

## ELECTRONIC MAINTENANCE

### 5.1 PREVENTIVE MAINTENANCE

Preventive maintenance for the electronic assemblies consists of making the overall performance checks (refer to paragraph 5.2) at scheduled intervals to determine that the equipment is operating within specifications.

### 5.2 OVERALL PERFORMANCE CHECKS

#### 5.2.1 General

These checks should be performed at scheduled intervals to determine whether alignment is required. Alignment procedures are described in paragraphs 5.3 and 5.4.

In all of these checks, blank tape is specified. However, it is permissible to use tape that has been recorded with material not necessary to save (that material will be erased during the recording part of the check).

#### NOTE

Always bulk-erase tape that was prerecorded on equipment employing a head configuration different from the equipment under test. Also, bulk-erase tape for 15/16 and 1-7/8 equipment, which has no erase head.

#### 5.2.2 Test Equipment Required

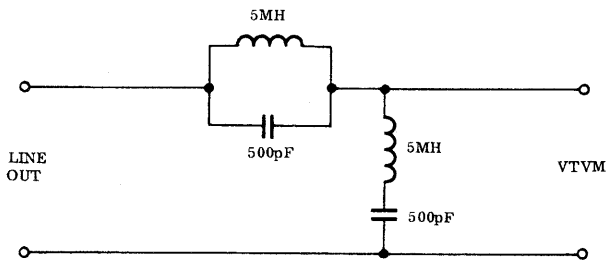
Signal Generator, Hewlett-Packard Model 200C or equivalent  
Bias Filter (see Fig. 5-1)  
A-C Vacuum Tube Voltmeter, Hewlett-Packard Model 400D or equivalent  
Bandpass Filter (see Fig. 5-2)  
Wave Analyzer (if available)

#### 5.2.3 Test Conditions

Line output terminated in 600 ohms for all checks  
Input through dummy plug (not accessory item)  
Heads cleaned and demagnetized before starting  
Covers installed on electronic assemblies  
All checks made using professional grade magnetic tape (Ampex No. 631 or equivalent)

#### 5.2.4 Overall Frequency Response Check

This check can be made while simultaneously recording and reproducing if a bias filter (see Fig. 5-1) is available. If this is not the case, record the tape, rewind, and then make the response run.



**Fig. 5-1. Bias Filter**

**Step 1:** Connect the signal generator to pins 1 and 3 of an INPUT connector (either input A or B may be used). Set the generator to 500 Hz at a nominal 1 volt level.

**Step 2:** Connect the bias filter to the OUTPUT connector, with the vtvm connected to the output of the filter.

**Step 3:** Place the OUTPUT SELECTOR switch, on the front panel of the electronic assembly, in the INPUT position. Adjust the applicable RECORD LEVEL control to achieve a -10 dbm output as indicated on the vtvm. Then turn the OUTPUT SELECTOR switch to the REPRODUCE position.

**Step 4:** At the tape transport, select the desired tape speed. Select the corresponding equalization at the electronic assembly.

**Step 5:** Thread blank tape on the equipment and place tape in motion in the record mode.

**Step 6:** While thus simultaneously recording and reproducing, change the frequency of the signal generator in discrete steps through the response spectrum applicable to the tape speed (refer to Section 1). Response, as indicated on the vtvm, should remain within specifications.

**Step 7:** Repeat Steps 4, 5, and 6 for the second speed.

**Step 8:** If this is two-channel equipment, repeat the entire procedure for the second channel.

Inadequate frequency response can result from any of the following causes:

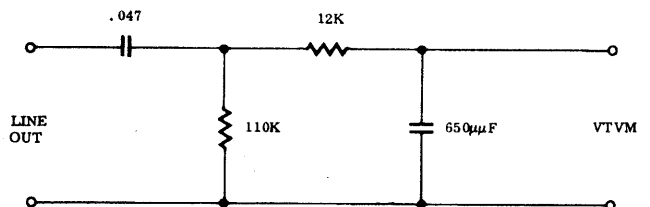
- a. Heads in need of cleaning (refer to Section 6).

- b. Heads in need of demagnetization (refer to Section 6).
- c. Head azimuths incorrectly adjusted (refer to paragraphs 5.3.6 and 5.3.8).
- d. Bias level incorrectly adjusted (refer to paragraph 5.3.7).
- e. Reproduce equalization incorrectly adjusted (refer to paragraph 5.3.7).
- f. Record calibration incorrectly adjusted (refer to paragraph 5.3.7).
- g. Record equalization incorrectly adjusted (refer to paragraph 5.4.2).
- h. Play holdback tension incorrectly adjusted (refer to Section 4).
- i. Record and playback heads not adjusted to same height (refer to Section 6).
- j. Magnetic tape not professional grade.
- k. Signalgenerator output not flat over response spectrum.

