6. Adjust the spring tension nut (Capstan Idler Force Adjust of Figure 5-6) for 9 lbs ±1/2 lb (3.9 to 4.3 kg).

ELECTRONIC ALIGNMENT

Complete electronic alignment consists of adjustment of power supply voltage, bias oscillator frequency, reproduce adjustments, and record adjustments. Procedures for complete electronic alignment of the 440C Recorder/Reproducer are provided below.

Test Equipment

Test equipment required for electronic alignment is listed in Table 5-1 (Items 1 through 11).

Preliminary Procedures

Check that the output line is terminated either externally or with the line termination switch. Also clean and demagnetize the heads.

Power Supply. The power supply (with the bias and erase oscillator) is mounted on a plug-in printed circuit board in the transport power supply box. Operation can be checked by connecting the dc voltmeter across pin 9 (positive) and pin 5 of any of the four receptacles (J701 through J704) on the power supply box cover. The voltmeter should indicate 39 (±1) volts.

If adjustment is necessary, open the cover on the power supply box (see Figure 5-8).

WARNING

FULL LINE VOLTAGE IS PRESENT WITHIN THE POWER SUPPLY BOX. DO NOT TOUCH THE FUSE POST OR TRANSFORMER LEADS WHILE THE SYSTEM IS ENERGIZED.

With the voltmeter connected as previously described, place the equipment in the reproduce mode, then adjust R712 (see Figure 5-8) for an indication of 39 (±1) volts.

Bias Oscillator Frequency. The bias oscillator is mounted on the same plug-in printed circuit board as the 39-volt power supply. The frequency can be measured by connecting a counter or oscilloscope between pin 2 or 3 (positive) and pin 1 or chassis ground on any of the four receptacles (J701 through J704) on the power supply box. The counter should read 150 kHz ±3 kHz. The oscilloscope should indicate a period of 6.53 to 6.80 microseconds. If the frequency needs adjustment, install an extender card and adjust the slug of coil T701 for 150 kHz or 6.66 microseconds.

Reproduce Alignment

High Frequency Equalization. The recommended method for adjusting high frequency response is to utilize a flux loop. This is a device which will induce constant flux into the head when placed in contact with the head and fed a constant voltage from a signal generator. In the absence of equalization the reproduce electronics will produce a flat response from a constant flux signal due to its integrating characteristics.

When high frequency equalization is added the response will rise with increasing frequency. In the absence of a flux loop a standard alignment tape may be used to set high frequency equalization. However, when using the standard tape the results will vary with the condition and accuracy of the tape.

Three controls are associated with the reproduce high frequency equalization: the low speed high frequency equalizer, the high speed high frequency equalizer and the head resonance control. The high frequency equalizers (Figure 1-3) set the turnover frequency established by NAB or IEC (CCR) standard. This frequency is expressed in microseconds. For example at 15 IPS NAB specifies that the high frequency equalization is 50 microseconds. This gives a 6 dB per octave rising characteristic with a transition frequency (3 dB point) of 3183 Hz (the turnover frequency being the reciprocal of $2\pi RC$). The head resonance control affects both speeds equally and is used to make a compromise compensation for the loss due to a finite reproduce head gap length. It does this by changing the frequency where the

