209

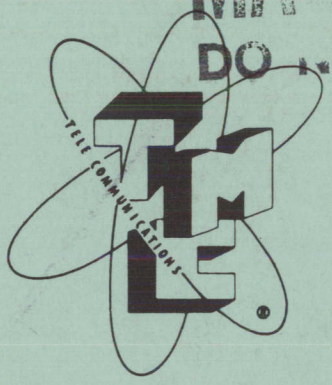
UNCLASSIFIED

# INSTRUCTION MANUAL

*for*

# OPERATION OF MODEL SBT-1KJ (AN/FRT-53)








THE TECHNICAL MATERIEL CORPORATION

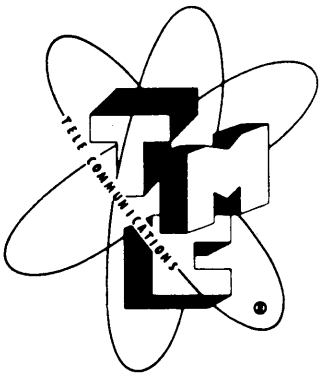
MAMARONECK NEW YORK

UNCLASSIFIED

INSTRUCTION MANUAL

*for*

# OPERATION OF MODEL SBT-1KJ (AN/FRT-53)




THE TECHNICAL MATERIEL CORPORATION

MAMARONECK NEW YORK

Issue Date: 1 April 1961

# TABLE OF CONTENTS



# LIST OF ILLUSTRATIONS



# LIST OF TABLES

# SECTION 1
# GENERAL DESCRIPTION

The TMC Model SBT-1KJ (AN/FRT-53) is a general purpose radio transmitter capable of providing SSB, DSB, ISB, AM, CW and FS operation throughout, the frequency range of 2 to 32 megacycles.

The entire transmitter is contained in a standard relay type rack measuring 66-3/4 x 20-5/8 x 21-1/2 inches. The rack is shock mounted for mobile operation.

The Model SBT-1KJ consists of the following TMC equipments. See Figure 1-1.

**MODEL**

PAL-1K
Linear Amplifier

RFD-1
Amplifier

PS-4
L. V. Power
Supply

PS-5
H. V. Power
Supply

SBE-3
Sideband Exciter

AO-101
Exciter Unit

A-1397
Power Supply

VOX-3 (0-330A/FR)
Variable Master
Oscillator

APP-4
Auxiliary Power
Panel

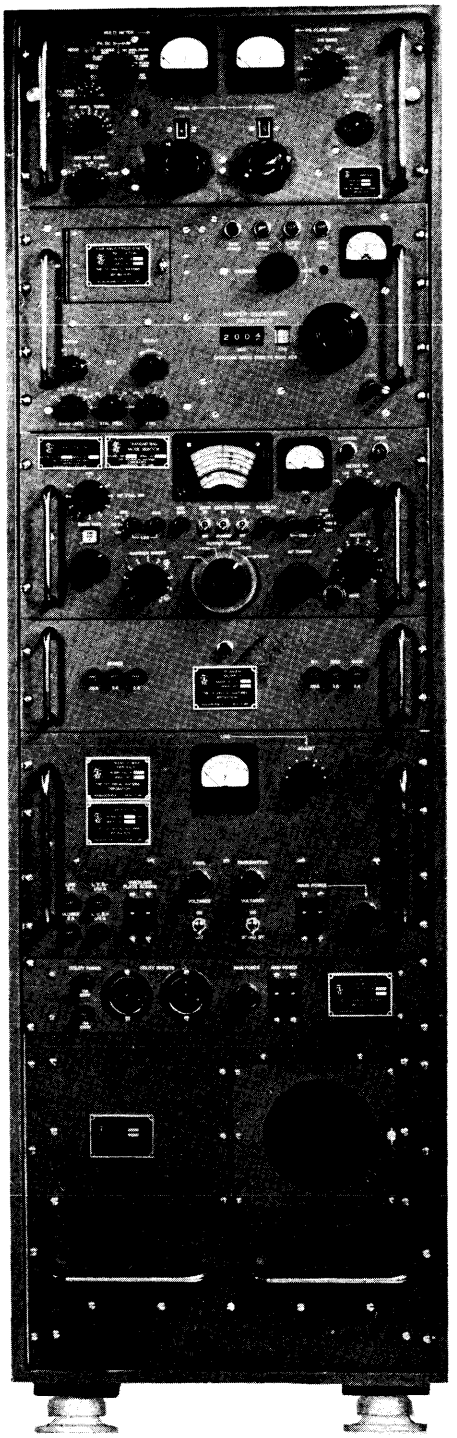


Figure 1-1

Model SBT-1KJ as used in Signal Corps Transportable Communications Central, AN/TSC-20(v)

