

105307



NATIONAL RADIO COMPANY

37 WASHINGTON STREET • MELROSE, MASSACHUSETTS

NATIONAL 200 TRANSCEIVER



ONE YEAR GUARANTEE

You now own a product manufactured by one of the world's oldest and most highly respected manufacturers of quality communications equipment. National has manufactured superb communications devices for nearly half a century. Our experience is unequalled. More than 75 per cent of our highly skilled test and assembly people have been with us for more than 25 years — an astonishing record in the relatively young electronics industry. Our people know their business . . . take pride in their fine workmanship — workmanship so outstanding that many National receivers purchased over 30 years ago are still in daily use.

We manufacture most of the components used in our equipment . . . and, in fact, National has been a prime supplier of electronic components to other important electronic manufacturers and government agencies for many years. As a result, we enjoy unusual control of component part quality.

We strongly recommend that you carefully study the instruction manual before attempting to use your new equipment. We are sure you will find that maximum performance will be achieved with complete understanding of its controls and operating features.

Your new National equipment has undergone an intense series of rigid quality control tests. However, as with any complex electronic equipment, it is possible that a defect may appear as a result of rough handling during shipment or through circumstances beyond our immediate control. For this reason, we suggest that you inspect your new equipment for such damage as soon as it is unpacked. In all cases of in-transit damage a claim must be filed against the carrier.

The component parts of this equipment (exclusive of vacuum tubes and transistors) are guaranteed to be free from defective material and workmanship, and repair or replacement will be made on any part found to be defective upon examination, provided that the unit is delivered to your dealer, authorized service agency or to the company, pursuant to the instructions below, within one year from the date of sale to original purchaser. On units returned during the initial 90 day period, National Radio Company, Inc. will absorb the labor cost of installation; for the remainder of the guarantee period the customer will be charged for such cost. The enclosed guarantee card must be returned to National Radio Company, Inc., within ten days from date of purchase in order to validate the guarantee. Naturally, this guarantee does not extend to any product

which has been subjected to misuse, neglect, accident, improper installations, or use in violation of instructions furnished by us. Nor does it extend to units which have been repaired or altered outside of our factory or its authorized agencies, nor to units where the serial number has been removed or defaced.

Should your new National equipment require servicing please do one of the following, whichever is most convenient:

1. Return it to the dealer from whom you purchased it.
2. Bring it to one of our authorized service agencies.
3. Write to the Service Manager, National Radio Company, Inc., 37 Washington Street, Melrose, Mass. and describe the difficulty. State type of unit and serial number. Describe as completely as possible the apparent defect. If we feel that the unit should be returned to the factory we will give you written authorization to ship the unit to us. Notify us that you are returning the unit and ship prepaid and fully insured in the original specially designed shipping carton.

Your unit will receive prompt and careful attention. If, in our judgment the unit is indeed defective, repair or replacement will be made at no cost to you if the unit is returned within 90 days after date of original purchase. Should the unit be returned to us after 90 days from date of purchase but before 365 days have elapsed, again, if in our judgment the unit is indeed defective, National Radio Company will provide a replacement of any such defective part (except vacuum tubes or transistors). If you wish us to install the part, you will be billed only for labor costs involved. At the end of one year, after expiration of guarantee, service will be billed to you at cost of parts and labor only.

This extended guarantee supersedes all previous warranties of National Radio Company, Inc. and is in lieu of all other warranties expressed or implied. Damages arising out of a breach of this guarantee are limited to repair or replacement of the defective part as stated above. We naturally reserve the right to change or improve our products without imposing any obligation upon ourselves to so modify products previously manufactured. Your new National Radio Company equipment is the finest of its type. It was skillfully designed, carefully manufactured and thoroughly tested. We are confident that your choice of our equipment will result in many years of pleasure.



SECTION 1

GENERAL DESCRIPTION

The NATIONAL 200 is a 5 band high performance transceiver covering the 80, 40, 20, 15 and 10 meter amateur bands. 3 modes of communication are provided: SSB, AM, and CW.

The NATIONAL 200 Main Tuning Dial is calibrated in 7 discrete bands, 4 covering the 80, 40, 20 and 15 meter bands and 3 bands covering the 10 meter band. This dial controls the V.F.O. of both receiver and transmitter portions of the transceiver; providing a high order of stability and tuning accuracy.

A National Crystal lattice bandpass filter is incorporated in both the transmit and receiver sections of the transceiver. The bandwidth is 2.8 KHz at the center frequency of 5.2020 MHz with a 6:50 db shape factor of 2.2 to 1.

ALC (automatic level control) is incorporated in the NATIONAL 200. Effective talk power is thereby increased and microphone gain and speech loudness are made less critical by this system. The 10 db range of the ALC circuit in the NATIONAL 200 minimizes "flat topping" and splatter.

An ALC input jack is provided on the NATIONAL 200 for use with the NCL-2000 2 kw linear amplifier for control of the NATIONAL 200 by the ALC voltage from the NCL-2000.

The transceiver operates on LSB on the 80 and 40 meter bands and USB on the 20, 15 and 10 meter Amateur Bands.

SECTION 2

INSTALLATION

2.1 The NATIONAL 200 transceiver requires a suitable power supply with excellent regulation and filtering, such as the NATIONAL NCX-A Power Supply/Speaker Console or the new AC-200 Supply (only). Both of these power units will operate from either 117 or 234 V.A.C. and are supplied with power cables to directly connect to the NATIONAL 200. When the NATIONAL AC-200 Supply is used, an external speaker is required (see Section 2.2 for installation detail). Figure No. 1 illustrates the power connections and power requirements. For use with a 12 volt DC power supply, connections to the power supply from the primary 12.6 volt source and between the power supply and transceiver should be made in accordance with the wiring instructions included with the 12 volt DC power supply. During mobile operation, make certain that the transceiver VR tube remains lit at all times and does not extinguish during voice peaks or under full TUNE input. Such VR tube extinction will cause severe frequency shift with modulation. Extinction of the VR tube usually results from improper loading or from low +280 volt output from the DC supply. It is important to use a DC supply which will provide rated power to the transceiver and also to provide adequate voltage to the DC supply.

2.2 SPEAKER INSTALLATION:

Two terminals on the 12 terminal Jones plug at the rear of the NATIONAL 200 (Pins 5 and 7)

are provided for a pair of leads to be brought out for speaker connection if the NCX-A Supply is not used (See figure No. 1). Alternatively, the rear-panel phone jack may be used for a speaker.

When the NATIONAL 200 is installed in an automobile for use with the 12 volt DC supply it will usually be most convenient to use the regular automobile broadcast radio speaker, connected through a DPDT switch mounted under the dash to allow a choice of speaker operation of either the NATIONAL 200 or the broadcast receiver.

2.3 MOBILE MOUNTING:

A mounting bracket is included with the NATIONAL 200 transceiver. For mobile operation, this bracket should be mounted under the automobile dashboard with two #10, 12 or 1/4 x 20 screws. For maximum stability, these screws should be located as far apart as possible in the mobile mounting bracket. A pair of large threaded knobs hold the transceiver directly to the bracket. These knobs permit rapid installation or removal of the transceiver from the mount. Mobile operation usually results in considerable vibration and shock. For maximum frequency stability of the NATIONAL 200 transceiver, it is important that all mounting screws used to hold the cabinet to the chassis and panel assembly be in place and firmly tightened. In mobile use, the rubber feet may be removed from the bottom of the NATIONAL 200. (See figure No. 2)

2.4 MICROPHONE CONNECTIONS:

The microphone input of the NATIONAL 200 is equipped with a three circuit jack providing a ground on the main shank of the three circuit plug. The audio output of a high-impedance ceramic or dynamic (recommended) microphone (a crystal microphone may be used, but is not recommended for mobile operation) should be connected to the ring of the three circuit jack. If the microphone is equipped with a push-to-talk button it should be so wired that the tip of the microphone plug is connected to the grounded shank of the plug when the push-to-talk button is pressed. The microphone push-to-talk button is connected to +12 V DC.

— CAUTION —

ACCIDENTAL INTERCHANGE OF THE WIRING ON THE MICROPHONE PLUG WILL RESULT IN APPLICATION OF +12 VOLTS TO THE MICROPHONE CARTRIDGE, WHICH MAY DAMAGE THE MICROPHONE.

The microphone input jack of the NATIONAL 200 is equipped with a grounding contact so that no modulation of the transceiver is possible when the

microphone plug is removed. Microphone connections are illustrated in figure No. 3. We recommend the use of a good quality, wire-range microphone, since all necessary restriction of audio bandwidth is accomplished in the NATIONAL 200 crystal lattice filter.

2.5 AUXILIARY RELAY CONTROL TERMINALS:

A pair of SPST relay terminals rated at 3 amperes current capacity are provided at the rear of the NATIONAL 200 to allow control of accessory equipment such as the NCL-2000 amplifier. Terminals are open during receive, closed during transmit.

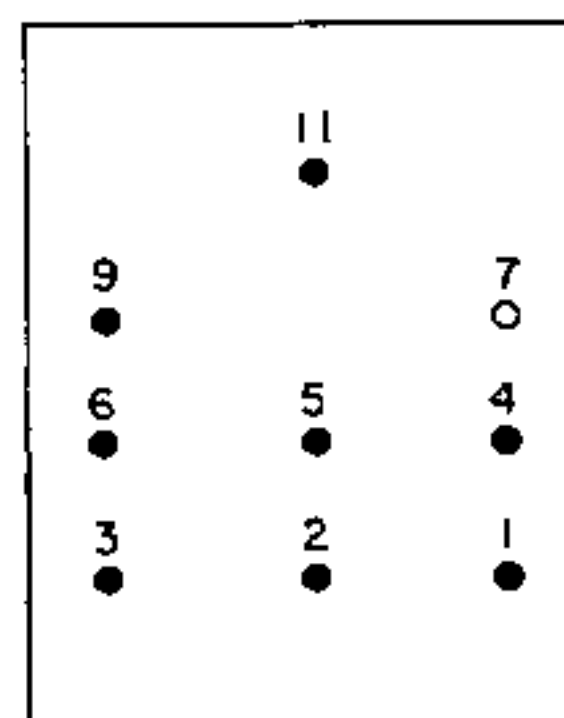
— CAUTION —

THE NATIONAL 200 IS WIRED FOR 12 VOLT NEGATIVE GROUND MOBILE INSTALLATIONS.

FOR USE ON POSITIVE GROUND INSTALLATIONS THE POLARITY OF THE 12 VOLT DIODE, D-6 AND THE 250 MFD CAPACITOR C-147 MUST BE REVERSED. FAILURE TO DO THIS WILL RESULT IN DAMAGE TO THE UNIT.