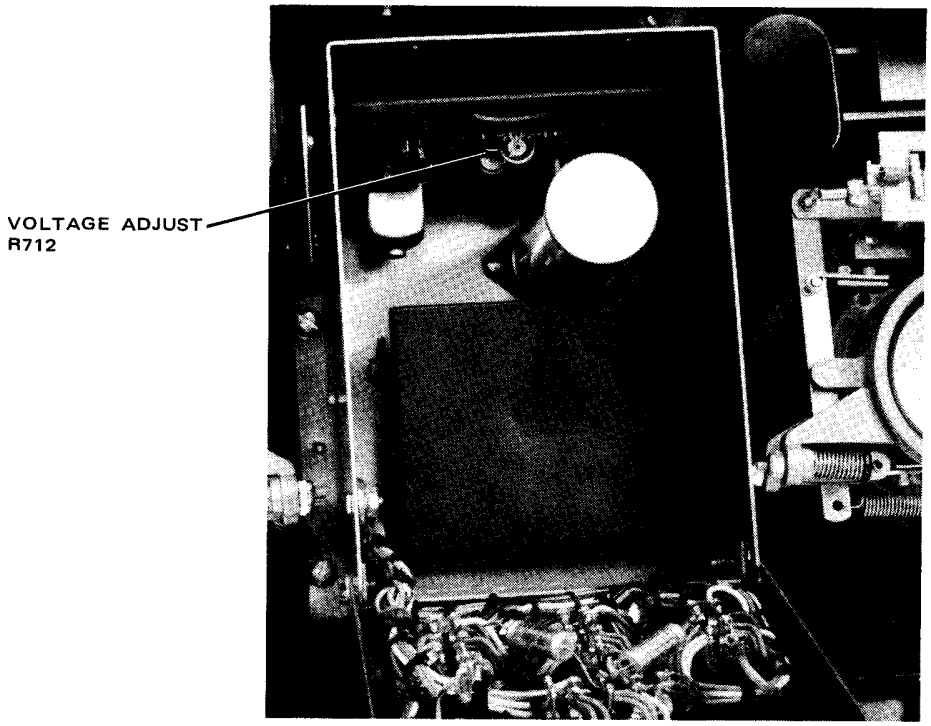

Figure 5-8. Power Supply Box Interior

head resonates with the input capacity. This resonance produces a rise above the curve generated by the high frequency equalizer. This control is located on the reproduce plug-in module. When turned clockwise viewed from the front it raises the resonant frequency and reduces the gap loss compensation.

INITIAL TEST STEPS. Connect the equipment and set controls as specified in steps 1 through 7 below:

1. Connect the flux loop to the signal generator and clip it on to the reproduce head.
2. Set the signal generator to deliver a maximum output 500 Hz signal.
3. Connect a vtvm, set to the -10 dBm scale, to the output receptacle.
4. Set the SAFE and REPRO pushbuttons.
5. Set the REPRODUCE LEVEL control to approximately 5.
6. Set the speed switch for the 7-1/2 in/s speed (15 in/s for 15-30 machines).
7. Turn on equipment power.

Note

Be sure that the signal generator maintains a constant output voltage for output frequencies of 500 Hz to 15 kHz.

FINAL TEST STEPS. If equalization is simply being verified or trimmed, proceed with steps 8 through 11. If equalization is suspected to be completely wrong, omit steps 8 through 11 and complete steps 8A through 14A.

8. With the vtvm set on the -10 dBm scale, adjust the reproduce level control and/or the signal generator to produce the 500 Hz reading in Table 5-7 that agrees with the equalization being verified. The dB readings in Table 5-8 should be interpreted as dB with respect to a -10 dBm reference.

9. Switch to 5 kHz and check that response agrees with Table 5-7, and if necessary adjust the HI FREQ equalizer that corresponds with the SPEED switch setting (high or low).

10. Switch to 15 kHz and adjust head resonance control (R32) if necessary. This adjustment is most easily accomplished with the reproduce module plugged into an extender board.

11. Change to the other speed pair and repeat steps 8 and 9.

Complete the following steps in place of steps 8 through 11 when equalization appears to be completely wrong.

8A. When starting from unknown equalizer adjustments, begin by turning both low and high speed high frequency equalizers to the extreme counterclockwise position. Set SPEED switch in position providing 7-1/2 in/s (15 in/s for 15 in/s/30 in/s machines).

9A. With the vtvm set on the -10 dBm scale adjust the reproduce level and/or signal generator to give exactly -10 dBm.

10A. Switch to 5 kHz and adjust the appropriate high frequency equalizer to give the reading in Table 5-7.