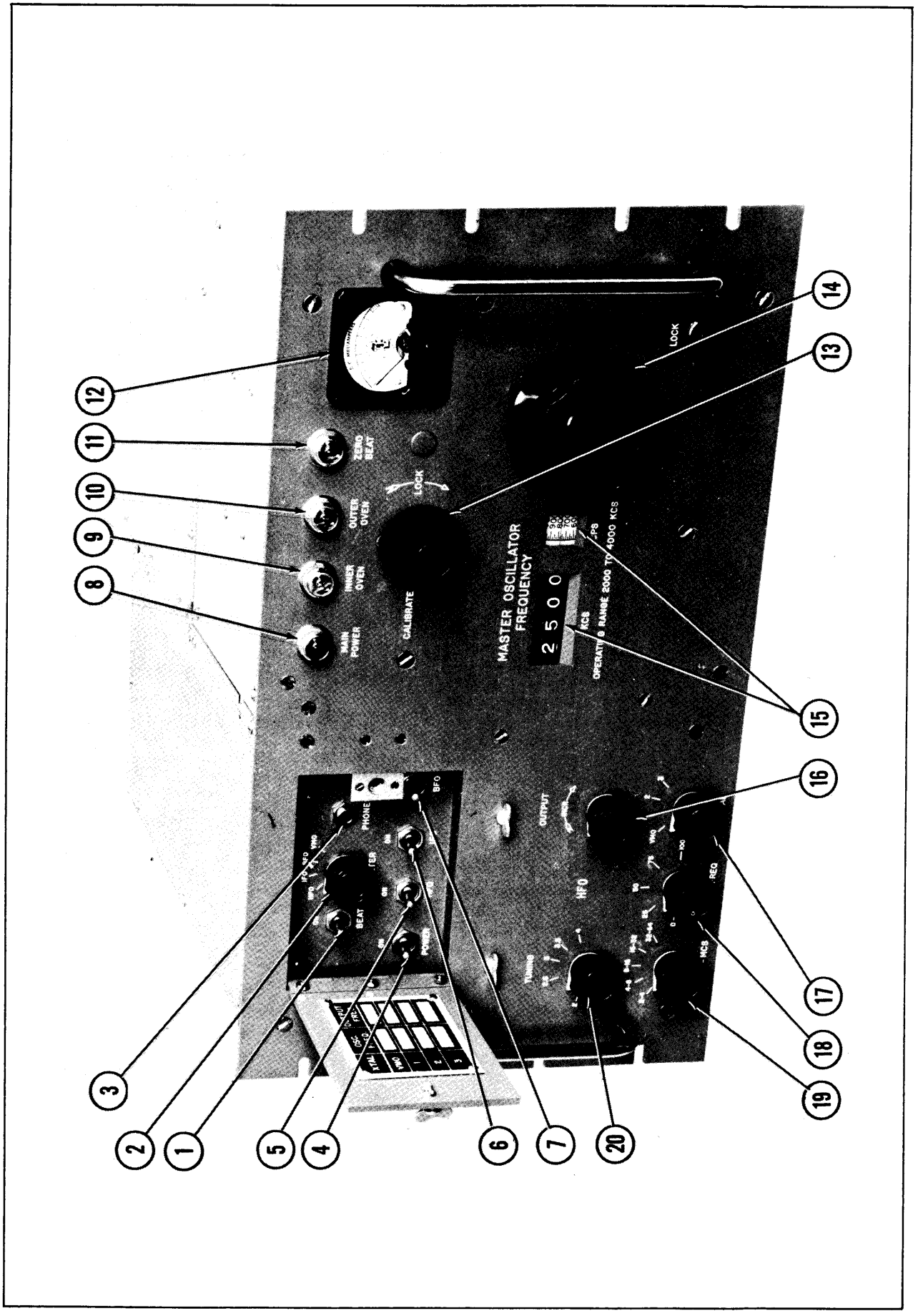



Figure 2-1. Operating Controls of VOX.

# SECTION 2
# OPERATORS' SECTION

## 2-1. GENERAL INSTRUCTIONS

Operation of the Model SBT-1KJ (AN/FRT-53) is simplified if its various units are turned on in logical order. When loading the PAL-1K, the RF drive of the SBE-3 should be increased slowly and conservatively; concurrently, the PAL-1K's PA PLATE CURRENT meter and PA screen current Isg should be kept within recommended limits. Otherwise, the units of the SBT-1KJ may be turned on independentally of each other as the following procedure shows.

## 2-2. OPERATION OF MODEL VOX

The first unit to be turned on should be the VOX.

### 2-2-1. GENERAL INSTRUCTIONS.

For oscillator stability, the VOX must be left turned on continuously and should be turned off only in the event of failure. This means that an independent source of primary power must be supplied to the unit so that when any associated units are turned off, the VOX will continue to operate. Interconnection between the VOX and associated units is accomplished through the use of BNC-type connectors.

In operation of the AN/FRT-53, the high frequency section of the Model VOX is not used. The output of the Model VOX is limited to the 2 - 4 mc output direct from its VMO. This output is fed to the associated SBE's VMO input circuit but is bridged onto the VOX's calibrating circuit for best indication. This means that high frequency multiplication for the associated PAL-1K transmitter operation occurs in the multiplication stages of the Model SBE.

### 2-2-2. DETERMINATION OF VOX FREQUENCY WHEN USED AS SBE's MF SUPPLY

As shown in the SBE's operating section, the medium frequency of the SBE may be crystal supplied (MF XTAL SW selects one of ten preselected crystals) or VMO supplied (Model VOX supplies proper frequency). Determine the VOX's frequency for operation of the SBE from the following formula.

$$f_o = f_{hf} - (f_{mf} - 0.25)$$

where

$f_o$ is SBE's (carrier) output frequency to the PAL-1K.

$f_{hf}$ is SBE's heterodyning frequency in the final stage.

$f_{mf}$ is VOX's frequency to heterodyne the SBE's MF stage.

### 2-2-3. CALIBRATION.

For maximum accuracy, the VOX must always be calibrated before use as close as practical to the frequency desired and, for this purpose, the VOX is provided with a calibrating circuit. A VMO and a 100-kc crystal-controlled calibrating oscillator are located within the VOX's oven. At numerous check points, harmonics of the VMO and the 100-kc oscillator correspond; consequently, at these check points, a zero-beat indicating device (phones and/or indicating lamp) may be used to adjust the VMO to its proper frequency. At a VMO frequency of 2,200,000 cps, for example, a check point exists; namely, fundamental of the VMO and 22nd harmonic of the 100-kc oscillator. At a VMO frequency of 2,214,286 cps, a check point also exists; namely, the seventh harmonic of the VMO and the 155th harmonic of the 100-kc oscillator. Again at a VMO frequency of 2,216,667 cps, another check point exists; namely, the sixth harmonic of the VMO and the 133rd harmonic of the 100-kc oscillator. Table 2-2 shows a number of checkpoints in the 2.2- to 2.3-mc frequency range. The 100-kc check points automatically cover 50- and 25-kc check points. A 100-kc crystal generates not only harmonics of the 100-kc fundamental but also harmonics of the 50- and 25-kc sub-tones. The sub-tone harmonics, however, are considerably weaker than the fundamental harmonics. Similar check points to those indicated in the 2.2- to 2.3-mc range exist in the 2.3- to 2.4-mc range and each higher 0.1-mc range.

To make these check point calibrations, the operator should perform the following functions:

| Step | Operation |
|---|---|
| 1 | Set POWER switch 4 to ON position. MAIN POWER indicator 8 should go on. |
| 2 | Set BEAT (ON-OFF) switch 1 to ON position. |
| 3 | Plug a headset into PHONES jack 3. |
| 4 | Turn BAND-MCS switch 19 to the desired band and XTAL switch 17 to VMO position. The operator should set MASTER OSCILLATOR FREQUENCY dial 14 which is marked directly in CPS, and turn this control until the dial reads to the nearest 50-kc point of the desired frequency. In order to calculate the correct dial reading, the operator must remember to divide the desired frequency by 2 for the 4- to 8-mc band, by 8 for the 16- to 32-mc band, etc. For accurate calibration and resettability, care must be taken to rotate the dial in the same direction (preferably from a lower dial reading to the higher) in order to prevent any error due to backlash. Then, by varying CALIBRATE control 13, a zero-beat indication will be obtained in the headset and on ZERO BEAT indicator 11. With a little experience, the operator finds that the visual indication alone is adequate, although he may continue to use the phones as an added convenience. The VOX has now been properly corrected for the dial region to be used and should be returned to the required frequency setting. |
| 5 | When the calibration procedure has been concluded, the operator must be certain that he sets BEAT (ON-OFF) switch 1 to OFF position. At the same time, METER switch 2 should be turned to HFO and HFO switch 5 turned to ON position. |
| 6 | The operator should now rotate TUNING knob 20 to a position roughly approximating the MASTER OSCILLATOR FREQUENCY dial, at which point he obtains a reading on the front panel milliammeter with OUTPUT control 16. TUNING knob 20 has been set properly when the highest milliammeter reading is obtained. |

In the event that a HFO crystal is used in place of the variable master oscillator, then proceed as follows:

| Step | Operation |
|---|---|
| 1 | Set POWER switch 4 to ON position |
| 2 | Set HFO switch 5 to ON position. |
| 3 | Turn METER switch 2 to HFO position. |
| 4 | Turn XTAL switch 17 to proper position. |
| 5 | Turn BAND-MCS switch 19 to proper band. |
| 6 | "Trim" the crystal by tuning XTAL FREQ trimmer 18 until the exact frequency is set, and peak with TUNING knob 20 as described above. |

## 2-2-4 OPERATING INSTRUCTIONS AFTER CALIBRATION

| Switch | Panel Designations | Operation | Result |
|---|---|---|---|
| 4 | POWER | ON | MAIN POWER indicator 8 goes on. |
| 5 | HFO | ON | INNER OVEN/OUTER OVEN indicators indicate a long warm-up period. Refer to CAUTION below. |
| 2 | METER | HFO, IFO, BFO, VMO | |
| 17 | XTAL | VMO or 1, 2, 3 | Selects the source for VOX's 2- to 64-mc output; namely, VOX's master oscillator (VMO) or an alternate VOX oscillator whose frequency is controlled by crystals 1, 2, and 3. |
| 19 | BAND-MCS | Proper band | Selects proper multiplier for VOX's master oscillator. |
| 14 | MASTER OSCILLATOR FREQUENCY | Desired oscillator frequency | |
| 16 | OUTPUT | Desired level | |
| 20 | TUNING | Maximize meter reading | May require a decrease in OUTPUT potentiometer 16. |

**CAUTION**

The VOX is a high stability precision instrument and requires an initial warm-up period of at least 48 hours of continuous duty; thereafter, the unit should never be turned off unless detailed repairs become necessary.