INSTALLATION DIAGRAMS—

- 1 POWER SWITCH
- 2 POWER SWITCH
- 3 -80 VOLT BIAS @ 6 MA
- 4 12.6 VOLT HEATER @ 5A
- 5 SPEAKER GROUND
- 6 COMMON GROUND
- 7 SPEAKER
- 9 +280 VOLT @ 200 MA
- 11 +700 VOLT @ 300 MA



POWER CONNECTIONS

FIGURE 1

FRONT VIEW
MALE PLUG

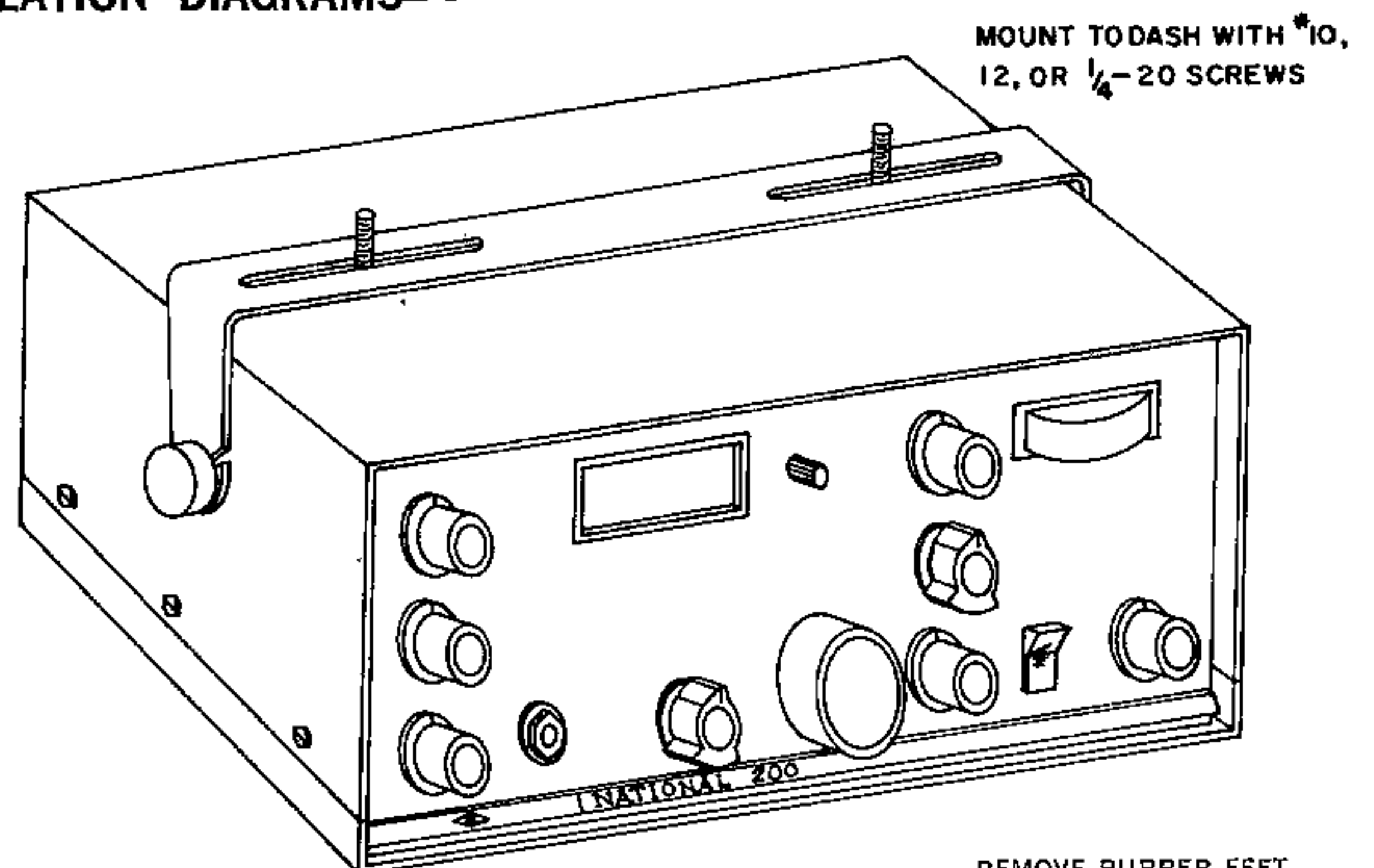
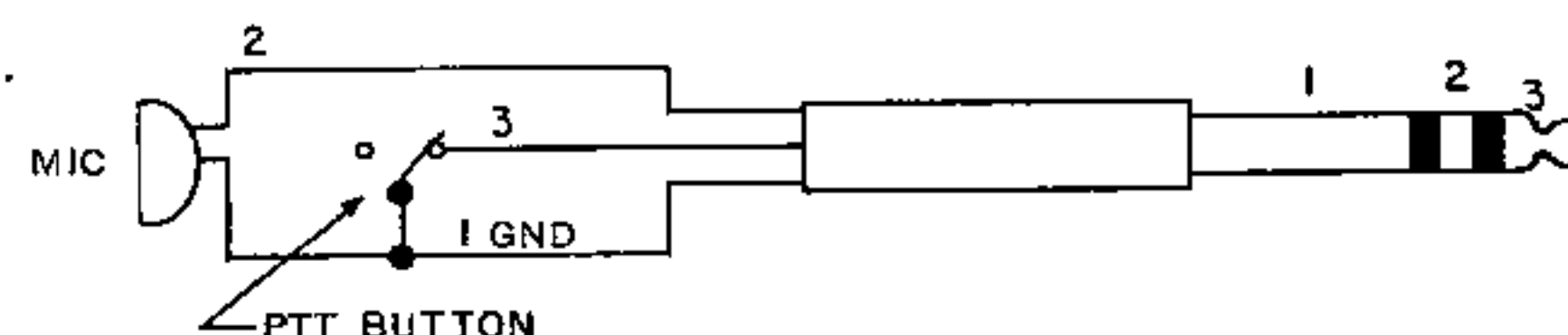


FIGURE 2



MICROPHONE CONNECTIONS

FIGURE 3

SECTION 3 OPERATION

3.1 TUNING PROCEDURE

— CAUTION —

BEFORE ATTEMPTING TO OPERATE THE NATIONAL 200 TRANSCEIVER, THE FOLLOWING PRELIMINARY CONNECTIONS SHOULD BE MADE. A SUITABLE ANTENNA OR DUMMY LOAD PRESENTING 40 TO 60 OHMS RESISTIVE LOAD IMPEDANCE SHOULD BE CONNECTED TO THE ANTENNA TERMINALS, A PROPER POWER CABLE SHOULD BE CONNECTED FROM THE TRANSCEIVER, AND A MICROPHONE OR KEY SHOULD BE CONNECTED TO THE APPROPRIATE INPUT JACKS. THE FUNCTION SWITCH SHOULD REMAIN IN THE "OFF" POSITION WHILE THE CONNECTIONS ARE BEING MADE.

3.1.1 PRELIMINARY ADJUSTMENTS

Set front panel controls as follows:

RF GAIN fully cw (clockwise)

AUDIO GAIN at 9 o'clock

BAND and MAIN TUNING to desired band and frequency

MOX switch: OFF

MIC GAIN fully ccw (counter-clockwise)

3.1.2 RECEIVER TUNE-UP (SSB)

Turn the FUNCTION switch from OFF to SSB

Adjust the PA TUNE and EXCITER TUNE controls for maximum S-meter reading or background noise. This adjustment automatically sets up approximate transmit tuning since these controls are common for both transmitter and receiver.

Adjust AUDIO GAIN for comfortable listening level.

3.1.3 TRANSMITTER TUNE-UP

— CAUTION —

DO NOT PROLONG TUNE-UP PROCEDURES FOR MORE THAN 30 SECONDS, IN ORDER TO PREVENT UNNECESSARY OVERHEATING OF COMPONENTS DURING OUT-OF-RESONANCE CONDITIONS. AFTER EXPERIENCE IS GAINED, TUNE-UP MAY BE ACCOMPLISHED IN A MATTER OF A FEW SECONDS.

Turn FUNCTION switch to TUNE and adjust EXCITER TUNE control for maximum meter reading.

Quickly adjust the PA TUNE control for minimum meter reading (dip) indicating proper tuning of the Pi network. Slowly rotate the PA LOAD control cw and dip meter reading with the PA TUNE control until meter reads 300 ma.

Return the FUNCTION switch to SSB.

NOTE:

If this is the first time that the NATIONAL 200 has been placed in operation, the rear panel BIAS control should be adjusted. Place the NATIONAL 200 in transmit with the MOX switch in the MOX position. The rear panel BIAS control should be adjusted until the meter reads between 50 and 60 ma. Return the NATIONAL 200 to the receive condition (MOX switch OFF).

3.1.4 MOX OPERATION

The NATIONAL 200 transceiver will now operate in both the transmit and receive modes using the MOX switch for transmit-receive control.

3.1.5 PTT OPERATION

Place the MOX switch in the OFF position.

Connect a suitable push-to-talk switch as shown in figure No. 3.

The NATIONAL 200 will operate in both the transmit and receive modes by control from the external push-to-talk switch.

3.1.6 SSB OPERATION

Insert microphone in the front panel MIC jack.

Turn the FUNCTION switch to TUNE and adjust the transmitter as described in Section 3.1.3.

Turn the FUNCTION switch to SSB.

Place the MOX switch in MOX or depress the microphone push-to-talk button.

Advance the MIC GAIN until the meter indicates voice peaks of 125 ma.

The NATIONAL 200 is now adjusted for SSB operation.

3.1.7 CW OPERATION

Insert key plug in the rear panel KEY jack.

Turn the FUNCTION switch to TUNE and adjust transmitter as described in Section 3.1.3.

Turn the FUNCTION switch to CW. Place the MOX switch in MOX and depress key. Rotate the rear panel CARRIER INSERTION control clockwise until the meter reads 300 ma. Do not continue to rotate the CARRIER INSERTION control beyond the point at which 300 ma is reached.

The NATIONAL 200 is now tuned for CW operation and is returned to the receive condition by switching the MOX switch to OFF.

3.1.8 AM OPERATION

Turn FUNCTION switch to TUNE, and adjust transmitter as described in Section 3.1.3.

Turn the FUNCTION switch to AM. Place the MOX switch in MOX, and rotate the CARRIER INSERTION control clockwise until the meter reads 150 ma.

Advance the MIC GAIN until meter just flickers on voice peaks.

The NATIONAL 200 is now adjusted for AM operation, and the AM detector is automatically in use.

3.2 DETAILED USE OF THE INDIVIDUAL CONTROLS

The operating instructions in SECTION 3.1 of this manual enable rapid set up of the NATIONAL 200 for SSB, AM, or CW transmission. Careful study of the following paragraphs will help you get the best performance from your NATIONAL 200 transceiver.

3.2.1 DIAL SET

The dial of the NATIONAL 200 may be adjusted to exact frequency (such as a 100 KHz marker from the optional plug-in XCU-27 calibrator) by tuning to the marker frequency with the receiver and then by turning the DIAL SET control until the fiducial line indicates correct frequency.