#### 5.2.5 Overall Signal-to-Noise Check

This check requires the use of an output bandpass filter, shown in schematic form on Fig. 5-2.

**Step 1:** Connect the signal generator to an INPUT connector (either input A or B can be used). Set the generator to 500 Hz at a nominal 1 volt level.



**Fig. 5-2. Bandpass Filter**

**Step 2:** Connect the bandpass filter to the OUTPUT connector, with the vtvm connected to the output of the filter.

**Step 3:** Place the OUTPUT SELECTOR switch in the INPUT position, and adjust the applicable RECORD LEVEL control to achieve a +10 dbm output as indicated on the vtvm.

Step 4: At the tape transport, select the desired tape speed. Select the corresponding equalization at the electronic assembly.

Step 5: Thread blank tape on the equipment, close the head gate, and start tape in motion in the record mode. Record a section of the tape with the 500 Hz signal.

Step 6: Stop tape motion and rewind the tape to the beginning of the recording made in Step 5. Close the head gate after rewinding.

Step 7: Remove the signal generator from the input. Turn the OUTPUT SELECTOR switch to the REPRODUCE position.

Step 8: Start tape in motion in the record mode with no input signal. The noise level, while thus erasing the 500 Hz signal, will be on the vtm.

#### NOTE

The signal-to-noise ratio is computed from peak record level, which is 6 db higher than normal record level. Therefore, 10 db must be added to the vtm indication in Step 8 to determine the actual signal-to-noise ratio, which should meet or exceed specifications (refer to Section 1).

Step 9: Repeat Steps 4 through 8 for the second speed.

Step 10: If this is two-channel equipment, repeat the entire procedure for the second channel.

An inadequate signal-to-noise ratio can result from any of the following causes:

- a. Heads in need of demagnetization (refer to Section 6).
- b. Heads in need of cleaning (refer to Section 6).
- c. Bias waveform not symmetrical (refer to paragraph 5.4.4).
- d. Fields from nearby motors, generators, etc.

- e. Head cables rubbing against moving parts on tape transport.
- f. Making noise run with head gate open.
- g. Record and playback heads not adjusted to same height (refer to Section 6).
- h. Magnetic tape not professional quality.

To check reproduce noise, remove the tape from the transport. Connect the vtm through the bandpass filter to the output connector. Hold the takeup tension arm away from its rest position (so it does not contact the safety switch) and press the PLAY pushbutton. Table 5-1 lists reproduce signal-to-noise for different speeds and track configurations.

#### 5.2.6 Overall Distortion Check

An accurate check of distortion requires the use of a wave analyzer to measure individual distortion products. (An instrument which measures total harmonic distortion will be influenced by tape noise and modulation noise in addition to actual distortion.) Also, the signal generator must have very low distortion (less than 0.1%) or addition and cancellation effects can occur.

To check distortion, record a 500 Hz signal on blank tape at normal operating level. On playback, the second harmonic content should not exceed 0.4%, and the third harmonic content should be between 0.6% and 1.1%.

The most common cause of high second harmonic distortion is a magnetized record head, but it could also result from a malfunctioning record or reproduce amplifier, or a non-symmetrical bias waveform.

Third harmonic distortion is dependent on the type of magnetic tape, the bias setting, and the accuracy with which the "normal recording level" is adjusted. A typical reel of tape will have a 500 Hz third harmonic content of 0.8% at operating level, but this might range as high as 1.1% or as low as 0.6%.

TAPE SPEED	HEAD	REPRODUCE SIGNAL/ NOISE (from 3% Level)
15 ips	Full Track	60 db
	Half Track	60 db
	Two Track	60 db
7-1/2 ips	Full Track	60 db
	Half Track	60 db
	Two Track	60 db
3-3/4 ips	Full Track	60 db
	Half Track	60 db
	Two Track	60 db
1-7/8	Full Track	55 db
	Half Track	55 db
	Two Track	55 db
15/16 ips	Full Track	55 db
	Half Track	55 db
	Two Track	55 db

Table 5-1. Reproduce Signal-to-Noise

### 5.3 NORMAL ALIGNMENT PROCEDURES

#### 5.3.1 Standard Alignment Tapes

In aligning the equipment, the playback function is first aligned to a standard by using an Ampex Standard Alignment Tape. The record function is then aligned by using the playback circuit as a reference.

Standard tapes are precisely recorded in an Ampex laboratory under stringently controlled conditions. They must be handled and stored with proper care if they are to retain their usefulness over extended periods of time. Heads and tape guides should be cleaned and demagnetized before the standard tape is installed on the equipment, and the tape should not be stored where temperature and humidity extremes occur. Also, the standard tape should be stored under the conditions existing after a normal play run - not after being rewound. After extensive use, the response of the standard tape will begin to fade, for example the head azimuth alignment tone may be down as much as 2 db.