**TABLE 2-1. TABLE OF EQUIVALENT CONTROL DESIGNATIONS**

| SERIAL DESIGNATION (SEE FIGURE 2-1) | PANEL DESIGNATION (SEE FIGURE 2-1) | COMPONENT DESIGNATION ON OVERALL SCHEMATIC DIAGRAM |
|---|---|---|
| 1 | BEAT (ON-OFF) | Toggle switch S104 |
| 2 | METER | Knob (4-position) selector switch S107 |
| 3 | PHONES | Telephone jack J105 |
| 4 | POWER | Toggle switch S101 |
| 5 | HFO | Toggle switch S103 |
| 6 | IFO | Toggle switch S102 |
| 7 | BFO | Toggle switch S106 |
| 8 | MAIN POWER | Indicator I302 |
| 9 | INNER OVEN | Indicator I301 |
| 10 | OUTER OVEN | Indicator I304 |
| 11 | ZERO BEAT | Indicator I303 |
| 12 | Output meter (No designation) | Meter M301 |
| 13 | CALIBRATE | Slug inductance L301 |
| 14 | MASTER OSCILLATOR FREQUENCY (knob) | Knob variable capacitor C301 and C302 |
| 15 | MASTER OSCILLATOR FREQUENCY (dial) | ——— |
| 16 | OUTPUT | Knob potenetiometer R215 |
| 17 | XTAL | Knob (4-position) selector switch S201, A, B, C, and D |
| 18 | XTAL FREQ | Knob variable capacitor C210 |
| 19 | BAND-MCS | Knob (5-position) selector switch S202, A, B, C, and D |
| 20 | TUNING | Knob (5-position) selector switch C225, A, B, C, and D |

**TABLE 2-2. VOX'S CHECK-OUT POINTS: VMO VS 100-KC CALIBRATION OSCILLATOR (2.2- TO 2.3-MC FREQUENCY RANGE)**

| VMO FREQUENCY | VMO HARMONIC | 100-KC FUNDAMENTAL HARMONIC | 50-KC HALF-TONE HARMONIC |
|---|---|---|---|
| 2,200,000 | 5 | 110 | 220 |
| 2,205,000 | 10 | - | 441 |
| 2,210,000 | 10 | 221 | 442 |
| 2,212,500 | 4 | - | 177 |
| 2,220,000 | 5 | 111 | 222 |
| 2,225,000 | 4 | 89 | 178 |
| 2,228,571 | 7 | 156 | 312 |
| 2,230,000 | 10 | 223 | 446 |
| 2,233,333 | 3 | 67 | 134 |
| 2,240,000 | 5 | 112 | 224 |
| 2,245,000 | 10 | - | 449 |
| 2,250,000 | 4 | 89 | 178 |
| 2,255,000 | 10 | - | 451 |
| 2,260,000 | 5 | 113 | 226 |
| 2,266,667 | 3 | 68 | 136 |
| 2,271,428 | 7 | 159 | 318 |
| 2,275,000 | 4 | 91 | 182 |
| 2,280,000 | 5 | 114 | 228 |
| 2,283,333 | 6 | 137 | 274 |
| 2,285,714 | 7 | 160 | 320 |
| 2,290,000 | 10 | 229 | 458 |
| 2,295,000 | 10 | - | 459 |
| 2,300,000 | 1 | 23 | 46 |

## TABLE 2-3. FRONT PANEL CONTROLS OF THE VOX

| CONTROL | FUNCTION |
|---|---|
| POWER toggle switch (compartment behind door): | Applies line voltage to, or disconnects line voltage from, power supply circuit. |
| HFO toggle switch (compartment behind door): | Applies DC plate voltage to HFO vacuum tubes. |
| IFO toggle switch (compartment behind door): | Applies DC plate voltage to IFO vacuum tube. |
| BFO toggle switch (compartment behind door): | Applies DC screen voltage to BFO vacuum tube. |
| BEAT ON-OFF toggle switch (compartment behind door): | Applies 100-kc oscillator to one of MIXER (V103) vacuum tube grids. Other grid receives output of VMO (cathode V302). |
| METER selector switch (compartment behind door): | Enables meter to measure output of HFO, IFO, BFO, and VMO. |
| PHONES jack (compartment behind door): | Enables plugged-in receiver to receive beat tones. |
| TUNING selector switch: | Tunes HFO output circuit. Used to maximize meter reading with METER selector switch in HFO position. |
| OUTPUT potentiometer: | Controls level of output of HFO circuit. |
| BAND-MCS selector switch: | Controls tuning elements in HFO circuit. |
| XTAL FREQ padding capacitor: | Enables small changes in crystal frequency. Used only when VOX uses a crystal for RF output. |
| CALIBRATE potentiometer: | A control to calibrate VMO with 100-kc oscillator at check points. |
| MASTER OSCILLATOR FREQUENCY knob: | Controls output frequency of VMO. |
| XTAL selector switch: | Determines whether VOX's output is produced by crystals in positions 1, 2, 3, or by its VMO. |
| MASTER OSCILLATOR FREQUENCY dial: | Registers output frequency of VOX. |
| Meter: | Registers level of VOX's RF outputs in line with position of METER selector switch located in compartment behind door. |
| ZERO BEAT indicator: | Indicates beat tones when calibrating VMO with 100-kc oscillator at check points. |
| OUTER OVEN indicator: | Lights when outer oven is receiving heat. |
| INNER OVEN indicator: | Lights when inner oven is receiving heat. |
| MAIN POWER indicator: | Lights when VOX is receiving 60-cycle power. |
| BFO ADJ potentiometer (chassis mounted at top): | Controls BFO output level. |
| BFO XTAL SW (chassis mounted at rear): | Determines which of two crystals shall be used for BFO beats. |