3.2.2 THE PA TUNE AND PA LOAD CONTROLS

Adjustment of the PA TUNE and PA LOAD controls is interdependent. For normal tune-up, the FUNCTION switch is placed in the TUNE position. The EXCITER TUNE control is set for maximum meter indication. The PA TUNE control is then set for minimum indication, indicating resonance of the Pi network. For a normal 40 to 60 ohm resistive antenna, the PA LOAD control should be rotated clockwise to increase the meter reading. As this is done, there will be some interaction with the PA TUNE control, and it will be necessary to slightly adjust the PA TUNE control for minimum meter indication. As the PA LOAD control is advanced, the minimum meter reading will increase. Proper loading for 200 watts peak input occurs at 300 ma. (marked in red on the meter scale). This loading current should not be exceeded, since the Pi network design is such that additional power input from a 700 volt supply will not result in additional power output. Above 300 ma. the efficiency of the NATIONAL 200 final amplifier will be impaired, and no further output will be obtained.

Proper operation of any linear amplifier depends on proper idling current adjustment and on sufficient drive for adequate peak plate current during an off-resonance condition. The adjustment of the BIAS setting of the NATIONAL 200 final amplifier is discussed in the operating instructions. Assuming this setting has been made for an idling current between 50 and 60 ma., it should be possible to obtain a

momentary maximum off-resonance plate current in excess of 350 ma. when the PA TUNE control is rotated away from the point of minimum indicated current. If 700 volts is being properly supplied to the plate circuit of the final amplifier, and the EXCITER TUNE control is properly adjusted, this off-resonance current should exceed 350 ma. If this current cannot be achieved, the cause should be found. Typical causes may include any of the following: improper BIAS setting, improper EXCITER TUNE adjustment, low plate supply voltage to the final amplifier under full load conditions, low driver B+, defective final amplifier tubes or driver tube, or improper alignment of the exciter stages resulting in low driving signal.

As mentioned above, low plate supply voltage to the final amplifier will frequently result in difficulty in obtaining a suitable off-resonance current (The AC 200 power supply is rated to deliver 700 volts to the final amplifier with 117 volt AC input). If the AC line voltage or the mobile battery supply voltage is low, the power supply output will be reduced. Under these conditions, off-resonance plate current of at least 350 ma. will probably not occur. This will not impair the operation of the NATIONAL 200 transceiver, provided that the PA LOAD control is not so adjusted as to result in excessive loading for the lower voltage. At no time should the PA LOAD control be advanced so that the plate current at the resonant dip exceeds 85% of the off-resonant plate current (which is noted by momentarily detuning the PA TUNE control).

In many instances an antenna load that is outside the 40 to 60 ohm range of the Pi network will be used with the NATIONAL 200. Antennas presenting this type of impedance should, if at all possible, be adjusted to present a proper load at the NATIONAL 200 antenna terminals. This can be done through the use of matching networks and, in many instances, by simply tailoring the length of the antenna transmission line to modify its terminal impedance.

Generally speaking, if the NATIONAL 200 exhibits a resonant plate current in the dip in excess of 300 ma. with the PA LOAD control rotated to its full counter-clockwise position, the antenna load impedance is below 40 ohms. If, on the other hand, the resonant dip is still less than 300 ma. with the PA LOAD control rotated to its full clockwise position, the antenna load impedance is above 60 ohms. It is possible to modify the Pi network output capacitors of the NATIONAL 200 to take care of some misloading in these directions. With the PA housing removed, a

group of four mica capacitors will be seen just below the BAND switch and connected between the BAND switch and chassis. These capacitors, C-1 (3.5 MHz), C-2 (7 MHz), C-3 (14 MHz), and C-5 (21 MHz) are, respectively, 1000, 470, 220, and 220 pF. They appear in parallel with the front panel PA LOAD control as shown on the schematic diagram and may be altered to extend the range of the Pi network. If the load impedance is too low, the capacitance should be increased. A good quality silver mica capacitor may be used for this purpose. It is advisable to use as large a case size on these capacitors as can be obtained.

There is of course some interaction of tuning between the PA LOAD control and the PA TUNE control. If load matching as described in the preceding paragraph is attempted, it is possible that the tuning of the PA TUNE control will be shifted to a point where this control will no longer cover the entire amateur band. In this event, it will be necessary to use external matching techniques. It is also possible that the antenna line will introduce an inductive or capacitive component to the NATIONAL 200 antenna terminals. In this event, there may be also a shift of the PA TUNE control so that it will not tune over the entire amateur band. Again it will be necessary to alter the antenna impedance by means of an external matching network or correction of the antenna difficulties. SSB operation should not be attempted unless the NATIONAL 200 is properly matched and loaded because severe distortion can result, as with any improperly matched SSB transmitter.

3.2.3 CARRIER INSERTION CONTROL

During tune-up (with the FUNCTION switch in the TUNE position), the CARRIER INSERTION control is inoperative. Full carrier is automatically inserted. In the AM and CW position, the CARRIER INSERTION control may be preset and will vary the carrier level from zero to full output as indicated by the meter. In the SSB position, the CARRIER INSERTION control is again inoperative, and full carrier suppression is present.

3.2.4 S-METER ADJUSTMENT

Proper S-METER adjustment of the NATIONAL 200 is obtained by disconnecting the antenna and detuning the EXCITER TUNE control while the NATIONAL 200 is set for SSB reception. With the RF GAIN fully clockwise (maximum gain),

the S-METER adjustment on the rear apron is rotated until the meter indicates between 0 and 1 "S" units. Some "wandering" of S-Meter zero may be experienced during warm-up.

3.2.5 THE MOX-OFF SWITCH

The MOX switch in the MOX (manual) operation position places the NATIONAL 200 in the transmit mode, regardless of the position of the FUNCTION switch. This position is useful for manual operation when the microphone is not equipped with a PTT switch and is necessary for CW operation.

3.2.6 MIC GAIN CONTROL

For SSB operation, set up the NATIONAL 200 by proper tuning of the final amplifier and exciter stages (Paragraphs 3.1.1-3.1.3), and advance the MIC GAIN control until the meter reads between 100 and 125 ma. with modulation. Single sideband audio has a rapidly varying energy content and the meter will rapidly fluctuate between the 50 to 60 ma. idling current and the 100 to 125 ma. meter reading. Actual peak current is about 300 ma. This fluctuation will be affected by the nature of the speech content and individual voice characteristics.

For AM operation with the CARRIER INSERTION control set as described in the operating instructions there will be a steady meter reading of 150 ma. If the MIC GAIN control is advanced during speech, AM modulation of the final amplifier will occur. When the MIC GAIN control setting reaches a point where the meter just indicates a slight flicker on speech peaks, modulation is 100%. Operation with the MIC GAIN control above this point should be avoided, since excessive drive will cause clipping of the modulation envelope, resulting in unwanted splatter.

3.2.7 TEN-METER SEGMENT SELECTION

If it is desired to operate on other than the 28.5 MHz to 29.1 MHz segment, the 10 meter band crystal (14.6 MHz) must be changed. Crystals are available from the Service Department of the National Radio Company at a cost of \$10.00 each. The optional crystals are 32.1 MHz (covering 28.0 MHz to 28.6 MHz) and 15.2 MHz (covering 29.1 MHz to 29.7 MHz). For operation on the 29.1 MHz to 29.7 MHz segment utilizing the 15.2 MHz crystal the 14.6 MHz crystal is removed and replaced with the 15.2 MHz crystal. For operation on the 28.0 MHz to 28.6 MHz segment THE 180 PF CAPACITOR C-73 ACROSS THE 10 METER OSCILLATOR TRIMMER MUST BE DISCONNECTED AT ONE END and the 32.1 MHz crystal should be inserted in the 14.6 MHz socket.

3.2.8 CARRIER INSERTION CONTROL AND CARRIER BALANCE

The carrier balance control R-56 of the NATIONAL 200 is internal and has been factory adjusted for proper carrier suppression. Readjustment should not be required for normal SSB operation. If desired, it may be set in the following manner:

Allow the transceiver to warm up for approximately 30 minutes; then tune and load as for SSB operation. Set the FUNCTION switch to SSB. Place the NATIONAL 200 in a transmit condition either by means of the push-to-talk button or by the MOX switch. In either event, the MIC GAIN control should be in full ccw position so that no audio modulation will occur. The carrier balance control is then adjusted for minimum meter indication. This meter reading should be between 50 and 60 ma. if the BIAS control is properly adjusted. When the carrier balance control is properly set, it may be left in this position for all subsequent operation. A more precise indication of carrier balance control setting should be obtained either by using an oscilloscope connected to the antenna line or by listening to the suppressed carrier on a separate receiver. With proper carrier balance and tuning of the transceiver circuits, voltage on the antenna line should not exceed 0.5 volts peak-to-peak as indicated on the oscilloscope.

For AM operation, it is necessary to adjust the CARRIER INSERTION control cw from zero until the meter indicates a final amplifier current of 150 ma. This corresponds to approximately 100 watts input to the final amplifier, thus assuring operation of the tubes within their plate dissipation rating.

For CW operation, it is necessary to adjust the CARRIER INSERTION control cw from its zero setting until a meter indication of 300 ma. is obtained. This assures an input to the final amplifier of 200 watts during key down transmit conditions of CW operation. Normal keying wave forms approximate a 50% duty cycle; that is, there is full input for about one-half of the time and no power for the remaining time. Thus the time-averaged input to the final amplifier is still approximately 100 watts, assuring conservative operation of the final amplifier.

In the SSB position the CARRIER INSERTION control is inoperative and full carrier suppression is obtained at all times. When the FUNCTION switch is turned to AM or CW, the CARRIER INSERTION control becomes operative and carrier is automatically inserted according to the preset position of the CARRIER INSERTION control.

SECTION 4 THEORY OF OPERATION

4.1 GENERAL

The NATIONAL 200 transceiver, designed to cover the 80 through 10 meter amateur bands, combines a single conversion superheterodyne receiver and single sideband transmitter, both employing a common crystal lattice filter. The final Pi network and driver tuning circuits of the transmitter also serve as RF circuits for the receiver. The carrier oscillator and VFO are common to the receiver and transmitter circuits while the receiver first IF stage is used as a low level amplifier in the transmitter function. The use of common filter and RF input components results in a sensitive and image-free selective receiver and in a high quality, low distortion SSB transmitter.

