

**OPERATING AND
SERVICE
INSTRUCTIONS
FOR...**

**COMMUNICATIONS
TRANSMITTER/EXCITER
MODEL HT-32
MARK I**

the hallicrafters CO.



A Subsidiary of Northrop Corp



Figure 1. Hallicrafters Model HT-32 Transmitter/Exciter

92-4164

SECTION I GENERAL

1-1 The Hallicrafters Model HT-32 Transmitter/Exciter is the ultimate in design of self-contained transmitting equipment. This twenty-tube precision built transmitter/exciter is capable of SSB (single sideband with suppressed carrier), DSB, and CW transmission in the 80, 40, 20, 15, 11, and 10 meter bands. This unit can represent the complete transmitting complement of any amateur station. The only requirements for immediate "on the air" operation are a 50-ohm terminated antenna system, key or microphone, and AC power source.

1-2. This unit may be utilized as a complete self-contained transmitter, or as an exciter for a linear power amplifier such as the Hallicrafters Model HT-33. If other linear amplifiers are employed, they should be capable of supplying a 50-ohm termination to the driver output to utilize the full capabilities of the HT-32. Maximum power output ratings of the HT-32 are:

SSB, 70-100 watts P. E. P. (peak envelope power);
CW 70-100 watts; and DSB 17-25 watts (carrier power).

Prominent features of the HT-32 Transmitter/Exciter are:

- New high frequency crystal sideband filter - rejection 50 db. or more.
- Bridged-tee sideband modulator.
- C. T. O. direct reading in kilocycles to less than 300 cycles from reference point.
- 144 watts plate input (P. E. P. two-tone).

- Six band output (80, 40, 20, 15, 11-10 meters).
- Unwanted sideband down 50 db. or more.
- Distortion products down 30 db. or more.
- Carrier suppression down 50 db. or more.

1-3. T. V. I. (Television Interference) SUPPRESSION

The HT-32 has been designed and constructed to suppress spurious radiations that may cause television interference. The TVI problem was given full consideration in the design of every circuit as well as in the selection and layout of parts. Adequate filtering has been provided for control circuits and AC power lines. Components were specifically selected to avoid undesired resonances and arranged to prevent parasitic oscillation.

Another important T. V. I. proofing feature is employed in the output coupling circuit of the final amplifier. The tuned output circuit is a pi network that has inherently excellent harmonic suppression ability. The unique design of this network is such that the conventional loading control is unnecessary and only the final tank tuning need be adjusted. The pi network is connected to a coaxial connector and permits the use of any antenna system having a transmission line impedance of 50 ohms. In addition to these factory installed precautions, a 50-ohm low pass TVI filter, which connects between the antenna and the transmitter/exciter output, is available as an accessory. This unit

may be obtained from your Hallicrafters dealer under part number 1X2621.

The Model HT-32 Transmitter/Exciter, as received from the factory, has had every advantage of Hallicrafters advanced engineering to minimize television interference. There are, however, some types of TVI that cannot be prevented within the transmitter itself. For example, when a television receiver is located in the immediate vicinity of the transmitter/exciter it is entirely possible that a fundamental signal will reach

the input grid of the receiver in sufficient strength to cause a slight amount of interference. In such cases, it will be necessary to install a filter or trap at the television receiver to attenuate the transmitter's fundamental signal. If the interfering signal does not enter the television receiver through the antenna, special shielding or filters on the TV receiver may be necessary. For a more complete discussion of measures that may be used to handle these special television interference problems, refer to the ARRL HANDBOOK.

SECTION II INSTALLATION

2-1. UNPACKING.

After unpacking the HT-32 Transmitter/Exciter, examine it closely for any possible damage which may have occurred during transit. Should any sign of damage be apparent, file a claim immediately with the carrier stating the extent of damage. Carefully check all shipping labels and tags for any special instructions before removing or destroying them.

2-2. LOCATION.

Although the Model HT-32 Transmitter/Exciter is provided with a built-in power driven fan for cooling purposes, avoid excessively warm locations such as those near radiators and heating vents. The unit should be placed in a location that provides adequate space around it, permitting free circulation of air through the

chassis to connect the HT-32 Transmitter/Exciter into your control system. The mating connector for this socket is an Amphenol 86-PM11. The instructions which follow may be modified to suit your particular needs.

2-4-3. KEY (Pins 8 and 9). For CW operation, the hand key or "bug" is connected to pins 8 and 9 of the control outlet. Pin 9 is internally grounded in the unit. When the key is up, cutoff bias is maintained at the third mixer and driver stages. Closing the key removes the cutoff bias providing signal excitation to the succeeding RF amplifier stages. A key jack is also provided at the front panel for those who prefer a panel connection for the key.

2-4-4. ANTENNA RELAY (Pins 2, 3 and 4). An external antenna change-over relay may be employed by

IMPORTANT: If in doubt about your power source, contact your local power company prior to inserting the power cord into an AC power outlet. Plugging the power cord into the wrong power source can cause extensive damage to the unit, requiring costly repairs.

2-4. REAR CHASSIS CONNECTIONS (See Figure 2)

Sockets are provided on the rear of the HT-32 Transmitter/Exciter for the following purposes:

2-4-1. R. F. OUTPUT.

This is a coaxial connector which connects the Transmitter/Exciter to the antenna system or a linear amplifier. The connecting cable (52 ohm coax.) should be fitted with an Amphenol type 83-ISP connector or its equivalent. The selection of the type of antenna and coupling will depend upon the frequencies used and the purpose of operation. Refer to the ARRL ANTENNA HANDBOOK for detailed information concerning transmitting antennas.

2-4-2. CONTROL OUTLET

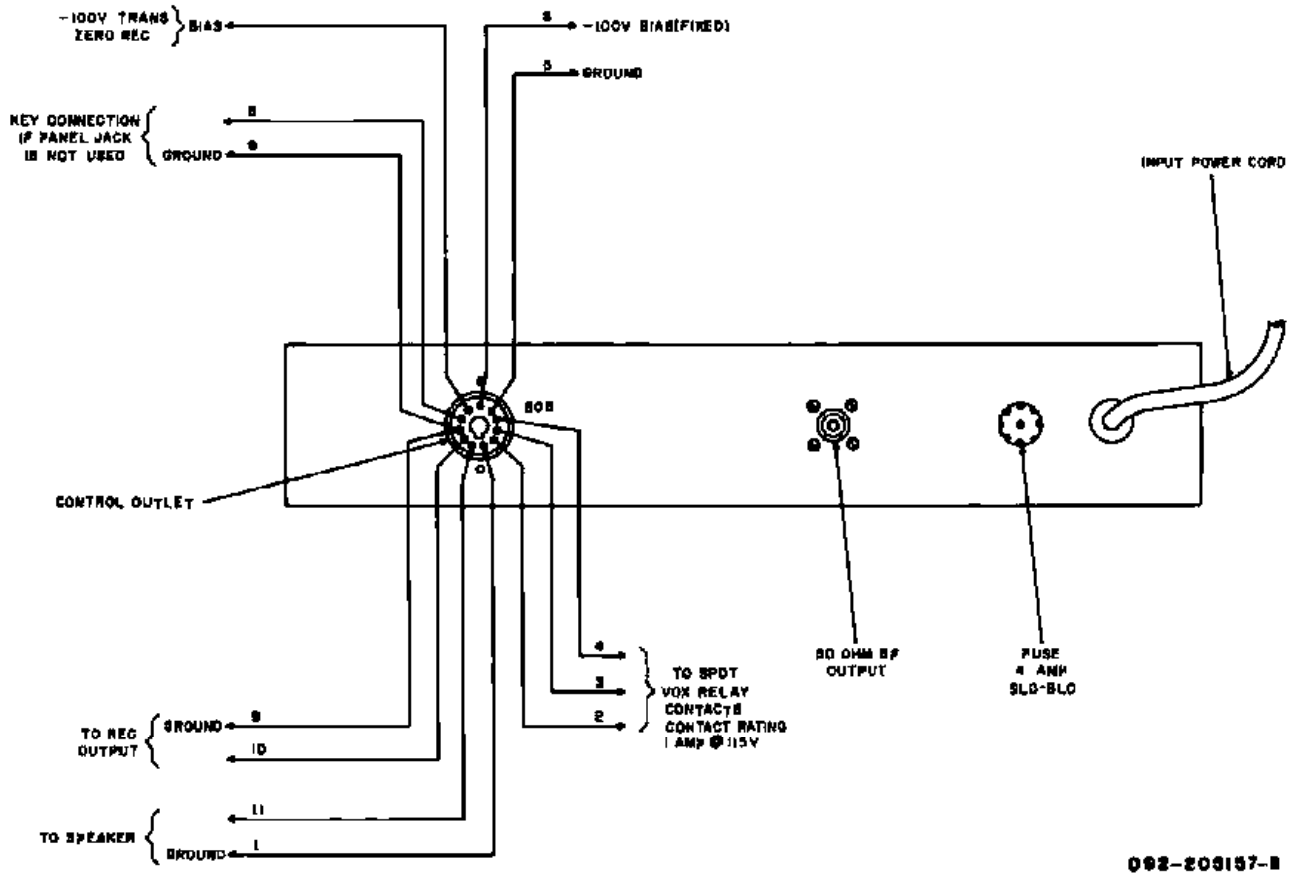
An eleven pin socket is provided at the rear of the

internal antenna change-over relay. For external applications where an open circuit is required when transmitting, pins 3 and 4 may be used. The voltage required of the external power source is dependent upon the type change-over relay used. A coaxial type relay for 50-ohm transmission line impedance is recommended. Where pins 2, 3, and 4 are used to switch external equipment loads, the load current should be limited to one ampere.

2-4-5. RECEIVER AUDIO (Pins 9 and 10) AND SPEAKER (Pins 1 and 11).

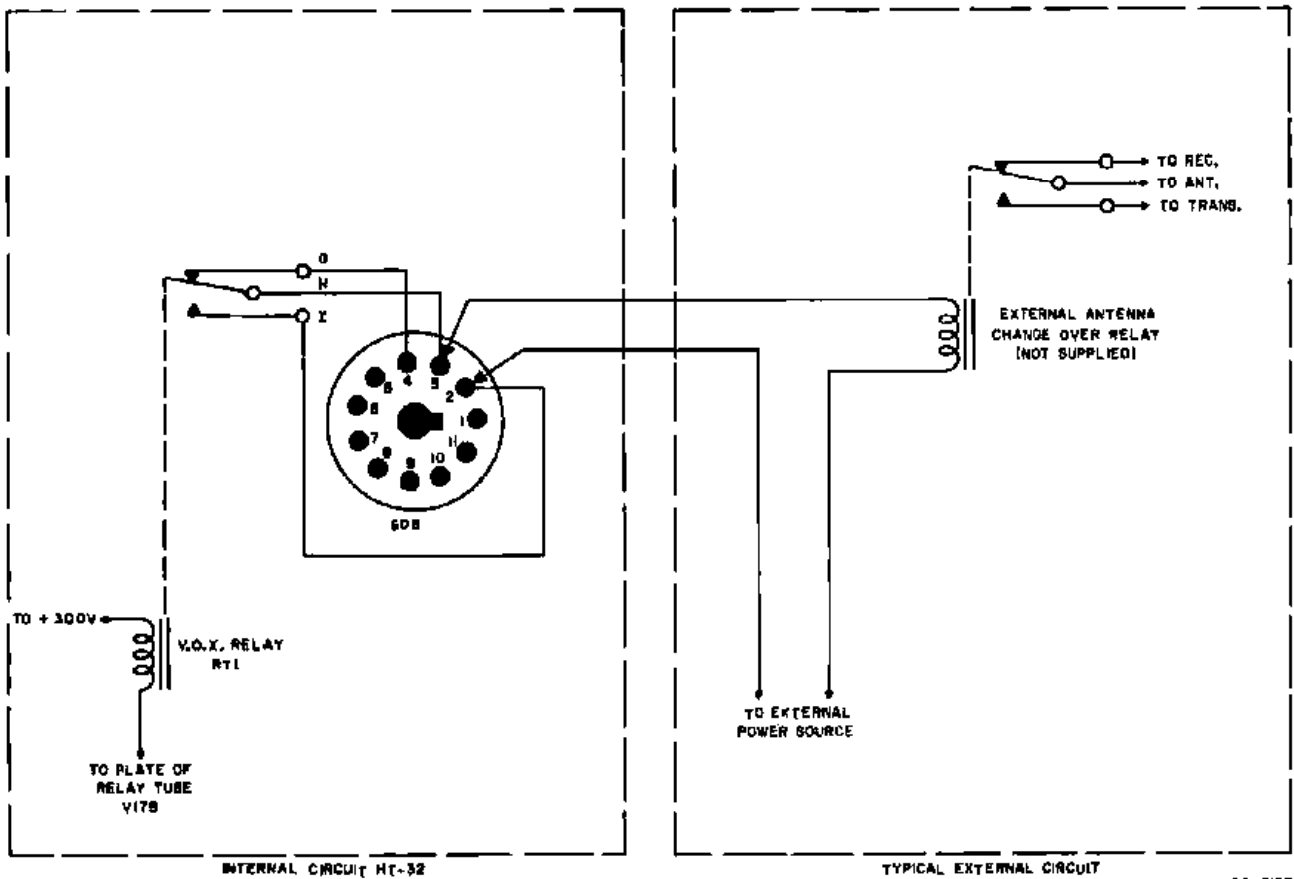
Connect the audio output of the station's receiver directly to pins 9 and 10 of the control outlet. (Pin 9 is ground or chassis side.) Connect a 2 watt resistor across the receiver audio output to maintain a load at all times. The receiver speaker is connected directly to pins 1 and 11. (Pin 1 is ground side.) Connecting the receiver and speaker in this manner prevents the actuating of the transmitter/exciter VOX circuit by incoming audio signals from the receiver and also disconnects the receiver output to the speaker when the transmitter/exciter is on the air. Use an 18-ohm 2 watt resistor for 3 to 8 ohm voice coil impedances or 1500 ohm 2 watt resistor for 500-600 ohm outputs.

2-4-6. BIAS (Pins 5, 6, and 7). Cutoff bias (-100V) or



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Figure 2. Rear Chassis Connections



92-2122

Figure 3. Control Outlet Relay Connections

control bias is available at either pin 6 or pin 7 with pin 5 used as the return or ground connection. At pin 6 the bias is fixed at -100V regardless of the mode of operation of the transmitter. At pin 7 the voltage is zero at standby or receive and -100V during transmis-

sion, an external relay may be used with the fixed bias provided at pin 6. Note that the bias source is high impedance and not intended as a "hard" bias source for fixed bias applications in power amplifiers.