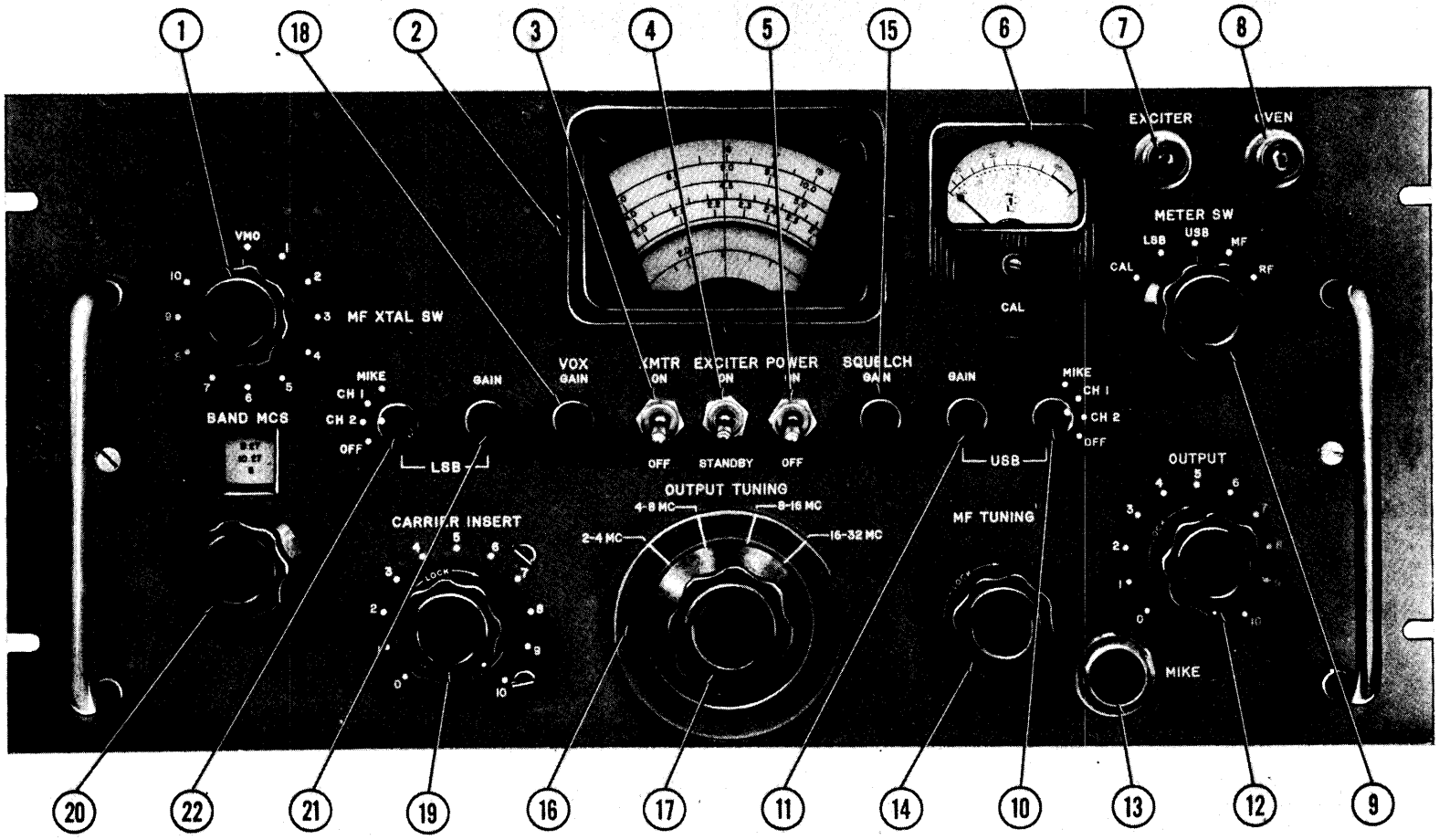



Figure 2-2. Operating Controls of SBE.

## 2-3. OPERATION OF MODEL SBE

2-3-1. PRELIMINARY CONSIDERATIONS.

Before attempting to operate the SBE (table 2-4 and figure 2-2), the following must be considered:.

a. Mode of transmission desired.

b. Input circuit controls.

c. Output frequency desired (crystal selection or use of VMO, bandwidth switch settings, etc.).

d. 250-kc carrier insertion.

e. MF circuit controls.

f. HF circuit controls.

g. Meter circuit and miscellaneous controls.

Mode of transmission breaks down into the following:

a. Single sideband with any degree of carrier insertion.

b. Double sideband with any degree of carrier insertion.

c. Independent sideband with any degree of carrier insertion.

d. Conventional AM operation.

e. Frequency-shift telegraphy.

f. CW or MCW telegraphy.

Input circuit controls are as follows:

a. LSB (channels, GAIN).

b. USB (channels, GAIN).

c. MIKE.

LSB control places audio channel 1, 2, or MIKE in the lower sideband position; USB control places audio channel 1, 2, or MIKE in the upper sideband position. A microphone connection is made into MIKE connector.

Initially, output frequency requirements are concerned with the following front panel controls: MF XTAL SW (1), BAND MCS (20), and OUTPUT TUNING knob (bandswitch element 17). Subsequently, tuning concerns the following front panel controls: OUTPUT TUNING disc (tuning element 16), MF TUNING (14), OUTPUT (level control 12), and METER SW (9) and its associated meter.

In this category of operations, the first consideration is whether the medium frequency (2 to 4 mc) is to be supplied by a VMO or a crystal. If by a VMO, the MF XTAL SW is placed in the VMO position; if by a crystal, MF XTAL SW is placed in the position that selects the proper crystal. More information on this phase of operation is given in the discussion below of medium frequency circuit controls.

The output frequency ($f_o$) desired requires the use of the proper medium frequency whether supplied by a VMO or a crystal. In the 2- to 4.25 -mc range of the SBE-3, the lower sideband output of the medium frequency modulator reaches the antenna without further modulation. The VMO or crystal frequency ($f_x$), therefore, is determined by the formula: $f_o = f_x - 0.25$. If the output frequency ($f_o$) is 2.00 mc, the crystal or VMO frequency ($f_x$) is 2.25 mc. Note that for $f_o$ between 3.75 and 4.25, the VMO or crystal frequency ranges between 4.00 and 4.50 mc. To provide an $f_o$ between 3.75 and 4.25 mc with VMO and XTAL frequencies below 4.00 mc, the medium frequency modulator is operated so as to pass its upper sideband to the antenna. The VMO or crystal frequency, therefore, is determined by the formula: $f_o = f_x + 0.25$. Under this arrangement, when $f_o$ is 3.75, $f_x$ becomes 3.50 mc; when $f_o$ is 4.00, $f_x$ becomes 3.75 mc; and when $f_o$ is 4.25, $f_x$ becomes 4.00 mc.

In the 4.25- to 32.25-mc range of the SBE-3, the output of the medium frequency modulator is modulated by the high frequency modulator whose lower sideband output, in turn, reaches the antenna. Consequently, the VMO or crystal frequency in this case is determined by the formulae:

$f_o = f_{hf} - (f_{mf} - 0.25)$; MF modulator passing lower sidebands

$f_o = f_{hf} - (f_{mf} + 0.25)$; MF modulator passing upper sidebands

The $f_{hf}$ (high frequency) crystals provide modulating frequencies of 8 to 34 mc in 2-mc steps; the $f_{mf}$ (medium frequency) crystals range between 2 and 4 mc. For example:

| $f_o$ | $f_{hf}$ | $f_{mf}$ |
|---|---|---|
| 4.25 | 8.00 | 4.00 |
| 8.00 | 10.00 | 2.25 |
| 15.00 | 18.00 | 3.25 |
| 21.50 | 24.00 | 2.75 |
| 27.25 | 30.00 | 3.00 |
| 32.25 | 34.00 | 2.50 |

Referring to 250-kc carrier insertion, the degree of carrier insertion is controlled by the setting of front panel potentiometer designated CARRIER INSERT (19). The magnitude of carrier relative to sidebands may be readily determined in transmitter operation by the use of a frequency spectrum analyzer.