When the standard tape is first run, it should be moved in the fast forward mode to the takeup side, then rewound to another reel (not the standard tape reel). The standard tape reel is then placed on the takeup turntable, and the tape is threaded. This allows storage on the original reel without the necessity of rewinding. Subsequent runs are made by putting the standard tape on the takeup turntable and rewinding to an empty reel on the supply turntable before proceeding with reproduce alignment.

#### 5.3.2 Test Equipment Required

D-C Voltmeter, 20,000 ohms-per-volt.  
A-C Vacuum Tube Voltmeter, Hewlett-Packard Model 400D or equivalent.  
Signal Generator, Hewlett-Packard Model 200C or equivalent.  
Wave Analyzer (if available).  
Electronic Counter (if available).  
Bias Filter (see Figure 5-1).  
Bandpass Filter (see Figure 5-2).

Ampex Standard Alignment Tapes as applicable.

15 ips NAB: No. 01-31311-01  
15 ips CCIR: No. 01-31313-01  
15 ips AME: No. 01-31312-01  
7-1/2 NAB: No. 01-31321-01  
7-1/2 CCIR: No. 01-31323-01  
3-3/4 ips (120 usec): No. 01-31331-01  
3-3/4 ips (200 usec): No. 01-31334-01  
1-7/8 ips: No. 01-31341-01  
15/16 ips: No. 01-31351-01

Normal tools used by technician.

#### 5.3.3 Alignment Conditions

Line output terminated in 600 ohms.  
Input through dummy plug (not accessory item).  
Heads cleaned and demagnetized.  
Covers installed on electronics unless otherwise indicated.  
Alignment made with professional grade magnetic tape (Ampex No. 631 or equivalent).

#### 5.3.4 Introduction to Normal Alignment Procedures

Procedures described in paragraphs 5.3.5 through 5.3.8 will usually suffice to cor-

rect any deficient operation revealed by the Overall Performance Checks (refer to paragraph 5.2). Other adjustment procedures, usually not required or required only after corrective maintenance, are included in paragraph 5.4.

If the equipment will be operated most of the time at one tape speed, with the other used only infrequently, that speed should be used for the first alignment run - where bias level is set and record level is calibrated. Reproduce equalization can then be adjusted for the second speed.

When both speeds are to be used alternately, alignment should be started with the 7-1/2 ips speed for 3-3/4 - 7-1/2 and 7-1/2 - 15 ips equipment, or with the 15/16 ips speed for 15/16 - 1-7/8 ips equipment. These speeds provide optimum settings for bias and record levels.

#### 5.3.5 Checking Power Supply Voltage

There is no adjustment for the power supply. However, its proper operation can be easily checked at an input accessory socket at the back of the electronic assembly.

Step 1: Remove one of the dummy plugs from either INPUT ACCESSORY SOCKET (J5 or J7) at the back of the electronic assembly.

Step 2: Apply power to the equipment and use pressure-sensitive tape or a rubber band to hold the takeup tension arm from its rest position (so it does not contact the safety switch).

Step 3: Place the equipment in the record mode (it is not necessary to thread tape on the transport).

Step 4: Check the voltage from pin 5 (positive) of the accessory socket to chassis ground, using the d-c voltmeter. It should be from 22 to 24.5 volts.

#### 5.3.6 Reproduce Head Azimuth Adjustment

For two channel equipment, this procedure will be easier if two vtvm's are available, because the output of both heads in the reproduce head stack can then be measured simultaneously. Using one vtvm requires that the azimuth be adjusted for one head, then the other, to arrive at

any necessary compromise setting. Of course, only one vtvm is required for single channel equipment. Azimuth need be adjusted at only one tape speed.

### **CAUTION**

Do not tamper with any screw on the head assembly other than the one for azimuth adjustment, or it may become necessary to adjust the head height.

Step 1: Connect the vtvm to the OUTPUT connector. If this is two-channel equipment, and if two vtvm's are available, connect one to each OUTPUT connector.

Step 2: Apply power to the equipment. At the tape transport, select the tape speed at which the adjustment is to be made. Select the corresponding equalization at the electronic assembly.

Step 3: Place the RECORD SELECTOR switch on the electronic assembly in the SAFE position.

### **CAUTION**

To prevent accidentally entering the record mode and thus erasing the standard tape, be sure the RECORD SELECTOR switch on each electronic assembly is in the SAFE position.

Step 4: Place the OUTPUT SELECTOR on each electronic assembly in the REPRODUCE position.

Step 5: Thread the standard alignment tape applicable to the tape speed, on the tape transport (refer to paragraph 5.3.1 if this is the first run of the standard tape).

### **NOTE**

Voice announcements on the standard tape can be monitored through headsets plugged into the PHONES jack, or through

an external amplifier/loud-speaker connected to the output of the vtvm.

**Step 6:** Place the standard tape in motion in the reproduce mode. As the first tone on the tape is reproduced, adjust the REPRODUCE LEVEL control(s) to achieve a convenient indication on the vtvm(s).