11A. Before adjusting head resonance, change to the other speed pair. Set 500 Hz to exactly -10 dBm. Switch to 5 kHz and set the other high frequency equalizer for the appropriate reading in Table 5-7.

12A. Return SPEED switch to original speed setting. Set signal generator output frequency to 500 Hz and adjust the REPRODUCE LEVEL control for the appropriate (Table 5-7) reading.

13A. Switch to 5 kHz and retrim the high frequency equalizer if necessary. This procedure is required because there is some interaction between the high speed and low speed equalizers.

14A. Switch to 15 kHz and adjust the head resonance control for the appropriate (Table 5-7) reading.

Reproduce Head Azimuth. It is recommended that the reproduce head azimuth be adjusted at 7-1/2 in/s for 3-3/4 – 7-1/2 or 7-1/2 – 15 machines and at 15 in/s for 15 – 30 machines. This adjustment may be made using the equipment vu meters. It is made by adjusting the left hand nut at the top of the reproduce head (see Figure 5-9).

CAUTION

DO NOT ADJUST ANY OF THE OTHER NUTS ON THE HEAD ASSEMBLY.

1. Remove the head cover by loosening captive screw on its angled back.

2. Apply power. Thread an appropriate standard alignment tape on the transport. Set the speed and reel size switches accordingly.

3. Set the pushbuttons at safe and repro. Connect head sets or a monitor amplifier speaker to the head phone jack or the output receptacle so the voice announcements on the tape can be heard.

4. Start the tape in the reproduce mode and adjust the reproduce level control for a 0 vu meter reading on the 700 Hz tone.

Table 5-7. High Frequency Equalization Response

OPERATION	FREQ	3-3/4 NAB 90 μS	7-1/2 IEC 70 μS	7-1/2 NAB 50 μS	15 NAB 50 μS	15 IEC 35 μS	30 AES 17.5 μS
Set level	500	+ 0.35 dB	+ 0.2 dB	+ 0.1 dB	+ 0.1 dB	+ 0.05 dB	0 dB
Adjust Hi Freq Equal	5,000	+ 9.5 dB	+ 7.7 dB	+ 5.4 dB	+ 5.4 dB	+ 3.4 dB	–
	10,000	–	–	–	–	–	+3.5 dB
Adjust head (R32) Resonance for 3-3/4 – 7-1/2 Recorder	15,000	–	+19 dB[1]	+16 dB[1]	–	–	–
Adjust head (R32) Resonance for 7-1/2 – 15 Recorder	15,000	–	+18 dB[1]	+15 dB[1]	–	–	–
Adjust head (R32) Resonance for 15 – 30 Recorders	15,000	–	–	–	+14.5 dB[1]	11.5 dB[1]	–

[1] Due to variation in head inductance it may not be possible to reach these center values. Set as close as possible to these readings.

5. On the 15 kHz tone, adjust the reproduce head azimuth adjustment nut (not the screw) for a maximum reading on the vu meters. On multi-channel equipment if all heads do not peak at the same setting, adjust for optimum output of all the heads.

Note

If the azimuth is far out of adjustment, minor peaks will appear on each side of the correct setting. Correct adjustment results in an output markedly higher than the minor peaks.

Reproduce Standard Tape Response. If the reproduce equalization has been adjusted with a flux loop, the standard tape response is a double check on this adjustment. If the standard tape plays back within ±1 dB of the 700 Hz reference tone in the 2.5 kHz to 10 kHz region and ±2 dB 12 kHz to 15 kHz, the previous adjustments are probably adequate. If it does not meet these requirements look for the problem area:

1. Bad alignment tape.
2. Dirty heads.
3. Head tracking improper (gap not centered on the tape contact area).
4. Reproduce high frequency equalizers set improperly.