SECTION III FUNCTION OF OPERATING CONTROLS

3-1. FUNCTION

The FUNCTION control is a four position rotary switch which selects CW, DSB, UPPER or LOWER SIDEBAND type of transmission as desired by the operator. An analysis of the FUNCTION switch operation is given in paragraphs 4-4, 4-5, and 4-6.

3-2. OPERATION

This control is a five position rotary switch which turns the power to the transmitter on or off, places the transmitter in calibrate operation or selects the mode of operation (VOX or MOX). The "CALIBRATE" position is used in conjunction with the CALIBRATE LEVEL control. (See paragraph 3-11.)

CAUTION

When turning off transmitter, stop momentarily in the "STANDBY" position, before turning switch to "OFF" position.

The "MOX" position energizes the transmitter control relay to the transmit position. This position of the OPERATION switch is used when manual control of transmission is desired. Return the switch to the "STANDBY" position during receiving periods.

In the "CALIBRATE" position, the transmitter/exciter control relay (VOX RELAY) is de-energized, permitting normal receiving operation with an antenna change-over relay (if used) in the receiver position. With the receiver in operation the transmitter signal can now be monitored and the signal level in the receiver controlled with the CALIBRATE LEVEL control. See paragraph 3-11.

In the "VOX" position, the transmitter control relay is operated by voice energy from the microphone. The relay tube is biased to cut-off and will not energize the VOX RELAY until signal excitation is received from the audio amplifier and vox amplifier stages.

3-3. DRIVER TUNING

This control is a variable capacitor in the VFO mixer plate, and driver plate circuits, and will resonate the circuits to any frequency in the 80, 40, 20, 15 and 10-11 meter bands.

3-4. BAND SELECTOR

The BAND SELECTOR control is a five position ro-

tary switch which selects the proper combination of tuned circuits and stages for the desired frequency band. It also selects the correct crystal oscillator (4.05 or 13.95 MC) to produce the desired sideband when the FUNCTION switch is set at either "UPPER" or "LOWER SIDEBAND"

3-5. FINAL TUNING

This control is a variable capacitor in the final amplifier tank circuit and will resonate the circuit to the operating frequency of the selected band. The dial calibrations permit presetting the control roughly during tune up.

3-6. FREQUENCY

The FREQUENCY control is a variable capacitor which sets the VFO frequency. The VFO covers the frequency range 5,000 kilocycles to 5,500 kilocycles. With mixing circuits, the VFO will set the transmitter/exciter to the desired operating frequency as indicated on the dial in any of the five bands. Each minor marker on the skirt of the FREQUENCY control is equivalent to approximately 200 cycles on all bands.

3-7. DIAL DRAG

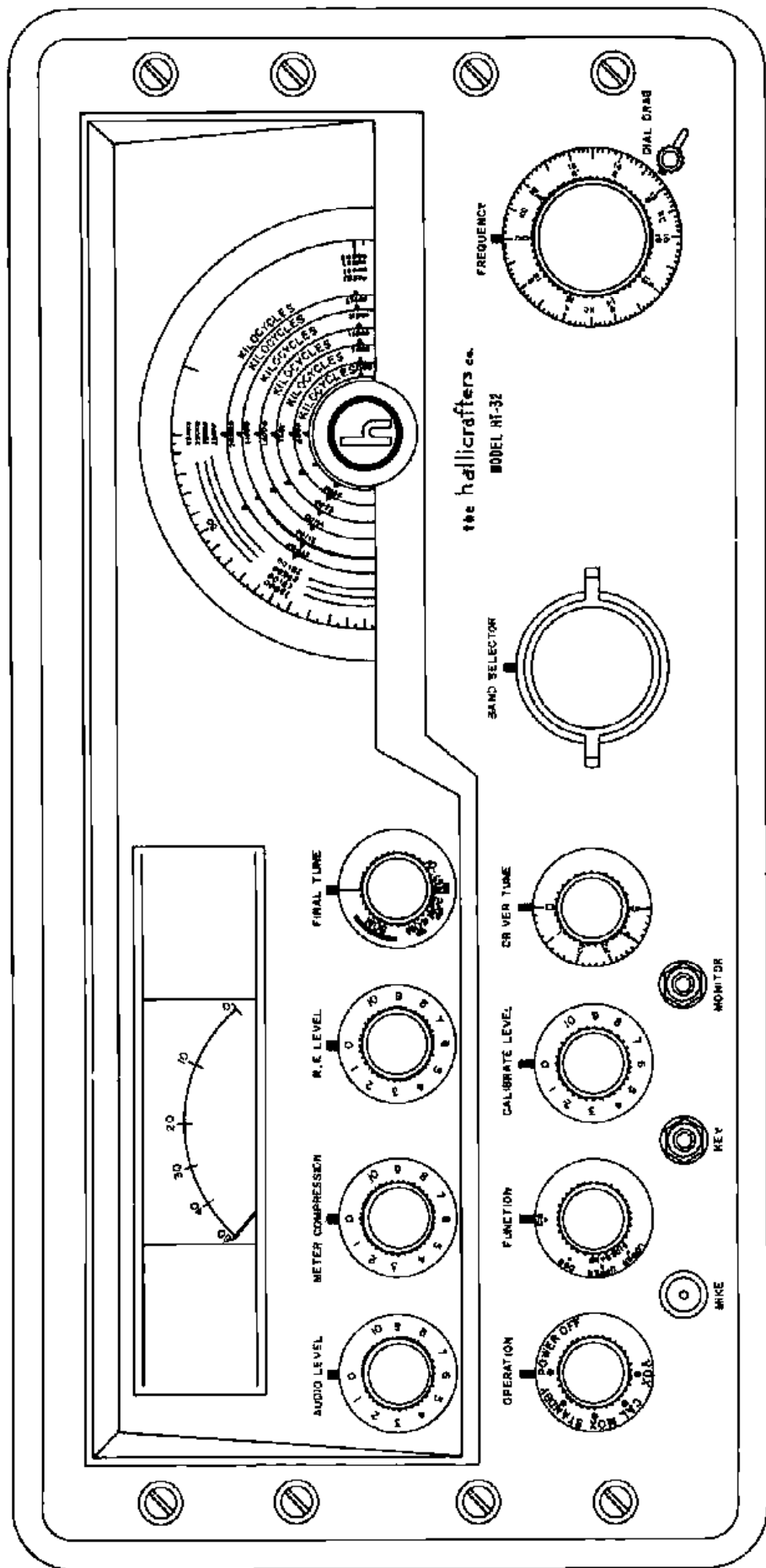
This is a mechanical brake which can be adjusted either to lock or apply drag to the FREQUENCY control to avoid accidental rotation of the control during operation.

3-8. AUDIO LEVEL

This control is a potentiometer connected in the grid circuit of the third audio amplifier stage and adjusts the amount of audio drive to the "bridged-T" balanced modulator. It has sufficient range to permit adjustment for any high level crystal microphone or low level dynamic microphone normally used for voice communications.

3-9. RF LEVEL

The RF LEVEL control is a potentiometer in the grid bias circuit of the 9 mc amplifier tube to adjust the gain of the 9 mc amplifier. On DSB and CW, the amount of carrier in the output signal is determined by the setting of the RF LEVEL control.



92-9199-1

Figure 4. Front Panel

3-10. METER COMPRESSION.

This is a meter sensitivity control which permits the operator to set the meter at maximum deflection (0 db) for desired output level (between approximately 1/4 power and full power) when establishing proper drive levels in the transmitter/exciter. (See LEVEL INDICATOR METER, paragraph 3-13.)

3-11. CALIBRATE LEVEL.

The CALIBRATE LEVEL control provides a low level adjustment of the transmitter output for SSB, DSB, or CW operation when the OPERATION control is set at CALIBRATE. The CALIBRATE LEVEL control is normally set to provide the desired signal level in the station receiver for monitoring purposes and need not be changed except possibly when changing bands. For CW or DSB work a carrier signal is obtained for "zero beat" frequency setting. On SSB a sideband signal is obtained when talking into microphone to "talk onto frequency". If the zero beat method is preferred by the sideband operator, the FUNCTION control is switched to DSB to obtain a carrier for calibration purposes then switched back to the desired sideband before going on the air. Note that on DSB or CW the preset RF LEVEL setting is not to be disturbed when calibrating.

3-12. MONITOR.

Inserting headphones into this jack permits voice controlled headphone reception in the VOX mode of operation. Inserting the plug of a headset in the jack will automatically cut off the receiver speaker when it is connected as instructed in paragraph 2-4-5.

3-13. LEVEL INDICATOR METER.

The LEVEL INDICATOR METER indicates the output of the transmitter/exciter in db below "0" db reference, enabling the adjustment of the transmitter/exciter for correct output (drive level required for a linear amplifier or approximate rated output for "barefoot" operation). Tuning of the transmitter has been simplified by the design of the front panel meter circuit. The meter scale is compressed to enable low-level signals to produce a usable indication, yet strong signals do not drive the meter winter off scale. This feature gives the meter a wide usable dynamic range which is not possible to obtain with a linear scale. The desired amount of compression may be obtained by adjusting the METER COMPRESSION control on the front panel. The output reading on the LEVEL INDICATOR METER can be shifted to read full scale ("0" db) down to approximately 1/4 of full power and any level below this reference can easily be read on the meter. A log of METER COMPRESSION control settings, for normal output into loads of controlled and reproducible characteristics, will aid in re-establishing proper drive levels and determining the proper operation of the unit. The log should be recorded at various frequencies and modes of operation.

To monitor carrier suppression for SSB operation set the METER COMPRESSION control to read zero db reference on the meter at the maximum sideband output (single tone) and read carrier level directly when the audio excitation is removed. Note that the MOX mode of operation must be used for this test since in VOX operation the transmitter is disabled between voice controlled transmissions by the operation of the VOX relay.

SECTION IV TUNING PROCEDURE

4-1. GENERAL.

The tuning procedure for the Model HT-32 Transmitter/Exciter has been simplified by design as much as possible to permit rapid adjustment by the operator. This does not mean, however, that a transmitter, commercial or home-built, may be operated successfully when only roughly adjusted. A clean signal from any transmitter requires good operator technique.

Two mis-tuning conditions on the HT-32 Transmitter/Exciter are possible, neither of which can be accidentally used on the air. These undesired signals are

or more below fundamental output when the transmitter is correctly tuned up.

1. On the 15-meter band the undesired signal will appear when the DRIVER TUNE control is set outside its normal tuning range, approximately 0 to 1 division on the dial. Note that its level cannot be increased on AM or CW with the RF LEVEL control or driver by speech input on SSB, hence may be identified in this manner.
2. On the 10-meter band the undesired signal will appear when the DRIVER TUNE control is set

outside its normal tuning range. For example when tuning the 29 mc to 29.5 mc segment of the 10-meter band, the DRIVER TUNE control will normally tune up around 4 on the dial while the unwanted signal tunes up at around 2 divisions on the dial. Here again it is identified by the fact that its level cannot be increased on AM or CW with the RF LEVEL control or driver on SSB with speech input

4-2. LOAD.

Connect a 50-ohm non-reactive load to the R.F.

linear amplifier. A 50-ohm non-reactive load of at least 100 watts dissipation capabilities is required to handle the full power output.

4-3. INITIAL CONTROL SETTINGS.

Set the front panel controls to their starting positions as outlined below.

OPERATION	STANDBY (Power on)
FUNCTION	DSB
AUDIO LEVEL	0
R.F. LEVEL	0

METER COMPRESSION.....5
 CALIBRATE LEVEL.....0
 DRIVER TUNING.....CENTER OF ROTATION
 FINAL TUNING.....DESIRED BAND SEGMENT
 BAND SELECTOR.....DESIRED BAND
 FREQUENCY.....DESIRED FREQUENCY

4-4. CW TUNING.

The tuning procedure for CW operation will be presented first since AM (DSB) and SSB tuning procedures are modifications of that required for CW operation.

The tuning procedure for CW operation is as follows:

1. Set the OPERATION switch at MOX, FUNCTION switch at DSB.
2. Tune the driver and final amplifier stages, with the DRIVER TUNE and FINAL TUNE controls, for maximum meter deflection. Advance the RF LEVEL control slightly if necessary to obtain reasonable meter readings for tune up. Since

MAXIMUM OUTPUT.

3. Set FUNCTION switch at CW and close key.
4. Advance the RF LEVEL control slowly while observing the output meter. When feeding a dummy or an antenna load set the control at a point where further rotation does not cause an appreciable increase in the meter reading. This is saturation output, operate slightly below this level for CW. When driving a final amplifier stage with the HT-32 Transmitter/Exciter, advance the RF LEVEL control until required excitation is obtained for the amplifier. In either case do not operate beyond the saturation level.
5. A convenient reference for this operating level may be obtained by setting the METER COMPRESSION control so that the output meter reads 0 db.
6. Recheck the driver and final tuning by reducing the carrier level by about 5 or 10 db on the output meter with the RF LEVEL control and touching up the DRIVER TUNE and FINAL TUNE controls for maximum output. Reset the RF LEVEL control for maximum output just below the saturation point as outlined above.
7. Open the key. The output should drop to zero.
8. When operating CW with separate transmitting and receiving antennas the OPERATION switch may be left in the MOX position since the transmitter is completely disabled when the key is open. If the transmitter and receiver share the same antenna, and the antenna change-over relay is operated by the relay in the transmitter, then the OPERATION

4-5. SSB TUNING.

The tuning procedure for SSB operation is as follows:

1. Set the OPERATION switch at MOX, FUNCTION switch at DSB (Audio level zero).
2. Tune the driver and final amplifier stages as described for CW tune up.
3. Set the FUNCTION switch to UPPER or LOWER sideband as desired. If the output meter was referenced at 0 db for maximum output with the COMPRESSION control, the meter will now indicate the carrier suppression directly in db below maximum output.
4. Set the OPERATION switch at MOX (manual operation).
5. While monitoring the transmitter output, proceed with SSB transmission, setting the AUDIO LEVEL control for the required audio gain which does not produce peak flattening or overload distortion of the output signal. Note that the output meter damping factor prevents the meter from indicating

6. If manual operation is desired on SSB, switch the OPERATION control between MOX and STANDBY. For voice control operation with the receiver and transmitter interconnected, set the OPERATION control at VOX. To "zero-in" on frequency see paragraph 3-11 regarding the calibration procedure. For information on the use of the VOX, DELAY, and ANTI-TRIP controls see paragraphs 4-8, and 4-9.