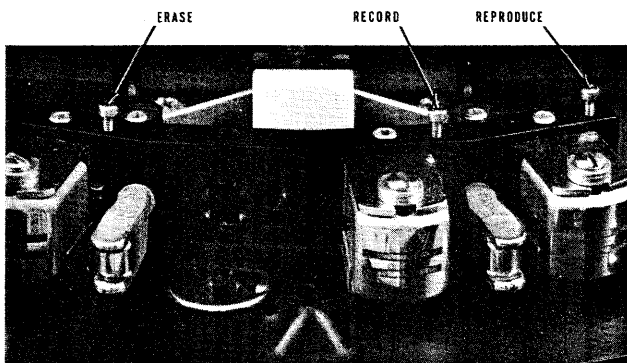
**Step 7:** The second tone on the tape is for use in setting the reproduce head azimuth. Open the head cover, and as this tone is reproduced turn the azimuth adjustment (see Figure 5-3) to achieve a maximum indication on the vtvm. If this is two channel equipment and two vtvm's are being used, adjust to the optimum setting for the two heads in the stack.

#### NOTE

When the head azimuth is far out of adjustment, minor peaks may be observed on each side of the correct setting. Proper adjustment will be unmistakable because it will result in an output obviously higher than the minor peaks.

**Step 8:** If this is two-channel equipment, and only one vtvm is being used, rewind the tape to the first tone and repeat Steps 6 and 7 for the second channel. If the output does not peak at exactly the same setting, work back and forth between the two channels to determine the optimum adjustment point.

Leave test equipment connected and the standard tape threaded, if reproduce/record alignment is to be made.



*Fig. 5-3. Head Azimuth Adjustment*

### 5.3.7 Reproduce/Record Alignment

**Step 1:** Repeat Steps 1 through 5 of the reproduce head azimuth adjustment procedure (refer to paragraph 5.3.6). Close the head cover.

**Step 2:** Start the standard tape in motion in the reproduce mode. As the first tone is reproduced adjust the REPRODUCE LEVEL control to achieve a convenient reference indication on the vtvm. (If tape speed is 15 ips adjust the record level to achieve a +4 dbm indication on the vtvm.)

#### NOTE

Fixed reproduce equalization is used on 15/16 and 1-7/8 ips equipment, so the adjustment described in Step 3 does not apply to that equipment.

**Step 3:** Following the first tone on the standard tape, there are a series of tones for use in checking reproduce high frequency equalization. As these tones are reproduced, adjust the appropriate HI FREQ EQUAL control (at the back of the electronic assembly) to achieve the flattest possible response within specifications. However, reproduce response must be within  $\pm 2$  db of the theoretical curves given in Figures 7-15, 7-16, and 7-17.

#### NOTE

When a standard tape is reproduced by a half track or two track head, readings below 700 Hz (7-1/2 and 15 ips) or 500 Hz (3-3/4, 1-7/8, and 15/16 ips) are invalid. The tape is recorded full track, and the "fringing" effect causes high indications at the lower frequencies. This effect does not occur when tapes are recorded and reproduced using heads of the same configuration.

**Step 4:** As the final tone on the tape is reproduced, adjust the REPRODUCE LEVEL control to achieve a +4 dbm indication on the vtvm

(this has already been accomplished at the 15 ips speed). The equipment vu meter should indicate 0 ( $\pm 3/4$  db).

### NOTE

The setting of the REPRODUCE LEVEL control in Step 4 must not be changed until record level is calibrated in Step 13.

Step 5: Allow the standard tape to continue in motion in the reproduce mode until it is completely wound on the standard tape reel. Remove the standard tape, mark it "Rewind before using", and store it in a safe place.

Step 6: Leave the vtm connected to the OUTPUT connector. Connect the signal generator to the INPUT connector (either A or B input can be used).

Step 7: Set the signal generator to provide a nominal 1 volt rms output at the appropriate frequency listed:

15 ips	1,000 Hz
7-1/2	500 Hz
3-3/4 ips	250 Hz
1-7/8 ips	250 Hz
15/16 ips	250 Hz

Step 8: Thread blank tape on the transport.

Step 9: At the electronic assembly, place the OUTPUT SELECTOR switch in the REPRODUCE position and the RECORD SELECTOR switch in the RECORD position. (If this is two-channel equipment, leave the RECORD SELECTOR on the second electronic assembly in the SAFE position so that it will not record.)

Step 10: Remove the small cover, secured by two screws, from the front of the electronic assembly.

Step 11: Start the equipment in the record mode and adjust the applicable RECORD LEVEL control to achieve a convenient indication on the vtm.

Step 12: Adjust the BIAS ADJUST control to achieve a peak indication on the vtm.

Step 13: Set the signal generator to 500 Hz at a nominal 1 volt level. Adjust the RECORD LEVEL control to achieve a +4 dbm indication on the vtm.

