the cooling fins of the tube.

Caution

Be sure that K102 does not touch the top of the tube. This would cause a damaging short circuit.

Refer to figure 6-2, which shows the power amplifier tube properly installed and the proper operating position of K102. Inspect the rf compartment to be sure there are no short circuits, and close the top cover.

4.9 PILOT LAMP REPLACEMENT

The "plate on" indicator lamp may be replaced without removing the front panel. The red and black jewel which covers this lamp snaps onto the panel. It is shown in figure 1-7 as the PILOT LAMP (7). Grasp the jewel and snap it off. Replace the bulb (DS202), and snap the jewel back in place. The meter and dial lamps may be replaced by removing the front panel. To replace these lamps, proceed as follows:

a. Remove all control knobs. Remove the power supply front cover.
b. Remove the flathead screws securing the front panel to the cabinet.

Note

Do not loosen any screws at the sides of the cabinet. The front panel is secured only by screws along the top and bottom edges.

c. Pull the front panel out and allow it to hang by its cable. Refer to figure 4-3.
d. To replace the dial lamps, slip their clip-on sockets off the ends of the bracket that is mounted above the dials. Replace the dial lamps and slip the clip-on sockets back on the bracket. Refer to figure 4-3.
e. To replace a meter lamp, pull the socket straight out from the meter case. Replace the lamp in the socket and snap the socket back into the hole in the meter case.

section 5
specifications

5.1 SPECIFICATIONS

Size ..... 77.79 cm (30-5/8 in) high, 43.18 cm (17 in) wide, 47.63 cm (18-3/4 in) deep (overall dimensions).

Weight ..... 72.56 kg (160 pounds).

Frequency range ..... 3.5 to 29.7 MHz, covering all amateur bands. By retuning input coils as necessary, the following general coverage bands may be covered.

FREQ BAND (MHz)	TOTAL COVERAGE (MHz)
3.5	3.4 to 6.0
7.0	6.0 to 10.0
14.0	10.0 to 15.0
21.0	15.0 to 22.0
28.0	22.0 to 30.0

Mode ..... Any type of emission.

Type of service ..... Intermittent commercial or amateur.

Plate power input

CW ..... 1000 watts input.

SSB ..... Nominal average input of 1000 watts with speech. Distortion products at this level are at least 30 dB down from signal.

Drive power requirements

SSB ..... 80 watts pep nominal.

CW ..... 60 watts nominal.

Primary power requirements ..... 230 volts ac, 3-wire, single-phase, at 15 amperes or 115 volts ac at 30 amperes.

Input impedance ..... 52 ohms.

Output impedance ..... 52 ohms nominal unbalanced with swr not to exceed 2 to 1.

Power output ..... Into a 52-ohm resistive load: SSB - 1000 watts pep with 35-dB signal to distortion ratio; CW - 600 watts with 1-kW input.

Noise level ..... 40 dB down from output signal with 1-kW single-tone input.

Harmonic and other spurious radiation outputs ..... At least 45 dB down from output signal.

Automatic load control ..... Up to 12 dB of automatic load control (compression), available at rear of cabinet for control of excitation source.

Vacuum tubes

Pa ..... 4CX1000A (one).

Rectifiers ..... 3B28 (two).