4-6. AM (DSB) TUNING.

The tuning procedure for AM operation is as follows:

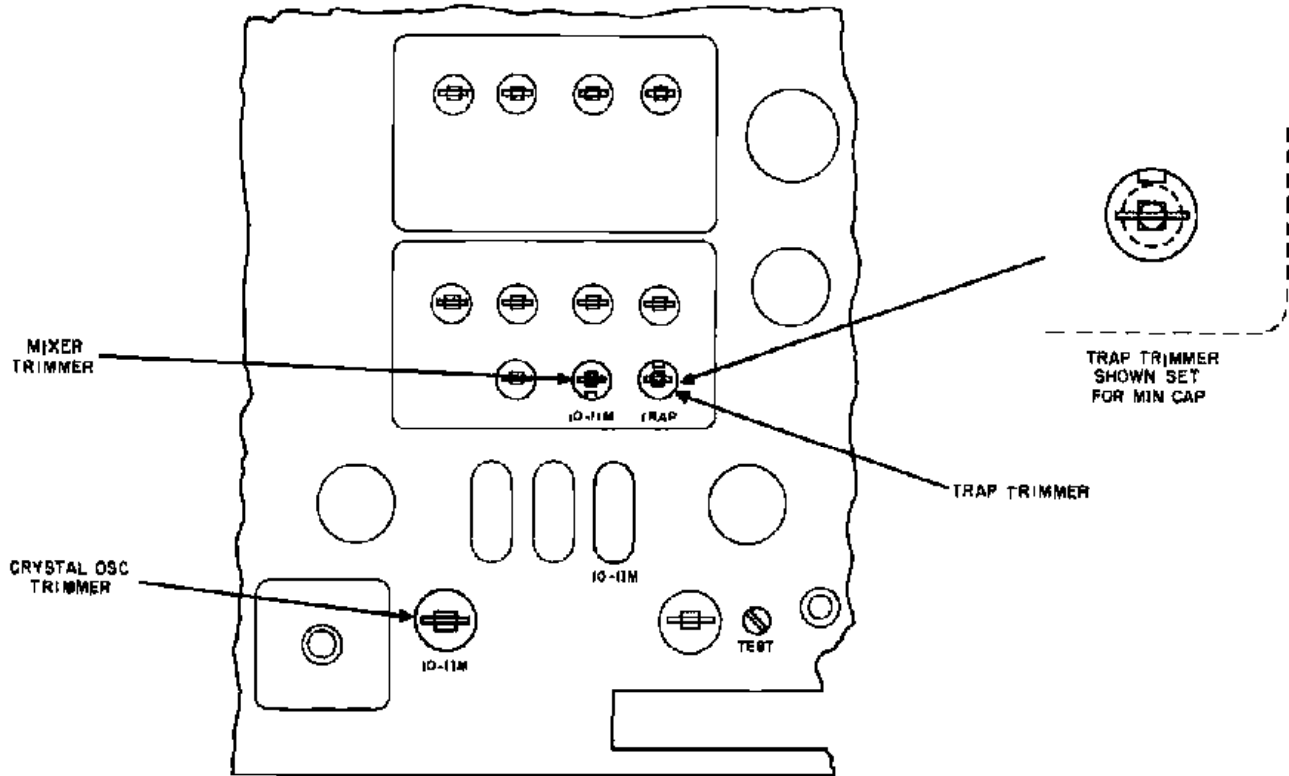
1. Set the OPERATION switch at MOX, FUNCTION switch at DSB (Audio level zero).
2. Tune the driver and final amplifier stages as described for CW tune up.
3. When feeding a dummy or antenna load advance the RF LEVEL control to the saturated output level and reference 0 db on the output meter with the METER COMPRESSION control as described for CW tune up. When driving a linear power amplifier with the HT-32 advance the RF LEVEL control until maximum linear power output is obtained from the final amplifier stage before setting the reference level on the output meter.
4. With the RF LEVEL control, reduce the carrier level 6 db as read on the output meter. This sets the maximum carrier level that the linear amplifiers in the HT-32 Transmitter/Exciter or following linear power amplifier can handle and provide 100% modulation capabilities. This carrier reference level can be established more pre-

imum power output capabilities are not attained at 100% modulation.

5. While monitoring the transmitter output, proceed with AM transmission, setting the AUDIO LEVEL control for the required audio gain which does not produce peak flattening or over modulation distortion of the output signal. Note that the output meter damping factor permits a rough operational check

on over modulation. The output meter will drop about 1 to 2 db in level when the percentage of modulation with voice excitation runs close to 100%.

6. If manual operation is desired on AM, switch the OPERATION control between MOX and STANDBY. For voice control operation with the receiver and transmitter interconnected, set the OPERATION control at VOX.



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Figure 5. 10-11 Meter Band Adjustments

4-7. SEGMENT ALIGNMENT FOR 10-11M BAND.

The HT-32 Transmitter/Exciter is set up at the factory to provide transmission in the 28.5 to 29.0 MC segment of the 10M band.

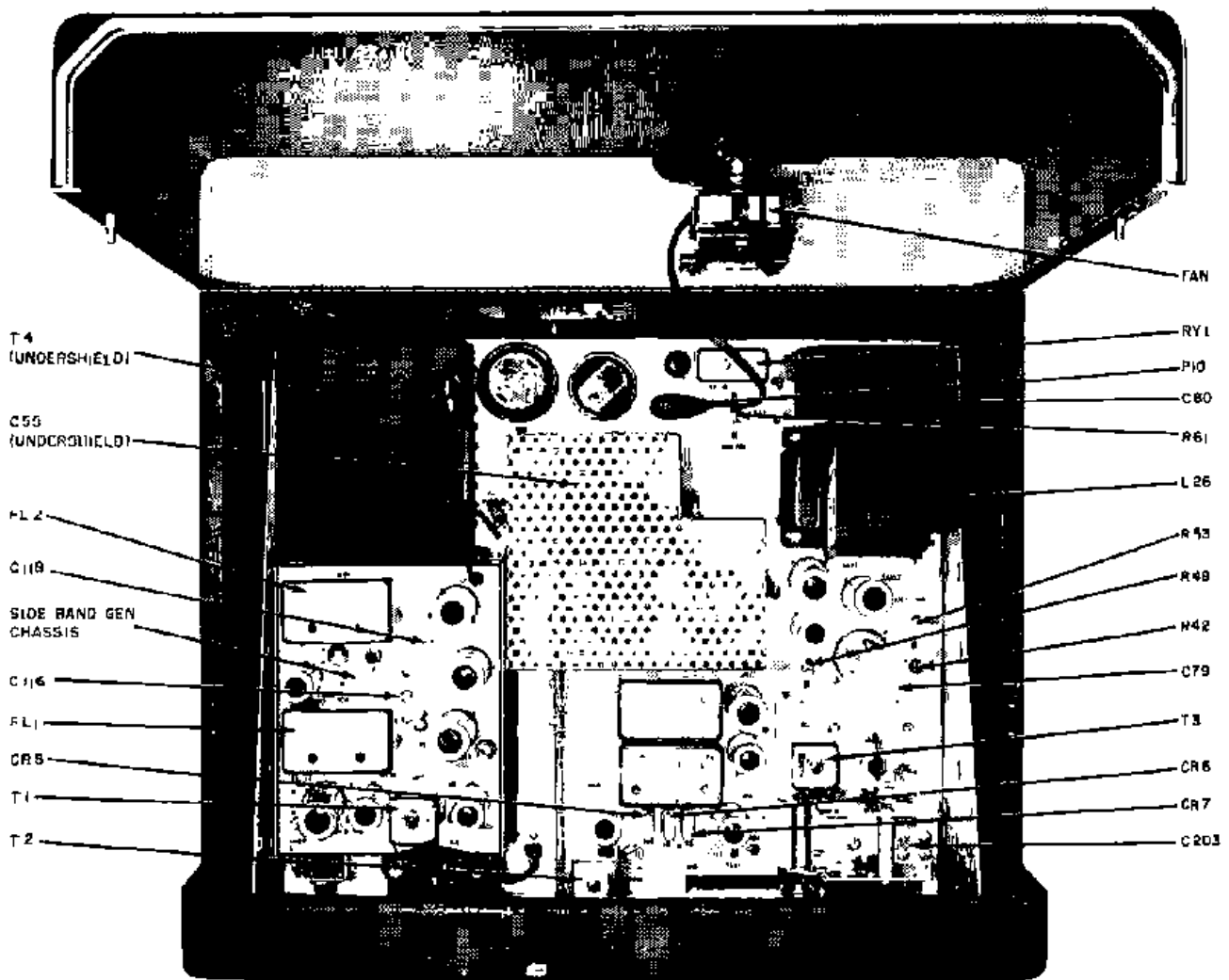
The 11M band or other 0.5 MC segments of 10M band are set up as follows; (Refer to Figure 5 for locations of the various adjustments referred to in the following procedure.)

1. Tune upon CW and determine the saturation level setting of the RF LEVEL control. Record this setting for future reference in step 5.
2. Remove the 32.5 MC crystal and insert desired crystal. *

BAND	NOMINAL FREQ.	OUTPUT FREQ.	PART NUMBER
11M	*30.9Mc	28.86 - 27.23mc	19B1982
10M	*32.0Mc	28.0 - 28.5 mc	19B1983
10M	32.5Mc	28.5 - 28.0 mc	19B1984
10M	*33.0Mc	29.0 - 29.5 mc	19B1985
10M	*23.5Mc	28.5 - 30.0 mc	19B1986

*NOTE: These crystals are available but not supplied with the transmitter.

3. Connect electronic voltmeter or similar high impedance DC voltmeter (0-10V) to crystal oscillator test point, and adjust crystal oscillator trimmer for approximately half of the voltage obtained at the maximum voltage setting of the trimmer. Set the trimmer on the gentle slope side of resonance.
4. Set TRAP TRIMMER for minimum capacity and adjust 11-10M mixer trimmer for maximum output. Increase RF LEVEL control setting if necessary to pick up an output meter reading as the mixer is tuned to resonance. Back off the RF LEVEL as resonance is obtained with mixer trimmer and DRIVER TUNE control.
5. Touchup FINAL TUNE control then adjust crystal oscillator trimmer and RF LEVEL control until the saturation output again occurs at the RF LEVEL setting originally obtained for the previous crystal used. See step 1.
6. Trap adjustment - This adjustment is optional as far as spurious output in the 10M band is concerned since its level is less than 60 db below fundamental only when the transmitter is mistuned. To locate



82-516.

Figure 6. Top Chassis View

the spurious signal, turn the RF LEVEL control to zero or switch to upper or lower sideband position of the operation switch, and tune the DRIVER TUNE and FINAL TUNE for maximum output. Adjust the 10-11M trap trimmer for minimum output meter reading.

7. Re-check the 10-11M mixer trimmer setting by again tuning upon the desired frequency and peaking the trimmer, since the trap adjustment will affect the original mixer setting slightly.

4-8. USE OF VOX AND DELAY CONTROLS.

The VOX and DELAY controls are located on the top of the transmitter/exciter chassis as illustrated in Figure 6. Both controls are utilized in conjunction with VOX operation and are adjusted to provide control of the transmitter and station receiver.

1. The VOX control is an audio sensitivity control which determines the audio level which will trip (energize) the VOX RELAY, placing the transmitter/exciter "on the air". This control should be adjusted with the microphone at the normal

speaking distance from the mouth. Advance the VOX control to a setting slightly above that which will "trip" the VOX RELAY. Excessive sensitivity will have the undesirable result of background noise "tripping" the VOX RELAY and placing the transmitter/exciter on the air. Note that the VOX sensitivity control and the AUDIO LEVEL control for the microphone are separate level adjustments, hence for example, backing off the AUDIO LEVEL control will not reduce the VOX sensitivity.

2. The DELAY control is in the grid circuit of the relay tube and determines the time lag in de-energizing the VOX RELAY when audio excitation is removed from the audio amplifier and VOX amplifier stages. This control should be advanced while speaking into the microphone and set at a position in which the time lapse between words will not de-energize the VOX RELAY. This adjustment will eliminate the constant keying of the transmitter/exciter at the beginning of each word when speaking. There is a slight interaction between the VOX and DELAY circuits, consequently, a slight re-adjustment of both controls may be necessary to obtain desired results.

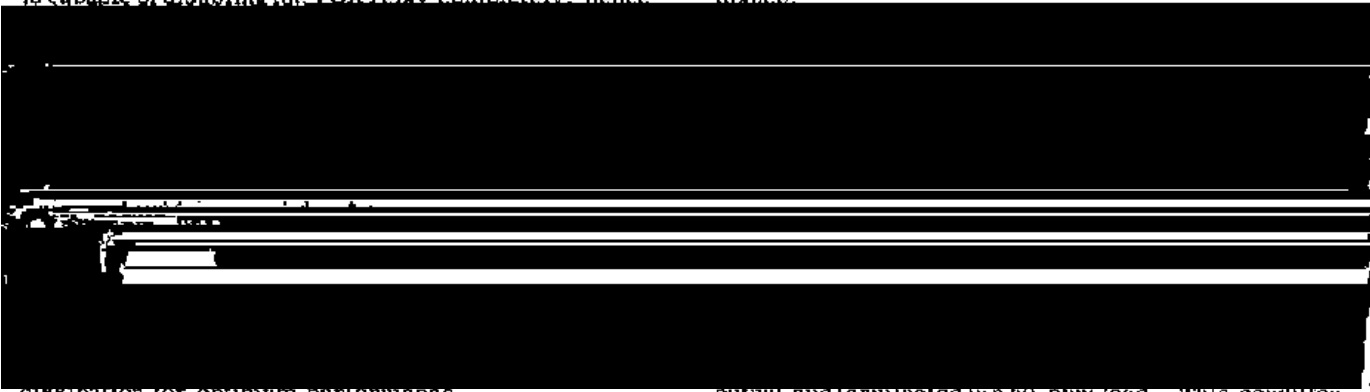
4-9. USE OF ANTI-TRIP CONTROL.

This control is located on top of the transmitter/exciter chassis (Figure 6) and is used in conjunction with VOX operation. When the station receiver and speaker are connected for VOX operation (paragraph 2-4-5), the speaker ANTI-TRIP control is advanced to a setting where the audio signal picked up by the microphone from the receiver's speaker will not energize the VOX RELAY. This feature prevents the re-transmitting of the incoming audio signals from your station receiver. Note that an excessive speaker gain setting is capable of disabling the VOX relay completely, hence

To adjust the bias, set the OPERATION switch at MOX, FUNCTION switch at either sideband (zero signal) and adjust for $-49V \pm 1V$ with the voltmeter connected between the test point terminal (-) and chassis (+). Note polarity since this is a bias voltage.

