

*series 351 full track and half track
recorder/reproducer*

*series 351-2 two track stereophonic
recorder/reproducer*

AMPEX
351

the standard of excellence in professional recorders



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AMPEX SERIES 351

SECTION I

DESCRIPTION AND PERFORMANCE CHARACTERISTICS

GENERAL

The AMPEX Series 351 Magnetic Tape Recorder/Reproducers are high quality precision instruments designed for the professional user who requires the finest and most faithful recording and reproduction.

A basic recorder/reproducer in the 351 series consists of a tape transport for operation at tape speed pairs of 3-3/4 inches per second (ips) and 7-1/2 ips or 7-1/2 and 15 ips, a head assembly for use with 1/4-inch magnetic tape, and an electronic assembly which contains the record amplifier, reproduce amplifier, bias and erase oscillator, and power supply -- all featuring etched board construction.

Head assemblies for either full (single) track, half track or two track stereophonic (351-2) operation are available.

CCIR equalization can be obtained on request when ordering equipment.

Several mounting arrangements are offered - console, two case portable and rack mount. In the portable equipment, one case contains the tape transport and the other houses the electronic assembly unit.

PERFORMANCE CHARACTERISTICS

<u>Tape Width</u>	1/4-inch	
<u>Tape Speed Pairs</u>	3-3/4 -- 7-1/2 (ips) 7-1/2 -- 15 ips	
<u>Frequency Response</u>	Speed (ips)	Response (cycles per second)
	3-3/4	± 2 db 50 to 7,500
	7-1/2	± 2 db 40 to 10,000
	15	± 4 db 30 to 15,000 ± 2 db 30 to 15,000
<u>Signal-to-Noise Ratio</u>	Speed (ips)	Peak Record Level to Unweighted Noise (db)
	3-3/4	50
	7-1/2	60 full track
	15	55 half track or two track Same as 7-1/2 ips

Peak record level is that level at which the overall (input to output) total rms harmonic distortion does not exceed 3 percent when measured on a 400 cycle tone. Noise is measured

Signal-to-Noise Ratio
(Cont'd)

when erasing a signal of peak recording level in the absence of new signal. Bias, erase and reproduce amplifier noise are included in the measurement. All frequencies between 50 and 15,000 cycles are measured.

Flutter and Wow

Speed (ips)	Flutter and Wow (percentage rms)
3-3/4	.25
7-1/2	.2
15	.15

Flutter and wow measurements include all components between 0 and 300 cycles using an rms meter calibrated to read the rms value of constant amplitude sine wave flutter.

Reproducing Time

(NAB 10-1/2 Inch Diameter
Reels, 2400 feet of tape)

Speed (ips)	Half Track		Full Track	
	(hrs)	(min)	(hrs)	(min)
3-3/4	4	16	2	8
7-1/2	2	8	1	4
15	1	4		32

Starting Time

The tape is accelerated to full speed in less than 1/10 of a second.

Stopping Time

When operating at 15 ips, the tape moves less than two inches after the STOP button is depressed.

Reproduce Timing
Accuracy

Accuracy (percentage)	Accuracy (sec)	Length of Recording (min)
± .2	± 3.6	30

Rewind Time

Approximately 1 minute for a full 2,400 foot NAB reel.

Controls

Tape Motion

All tape motion is controlled by four pushbuttons, PLAY, STOP, FAST FORWARD and REWIND.

Record Control

A separate RECORD button on the face of the electronic assembly, when depressed, energizes the record relay which drops out when the STOP button is depressed.

Controls
(Cont'd)

The stereophonic function (two track) is controlled by depressing the RECORD buttons on both electronic assemblies simultaneously. In two track operation, for consistency, the master electronic assembly is usually connected to the upper track in the head assembly so that, when the RECORD button on the master (only) is depressed, recording takes place on the upper track. The lower track can be brought into the recording mode by selecting the lower track RECORD button at the slave electronic assembly.

(Concurrent dual track recording can be achieved by depressing one RECORD button only when the Remote Control Unit is included in the system.)

Tape Speed

Tape speed can be changed by the TAPE SPEED switch. LOW or HIGH positions are used to select drive motor windings.

Equalization

An EQUALIZATION switch on the face of the electronic assembly provides a means for selecting LOW or HIGH speed equalization appropriate to the tape speed to be used.

Reel Size

A REEL SIZE toggle switch on the tape transport makes possible selection of the proper tape tensioning for the NAB 10-1/2 inch diameter reel or the EIA 5 inch and 7 inch reels.

Record Inputs

The INPUT TRANSFER SWITCH provides a means for selecting three different types of inputs:

Input

MICROPHONE

150 to 250 ohms nominal
(transformer can be strapped for 30-50 ohms nominal).

Minimum Input Signal that
will produce Operating Level
(1% tape characteristic distortion)

150 microvolts

Input
(Cont'd)

BAL BRIDGE

300K ohms

-10 dbm

UNBAL BRIDGE

140K ohms

-13 dbm

Reproduce Output

Zero indication on the v-u meter corresponds to +8 dbm \pm 1 db. Sufficient gain and power handling capabilities exist to feed a +14 vu line. Output into 600 ohms balanced or unbalanced. The center tap of the output transformer can be strapped to ground for balanced output. Plus 4 vu also can be obtained by strapping. (See INSTALLATION).

Head Housing

The erase, record, and reproduce heads are contained in a single head housing.

Monitoring
(aural and visual)

The signal on the tape can be monitored while the equipment is recording. Two phone jacks are available to allow monitoring the record input signal, or the output signal from the reproduce head. A two position switch provides a means for making direct comparison between the original program and the recorded program. The same switch transfers a 4 inch vu meter for level comparison and monitoring. The vu meter also is used to read bias and erase current.

Power
Requirements

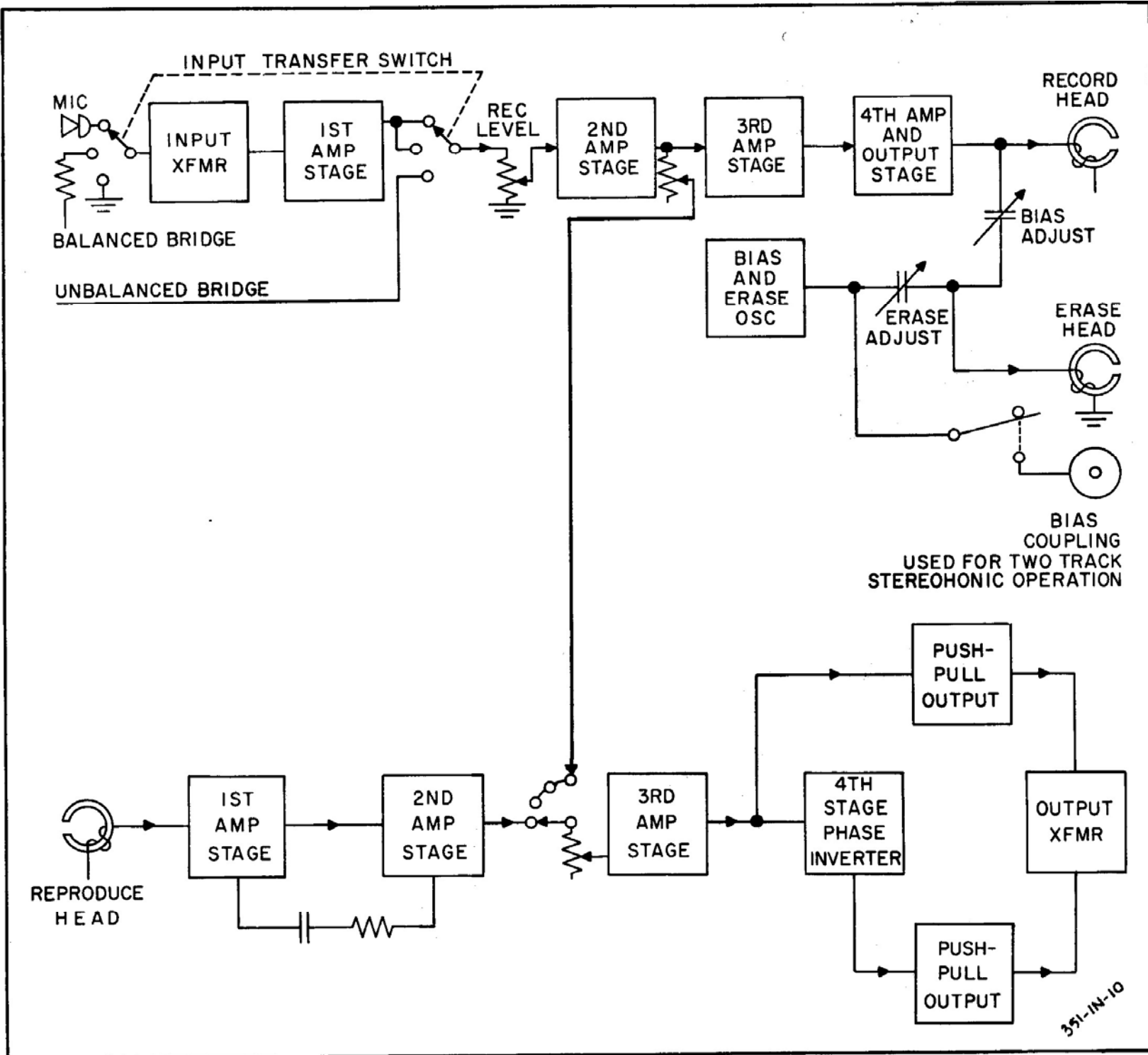
The half track and single track equipment requires 2.0 amperes at 117 volts ac (200 watts) and is available for 50 or 60 cycle line frequency.

Two track equipment requires 2.5 amperes at 117 volts ac (250 watts), 50 or 60 cycles.

When the Ampex Model 375 Precision Frequency 60 cycle amplifier is used with the equipment, power requirements are greater by 2.5 amperes: single track equipment 4.5 amperes; dual track 5.0 amperes.

EQUIPMENT AVAILABLE

<u>Dimensions and Weight</u> (in.) (lb.)	<u>Item</u>	<u>Height</u>	<u>Depth</u>	<u>Width</u>	<u>Weight</u>
<u>Rack Mount</u>	Tape Transport	15-3/4 (rack space)	8 (beyond rack)	19	50
	Electronic Assembly	7 (rack space)	8-1/2 (beyond rack)	19	18
<u>Console</u>	Console	48 (max)	28-1/2 (max)	24-1/2	155
<u>Two Case</u> <u>Portable</u>	Tape Transport Case (Equipment in Case)	15-1/2	17	20-1/4	69
	Electronic Assembly Case (Equipment in Case)	9	13	21	38
	Two Track Stereophonic Electronic Assembly Case (Equipment in Case)	16-1/2	13	21	80
<u>Remote Control</u>	5763-02	3-3/4	3-3/4	10-3/4	5
	5763-03				



SYSTEM BLOCK DIAGRAM

INSTALLATION

NOTE

Before operating the equipment read this SECTION and SECTION 3, OPERATION.

GENERAL

The 351 Series equipment is shipped mounted in consoles or portable cases after a thorough inspection and performance check at the factory. In the event that the equipment is requested disassembled, for customer rack mounting, all assembly hardware is provided.

INTERCONNECTING

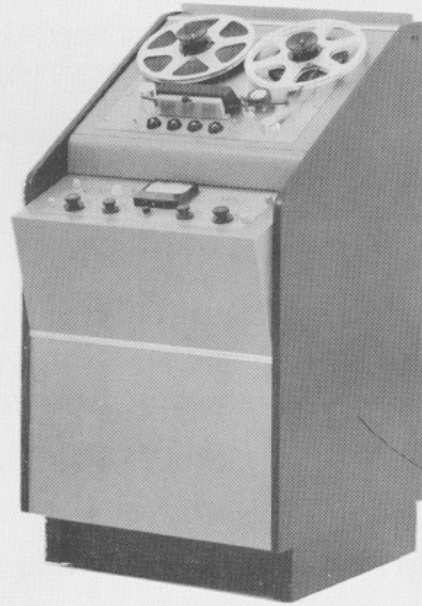
See the appropriate interconnecting diagrams at the back of this section.

MOUNTING

Console Models

To assemble the console model proceed as follows:

- Step 1: Install the tape transport in the cabinet frame, securing the 8 oval-head screws and finishing washers.
- Step 2: Place the two springs in the holes for the electronic assembly cabinet frame.
- Step 3: Attach the two rails to the electronic assembly using the number 8 screws.
- Step 4: Slide the cabinet back panel up and out to allow connecting of the a-c power cable and plug the input cable and the output cable into their receptacles on the back of the electronic assembly.
- Step 5: Install the electronic assembly, tightening the four knurled nuts to fasten it to the frame.
- Step 6: Connect the captive head cables at their locations on the electronic assembly.
- Step 7: Connect the captive CABLE TO ELECTRONICS to the electronic assembly.
- Step 8: Replace the back panel, making certain that all cables run freely through the semi-circular cut-outs at the bottom of the sliding panel.



351-IN-1

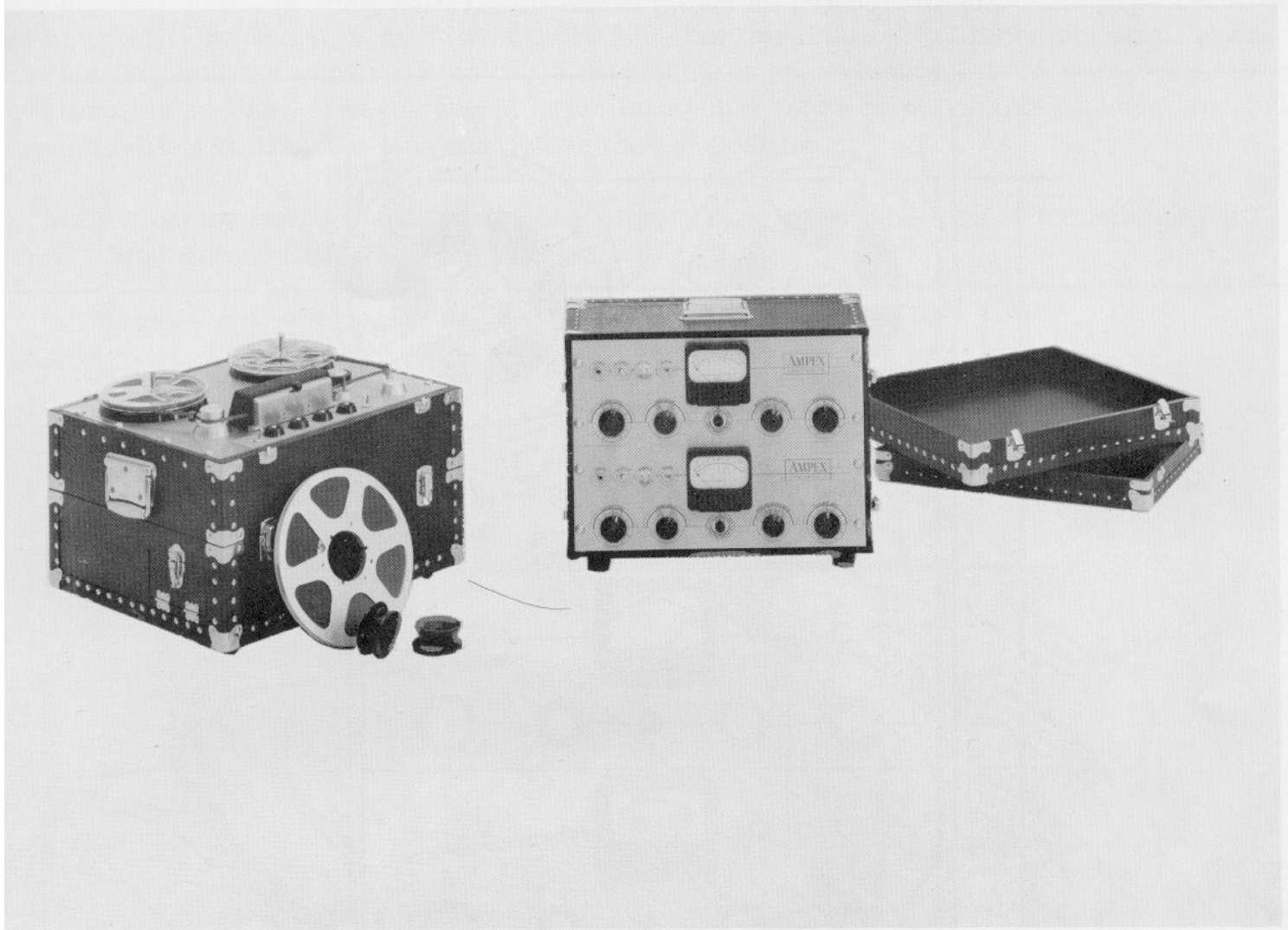
CONSOLE MODEL

Two Case Portable Models (For 351-2 see the applicable INTERCONNECTING illustration at the back of this SECTION).

The two case portable models are shipped in a ready to operate condition, except for the connection of interconnecting cables. Convenient rubber feet are located at both ends of each case, and metal rests are provided on the backs of each case. To set up the equipment follow these steps:

Step 1: Arrange the cases so that the mechanical assembly case is to the right of the electronic assembly case.

Step 2: Unlatch and remove the top cover and the side access door on the mechanical assembly case.



351-1N-2

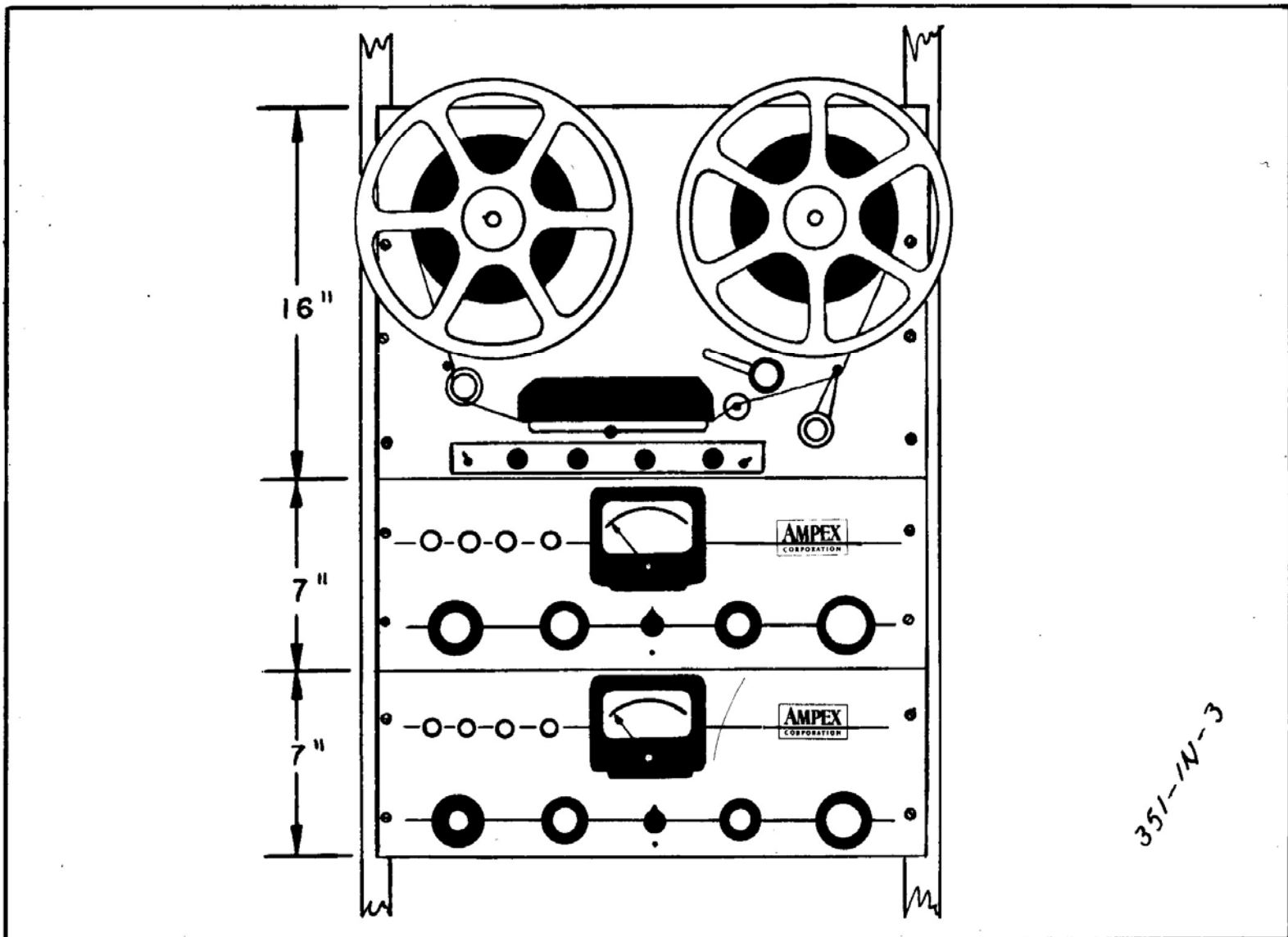
TWO CASE PORTABLE EQUIPMENT

- Step 3: Unlatch and remove the front and rear covers on the electronic assembly case.
- Step 4: Uncoil the interconnecting cables from behind the cable access door on the tape transport case and plug them into mating receptacles at the rear of the electronic assembly.
- Step 5: Connect the a-c power, and the input and output to the rear of the electronic assembly.

Rack Mounted Models

Mount these versions of the equipment on a standard 19-inch relay rack with the mechanical assembly above the main electronic panel.

The 351-2 equipment can be mounted as shown in the illustration.



TYPICAL RACK LAYOUT

POWER CONNECTION

Connect the power cable from the a-c POWER input connector, J8, on the electronic assembly to a convenient 115 volt a-c power source.