The operation of the NATIONAL 200 is best

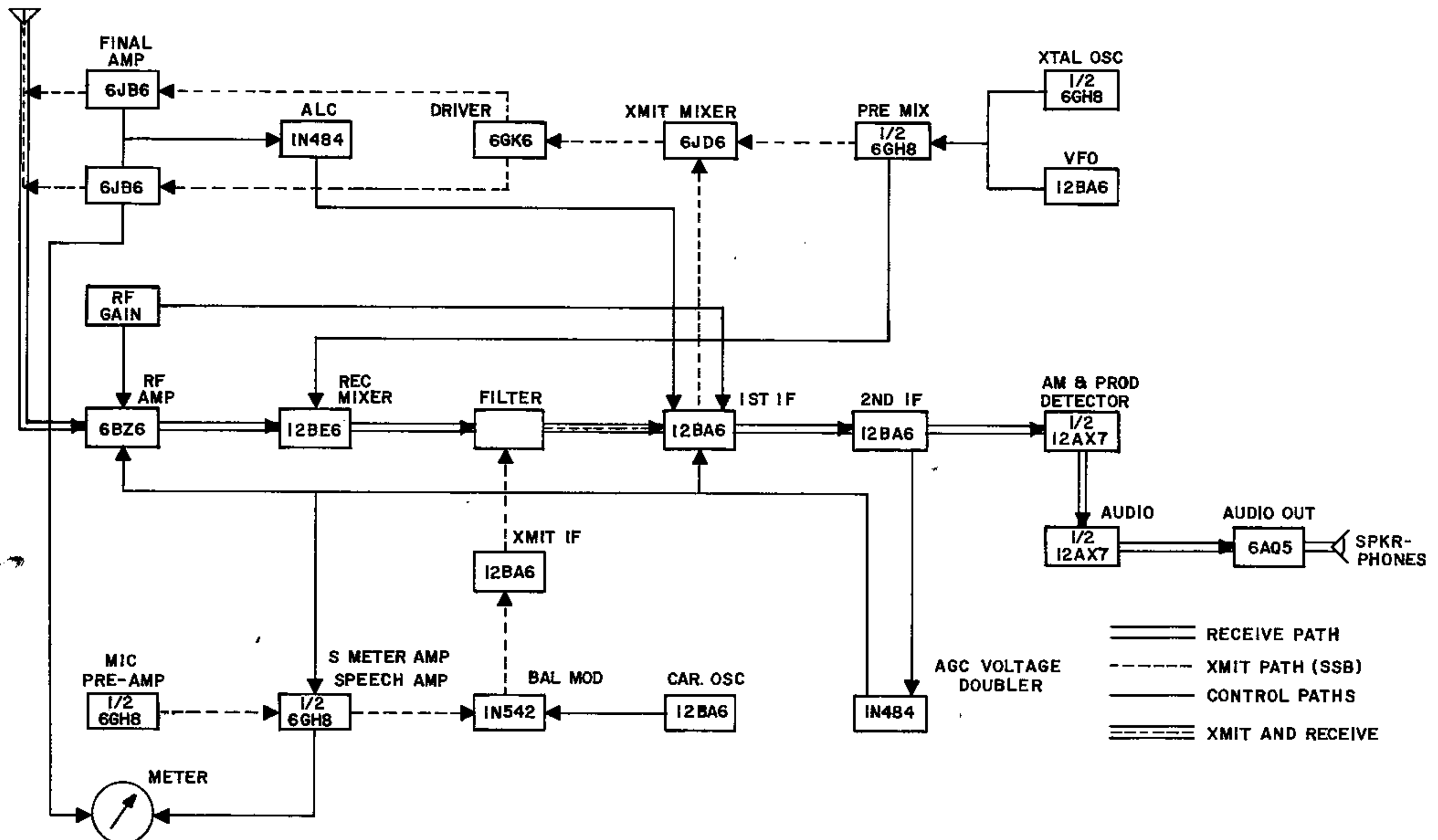
understood by reference to the block diagram, figure No. 4, and the frequency chart, figure No. 7.

4.2 THE TRANSMITTER

The transmit signal path of the NATIONAL 200 is indicated on the block diagram by a dashed line starting at the mike jack and carrier oscillator. The microphone input circuit is designed for high-impedance (dynamic or crystal) microphones and provides a push-to-talk microphone circuit. The microphone is connected directly to the grid of the pentode section of a 6GH8 (V-7A) tube which operates as a preamplifier. The signal is then fed through the microphone gain control to the triode section of the 6GH8 (V-7B) speech amplifier. The cathode circuit of this speech amplifier is coupled to the diode balanced modulator.

BLOCK DIAGRAM

FIGURE NO. 4



A 12BA6 (V-8) tube is used for the carrier oscillator. The carrier signal appears across a resistive plate load and is fed to the diode balanced modulator. The ring balanced modulator has both a resistive balance adjustment and a capacitive phase balance adjustment. The balanced primary winding of the output transformer is coupled to a single-ended winding which feeds the input of the 12BA6 (V-9) which functions as a transmit IF stage. The transmit IF stage feeds a double tuned output circuit. The secondary winding serves as an input source for the four pole crystal lattice filter.

The crystal lattice filter is terminated by the IF input circuit coupled to the grid of the 12BA6 (V-3) first IF stage. The single tuned plate circuit is coupled to the grid of the 6JD6 (V-12) transmit mixer.

The VFO uses a 12BA6 (V-10) tube operating as a grounded cathode Hartley oscillator. The tank circuits of this oscillator use extremely stable capacitors to provide minimum warm-up drift and maximum frequency stability. Output is obtained from the screen grid assuring maximum stability with change in output load.

A crystal controlled band oscillator using the triode section of a 6GH8 (V-11 A) provides crystal frequencies of 21.5 MHz, 25.1 MHz and 14.6 MHz. This signal is mixed with the VFO output in the pentode section of the 6GH8 (V-11 B) resulting in an injection signal for the first receive and transmit mixers. A single tuned circuit is used in the output of the pre-mix circuit to provide for oscillator purity.

The plate circuit of the transmit mixer is single-tuned and feeds the grid of the 6GK6 (V-13) driver. The single-tuned plate circuit of the driver feeds the grid of the final amplifier. The coils in the plate circuits of the transmit mixer, driver, and pre-mixer are band switched for the 80, 40, 20, 15, and 10 meter amateur bands. The tuning gang is tracked so that exciter tuning can be accomplished with only one control. The gain of the transmit mixer and driver are such that a driving signal in excess of 100 volts can be obtained at the grid of the final amplifier, thus assuring linear operation of the exciter to well above the level necessary for proper drive.

The final amplifier employs a pair of 6JB6 (V-14 and V-15) tubes operating in parallel. A BIAS control on the rear apron sets proper idling current. The plates of the 6JB6 final amplifier tubes are coupled to a high efficiency Pi network. The band switch selects proper inductance, tuning and load capacitance to match a 40 to 60 ohm resistive load over the entire 80, 40, 20, 15, and 10 meter amateur bands. The Pi network is designed for continuous operation at a

power level of 200 watts input. A small adjustable capacitor coupled from the plate of the 6JB6 final amplifier to the partially by-passed return of the final grid circuit coils (driver plate coils) provides neutralization. When the final amplifier is properly neutralized, maximum output *on a matched antenna* or accurate 50 ohm dummy load will occur at the point of plate current dip as indicated on the meter.

An effective ALC (automatic level control) circuit is included. If the final amplifier grids are over-driven on voice peaks, the grids will actually see a driving signal positive with respect to the cathodes, and grid current will result. This current will cause a negative voltage change on the bias circuit. The resulting audio signal on the bias circuit is capacitively coupled to a voltage-doubling rectifier. This rectifier will provide a negative DC output which is coupled to the grid return of the 12BA6 (V-3) first IF amplifier. When overdrive occurs, the gain of the first IF amplifier is reduced, resulting in less driving signal at the final amplifier. Charging takes place rapidly from the low-impedance bias source through the rectifying diodes, but the negative ALC voltage cannot discharge through the reverse biased diodes, resulting in a fast attack—slow release action. A gating diode prevents cross connection of the ALC and AGC circuits at the common IF grid return point. The ALC circuit will provide automatic level control for input signal variations of more than 10 db., and makes the setting of the MIC GAIN control quite non-critical. In addition, sudden changes in voice level or disturbing background noises are controlled without overdrive and distortion of the NATIONAL 200 transmitter signal.

4.3 THE RECEIVER

The receiver circuits are indicated by the double solid lines in the block diagram. The receiver RF circuits are common to the transmitter RF circuits. The high impedance point of the transmitter Pi network is capacitively coupled to the grid of a 6BZ6 (V-1) RF amplifier. The transmit driver and RF amplifier plates are connected to the same tuned circuit insuring consistency in receive and transmit tuning as well as high selectivity. The output from the RF amplifier is coupled to the signal grid of the first receive mixer, a 12BE6 (V-2). The plate of this mixer is coupled to the secondary of the transmit IF transformer (T-2) which serves as the input coil to the crystal lattice filter.

The output of the crystal lattice filter, as in the transmitter, couples to the input of a two stage single-tuned IF amplifier operating at approximately 5.2 MHz. The detector and AGC circuits are fed through separate voltage dividers. The product detector em-

plays one triode of the 12AX7 (V-5) tube with the signal from one IF voltage divider fed to the grid. A BFO signal is coupled from the crystal controlled 12BA6 (V-8) carrier oscillator to the cathode of the product detector, and the resulting audio signal is obtained across a resistive load in the plate circuit. For AM operation, the cathode of the product detector is grounded to permit operation as a grid leak detector.

The output from the detector is coupled to the audio gain control, and then to the grid of the remaining triode section of the 12AX7 (V-5 B) tube functioning as a grid-leak biased, first audio amplifier. The plate circuit is coupled to the grid of the 6AQ5 (V-6) audio output stage. The audio output stage feeds the output transformer with a 3.2 ohm secondary. This output signal is available on the speaker output pins of the power plug or at the phone jack. The low impedance nature of the phone jack feed permits use of either high or low-impedance phones.

A secondary feed is obtained from the plate circuit of the last IF amplifier and is fed to a voltage-doubling AGC rectifier (D-4 & D-5). The low-impedance driving source provides a rapid charge of the AGC bus. When the signal disappears, the negative AGC bus cannot discharge through the diodes, which provides a long release time, thus giving the AGC a very effective, fast-attack, slow release action. The AGC is fed to the grid of the 6GH8 (V-7 B) S-Meter amplifier. AGC voltage is connected to the grid return of the RF stage, through the gating diode (D-3) to the first IF stage and to the second IF stage for control of receiver gain.

4.4 THE FUNCTION SWITCH

The following paragraphs describe the operation of the various switching circuits with the FUNCTION switch in all possible positions.

4.4.1 FUNCTION SWITCH OFF

In this position the FUNCTION switch interrupts the primary power, either directly in case of the NATIONAL AC-200 power supply or through a remote relay in the case of a 12 volt DC supply.

4.4.2 FUNCTION SWITCH IN SSB POSITION

In this position the following circuits are set up: The product detector and the microphone amplifier are connected into the circuit. The key jack is disconnected to prevent accidental keying. The CARRIER INSERTION control is disconnected and a negative bias is applied to the 12BA6 (V-9) transmit IF stage, to reduce gain. With the MOX switch in the OFF position, the push-to-talk contact is connected across the relay line. When the push-to-talk

contact is pushed, the relay line is grounded, closing the relay. With the MOX switch in the MOX position, the relay line is grounded directly. Switching occurs as with push-to-talk operation. Returning the MOX switch to OFF will turn the transmitter off and put the equipment in the *receive* mode.