Step 14: Turn the OUTPUT SELECTOR switch to the INPUT position. Adjust the RECORD CAL control to achieve a 0 indication on the equipment vu meter.

Step 15: Repeat Steps 1, 2, and 3 for the second tape speed, using the appropriate standard alignment tape and HI FREQ EQUAL control.

Step 16: If this is two-channel equipment, repeat the entire procedure for the second channel.

### 5.3.8 Record Head Azimuth Adjustments

For two-channel equipment, this procedure (similar to the one for reproduce head azimuth adjustment) will be simplified if two vtm's are available. The adjustment need be made at only one speed.



Do not tamper with any screw on the head assembly other than the one for azimuth adjustment, or it may become necessary to adjust head height.

Step 1: Connect the vtm to the OUTPUT connector. On two-channel equipment where two vtm's are available, connect one to each OUTPUT connector.

Step 2: Connect the signal generator to the INPUT connector (either input A or B may be used). If two vtm's are being used to adjust two-channel equipment, connect the signal generator to the input of both channels.

Step 3: Set the signal generator to a nominal 1 volt rms output level at the appropriate frequency listed:

15	ips	15,000 Hz
7-1/2	ips	15,000 Hz
3-3/4	ips	7,500 Hz
1-7/8	ips	5,000 Hz
15/16	ips	3,000 Hz

Step 4: At the electronic assembly, place the RECORD SELECTOR switch in the RECORD position and the OUTPUT SELECTOR switch in the INPUT position.

Step 5: Adjust the RECORD LEVEL control to achieve a -6 dbm indication on the vtm. Turn the OUTPUT SELECTOR switch to the REPRODUCE position.

Step 6: Thread blank tape on the transport.

Step 7: Start the equipment in the record mode (both channels of two-channel equipment when two vtm's are employed).

Step 8: While thus simultaneously recording and reproducing, open the head cover and adjust the record head azimuth (see Figure 5-3) to achieve a maximum indication on the vtm. If this is two-channel equipment and two vtm's are being used, adjust to the optimum setting for the two heads in the record stack.

#### NOTE

Minor peaks may be observed on each side of the correct setting. Proper adjustment will be unmistakable, however, because it will result in an output obviously higher than the minor peaks.

Step 9: If this is two-channel equipment, and only one vtm is being used, repeat the procedure for the second channel. If the azimuth does not peak at exactly the same setting, work back and forth between the two channels to determine the optimum adjustment point.

## 5.4 INFREQUENTLY REQUIRED ALIGNMENT PROCEDURES

### 5.4.1 Low Frequency Reproduce Equalization

#### NOTE

This adjustment requires access to the LO FREQ EQUAL controls on the back panel of the electronic assembly. Also, the adjustment does not apply to 15/16 and 1-7/8

ips equipment, where fixed equalization is employed.

Step 1: Connect the vtm to the OUTPUT connector.

Step 2: Connect the signal generator to the INPUT connector (either input A or B may be used). Set it to 500 Hz at a nominal 1 volt level.

Step 3: Apply power to the equipment. At the tape transport select the tape speed to be used. Select the corresponding equalization at the electronic assembly.

Step 4: Thread blank tape on the transport. Place the OUTPUT SELECTOR switch in the INPUT position and adjust the RECORD LEVEL control to achieve a 0 dbm indication on the vtm.

Step 5: Start the equipment in the record mode. Turn the OUTPUT SELECTOR switch to the REPRODUCE position and adjust the REPRODUCE LEVEL control for a 0 dbm indication on the vtm.

Step 6: While thus simultaneously recording and reproducing, change the frequency of the signal generator in discrete steps from 250 Hz to 30 Hz, adjusting the applicable LO FREQ EQUAL to obtain the flattest possible result within specifications. This is accomplished by adjusting for equal excursions of the positive-going and negative-going head bumps.

Step 7: Repeat Step 6 for the second tape speed.

Step 8: If this is two-channel equipment, repeat the entire procedure for the second channel.

### 5.4.2 Record Equalization

The adjustment will be simplified by using the bias filter, shown in schematic form on Figure 5-1. If the filter is not used, a trial-and-error method must be employed, where the tape is first recorded at different settings of the REC EQUALIZATION control and then reproduced to determine the correct setting. This will require several record and reproduce runs before the proper adjustment is finally determined.



Step 1: Repeat Steps 1, 2, and 3 of the Low Frequency Reproduce Equalization procedure. In Step 1, connect the bias filter between the OUTPUT connector and vtvm.

Step 2: Remove the small cover secured by two screws to the front panel of the electronic assembly.