OUTPUT

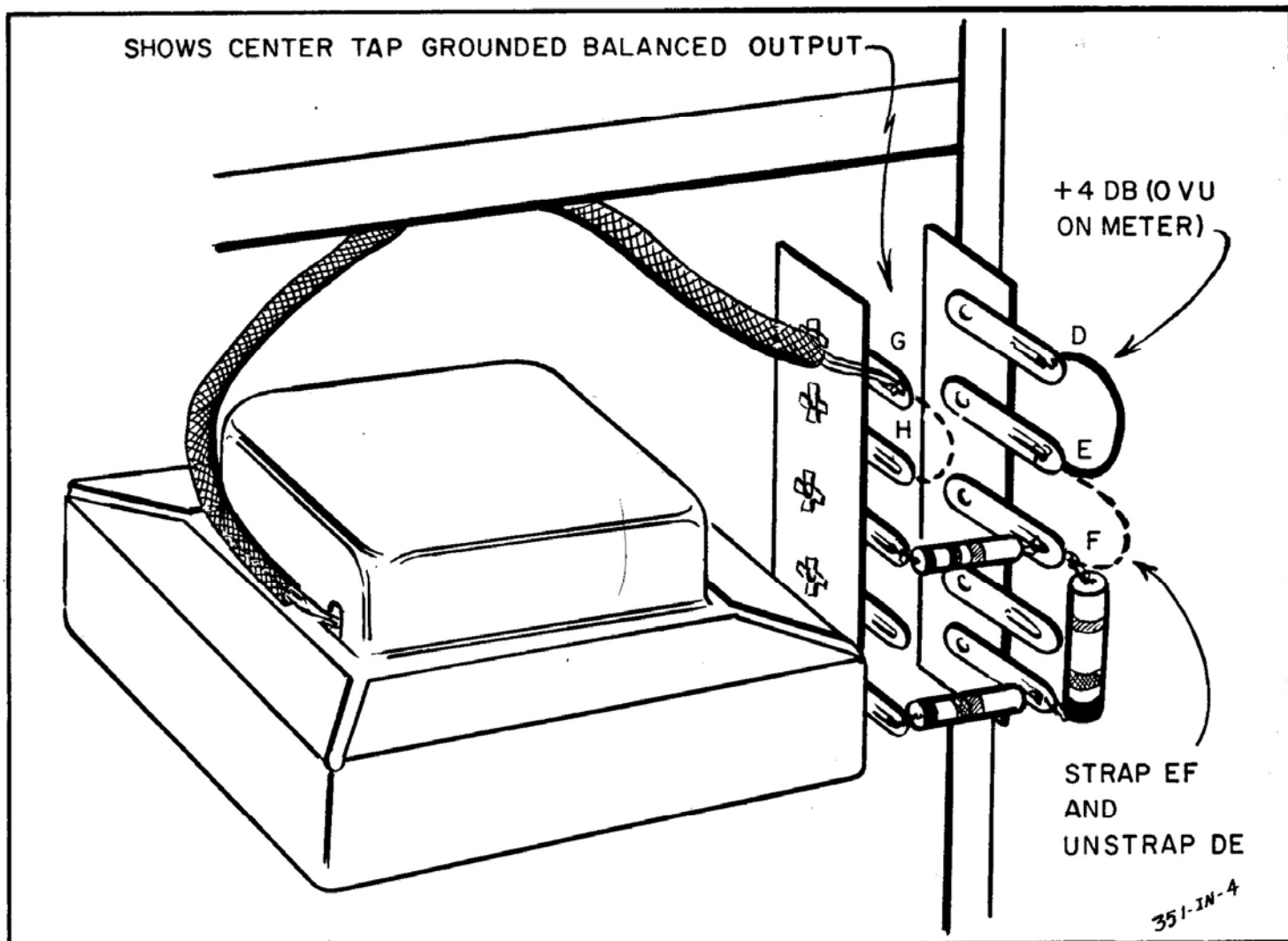
A mating connector for LINE OUTPUT is supplied. The user must fabricate his own cables.

Studio Line

Plus 8 v-u, 600 ohm line output, balanced or unbalanced, is available across terminals 2 and 3 of the line out connector, J5. Pin 1 is the chassis ground.

If unbalanced output is desired, wire the mating connector so that the pin 2 side of the line is tied to ground or tie A to B at TS1. Supply 600 ohm termination to this output at all times to maintain correct meter calibration while recording or reproducing. If the output is not feeding a terminated line, or if the output is not connected, such as on remote pickups, the line out termination switch, S4, must be left in the ON position.

To obtain a center tap, grounded balanced output, strap the black lead of transformer T3 to ground at the tie point shown in the illustration.



*CENTER TAP GROUNDED BALANCED OUTPUT
AND STRAPPING FOR 4 VU OUTPUT*

Plus 4 v-u output can be achieved by unstrapping D and E at transformer T3 and strapping E to F. Readjust the record calibration according to the instructions in SECTION 5 ALIGNMENT AND PERFORMANCE CHECKS.

High Impedance Amplifier Input

Wire the mating connector so that pin 3 of the line out connector, J5 is connected to the high side of the amplifier input. Strap pins 1 and 2 of the mating connector for connection to the ground side of the amplifier input. The line out termination switch S4, must be left in the ON position at all times.

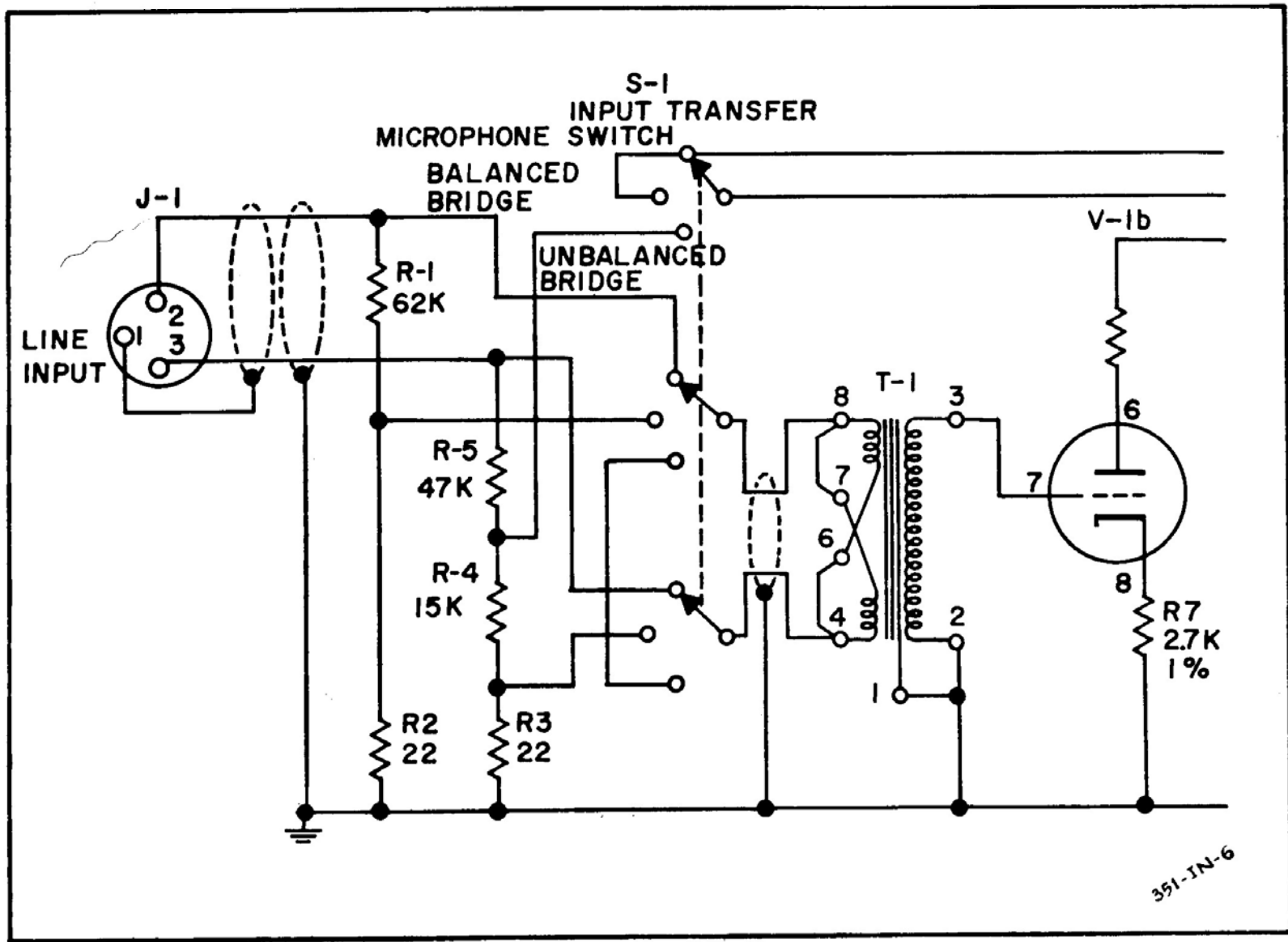
INPUT

During this discussion refer to the foldout illustration - Schematic Diagram - Electronic Assemblies at the back of SECTION 5.

Microphone Input

Any low impedance microphone having a nominal impedance between 30 and 250 ohms can be plugged directly into the equipment. Wire the mating connector so that the microphone is connected to pins 2 and 3 of LINE INPUT, J1. The cable shield must be connected to pin 1. Place the input transfer switch, S1, in the MIC position.

The microphone input transformer is strapped for the optimum step up when using a 150 to 250 ohm source. With microphones of 50 ohms or less impedance, to obtain 6 db additional gain strap the input as shown.



MICROPHONES WITH 50 OHMS OR LESS IMPEDANCE

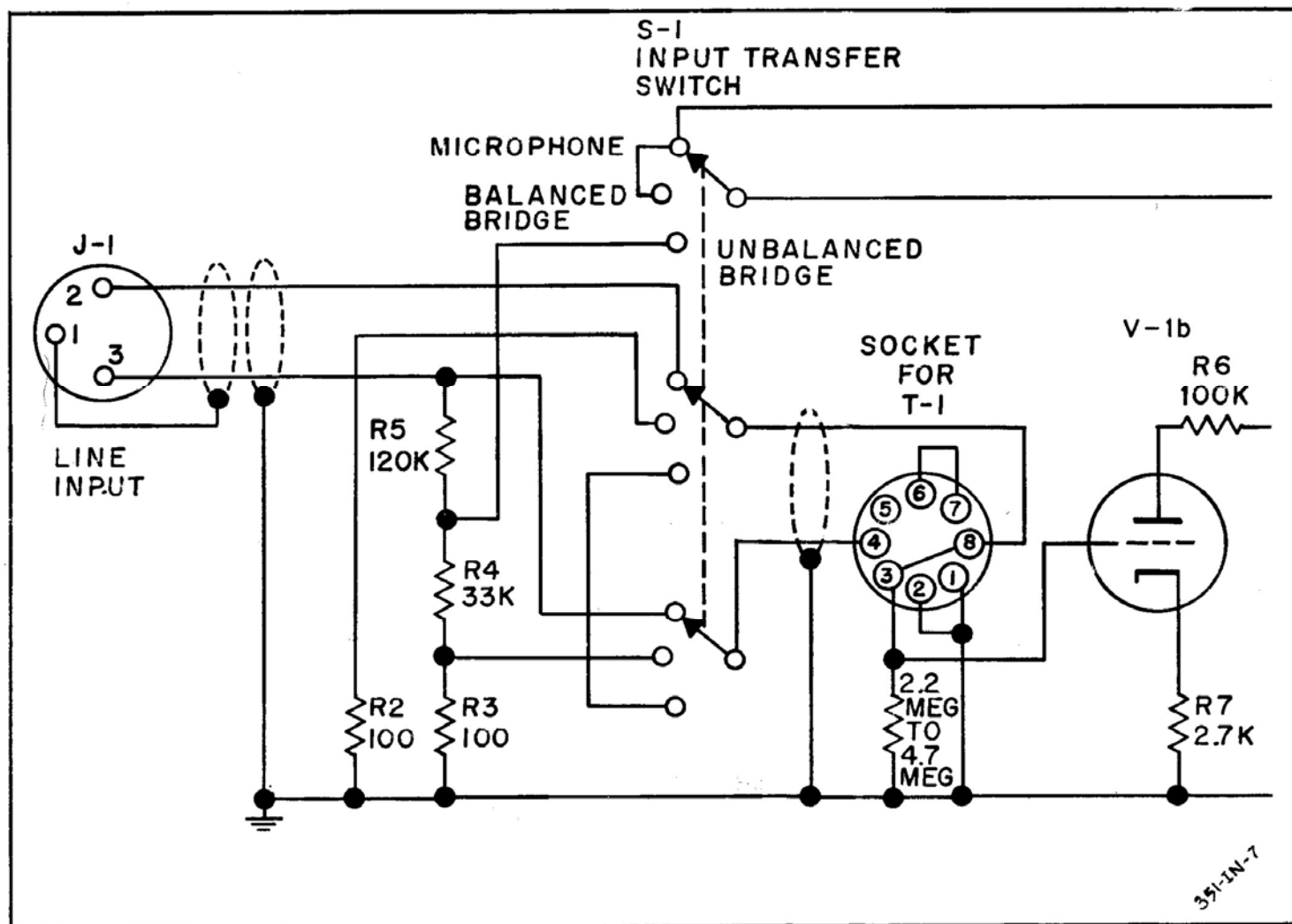
This should be done only if insufficient gain is found to exist when the input is fed from a source impedance greater than 50 ohms.

IMPORTANT

To maintain flat response in the balanced bridge condition when the transformer is strapped for 50 ohms, change resistor values of the following:

- | | |
|----------------|----------------|
| R1 -- 62K ohms | R3 -- 22 ohms |
| R2 -- 22 ohms | R4 -- 15K ohms |
| R5 -- 47K ohms | |

High impedance microphones are not recommended for use in this equipment because, in general, the quality is not satisfactory for professional work. If it becomes necessary to connect a high impedance microphone, the input circuit must be re-wired as shown below:



HIGH IMPEDANCE MICROPHONE INPUT

- Step 1: Remove the input transformer T1.
- Step 2: Remove the 150,000 ohm resistor R1 from the switch S1.
- Step 3: Between pin 3 and pin 1 on the input transformer socket, connect a resistance the value of which is between 2.2 megs and 4.7 megs.
- Step 4: Using a jumper connect pin 3 to pin 8 on the transformer socket.
- Step 5: Wire the microphone input connector for connection to pins 1 and 2 (shield to pin 1), and leave pin 3 open.

Bridging a Balanced Studio Line

Connect a balanced line to pins 2 and 3 of the input connector, J1. Pin 1 is ground. Place the input transfer switch, (S401) in the BALANCED BRIDGE position. Input levels of minus 10 to plus 20 v-u can be accommodated. The load placed on the line is approximately 300,000 ohms.

Bridging an Unbalanced Source

Connect an unbalanced line, radio tuner, etc., to pins 1 and 3 of the input connector. Pin 1 is the ground side. Place the input transfer switch S1, in the UNBALANCED BRIDGE position. This connection provides a 140,000 ohm bridging input for any rms program voltage greater than .2 volt.

Gain Changes in Balanced Bridge or Unbalanced Bridge

An increase of 10 db in balanced and unbalanced bridge can be achieved by changing two resistors. Change R1 to 47,000 ohms and R5 to 15,000 ohms. The resulting input impedances will be 100,000 ohms in the balanced bridge position and 40,000 ohms in the unbalanced bridge position.

An increase of 14 db unbalanced bridge gain without changing balanced bridge gain can be obtained by shorting out resistor R5 and changing R4 to 150,000 ohms. Resulting input impedance will be 60,000 ohms.

For a 10 db increase in balanced bridge gain without changing unbalanced bridge gain, change resistor R1 to 47,000 ohms, R5 to 39,000 ohms and R4 to 10,000 ohms. Resulting input impedances will be 100,000 ohms for balanced bridge and 50,000 ohms for unbalanced bridge.

SUMMARY

<u>For Gain Increase</u>	<u>Component</u>	<u>New Value</u>	<u>New Input Impedance</u>	
			<u>BAL BRIDGE</u>	<u>UNBAL BRIDGE</u>
10 db BAL BRIDGE and UNBAL BRIDGE	R1	47,000 ohms	100,000 ohms	40,000 ohms
	R5	15,000 ohms		
14 db UNBAL BRIDGE	R5	zero (short out)	300,000 ohms	60,000 ohms
	R4	150,000 ohms		
10 db BAL BRIDGE	R1	47,000 ohms	100,000 ohms	50,000 ohms
	R5	39,000 ohms		
	R4	10,000 ohms		

PHONES

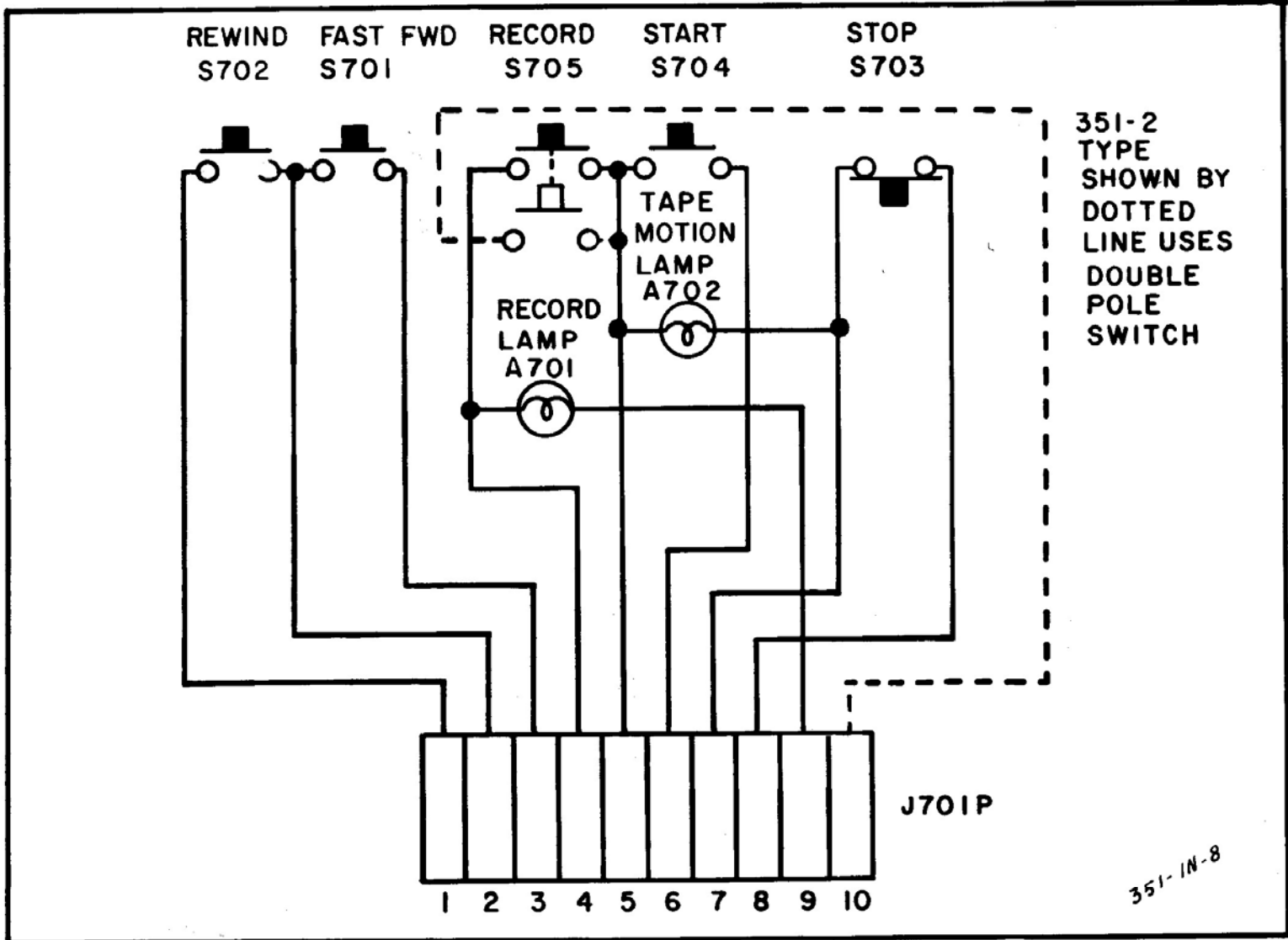
High impedance head phones must be used. To monitor the incoming line or reproduce output, plug the high impedance phones into phone jack J6 PHONES on the amplifier face panel or J4 MONITOR on the back of the amplifier chassis.

REMOTE CONTROL

The operation of the tape transport mechanism can be remotely controlled by an Ampex Catalog No. 5763 or 5763-2 Remote Control Unit. The catalog No. 5763 or 5763-2 unit is supplied in a wooden case, completely wired and ready to plug into the remote control connector, J502S, on the tape transport circuits assembly. The catalog No. 5763-1 and 5763-3 units are mounted on a flat plate for installation in studio consoles, and are not wired. For Model 351-2, use only 5763-2 in the wooden or 5763-3 mounted on the flat plate. To install, wire as shown in the figure, and plug into J502S.

NOTE

Whenever the remote control unit is not connected, the dummy plug P502P, supplied with the equipment, must be plugged into J502S.



SCHEMATIC DIAGRAM --
REMOTE CONTROL UNIT

60 CYCLE AMPLIFIER

The Ampex Model 375 Precision 60 Cycle Amplifier can be plugged directly into the equipment at J503S. No other connections are necessary. The Model 375 is used where power sources are erratic and there is need for a precision 60 cycle time base for driving the capstan.

CAUTION

If this unit is used with the recorder/reproducer, the control circuit fuse F402 must be increased to 5 amperes.

NOTE

Do not remove the dummy plug P503P unless the 60 cycle amplifier is connected.

OVERALL PERFORMANCE CHECK (Read SECTION 3, OPERATION before making these checks.)

Make the following equipment performance checks at the time of installation and when necessary thereafter:

REPRODUCE (Playback) LEVEL
REPRODUCE (Playback) RESPONSE
REPRODUCE (Playback) NOISE MEASUREMENT

RECORD CALIBRATION
FREQUENCY RESPONSE
RECORD NOISE MEASUREMENT

Complete instructions for making the above checks are given in SECTION 5 ALIGNMENT AND PERFORMANCE CHECKS.

DISTORTION

Overall distortion can be measured by connecting any standard distortion measurement apparatus across the output. The readings from a wave analyzer or selective frequency distortion meter will be more accurate than those from a null type instrument at lower distortion levels. Distortion readings are somewhat dependent on tape. A reading of 1% is normal at operating level while a reading of 3% is normal at 6 db above operating level. Second harmonic distortion is negligible; measured distortion is predominantly third order.

FLUTTER AND WOW

Flutter and wow are produced by periodic irregularities in tape speed and appear as cyclic frequency deviations in recording or reproduction. They can be measured by means of any standard flutter bridge. Variations in amplitude as indicated on level measurements do not constitute flutter and are entirely due to tape coating variations. Readings will be well under .14% rms at 15 inch, .18% rms at 7-1/2 inch, and .21% rms at 3-3/4 inch speed. The Ampex Professional Products Division primary standard of measurements is based on the use of a flutter meter calibrated to indicate the deviation from mean carrier frequency of any rate between .5 and 300 cps expressed in percent rms.