If the standard tape is to be used for reproduce equalizer adjustment, the reproduce high frequency

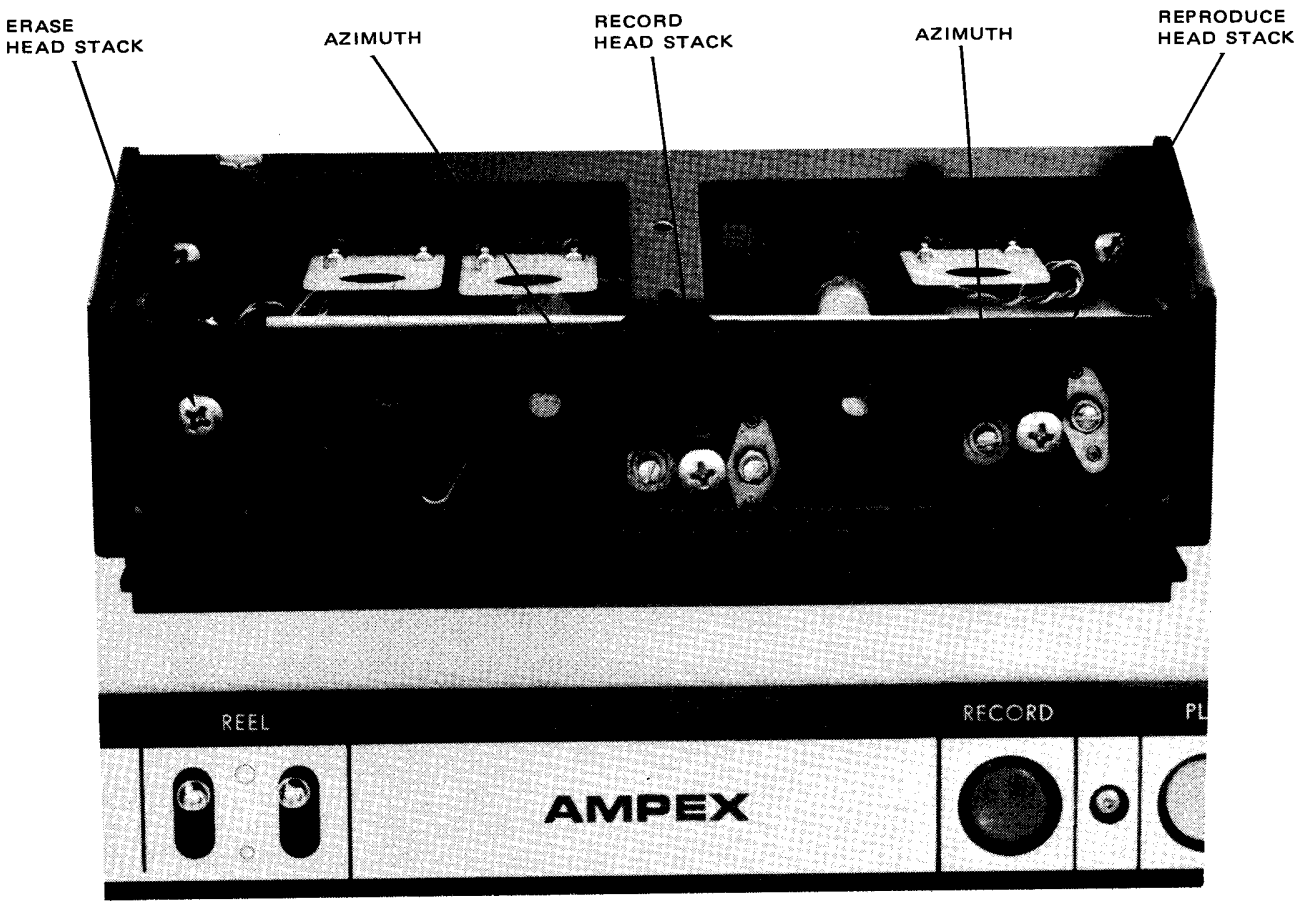

Figure 5-9. Head Azimuth Adjustments

equalizer should be adjusted on the 5 kHz or 7.5 kHz tone for flat response. Then rewind to the 15 kHz tone and adjust the head resonance control for desired 15 kHz response remembering that the head resonance affects both speeds equally. For example, if the 15 kHz response at 7-1/2 in/s is adjusted to 0, thus compensating for all gap loss, the response at 15 kHz 15 in/s (where the gap loss will be less) may be +1-1/2 to +2 dB above the 700 Hz reference.