4-11. MODEL HT-32 WITH LINEAR POWER AMPLIFIER.

When the Model HT-32 Transmitter/Exciter is used to drive a linear amplifier, swamping or padding between the units may be required for optimum performance.



dissipation for optimum performance.

output and terminated in a 50-ohm load. This condition

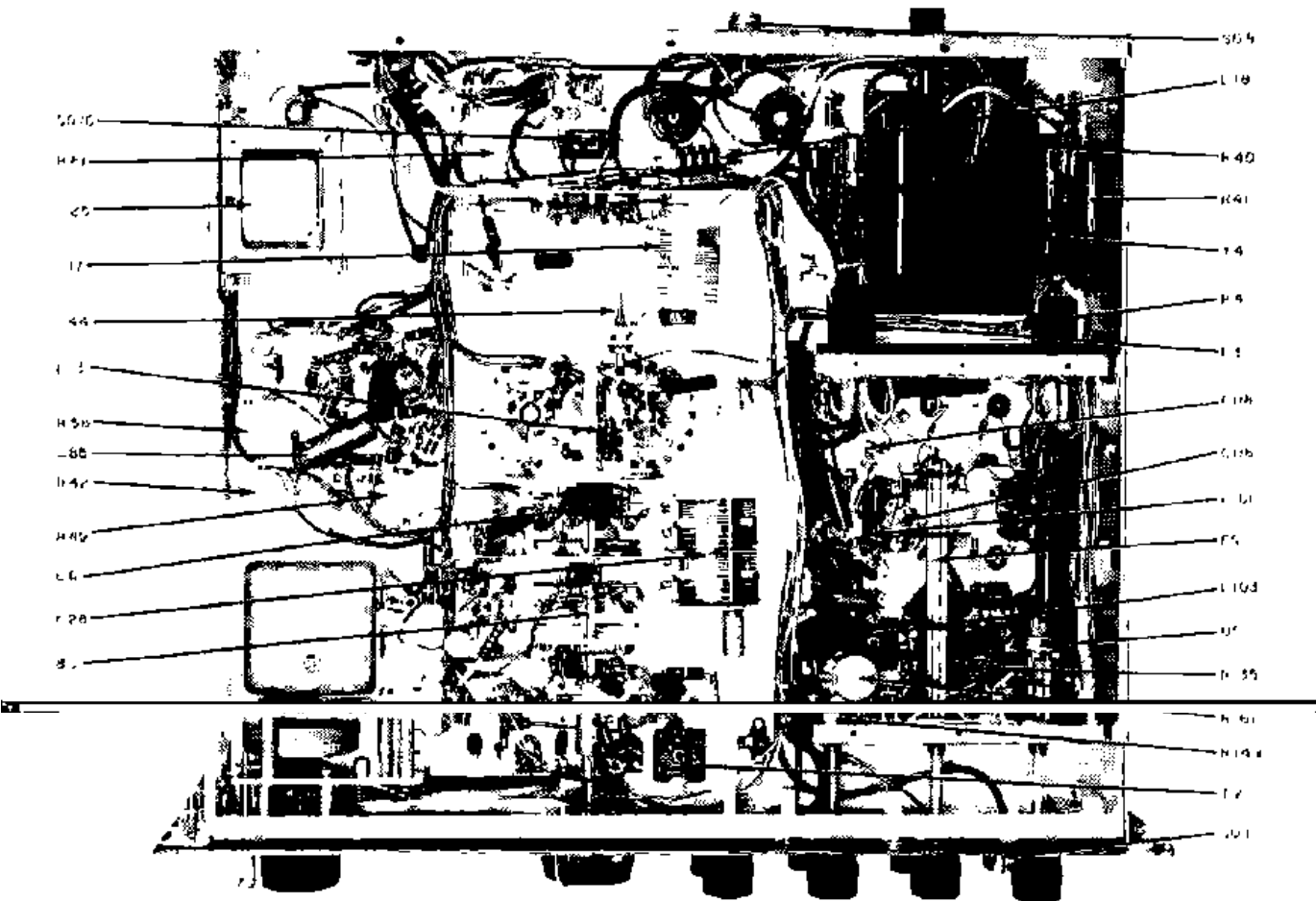


Figure 7. Bottom Chassis View

will retain the carrier suppression of the HT-32 for the overall system as well as hum and noise ratio which are all related to the peak envelope power output.

For example - Should the linear power amplifier require 40 to 50 watts of drive then a 3 db T pad designed for 50-ohm terminations would fully load the HT-32 while still transferring the required driving power to the final amplifier grids.

4-12. SERVICE OR OPERATING QUESTIONS.

For further information regarding operation or servicing of your Model HT-32 Transmitter/Exciter, write to:

General Service Manager
The Hallicrafters Co.
4401 West Fifth Ave.
Chicago 24, Illinois

Be sure to include the model, serial, mark number, and date purchased.

Make no service shipments to the factory unless instructed to do so by letter. The Hallicrafters Company will not accept the responsibility for unauthorized shipments.

The Hallicrafters Company reserves the privilege of making revisions in current production of equipment and assumes no obligation to incorporate these revisions in earlier models.



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SECTION V SERVICE DATA

5-1. TECHNICAL SPECIFICATIONS.

TUBES 17 plus 1 voltage regulator and
2 voltage rectifiers
POWER SOURCE.... 105-125 volts, 50/60 cycles AC
POWER OUTPUT:
SSB (PEP).....70-100 watts
CW.....70-100 watts
AM (CARRIER).....17-25 watts
AUDIO INPUT 0.004V rms minimum
STABILITY..... 0.009 % maximum
HUM AND NOISE OUTPUT..... At least 40 db below
carrier
UNWANTED BEAT OUTPUT At least 55 db below
carrier

FREQUENCY SELECTION Self contained VFO
DIMENSIONS..... 10-3/8" Height,
16" Deep, 20" Wide
SHIPPING WEIGHT 15-1/4 lbs

5-2. CHASSIS REMOVAL.

The chassis and front panel assembly are removable as a unit from the cabinet by removing 2 screws at each side of the front panel and the 3 screws on the underside of the cabinet.

5-3. TUBE AND DIAL LAMP REPLACEMENT

The complete system is first discussed for SSB operation and a brief description of CW and AM operation follows.

6-2. GENERAL DESCRIPTION.

Tube V1A is a 4.95 MC crystal controlled oscillator; its output frequency is ultimately converted to the de-

In SSB operation, (FUNCTION switch in UPPER SB or LOWER SB position), the bridged-T modulator network is placed in a balanced condition and carrier output is at least 50 db below peak envelope power. Under balanced conditions, the output of the bridged-T modulator network consists of the upper and lower sideband of 4.95 mc. A filter system, in the input and output circuits of the sideband filter amplifier stage, V2,

determines whether the upper or lower sideband is transmitted. For example:

1. Upper sideband - the upper sideband of 4.95 mc is mixed (sum) with 4.05 mc to obtain the upper sideband at 9 mc. The inter-stage coupling between 1st mixer, V3; 9 mc amplifier, V5; and 2nd

is mixed with 13.95 mc to obtain the lower sideband at 9 mc. As in the upper sideband condition, the inter-stage coupling of V3, V5, and V7 pass only the frequencies near 9 mc.

Up to the input stage of 2nd mixer, V7, the operation of the HT-32 Transmitter/Exciter is identical on all bands. The remaining stages "beat" (sum or difference) the selected 9 mc sideband to the desired operating frequency. Frequency multiplication cannot be used since doubling the frequency would double the spacing of the sidebands. This would change the relative frequency of the modulating frequencies when the signal is detected.

6-3. 80 METER OPERATION.

The selected sideband (upper or lower) at 9 mc is amplified by 9 mc amplifier, V5, and fed to the 2nd mixer V7. On 80 meters, heterodyne oscillator, V6, has no output and the 2nd mixer, V7, functions as an additional amplifier. At the 3rd mixer, V8, the sideband is mixed (difference) with the output frequency of the VFO, V9. Since the VFO output frequency is tunable from 5.0 to 5.5 mc, the difference output of V8 is the sideband of a frequency between 3.500 to 4.000 mc.

6-4. 40 METER OPERATION.

The selected sideband at 9 mc is mixed (difference) with a 21.5 mc output of heterodyne oscillator V6 in 2nd mixer, V7. The output of V7 is a sideband at 12.5 mc which is applied to the 3rd mixer, V8. In this stage, the signal is mixed (difference) with the VFO output (5.0 to 5.5 mc); the resulting signal is the sideband of a frequency between 7.000 to 7.500 mc.

6-5. 20 METER OPERATION.

Operation on 20 meters is essentially the same as 80 meters except that "sum" mixing is employed in place of "difference" mixing at 3rd mixer, V8. When the VFO output (5.0 to 5.5 mc) is mixed with the upper or lower sideband at 9 mc, the resulting signal is the sideband of a frequency between 14.000 mc to 14.5 mc.

6-6. 15 METER OPERATION.

The selected sideband (upper or lower) at 9 mc is mixed (difference) at 2nd mixer, V7, with a 25 mc signal from heterodyne oscillator V6; the output of V7 is a sideband of a 16 mc signal. This signal is applied to 3rd mixer, V8, where it is mixed (sum) with the 5.0

band at 9 mc is mixed (difference) at 2nd mixer, V7, with a 30.9 mc output signal of heterodyne oscillator, V6. The resulting signal, a sideband at 21.9 mc, is again mixed at 3rd mixer, V8, with the VFO output signal (5.0 to 5.5 mc). The output of V8 is then a sideband of a frequency from 26.9 mc to 27.4 mc.

operation in the four ranges is as follows:

1. 28 mc to 28.5 mc. - The selected sideband at 9 mc is mixed (difference) at 2nd mixer, V7, with a 32.0 mc signal from heterodyne oscillator V6. The resulting signal, a sideband at 23.0 mc is applied to 3rd mixer, V8. In this stage, the sideband at 23.0 mc is mixed (sum) with the VFO output (5.0 mc to 5.5 mc). The resulting signal is a sideband at a frequency between 28.0 mc to 28.5 mc.
2. 28.5 mc to 29 mc. - For this range, the 9 mc sideband is mixed (difference) with the 32.5 mc signal from heterodyne oscillator V6, in 2nd mixer V7. The resulting signal, a sideband at 23.5 mc, is mixed (sum) in the 3rd mixer, V8, with the 5.0 mc to 5.5 mc output of the VFO. The output of V8 is a sideband at a frequency between 28.5 mc to 29 mc.
3. 29 mc to 29.5 mc. - As in the above two ranges, the selected sideband of the 9 mc signal from V5 is applied to 2nd mixer, V7. Here it is mixed (difference) with the 33 mc output of V6. The output of V7 is a sideband at 24 mc. This signal is mixed (sum) in 3rd mixer, V8, with the VFO output. The resulting signal is a selected sideband at a frequency between 29 mc to 29.5 mc.
4. 29.5 mc to 30 mc. - For operation in this range, the heterodyne oscillator, V6, injects a 33.5 mc signal in V7 and is mixed (difference) with the selected sideband at 9 mc. The resulting frequency, a sideband at 24.5 mc is mixed (sum) in V8 with the 5.0 mc to 5.5 mc output of the VFO. The output of V8 is a sideband at a frequency between 29.5 mc to 30 mc.

6-9. CW OPERATION.

When the FUNCTION control is set to CW or DSB position it unbalances the "bridged-T" modulator network, allowing a carrier to be amplified and heterodyned to the desired output frequency. Two sections of the FUNCTION switch bypasses the 4.95 mc filter (V2 and associated circuitry) in the "CW" or "DSB" position. With these exceptions, CW operation is the same as SSB operation.

6-10. DSB (AM) OPERATION

SECTION VII

HT-32 SERVICE AND ALIGNMENT PROCEDURES

(Figures 8 and 9 Cover These Procedures)

7-1. EQUIPMENT REQUIRED.

1. RF Signal Generator — Measurements Corp. Model 65B or equivalent having a 1V RMS output at an impedance of 70 OHMS or less. (A 100 mmf DC blocking capacitor must be placed in series with the RF lead.)
2. Vacuum tube voltmeter (VTVM) — Hewlett Packard 410A or equivalent having an RF probe good to 35 MC.
3. Dummy load — 50 ohms non-inductive, rated at 100 watts. The dummy load may be made up of carbon resistors, Bird Wattmeter, or equivalent.
4. DC Milliammeter 0 - 300 MA DC.
5. Oscilloscope — with external vertical plate connection.
6. Receiver (3-30 MC range) with 50 KC calibrator.

7-2. INITIAL CONTROL SETTINGS.

- OPERATION..... STANDBY (Power on)
 FUNCTION..... DSB
 CALIBRATE LEVEL..... 0
 DRIVER TUNING..... Fully counterclockwise (Closed gang)
 FINAL TUNING..... ON INDEX (Closed gang)
 FREQUENCY..... Fully counterclockwise (Closed gang)
 BAND SELECTOR..... As instructed
 AUDIO LEVEL..... 0
 METER COMPRESSION..... 10
 RF LEVEL..... 0

7-3. BIAS ADJUSTMENT.

Check the bias voltage before running any extensive checks with the plate and screen voltage applied to the 6146 final amplifier tubes. Set BIAS ADJ. for -49V DC \pm 1V with the OPERATION switch at MOX., FUNCTION switch at either upper or lower sideband (zero signal). Line voltage 117V.