Referring to medium frequency circuit controls, the following front panel controls are used to adjust the medium frequency modulator: CARRIER INSERT, MF TUNING, and METER SW and its associated meter. The medium frequency modulator receives 250-kc sideband signals and VMO or MF XTAL frequencies; its output circuit is tuned to (passes) the lower sideband of the VMO or MF XTAL frequency.

Referring to high frequency circuit controls, the following front panel controls are used to adjust the high frequency modulator together with the SBE's RF circuit's tuning elements: BAND MCS, OUTPUT TUNING (bandswitch, tuning elements), OUTPUT (level), METER SW and its associated meter. The high frequency modulator receives the lower sideband output of the medium frequency modulator in addition to the output of the high frequency crystal oscillator; its output circuit and that of the SBE's RF circuit is tuned to (passes) the lower sideband of the high frequency crystal oscillator's frequency.

Referring to meter circuit and miscellaneous controls, the transmitter is operated with the front panel controls listed below as shown:

| | |
|---|---|
| VOX GAIN (18): | fully CCW |
| XMTR (3): | ON |
| EXCITER (4): | ON |
| POWER (5): | ON |
| SQUELCH GAIN (15): | fully CCW |

2-3-2. SINGLE SIDEBAND WITH ANY DEGREE OF CARRIER INSERTION.

| Step | Panel Serial Desig. | Operation | Purpose |
|---|---|---|---|
| Part I - Tuneup on Carrier: | | | |
| 1 | 3 | XMTR toggle switch, ON | Not effective on tuneup on carrier. |
| 2 | 4 | EXCITER toggle switch, ON. | |
| 3 | 18 | VOX GAIN, fully CCW | |
| 4 | 15 | SQUELCH GAIN, fully CCW. | |
| 5 | 21,22 | LSB, OFF/GAIN, fully CCW. | Not in circuit on tuneup on carrier. |
| 6 | 10,11 | USB, OFF/GAIN, fully CCW. | |
| 7 | 5,8 | POWER toggle switch, ON. | Energizes. OVEN indicator 8 should go on. |
| 8 | 1 | MF XTAL SW, use correct MF VMO/XTAL, frequency | Refer to paragraph 2-3-1. |
| 9 | 20 | BAND MCS, use correct MF frequency. | Refer to paragraph 2-3-1. |
| 10 | 19 | CARRIER INSERT, fully CW. | Provides 100% carrier. |
| 11 | 9 | METER SW, MF position. | In preparation for Step 13. |
| 12 | 16,17,2 | OUTPUT TUNING switch: knob 17 (coarse setting) for proper band, and disc 16 (vernier setting) for a frequency slightly below the desired output frequency on multi-scale dial 2. | In preparation for Step 13. |

| Step | Panel Serial Desig. | Operation | Purpose |
|---|---|---|---|
| Part I - Tuneup on Carrier (Cont.) | | | |
| 13 | 14,6,19, 2 | MF TUNING knob 14, tune MF. Peak SBE's meter 6 reading. | Decrease CARRIER INSERT 19 as necessary to avoid an off-scale reading. The reading on single-scale dial 2 should agree with the frequency of VMO on MF XTAL SW 1. |
| 14 | 9 | METER SW, RF position. | In preparation for Step 15. |
| 15 | 16,6 | OUTPUT TUNING disc 16, tune RF. Peak SBE's meter 6 reading. | Advance the OUTPUT TUNING vernier switch 17 slightly to peak the reading on the SBE's meter.<br>**NOTE**<br>Several peaks, due to modulation products, are possible. The correct (lower sideband) peak is the first one encountered as the vernier switch is slightly advanced. |
| 16 | 12,19 | Adjust OUTPUT knob 12 to control magnitude of the RF output. | Operation of OUTPUT knob 12 controls the magnitude of the RF output. The same is true by operating CARRIER INSERT switch 19. |
| 17 | | The SBE is now tuned on carrier. | |
| Part II - Tuneup on SSB with Any Degree of Carrier Insertion: | | | |
| 18 | 21,22 | LSB circuit to CH 1, CH 2, or MIKE as required. Set GAIN to mid position. | To place audio channel in lower sideband. |
| 19 | 10,11 | USB circuit to CH 1, CH 2, or MIKE as required. Set GAIN to mid position. | To place audio channel in upper sideband. |
| 20 | 19 | Set CARRIER INSERT to 0. | To suppress carrier 100%. |
| 21 | 6,9,10,11, 21,22 | Set METER SW 9 to USB or LSB. Advance or decrease GAIN control 11 or 21 as required until meter shows a maximum reading of 100 on audio peaks. (Lower peak values are frequently compatible with sufficient RF output as determined by the subsequent setting of OUTPUT control 12.) | **CAUTION**<br>With METER SW 9 in USB, LSB, or RF position, meter peaks must never exceed 100 as intermodulation distortion may become excessive beyond this point. |

| Step | Panel Serial Desig. | Operation | Purpose |
|---|---|---|---|

Part II - Tuneup on SSB with Any Degree of Carrier Insertion (Cont.)

| | | | |
|---|---|---|---|
| 22 | 9 | Set METER SW 9 to RF position. | Preparatory to step 23. |
| 23 | 12,19 | Adjust OUTPUT control 12 for desired level simultaneously with adjusting CARRIER INSERT control 19 for desired degree of carrier insertion. | |
| 24 | 6,9,12, 19 | With METER SW 9 in RF position and CARRIER INSERT 19 in 0 position, set OUTPUT control 12 to give meter 6 reading of 90 with one of the audio channels in operation. Now advance CARRIER INSERT control 19 until meter 6 reading becomes 100. | Steps 24 and 25 illustrate the procedure to inject a carrier 20 db down from full PEP. Increasing a meter reading of 90 due to audio with no carrier and to 100 with carrier (audio level unchanged) signifies a carrier level of 10% (-20 db) of the combined audio and carrier level. |
| | | **NOTE**<br>As explained more fully in Section 5, the SBE's meter circuit, as is the case with most VTVM's, has a small amount of waveform error. For this reason, carrier and sideband addition may not be precisely linear. | |
| 25 | 12 | Decrease OUTPUT control 12 for desired PEP output. Do not change audio and carrier settings (11,19 and 21). | Decreases audio and carrier proportionately. |

## 2-3-3. INDEPENDENT SIDEBAND WITH ANY DEGREE OF CARRIER INSERTION.

Part I, tuneup on a carrier, is the same as part I in paragraph 2-3-2.After completing part I, proceed as follows: (For convenience, the following steps, 18 through 32, assume that channel 1 is used on the lower sideband and channel 2 is used on the upper sideband with either 0- or 10-percent carrier insertion. In case channel 1 is used on the upper sideband and channel 2 is used on the lower sideband with either 0- or 10-percent carrier insertion, substitute CH 2 or CH 1 and vice versa in the settings of USB 10 and LSB 22 controls.)