INTERCONNECTING
SINGLE TRACK

<u>Cable</u>	<u>Catalog Number</u>	<u>Qty.</u>	<u>Receptacle</u>	<u>From</u>	<u>Chassis</u>	<u>Receptacle</u>	<u>To</u> <u>Chassis</u>
A-c	2413	(1)	J8 POWER		Electronic Assembly	A-c source	
Power Interconnecting	----	(1)	J7 TAPE TRANSPORT		Electronic Assembly	CABLE TO ELECTRONICS	Captive at Tape Transport
Reproduce Head		(1)	J3 PLAYBACK HEAD		Electronic Assembly	Captive at Tape Transport	
Record Head		(1)	J2 RECORD HEAD		Electronic Assembly	Captive at Tape Transport	
Erase Head		(1)	J10 ERASE HEAD		Electronic Assembly	Captive at Tape Transport	

PORTABLE
SINGLE TRACK

Power Extension	3768-1	(1)	J7 TAPE TRANSPORT		Electronic Assembly	End of Captive Tape Transport power interconnecting cable.	
-----------------	--------	-----	-------------------	--	---------------------	--	--

DUAL TRACK EQUIPMENT (Unmounted)

Power Interconnecting	30812-01	(1)	J7 TAPE TRANSPORT		Electronic Assembly 1 and 2	End of Captive Tape Transport power interconnecting cable.	
-----------------------	----------	-----	-------------------	--	-----------------------------	--	--

				<u>From</u>	<u>Chassis</u>	<u>Receptacle</u>	<u>To</u> <u>Chassis</u>
Bias Interconnecting	14943-02	(1)	J9 BIAS COUPLING		Master Electronic Assembly	J9 BIAS COUPLING	Slave Electronic Assembly

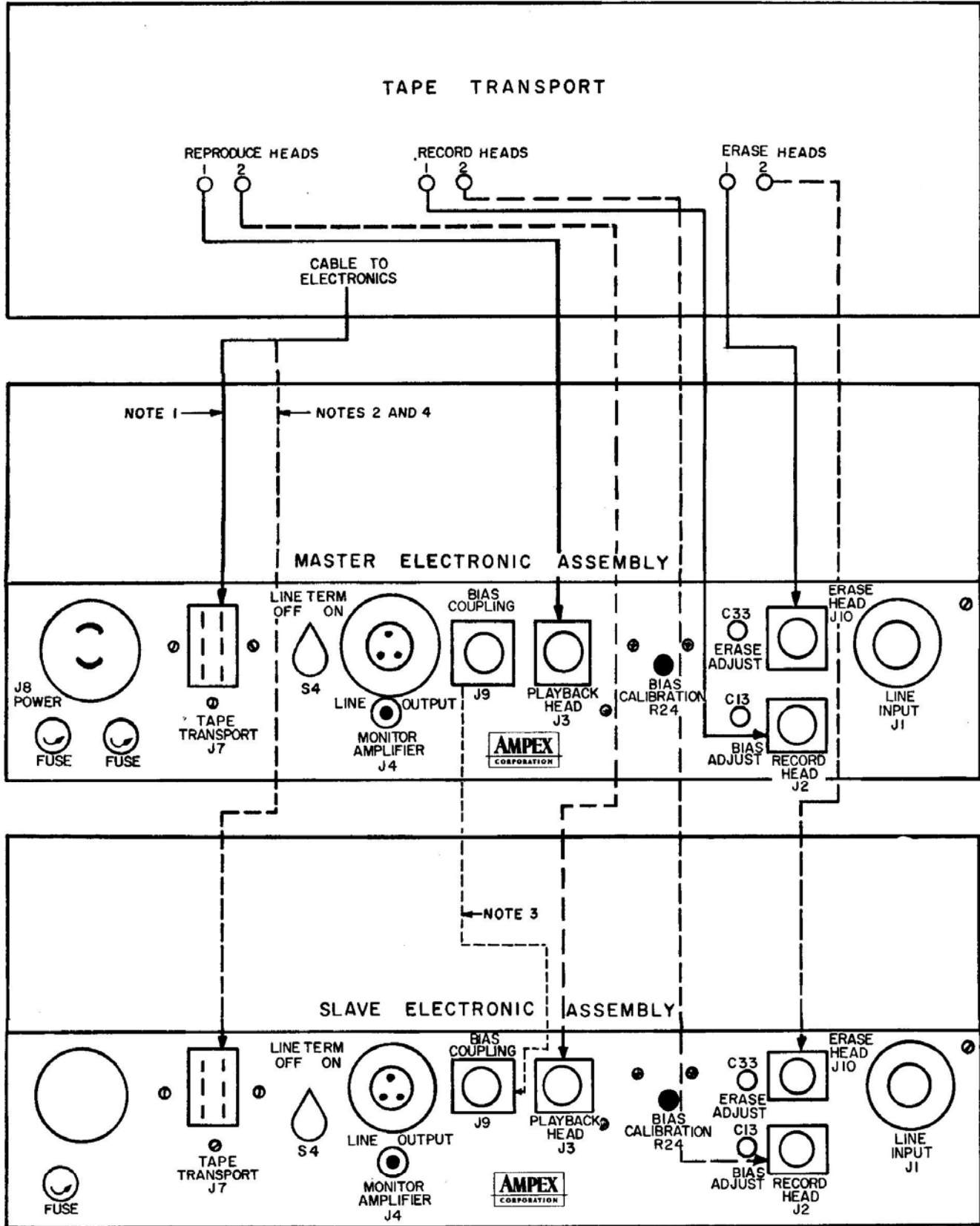
DUAL TRACK EQUIPMENT (Portable)

Power Interconnecting	30812-02	(1)	J7 TAPE TRANSPORT		Electronic Assembly 1 and 2	End of Captive Tape Transport power interconnecting cable.	
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NOTE

Cables marked with a red band, interconnect in upper electronics for the Model 351-2 only from top to bottom.

TAPE TRANSPORT



NOTES

1. A 3768-1 POWER EXTENSION CABLE IS USED WITH SINGLE TRACK PORTABLE EQUIPMENT.
2. A 30812-01 POWER INTERCONNECTING Y CABLE IS USED WITH DUAL TRACK STEREOPHONIC EQUIPMENT.
3. A 14943-02 BIAS INTERCONNECTING CABLE IS USED WITH DUAL TRACK STEREOPHONIC EQUIPMENT.
4. A 30812-02 POWER INTERCONNECTING CABLE IS USED WITH PORTABLE DUAL TRACK STEREOPHONIC EQUIPMENT.



SERIES 351 EQUIPMENT

SECTION 3

OPERATION

GENERAL

The 351 Series recorder/reproducers are available for full (single) track, half track or two track stereophonic operation. All operating controls are located on the tape transport with the exception of the record control which is on the front panel of the electronic assembly. When the remote control unit is furnished, duplicate tape motion controls, a RECORD button and RECORD INDICATOR light and a TAPE MOTION indicator light are mounted on the remote unit.

The equipment can handle the NAB 10-1/2 inch diameter tape reels or the EIA 5 and 7-inch reels. Provision is made for selection of proper tape tensioning at the REEL SIZE switch on the tape transport for the LARGE or SMALL size reels.

Either of two capstan drive motor speeds can be selected at the LOW-HIGH TAPE SPEED switch which is also on the tape transport.

On the front panel of the electronic assembly are facilities for setting RECORD LEVEL and (reproduce) PLAYBACK LEVEL, selecting LOW SPEED or HIGH SPEED EQUALIZATION, selecting three input arrangements by means of the INPUT TRANSFER SWITCH, and switching the vu meter at the METER and OUTPUT switch so that (reproduce) PLAYBACK, RECORD, BIAS and ERASE LEVEL(S) can be read. A phone jack (PHONES) for monitoring, a RECORD button, a RECORD INDICATOR light, and a POWER OFF-ON switch are also mounted on the electronic assembly front panel.

Another MONITOR AMPLIFIER phone jack and a line termination (LINE TERM) OFF-ON switch are located on the back of the amplifier-chassis.

SUMMARY OF CONTROLS, SWITCHES AND INDICATORS

<u>Item</u>	<u>Schematic Reference Symbol</u>	<u>Location</u>	<u>Function</u>
POWER OFF-ON SWITCH	S-5	Electronic Assembly front panel	Controls power to the electronic and mechanical assemblies. When power is on capstan will rotate if tape is properly threaded or the safety switch de-activated. The v-u meter lamps light when power is on, and are unaffected by the safety switch, remaining lighted till the power is turned off.

For stereophonic 351-2 operation POWER switches of both electronic assemblies must be in the ON position.

<u>Item</u>	<u>Schematic Reference Symbol</u>	<u>Location</u>	<u>Function</u>
TAPE SPEED	S503	Tape Transport control cluster	Determines speed of the capstan drive motor by high or low speed winding. Used in conjunction with EQUALIZATION switch S2.
EQUALIZATION LOW HIGH SPEED SPEED	S2	Electronic Assembly front panel	Used to select appropriate equalization circuitry for tape speed chosen.
REEL SIZE LARGE SMALL SWITCH	S504	Tape Transport	Adjusts tape tensioning circuitry for the reel size used. The switch is closed when (LARGE position) NAB 10-1/2 inch reels are used. In the SMALL position the switch is open, connecting resistance R502 with the torque motors, thereby reducing holdback tension.
METER AND OUTPUT SWITCH	S3	Electronic Assembly front panel	Provides a means for switching the meter to read indications of record input, erase and bias, and reproduce output. In the reproduce (PLAYBACK) position, the meter indicates the signal level at the secondary of the output transformer. In the RECORD position the meter indication shows a flat amplifier reading of the input signal.
RECORD LEVEL	R9	Electronic Assembly front panel	Adjusts record level.
PLAYBACK LEVEL	R36	Electronic Assembly front panel	Adjusts reproduce level.
VU METER	M1	Electronic Assembly front panel	Provides a means for visually monitoring record input level, reproduce level, and bias and erase.

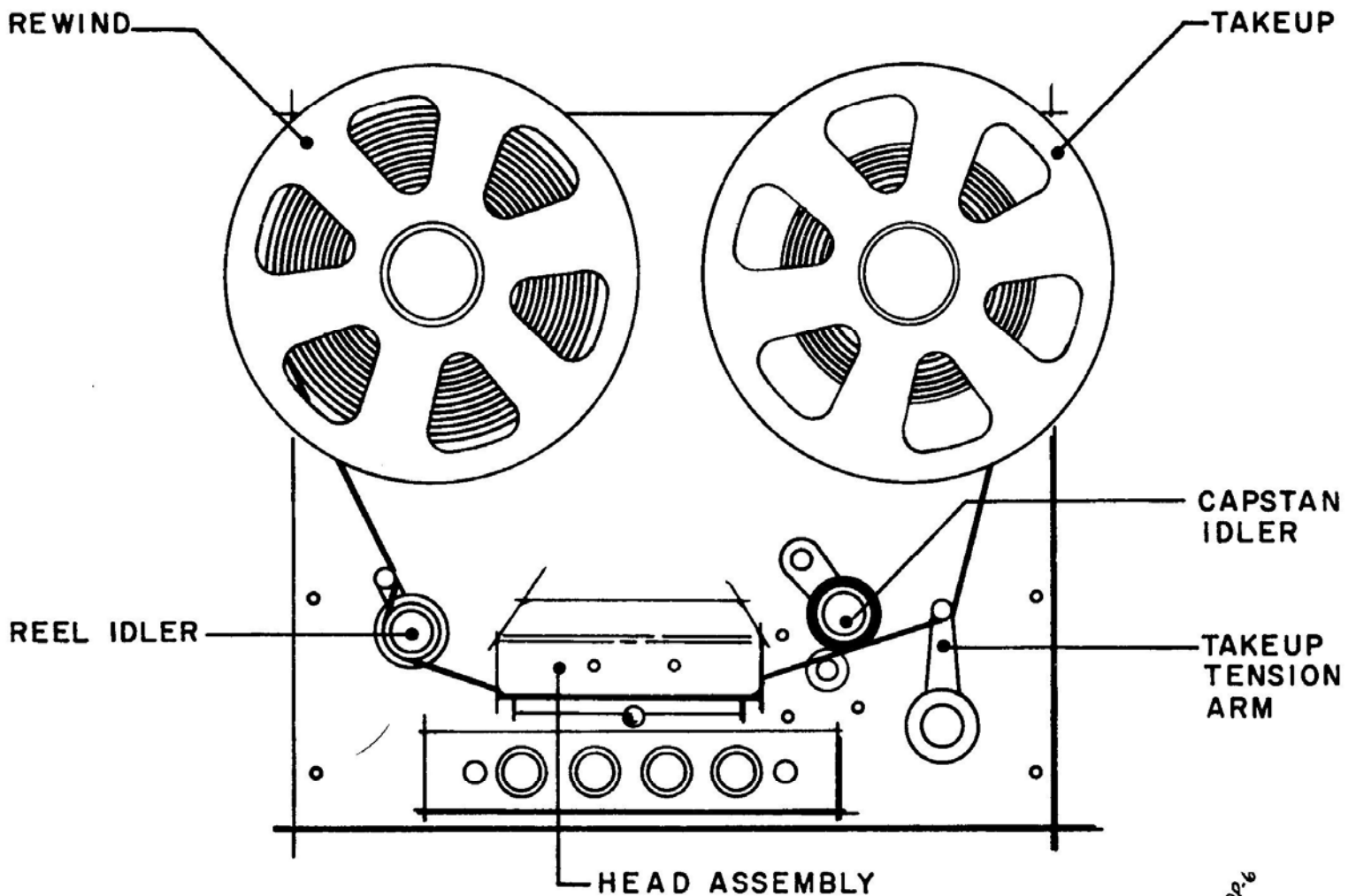
<u>Item</u>	<u>Schematic Reference Symbol</u>	<u>Location</u>	<u>Function</u>
INPUT TRANSFER SWITCH	S1	Electronic Assembly front panel	Provides a means for selecting the appropriate input circuitry to record with a microphone or from a balanced or unbalanced line.
LINE TERM OFF ON	S4	Electronic Assembly back panel	Controls output termination of the reproduce amplifier. In the ON position a 560 ohm resistor is across the output. In the OFF position, the resistor is out of the circuit and the amplifier must then feed a 600 ohm device.
PLAY button	S505	Tape Transport Control Cluster	Controls tape motion in the reproduce (PLAY) and record modes. Interlocked with rewind and fast forward modes.
RECORD button	S6	Electronic Assembly front panel	Controls the record relay in the electronic assembly. Power is connected to the bias oscillator when this button is depressed. PLAY button must be depressed to put the tape in motion before the record button is used.
REWIND button	S507	Tape Transport Control Cluster	Controls the rewind relay. Full a-c power is connected directly to the rewind (supply) motor when this button is depressed, and resistance R504 is placed in the a-c circuit to the take-up motor.
FAST FORWARD button	S506	Tape Transport Control Cluster	Controls the fast forward relay. Connects full a-c power to the take-up motor and places resistance R504 in the a-c circuit to the rewind motor when this button is depressed.
STOP button	S502	Tape Transport Control Cluster	When this button is depressed, the brake solenoids and all relays are deenergized.

OPERATING TECHNIQUES

Threading the Tape

Thread the tape as shown in the illustration. Unwind and inspect all new factory wound reels of tape by running them through in the FAST FORWARD mode.

New tapes are usually looped to the hub in such a manner that the tape will not come free of the reel at the end. This will prevent the safety switch (S501) from disengaging the capstan idler from the capstan which results in a flat being worn on the capstan idler wheel. (Any adhesive material accumulation on the reel hub may also keep the tape from coming free at the end of the reel, and should therefore be removed with solvent.)



351-02-6

TAPE THREADING PATH

Power

Power is supplied through power switch 4S5, which must be turned on to operate the electronic and mechanical assemblies. The mechanical assembly and electronic assembly are individually fused by the 3 ampere control circuit fuse 5F2 and the 1/2 ampere electronic fuse 5F1.

Speed switches

There are two switches associated with operating speed. The tape speed switch S503 determines the speed of the capstan drive motor, and the equalization switch 4S2 changes the equalization in the amplifiers appropriately.

Tape Motion

The tape motion is controlled by means of four pushbuttons labelled REWIND, FAST FWD, STOP and PLAY.

PLAY OR RECORD

The tape is set into play motion at the speed selected by the tape speed switch when the PLAY button S505 is depressed. The tape must be completely stopped before starting in this mode. To change from play to the record mode with the tape in motion, press the record button 4S6 on the electronic assembly.

STOP

To stop the tape while it is moving in any mode, press the STOP button S502. The equipment will stop automatically if the tape breaks or runs off either reel.

FAST FORWARD

The equipment can be started in fast forward or switched to fast forward from any of the operating modes by simply depressing the fast forward button S506.

REWIND

The equipment can be started in rewind or switched to rewind from any of the operating modes by simply depressing the rewind button S507.

NOTE

In using either the fast forward or rewind mode, it is desirable to remove the tape from direct contact with the heads by opening the gate of the head assembly. This will reduce wear on the heads and prevent the oxide coating on the tape from depositing on the heads and impairing their performance.

Editing and Cueing

Indexing the tape as in editing or cueing, or when approaching the end of the reel, is simplified by holding down a combination of buttons. Tape motion can be reduced to a slow creep by holding down the fast forward and rewind buttons simultaneously, and then alternating between the two to control tape direction. When the desired point is reached, the STOP button must be held down until the other buttons are released.

CAUTION

Never press the STOP and PLAY buttons in rapid sequence when the tape is traveling at high speed in the rewind or fast forward modes. This will almost invariably break the tape since it does not allow sufficient time for the tape to stop before the Capstan Idler locks it to the Capstan.

Reproduce (Playback)

To reproduce a previously recorded tape, turn the METER and OUTPUT SWITCH 4S3, to the extreme left position designated PLAYBACK LEVEL, then start the tape in motion as indicated under PLAY. A PLAYBACK LEVEL Control 4R36 has been provided on the front panel to adjust the tape level to plus 8 vu output (zero on the vu meter).

Record

To record a new program on previously recorded tape, or on blank tape, turn the METER and OUTPUT SWITCH 4S3 to the second position from the left which is designated RECORD LEVEL. Turn the RECORD LEVEL CONTROL 4R9 clockwise until the level reads 0 (zero) on the vu meter on the most intense program peaks. The program can be audibly monitored through either the phone jack (PHONES) 4J6, Monitor 5J4, or the line out connector (LINE OUTPUT) 5J5 before the tape is in motion. This direct monitor feature allows the program to be set up through the machine without actually recording during the set up period.

NOTE

For correct meter calibration it is important that the line out be properly terminated in a nominal 600 ohms either external to the machine or by the use of the line out termination switch (LINE TERM) 5S4.

When the program level is properly set, open the head gate and start the tape in motion as indicated under PLAY. Then push the RECORD BUTTON 4S6 and close the head gate. This procedure results in minimum transients during the start of recording. The record indicator 4I1 next to the record button will now glow and the equipment is recording.

The erase position of the METER and OUTPUT SWITCH provides for metering of erase current. The erase current is not critical and has been factory adjusted to read approximately $-1/2$ on the vu meter for half track and stereophonic heads and $+1$ for full track heads. Both the erase and bias current will vary directly with line voltage. The bias current is more critical and is factory set to read zero at 117 volt line voltage, using an average tape. It should read between $-1/2$ and $+1/2$ for the optimum high frequency response at $7-1/2$ and $3-3/4$ inch tape speeds using a median tape. For the flatest possible response with a given tape, the bias can be reset as described in Section 5 ALIGNMENT AND PERFORMANCE CHECKS. Note the bias current reading for this particular tape and log it for future reference

The bias is adjusted by means of the Bias Control R460, located on the electronic chassis. The meter calibration for bias measurement can be checked as indicated in SECTION 5.

CAUTION

While in the record mode during stereophonic operation always bring the tape motion to a stop before depressing either the FAST FORWARD or REWIND buttons.

Half Track Operation

The tape is threaded and operated as described under TAPE THREADING and TAPE MOTION. However, only the upper half of the tape will be used on the half track equipment. To utilize the lower half of the tape, the full reel on the takeup turntable should be removed, turned over and placed on the tape supply turntable upside down. Place an empty reel on the takeup turntable. Repeat the operation as performed on the first track.

Remote Control

For remote operation, remove the dummy plug P502P from the receptacle J502S on the control box of the tape transport and connect the remote control cable from J502S to the remote control unit (see INSTALLATION -- REMOTE CONTROL).

Notes on Stereophonic Operation

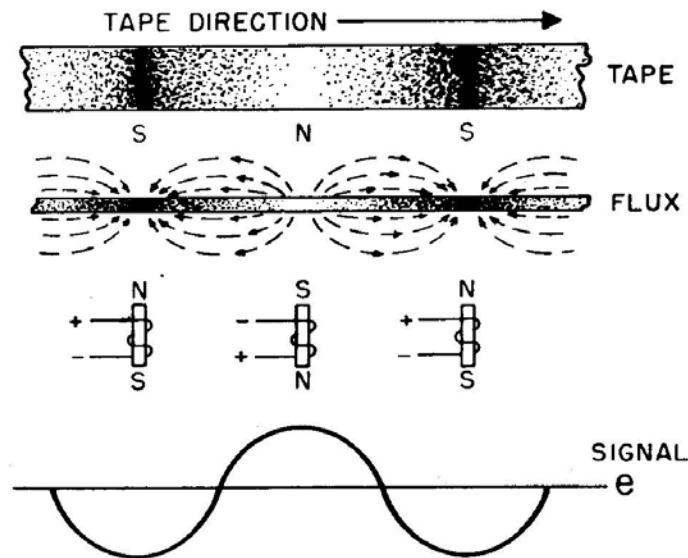
Because the stereophonic equipment has a separate erase feature, permitting either track to be erased independently of the other, it is necessary to depress the RECORD buttons on each amplifier to place both amplifiers in the record mode.

When using the remote control unit the single RECORD button will energize both electronics (concurrent record feature).

THEORY OF MAGNETIC TAPE RECORDING

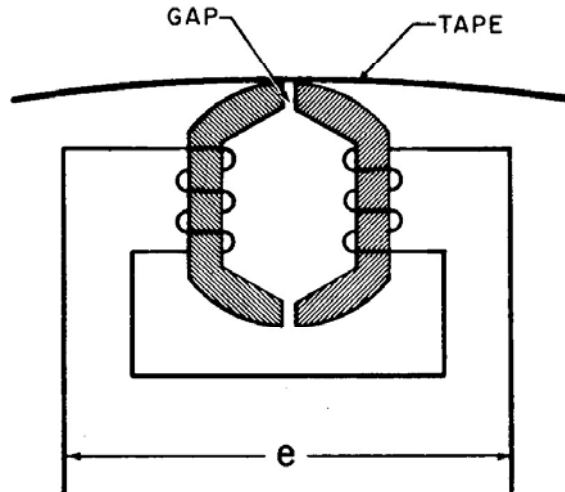
If a material capable of being magnetized is placed in the proximity of a magnetic field the molecules of that material will be oriented according to the direction of the field. Any of several methods may be used to produce a magnetic field, but of most interest in magnetic recording is the field produced by a current flowing through a coil of wire. The current itself may be derived from a transducer such as a microphone which converts the mechanical energy of sound to electric current.

Magnetic recording tape consists of finely divided iron-oxide particles deposited upon a plastic backing. During the recording process this tape is moved through a magnetic field in which the magnetizing force is alternating, and the iron oxide particles are aligned according to the instantaneous direction and magnitude of the field.



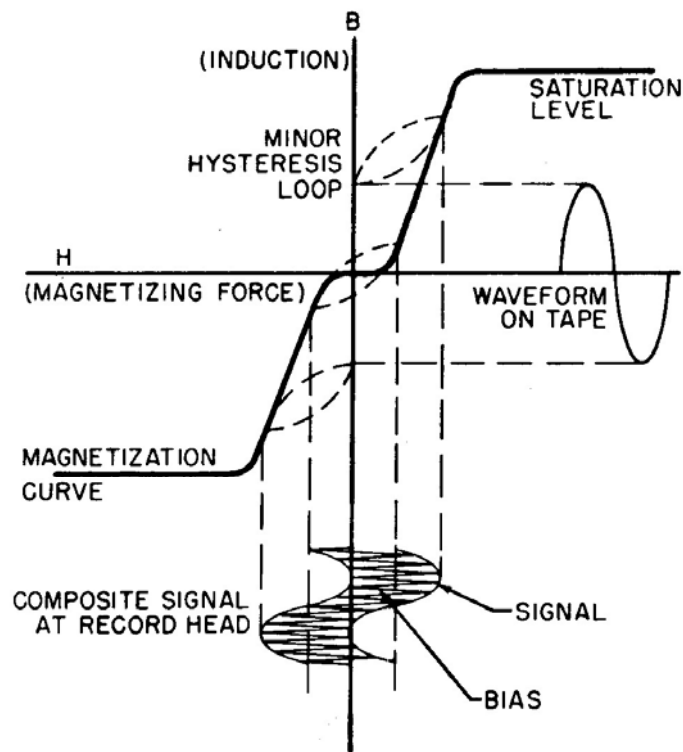
MAGNETIZATION OF TAPE

The magnetic field is produced in the gap of a recording head (which is essentially an electromagnet), over which the recording tape passes. The head consists of an incomplete ring of highly permeable material inserted in a coil of wire. The discontinuity in the ring forms the gap, and the ring itself is the core of the electromagnet. The recording head and its gap thus constitute a series magnetic circuit.



RECORD HEAD

The magnetization curve of the iron oxide used as the recording medium is similar to that shown as the heavy line in the illustration below.