Step 3: Set the signal generators to provide a 1 volt rms output at the applicable frequency listed:

15	ips	18,000 Hz
7-1/2	ips	15,000 Hz
3-3/4	ips	8,000 Hz
1-7/8	ips	5,000 Hz
15/16	ips	3,000 Hz

Step 4: Thread blank tape on the equipment. Place the OUTPUT SELECTOR switch in the INPUT position and adjust the RECORD LEVEL control to achieve a -10 dbm indication on the vtvm.

Step 5: Start the equipment in the record mode. Turn the OUTPUT SELECTOR switch to the REPRODUCE position.

Step 6: While thus simultaneously recording and reproducing, change the frequency of the signal generator over the top end of the response spectrum for this tape speed (refer to Specifications in Section 1). Adjust the applicable REC EQUALIZATION control (LOW speed or HIGH speed) for the flattest possible high frequency response, in reference to 500 Hz, in accordance with specifications.

Step 7: Repeat Steps 3, 4, 5, and 6 for the second speed.

Step 8: If this is two-channel equipment, repeat the entire procedure for the second channel.

#### 5.4.3 Bias Oscillator Frequency Adjustment

This adjustment is made at the factory using an electronic counter. If such a counter is available, connect it across R41 on the record printed wiring board (with the record head connected). Place the equipment in the record mode

(on one channel only if this is two-channel equipment). Adjust the tuning slug in transformer T1 (also on the record printed wiring board) to achieve a bias frequency as close as possible to 100,000 Hz.

#### NOTE

If this is two-channel equipment, the frequencies of the bias oscillators in the two electronic assemblies must be identical within  $\pm 1,000$  Hz.

If an electronic counter is not available, do not attempt to adjust the bias oscillator frequency, except on two-channel equipment when a beat frequency becomes noticeable. If this should occur, slowly and carefully adjust the tuning slugs, alternating between the two oscillators, until the beat frequency is eliminated.

#### 5.4.4 Bias Symmetry Adjustment

This adjustment is made at the factory using a signal generator with a second harmonic distortion less than 0.2%, and a wave analyzer. The BIAS SYM control, on the back panel of the electronics assembly, is adjusted for minimum second harmonic distortion of a 500 Hz signal, placing only one channel at a time in the record mode.

If a wave analyzer is not available, do not change the factory setting of this control unless some component in the bias and erase oscillator requires replacement. After completing such corrective maintenance, monitor the output through a high gain amplifier and loudspeaker (or headset) while simultaneously recording and reproducing with no input signal. Adjust the BIAS SYM control for minimum popping or hissing noise.

#### NOTE

If the BIAS SYM control has no audible effect, simply leave it in the mid-position.

### 5.5 PRINCIPLES OF OPERATION

#### 5.5.1 General

A block diagram of the record/reproduce circuits is presented in Figure 5-4. Complete