Note

Many test tapes are recorded full track. When reproduced by a half-track or multi-track head, the fringing effect produces invalid response at frequencies below 700 Hz. This effect, which results in high indications in the lower frequencies, does not occur when tapes are recorded and reproduced with heads of the same configuration. Do not adjust the low frequency reproduce equalizers for flat response from a full track standard tape.

Operating Level Adjustment. This adjustment is made with the operating level 700 Hz signal from the standard alignment tape. It is important that this adiustment be accurate since it affects signal to noise ratio, distortion, and tape saturation level. On Ampex standard alignment tapes this level is 185 nWb/m and is the first tone for 15 in/s and 30 in/s tapes, the last tone for 7-1/2 in/s and 3-3/4 in/s tapes. It is suggested that operating level be set at the speed at which the equipment

will usually run. If used equally, set at 15 in/s except 7-1/2 in/s for 7-1/2 – 3-3/4 recorders. The adjustment is made with the reproduce calibrate potentiometer when the reproduce level control is in the calibrate (Cal) position.

Adjusting for a 185 nWb/m operating level. Reproduce the 185 nWb/m 700 Hz operating level tone from the alignment tape. With the reproduce level control in the Cal position adjust the reproduce potentiometer (Table 3-2) for a 0 reading on the vu meter or a +4 or +8 dBm reading on the vtvm depending upon the line level selected.

Adjusting for a 260 nWb/m operating level. Reproduce the 185 nWb/m 700 Hz operating level tone from the alignment tape. With the reproduce level control in the Cal position, adjust the reproduce calibrate potentiometer for a -3 reading on the vu meter or a +1 dBm reading on the vtvm if a +4 dBm line level is used, or +5 dBm reading if a +8 dBm line level is used.

Note

If an alignment tape with a 200 nWb/m operating level is used, add 0.7 dB to the readings called out above. For example, if the vu meter reading with a 185 nWb/m signal should be -3, it should be set to -2.3 with a 200 nWb/m signal.

Sel-Sync Level Adjustment. While reproducing the operating level signal, press the sync button. Adjust the sync calibration potentiometer (Table 3-2) for the same vu meter reading that the reproduce position indicates.

Record Alignment

Erase Peaking. The erase peaking consists of adjusting the erase adjust capacitor C40 (ERASE PEAK in Figure 1-3), and the slugs of coils T3 and T4 to produce the maximum erase voltage. An extender cord is needed for adjustment of T3 and T4. The coils need adjustment if the bias frequency changes. For example, if a bias module were changed to another recorder, the slugs should be tuned. If the bias module is changed to another channel, only the erase adjust capacitor requires tuning to match it to the head. Proceed as follows:

1. Install the bias module on the extender card.
2. Press the bias pushbutton on the channel being adjusted (the remaining channels should be in SAFE).
3. Start the tape in the record mode.
4. Adjust the bias calibrate potentiometer to provide an "on scale" reading of the vu meter. The bias reading on the vu meter changes when an extender card is used.
5. Adjust the erase adjust capacitor for maximum vu meter reading, then adjust the slugs on the coils. Since the three adjustments interact slightly, repeat the adjustment until the maximum reading is obtained.
6. Stop the tape.
7. Press SAFE.
8. Reinstall the bias module and proceed to the next channel.

Note

The adjustment of erase adjust capacitor C40 is quite broad but does affect second harmonic distortion. Usually any spot on the peak produces acceptable second harmonic distortion. If the absolute minimum second harmonic distortion is desired, C40 can be trimmed while measuring distortion. This distortion measurement should be made after the remaining steps in the record alignment are completed.