4.4.3 FUNCTION SWITCH IN AM POSITION

The AM position of the FUNCTION switch applies bias to the carrier oscillator during receive conditions to silence the BFO signal. The product detector cathode is grounded during receive periods to convert the detector to a grid leak AM detector. In this position, the *carrier insertion* control is connected and bias is removed from the 12BA6 (V-9) transmit IF stage, providing full carrier insertion from 60 to 300 ma.

PTT and MOX functions now operate in the same manner as described under SSB.

4.4.4 FUNCTION SWITCH IN CW POSITION

In this position the function switch will ground the plate of the microphone preamplifier to prevent accidental modulation, and will connect the KEY jack to the transmitter bias line. The product detector is connected. The CARRIER INSERTION control is still connected as described in the AM position.

4.4.5 FUNCTION SWITCH IN TUNE POSITION

In this position the FUNCTION switch will ground the relay line, placing the transmitter into operation, as described under SSB-PTT Operation. The MOX, PTT, and key circuits are disabled and have no influence on the tuning procedure. The center arm of the CARRIER INSERTION control is switched to the top of the control, providing an unbalanced condition. The bias on V-10 is still at zero. This provides appropriate drive for tune-up.

4.5 RELAY OPERATION

In the foregoing discussion, the exact nature of the relay switching was not described. The six-pole double throw relay is actuated by completing the ground side of the 12VDC Relay Bus. The NATIONAL 200 is placed in a transmit condition when the relay is energized.

The 6 poles of the relay are used in the following manner, reading from left to right on the schematic diagram:

1. Connects the S-Meter to the cathode of the S-Meter amplifier tube during receive periods and grounds the S-Meter so that it will function as a plate current indicator during transmit periods.

2. Closes the external relay terminals during receive periods.
3. Switches the 220V B+ to various receiver stages during receive periods and to various transmitter stages during transmit periods.
4. Removes bias from various receiver stages during receive periods and removes bias from various transmit stages during transmit stages. Transmitter bias is not removed when the function switch is placed in the CW position allowing the key to function through this pole and provide grid block keying.
5. Grounds the RF Gain control bus during transmit periods to remove RF Gain control from the first IF amplifier which is used as a transmitter amplifier.
6. Connects the product detector cathode return during receive periods and grounds the AGC circuit during transmit periods to prevent accidental charge of the AGC bus.

SECTION 5

TEST AND ALIGNMENT

NOTE:

TEST AND ALIGNMENT OF THE NATIONAL 200 TRANSCEIVER SHOULD ONLY BE PERFORMED BY COMPETENT, QUALIFIED PERSONNEL

5.1 EQUIPMENT REQUIRED

1. Signal generator providing output at the following frequencies. 3.5 MHz, 4.1 MHz, 5.2 MHz, 9.0 MHz, 12.5 MHz, 16.1 MHz, 22.8 MHz, 24.5 MHz, 27.9 MHz, 29.2 MHz.
2. Vacuum tube voltmeter (VTVM).
3. Standard audio output meter.
4. High frequency oscilloscope covering the range from DC to 30 MHz with a maximum sensitivity of 50 mv per centimeter or better and a low capacity input probe (Tektronix type 540 Series with type L preamplifier or equivalent).
5. 50 ohm dummy load with calibrated output meter covering the frequency range from 3.5 to 30 MHz (A high frequency vacuum tube voltmeter with a 100 volt full scale range may be substituted for the calibrated output power meter).
6. Power supply capable of supplying +700 volts at 300 ma., +280 volts at 200 ma. and -80 volts at 6 ma.
7. 1000 Hz audio generator with an output level of 10 mv.
8. High quality microphone equipped with push-to-talk button.

9. Transmitting key.
10. Suitable alignment tools for adjustment of coils and capacitors.
11. XCU-27 crystal calibrator.

Power Connections:

Disconnect the 700 volt output of the power supply. The heater wire connecting the two 6JB6 sockets should be removed.

5.2 5.2 MHZ IF ALIGNMENT

Turn the FUNCTION switch to AM. Set the RF GAIN and AUDIO GAIN controls to maximum, fully cw.

Connect the audio output meter to the speaker leads. This may be conveniently done by plugging the meter into the phone jack. Connect the signal generator through a 1000 pF capacitor to the grid (Pin #7) of the 12BE6 (V-2) receive mixer tube socket. Set the signal generator output to approximately 5.2 MHz with audio modulation at 30%. Audio output should be audible. Adjust the signal generator frequency to match the center frequency of the band pass filter as indicated by maximum output. Tune the slugs of the 1st and 2nd IF coils L-23, L-24, L-25 and the bottom slug of T2 (transmitter IF) for maximum output being careful to avoid overload of the receiving channel. The signal generator output should be reduced throughout the alignment procedure so that the output meter reading does not exceed 0.5 watts. After all coils are tuned and peaked the output level of the audio meter should read 0.5 watts with 20 μ v input from signal generator. Disconnect the signal generator and output meter.

5.3 CARRIER OSCILLATOR AND BALANCED MODULATOR ALIGNMENT

Place the FUNCTION switch in TUNE position. Connect the oscilloscope to junction of F-1, C-98 and C-99. (output of the 5.2 MHz Crystal Filter). Tune the top slugs of T1 and T2 transmitter IF transformer for maximum output on the oscilloscope. Adjust the carrier oscillator trimmer (C-146) until the indicated signal level is 0.4 volts peak to peak as indicated on the oscilloscope. Disconnect the oscilloscope from circuit.

5.4 VFO ALIGNMENT

Place the FUNCTION switch in the SSB position. Set the BAND switch to 3.5 MHz. Place the MOX switch in the OFF position. Connect the high frequency signal generator to antenna jack. Set the generator output to 3.5 MHz and tune the main tuning dial to 3.5 MHz. Tune the VFO coil slug (L-20) for zero beat. Now tune the main tuning dial to 4.1 MHz and set the generator to hear a signal at the 4.1 MHz dial setting. Check for zero beat. If zero beat occurs higher than 4.1 MHz adjust the VFO trimmer capacitor (C-86) for more capacity. If zero beat occurs lower than 4.1 MHz adjust the VFO trimmer capacitor (C-86) for less capacity. Now return the VFO dial to 3.5 MHz and set the signal generator to 3.5 MHz and repeat the procedure until the 3.5 MHz beat note occurs at the 3.5 MHz dial setting and the 4.1 MHz beat note occurs at the 4.1 MHz dial setting or until desired accuracy is achieved.

5.5 PRE-MIX AND DRIVER ALIGNMENT

Connect the signal generator output to the grid (Pin #2) of the pre-mixer on 6GH8 (V-11) through a 1000 pF capacitor. Remove the 12BA6 (V-10) VFO tube then remove the 14.6 MHz, 25.1 MHz and 21.5 MHz crystals from the sockets of the crystal oscillator. Connect the oscilloscope to the grids of the 6GJ5 (V-14 and V-15) final amplifier tubes. Set the FUNCTION switch to the TUNE position and the BAND switch to the 3.5 MHz position. Set the signal generator to 9.0 MHz and turn the EXCITER TUNE knob to #5 on panel. Adjust the pre-mix trimmer (C-62), the mixer coil (L-11) and driver coil (L-5) for maximum indication on the oscilloscope. This output should exceed 200 volts peak-to-peak.

FOR EACH BAND REPEAT THE PROCESS USED ON THE 80 METER BAND.

40 Meter Band—Set the signal generator to 12.5 MHz. Then turn the EXCITER TUNE knob to #8 on panel. Adjust the pre-mix trimmer (C-57); the mixer coil (L-12) and the driver coil (L-6) for more than 200 volts on final grids.

20 Meter Band—Set signal generator to 9.0 MHz. Then turn the EXCITER TUNE knob to #3 on panel. Adjust the mixer coil (L-13) and the driver coil (L-7), for more than 200 volts on final grids.

10 Meter Band—Set signal generator to 29.2 MHz and tune the trap (C-152) to minimum signal. Set signal generator to 27.9 MHz and tune the trap (C-151) for minimum indication. Set the EXCITER TUNE knob to #2 on the panel. Now set the signal generator to 22.8 MHz and align the pre-mix coil (L-16), the mixer coil (L-15) and the driver coil (L-9) for maximum indicated output on oscilloscope. Set signal generator to 24.5 MHz and turn the EXCITER TUNE knob to #7 on panel. Adjust the pre-mix trimmer (C-60) for maximum reading on oscilloscope. Repeat this procedure until proper tracking is achieved. The indicated output on oscilloscope at both frequencies should read 150 volts peak-to-peak.

15 Meter Band—Set signal generator to 16.1 MHz. Then turn the EXCITER TUNE knob to #7 on panel. Adjust the pre-mix trimmer (C-59), the mixer coil (L-14) and the driver coil (L-8) for maximum indicated output of 200 volts peak-to-peak.

Remove the signal generator and replace the VFO tube 12BA6 (V-10) and the crystals in their proper sockets. This completes the adjustment of the mixer and driver stages with the exception that a slight mis-alignment now exists in the driver coil due to the presence of the oscilloscope probe during previous adjustments and measurements. This error will be corrected during testing of the final amplifier stages to be described later.

5.6 CRYSTAL OSCILLATOR ALIGNMENT

Connect the oscilloscope probe to the grid (Pin #2) of the 6GH8 (V-11 B) pre-mixer tube. Turn the BAND switch to 7.0 MHz. Set the FUNCTION switch to the SSB position. The 21.5 MHz crystal oscillator now supplies the signal. Tune the 21.5 MHz crystal trimmer (C-78) to maximum indication on oscilloscope. When this point is reached add slightly more capacity to reduce the output reading to 80% of the maximum reading. Set the BAND switch to 21.0 MHz. This position uses the 25.1 MHz crystal; tune the 25.1 MHz crystal trimmer (C-76) to maxi-

imum indication on the oscilloscope. Then reduce the output reading to 80% of the maximum reading. Now set the BAND switch to 28.0 MHz where the 14.6 MHz crystal is now used. Tune the 14.6 MHz crystal trimmer (C-74) to 2 volts peak to peak at this point.

5.7 FINAL AMPLIFIER PRELIMINARY ADJUSTMENTS

Although the NATIONAL 200 does not require any alignment of the final amplifier, it is necessary at this time to check for proper operation at the high and low ends of all bands. In addition it is necessary to make final adjustments on the driver plate coils and on the neutralizing capacitor. These checks should be made in following sequence: Reconnect the 700 volt in power supply. Connect heater wire between the 6JB6 sockets. Place the FUNCTION switch in TUNE position and allow 30 seconds for warm-up of final tubes.