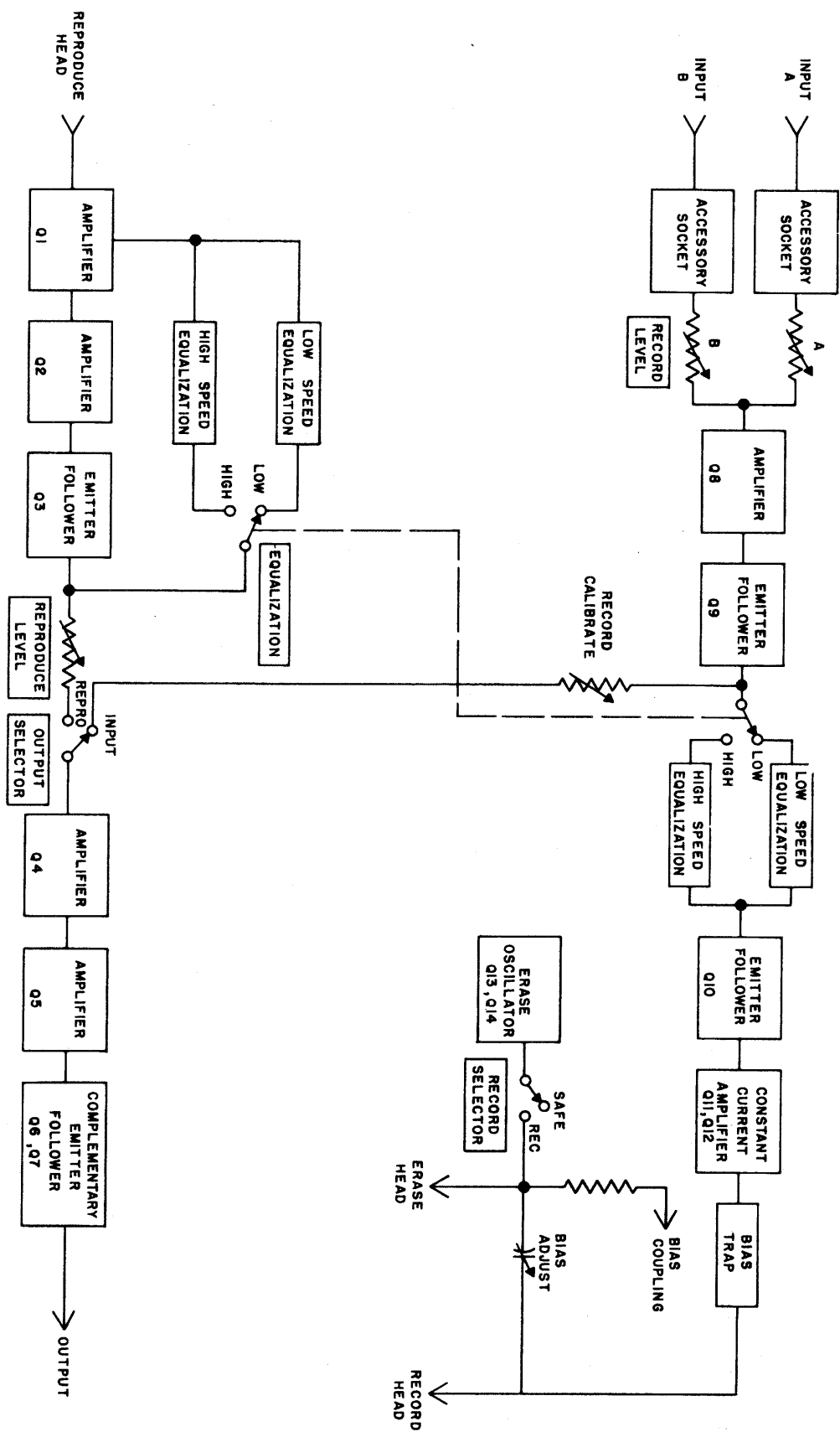


Fig. 5-4. Block Diagram, Electronic Circuit

schematic diagrams are provided in Section 7 for all available versions of the equipment.

#### 5.5.2 Record Circuit

The signal to be recorded is connected to either or both receptacles J4 (input A) or J6 (input B), and is then routed to INPUT ACCESSORY sockets J5 or J7 respectively. Dummy plugs (provided) or optional accessory input transformers or microphone preamplifiers (refer to Section 1) must be inserted in J5 or J7 to complete the signal path.

Note that one side of the signal path is connected to the accessory sockets at pin 4, leaves the socket at pin 3 and is connected across the RECORD LEVEL control, returns to the accessory socket at pin 6, and finally leaves at pin 7. This connection allows the record level controls to be inserted between the two amplifier stages in the microphone preamplifier, when that optional accessory is used. The preamplifier can thus function as a variable gain device which will accommodate a wide variety of microphones.

Following the accessory socket and level control the two inputs are connected together through a resistive mixing circuit. The signal is then routed to the base of amplifier stage Q8. Note that the collector load for Q8 consists of the base circuit of emitter follower stage Q9.

Following Q9 there are two signal paths. The record signal is connected to contacts of EQUALIZATION switch S2, which select either the HIGH speed or LOW speed record equalization circuit. This circuit consists of resistor R29 shunted by resistor R56 and either capacitor C25 (high speed) or C26 (low speed) as selected by the switch. The record monitor signal is connected, through resistor R51 and the RECORD CAL control R50, to contacts of the OUTPUT SELECTOR switch. When that switch is in the INPUT position, the signal proceeds through the final three stages of the reproduce circuit (refer to paragraph 5.5.3) to the vu meter and output line for monitoring and calibration purposes.

Emitter follower stage Q10 follows the record equalization circuit in the record signal path. The signal is then amplified in a constant current amplifier stage formed by Q11 and Q12.

In this amplifier, Q12 acts as a bootstrap on Q11 and the circuit presents a relatively high a-c impedance (to provide a constant current signal drive) but a relatively low d-c impedance (so that the d-c operating voltage may be fully utilized). The signal then proceeds through a bias trap (L1, C15), is mixed with the a-c bias, and is delivered to the record head.

The record amplifier is made operative through contact set 6-8 of record relay K1. Closing these contacts shifts the d-c bias on transistor Q10, causing it and subsequently Q11 and Q12 to conduct, when the contacts are open the three transistors are cut off. Thus the amplifier is inoperative in any but the record mode.

Transistors Q13 and Q14 form the bias and erase oscillator. This is a conventional push-pull circuit connected as a tuned flip-flop. Operating voltage is delivered only when the equipment is in the record mode, through contact set 9-11 of record relay K1. Symmetry of the output waveform is adjustable at variable resistor R62, while the frequency is adjustable by a tuning slug in transformer T1 (nominal bias frequency is 100,000Hz).

The output of the bias and erase oscillator is taken from the secondary of T1 to RECORD SELECTOR switch S4. When that switch is in the RECORD position the bias current is delivered through capacitor C28 to the erase head, and is adjusted at capacitor C27, mixed with the record signal and delivered to the record head. Also, a bias line is run through resistor R58 to pin 7 of receptacle J11. In two channel equipment this pin is connected to the output of the bias oscillator in the second electronic assembly; the coupling locks the frequencies of the two oscillators together, so that no beat frequency is generated.