RECORDING MEDIUM MAGNETIZATION CURVE

At points near the origin the curve is extremely non-linear and, without some corrective factor, the signal recorded on the tape would not be directly proportional to the signal applied to the head, resulting in a high degree of distortion when the tape was reproduced. This distortion is greatly reduced by mixing a high frequency, constant amplitude, bias signal with the actual signal being recorded, so that operation is obtained on the linear portion of the curve. This may be likened to applying a d-c bias to a tube to force it to work on the linear portion of its curve. The bias signal is generally selected to be at least five times the highest frequency to be recorded so that no beating will occur between the bias frequency and the harmonics of the recorded signal.

While the tape is in the recording gap the bias causes the magnetization characteristics of the iron oxide to follow the dashed line loops known as the "minor hysteresis loops." As the tape leaves the gap the influence of the magnetic field created by the bias is reduced to zero and the tape assumes a permanent state of magnetization (known as "remanent induction") determined by the gap flux at that time.

After the recording process there exists on the tape a flux pattern which is proportional in magnitude and direction to the signal recorded. If the tape is then moved past a reproduce head -- which is similar in construction to the record head -- the magnetic flux on the moving tape will induce a voltage in the coil of the reproduce head. This induced voltage is proportional to the number of turns of wire on the head and the rate of change of flux. This is expressed by the equation $E = N (d\phi/dt)$

Where

E = induced voltage

N = number of turns of wire

$d\phi/dt$ = rate of change of flux

It is desirable that the gap in the reproduce head be as small as possible so it will intercept less than one wave length of the signal on the tape at the highest frequency to be reproduced. However, as the gap is made smaller the induced voltage decreases, so there is a practical limitation in decreasing the gap and still maintaining an adequate signal-to-noise ratio.

The voltage induced in the reproduce head during reproduction is computed by the equation

$$E = B_M V \text{ SIN } \pi \omega / \lambda$$

Where

E = induced voltage

B_M = maximum flux density of the recording material

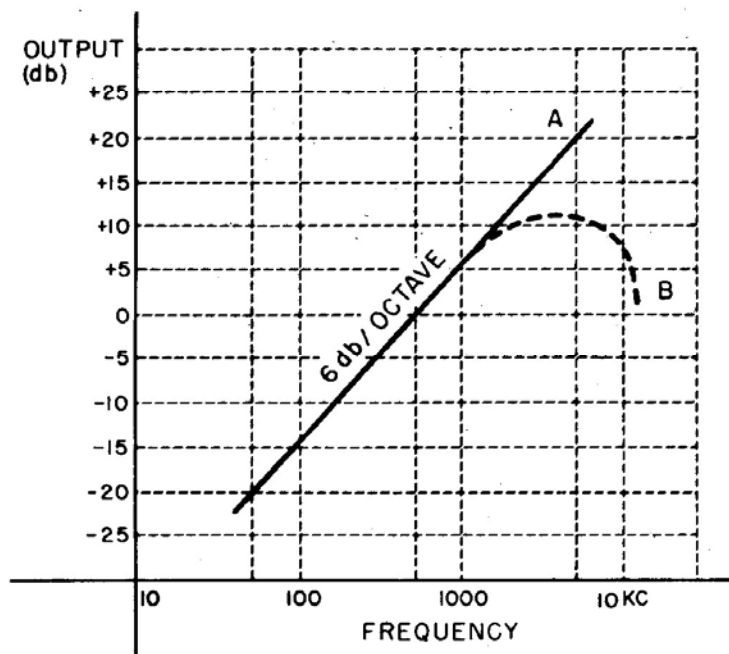
V = velocity of tape over the head

ω = width of the gap

λ = wavelength of the signal on the tape

From this equation it can be seen that the voltage across the coil increases directly as the velocity increases and as the wavelength decreases (frequency increases). If the tape velocity and gap width are assumed to be constant, the output voltage from the head is directly proportional to the frequency as long as the wavelength on the tape is large compared to the

gap width. This results in an output vs. frequency characteristic such as is shown in curve A of the figure below.



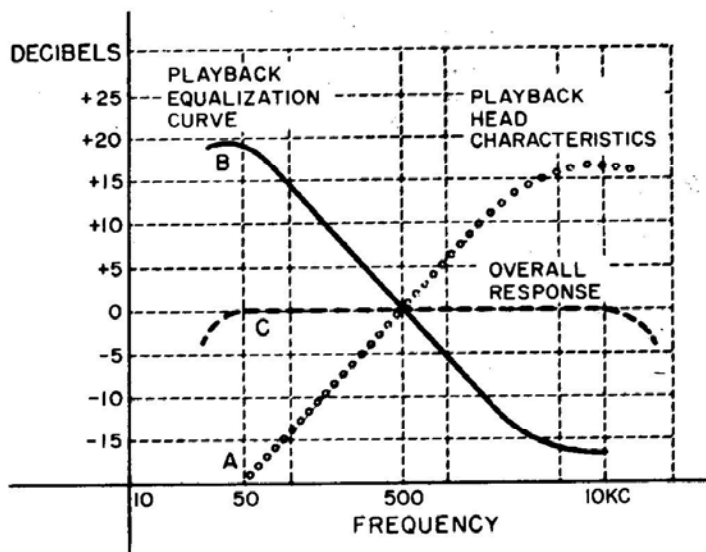
REPRODUCE HEAD CHARACTERISTICS

The voltage does not continue to rise indefinitely. As electrical losses in the core material increase and as the wavelength on the tape approaches the same dimensions as the reproduce head gap, the actual output resembles curve B in the same figure.

In order to provide an over-all frequency response that is flat (see the figure below) an equalization circuit consisting of a series resistance and capacitance is inserted in one of the early stages of the reproduce amplifier. This equalizing circuit has a high-frequency droop characteristic (curve B) which is the inverse of the reproduce head characteristic curve A of the above figure. In order to extend the high frequency response, additional equalization is included in the record amplifier in the form of a high frequency boost circuit designed to compensate for the droop in record and reproduce head characteristics caused by core losses, self-demagnetization of the tape at the short wave lengths and the wave length approaching the gap dimensions.

Disregarding the response of the associated amplifiers, the physical aspects of maintaining constant tape speed and good head-to-tape contact, and core losses in the head -- all of which can be placed at a high performance level by good engineering design -- there are certain inherent properties which define the frequency limits in recording and reproducing information on a specific magnetic tape recorder-reproducer. While these properties can be varied to meet differing requirements, the over-all result represents a compromise arrangement in which frequency response, signal-to-noise, and distortion are interrelated.

In this respect the high frequency response is primarily limited by the dimension of the reproduce head gap, and the frequency at which that head resonates with the capacity in the circuit.



ACHIEVING FLAT OVERALL RESPONSE

During the recording process the tape assumes a permanent state of magnetization as it leaves the head gap, thus the record head gap width is relatively uncritical. However, in the reproduce mode the magnetic flux on the moving tape must induce a voltage differential across the reproduce head coil if a current is to flow in that coil. This induced voltage is attained as the flux travels through each branch of the head core, forced into that path by the high reluctance of the head gap. Therefore, an instantaneous difference in the magnitude of the moving flux must exist across the head gap to cause the flux to travel through the core and magnetically induce a voltage difference in the head winding.

When the recorded frequency rises to a degree where the reproduce head gap intercepts a complete wavelength of the signal (as it appears on the tape) there can be no difference in flux magnitude across the gap, and head output will reduce to zero. This cancellation effect will occur at multiples of the represented frequency, and for all practicable purposes the output is useless.

There are two means of counter-acting this "gap effect" -- either the reproduce head gap width can be reduced or the record-reproduce tape speed can be increased. There are limitations in reducing the gap width and retaining adequate signal level and realistic manufacturing tolerances; as these limitations are reached any further extension of high frequency requirements must be accompanied by corresponding increases in record-reproduce tape speed. (In instrumentation applications it is also possible to record at a high tape speed and reproduce at a low tape speed, thus providing a signal expansion characteristic. For example, a 10 kc signal recorded at 7-1/2 ips, will reproduce as a 5 kc signal if the reproduce tape speed is 3-3/4 ips. This procedure of course cannot be used in standard audio applications where music or voice is recorded, and will result in the loss of the low frequency components of the signal.) Increasing the record-reproduce tape speed lengthens the wavelength of the signal as it appears on the tape, with the result that higher frequency wavelengths do not approach the gap dimension. (It also decreases the "self-demagnetizing" effect which occurs as the opposite poles of individual magnetic fields on the tape come closer and closer together.)

The resonant frequency of the inductance of the head coil and the capacitance -- either actual or distributed -- of its circuit must normally be either outside the pass band of the system (so the drop in output following the point of resonance will not adversely effect the frequency response) or so placed at the extreme upper limit so that the increased output at the moment of resonance actually provides an extended response. When good engineering design has reduced circuit capacitance to an irreducible minimum, the only means of placing head resonance at a higher frequency is to reduce the inductance of the head coil by reducing the number of turns of wire. This adversely affects the output over the entire frequency range, and will particularly influence the low frequency limit.

Low frequency response is primarily determined by the relationship of the required signal-to-noise ratio, the characteristic curve of the reproduce head, the distortion which can be tolerated, and the bandwidth which must be recorded.

As previously explained the output of a reproduce head rises directly with frequency at an approximate 6 db per octave rate. Stated conversely, the reproduce head output drops directly with frequency at an approximate 6 db per octave rate. The low frequency limit is determined by how far this decreasing output can be tolerated while maintaining an adequate signal-to-noise ratio. Thus, the noise generated by the associated electronic assemblies will have a definite effect on low frequency response. Increasing the record level to offset this decreasing output will eventually result in an increase in distortion.

Bandwidth is a determining factor in low frequency response because the 6 db per octave dropoff in reproduce head output normally starts at the highest frequency which must be reproduced, and is constant regardless of tape speed. Thus as the upper frequency requirement is extended, the lower frequency limit -- dictated by the required signal-to-noise ratio rises inexorably with it, octave for octave. A general rule is that the maximum bandwidth which can be effectively reproduced by any magnetic tape device is approximately ten octaves.

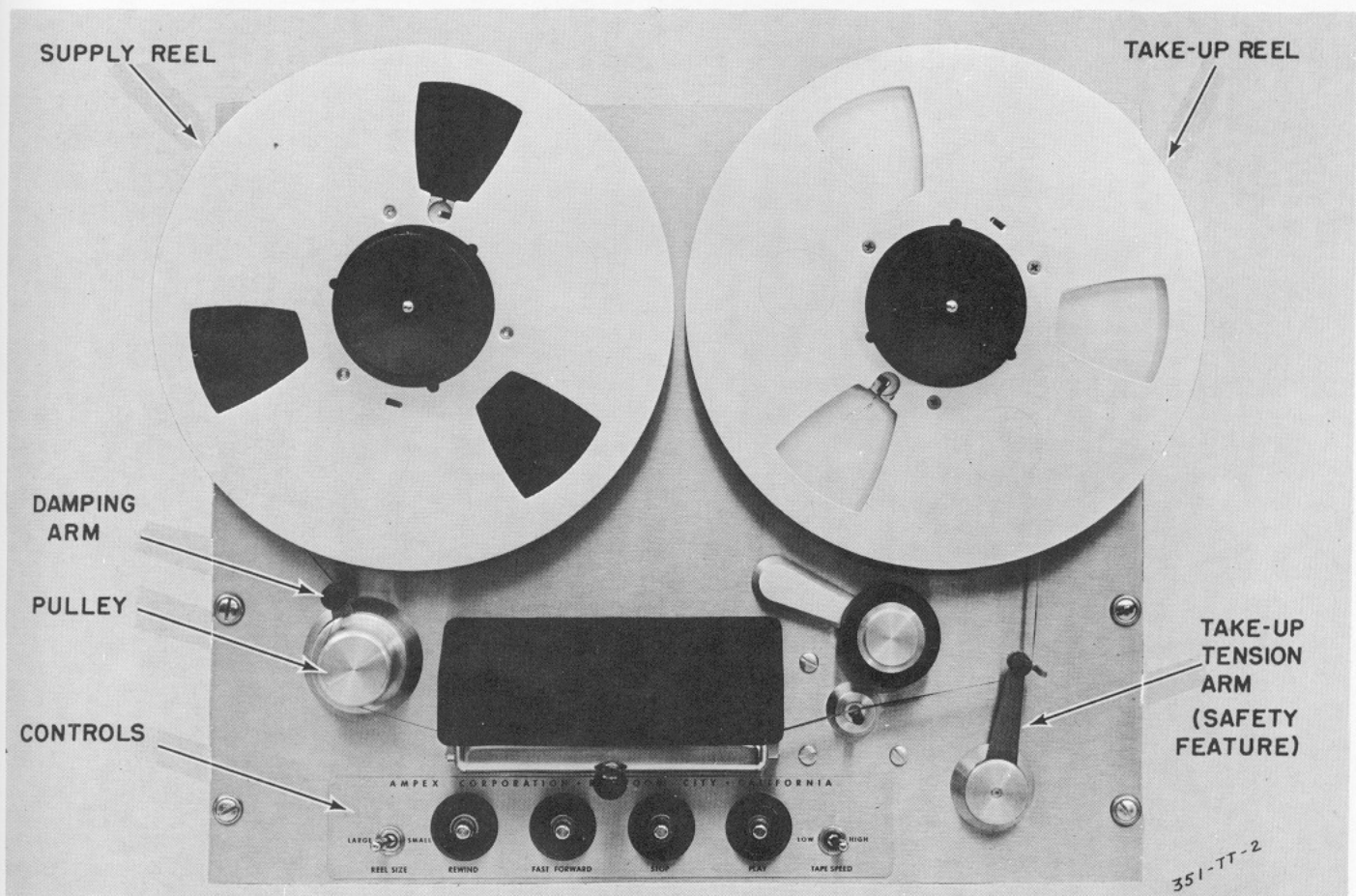
It should now be apparent that compromises are necessary in designing a magnetic tape recorded for a given purpose. If a high frequency requirement is imposed, then low frequency, signal-to-noise, or distortion must be limited (or perhaps a modulating-demodulating system employed which will effectively compress the bandpass requirements). Conversely, a low frequency requisite limits the high frequency response which can be obtained.

SECTION 4

TAPE TRANSPORT MECHANISM

GENERAL

The tape transport mechanism provides tape motion for all modes of operation. Interaction of four basic assemblies and their associated components -- the tape supply system, the tape take-up system, the tape drive system, and the control circuit -- insures smooth, positive movement of the tape across the head assembly, and proper tape tensioning when the equipment is in the record or reproduce modes. All tape motion controls, a reel size selector, a LOW-HIGH tape speed switch, a safety microswitch and the head assembly are located on the tape transport.



TAPE SUPPLY AND TAKE-UP

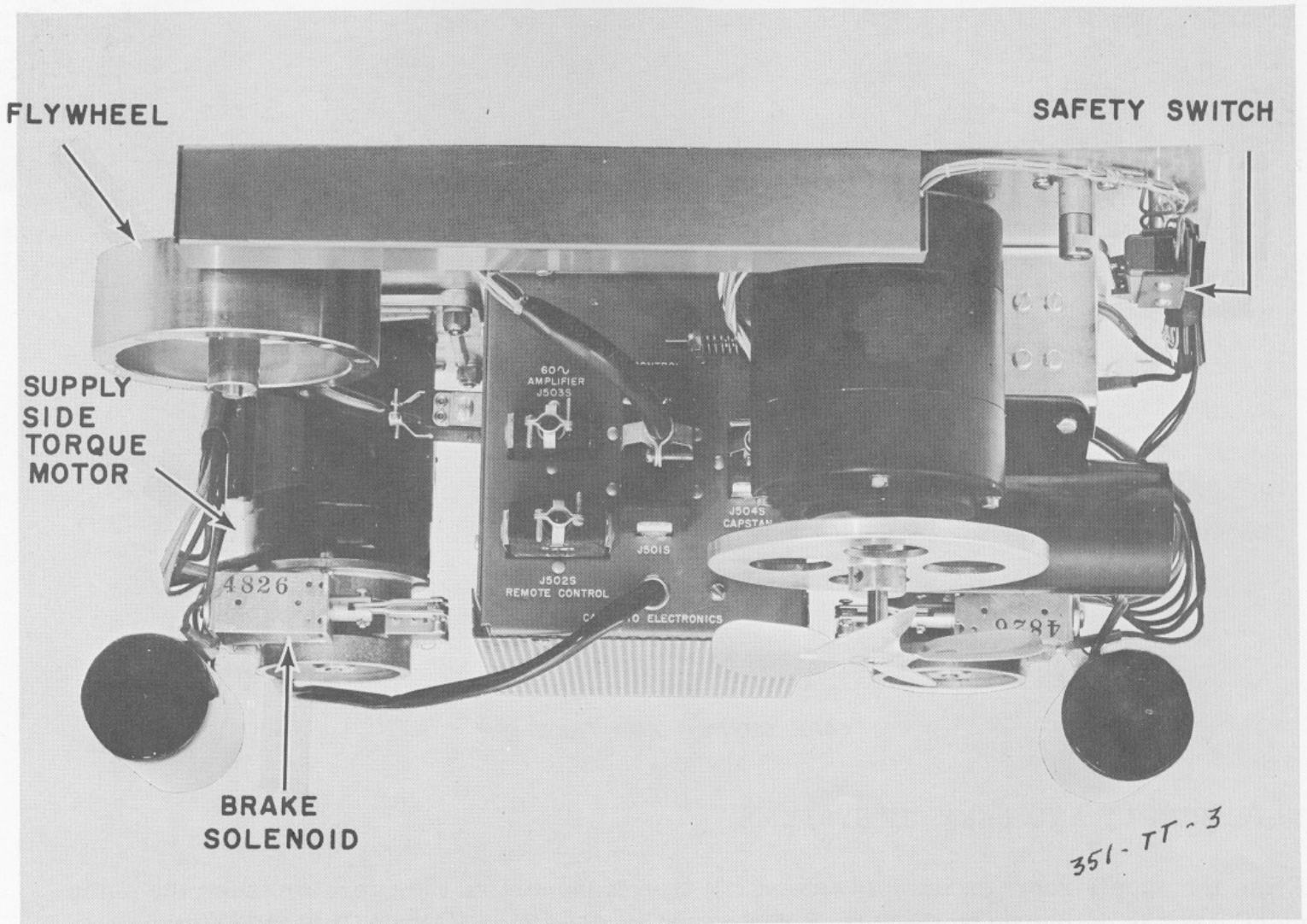
TAPE SUPPLY AND TAKE-UP SYSTEMS

From the supply reel, on the left side of the tape transport as the operator faces the equipment, tape is delivered to the takeup reel when the PLAY or FAST FORWARD buttons are depressed, tape is rewound onto this same supply reel when the REWIND button is depressed. Proper tape tensioning is maintained during the record and reproduce modes by means of two reel induction torque motors, the supply reel idler and damping arm.

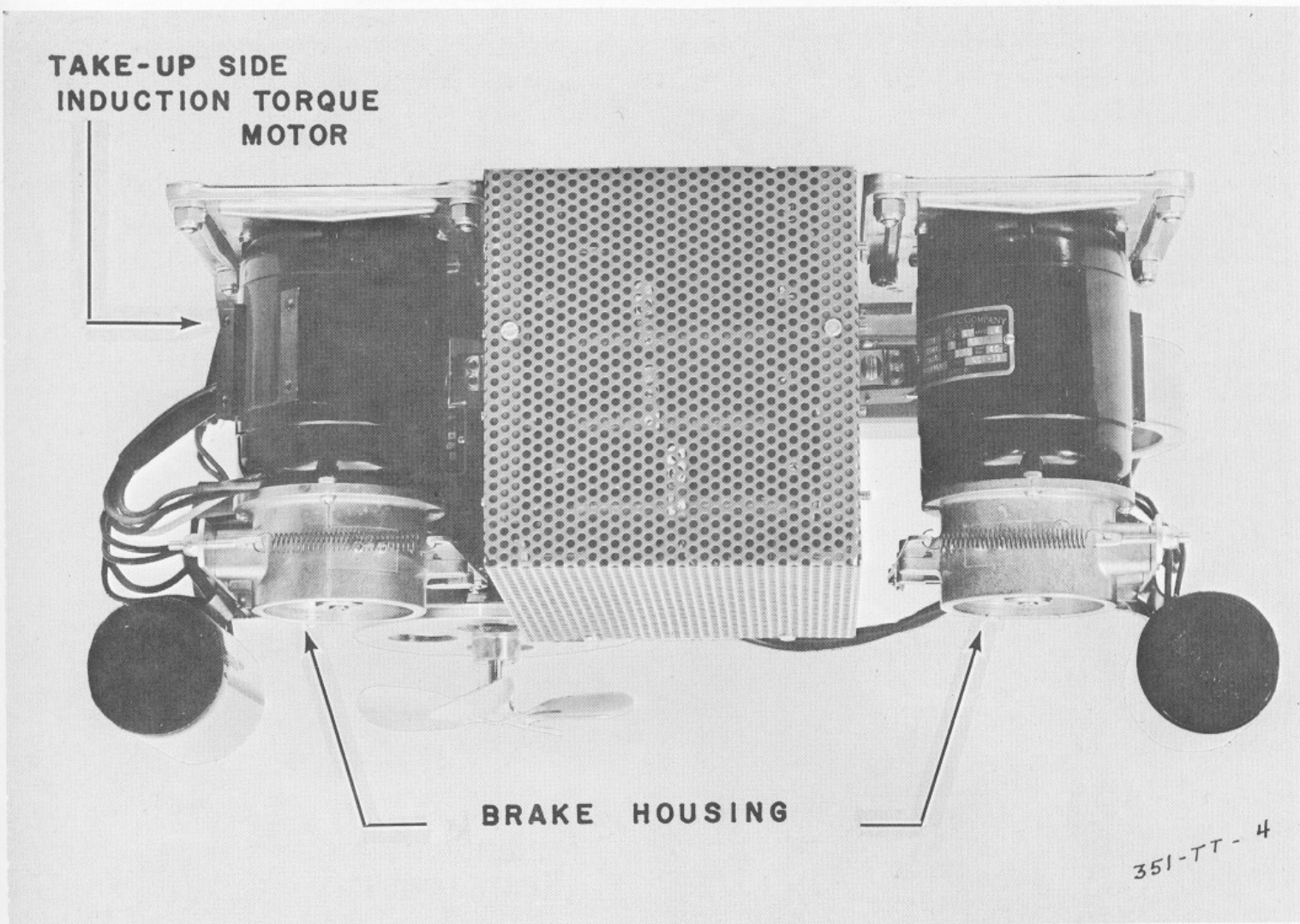
The reel idler assembly on the supply side of the tape transport is composed of a pulley, a spring-pivot-mounted arm and a flywheel for the purpose of smoothing out transient speed variations in the tape system.

On the take-up side of the tape transport, the tension arm assembly with a spring-pivot-mounted-arm forms a safety feature. Near the base of the shaft on which the tension arm is mounted, a drivelock pin actuates the safety switch (S501), stopping tape motion if the tape tension is lost for any reason including tape breakage.

Both the tape supply and take-up assemblies are composed of induction torque motors (B503 Supply-Rewind, B502 Take-up), a turntable mounted directly on each motor shaft, a brake housing assembly and a flange for mounting the entire assembly. Because the brake housings are mirror images of each other, these assemblies are not interchangeable. The brakes are solenoid operated, remaining in the braking position until the brake solenoids K505 and K506 are energized at which time the brakes are released.