— CAUTION —

UP TO THIS POINT, THERE HAS BEEN NO POWER APPLIED TO THE FINAL AMPLIFIER. ALL CIRCUITS WHICH HAVE BEEN OPERATING AND WHICH HAVE BEEN TESTED ARE LOW LEVEL, COMPARATIVELY LOW VOLTAGE CIRCUITS. FROM HERE ON VOLTAGES AND CURRENTS ARE PRESENT WHICH ARE PARTICULARLY DANGEROUS TO PERSONNEL, TO THE TEST EQUIPMENT, AND THE UNIT UNDER TEST. IT IS ESSENTIAL TO BE SURE THAT NO PIECE OF TEST EQUIPMENT IS MIS-CONNECTED TO THE NATIONAL 200, AND THAT IT NOT BE PLACED INTO A TRANSMITTING CONDITION WITHOUT PROPER TUNING SINCE DAMAGE MAY RAPIDLY RESULT. IN A NUMBER OF THE FOLLOWING TESTS, THE TRANSMITTER WILL BE OPERATED AT FULL POWER OUTPUT. IT IS IMPORTANT THAT THE UNIT BE RETURNED TO A RECEIVING CONDITION IF MISINDICATIONS ARE OBTAINED, OR IF THE TEST IS NOT COMPLETED WITHIN A PERIOD OF 30 SECONDS, OR IF THE UNIT IS NOT TUNED UP WITHIN A PERIOD OF 30 SECONDS. OTHERWISE, SERIOUS AND PERMANENT DAMAGE MAY OCCUR IN THE FINAL OUTPUT CIRCUIT.

Disconnect all previously used test equipment from the NATIONAL 200. Attach the 50 ohm dummy load and calibrated output meter to the antenna connector. Set the BAND switch to 28.0

MHz. Set the main tuning dial to 28.8 MHz. Now turn the FUNCTION switch to TUNE and rapidly peak the EXCITER TUNE for maximum meter reading on the combination S-meter and cathode current meter. Adjust the 10 meter driver plate coil (L-9) for maximum meter reading while slowly rocking the EXCITER TUNE control. This will correct for the presence of the oscilloscope probe in the previous setting. Now rotate the PA TUNE control and observe whether a dip occurs in plate current reading.

Note the power output recorded by the power output meter. This power output should exceed 100 watts at all frequencies, provided that the PA LOAD control is adjusted so that the final amplifier draws 300 ma. With the PA TUNE control set for a plate current dip, the PA LOAD control is slowly rotated in a clockwise direction. As the PA LOAD control is advanced, it will be necessary to slightly retune the PA TUNE control to stay in the dip. Continue this process until the minimum reading in the dip corresponds to 300 ma. on the meter.

5.8 NEUTRALIZING CAPACITOR

With the FUNCTION switch in the TUNE position, rotate the PA TUNE control to either side of the resonant point and observe the plate current meter. It is necessary that the off resonance current exceed 350 ma. Having noted the off resonance plate current, retune the PA TUNE control to the plate current dip at 300 ma. and observe the power output. It should exceed 100 watts. Carefully rotate the PA TUNE control to either side of the dip and observe whether the power output rises or falls. With proper setting of the neutralizing capacitor, the power output should fall on either side of the dip. If the power output rises as the PA TUNE control is tuned away from the dip, it will be necessary to adjust the neutralizing capacitor. This can be quickly done on a trial and error basis by rotating the neutralizing capacitor and observing whether maximum power output occurs at the plate current dip. As proper neutralization is achieved, maximum power output will occur at minimum plate current. Return the FUNCTION switch to CW.

5.9 FINAL AMPLIFIER PRELIMINARY ADJUSTMENT (80-15 METERS)

Set the BAND switch to 21.0 MHz and the main tuning dial to 21.250 MHz. Turn the FUNCTION switch to TUNE and rapidly peak the EXCITER TUNE for maximum meter reading. Adjust the 15 meter driver plate coil (L-8) for maximum meter reading while slowly rocking the EXCITER TUNE

control. This will correct for the presence of the oscilloscope probe in previous tests. Now rotate the PA TUNE control and observe whether a dip appears in the reading. Advance the PA LOAD in a clockwise direction and slightly retune the PA TUNE control to stay in dip. Continue this process until the minimum meter reading in the dip corresponds to 300 ma. The power output should exceed 100 watts and proper neutralization should be observed. Repeat this procedure at the following BAND switch and tuning settings, in each case adjusting the proper driver coil for maximum meter indication while rocking the EXCITER TUNE control.

MAIN BANDSWITCH TUNING DIAL DRIVER COIL		
14.0 MHz	14.2 MHz	L-7
7.0 MHz	7.2 MHz	L-6
3.5 MHz	3.7 MHz	L-5

5.10 CARRIER SUPPRESSION, SIDEBAND SUPPRESSION, MODULATION AND ALC CHECKS

Connect the audio generator to the MIC jack and supply 10 mv of audio signal to the NATIONAL 200. Rotate the FUNCTION switch to the TUNE position. Connect the high-frequency oscilloscope to the antenna line which is connected to the dummy load. Tune the final amplifier for maximum output at 300 ma. input as described in the previous sections. A level well in excess of 200 volts peak-to-peak should be noted on the oscilloscope. Turn the FUNCTION switch to the SSB position. Place the MOX switch in the MOX position, set the carrier balance control for minimum indication on the oscilloscope which should correspond to minimum indication on the meter. Adjust the BIAS control for 60 ma. on the meter. The level remaining on the oscilloscope should not exceed 0.5 volts peak-to-peak, thus insuring carrier suppression better than 50 db. If necessary, carefully adjust the balanced modulator phase trimmer (C-6) for minimum indication while rocking the carrier balance control through minimum until the required 0.5 volt level is obtained. Now rotate the MIC GAIN control slowly in a clockwise direction. A signal should again appear on the oscilloscope. The MIC GAIN should be advanced until the cathode current meter reads 250 ma. Output at the scope should be 120-180 volts. The wave form at this point should appear as indicated in figure No. 6A. It is necessary to note the level of ripple on the wave form to total wave form level. The ripple should not exceed 1/30 of the total wave

form. This indicates that the unwanted sideband suppression with a 1000 cycle tone is in excess of 30 db.—the limit of this measuring technique.

It is important to note the difference between carrier balance and unwanted sideband suppression in the previous measurement. If the carrier balance control is rotated slightly, the wave form of figure No. 6A will be altered to the wave form of figure No. 6B. If this wave form is present while attempting to make the sideband suppression measurement, the carrier balance control should be slightly adjusted to compensate and return the picture to that of figure No. 6A.

Place the FUNCTION switch in the AM position. Now further advance the MIC GAIN until the meter just reaches 300 ma. as set by the previous tune-up procedure. Note the oscilloscope level. Slowly advance the CARRIER INSERTION control cw from the minimum setting. As this occurs, the wave form will begin to develop large cusps and peaks which will tend to exceed the noted oscilloscope level. Slowly reduce the MIC GAIN to keep the peaks at the predetermined level by carefully adjusting both the MIC GAIN and the CARRIER INSERTION control. It should be possible to obtain a picture as illustrated in figure No. 6C. It is important that the peaks of this figure be at exactly the level determined with the balanced carrier at 300 ma. of cathode current. This is equivalent to a two-tone test and is useful in indicating distortion in the transmitter channel and performance of the modulating circuits. The wave form which is observed should have a clean sharp cusp and should have a sine wave envelope. There should be no flattening of the peaks and no broadening of the cusps. Typical incorrect wave forms are indicated in figure Nos. 6D & 6E.

5.11 ALC AUTOMATIC LEVEL CONTROL

Advance the MIC GAIN control to maximum and readjust the CARRIER INSERTION control for sharp CUSPS. The final amplifier should now be overdriven and ALC voltage should result. The oscilloscope wave form should remain as shown in figure No. 6C. Check the ALC output at the junction of D-1, C-25, R-6 and R-29. There should be approximately 5 volts at this point.

The rear ALC jack may now be checked by applying -10 volts at the ALC input jack. The oscilloscope display amplitude should decrease indicating proper external control.

Press the MOX switch to OFF. The set is now ready for push-to-talk operation. If all of the tests are met satisfactorily, it can be assumed that the transmitter section is working properly, although it is of some value to check the dynamic operation of the transmitter on the microphone. To do this, return the MIC GAIN to zero and place the FUNCTION switch in the SSB position. Now remove the audio generator from the MIC jack and replace it with the test microphone.

Press the push-to-talk switch and speak normally into microphone. Slowly advance MIC GAIN control until peaks of the resulting signal reach the amplitude used for the previous two tone test. At this point the meter will be fluctuating rapidly with the speech content. The meter should generally average around 125 ma. of current and the output wave form should appear as illustrated in Figure No. 6F.

5.12 CW CHECK

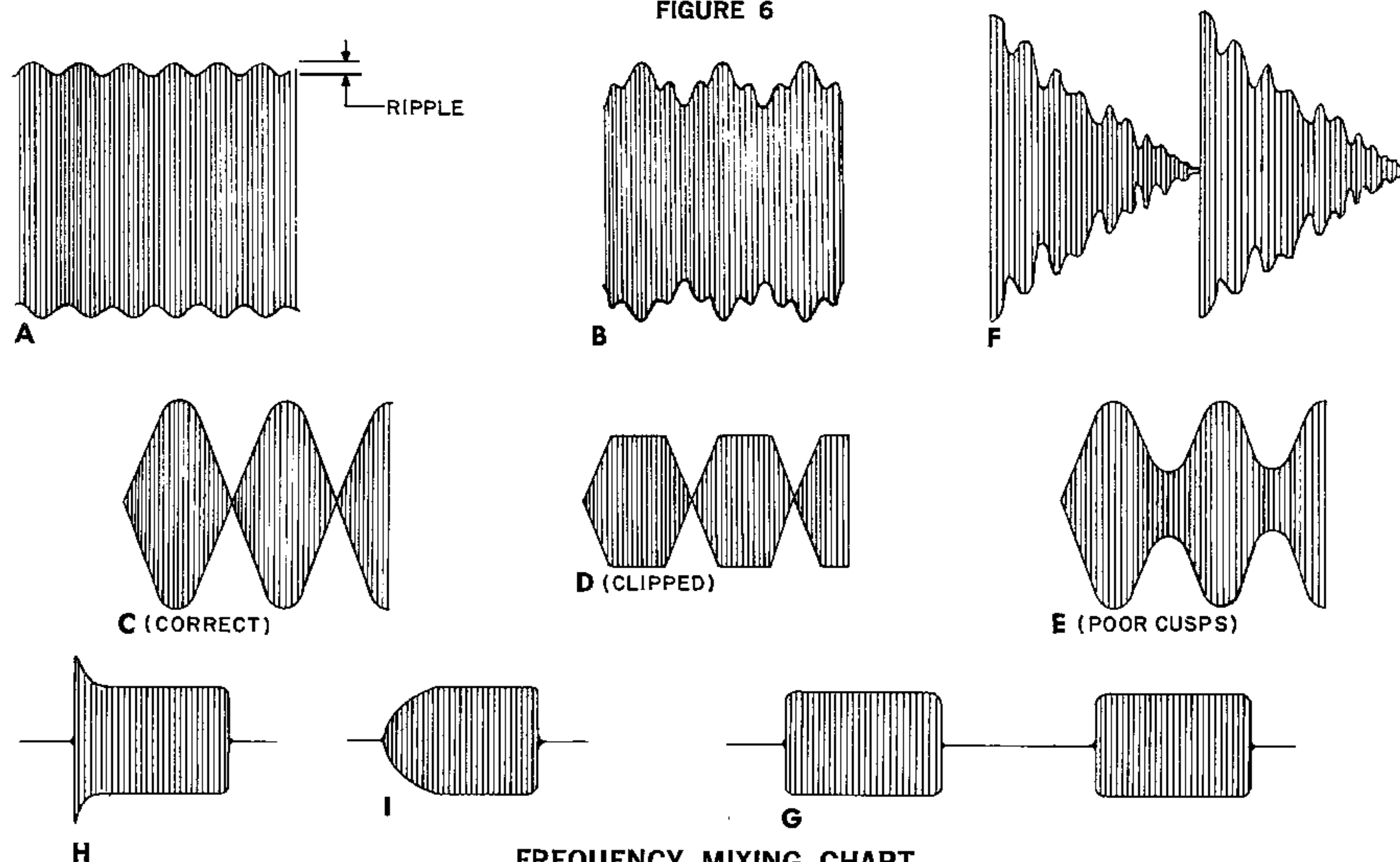
Place the FUNCTION switch in the CW position. Plug the key in the key jack. Load the transmitter as in previous checks. Press the MOX switch to MOX. With key down, rotate the CARRIER INSERTION control until meter reads 300 ma. Now key the transmitter and check the pattern of RF on the oscilloscope. A correct pattern should look like the figure No. 6G. Remove the oscilloscope.