A simplified diagram of the record relay is shown in Figure 5-5. When the RECORD SELECTOR switch is in the RECORD position, and the equipment is first started in the play mode, pressing the RECORD pushbutton will energize the relay. Contact set 3-5 then forms a holding circuit for the relay, which will then remain energized until the STOP pushbutton is pressed, or tape is exhausted (safety switch opens). (Note that it is possible to drop out the record mode by returning the RECORD SELECTOR switch to the SAFE position. This, however, will cause severe

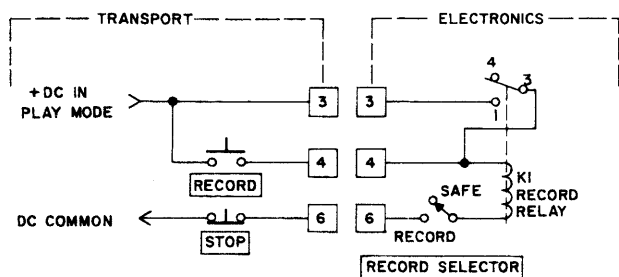


Fig. 5-5. Simplified Diagram, Record Relay

pops on the tape, and will probably magnetize the record head, so it is not a recommended practice.)

### 5.5.3 Reproduce Circuit

From the reproduce head, the signal from the tape is routed through two amplifier stages (Q1 and Q2) and an emitter follower stage (Q3). Reproduce equalization is connected through contacts of EQUALIZATION switch S2, from the emitter of Q3 to the emitter of Q1. Variable resistors R47 (high speed) and R48 (low speed) are used to equalize high frequencies, while R46 (high speed) and R63 (low speed) are for equalizing low frequencies.

#### NOTE

Fixed reproduce equalization is employed on 15/16 - 1-7/8 equipment.

Following emitter follower Q3 is the REPRODUCE LEVEL control, R49. The signal then proceeds through contacts of OUTPUT SELECTOR switch S3, which must be in the REPRODUCE position during playback. (Note that when this switch is in the INPUT position, the record monitor circuit is connected to the final three stages for calibration and monitoring of the record signal.)

After the OUTPUT SELECTOR switch, there are two amplifier stages (Q4 and Q5), and a complementary emitter follower output stage Q6/Q7. The output is transformer-coupled to the vu meter and OUTPUT connector J3. Headsets with impedances of 8 ohms or more can be used to monitor the output, either record or reproduce, at PHONES jack J2, which is connected in series with resistor R52 across the primary of the output transformer.

### 5.5.4 Power Supply Circuit, Domestic Equipment

The a-c power line voltage is connected

from the transport, immediately following the POWER switch, to pins 9 and 10 of the electronic assembly. One side of the line is fused by F1, and line power is then connected across the primary of power transformer T3.

Diodes CR2 and CR3 provide full wave rectification in the center tapped secondary of T3. Transistor Q15 is a series (emitter follower) power transistor. Regulation is achieved by Zener diode VR1 which holds the base, and thus the emitter, of Q15 at a constant potential (23.4 volts,  $\pm 5\%$ ).

### 5.5.5 Power Supply Circuit, International Equipment

The only difference between this circuit and that in the domestic equipment is in the power input. In the international version, a selector switch on the back panel of the electronic assembly must be positioned in accordance with the a-c power line voltage - either 115 volts or 230 volts.

A simplified diagram of the international power input circuit is shown on Fig. 5-6. Line power is connected to receptacle J118P on the tape transport. Both sides of the line are switched by power switch S106 and fused by F101 and F102. The a-c power is then connected from the transport to the electronics assembly.

In the electronics assembly, the a-c power is connected across the two primary windings of power transformer T3. Note, however, that the 115V - 230V switch is connected between the two primary windings. In the 230V position of this switch the windings are connected in series across the power line. The 115 volts a-c at the junction of the two windings is returned to the transport. In the 115V position of the switch, the two windings are connected in parallel, and both sides of the line are returned to the transport.

The voltage regulator action in the electronics power supply is identical to that previously described for the domestic equipment.

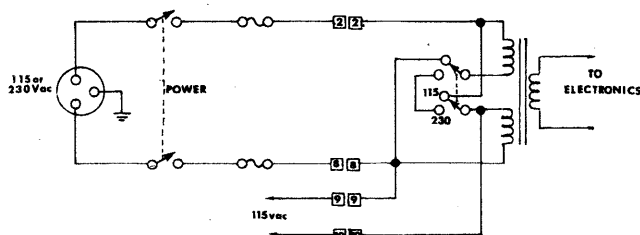


Fig. 5-6. Simplified Diagram, Power Input, International