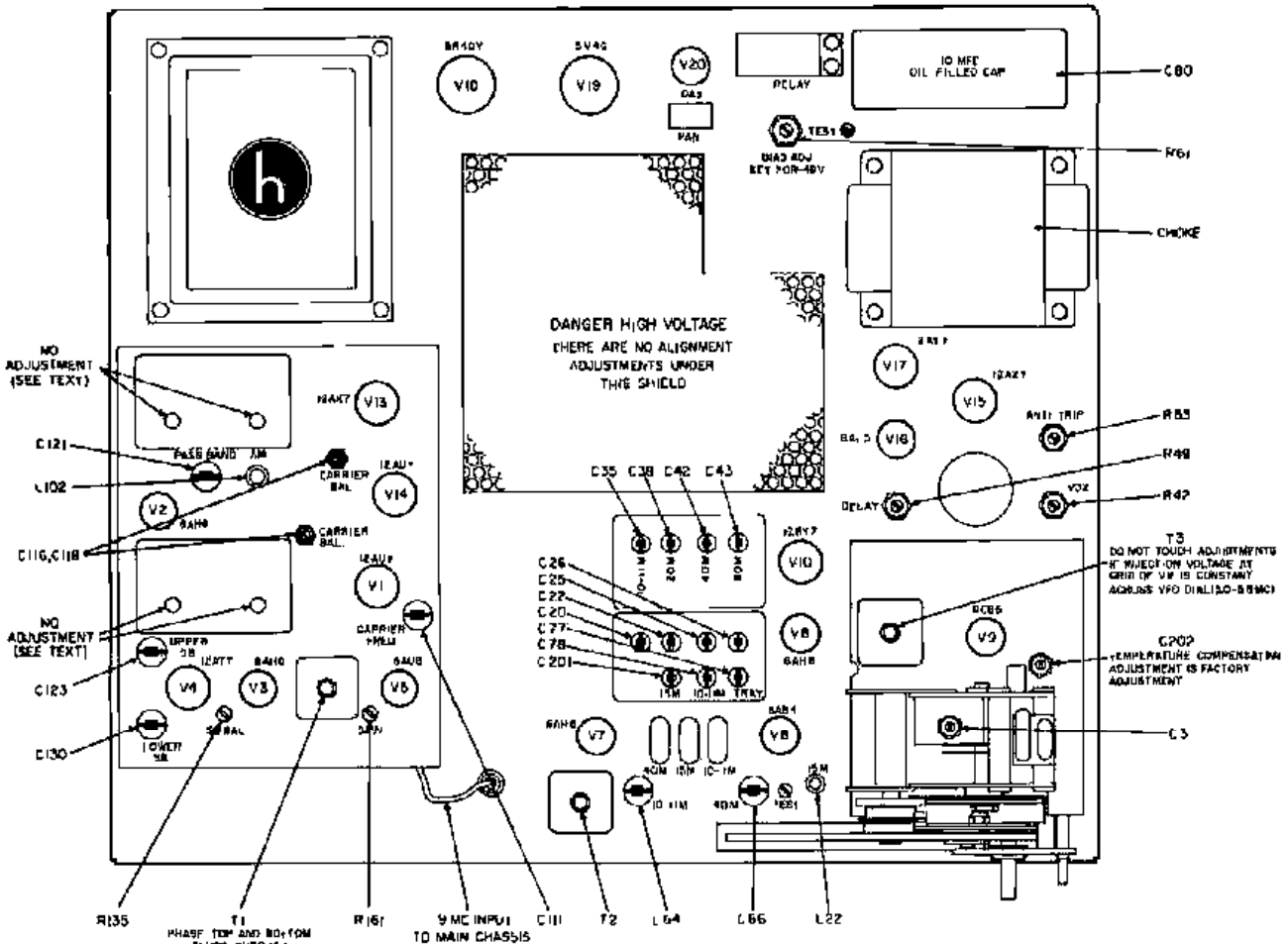


Figure 8. Top Chassis Alignment Points

7-4. RF ALIGNMENT 2ND AND 3RD MIXER AND DRIVER STAGES.

IMPORTANT: The RF alignment should only be attempted when a transmitter-exciter malfunction has been analyzed and definitely traced to RF mis-alignment.

Disconnect screen lead of V11 (6146, Final Amp) from lug -- of terminal board on underside of chassis. Set neutralization capacitor C44 and VFO coupling capacitor C15 at mid-capacity, if this is to be a complete alignment.

To place the transmitter in operation for alignment,

7-5. 3RD MIXER AND DRIVER STAGES.

ALIGNMENT CHART									
Step	Band	Signal Generator Connection	VTVM Connection	Trimmer Adjust for Maximum	Coil Adjust for Maximum	Signal Generator Freq. MC		Approx. Driver Tuning Setting	
						f ₁	f ₂	D ₁	D ₂
1	80M	High Side to Pin #1 grid of V8 (6AH6, 3rd Mixer) Common side to chassis. (Generator leads must be kept to absolute minimum to prevent regeneration.)	VTVM to Pin #5 grid of V11 (6146 Final Amp). Common to chassis.	C26 C43	L7 L11	3.5	4.0	1.3	3.7
2	40M	Same as step 1.	Same as step 1.	C25 C42	L6 L10	7.0	7.3	0.9	4.1
3	20M	Same as step 1.	Same as step 1.	C22 C38	L5 L9	14.0	14.35	1.5	3.6
4	15M	Same as step 1.	Same as step 1.		L5 L9	21.0		2.1	
5	11-10M	Same as step 1.	Same as step 1.	C20 C35	L4 L8	26.9	29.7	0.3	4.6

7-6. ALIGNMENT PROCEDURE.

1. The 3rd mixer and driver stages alignment procedure for 80, 40, 20 and 11-10 meter bands, is essentially the same, differences being only in frequency used and adjustment location which can be obtained from the chart above. The following is the alignment procedure for 80 meters. Preset the Initial Control Settings with the BAND SELECTOR set on the band being aligned (80M).

- (a) Set trimmers (C26 and C43) to mid-capacity.
- (b) Preset slugs (L7 and L11) to their maximum inductance if they have never been previously aligned.
- (c) Set the DRIVER TUNING to D₁ (1.3 on Knob).
- (d) Set the R.F. Generator to f₁ (3.5 MC) using sufficient generator output to obtain a readable indication on the VTVM. If 1V out of the signal generator does not provide a VTVM reading proceed with slug adjustment below.
- (e) Carefully adjust each slug (L7 and L11) for maximum deflection on VTVM. Use reference voltage on VTVM of approximately 20V RMS.

(f) Adjust the output frequency of the R. F. generator to f₂ (4.0 MC) using sufficient generator output to obtain about 20V RMS at the grid.

(g) Tune DRIVER TUNING for maximum deflection on VTVM. Driver tuning setting should be approximately D₂ (3.7 on the Knob).

(h) Adjust trimmers (C26 and C43) for maximum deflection on VTVM.

(i) Repeat steps (c) thru (h) until the adjustments result in no appreciable increase in grid voltage. The band is then correctly tracking with maximum output.

2. The 3rd Mixer and Driver Alignment procedure for 15M is slightly different, since the 20M and 15M bands share the same coil. The following is the alignment procedure for 15 meters.

(a) Align 20 meter band as outlined above.

(b) Set BAND SELECTOR at 15M.

(c) Set the R. F. generator at f₁ (21.0 MC) using sufficient generator output to obtain about 20V RMS at the grid of the final amplifier.

(d) Tune DRIVER TUNING for maximum deflection of VTVM. Driver tuning setting should be approximately D. (2.1 on the haoh)

with this adjustment, repeat 20 meter trimmer alignment at 14.35 MC and check 14.0 MC for uniform gain on 20M band.

(e) Adjust slugs (L5 and L9) for maximum deflection of VTVM. If additional gain is obtained

(f) Repeat above procedure until no further gain can be obtained on both bands.

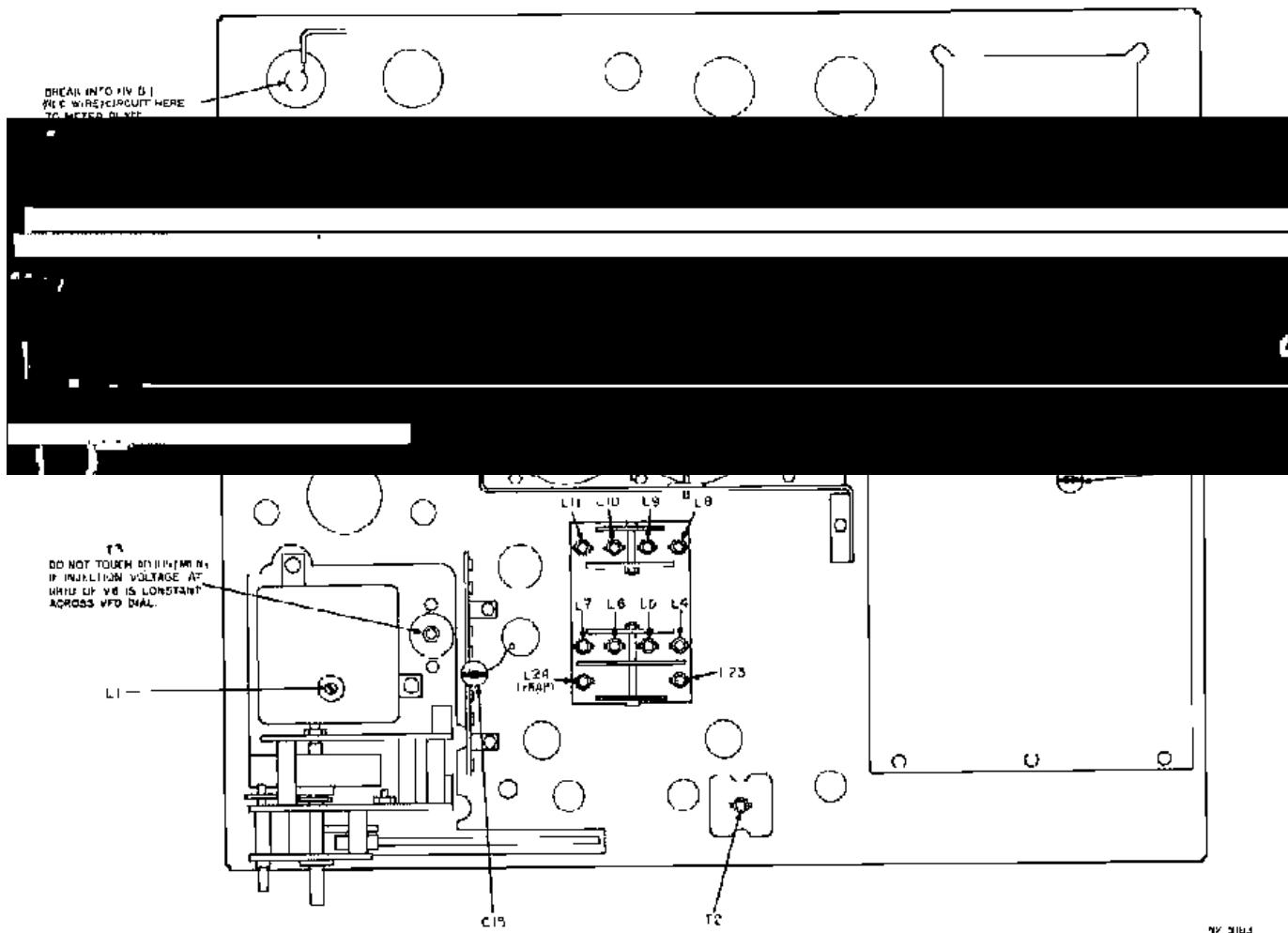


Figure 9. Bottom Chassis Alignment Points

7-7. 2ND MIXER STAGE

ALIGNMENT CHART								
Step	Band	Signal Generator Connection	VTVM Connection	Trimmer Adjust for Maximum	Slug Adjust for Maximum	Signal Generator Freq. (MC)		VFO Freq. (MC)
						f ₁	f ₂	
1	40M	High side to pin #1 grid of V7 (6AH6, 2nd Mixer). Common side to chassis.	VTVM to pin #5 grid of V11 (6146, Final Amp.). Common to chassis.		L23	7.2	12.5	7.2
2	15M	Same as step 1.	Same as step 1.	C201		21.0	16.0	21.0
3	11-	Same as step 1.	Same as step 1.	C78		29.0	23.6	29.0

7-9. ALIGNMENT PROCEDURE.

The 2nd mixer alignment procedure must follow the sequences shown in the chart, since the setting of the coil inductance on 40M must precede the trimmer adjustments on 15M and 10-11M bands. The following is the alignment procedure for 40 meters.

1. Set BAND SELECTOR at 40M.
2. Set trimmers C201 and C78 at mid-capacity.
3. Set slug (L23) at it's maximum counterclockwise position (minimum inductance).
4. Set Signal generator at f_1 (7.2 MC) with sufficient output to permit setting the driver tuning to resonance.
5. Adjust DRIVER TUNING for maximum deflection on VTVM.
6. Set BFO dial to 7.2 MC.
7. Set R. F. generator at f_2 (12.5 MC). Set gnerator output for approximately 20V RMS at the final grid while making alignment adjustments.
8. Adjust mixer coil slug L23 for maximum deflection on VTVM.

9. Proceed with the alignment of the 2nd mixer stage on 15M and 10-11M using the chart and the above procedures used on 40M.

NOTE

The above alignment data for 10-11M 2nd mixer adjustment covers the 28.5-29.0 MC 10M segment (32.5 MC xtal) supplied with the HT-32 Transmitter/Exciter. For alignment instructions covering the use of other 11M or 10M 0.5 MC segments, refer to SEGMENT ALIGNMENT for 10-11M BAND in paragraph 4-7.

The 2nd mixer plate frequency (f_2) for the various crystals used on the 10-11M band are as follows:

Trans. freq. range	Xtal freq.	2nd Mixer freq. (f_2)
26.9 - 27.4 MC	30.9 MC	21.9 MC
28.0 - 28.5 MC	32.0 MC	23.0 MC
28.5 - 29.0 MC	32.5 MC	23.5 MC
29.0 - 29.5 MC	33.0 MC	24.0 MC
29.5 - 30.0 MC	33.5 MC	24.5 MC

7-9. HETERODYNE XTAL OSCILLATOR ALIGNMENT

ALIGNMENT CHART					
Step	Band Selector	VTVM Connection	Trimmer Adjustment	Coil Adjustment	Injection Level
1	15M	VTVM to pin #1 of V7 (6AH6, 2nd Mixer). Common side to chassis.		L22	0.25V RMS
2	40M	VTVM to pin #1 of V7 (6AH6, 2nd Mixer). Common side to chassis.	C66		0.5 V RMS
3	11-10M	VTVM to pin #1 of V7 (6AH6, 2nd Mixer). Common side to chassis.	C64		0.5 V RMS

7-10. ALIGNMENT PROCEDURE.

The heterodyne crystal oscillator alignment procedure must follow the sequence shown in the chart, since the setting of the coil inductance on 15M must precede the trimmer adjustments on 40M and 10-11M bands.

1. Set BAND SELECTOR at 15M.
2. Adjust Xtal Osc coil slug (L22) for 0.25V RMS on the gentle slope side of resonance.
3. Set BAND SELECTOR at 40M.
4. Adjust Xtal Osc trimmer C66 for 0.5V RMS on the gentle slope side of resonance.