5.13 RECEIVER IF TRAP ALIGNMENT

Connect the signal generator to antenna jack. Set the signal generator to 5.2 MHz (center frequency of the bandpass filter). Adjust the IF trap capacitor (C-91) for minimum output.

WAVE FORMS

FIGURE 6

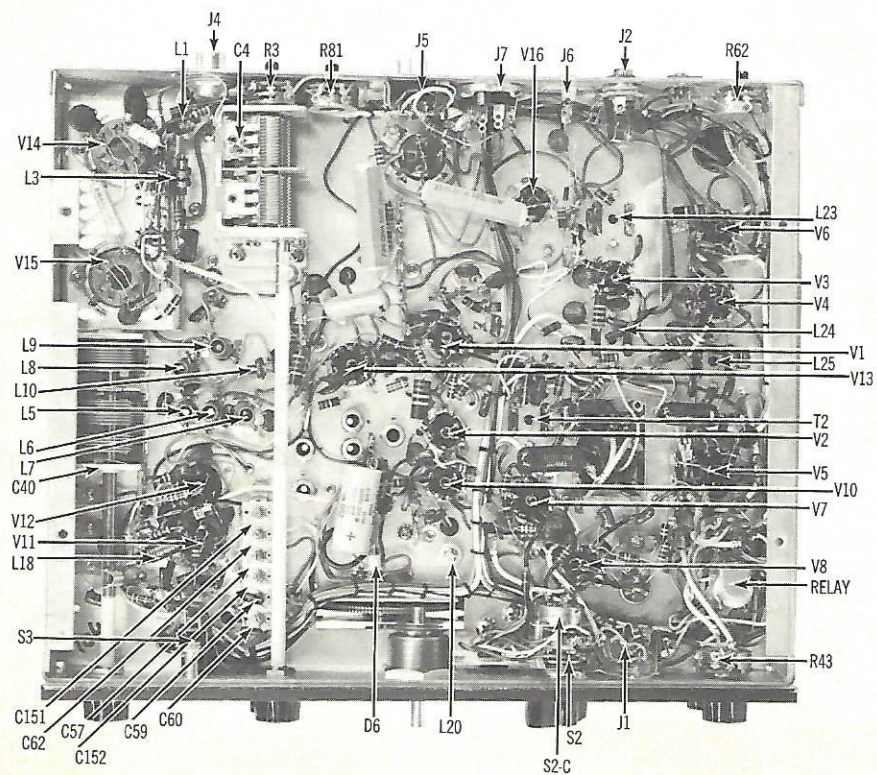


FREQUENCY MIXING CHART

FIGURE NO. 7

BAND	XTAL OSC.	PRE-MIX	VFO OSC.	MIX	CARRIER OSC.	FREQ: RESULTANT OUTPUT
80	NOT USED	+	8.7 to 9.3	-	5.2003	3.5 MHz to 4.1 MHz
40	21.5	-	8.7 to 9.3	-	5.2003	7.0 MHz to 7.5 MHz
20	NOT USED	+	8.7 to 9.3	+	5.2003	13.9 MHz to 14.5 MHz
15	25.1	-	8.7 to 9.3	+	5.2003	21.0 MHz to 21.6 MHz
L 10	32.1	-	8.7 to 9.3	+	5.2003	28.0 MHz to 29.6 MHz
M 10	14.6	+	8.7 to 9.3	+	5.2003	28.5 MHz to 29.1 MHz
H 10	15.2	+	8.7 to 9.3	+	5.2003	29.1 MHz to 29.7 MHz

FIGURE 5



SECTION 6

PARTS LIST

ALL READILY AVAILABLE RESISTORS AND CAPACITORS ARE OMITTED FROM THE FOLLOWING PARTS LIST, BUT ARE COMPLETELY IDENTIFIED ON THE SCHEMATIC:

SYMBOL	DESCRIPTION	PART NUMBER	SYMBOL	DESCRIPTION	PART NUMBER
SOCKETS AND JACKS			COILS AND CHOKES (Cont.)		
	Socket Crystal	A-50799	L13	20 Meter Mixer	B-50760-2
	Socket Novar	A-50802	L14	15 Meter Mixer	B-51514-2
	Socket 7 Pin	B-27669-3	L15	10 Meter Mixer	B-51516-2
	Socket Octal	B-27674-1	L16	Pre-Mix Coil	B-51514
	Socket 9 Pin	B-27669-3	L17	80 Meter Pre-Mix	B-52053
J1	Jack, Microphone, 3 ckt.	A-50793-2	L18	Oscillator Coil	B-52047
J2	Jack, Key, 2 ckt.	A-50793-1	L19,	220 μ h Choke	A-50206-1
J3	Jack, sht. phones, 2 ckt.	A-50793-3	L22,		
J4	Connector, Antenna	A-51479	L30		
J5	Plug Power	A-50791	L20	VFO Coil	B-52037
J6	Jack, External ALC In	A-11998	L21	4.7 μ h Choke RF	C-50750-21
J7	Strip Term.—Relay	C-19458-6	L26,	3.3 μ h Choke	C-50750-19
			L27		
			L28,	Choke, Parasitic	B-51545
			L29		
			L31	68 μ h Choke	C-50750-35
MISCELLANEOUS ELECTRICAL			SWITCHES		
M	Meter	A-52039	S1-A, B	PA Bandswitch Wafer	A-51523
K1	Relay 6PDT 62.3 Ω	A-52038	S1-C, D	Driver Wafer	A-51525
F1	Filter Band Pass 5.2 MHz	A-52004	S1-E, F	Mixer Wafer	A-51521
X1	Crystal 5.2003 MHz	B-50769	S1-G, H	Bandswitch & Detent	B-52003
X2	Crystal 14.6000 MHz	B-52042-3	S2	Function Switch	B-52002
X3	Crystal 25.1000 MHz	B-52042-2	S3	Rocker MOX-ON	A-52004
X4	Crystal 21.5000 MHz	B-52042-1			
	Panel Lamp Socket Assy.	B-52051	KNOBS		
	Panel Lamp	NPL-47		Main Tuning	A-52045-3
				Knob Pointer	A-52045-1
				Knob Round	A-52069
TUBES AND DIODES			SHAFTS, COUPLINGS, DRIVE TRAIN		
V1		6BZ6		Shaft, Bandswitch	B-50854
V2		12BE6		Shaft, PA Load	B-50818-3
V3, V4,		12BA6		Shaft, PA Tune	B-50818-1
V8, V9,				Shaft, Exciter Tune	B-50818-9
V10				Set Screws	SS6-RC-3X
V5		12AX7		Coupling, Rigid	A-12611
V6		6AQ5		Coupling, Link	B-25000
V7, V11		6GH8		Bushing, Panel	A-50840
V12		6JD6		Palnuts $\frac{3}{8}$ -32	B-19332-8
V13		6GK6	COVERS		
V14, V15		6JB6		Cover, VFO	B-52007
V16		0A2		Cover, PA	C-50815-4
D1, D2,	Diode IN484	A-51672		Front Panel Assy.	C-52009-2
D3, D4				Cabinet Chassis Cover	D-52011
D5				Cabinet Bottom Pan	C-52010
D6	Diode	A-51294-1		Hanger Bracket	C-50836-2
D7, D8	Diode IN542	IN542		Hanger Screws	A-50835
D9, D10				Rubber Feet	A-52041

SYMBOL	DESCRIPTION	PART NUMBER	SYMBOL	DESCRIPTION	PART NUMBER
POTENTIOMETERS AND CONTROLS			CAPACITORS (Cont'd)		
R3	Bias	B-50541-1	C11	Ceramic 75 pF 500 V	A-50849-3
R43	Audio Gain	B-50768-4		± 5%	
R52	MIC Gain Cal. ON-OFF	B-50986-1	C12	Ceramic 51 pF 500 V	A-50849-2
R56	Carrier Balance	A-51847		± 5%	
R62	Carrier Insertion	B-50541-1	C13, C14	Ceramic 500 pF 3 KV	A-50849-5
R73	RF Gain	B-50768-3		± 5%	
R81	S-Meter	B-50541-10	C8	Ceramic 150 pF 500 V	A-50849-10
				± 5%	
RESISTORS			C83	Ceramic 330 pF +180 PPM	A-52062
R1	3.2 ohms 2w ± 3%	B-17436-10		± 1%	
R2	650 ohms ½ W ± 2%	RC20- BF651G	C84	Ceramic 150 pF -750 PPM	A-52063
R78	3.3 k 10W ± 10%	B-17436-24	C123	Electrolytic 40-40-20	C-19458-8
R79	750 ohms 10W ± 10%	B-17436-16		20 Mfd.	
TRIMMERS			TRANSFORMERS		
C6, C9	Piston 1-8.0pF	A-51997	T1	Balanced Modulator	B-51821
C17	APC Air,	B-50364	T2	Transmit IF	B-50764
	Neutralize 4-15.0pF		T3	Audio Output	B-19435-4
C57, C59,	Trimmer U Bracket	B-51304-7	L23,	IF Transformers 5.2 MHz	B-50766
C60,	Mtd 1.5-20pF		L24,		
C62,			L25		
C151,					
C152					
			COILS AND CHOKES		
C74, C75,	Trimmer U Bracket	B-51304-2	L1	Antenna Choke	C-50523-3
C78	Mtd 1.5-20pF		L2	Pi Network	B-51518-2
C86	Ceramicon 5-25pF NPO	B-19783-4	L3	100µh choke	C-50527-4
C91	Mica, 7-100pF	A-52049	L4	PA choke	A-51529
C146	Ceramicon 5-25pF NPO	A-19783-2	L5	80 Meter Driver	B-50755
CAPACITORS			L6	40 Meter Driver	B-50757-2
C4	Gang: PA Load	C-50788	L7	20 Meter Driver	B-50759-2
C7	Gang: PA Tune	C-50789	L8	15 Meter Driver	B-51515-2
C40	Gang: Exciter Tune	C-51011-2	L9	10 Meter Driver	B-51517-2
C85	Gang: VFO Tune	C-52005	L10	220 µh choke	A-50206-1
			L11	80 Meter Mixer	B-50756
			L12	40 Meter Mixer	B-50758

SECTION 7

VOLTAGE AND RESISTANCE MEASUREMENTS

RESISTANCES TAKEN WITH FUNCTION SWITCH IN SSB POSITION: POWER PLUG REMOVED. AUDIO; RF GAIN; MICROPHONE GAIN AT MAX. POS. BANDSWITCH IN 80 METER POSITION.