| Step | Panel Serial Desig. | Operation | Purpose |
|---|---|---|---|

Part II - Tuneup on ISB with Any Degree of Carrier Insertion:

| | | | |
|---|---|---|---|
| | | **NOTE**<br>Step numbering begins with 18 since this part II follows part I of paragraph 2-3-2 | |
| 18 | 21,22 | LSB circuit to CH 1; set GAIN to quarter-scale. | To place desired audio channel in lower sideband. |
| 19 | 19 | CARRIER INSERT, set to 0. | To suppress carrier 100%. |

| Step | Panel Serial Desig. | Operation | Purpose |
|---|---|---|---|

Part II - Tuneup on ISB with Any Degree of Carrier Insertion (Cont.)

| | | | |
|---|---|---|---|
| 20 | 10,11 | USB circuit to OFF, set GAIN to quarter-scale. | To cut off desired audio channel in upper sideband. |
| 21 | 9 | Set METER SW to LSB. | To measure desired audio channel level to lower sideband. |
| 22 | 6,21 | Adjust LSB GAIN until the meter shows the following readings on audio peaks:<br>Carrier Insertion Eventually Wanted — Audio Peaks<br>0 — 50<br>10% (-20 db) — 45 | To obtain proper desired audio channel level in lower sideband with or without 10% carrier insertion. |
| 23 | 22 | Set control 22 to OFF | To cut off desired channel in lower sideband. |
| 24 | 10,11 | USB circuit to CH 2; set GAIN to quarter-scale. | To place desired audio channel in upper sideband. |
| 25 | 19 | CARRIER INSERT, leave on 0. | To suppress carrier 100%. |
| 26 | 9 | Set METER SW to USB. | To measure desired audio channel level in upper sideband. |
| 27 | 6,11 | Adjust USB GAIN until the meter shows the following readings on audio peaks:<br>Carrier Insertion Eventually Wanted — Audio Peaks<br>0 — 50<br>10% (-20 db) — 45 | To obtain proper desired audio channel level in upper sideband with or without 10% carrier insertion. |
| 28 | 9 | Set METER SW to RF. | To measure audio level after RF modulation. |
| 29 | 12,6 | Advance OUTPUT control 12 from 0 until meter 6 reads same as in step 27. | Check that LSB switch is OFF and USB switch is in desired channel. |
| 30 | 10,22 | Set USB switch to OFF and LSB switch to its desired channel. | Check that METER SW is in RF position. |
| 31 | 6,21 | Note reading on meter 6. Re-adjust LSB GAIN control 21 until meter 6 reads same as in step 22. | |
| 32 | 6,22,10 | Turn controls 22 and 10 to place CH 1 or CH 2 in both sidebands. Meter 6 should now read as follows on peaks: | |

| Step | Panel Serial Desig. | Operation | Purpose |
|---|---|---|---|

Part II - Tuneup on ISB with Any Degree of Carrier Insertion (Cont.)

| | | | |
|---|---|---|---|
| 32 cont. | | Carrier Insertion Finally Wanted / Audio Peaks<br>0 / 100<br>10% (-20 db) / 90 | |
| | | As explained more fully in Section 5, the SBE's meter circuit, as is the case with most VTVM's, has a small amount of waveform error. For this reason, carrier and sideband additions may not be precisely linear. | |
| 33 | 19 | Set CARRIER INSERT to give desired amount of carrier insertion. For 0 insertion: turn control 19 to 0; peak readings on Meter 6 should reach 100. For 10% (-20 db) insertion: advance control 19 until peak readings on meter 6 rise from 90 to 100. | |

**TABLE 2-4. TABLE OF EQUIVALENT CONTROL DESIGNATIONS**

| SERIAL DESIGNATION (SEE FIGURE 3-1) | PANEL DESIGNATION (SEE FIGURE 3-1) | COMPONENT DESIGNATION ON OVERALL SCHEMATIC DIAGRAM |
|---|---|---|
| 1 | MF XTAL SW | Knob (11-position) selector switch S107 |
| 2 | 2-position dial (no designation) | ——— |
| 3 | XMTR ON-OFF | Toggle switch S104 |
| 4 | EXCITER ON-OFF | Toggle switch S105 |
| 5 | POWER ON-OFF | Toggle switch S103 |
| 6 | Output meter (no designation) | Meter M101 |
| 7 | EXCITER | Indicator I101 |
| 8 | OVEN | Indicator I102 |
| 9 | METER SW | Knob (5-position) selector switch S109 |
| 10 | USB (audio channels) | Knob (4-position) selector switch S101 |
| 11 | USB GAIN | Knob potentiometer R168 |
| 12 | OUTPUT | Knob potentiometer R205 |

continued overleaf

| SERIAL DESIGNATION (SEE FIGURE 3-1) | PANEL DESIGNATION (SEE FIGURE 3-1) | COMPONENT DESIGNATION ON OVERALL SCHEMATIC DIAGRAM |
|---|---|---|
| 13 | MIKE | 3-conductor jack J101 |
| 14 | MF TUNING | Knob variable capacitor C167, A and B |
| 15 | SQUELCH GAIN | Knob potentiometer R129 |
| 16 | OUTPUT TUNING (disc) | Disc variable capacitor C181, A, B, and C |
| 17 | OUTPUT TUNING (knob) | Knob (4-position) selector switch S106, A, B, C and D |
| 18 | VOX GAIN | Knob potentiometer R140 |
| 19 | CARRIER INSERT | Knob potentiometer R263 |
| 20 | BAND MCS | Knob (18-position) selector switch S108, A and B |
| 21 | LSB GAIN | Knob potentiometer R169 |
| 22 | LSB (channels) | Knob (4-position) selector switch S102 |

**TABLE 2-5. FRONT PANEL CONTROLS OF THE SBE-3**

| CONTROL | FUNCTION |
|---|---|
| POWER ON-OFF (S103) | ON - Applies line voltage to SBE.<br>OFF - Turns off entire SBE. |
| EXCITER ON-STANDBY (S105) | ON - Activates SBE without need for VOX or push-to-talk input and without operating GPT-10K.<br><br>STANDBY - Allows VOX or push-to-talk to activate the SBE and the GPT-10K which the SBE serves. |
| XMTR ON-OFF (S104) | ON - Activates GPT-10K. Eliminates need for VOX or push-to-talk, through S105 (above), by completing the ground circuit of the XMTR final plates relay.<br><br>OFF - GPT-10K operated by VOX or push-to-talk circuit when EXCITER switch is in STANDBY position. |
| LSB | Switch selects audio input source for lower sideband channel.<br><br>GAIN - Adjusts level of LSB audio input. |
| USB | Switch selects audio input source for upper sideband channel.<br><br>GAIN - Adjusts level of USB audio input. |
| VOX GAIN | Voice operated GPT-10K circuit gain control. |
| SQUELCH GAIN | Used in conjunction with VOX GAIN. (Refer to paragraph 4-4f of Volume II of the manual.) |