5. Set BAND SELECTOR at 11-10M.

6. Adjust Xtal Osc trimmer C64 for 0.5V RMS on the gentle slope side of resonance.

7-11. VFO CALIBRATION ALIGNMENT

The VFO unit has been carefully aligned and temperature compensated at the factory. Before touching up trimmer C3 or coil L1 check the dial calibration at the 100KC points. If all points fall to one side of the pointer, reset the pointer position. If the calibration "runs out" across the dial proceed as follows:

1. Set OPERATION control at STANDBY.

2. Place the antenna lead of the receiver near the VFO unit and set the receiver at 5.0 MC with the 50 KC calibrator. Receiver BFO turned off.
3. Tune the VFO unit to 4000 kc on 80M.
4. Adjust slug 1.1 for zero-beat.
5. Set the receiver to 6.5 MC with the 50 DC calibrator at zero beat.
6. Tune the VFO unit to 3500 kc on 80M.
7. Adjust air trimmer C3 for zero beat.
8. Repeat steps 2, 3, 4, 5, 6, and 7 until calibration is obtained at either end of the dial scale.

7-12. RF ALIGNMENT 9 MC AMPLIFIER STAGES.

Signal Generator Connection	Signal Generator Frequency	VTVM Connection	Control Setting	Remarks
High Side to Pin #1 Grid of V3 (6AH6, 1st Mixer) Common to chassis	9 MC (Unmod.)	VTVM RF probe to pin #5 Plate of V7 (6AH6, 2nd Mixer.) Common side to chassis	BAND SELECTOR, 20M. OPERATION, Standby. RF LEVEL, 10. (All other controls at initial control setting.)	Remove OSC. tubes V1, V4. Peak upper and lower core adjustments of T1 and T2 for maximum deflection of VTVM. (1V RMS)

7-13. CARRIER OSC. AND SIDEBAND SWITCHING OSC ALIGNMENT.

The carrier oscillator and sideband switching oscillators are provided with minor frequency correction trimmers which permit setting each oscillator to exact frequency. The object of the oscillator frequency adjustment in the sideband generator unit is to provide a carrier signal frequency of exactly 9000 kc. This is accomplished by heterodyning the carrier oscillator frequency (4950 kc) with either the 4050 kc or 13,950 kc sideband switching oscillator to produce a 9000 kc

7. Set the carrier level with the DRIVER TUNE control for 50V RMS across the dummy load, or use the output meter on the transmitter taking care to avoid driving the final into the saturation level. Set the output meter sensitivity for zero db.
8. Decrease the carrier oscillator frequency by turning the CARRIER FREQ. trimmer until the carrier level drops 20 db to 30 db.

NOTE. The carrier oscillator frequency may not fall exactly on 4950 kc which is stated in the man-

Ordinarily the carrier oscillator will not require adjustment in the field. If the 9 MC signal is not on frequency, adjust the sideband switching oscillators only. In cases where the carrier oscillator frequency must be set, proceed as follows:

1. Set the OPERATION switch at the MOX position.
2. Set the FUNCTION switch at DSB.
3. Tune up the transmitter on 80M into a dummy load.
4. Reset the FUNCTION switch for either USB or LSB.
5. Set the two CARRIER BAL. trimmers on the sideband unit for maximum carrier level and if necessary detune with the DRIVER TUNE control to prevent over-driving the final.
6. Adjust the CARRIER FREQ. trimmer (C-111) for maximum carrier level, again detuning with the DRIVER TUNE control to prevent driving the final stage into a saturation output.

9. Rebalance for maximum carrier suppression with the carrier balance trimmers. Retune the driver stage and check the low frequency audio response. Use a 50V RMS RF output level at 1000 CPS audio reference frequency. The low frequency response for -3 db will fall between 500 CPS and 650 CPS.

NOTE. The low frequency audio response is directly governed by the CARRIER OSCILLATOR frequency. The carrier frequency is set in this manner to insure carrier suppression of 40 db or more after a 30 minute warm-up.

10. Check the audio frequency response at the high end of the range. The output level should fall -3 db at 3000 to 4000 CPS. If adjustment is required, adjust the AM coil (L-102) for the correct response.

NOTE. A change in the AM coil adjustment will generally require an adjustment of trimmer C-146, in order to repeak the carrier level output for DSB or CW operation.

11. After the carrier frequency has been set, it is now necessary to adjust the sideband switching

oscillators for exactly 9000 kc from the sideband unit as described in para. 7-15.

7-15. SIDEBAND SWITCHING OSCILLATORS.

1. Set band switch at 80M.
2. Disconnect shielded cable from sideband unit at main chassis connector.
3. Place antenna lead of receiver near the center terminal of the shielded plug and set the receiver at 9000 kc, with the crystal calibrator Receiver BFO turned off.
4. Set the FUNCTION switch at LSB.
5. Adjust LOWER SB osc. trimmer (C130) for zero beat.
6. Set the FUNCTION switch at USB.
7. Adjust UPPER SB osc. trimmer (C123) for zero beat.

NOTE: It may be desirable to unbalance the carrier balance adjustments slightly to obtain a higher signal level for the receiver.

7-16. SIDEBAND BALANCE ADJUSTMENT.

The SB BAL control is a potentiometer (R 105).

3. Set the FUNCTION switch at "Lower Sideband". The meter indication for both "UPPER" and "LOWER SIDEBAND" should be essentially the same. Any difference in output between the 4.05 MC oscillator and 13.95 MC oscillator can be compensated by adjusting the SB BAL control. Rotating the SB BAL control will increase the output of one sideband and decrease the other simultaneously. Consequently, it is necessary to alternate between the "UPPER" and "LOWER SIDEBAND" positions of the FUNCTION switch, checking for equal output, while adjusting the SB BAL control.

4. There is a slight interaction between the SB BAL adjustment and SB frequency adjustment, hence a relatively large change in one will effect the performance of the other. If a large correction in sideband balance is required, check the sideband switching oscillator frequency adjustment again.

7-17. NEUTRALIZATION OF FINAL AMPLIFIER.

Although a signal generator is used here for this ad-

justment, the carrier on DSB or CW generated by the transmitter may be used on the 10M and 15M bands.

1. Connect signal generator to pin #1 of V7 (2nd mixer) through 100 uuf capacitor. Common side to chassis.
2. Connect dummy load to transmitter output.
3. Remove heterodyne oscillator tube (V6) and 9 MC output cable from sideband generator unit.
4. Connect 0-300 MA milliammeter in H.V. plate lead between the filter capacitor (C80) and shunt feed choke (L18).
5. Insert HV rectifier and reconnect screen supply lead.
6. Set neutralizing capacitor at mid-capacity.
7. Set OPERATION switch at MOX. and frequency dial at mid position.
8. Set BANDSWITCH at 10-11M, signal generator at 23 MC and adjust DRIVER and FINAL TUNING for maximum output. Set signal generator output for 150-175 ma plate current.

7-18. CARRIER BALANCE ALIGNMENT.

The CARRIER BAL C116 and C118 are air trimmers located at the top side of the sideband generator unit. The adjustment of trimmer C116 tunes the Bridged T coil to resonance and the adjustment of trimmer C118 adjusts the phase of the Bridged T network so that the carrier frequency is balanced out, when operating in either side band position of the FUNCTION switch. The best working carrier balance adjustment will be obtained if adjustment is made after the transmitter has reached a normal operating temperature, which is usually in about 2 to 3 hours.

1. Tune the transmitter-exciter for DSB operation.
2. Set FUNCTION switch to one sideband position.
3. Adjust C116 and C118 systematically for maximum carrier suppression. (Minimum output meter reading.)
4. Set FUNCTION switch to the other sideband position.
5. Re-adjust C116 and C118 until the maximum carrier suppression is equalized in both sideband positions.

7-19. VFO INJECTION ADJUSTMENT.

This adjustment is a coupling trimmer in the output of the VFO unit which governs the amount of VFO injection voltage applied to the 3rd mixer stage.

1. Set BAND SELECTOR at 15M.
2. Set VFO dial to 21.33 MC.
3. Tune the transmitter-exciter for DSB operation into 50-ohm load.
4. Disconnect 9 MC cable input from SB generator.
5. Adjust VFO coupling trimmer (C15) for 0.1 RMS RF output across 50 ohms.
6. Connect VTVM probe to pin #1 grid of V8 (6AH6, 3rd Mixer). The injection voltage will be approximately 0.3 to 0.4V RMS. If below 0.3V check screen and bias voltages on tubes V8 and V10 and check tubes V8 and V10 for malfunction.
7. Replace 9 MC cable input from SB generator and tune for maximum saturated power output, which should be at least 60V RMS across 50 ohm load.

7-20. 10 METER TRAP COIL ADJUSTMENT.

This adjustment should be made with a 33.5 MC crystal in the 11-10 meter heterodyne osc. xtal socket. If the 33.5 MC xtal is not available to the operator, the 32.5 MC xtal supplied with the HT-32 may be used to adjust the trap coil. However, when higher frequency xtals are installed, the trap coil must then be reset as outlined below.

1. Preset the trap trimmer (C-77) to minimum capacity (slot toward center of RF disk). See Figure 5.
2. Preset the trap coil slug (L-24) for minimum inductance (maximum counterclockwise).
3. Tune the transmitter for CW operation on the 10M band.
4. Set the FUNCTION switch at LSB.
5. Adjust DRIVER TUNING and FINAL TUNING for the spurious output. (33.5 MC Xtal - VFO frequency = 28.0 to 28.5 MC.)
6. Adjust trap coil slug L-24 for minimum output.
7. Increase trap trimmer capacity slightly, and reset the trap coil slug for minimum output. Use just enough capacity in the trap trimmer to observe two resonant dips in the spurious output when the trimmer is rotated through minimum capacity.

9. Tune DRIVER TUNING and FINAL TUNING to desired frequency between 29.5 - 29.7 MC.
10. Readjust 10-11M 2nd mixer trimmer (C-78) for maximum output with RF LEVEL slightly advanced.
11. Set FUNCTION switch at LSB.
12. Retune DRIVER TUNING and FINAL TUNING for spurious output.

13. Adjust trap coil slug for minimum spurious output and repeat step 10 to be sure the mixer stage is resonant.

14. When crystals other than the 33.5 MC crystals are now used on the 10M band, it is only necessary to adjust the trap trimmer. The trap coil adjustment is left as adjusted for the highest frequency crystal.

7-21. 9 MC GAIN ADJUSTMENT ON SIDEBAND UNIT.

This control (R-161) is located on the sideband generator unit and is accessible at the top of its chassis. The control sets the gain of the 9 MC amplifier and is considered a factory adjustment which will generally not require readjustment unless extensive service work has been done on the equipment.

Before changing the adjustment, check the performance of the transmitter as follows:

1. Tune up the transmitter on single sideband using a dummy load. With a 1000 cps audio oscillator, measure the audio signal level at the microphone connector for peak or saturation power output on each of the bands.
2. The audio signal level at the microphone input should run between 2 to 4 millivolts rms for saturation or peak power output. Should any one band require substantially more audio signal level than the rest, re-check the alignment on that band.
3. If the audio level required is uniformly higher on all bands, advance the 9 MC amplifier gain adjustment to bring it into agreement with the level specified in step 2. If the audio level required runs less than 2 millivolts, the gain is excessively high and will not permit the carrier suppression and associated sideband to reach 50 db below maximum output. In this case reduce the gain setting accordingly.

7-22. CRYSTAL FILTER ALIGNMENT.

Due to the specialized techniques and test equipment required it is recommended that realignment of the filter units (FL1 and FL2) be handled through the company service department. The operation of the filter can be checked out as follows to determine whether the filter requires realignment.

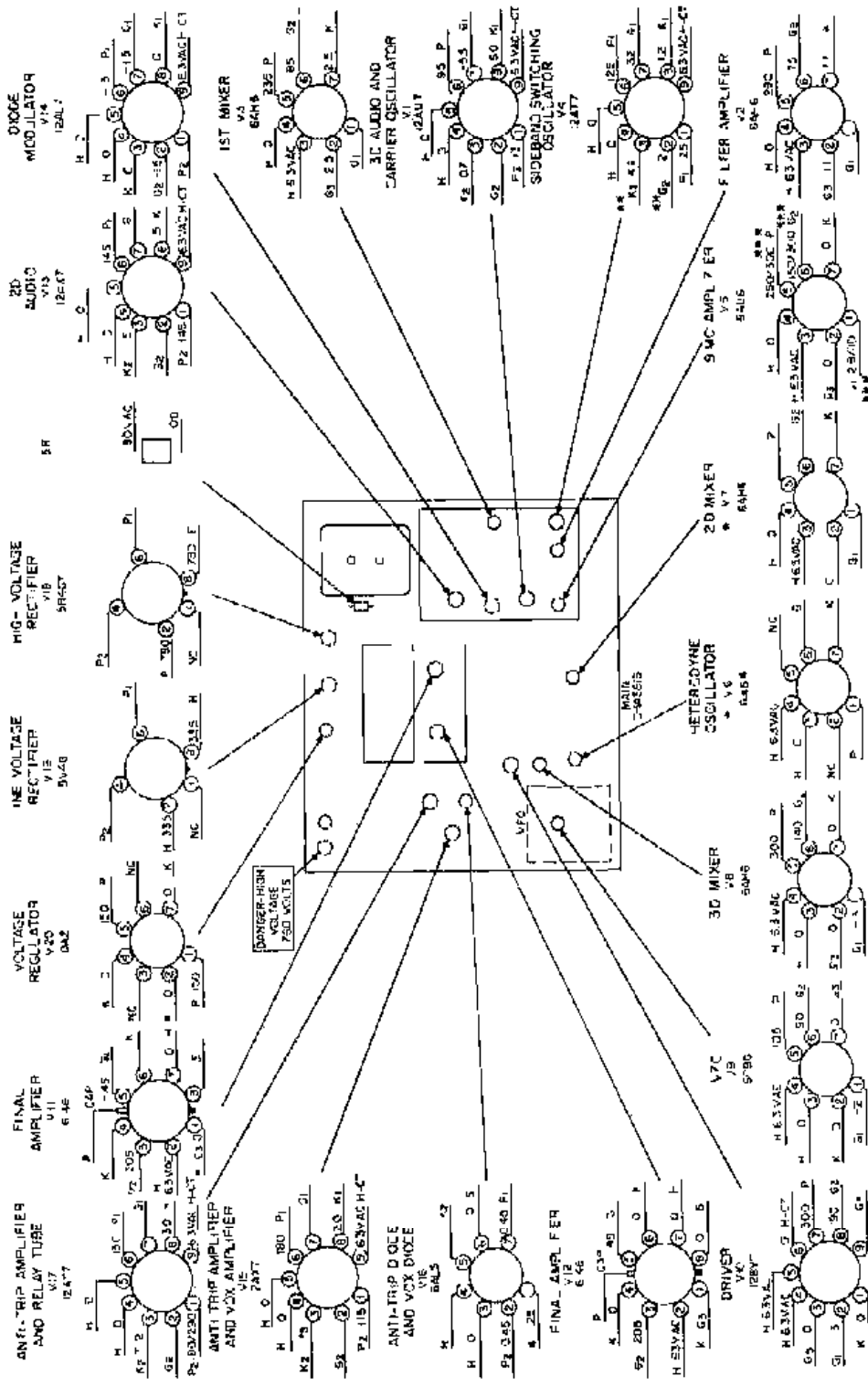
1. Tune up the transmitter for single sideband operation into a 50-ohm load.
2. With a 1000 cps audio generator, adjust the transmitter output for zero db reference on the output meter with the METTER COMPRESSION set for operating the transmitter well below the saturation output level.
3. Hold the generator output voltage constant and check the transmitter output at 650 cps and 3000 cps. The transmitter output should not drop below approximately 3 db at these extremes of the audio passband. If the transmitter output vs frequency is tilted, the correction may be made by adjusting the PASSEBAND trimmer (C-121) located on the top deck of the sideband unit.