Tube	Type	Function	Pin	Receive	Transmit	Resistance
V1	6BZ6	R.F. AMPLIFIER	1	AGC	—	2 meg
			2	+1.2	-110	68 Ω
			3	0	0	
			4	6.3 V.	6.3 V.	
			5	+280	+280	20 k
			6	+125	+125	67 k
			7	0	-40	0
V2	12BE6	RECEIVER MIXER	1	-8	-40	27 k
			2	0	0	0
			3	0	0	0
			4	12.6 V.	12.6 V.	
			5	+240	+240	20 k
			6	+70	-.8	40 k
			7	0	-40	8 Ω

<i>Tube</i>	<i>Type</i>	<i>Function</i>	<i>Pin</i>	<i>Receive</i>	<i>Transmit</i>	<i>Resistance</i>
V3	12BA6	1ST I.F. AMPLIFIER	1	AGC	ALC	150 k
			2	0	0	0
			3	0	0	0
			4	12.6 V.	12.6 V.	0
			5	+240	+240	27 k
			6	+100	+100	
			7	+1.5	+1.5	
V4	12BA6	2ND I.F. AMPLIFIER	1	AGC	.7	1.5 meg
			2	0	0	0
			3	0	0	0
			4	12.6 V.	12.6 V.	0
			5	+240	0	22 k
			6	+80	0	10 k
			7	+1.5	0	150 Ω
V5 a V5 b	12AX7	PRODUCT DET AM DETECTOR AUDIO AMPLIFIER	1	+90	+240	300 k
			2	-.4	-22	10. meg
			3	0	0	0
			4	12.6 V.	12.6 V.	0
			5	12.6 V.	12.6 V.	0
			6	+1.0	+240	120 k
			7	+1.5	-22	100 k
			8	0	0	0
			9	6.3 V.	6.3 V.	
V6	6AQ5	AUDIO OUTPUT	1	*	*	
			2	+12	+12	270 Ω
			3	12.6 V.	12.6 V.	
			4	6.3 V.	63 V.	
			5	+260	+270	22 k
			6	+240	+240	22 k
			7	0	0	470 k
V7 a V7 b	6GH8	MICROPHONE PRE-AMP S-METER	1	+250	+230	
			2	-40	-1	
			3	+240	+40	
			4	0	0	
			5	6.3 V.	63 V.	
			6	+250	0 on cw Tune—Function	120 k
			7	0	+95 SSB or AM	
			8	+4	+3.5	
			9	0	AGC	
V8	12BA6	CARRIER OSCILLATOR	1	-5	-5	1 meg
			2	0	0	
			3	0	0	
			4	12.6 V.	12.6 V.	
			5	+40	+40	75 k
			6	+50	+50	75 k
			7	0	0	
V9	12BA6	BALANCED MODULATOR	1	-4	-4	82 k
			2	0	0	
			3	0	+1.0	8
			4	12.6 V.	12.6 V.	
			5	0	+240	22 k
			6	0	+150	47 k
			7	0	+3	270 k
V10	12BA6	V.F.O.	1	-5	-5	100 k
			2	0	0	
			3	0	0	
			4	12.6 V.	12.6 V.	
			5	+130	+130	25 k
			6	+130	+130	27 k
			7	0	0	

<i>Tube</i>	<i>Type</i>	<i>Function</i>	<i>Pin</i>	<i>Receive</i>	<i>Transmit</i>	<i>Resistance</i>
V11 a V11 b	6GH8	PRE-MIX XTAL OSC.	1	+150	+150	25 k
			2	-.7	-.7	47 k
			3	+100	+100	120 k
			4	0	0	
			5	6.3	6.3 V	
			6	+240	+240	20 k
			7	0	0	0
			8	+1.0	+1.0	120 Ω
			9	-1.5	-1.5	100 k
V12	6JD6	TRANSMIT MIXER	1	*	*	
			2	-40	0	100 k
			3	0	+3.5	470 Ω
			4	0	0	
			5	6.3 V.	6.3 V	
			7	+230	+280	27 k
V13	6GK6	DRIVER	1	0	+3.5	150 Ω
			2	-40	-0.2	200 k
			3	0	0	
			4	12.6 V.	12.6 V.	
			5	6.3 V.	6.3 V.	
			6	*	*	
			7	+280	+280	20 k
			8	+280	+280	20 k
			9	0	0	
V14	6GJ5	FINAL AMPLIFIER	1	0	+240	100 Ω
			2	-60 to -80 V ADJ WITH BIAS CONTROL		20 k
			3	0	+.96	3.2 k
			4	12.6 V.	12.6 V.	
			5	6.3 V.	6.3 V.	
			6	*	*	20 k
			7	0	+240	100 Ω
			8	0	0	
			9	0	0	
			TC	+800	+700 DO NOT MEASURE IN TRANSMIT POS.	
V15	6GJ5	FINAL AMPLIFIER	1	0	+240	100 Ω
			2	-60 to -80 V ADJ WITH BIAS CONTROL		20 k
			3	0	+.96 V.	3.2 k
			4	12.6 V.	12.6 V.	
			5	6.3 V.	6.3 V.	
			6	*	*	20 k
			7	0	+240	100 k
			8	0	0	
			9	0	0	
			TC	+800	+700 DO NOT MEASURE IN TRANSMIT POS.	
V16	OA2	VOLTAGE REGULATOR	1	+150	+150	25 k
			2	0	0	0
			3	NO CONNECTION		0
			4	*	*	0
			5	+150	+150	0
			6	NO CONNECTION		0
			7	0	0	0

*PINS SO INDICATED MAKE INTERNAL CONNECTIONS IN THE VACUUM TUBE AND WILL INDICATE VOLTAGE EVEN THOUGH NO EXTERNAL CONNECTION IS MADE.

†VOLTAGE MEASUREMENTS AND RESISTANCE MEASUREMENTS MADE WITH SIMPSON 260 OR EQUIVALENT TYPE OF METER. 20,000 Ω PER VOLT.

SPECIFICATIONS NATIONAL 200

NATIONAL 200—SPECIFICATIONS

FREQUENCY RANGE: With crystals supplied—3,500 to 4,000 kHz, 7,000 to 7,300 kHz, 14,000 to 14,500 kHz, 21,000 to 21,500 kHz, 28,500 to 29,100 kHz. (Two additional crystals required if coverage of entire 28,000—29,700 kHz band is desired.)

POWER INPUT: 200 watts PEP SSB; 200 watts CW; 100 watts AM.

R.F. POWER OUTPUT (Nominal): 120 watts PEP SSB; 120 watts CW; 30 watts AM.

TYPES OF EMISSION: SSB (USB 20, 15, 10 meters, LSB 80 and 40 meters), AM, CW.

OUTPUT IMPEDANCE RANGE: 40–60 ohms minimum, Pi-network.

FREQUENCY DETERMINATION: Single conversion with pre-mixed crystal-controlled high frequency oscillators and tunable VFO.

OPERATING FACILITIES: (All modes) Full AGC and S-meter on receive; (SSB) PTT or front panel manual operation on transmit with ALC, product detector on receive; (AM) PTT or front panel manual operation on transmit with automatic carrier insertion, AM detector on receive; (CW) grid-block keying on transmit with automatic carrier insertion, product detector on receive.

SSB GENERATION: Crystal lattice filter; 6–50 db shape factor 2.2 to 1; Bandwidth 2.8 kHz at 6 db; Center frequency 5.202 MHz. Solid state balanced modulator.

DIAL CALIBRATION: 5 kHz; Identical on all bands.

TUNING RATIO: 45:1; Identical on all bands.

FREQUENCY STABILITY: Nominal 1500 cps in first 30 minutes after 5 minute warm-up; long-term stability nominal 400 cps in room ambient conditions.

SUPPRESSION: Carrier —50 db, unwanted sideband —40 db, 3rd order distortion products —30 db at full output.

RECEIVER SENSITIVITY: Nominal 0.5 μ v for 10 db S/N in SSB mode.

AUDIO OUTPUT: Better than 2 watts; 3.2 ohms.

MICROPHONE INPUT: High impedance (dynamic microphone recommended).

METERING: Back-lit edge reading; PA cathode current on transmit; S-units on receive.

CONTROLS: Front Panel: *Main Tuning, Band Selector, Audio Gain, R.F. Gain, Calibrator, Exciter Tune, P.A. Tune, P.A. Load, Dial Adjust, Function, MOX-OFF Switch, Microphone Input, Microphone Gain.* Rear Panel: Antenna, Bias Adjust, Phones or Speaker, Key, Power Input, External ALC Input, Calibrator Socket, External Relay Control, Carrier Insertion, S-Meter Adjust.

TUBE AND SEMICONDUCTOR COMPLEMENT: 16 tubes, 10 semiconductors; Parallel 6JB6's in P.A.

DIMENSIONS: 6 $\frac{3}{16}$ " H, 13 $\frac{3}{8}$ " W, 11" D.

MECHANICAL: $\frac{1}{8}$ " solid extruded aluminum front panel, satin-anodized off-white finish; Perforated aluminum enclosure with gray-blue wrinkle enamel finish; Gloss black knobs with aluminum caps. Universal mobile mount included.

WEIGHT: 15 pounds.

POWER REQUIREMENTS: 700 V.D.C. at 300 Ma., 280 V.D.C. at 200 Ma., —80 V.D.C. at 10 Ma., 12.6 V. at 5A.

ACCESSORIES: AC-200 power supply (operates from either 117 or 234 V.A.C. 50–60 Hz and supplies all necessary operating voltages); XCU-27 100 kHz plug-in crystal calibrator.

NOTES

177