| CONTROL | FUNCTION |
|---|---|
| MF XTAL SW | Selects either external oscillator (VMO) or proper crystal for mid-frequency oscillator. |
| BAND MCS | Indicates injection frequency range of high-frequency modulator in 2-mc increments. It is controlled by the knob beneath the dial. |
| CARRIER INSERT | Controls level of carrier insertion. |
| OUTPUT TUNING | Selects output frequency band and adjusts setting of main tuning dial centrally located above knob. |
| MF TUNING | Selects setting of mid-frequency as indicated in lower section of main tuning dial. |
| OUTPUT | Adjusts exciter output power level. |
| METER SW | Selects point in system to be measured by built-in VTVM circuit. CAL position is used to zero meter. |
| CAL | Meter adjustment located directly beneath meter. Use screwdriver to zero meter when METER SW is in CAL position. |
| EXCITER lamp | Glows during operation when EXCITER switch is in ON position or EXCITER is activated by VOX or push-to-talk. |
| OVEN lamp | Glows during operation when thermostats demand oven heating (automatic). |
| MIKE | Input jack to audio pre-amp for all high-impedance (500 k) microphones. |
| POWER SUPPLY | |
| Lamp | Glows during operation. Indicates MAIN fuse intact and power is applied.<br>B+ FUSE: 100 volts 0.25 amp; 220 volts 0.25 amp<br>MAIN FUSE: 100 volts 3.0 amp; 220 volts 1.5 amp<br>OVEN FUSE: 100 volts 2.0 amp; 220 volts 1.0 amp<br>These fuses protect their respective circuits. |

## 2-4. OPERATION OF MODEL PAL-1K

2-4-1. PRELIMINARY POWER OFF ADJUSTMENTS.

Place the following controls in the positions indicated before applying AC power to the PAL-1K.

ASSOCIATED EXCITER

POWER ON/OFF — ON

OUTPUT — OFF or MINIMUM

(Permit the exciter to warm up for the proper length of time before applying power to the associated transmitter.)

**NOTE**

All frequency determining elements of the exciter units should be given their proper warm-up times before attempting to transmit. Single sideband suppressed carrier transmission requires a degree of high frequency stability for maximum effectiveness, and a 24-hour warm-up period is recommended.

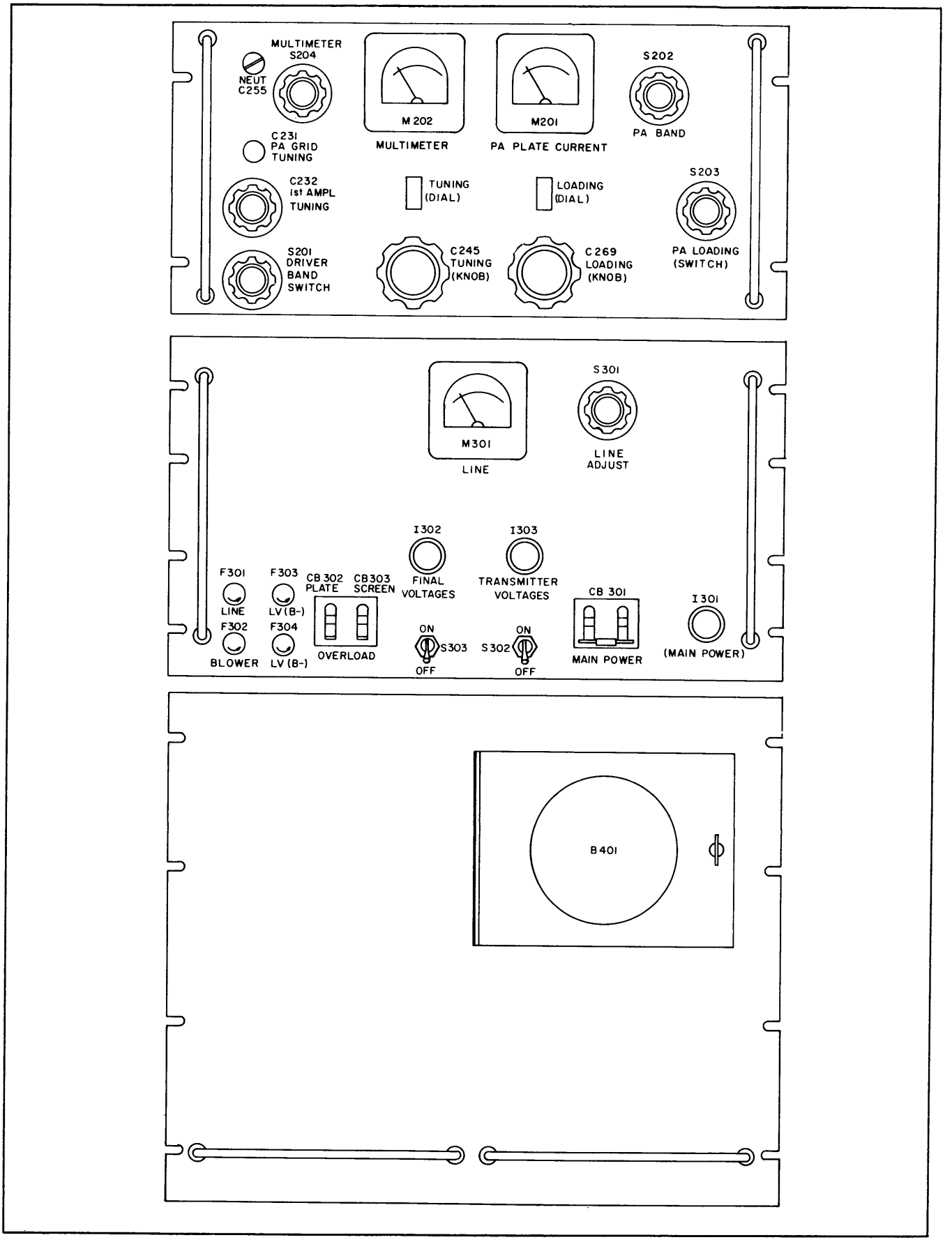



Figure 2-3. Operating Controls, PAL-1K.

PS-4

| | |
|---|---|
| LINE ADJUST | Position 4 from fully ccw. |
| FINAL VOLTAGES | OFF |
| TRANSMITTER VOLTAGES | OFF |
| OVERLOAD PLATE SCREEN | OFF |
| MAIN POWER | OFF |

2-4-2. PRELIMINARY POWER ON ADJUSTMENTS.

a. Tune the associated exciter for the desired output frequency. Return output to zero.

**NOTE**

No provision is made for a different output from input frequency in the RFD. The frequency of output is the same as that fed from the exciter. Since the RFD is a linear amplifier, attempts to multiply frequency in this unit prove unsuccessful.

b. Set MAIN POWER circuit breaker located on PS-4 to ON; the indicator should go on. If not, check to see that the previous steps have been performed properly, or refer to Section 6.

c. Check the filament LINE meter for a reading of 115 volts. Use LINE ADJUST switch for correction if necessary. Set OVERLOAD PLATE SCREEN circuit breaker to ON. Select the range to be used by turning the DRIVER BAND and PA BAND switches on RFD to position of selected frequency.