SERVICE PARTS LIST

Schematic Symbol	Description	Ball/Crafters Part Number	Schematic Symbol	Description	Ball/Crafters Part Number	Schematic Symbol	Description	Ball/Crafters Part Number
CAPACITORS (MAIN CHASSIS)			CAPACITORS (SIDE-BAND GEN ASSEMBLY)			*RESISTORS (MAIN CHASSIS) (Cont.)		
C-1	12 mfd., ±5% N1500, Ceramic	470-015120	C-101	200 mmf., 5% Duramic	482-162201	R-40	5 megohms, Delay	025-201141
C-2	22 mfd., ±5% NPO; Ceramic	491-005120-23	C-102 105	001 mfd., 20% 500V Ceramic Disc	081-100503	R-50	52K ohms	451-352823
C-3	2 k-13.3 mfd. Variable Trimmer	048-000370	C-103	10 mfd., 350V Electrolytic	015-200415	R-52	1.5K ohms	451-352152
C-4	18 mfd., ±5% N80; Tubular Ceramic	401-005180-12	C-104, 106, 112, 131, 134, 135, 136, 140, 142, 143, 145, 147, 148, 150	005 mfd., 20% Ceramic Disc	047-100442	R-53	1 megohm Anti-Trip Sensitivity	025-201137
C-5, 6	1000 mfd., 5% 300V Mica	047-100023	C-107	02 mfd. ±0.05-20% 500V Ceramic Disc	047-100342	R-55, 57, 66	1 megohm	451-352155
C-7, 9	01 mfd., 10% 300V Mica	470-643103	C-108	10 mfd., 150V Electrolytic	045-200307	R-61	1.5K ohms, Dia. Adj.	025-201412
C-8, 10, 51, 52, 50, 51, 84, 80, 87, 88	01 mfd., 100V Ceramic Disc	047-200224	C-109	022 mfd., 10% 300V Molded Paper	499-014223	R-62	12K ohms	451-352153
C-11	8 mmf., 10% NPO, Ceramic	491-005060-22	C-111 121	3.28 mmf., Trimmer	044-100473	R-67, 68	220K ohms, 10%, 3W	451-352822
C-12 14	Part of T3 (41 mmf.)	-----	C-112	35 mmf., 5% Duramic	484-162330	R-69	0.2K ohms	451-352822
C-13	Part of T3 (470 mmf.)	-----	C-113	180 mmf., 5% Duramic	482-162121	R-71	10K ohms, 5%, 1/2W	451-251102
C-16	1.5-7 mmf. Variable Trimmer	048-100457	C-114	98 mmf., 3%, N80; Tubular Ceramic	491-054080-32	R-72	4.7K ohms, 5%, 1/2W	451-351472
C-18 30	47 mmf., 10% N750 Ceramic	491-105410-05	C-115	18 mmf., ±5% NPO, Ceramic	401-005180-42	R-100, 109	4.7K ohms	451-452472
C-17 18, 20, 21, 22, 27, 40, 47, 48, 49, 50, 53, 53, 72, 73, 80, 81, 82, 93, 94, 95, 96, 97	005 mfd., 20%, 1KV Ceramic Disc	047-100023	C-116	98 mmf., 3%, N80; Tubular Ceramic	491-054080-32	R-107, 108	1 megohm, 10%, 1/2W	451-252105
C-20, 22, 26, 28, 35, 36, 42, 43	5-25 mmf., NPO, Trimmer Strip (4 Section)	044-200454	C-117	39 mmf., 3% Duramic	482-162360	R-110, 125	1 megohm, Audio Level	025-201414
C-21, 35	110 mmf., 2% Fixed Ceramic	491-154111-15	C-119	390 mmf., 5% Duramic	081-162301	R-111, 125, 132, 133, 131, 132, 130	220K ohms, 10%	101-252424
C-23, 39	32 mmf., 5% Fixed Ceramic	451-155820-83	C-120 125	10 mmf., 2% NPO Tubular Ceramic	491-160180-23	R-112, 119	10K ohms	451-352105
C-24, 41	240 mmf., 2% Mica	470-231241	C-128 120	43 mmf., 5% NPO, Tubular Ceramic	491-125430-22	R-115	2.7K ohms	451-352222
C-37	47 mmf., 2% Fixed Ceramic	491-024410-22	C-130	3-13 mmf., NPO, Trimmer	044-200483	R-119, 121, 136, 137	2.7K ohms, 5%, 1/2W	451-251223
C-38 A, H, C, D	Variable, Drivee Tuning	048-406781	C-132	47 mmf., 5% NPO; Tubular Ceramic	491-125470-22	R-120	1.1 megohm, +10%	025-201222
C-33	43 mmf., 7% Fixed Ceramic	451-024330-22	C-133	01 mfd., 500V; Ceramic Disc	047-000224	R-124	220K ohms, 5%, 1/2W	451-251224
C-34	0027 mfd., 20% 1KV; Cer. Disc	047-200524	C-137, 138	Part of T1	-----	R-126	470 ohms, 10%, 1/2W	451-252471
C-40	2000 mmf. Feed-thru Mica	041-200040	C-138, 141	100 mmf., 10%, N750, Ceramic	401-126101-05	R-128	180 ohms	451-352131
C-41	2-13 mmf. Variable	040-200710	C-144	100 mmf., 5% NPO Ceramic	491-065101-23	R-135	5K ohms, Oscillator Level	025-201322
C-45	100 mmf., 10% N750 Ceramic	401-126101-05	C-148	8-50 mmf. N750, Trimmer	044-200484	R-140	2.2K ohms, 10%, 1/2W	451-252222
C-52, 54	1.001 mfd., 3000V, Ceramic Disc	047-100023, 048-400388	C-149	5 mmf., 10% N750 Ceramic	401-126050-23	R-141, 162	4.7K ohms, 10%, 1/2W	451-252472
L-56	Variable, Final Tank	047-100068	C-150	100 mmf., 5% NPO Ceramic	491-065101-23	R-142	470 ohms	451-452471
C-56	380 mmf., Toothpick	047-000509	C-151	8-50 mmf. N750, Trimmer	044-200484	R-143	100K ohms	451-352104
C-57	220 mmf., Toothpick	470-221271	C-152	5 mmf., 10% N750 Ceramic	401-126050-23	R-147	50K ohms, Calibrate Level	025-201415
C-58, 59	270 mmf., 2% Fixed	044-100070	C-153	100 mmf., 5% NPO Ceramic	491-065101-23	R-150	22K ohms, 5%, 1/2W	451-251223
C-64	2-25 mmf., Trimmer	041-124300-23	R-1, 6, 32	47K ohms, 10%, 1/2W	451-252470	R-153	470K ohms, 10%, 1/2W	451-252474
C-65	39 mmf., 2% NPO, Tubular Ceramic	491-105410-23	R-2 13 15	27K ohms	451-352223	R-155	320K ohms, 10%, 1/2W	451-352824
C-66	8-30 mmf., N750, Trimmer	044-200437	R-3, 5, 58	4.7K ohms	151-352472	R-156	1.8 megohms, 10%	451-251255
C-68	5 mmf., 10% N750, Ceramic	491-105410-23	R-4	1K ohms, 10%, 1/2W	451-252102	R-157	1.2W	451-251255
C-69, 70	Part of T2 (56 mmf.)	-----	R-5	3.9K ohms, 10%, 1/2W	451-252342	R-168	120K ohms, 10%, 1/2W	451-251254
C-71	50 mfd., 5% N750; Tubular Ceramic	101-125680-05	R-7, 25	220K ohms, 5%, 1/2W	451-251224	R-169	1 megohm, RF Level	025-201416
C-74	300 mmf., 2% Mica	470-231261	R-8	4.7K ohms	451-352472	R-181	300K ohms, Gain Level	125-201426
C-70	88 mmf., 5% Fixed Ceramic	401-125880-47	R-9, 10, 31, 36, 39	1K ohms	451-452102	*Resistors are 1%, 1 watt, unless otherwise noted.		
C-77 78, 101	Ceramic Trimmer Strip (3 Section)	044-200474	R-10, 28	100K ohms, 10%, 1/2W	451-252104	L-1	Coil Assembly, VFO	051-202180
C-70A 70B	60-60 mfd., 475V Electrolytic	045-200226	R-11	30K ohms, 10%, 2W	451-652392	L-2	Choke, VFO Filament	055-200259
C-80	10 mfd., 1000V Oil Filled	140-300636	R-12	12K ohms, 10%, 2W	151-652336	L-3, 13	Choke, R.F. 2.5 mb	053-200325
C-81 82	01 mfd., 1KV Ceramic Disc	047-200109	R-13	12K ohms, 10%, 2W	151-652336	L-4, 8	Coil, 11 10M	051-202015
C-85	.22 mfd., 200V; Molded Paper	490-014224	R-14, 57	10K ohms	451-352183	L-5, 9	Coil, R.F. 15-20M	051-202181
C-80, 204	1 mfd., 200V Molded Paper	490-044104	R-15	10K ohms, 5%	451-351103	L-6, 10	Coil, 40M	051-202074
C-88 90	10 mfd., 150V Electrolytic	045-200307	R-17, 18	100 ohms	451-452101	L-7, 11	Coil, 40M	051-202074
C-902	Variable, Trimmer	048-000875	R-20	6.8K ohms, 5% 2W	451-551682	L-12, 14	Choke, Parasitic Suppressor	053-200417
C-203	Variable, Main Tuning	048-300843	R-21	1.2K ohms, 5%	451-351138	L-15	Choke, Filament	053-200356
			R-22	5.6K ohms, 5% 1/2W	451-251562	L-16	Choke, RF, Final Plate	053-200426
			R-23	50K ohms, Meter Compression	025-201113	L-17	Coil, Final Tank	051-202229
			R-24	22K ohms, 10% 1/2W	451-252223	L-18	Choke, RF Safety	053-100160
			R-25	15K ohms, 5%, 1/2W	451-251183	L-19 20	Coil, XFAI Out	051-202251
			R-27	47 ohms, 10%, 1/2W	451-252470		Grid, 15 & 40M	051-202251
			R-28	10K ohms, 10%, 1/2W	451-252103	C-21	Coil, XFAI Out	051-202251
			R-30	220 ohms	451-352221	L-22	Grid, 10 & 11 M	051-202250
			P-33, 34 57	470 ohms	451-352271	L-23	Grid, R.F. Oscillator	051-202253
			R-35	27K ohms	451-352273	L-24	Coil, 22-31 5 MC Trap	051-202284
			R-36, 4, 50	100K ohms	151-352104	L-25	Choke, Filter - 400V @ 135 MA	050-200268
			R-40	1.5K ohms, 5% 10W	153-001152	L-26	Choke, Filter - 400V @ 175 MA	050-200268
			R-41	2.5K ohms, 5%, 10W	453-001252	L-101	Coil, Modulator	051-202247
			R-42	1 megohm, Vox	025-201137			
			R-43, 56	1 megohm, 10% 1/2W	451-252106			
			R-44 56 57	330K ohms	451-352334			
			R-45	1.2K ohms	451-352122			
			R-46	220K ohms, 10% 1/2W	451-252224			
			R-48	820K ohms	451-352024			

SERVICE PARTS LIST (Cont.)