Bias Adjustment. The selection of bias point is an individual decision; some users prefer peak biasing, some overbiasing or other bias setting. Two bias adjustment procedures will be described; peak biasing at a long wavelength (15 mils), and overbiasing at a medium wavelength (1.5 mils). The overbiasing procedure provides a more precise setting and is recommended when using Ampex 406 high output low noise tape. Biasing should be done at the tape speed commonly used. If both are used equally, adjust at 15 in/s except 7-1/2 in/s for 3-3/4 – 7-1/2 machines.

LONG WAVELENGTH PEAK BIASING. Proceed as follows:

1. Adjust the signal generator to 2000 Hz at 30 in/s, 1000 Hz at 15 in/s, 500 Hz at 7-1/2 in/s or 250 Hz at 3-3/4 in/s.
2. Select READY and REPRO.
3. Set REPRODUCE LEVEL control to CAL.
4. Start the tape in the record mode.
5. Adjust the RECORD LEVEL control for an on-scale reading of the vu meter.
6. Adjust the BIAS ADJ (Figure 1-3) for maximum reading on the vu meter.

MEDIUM WAVELENGTH OVERBIASING. Proceed as follows:

1. Adjust the signal generator to 20 kHz at 30 in/s, 10 kHz at 15 in/s, 5 kHz at 7-1/2 in/s, or 2.5 kHz at 3-3/4 in/s.
2. Select READY and REPRO.
3. Set REPRODUCE LEVEL control to CAL.
4. Start the tape in the record mode.

Note

This adjustment can be made at operating level at 15 in/s and 30 in/s but should be made at least 10 dB below operating level at 3-3/4 and 7-1/2 in/s.

5. Adjust the RECORD LEVEL control for an on-scale reading of the vu meter.
6. Adjust the BIAS ADJ for maximum reading on the vu meter.
7. Since the azimuth must be in approximate alignment to provide a signal at the 1-1/2 mil wavelength, it may be necessary to make a preliminary azimuth adjustment at this time. Place a nut-driver on the left hand nut of the record head (Figure 5-9) and adjust for a maximum reading on the vu meter.
8. At the 15 and 30 in/s speed, adjust the RECORD LEVEL control for a vu meter reading of +1. Check that this is still the maximum reading point by turning the bias adjust control, then overbias 1-1/2 dB by turning the control clockwise until the vu meter drops to -1/2.
9. When adjusting at 3-3/4 or 7-1/2 in/s, after adjusting the bias adjust and record head azimuth for a maximum reading (steps 6 and 7), adjust the RECORD LEVEL so that the vu meter reads between the 20% mark and -10.
   a. Adjust the REPRODUCE LEVEL control so the vu meter reads +1.
   b. Check that this is still the maximum reading point by turning the BIAS ADJ control, then overbias 1-1/2 dB by turning BIAS ADJ clockwise until the vu meter reads -1/2.

Note

When using Ampex 406 tape, 1-1/2 dB overbias at 1.5 mil falls within the range of peak bias at 15 mils.

Bias Metering Calibration. Immediately after adjusting the bias (see paragraph above) and while still recording, press the bias pushbutton. Adjust the bias calibration potentiometer so that the vu meter indicates 0.

Record Head Azimuth. This adjustment is similar to the reproduce head adjustment except that it is made while simultaneously recording and reproducing a short wavelength signal. This procedure ensures that the azimuth of both heads coincide. Proceed as follows:

1. Use a 15 kHz signal generator output at 7-1/2 in/s or a 25 kHz signal at 15 in/s.
2. Use pushbuttons to select READY and REPRO.
3. Set REPRODUCE LEVEL control to CAL.
4. Start the tape in the RECORD mode.
5. Adjust the RECORD LEVEL control for a vu meter reading near the 20% mark.
6. Adjust the REPRODUCE LEVEL control so that the vu meter indicates between 0 and -5.
7. Adjust the record head azimuth nut (not the screw) shown in Figure 5-9 for a maximum reading on the vu meters. On multichannel equipment, if all heads do not peak at the same setting, adjust for optimum output of all the heads.