TAPE SUPPLY AND TAKE-UP (BOTTOM VIEW FRONT)



TAPE SUPPLY AND TAKE-UP (BOTTOM VIEW REAR)

During the reproduce or record modes, the two induction torque motors B502 and B503 act as tensioning devices (see Tape Tensioning in this SECTION) and in the fast forward and re-wind modes the motors respond to the commands from either pushbutton by operating at maximum torque in the selected function.

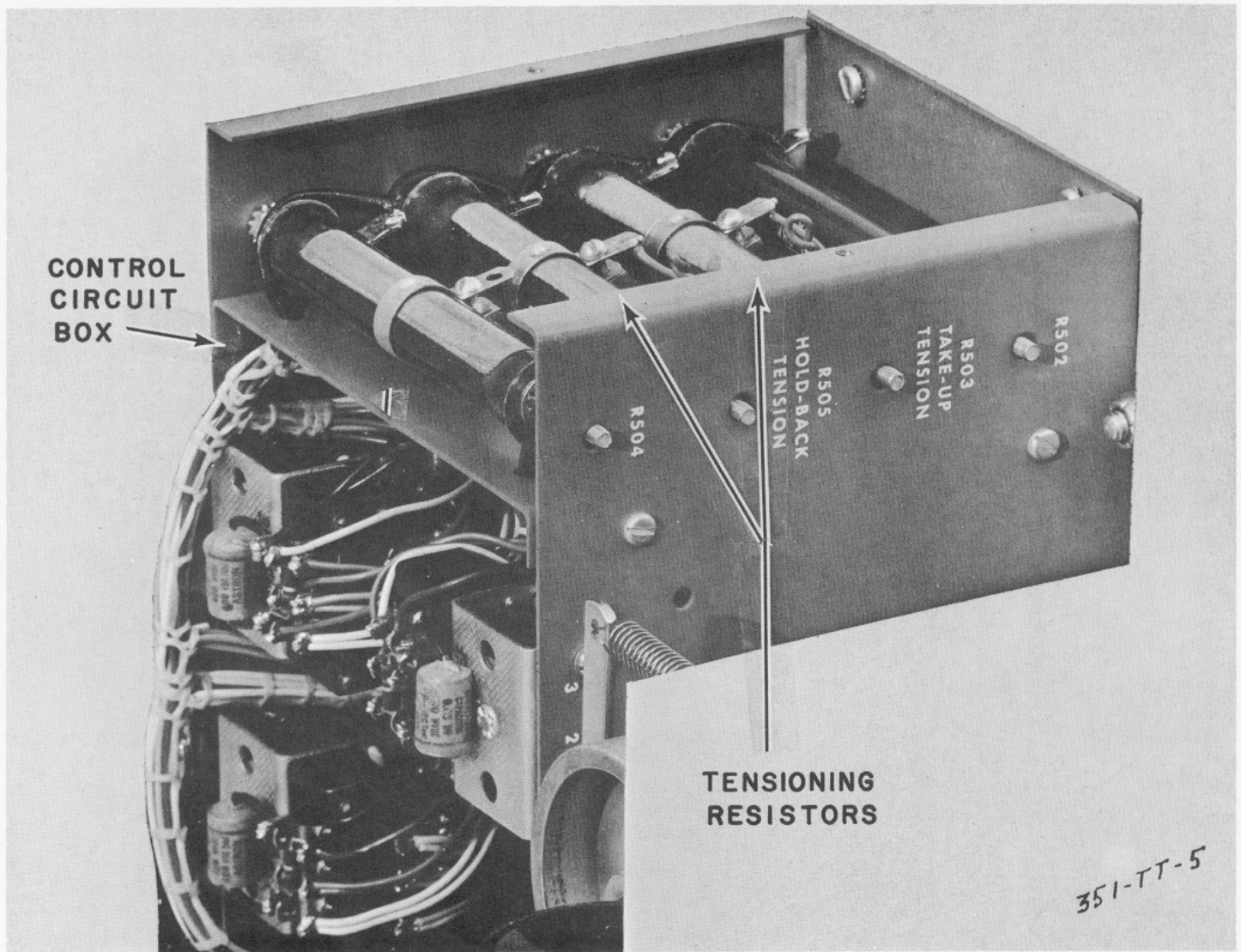
Tape Tensioning

The purpose of the Tape Tension System is to provide proper tape tension in all modes of operation.

The supply (rewind) and take-up induction torque motors are so connected that when power is applied with no tape threaded, the turntables, fixed to their shafts, will rotate in opposite directions. The tape supply turntable, fixed to its motor shaft, will rotate clockwise. The tape take-up turntable, fixed to the take-up motor shaft, will rotate counterclockwise.

Motor torque in the reproduce and record modes is adjusted to equality by the tensioning adjustment resistors (R503 TAKE-UP and R505 HOLDBACK) in series with each motor. In the fast forward mode, the torque of the supply (rewind) motor is reduced considerably by intro-

duction of a series resistance (R504). In the rewind mode, R504 is in series with the take-up motor. Basic tape tensioning operation is shown in the illustrations.



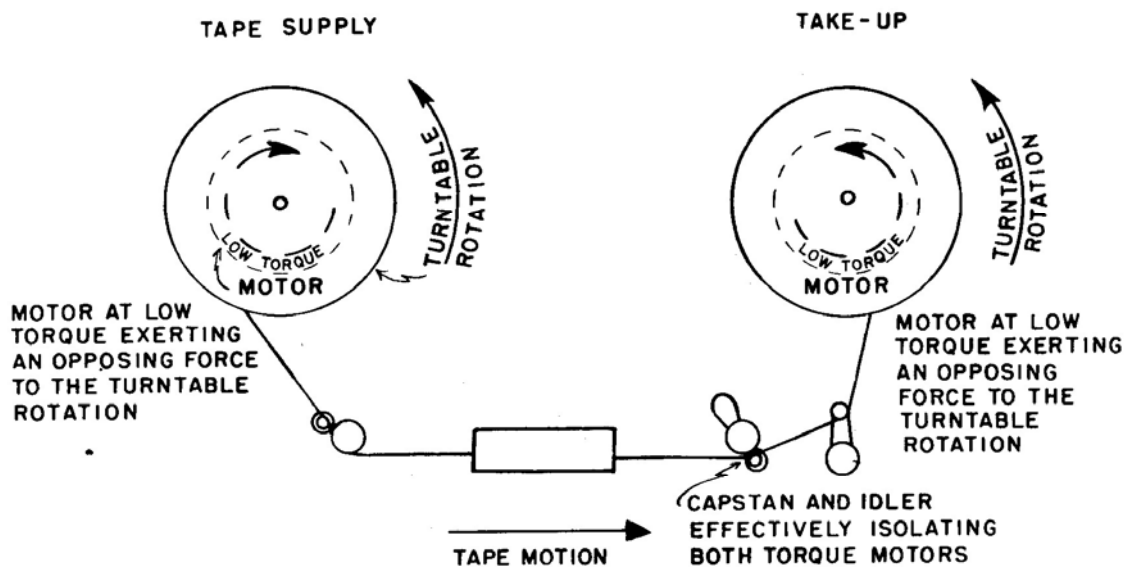
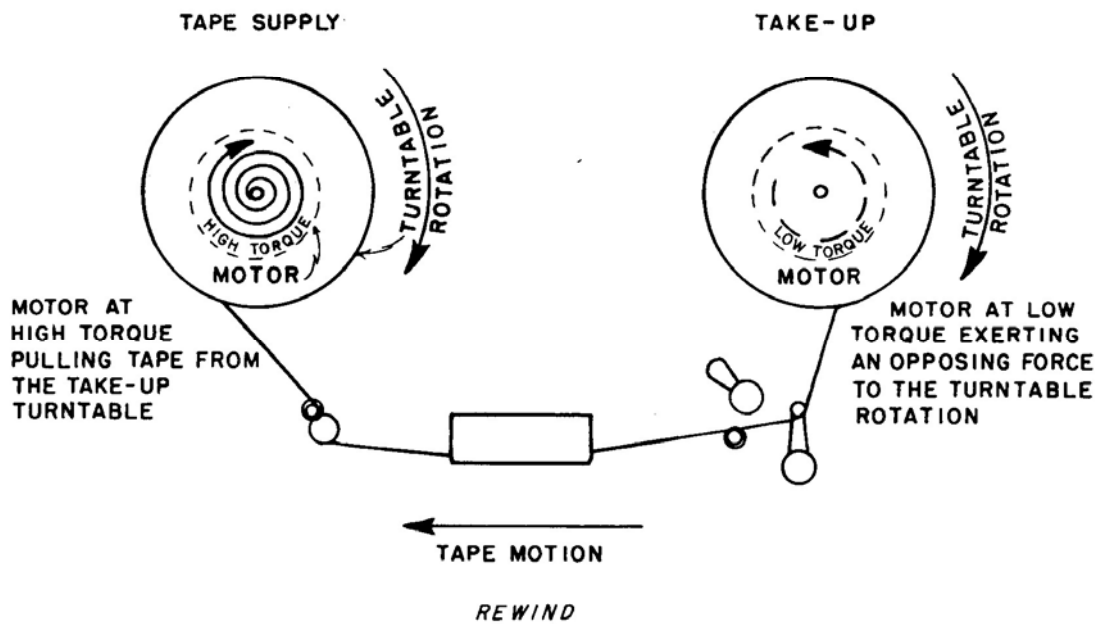
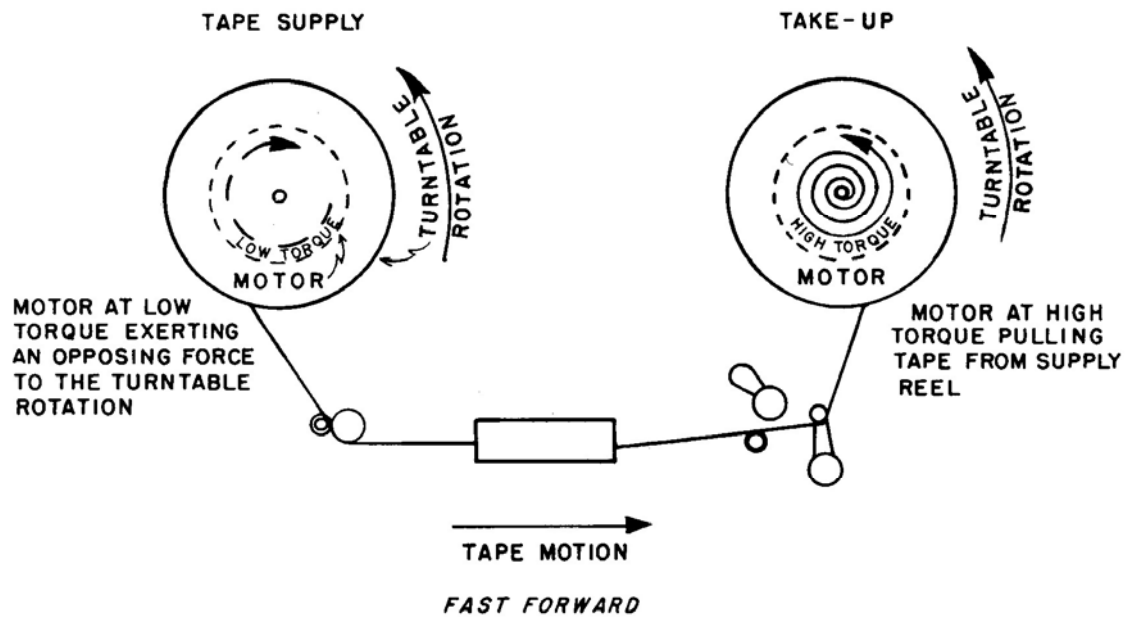
TAPE TENSIONING RESISTORS

In the fast forward mode, the take-up motor operates at full torque, the supply motor at reduced torque, and the tape is pulled from the tape supply reel. Because the torque of the tape supply turntable motor (rewind motor) is applied in the opposite direction to the turntable rotation, the tape is held under continuous tension as it is pulled from the reel.

In the rewind mode, the supply motor operates at full torque and the take-up motor holds the tape under continuous tension by its opposite and reduced torque

In the reproduce or record modes, both torque motors operate at reduced torque. The tape drive capstan and the capstan idler, between which the tape is clamped, then determines the tape speed, and the tensioning system supplies tape or takes it up as metered by the capstan drive.

From the point of view of the tape supply turntable, the capstan and idler action exerts sufficient pull on the tape to overcome the opposing torque of the supply motor, which constitutes the hold back tension. From the point of view of the tape take-up turntable, the capstan and idler action is feeding the tape to it. The tape is held under tension here, because the take-up rate exceeds the feed rate (a tape loop will be thrown on the right side of the capstan whenever any malfunction causes the feed rate to exceed the take-up rate).



RECORD OR REPRODUCE

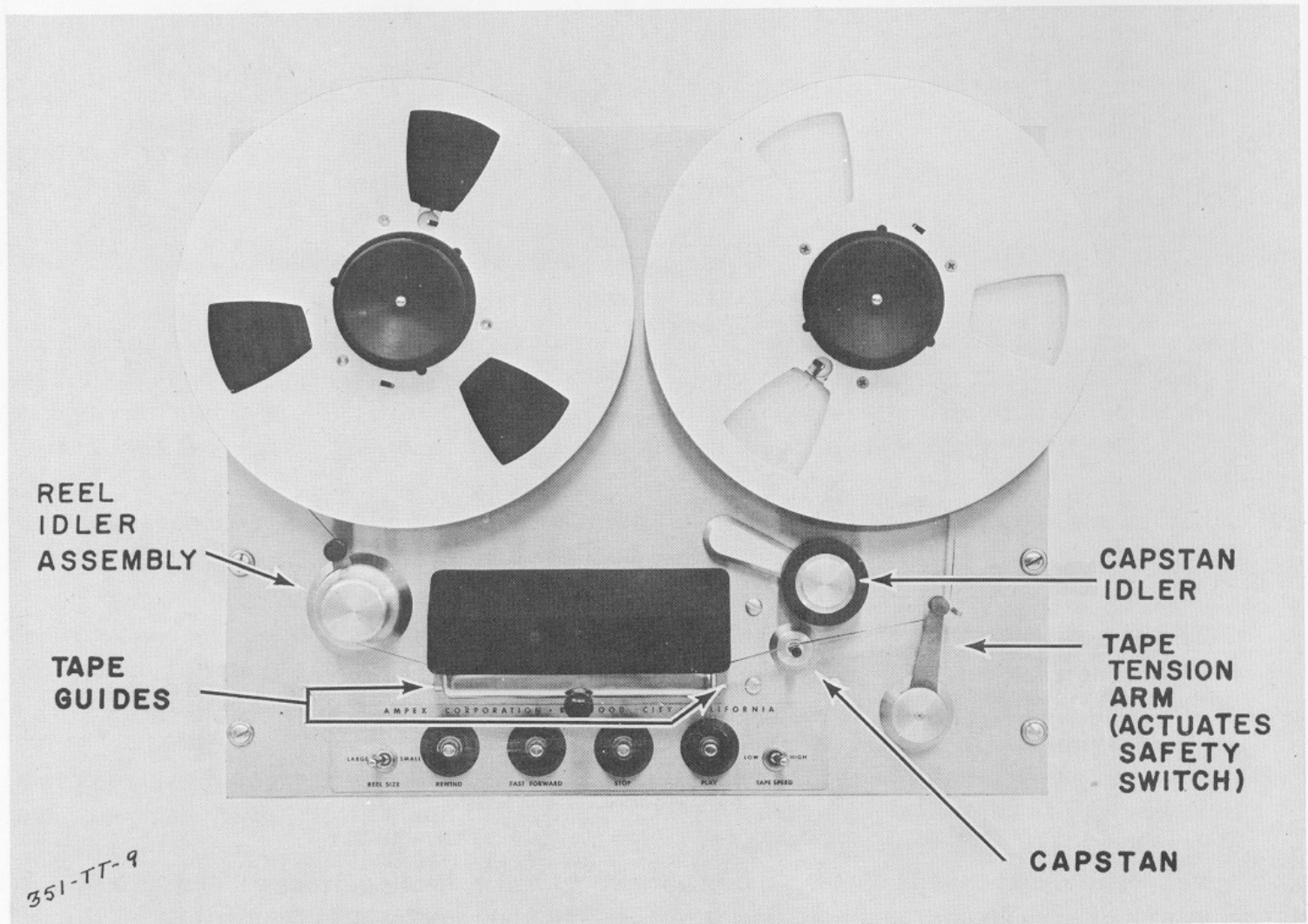
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If a tape loop is thrown, or the tape breaks, the take-up tension arm will actuate the safety switch S501 and stop the equipment. The take-up tension arm is not a part of the tape tension system. Its function is to take up tape slack, especially when starting, and to operate the safety switch.

The reel idler assembly smooths out transients in the tension system. For example, when starting the tape in the reproduce mode, the momentary strain transmitted through the tape to the tape supply turntable when the capstan idler forces the tape against the capstan is considerable. Under some circumstances, this impulse tends to stretch or break the tape. A momentary decrease in hold-back tension might be sufficient to start a transient oscillation in the tape tension system which would be reflected as a periodic variation in the distance of the tape from the heads. This variation might be of sufficient magnitude to appear as an undesirable fluctuation in the signal level at the start of recording or reproduction. The reel idler arm absorbs most of the starting strain, and prevents or minimizes this type of oscillation. The reel idler pulley and flywheel provide additional stability in the tape tension system, by smoothing out such transients as motor torque fluctuations and irregularities due to faulty tape wrap on the supply reel. This is accomplished because the high inertia of the reel idler pulley and flywheel effectively isolate the reel assembly from the heads.

TAPE DRIVE SYSTEM

The tape drive system is composed of the drive motor, the extended shaft of which forms the

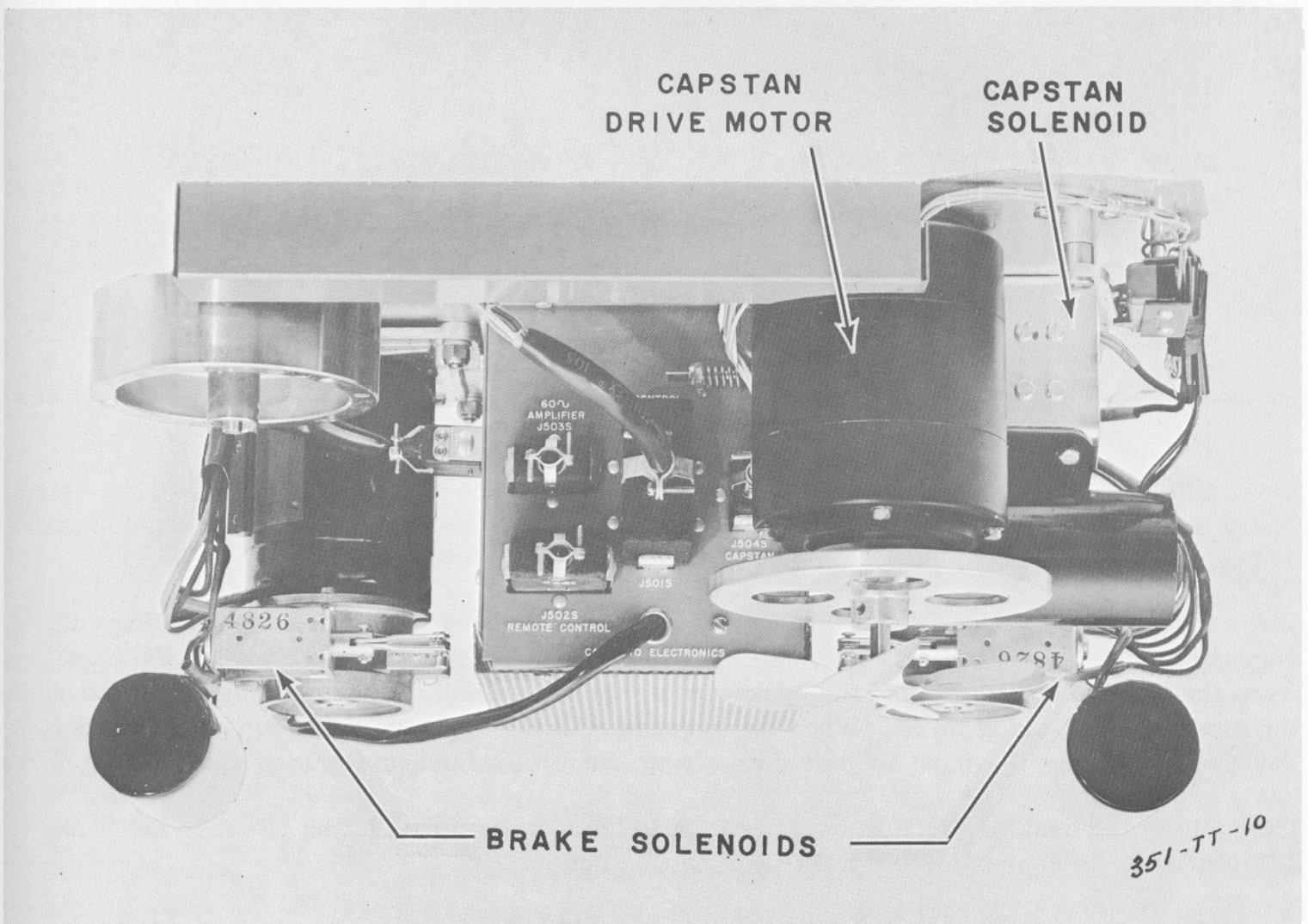


TAPE DRIVE SYSTEM

capstan, the capstan idler arm and idler, and the tape guides at the tape entrance and exit within the head assembly.

The purpose of the tape drive system is to transport the tape across the heads at a uniform speed during the record and reproduce processes. By means of a hysteresis synchronous capstan drive motor (B501) the extended shaft of which forms the tape drive capstan, and a capstan idler, the magnetic tape is driven at constant speed after power has been applied to the equipment and the PLAY button is depressed. (The drive motor has two windings to provide two tape speeds either of which can be selected at the TAPE SPEED toggle switch S503).