Schematic Symbol	Description	Hallcrafters Part Number	Schematic Symbol	Description	Hallcrafters Part Number	Schematic Symbol	Description	Hallcrafters Part Number
TRANSFORMERS AND COILS (Cont.)			LAMPS AND FUSES (Cont.)			MISCELLANEOUS (CONT.)		
L-102	Coil, Modulator Output	051-202240	LM-2, 3	Lamp, Pilot Type #44 Dual	039-100008		Connector	010-100981
L-103	Choke, R F	053-100107	F-1	Fuse, 4 amp. 510 Hiro 3AG	039-100448		Coupler, Solid	020-100284
T-1, 2	Transformer, 1 F U MC	050-200701	KNOBES				Cover, Sideband Gen	000-401468
T-3	Transformer, VFO	050-200679		Knob, Final Tuning	015-201049		Cover, Cabinet Top	066-101491
T-4	Transformer, Power	052-400477		Knob, Operation	015-201050		Cover, Final Amp.	066-401458
SWITCHES AND WAFERS				Knob, Function	015-200807		Cover, Box	066-201457
BS-1, 2	Switch, Band Selector	000-201784		Knob, Meter Compression	015-200812		Cover, Transformer	066-201459
BS-3	Wafer, Switch, 2nd Mixer	062-200102		Knob, R. F. Level	015-200812		Cover, Relay	066-201460
BS-1, 5	Wafer, switch, 3rd Mixer and Driver	062-200103		Knob, Audio Level	015-200812		Crescent Ring (Gear Drive)	070-100725
BS-6	Switch, Wafer	062-200113		Knob, Calibrator Level	015-200812		Dial, Scale, Main Tuning (Gear Drive)	063-500658
FS	Switch, Function	060-000832		Knob, Friction Brake	015-100899		Escalator Front Panel	007-500659
OS	Switch, Operation	000-000831		Knob, Main Tuning VFO	015-201040		Fan Blade	060-300305
PLUGS, SOCKETS, AND CONNECTORS				Knob, Bandwidth	015-201047		Flywheel	071-100205
P-2, 5	Plug, Phone	010-100231	CRYSTALS AND DIODES				Gear, Pinion Assembly	041-250012
P-3	Plug, 10 Pin	006-100715	CR-1	Crystal, Carrier Car (4050.000 KC)	010-001956		Gear, Idler Assembly	026-200288
P-4	Plug, 6 Pin	006-100714	CR-3	Crystal, Sideband Rev (4050.000 KC)	010-001897		Glass, Dial (MT)	022-200540
P-12	Plug, AC (Part of Fan Motor Assembly)	-----		Crystal, 21.5 MC	010-001880		Grounded Motor Mounting	016-100634
SO-1	Connector, Mike	029-100044	CR-5	Crystal, 35 MC	010-001901		Holder, Fuse	006-100451
SO-2, 6	Jack, Phone	006-100712	CR-6	Crystal, 32.5 MC	010-201894		Insulator, Front-Thru	008-101015
SO-3	Socket, 10 Pin	006-100713	CR-7	Crystal, 30.9 MC	010-201893		Insulator	008-100668
SO-4	Socket, 6 Pin	006-100084		Crystal, 32.0 MC	010-201893		Insulator (Insert)	008-100897
SO-5	Jack, Non Shorting	036-100082		Crystal, 33.0 MC	010-201895	M-1	Insulator (Insert)	008-100722
SO-7	Jack, Shorting	006-100707		Crystal, 33.5 MC	010-201898		Insulator, (Feed Thru)	008-100014
SO-8	Socket, Power, 11 Prong Plug, 11 Prong	025-100040	CR-8	Rectifier Diode	010-101918			
SO-9	Connector, Coax	010-100036	MISCELLANEOUS					
SO-10	Socket, AC (Fan)	010-200015		Ball Bearing (Gear Drive)	077-100505			
	Socket, Tube (Dial)	006-100760		Ball Bearing (Gear Drive)	077-101099			
	Mica	006-200291		Ball Race (Gear Drive)	077-201020			
	Socket Assembly	006-100384		Box, Tank Coil	060-301488			
	Pilot Light	006-100320		Bracket, Mtg. Relay	067-200146			
	Socket, Tube 7 Pin Min. Car	006-200059		Bracket, Mtg. Crystal Filter	067-204347			
	Socket, Dial	006-100644		Bracket, Control Mtg. Int.	067-104355			
	Forker, Tube, 7 Pin Min. Mica	006-100644		Bracket, Motor Mtg.	067-204183			
	Socket, Tube 7 Pin Min.	006-100644		Bracket, Control Mtg. Ex.	067-104204			
	Socket, Tube, 8 Pin w/Base	006-200372		Bracket, Meter Mtg. R. H.	067-204340			
TUBES AND RECTIFIERS				Bracket, Meter Mtg. L. H.	067-204341			
V-1, 14	Tube, Electron Type 6AR5/12AL7	030-801110		Bracket, Motor Support	067-304345			
V-2, 3, 7, 8	Tube, Electron Type 6AV6	030-900703		Bracket, Mtg. Trimmer & Coil	067-203456			
V-4, 17	Tube, Electron Type 12AT7	030-900064		Bracket, Mtg. Cntl. Assembly	067-103458			
V-5	Tube, Electron Type 6AU6	030-900806		Bracket, Gear Drive & Shield Mtg.	067-107439			
V-6	Tube, Electron Type 6AB4	030-900784		Bracket, Trimmer Mtg.	067-103922			
V-9	Tube, Electron Type 6CB6	030-901115		Bracket, Gear Drive Mtg.	067-103611			
V-10	Tube, Electron Type 12BY7	030-900041		Bracket & Shaft Assembly (Idle Gear)	067-303113			
V-11, 12	Tube, Electron Type 6145	030-900758		Bracket Mtg. (Stop Arm)	067-203163			
V-13, 15	Tube, Electron Type KCC83/12AX7	030-901230		Bracket, PA Tuning mtg.	067-204342			
V-16	Tube, Electron Type 6AL5	030-901163		Bracket (Unit Mounting) (Driver Assembly)	067-304343			
V-18	Tube, Electron Type 6RA5	030-900705		Bushing & Cam Assembly (Gear Drive)	077-200951			
V-19	Tube, Electron Type 6V4G	030-900723		Bushing, Dial (Gear Drive)	077-201039			
V-20	Tube, Electron Type 6A2	030-900001		Bushing, Friction Brake (Gear Drive)	077-101037			
SR-1	Rectifier Selenium	027-200226		Cabinet, Front	066-401494			
LAMPS AND FUSES				Cabinet, Bottom	010-200929			
LM-1	Lamp, Pilot Type #47 Meter	038-100004		Channel, Rubber	010-200929			



TUBE	PIN	SWM	20V	20M	50M	50M
6A6	1	145V	145V	145V	145V	145V
6A6	2	12V	12V	12V	12V	12V
6A6	3	12V	12V	12V	12V	12V
6A6	4	12V	12V	12V	12V	12V
6A6	5	12V	12V	12V	12V	12V
6A6	6	12V	12V	12V	12V	12V
6A6	7	12V	12V	12V	12V	12V
6A6	8	12V	12V	12V	12V	12V
6A6	9	12V	12V	12V	12V	12V
6A6	10	12V	12V	12V	12V	12V
6A6	11	12V	12V	12V	12V	12V
6A6	12	12V	12V	12V	12V	12V
6A6	13	12V	12V	12V	12V	12V
6A6	14	12V	12V	12V	12V	12V
6A6	15	12V	12V	12V	12V	12V
6A6	16	12V	12V	12V	12V	12V
6A6	17	12V	12V	12V	12V	12V
6A6	18	12V	12V	12V	12V	12V
6A6	19	12V	12V	12V	12V	12V
6A6	20	12V	12V	12V	12V	12V

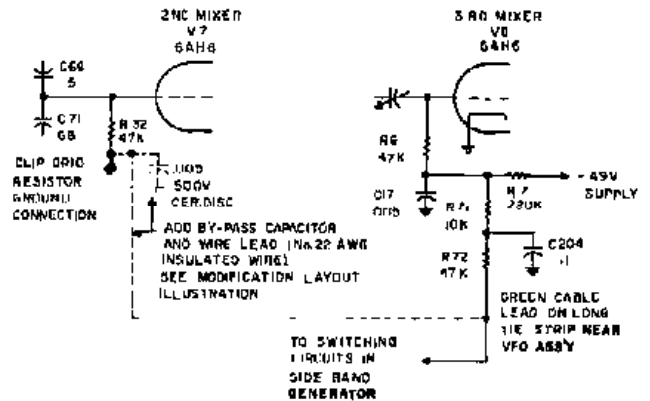
- NOTES
1. 6A6, 6C DESIGNATED ON BOTTOM VIEW OF TUBE SOCKETS
 2. A SOCKET VOLTAGE VS. BAND SWITCH-SETTING (SEE CHART)
 3. 6A6 CHART VOLTAGES SHOWN ARE FOR UNLOADED SIDEBAND POSITION ON 30 METERS AND MODULATION GAIN IS SET
 4. 6A6 VOLTAGE CHANGE ACCORDING TO WHERE FACTOR 30 IS SET
 5. FOR CONVENIENCE ON SIDEBAND DEVIATOR UNIT USE TUBE SOCKET ADAPTED TO TUBE CHECKS

Figure 11 Voltage Chart

Modification to Key 2nd Mixer of Model HT-32 and HT-32A Transmitters.

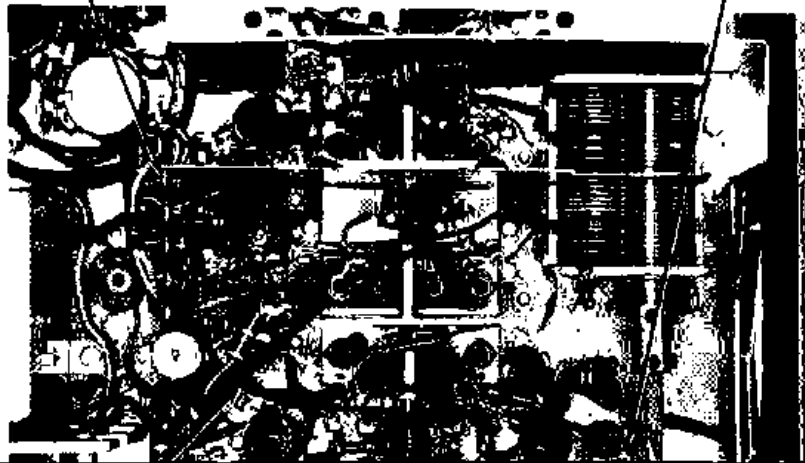
Certain installations involving Models HT-32 or HT-32A, where a TR switch or two separate antennas are used, make it necessary to "key" or "cut off" more than one mixer stage. This is necessary to attenuate the signal sufficiently so that it will not be heard by sensitive receivers. To alleviate this condition, a modification is necessary to apply "cut off" bias to the second mixer grid as well as to the third mixer grid during stand-by or when the key is in up during CW transmission. With both mixers blocked, the signal level will fall well below the noise level encountered in even the most quiet receiver locations.

NOTE: This modification will not require any readjustment of the HT-32 or HT-32A circuits, nor will it change the operating procedure from that specified in the Instruction Manual.



CONNECT NEW WIRE TO THIS TERMINAL (JUNCTION OF 4700 OHM RESISTOR AND GREEN CABLE WIRE)

BY-PASS AT THIS POINT WITH C05 MFD CERAMIC DISC (500V)



092-104364

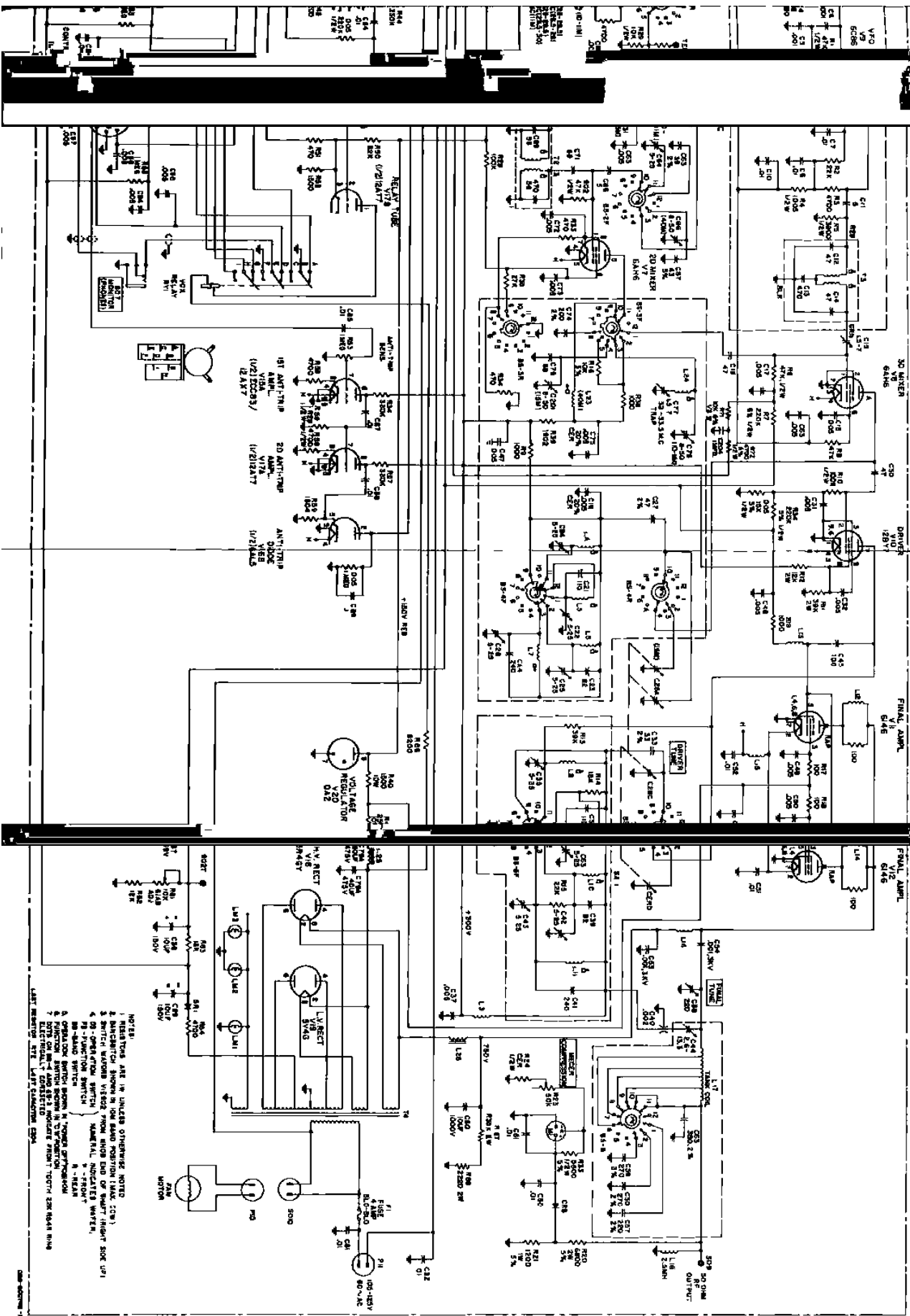
LAY NEW WIRE LEAD ALONG THIS PATH LAY WIRE DOWN ON CHASSIS TO AVOID STRAY PICKUP

CLIP GROUND SIDE R-32 (47K) RESISTOR

NEW POSITION FOR R-32

CONNECT NEW WIRE LEAD AT JUNCTION OF R-32 (47K) RESISTOR AND DISC BY-PASS

094-901652



- NOTES:
1. RESISTORS ARE IN UNLESS OTHERWISE NOTED
 2. SWITCHES ARE IN LOW POSITION UNLESS NOTED
 3. 20W7 TUBE IS A 20W7-RT (RETRACTED) TYPE
 4. 6X - OPERATOR SWITCH (MANUAL) INDICATES W/RTM
 5. 6X - OPERATOR SWITCH (MANUAL) INDICATES W/RTM
 6. 6X - OPERATOR SWITCH (MANUAL) INDICATES W/RTM
 7. BOTH ON 6X AND 6Y1 INDICATE FRONT TOWNS 25K 500K 500K
 8. ELECTRICALS ARE LEFT UNCONNECTED