Record High Frequency Equalization. This adjustment can be made at operating level for 15 or 30 in/s, but should be made at least 14 dB below operating level for 3-3/4 and 7-1/2 in/s. Proceed as follows:

1. Select READY and REPRO.
2. Set REPRODUCE LEVEL control to CAL.
3. Set signal generator output frequency to 700 Hz.
4. Start the tape in the record mode.
5. For 15 or 30 in/s speeds adjust the RECORD LEVEL control so the vu meter indicates 0.

5A. For 3-3/4 or 7-1/2 in/s speeds adjust the RECORD LEVEL control so that the vu meter indicator is at the 20% mark. Adjust the REPRODUCE LEVEL control so the vu meter indicates 0.

6. Change the signal generator output frequency to 7 kHz.
7. As a preliminary setting, adjust the appropriate low or high speed record equalizer so that the vu meter indicates 0.
8. Check the response above and below 7 kHz and trim the record equalizer for the response desired. If the desired response cannot be obtained the reason may be:
   a. Heads are dirty.
   b. Improper head tracking (gap not centered on the tape contact area).
   c. Attempting to adjust 3-3/4 or 7-1/2 in/s response at operating level.
   d. Forgetting to place the reproduce level in the CAL position when adjusting record level.
   e. Bias set incorrectly. The bias adjustment can be used to improve response. However, remember that compensating for record deficiencies by under biasing increases distortion.

Before repeating the Record High Frequency Equalization adjustments at the other tape speed, proceed with the Reproduce Low Frequency Equalization procedure given below. Then perform the High Frequency and Low Frequency Equalization procedures at the other tape speed.

Reproduce Low Frequency Equalization. This adjustment is made while simultaneously recording and reproducing to avoid fringing effects present if the adjustment is made with a full track standard tape. Proceed as follows:

1. Using the 700 Hz reference level noted during record high frequency equalization, sweep the signal generator frequency slowly from 700 Hz down to 30 Hz (note the magnitude of the peaks and dips).

2. Adjust the appropriate low or high speed reproduce low frequency equalizer for the flattest possible response. This is done by adjusting the head "bump" excursions for an equal magnitude above or below the 700 Hz reference frequency.

Input Calibration Adjustment. Adjust the input calibration as follows:

1. Select READY and REPRO.

2. Set RECORD LEVEL and REPRODUCE LEVEL controls to CAL.

3. Set signal generator frequency to 700 Hz and output level at +4 or +8 dBm, depending upon the line level used.

4. Start the tape in the record mode.

5. Adjust the input calibrate potentiometer (Table 3-2) for a 0 reading on the vu meter.

Record Calibrate Adjustment. After completing the Input Calibration Adjustment procedure above, proceed as follows:

1. Press the INPUT pushbutton.

2. Adjust the RECORD calibrate adjustment on the Record plug-in module for a 0 indication on the vu meter.

Servo Gain Adjustment

Note

This adjustment should be made only when a major component of the servo system is changed. If 1200 Hz carrier whine is audible, reduce servo gain (turn R19 clockwise).

Proceed as follows:

1. Put the capstan-servo PWA on extender (4050695).

2. Attach a scope probe to test point number 2 of the capstan servo PWA.

3. Put recorder in PLAY.

4. Adjust R19 on capstan servo PWA for minimum signal jitter.

HEAD MAINTENANCE

Head cleaning and demagnetizing was discussed in the *Preventive Maintenance* portion of this section, under headings *Cleaning* and *Demagnetizing.* Adjustment of head azimuth was discussed in the *Electronic Alignment* portion of this section, under the heading *Record Head Azimuth.* Changing the head assembly is explained in the *Installation Section* (section 2), under the heading *Conversion*. The head and tape adjustments are explained below. Head height is precisely set at the factory, therefore, head adjustment is seldom required except when a head stack is changed.