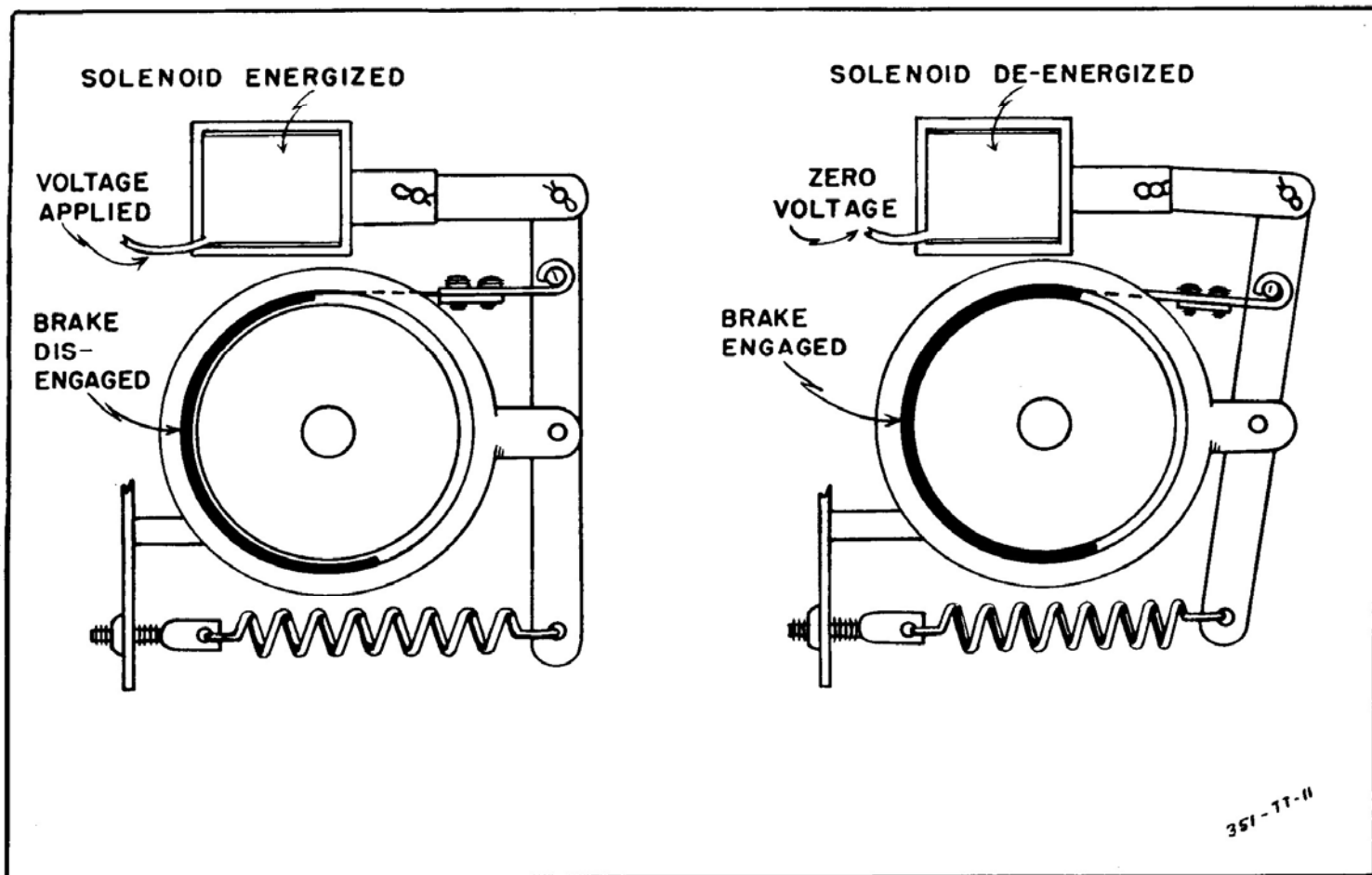
After the POWER switch at the electronic assembly has been placed in the ON position, the drive motor operates continuously, its capstan awaiting the PLAY command (the RECORD function is selected at the amplifier). When the PLAY button is depressed (provided the tape is properly threaded or the tape tension arm controlling the safety microswitch has been locked in the on position with masking tape or a rubber band as in some function checks), the capstan solenoid (K501) and the brake solenoids (K505 and K506 - releasing brake pressure) are energized. The capstan solenoid pulls the rubber tired capstan idler wheel, which is mounted on a swivel type arm, against the tape, causing the tape to make firm positive contact with the capstan. The tape is then driven at a constant speed across the head assembly.



TAPE DRIVE SYSTEM (BOTTOM VIEW)

BRAKE OPERATION

Smooth brake operation is extremely important in maintaining proper tape tension when stopping the tape. Because the holdback tension, supplied by the trailing turntable motor torque, is lost after the STOP button is pressed, maintenance of tape tension then becomes a function of brake operation. The braking force acting on the turntable from which the tape is being pulled (the trailing turntable) in any of the modes of operation must always exceed the braking force acting on the turntable taking up the tape (the leading turntable) to prevent the throwing of tape loops.



BRAKE OPERATION

One end of the brake band is fixed to the brake housing. The other end is linked to the brake lever and is free to move. When the brake solenoid is de-energized, the brake tension spring acting on the brake lever draws the brake band against the brake drum.

For example if the brake drum of the supply motor, as viewed from the brake housing end, is rotating clockwise when the brake band is applied, the frictional force will cause the band to wrap itself more tightly around the brake drum, the linked end of the band moving to the right, thus increasing braking force. When the drum is rotating counterclockwise, the process is reversed, causing the band to pull away from the drum, and decreasing the braking force.

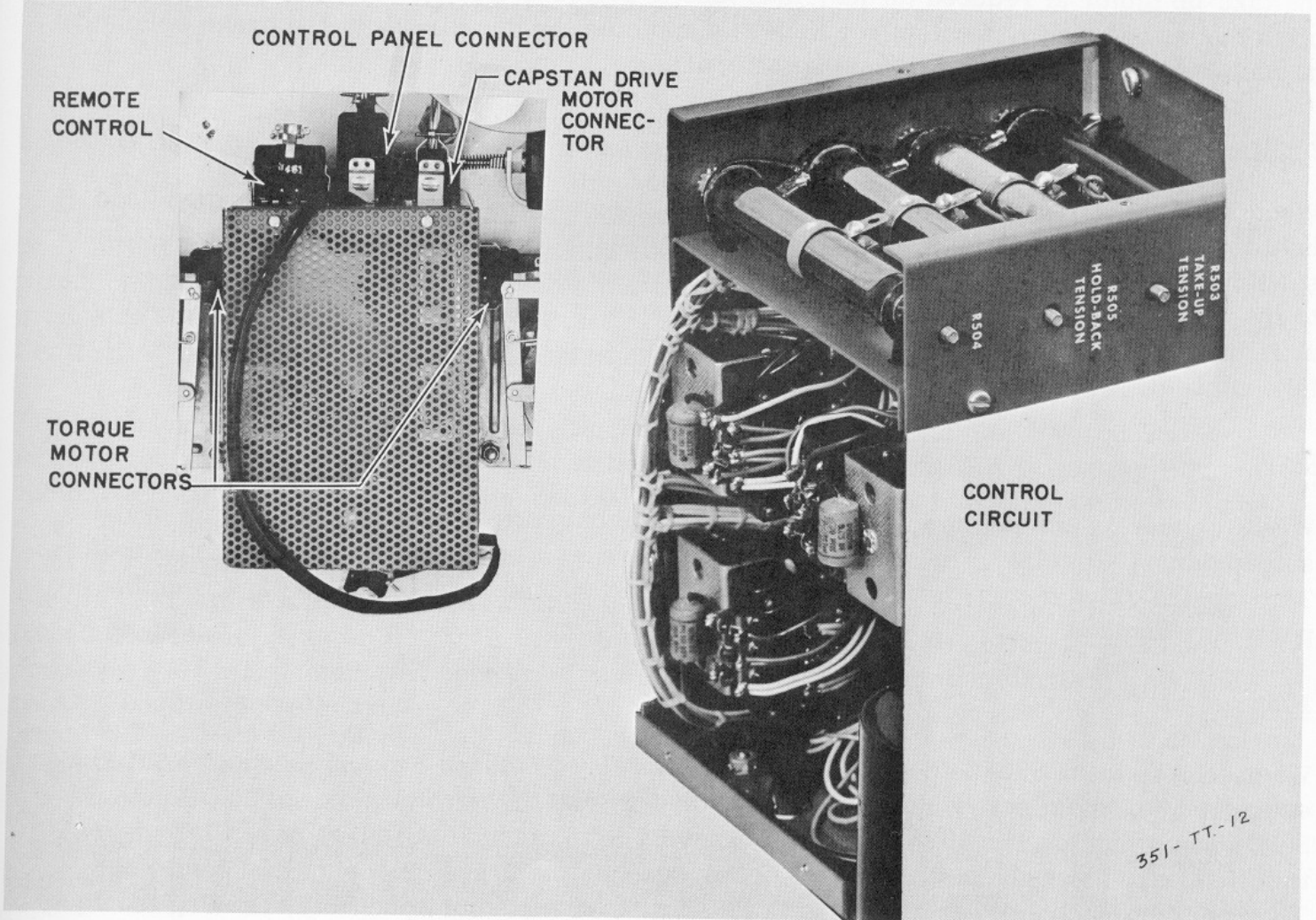
The ratio of the braking force in one direction to the braking force in the other -- the brake differential -- is approximately two to one on this equipment.

In all modes of operation, the greater braking force always acts on the trailing turntable, maintaining the tape under tension as the system is stopped.

CONTROL CIRCUIT (Refer to schematic diagram - Tape Transport Control Circuits).

Located in the control circuit box underneath the tape transport are all relays, the tension adjustment resistors, and electronic components such as the capacitors and resistors shown in the foldout illustration, Tape Transport Control Circuits, with the exception of the three motor starting capacitors, the capstan solenoid, the brake solenoids and the safety micro-switch which are mounted adjacent to the assemblies they serve.

On the outside of the control circuit box receptacles are available for the cables from the drive motor, supply motor, take-up motor and control cluster. Female receptacles and plugs (cables not supplied) are also available for interconnecting between the tape transport and accessory units such as remote control panels and a 60 cycle precision frequency source (when furnished).



CONTROL CIRCUITS

NOTE

The special connector jumper plugs supplied for receptacles J503S 60 CYCLE AMPLIFIER and J502S REMOTE CONTROL must be plugged into their receptacles when these accessory units are not used because jumpers in these plugs complete the necessary circuits in the system for proper operation.

All functional control of the tape transport, with one exception, takes place at the control circuit switch assembly comprising four pushbuttons: REWIND, FAST FORWARD, STOP and PLAY. Two toggle switches REEL SIZE and TAPE SPEED are mounted at either end of the control cluster. The exception is the RECORD function which is controlled at the amplifier. The safety switch (not an operating control) is mounted under the tape transport.

Rewind

When REWIND button S507 is depressed, rewind relay K504 is energized and held in this condition by relay contact sets K504-1, K503-3 and the normally closed STOP button S502. Contact set K504-2 connects the full a-c power directly to the rewind (supply) motor, and places R504 in the a-c circuit to the take-up motor. The rewind motor operates at full torque and the take-up motor at reduced torque, thus tape is pulled at a maximum speed from the take-up to the rewind reel. Contact set K504-3 completes the d-c circuit to the brake solenoids at each reel assembly, thus releasing the brakes.

Fast Forward

When FAST FORWARD button S506 is depressed, the fast forward relay is energized and held through contacts K503-1, K504-3 and the normally closed STOP button S502. Contact set K503-2 connects the full a-c power to the take-up motor, and places R504 in the circuit to the rewind motor. The take-up motor now operates at full torque and the rewind motor at reduced torque, causing the tape to be pulled at a maximum speed from the rewind to the take-up reel.

Stop

When the tape is moving in any mode and the STOP button (S502) is depressed, the brake solenoids and all relays are de-energized. The brakes are applied to both turntable motors. The capstan drive motor, however, will continue to operate so long as the tape remains properly threaded.

Play

When PLAY button S505 is depressed, both play relay K502 and capstan solenoid K501 are energized. Contact sets K502-1, K503-1, K504-3, and the normally closed STOP button S502 form a holding circuit. Power is connected to the turntable reel motors through contact K502-2. Through contact K502-3 power reaches the brake solenoids K505 and K506. The reel motors are powered and the brakes are released simultaneously, causing the equipment to operate in the reproduce mode at the speed selected by TAPE SPEED SWITCH S503.

NOTE

The record mode is not a tape motion control function, but it is interlocked and dependent on the PLAY button which must be depressed before the record mode can be energized at the amplifier.

Safety Interlocks

When the tape is moving in either of the high speed modes (fast forward or rewind) it is not possible to switch to the play mode without first pushing the STOP button. In fast forward, contact K503-1 interlocks the play relay and capstan solenoid. In rewind, K504-3 is the interlock.

CAUTION

If the STOP and PLAY buttons are depressed in too rapid a sequence when the tape is in either high speed mode, tape will almost invariably be broken or deformed. Always allow time for the tape to stop completely when switching from either of the fast modes to play.

Reel Size Switch

Selection of proper holdback tension, depending on reel hub size, is made at the two position toggle switch labeled LARGE-SMALL. Holdback tension is not a constant in any mode of operation, varying directly as a function of the trailing turntable motor torque, and inversely as a function of the effective trailing reel hub diameter (hub diameter includes the tape wound on the hub). For a given torque on the trailing motor, the holdback tension will increase as the effective hub diameter of the trailing reel decreases. Reducing the torque on the trailing turntable motor will decrease the holdback tension.

The holdback tension resistors for adjustment of take-up and rewind motor torques are factory-set for NAB 10-1/2 inch reels. If the smaller (7 or 5 inch) EIA (formerly RETMA) reels are used, compensation for the overall increase in holdback tension must be made by placing the switch in the SMALL position to prevent excess tape tension. This is done by inserting resistor R502 in series with the take-up and rewind motors thus reducing the torque of both motors when the EIA reels are used. The REEL SIZE switch is a SPST switch placed across the resistor R502. It is closed when the LARGE position for 10-1/2 inch diameter NAB is selected; and open (resistor R502 in the torque motor circuits) when the SMALL position is selected.

ROUTINE MAINTENANCE

Carefully follow the routine maintenance program outlined below if proper performance is expected of the equipment at all times. Keep an Operation and Maintenance Log.

Cleaning

Clean the capstan, the head faces and tape guides daily. Clean the capstan idler wheel weekly. Great care must be taken to see that oil does not reach the rubber tire. Avoid, as much as possible, touching the tire with the fingers.

The agent for cleaning Ampex head assemblies is a mixture of Xylene and 0.1% Aerosol, and is available in 4 oz. bottles (Ampex Catalog No. 087-007). Other solvents can have detrimental effects on these precision parts.

To clean any head assembly, wind a clean, lintless cloth on a wooden swab-stick and moisten with this mixture. Swab the heads periodically to remove all dirt and accumulated oxide deposited from some tapes.

CAUTION

DO NOT USE ANY OTHER SOLVENTS AS THERE ARE SOME WHICH MAY DAMAGE THE LAMINATIONS OF THE HEAD ASSEMBLY. DO NOT USE METAL SWAB-STICKS.

Cleanliness of all parts of the tape drive mechanism is required for consistent optimum performance. Clean all parts except the head assembly using a lintless cloth moistened with denatured alcohol. This cleaning is of particular importance because most tape manufacturers lubricate their tapes, and the lubricant will gradually form a coating on the components in the tape threading path which will result in a loss of positive drive at the capstan, flutter and wow, drop-outs or poor high frequency response.

Lubrication

The following parts of the tape transport mechanism require lubrication every three months, or after every thousand hours of operation, whichever occurs first.

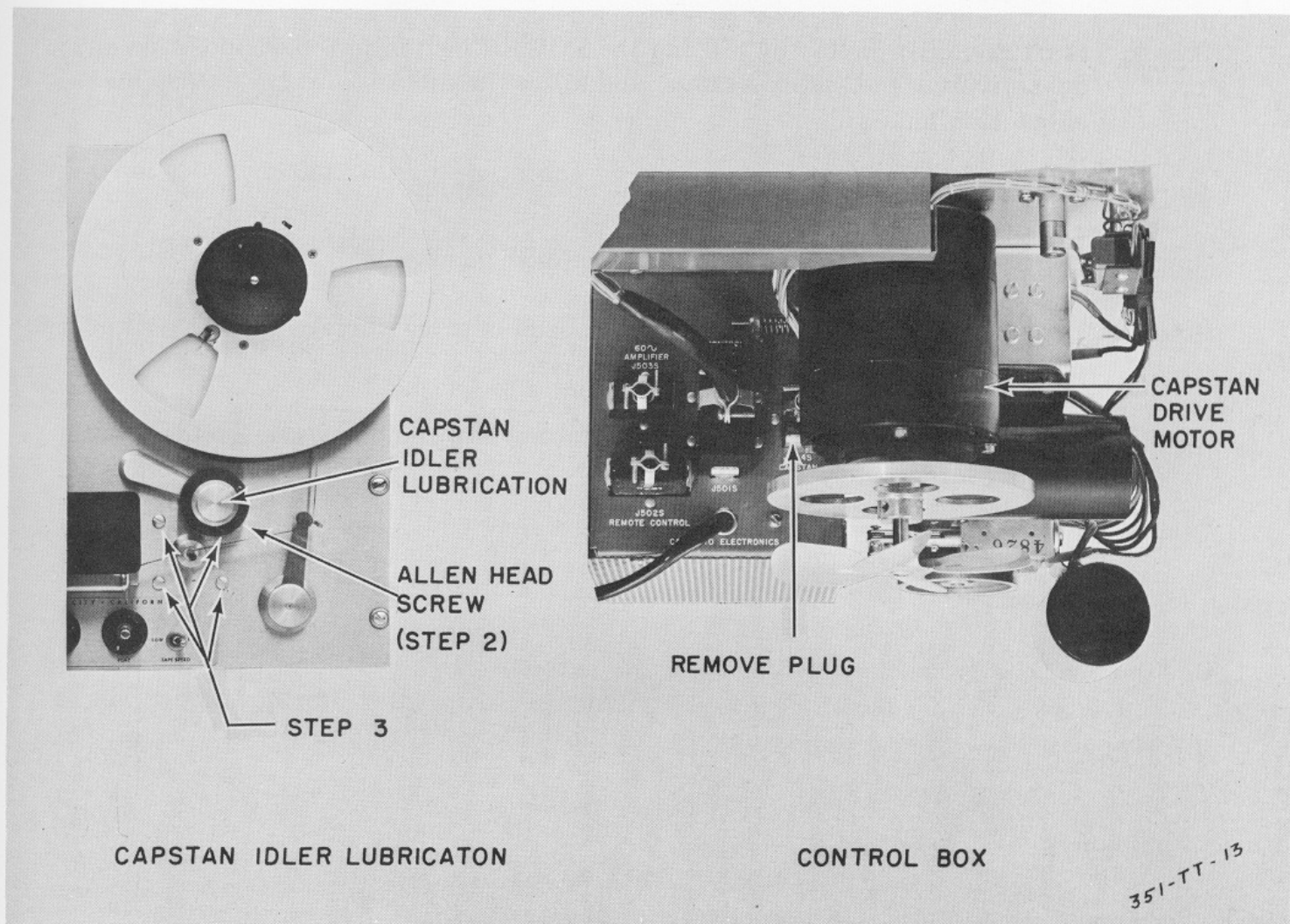
Capstan Drive Motor Lubrication

Lubricate the upper sleeve bearing of the capstan drive motor with one of these oils or its equivalent:

Caloil OC-11 (Ampex Catalog Number 087-005)
Standard Oil Company of Indiana-Standard No. 18 or No. 25
Socony Vacuum, Oil Company - Gargoyl DTE Light

There are two ways to lubricate the drive motor, the first of which requires its removal. The second, and simpler method, does not require removal of the motor. See alternate method. To remove the drive motor proceed as follows:

- Step 1: Unplug the motor connector P504P from its receptacle J504S at the control circuit box.
- Step 2: Remove the capstan idler by loosening the Allen head screw on the idler arm and gently pulling the idler assembly away (the capstan idler must be removed because one of the mounting screws is beneath it).
- Step 3: Support the motor in one hand and remove the four mounting screws that hold it to the tape transport.
- Step 4: Now pull the motor free.
- Step 5: Locate the oil hole which will be on the top or the side of the motor end bell.



REMOVING DRIVE MOTOR FOR LUBRICATION

Step 6: Place about ten drops of a recommended lubricant in the oil hole.

CAUTION

Do not over-lubricate. Wipe off excess oil.

Step 7: Replace the motor.

Step 8: Replace the capstan idler.

CAUTION

The capstan idler must be the proper distance from the idler arm. Thread tape on the equipment along the prescribed tape threading path, and set the idler so that the tape travel is centered on the tire. Placement is not critical and visual alignment is adequate.

Step 9: Readjust the capstan idler pressure if necessary (see Capstan Idler Pressure).

The alternate method for drive motor lubrication is:

- Step 1: Start the drive motor by placing the POWER switch in the ON position and de-activating the safety switch, and allow the motor to warm up (requires about 15 minutes).
- Step 2: Turn off the equipment when warm-up is complete.
- Step 3: Gently pry up and remove the capstan dust cap.
- Step 4: Drop the recommended oil on the exposed bearing surface until it will accept no more oil.
- Step 5: If the bearing appears dry after the motor has cooled, warm up the motor and repeat the above procedure.
- Step 6: Wipe capstan dry of any excess oil that may have been applied accidentally.

Capstan Idler Lubrication

Gently pry the dust cap from the wheel hub (a knife blade can be used), and saturate the felt washer with 6 drops of SAE 20 oil. Failure to perform capstan idler lubrication can result in the felt washer becoming completely dry. In this case more than 6 drops will be needed.

CAUTION

DO NOT OVERLUBRICATE or the wheel will throw oil in operation. If oil spills on the rubber tire, clean it immediately with ethyl alcohol.

NOTE

The reel idler assembly, the take-up tension arm assembly and the take-up and rewind motors contain permanently lubricated bearings, and require no further lubrication.

Head Demagnetization

Occasionally, the heads may become permanently magnetized through electrical faults in the amplifiers, improper use of the equipment, or by contact with magnetized objects. Magnetized heads will cause an increase of 5 to 10 db in background noise level, and can impair good recordings by partially erasing high frequencies. The full dynamic range of the equipment cannot be realized if the heads are magnetized.

Any phenomena that tend to put large unbalanced pulses through the record head will magnetize it. Observe these precautions and no difficulty should be experienced.

Do not remove any tube from the record amplifier while the equipment is recording.

Do not connect or disconnect the input leads or the head leads while recording.

Do not saturate the record amplifiers with abnormally high input signals. Such signals would be 10 db greater than tape saturation or approximately 30 db greater than normal operating level.

Do not test the continuity of the heads with an ohm meter.

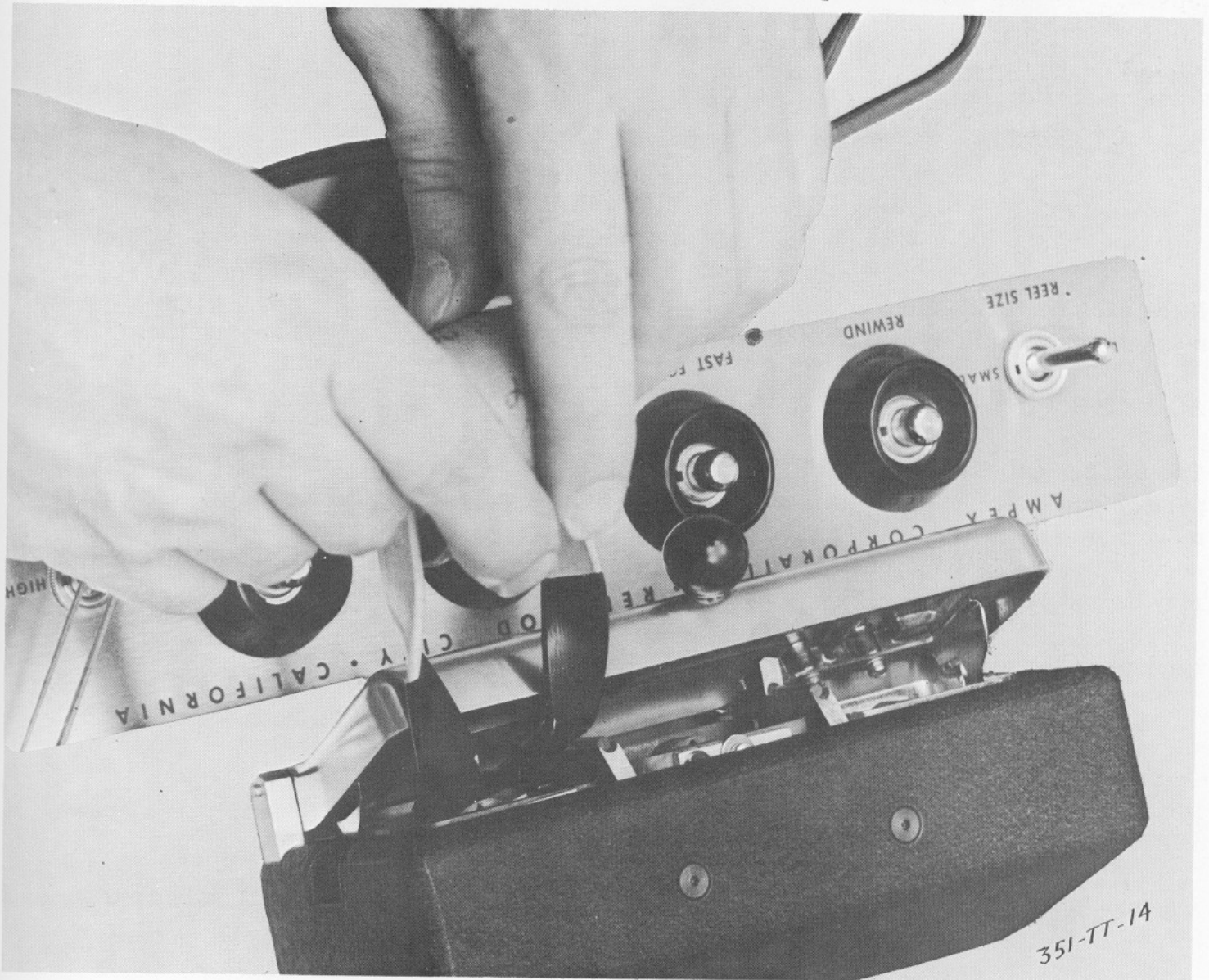
If the heads become magnetized, proceed as follows, using an Ampex Demagnetizer, Catalog No. 704:

Step 1: Place the equipment power switch in the OFF position.