2-4-3. PAL-1K TUNING.

a. Turn the TRANSMITTER VOLTAGES switch to ON; the indicator goes on after the MAIN POWER circuit breaker has been ON for about 2 minutes. When the indicator does go on, the procedure may be continued.

b. Turn the MULTIMETER switch on the RFD to the 1ST AMPL $E_p$ position.

c. Increase OUTPUT control of exciter until a usable reading is obtained on the MULTIMETER of the RFD.

d. Rotate the 1ST AMPL TUNING control, observing the MULTIMETER for a peak reading.

e. Turn the MULTIMETER switch to PA $E_g$.

f. Rotate the PA GRID TUNING control, observing the MULTIMETER for a peak reading.

g. Rotate the OUTPUT control of the exciter fully ccw.

h. Turn the PA TUNING control to approximate setting as indicated in tuning chart, table 2-6.

i. Turn PA LOADING switch as indicated in tuning chart, table 2-6.

j. Turn PA LOADING control as indicated in tuning chart, table 2-6.

k. Turn the FINAL VOLTAGES switch to ON.

l. Increase the OUTPUT of the exciter until the PA PLATE CURRENT meter on the RFD indicates about 300 ma. (Idling current about 200 ma).

m. Adjust PA TUNING control, observing the PLATE CURRENT meter for a dip.

n. Increase the PA LOADING control until the plate current rises.

o. Readjust OUTPUT control on the exciter unit for a PA PLATE CURRENT of 300 ma.

p. Adjust PA TUNING control for a PA PLATE CURRENT dip.

q. Repeat PA TUNING and PA LOADING adjustments until the desired power output is reached with a minimum OUTPUT on the exciter as indicated on RFD MULTIMETER (PA $E_g$.). The screen current (PA $I_{sg}$.) is with a resistive load, usually under 35-40 ma. At no time should the screen current reading exceed full scale.

r. Turn the TRANSMITTER VOLTAGES switch to OFF.

2-4-4. PAL-1K OPERATION.

The transmitter may be operated by turning the TRANSMITTER VOLTAGES switch to ON or it may be operated remotely through the external interlock connection.

PA PLATE CURRENT OVERLOAD current is approximately 600 ma. Rated RF output power should be obtained on approximately 500 ma.

PA SCREEN CURRENT OVERLOAD setting is fixed by screen grid overload breaker CB 303 in power supply PS-4; set to open at 50 ma.

2-4-5. SHUTDOWN PROCEDURE.

Turn the FINAL VOLTAGES and TRANSMITTER VOLTAGES to OFF. Wait 5 minutes before turning the MAIN POWER switch to OFF, thus permitting tube PL-172 to cool, prolonging its life.

2-4-6. OVERLOAD CIRCUIT BREAKERS.

If during tuning or operation, the transmitter should automatically be shut down (red indicators off) check the OVERLOAD PLATE SCREEN switch. If they are OFF reduce the exciter output before switching them to ON. Check the PA PLATE CURRENT and/or PA $I_{sg}$. to be sure there is no overload as indicated by very high or off scale readings.

2-4-7. OPERATOR'S MAINTENANCE.

a. Fuses should be replaced with fuses of the same value. If fuses continue to open, do not insert a larger fuse unless continued operation is more important than damage to the equipment. Refer to paragraph 2-3-3 for fuse values.

b. In order to prevent failure of the equipment due to corrosion, dust, and other destructive ambient conditions, thoroughly inspect the inside of the chassis for signs of dirt, dampness, molding or corrosion. This should be done periodically depending upon the severity of the conditions. Clean the affected parts with a cleaning agent of proven quality.

**TABLE 2-6. TUNING CHART**

| f | VMO Freq. | PA Band | 1st AMPL RF Volts | PA $E_g$ Volts | PA Tuning | PA Loading | PA Loading Pos. |
|---|---|---|---|---|---|---|---|
| 2.0 | 2.500 | 2.0-2.5 | 10 | 21 | 020 | 105 | 1 |
| 2.5 | 3.000 | 2.0-2.5 | 10 | 20 | 054 | 118 | 2 |
| 2.5 | 3.000 | 2.5-3.0 | 10 | 24 | 040 | 002 | 2 |
| 3.0 | 3.500 | 2.5-3.0 | 11 | 20 | 062 | 005 | 3 |
| 3.0 | 3.500 | 3.0-4.0 | 11 | 20 | 053 | 069 | 2 |
| 4.0 | 2.250 | 3.0-4.0 | 11 | 20 | 079 | 089 | 3 |
| 4.0 | 2.250 | 4.0-6.0 | 11 | 20 | 074 | 058 | 2 |
| 6.0 | 3.250 | 4.0-6.0 | 10 | 20 | 196 | 067 | 3 |
| 6.0 | 3.250 | 6.0-8.0 | 9 | 23 | 141 | 058 | 2 |
| 8.0 | 2.125 | 6.0-8.0 | 9 | 22 | 184 | 040 | 3 |
| 8.0 | 2.125 | 8.0-12 | 10 | 20 | 142 | 050 | 2 |
| 12 | 3.125 | 8.0-12 | 10 | 19 | 197 | 041 | 3 |
| 12 | 3.125 | 12-16 | 8 | 20 | 172 | 008 | 3 |
| 16 | 2.062 | 12.16 | 9 | 18 | 205 | 060 | 3 |
| 16 | 2.062 | 16-22 | 8 | 20 | 170 | 009 | 3 |
| 22 | 2.812 | 16-22 | 11 | 18 | 205 | 081 | 3 |
| 22 | 2.812 | 22-32 | 12 | 20 | 170 | 039 | 3 |
| 32 | 2.031 | 22-32 | 12 | 22 | 147 | 097 | 3 |

**NOTE**

This tuning chart was obtained on an early model and is presented for illustrative purposes only. In each specific case, on initial setup the settings of PAL-1K's dials should conform with the tuning chart supplied with the equipment. This chart was obtained by factory checkout tests made under factory conditions. Subsequently, this chart, too, should be replaced by settings obtained under field usage conditions of the PAL-1K.

# ADDENDUM

Adjustments

(Section 6 of Technical Manual for Linear Power Amplifier PAL-1K)

1. PA PLATE IDLING (No Drive) current - Approximately 200 ma.
   Set by adjusting PS-4's PA BIAS ADJ resistor R310.

2. PA PLATE CURRENT OVERLOAD Current - Approximately 600 ma.
   Set by adjusting PS-4's PA PLATE OVERLOAD ADJ resistor R303.

3. PA SCREEN CURRENT OVERLOAD SETTING
   Fixed by screen grid overload breaker CB 303 in power supply PS-4. Set to open at 50 ma.

4. Typical PA PLATE and SCREEN CURRENT

| OPERATION | PLATE | SCREEN | REMARKS |
|---|---|---|---|
| SSB | 400-480 | 30-45 | Values depend upon |
| CW/FS | 550-600 | 35-50 | age of tube. |

5. Neutralization - see page 6-3, paragraph 6-5, g.
   a. Tune and load amplifier at 8 mc. Remove PL-172's B+. Connect a VTVM across PL-172's tank. Adjust RFD's NEUTRALIZING capacitor C255 to minimize VTVM's reading.

   b. Tune and load amplifier at 30 mc. Remove PL-172's B+. Connect a VTVM across PL-172's tank. Readjust RFD's NEUTRALIZING capacitor C255 to minimize VTVM's reading.

   c. If the setting in items a and b differ, use a compromise setting to keep VTVM's readings low at both the 8 and 30 mc points.

6. Errata in Sections 2, 3, and 4 of above reference manual.
   Page 2-0, Paragraph 2-4, b: change C connector to HN connector
   Page 3-2, Paragraph 3-5, g: change 15 ma to 35-40 ma.
   Page 4-1 Table: change +400 to +575.