Step 2: Plug the demagnetizer into a 117-volt a-c source.

NOTE

If the plastic coating wears off, place one layer of electrical friction tape on the demagnetizer tips. Scratching the heads will then be prevented.



DEMAGNETIZING THE HEADS

- Step 3: Bring the tips of the demagnetizer to within approximately 1/8-inch (if the demagnetizer tips are taped or covered, contact with the heads can be made) of the record head core stack, straddle the head gap and draw the demagnetizer tips up and down the length of the core stack three or four times.
- Step 4: Remove the demagnetizer slowly from the head stack to a distance of 3 or 4 feet, thus allowing its a-c field to diminish gradually. This slow removal is extremely important.

CAUTION

Do not unplug the demagnetizer while it is near the heads; the collapse of its magnetic field will re-magnetize the head.

- Step 5: Repeat Steps 3 and 4 at the reproduce and erase heads.
- Step 6: If necessary, repeat the process till complete demagnetization is effected in each case.

NOTE

The erase head, under certain conditions, is susceptible to magnetization by spurious sources and can require demagnetization.

If the capstan, tape guides or other metal parts become magnetized, a few passes of the demagnetizer along their lengths and the slow withdrawing technique should be adequate.

ADJUSTMENTS

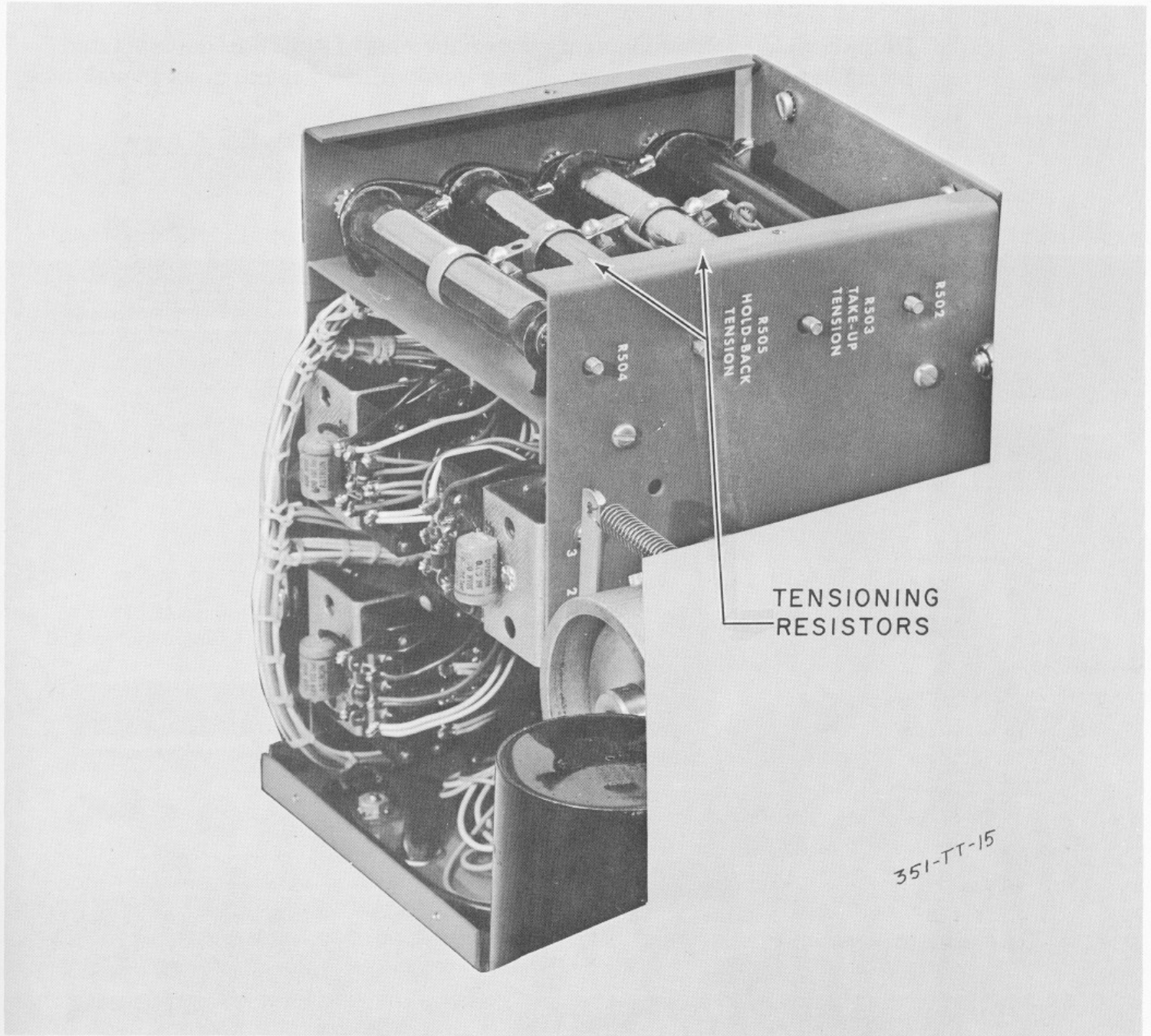
The mechanical assembly is shipped from the factory with all adjustments set for correct performance. It should be unnecessary to change any adjustment before putting the equipment into service, unless shipping damage has occurred. In the course of wear in normal service, or in the event of component failure, and replacement of parts, some readjustments may be necessary.

Equipment Required:

Spring Scale 0-16 oz
Spring Scale 0-80 oz
3/8-inch Nut Driver
3/16-inch Screwdriver
Nylon Lacing Twine or Strong String
7/16 -inch Socket Wrench
5/64 -inch Allen Wrench

Take-up and Supply (Rewind) Tension

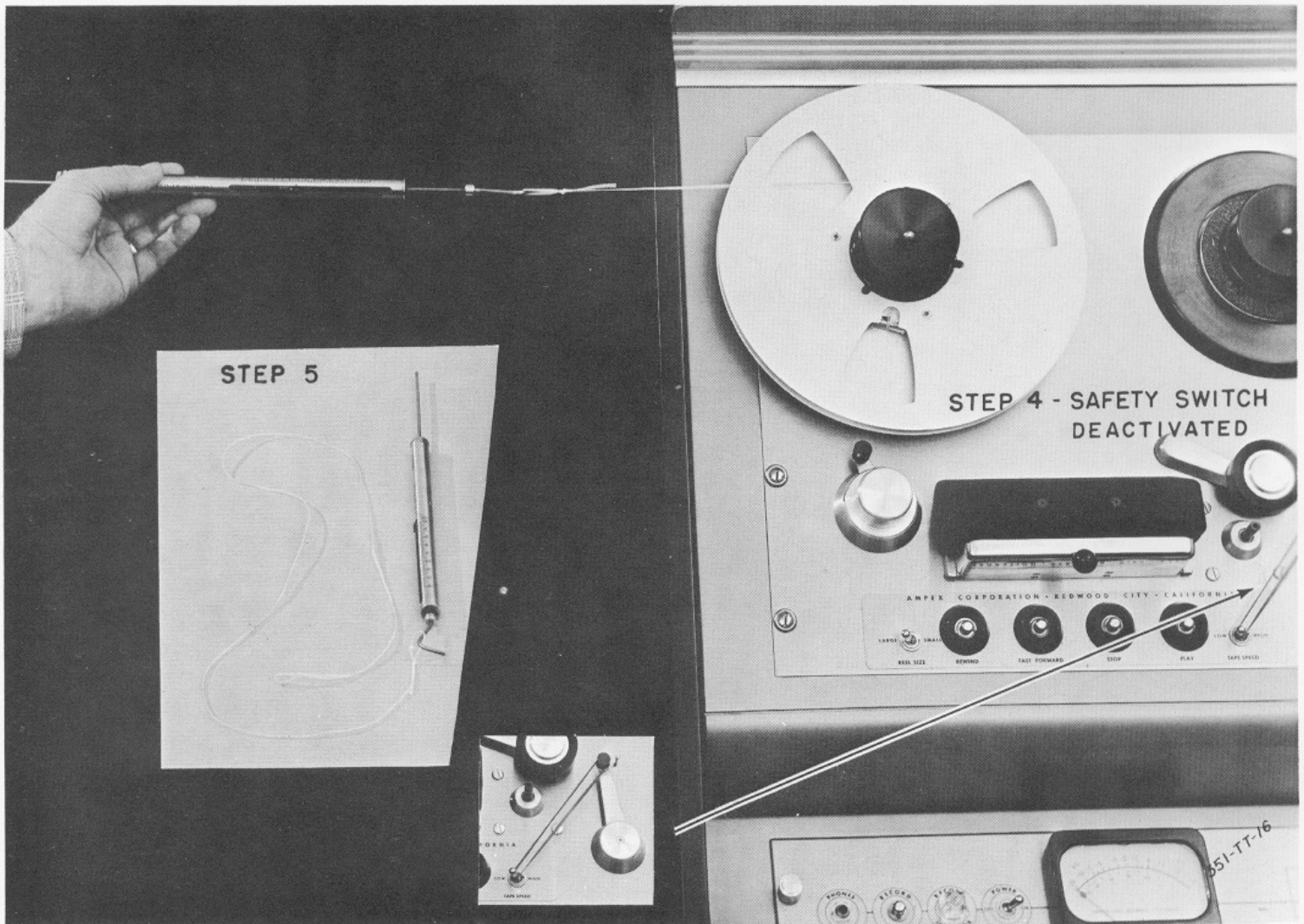
Take-up and supply tensions are determined by the positioning of the sliders on resistors R503 and R505 located in the tape transport control circuit box.



LOCATION OF TAPE TENSIONING RESISTORS

The torque of both the rewind and take-up motors must be adjusted to between 6 and 8 ounces as read on the 16 oz spring scale at NAB reel hub diameter. Checking techniques are not difficult and should be performed carefully.

- Step 1: Place an empty 10-1/2 inch NAB reel on the tape supply turntable.
- Step 2: Place the POWER switch in the ON position.
- Step 3: Place the REEL SIZE switch in the LARGE position.
- Step 4: Hold the take-up tension arm so that the safety switch is de-activated (a rubber band or piece of masking tape will hold the arm as though tape were threaded on the equipment).



MEASURING TAPE TENSIONING

- Step 5: Make small loops at both ends of a thirty inch piece of nylon lacing twine.
- Step 6: Attach one loop to the tape anchor on the reel hub and the other to a 0 to 16 oz. spring scale.

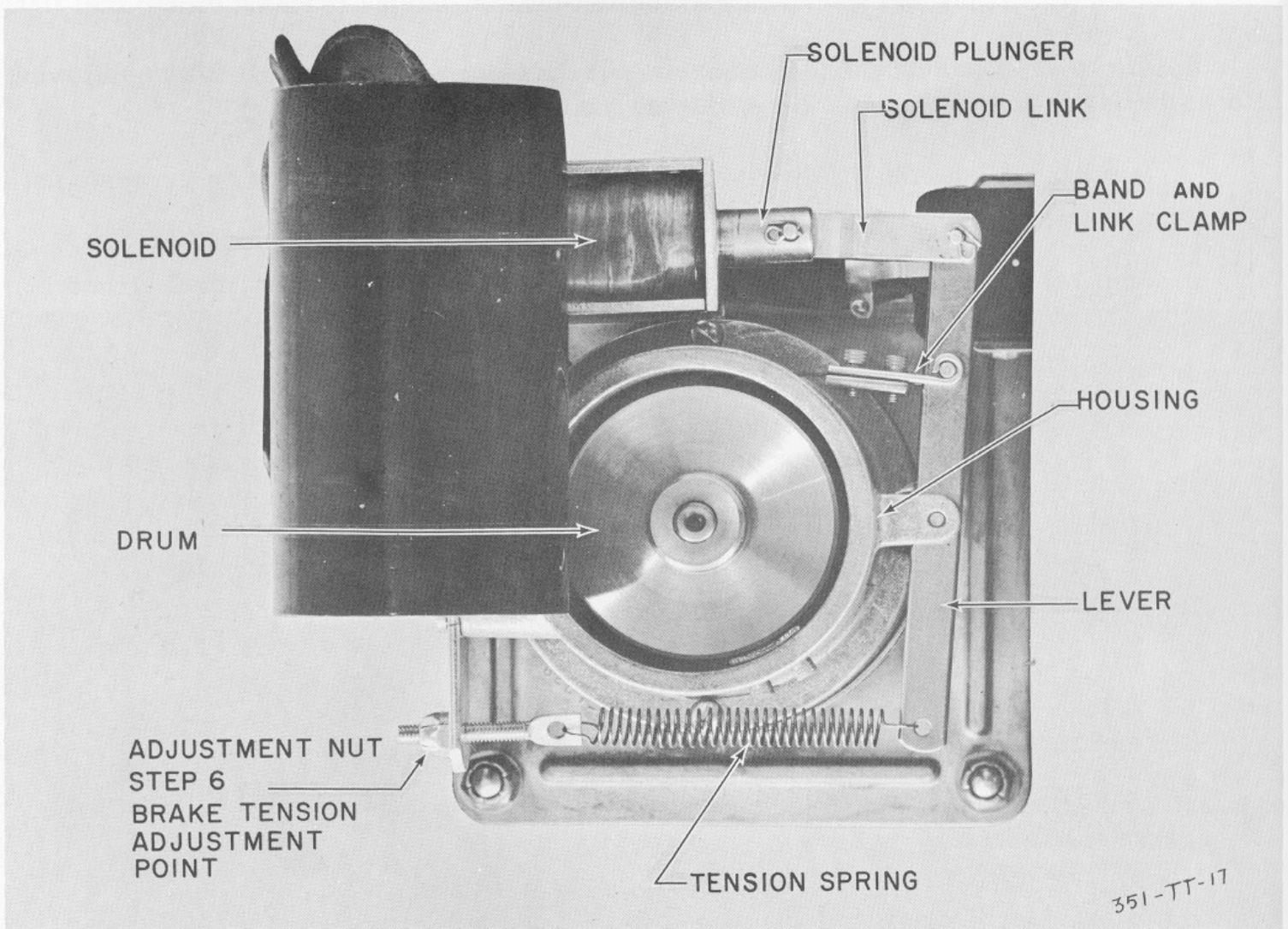
- Step 7: Depress the PLAY button and allow the clockwise motion of the supply reel (torque motor tension) to draw a turn of twine onto the hub.
- Step 8: Make certain that the twine is now parallel to the plane of the top of the tape transport and that the twine is centered and not touching either reel flange.
- Step 9: Now, let the torque motor pull the twine slowly onto the hub by following the torque motor force with the scale.
- Step 10: Using this "following" technique, observe the readings on the scale until a constant reading is obtained.
- Step 11: If necessary, adjust the slide on resistor R505 in the control circuit box until a scale reading between 6 and 8 ounces is achieved.
- Step 12: A good check consists in placing the REEL SIZE switch in the SMALL position, then checking the torque using the same procedure as above. The scale should indicate approximately one-half the LARGE reel size reading.
- Step 13: Use the procedures in the preceding steps to check and adjust the take-up tension which is set at R503 (note that the reel on this side will move counterclockwise).

Brake Adjustment

Brake adjustment is made (with no power applied to the equipment) at the point shown in the illustration.

- Step 1: Place an empty 10-1/2 inch NAB reel on the tape supply turntable.
- Step 2: Make small loops at both ends of a thirty inch piece of nylon lacing twine.
- Step 3: Attach one loop to the tape anchor on the reel hub and the other to a 0-16 oz. spring scale.
- Step 4: Manually rotate the reel clockwise to wind several turns of twine onto the hub.
- Step 5: Pull the scale, making certain that the twine does not touch either flange of the reel. The turntable will rotate counterclockwise. Take a reading only when the turntable is in steady motion, because the force required to overcome the static friction will produce a false and excessively high initial reading.

Step 6: Adjust the supply (rewind) motor brake for a scale reading of approximately 14 ounces (+3 oz -2 oz).



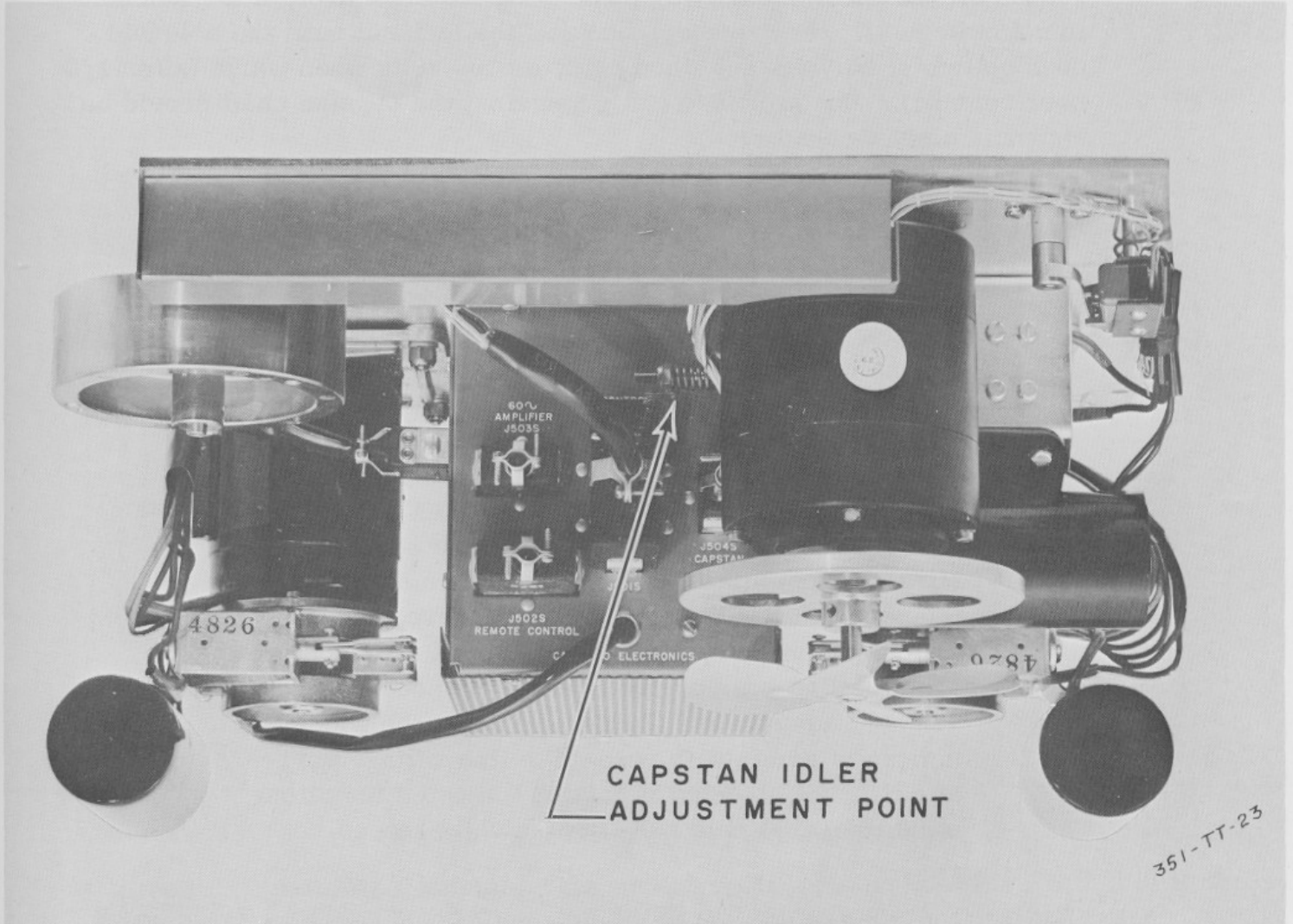
BRAKE TENSIONING ADJUSTMENT

Step 7: Now wind the twine on the hub by rotating the reel counterclockwise; pull, and take a reading. The turntable will rotate clockwise. The reading should be approximately 7 (+2 oz -1 oz) ounces (two-to-one brake differential).

Step 8: Repeat the entire process on the take-up turntable. Again adjust for approximately 14 ounces when the table is rotating clockwise and approximately 7 ounces counterclockwise.

Capstan Idler Pressure

The capstan idler is forced against the capstan by the action of capstan solenoid K501. Idler pressure is supplied by the capstan idler pressure spring, and is adjusted by a lock nut on the capstan solenoid spade bolt. See the illustration. Tightening the lock nut increases idler



*CAPSTAN IDLER PRESSURE
ADJUSTMENT POINT*

pressure until a point is reached where the solenoid will not bottom. At this point, idler pressure drops to a value which is inadequate to permit the capstan to drive the tape, and slippage will occur unless the nut is backed off. Excessive pressure also throws an unnecessary load on the upper sleeve bearing of the drive motor. The recommended procedure for adjusting idler pressure is as follows:

Step 1: Hold the take-up tension arm so that the safety switch is de-activated.

Step 2: With the POWER switch in the ON position, press the PLAY button, and note whether the capstan solenoid is bottomed. (The capstan idler can be pushed off the capstan easily by pushing on the idler arm, if the solenoid is not bottomed). If necessary, back off the lock nut until the solenoid does bottom at 90 volts a-c when cold, or 105 volts when warm (after 1/2 hour running). The pressure ("dig") against the capstan shaft should be approximately 5 pounds.

NOTE

In the course of normal operation in the reproduce or record modes, the temperature of the capstan solenoid will rise, and its d-c resistance will increase. Therefore, the minimum line voltage required to bottom the solenoid when it is hot will be greater than that required when it is cold. If the equipment is operating on unusually low line voltage below (100 to 105v.), sometimes encountered in areas where regulation is poor, the solenoid may fail to bottom after it has reached normal operating temperature. It is advisable, therefore, to allow the equipment to operate in the reproduce mode for about half an hour before making any necessary solenoid adjustments. This will allow the widest margin of safety with respect to line voltage variations. The solenoid is factory-adjusted to bottom at 90 line volts cold and 105 line volts hot.

Step 3: If it is desired to measure capstan dig, press the STOP button at this point and select a piece of nylon lacing twine about 30 inches long and tie the ends together.

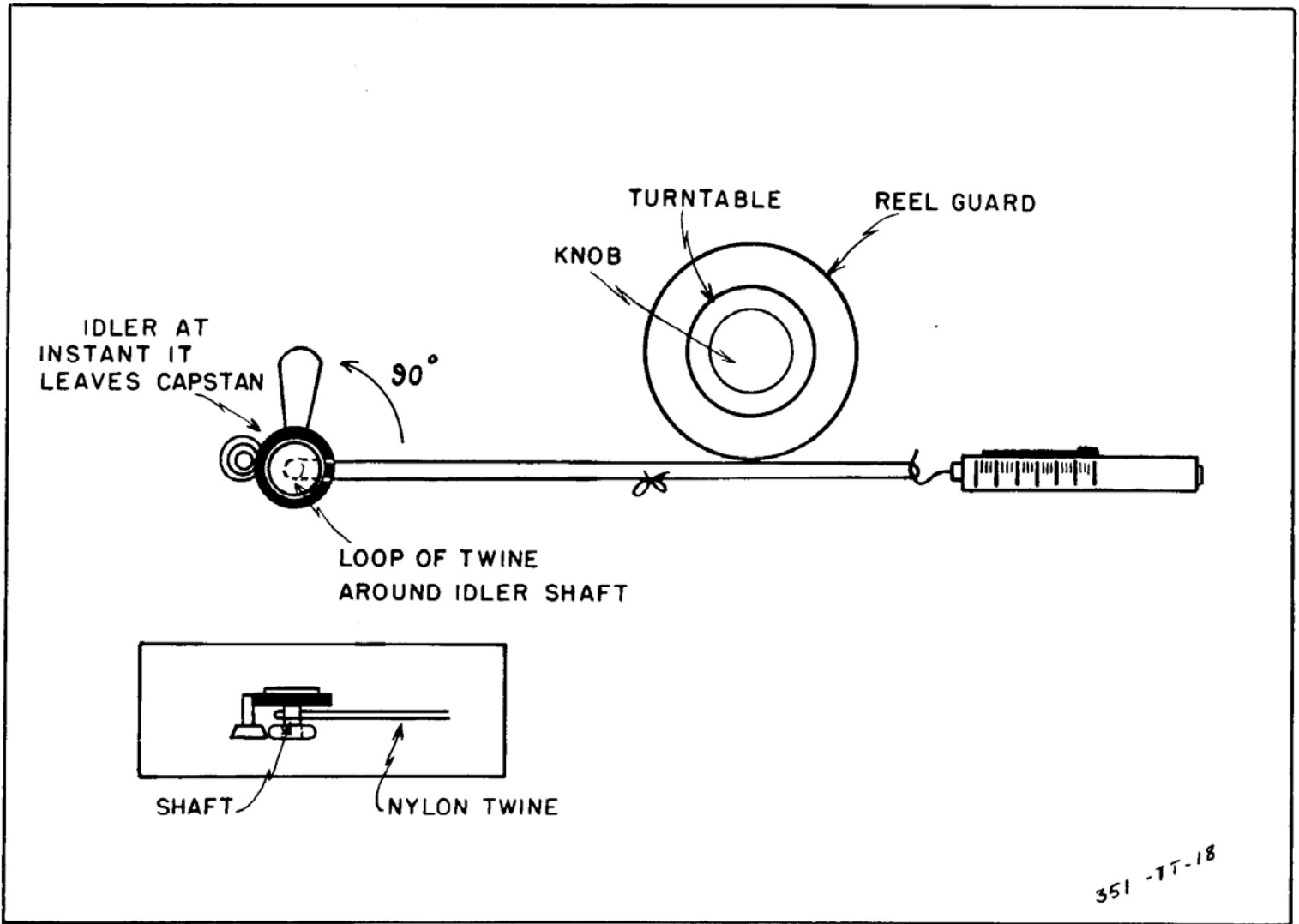
Step 4: Slip the twine loop just formed between the idler and idler arm so that the nylon rests against the idler shaft.

Step 5: Attach the other side of the loop to a 0 to 80 oz scale, letting the nylon twine remain slack.

Step 6: Depress the PLAY pushbutton, causing the capstan idler to clamp against the capstan.

Step 7: Pull the scale away so that the nylon twine is taut and makes a 90 degree angle with the idler arm.

Step 8: Now, slowly pull the scale away with sufficient power to cause the capstan idler to leave the capstan, reading the scale at the instant the capstan idler



CAPSTAN IDLER PRESSURE MEASUREMENT

Step 8: leaves the capstan. The scale reading should be 5 lbs \pm 1/2 lb. If necessary, adjust the capstan dig at the point shown in the illustration.
(Cont'd)

Replacement of Parts

All sub-assemblies of the tape transport mechanism can be easily dismantled with the use of a screwdriver and a few small socket-head screw keys.

CAUTION

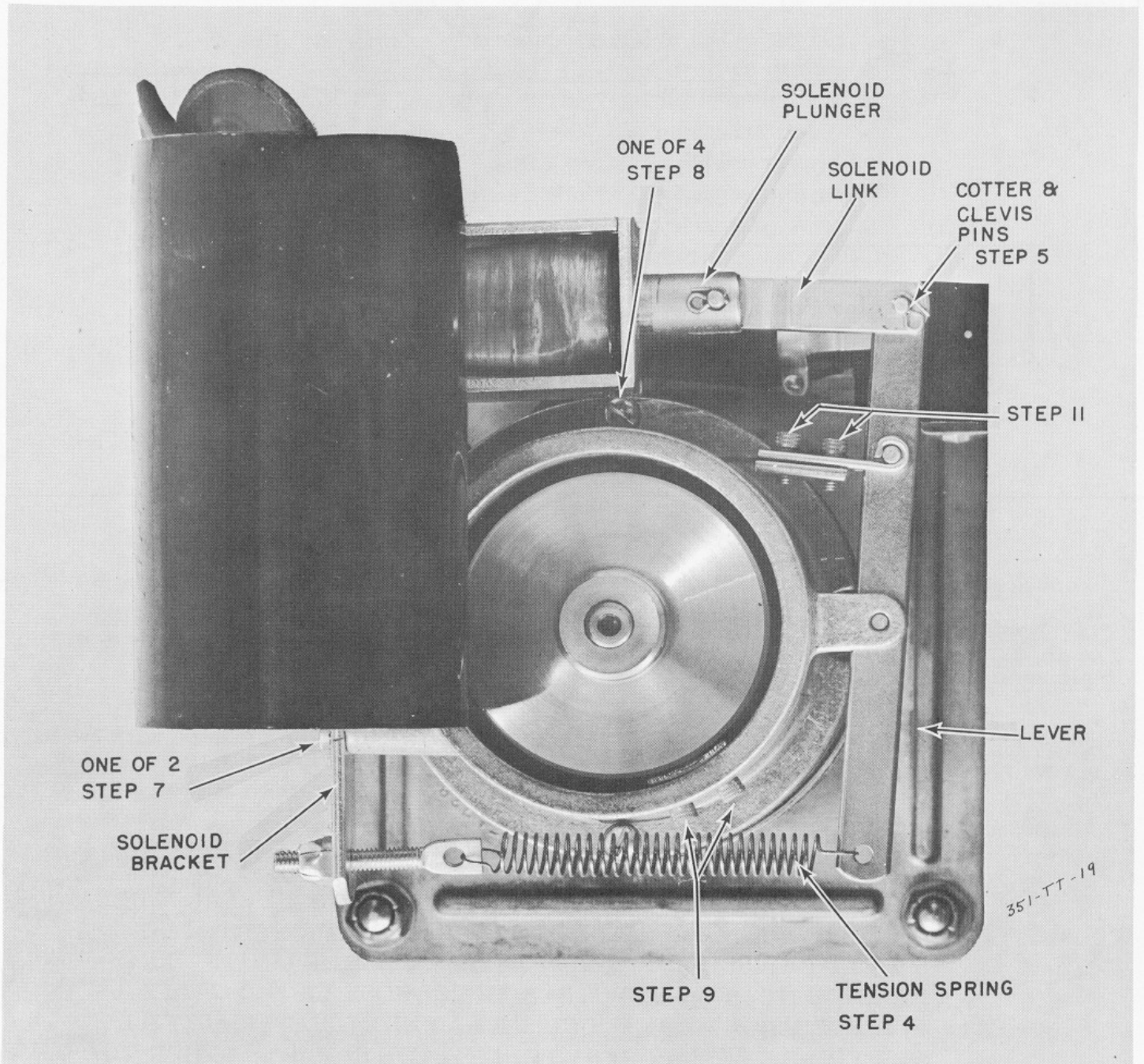
DO NOT ATTEMPT COMPLETE DISASSEMBLY OF ANY OF THE SUB-ASSEMBLIES. THE LIST OF INDIVIDUALLY REPLACEABLE PARTS UNDER EACH ASSEMBLY LISTING IN THE PARTS LIST SHOULD BE USED AS A GUIDE TO DISASSEMBLY LIMITS. REPLACEMENT OF PARTS OTHER THAN THOSE LISTED CALLS FOR PRECISION WORK WHICH SHOULD NOT BE ATTEMPTED IN THE FIELD. ASSEMBLIES WITH DEFECTS IN PARTS OTHER THAN THOSE LISTED AS REPLACEABLE SHOULD BE RETURNED TO THE FACTORY OR TO AN AMPEX AUTHORIZED SERVICE CENTER FOR REPAIR OR REPLACEMENT.

Write the Service Department for a proper authorized equipment return tag. Do NOT ship unidentified parts to factory; Ampex can assume no responsibility for their proper care or return under such circumstances.

Brake Band Replacement

The most convenient method for changing the brake band is first to remove the entire motor assembly.

Step 1: With a 7/16-inch socket wrench remove the four mounting screws and washers at the motor mounting plate, carefully holding the motor with one hand to prevent it from falling.



BRAKE BAND REPLACEMENT

- Step 2:** If the tape transport is in a rack or opened console, support the reel guard with one hand to insure that it doesn't fall and gently draw the motor free. The turntable will remain attached to the motor assembly.
- Step 3:** Take the motor to a convenient work area.
- Step 4:** Unhook the brake tension spring from the brake lever.
- Step 5:** Remove the cotter and clevis pin from the solenoid link.
- Step 6:** Remove the solenoid plunger.
- Step 7:** Loosen (do not remove) the two screws holding the solenoid bracket to the brake housing.
- Step 8:** Remove the four screws that hold the brake housing to the motor, noting the positioning of the washers and spacers, and remove the entire housing.
- Step 9:** Using a 5/64-inch Allen wrench remove the 2 cap screws on the brake housing between the brake lever and the solenoid bracket.
- Step 10:** Remove the band link clamp, the 1-1/8 inch leaf spring and the 7/8-inch leaf spring.
- Step 11:** Loosen (do not remove) the two Allen head screws holding the brake band link and band link clamp, and pull the brake band free.

NOTE

Immediately before installing the new brake band assembly, it should be pressed flat between two boards in a vise in order to compress the felt lining. If this is not done the lining might be too thick to permit free rotation of the brake drum after installation, which will result in dragging brakes and improper brake differential. Once the band is installed, the felt will no longer swell, as it might when the bands are not bent in their normal curve.

- Step 12:** Position the new brake band, 1-1/8 inch leaf spring, 7/8 inch leaf spring and clamp in the housing and replace the 2 cap screws removed from the brake housing in Step 9.
- Step 13:** Replace the brake housing, making certain that the spacers, the housing, the washers and the screws are replaced in that order, and tighten the screws.
- Step 14:** Insert the brake band between the band links and band link clamp. DO NOT tighten the two cap screws loosened in Step 11.

Step 15: Push the solenoid plunger down until it bottoms. Adjust the depth of insertion of the brake band between the link and clamp so that the brake drum rotates freely with no drag; then, tighten the screws.

CAUTION

If the band is set too far forward in the link, it will buckle slightly when the solenoid plunger is bottomed by hand. If this condition exists the plunger may not bottom when the solenoid is energized.

Step 16: Replace the solenoid plunger.

Step 17: Replace the solenoid link, the cotter and clevis pins.

Step 18: Tighten the solenoid bracket screws loosened in Step 7.

Step 19: Hook the brake spring to the brake lever (Step 4).

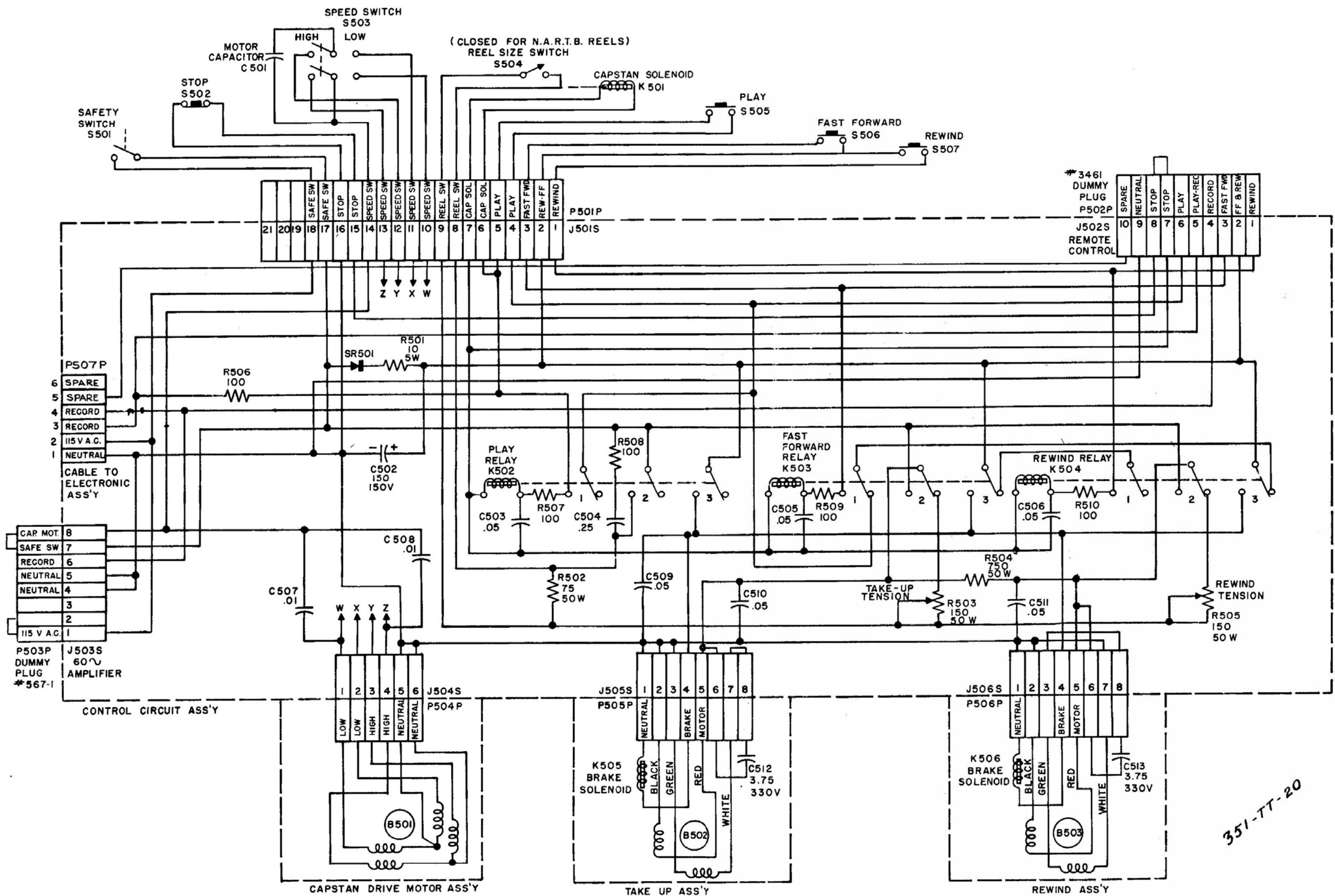
Step 20: Replace the motor assembly, tightening the four screws (Step 1).

Packing Precautions for Motors

In packing motors for return to the factory, take particular care to prevent the bending of their shafts in transit. When packing a capstan drive motor, always remove the fan and flywheel from the motor shaft. Retain the fan and send the flywheel with the motor. This part is balanced with the individual motor.

REF. NO.	PART DESCRIPTION	AMPEX PART NO.
	<u>TAPE TRANSPORT MECHANISM</u>	
B501	DRIVE MOTOR ASSEMBLY	
	7-1/2 - 15 ips, 60 Cycle Motor	6150-0
	7-1/2 - 15 ips, 50 Cycle Motor	6151-1
	3-3/4 - 7-1/2 ips, 60 Cycle Motor	5585-0
	3-3/4 - 7-1/2 ips, 50 Cycle Motor	5778-1
C501	Each includes: Capacitor Assy., 5 uf Flywheel with Bodine Motor with Ashland Motor Set Screw, 10-32 x 1/4 Mounting Adaptor Four Screws 8-32 x 1-1/2 Plug, 6-contact, Jones	9487-2 981 2212 477-118 2211 471-489 145-012
	FAN	591-001
B502	TAKEUP ASSEMBLY	9451
	Turntable Motor Assembly Includes Motor, Mounting Flange, Brake Drum, and Turntable with Pad.	7558
C512	Pad Capacitor, 3.75 uf Brake Housing Brake Band Assembly (Kit of two) Brake Band Leaf, 1-1/8" long Brake Band Leaf, 7/8" long	958 035-111 317 7970-1 720-1 720-2
K505	Brake Solenoid Brake Tension Spring Plug, 8-contact, Jones	337 322 145-013
B503	REWIND ASSEMBLY (60 cycle)	9452
	Turntable Motor Assembly Includes Motor, Mounting Flange Brake Drum, and Turntable with Pad.	7558
C513	Pad Capacitor, 3.75 uf Brake Housing Brake Band Assembly (Kit of two) Brake Band Leaf, 1-1/8" long Brake Band Leaf, 7/8" long	958 035-111 316 7970-1 720-1 720-2
K506	Brake Solenoid Brake Tension Spring Plug, 8-contact, Jones	337 322 145-013
B503	REWIND ASSEMBLY (50 cycle) Capacitor, 4.00 mfd (All other parts identical to 60 cycle)	30782 035-116
	TAKEUP TENSION ARM ASSEMBLY	425-0
	Individually Replaceable Parts: Takeup Tension Arm Spring Tape Guide Tape Guide Hook	422-0 675-0 355
	REEL IDLER ASSEMBLY, with arm and guide, but without flywheel.	
	For 7-1/2 - 15 ips Machine	4459-0
	For 3-3/4 - 7-1/2 ips Machine	4459-3
	Tape Guide	257-0
	Reel Idler Flywheel	636-1
	Pulley Assembly (7-1/2 - 15 ips)	5893
	Pulley Assembly (3-3/4 - 7-1/2 ips)	5893-1
	CAPSTAN IDLER WHEEL ASSEMBLY	
	For 7-1/2 - 15 ips Machine	500-0
	For 3-3/4 - 7-1/2 ips Machine	6092
	Capstan Idler Arm	372-1
	Capstan Idler Arm Bushing	6755
	Capstan Dust Cap	
	For 7-1/2 - 15 ips Machine	3506-0
	For 3-3/4 - 7-1/2 ips Machine	3506-1
	Individually Replaceable Parts: Felt Washer Retaining Ring	3583-2 432-007
K501	Capstan Solenoid Capstan Solenoid Eye-Bolt Capstan Solenoid Stop Capstan Solenoid Felt Washer Capstan Solenoid Pressure Spring Capstan Solenoid Return Spring	670 396-3 388 503-015 676 5757
	PUSHBUTTON GUARDS	361
P502P	CONNECTOR, plug: male, 10 contacts (Remote dummy)	3461
P503P	CONNECTOR, plug: male, 8 contacts (60 cycle dummy)	567-1
S501	SWITCH ASSEMBLY, safety: SPST, normally closed; Unimax part No. 2HBT-215-1W	6582
S502	PUSHBUTTON, STOP: SPST, normally closed	120-014
S503	SWITCH, toggle, tape speed: DPDT	120-004
S504	SWITCH, toggle, reel size: SPST	120-005
S505	PUSHBUTTON, PLAY: SPST, normally open	120-013
S506	PUSHBUTTON, FAST FWD: Same as S505	
S507	PUSHBUTTON, REWIND: Same as S505	

REF. NO.	PART DESCRIPTION	AMPEX PART NO.
	ORDER BY AMPEX CATALOG NUMBER	
	<u>CONTROL CIRCUIT ASSEMBLY</u> Catalog No. 5703	
C502	CAPACITOR, fixed: electrolytic tubular, 150 uf. 150 vdcw; C. D. Part No. 15015	031-045
C503	CAPACITOR, fixed: metallized tubular, axial leads, .05 uf ± 20%, 400 vdcw; Astron Part No. ML-4-05	033-006
C504	CAPACITOR, fixed: metallized tubular, axial leads, .25 uf ± 20%, 400 vdcw; Astron Part No. ML-4-25	033-008
C505	Same as C503	
C506	Same as C503	
C507	CAPACITOR, fixed: metallized tubular, axial leads, .01 uf ± 20%, 400 vdcw; Astron Part No. ML-4-01	033-005
C508	Same as C507	
C509	Same as C503	
C510	Same as C503	
C511	Same as C503	
J501S	CONNECTOR, receptacle: female, 21 contacts chassis mounted; Jones Part No. S-321-AB	146-057
J502S	CONNECTOR, receptacle: female, 10 contacts chassis mounted; Jones Part No. S-310-AB	146-018
J503S	CONNECTOR, receptacle: female, 8 contact chassis mounted; Jones Part No. S-308-AB	146-003
J504S	CONNECTOR, receptacle: female 6 contact chassis mounted; Jones Part No. S-306-AB	146-004
J505S	Same as J503S	
J506S	Same as J503S	
K502	RELAY, PLAY: 3PDT, 115 volt dc coil std. 10 amp contact; Philtrol Part No. 33QA	020-006
K503	RELAY, FAST FWD: Same as K502	
K504	RELAY, REWIND: Same as K502	
P501P	CONNECTOR, plug, male, 21 contacts; Jones Part No. P-321-CCT-L	145-022
P504P	CONNECTOR, plug, male, 6 contacts; Jones Part No. P-306-CCT-L	145-012
P505P	CONNECTOR, plug, male, 8 contacts; Jones Part No. P-308-CCT-L	145-013
P506P	Same as J505P	
P507P	Same as P504P	
R501	RESISTOR, fixed: wirewound, 20 ohm ± 10%, 5 watts; Tru-Ohm Part No. type FRL-5	043-154
R502	RESISTOR, fixed: wirewound, 75 ohm ± 5%, 75 watts; Tru-Ohm Part No. FR-50	043-002
R503	RESISTOR, adjustable: wirewound, 150 ohm ± 5%, 50 watts; Tru-Ohm Part No. AR-50	040-011
R504	RESISTOR, adjustable: wirewound, 750 ohm ± 5%, 50 watts; Tru-Ohm Part No. AR-50	040-007
R505	Same as R503	
R506	RESISTOR, fixed: composition, 100 ohm ± 10%, 1/2 watt; MIL-R-11A, RC20GF101K	041-038
R507	Same as R506	
R508	Same as R506	
R509	Same as R506	
R510	Same as R506	
SR501	RECTIFIER, selenium: single phase, half wave; G. E. Part No. 6R525PH6ATD1	582-016



NOTE
 1. ALL RESISTORS IN OHMS & RATED 1/2 WATT UNLESS OTHERWISE NOTED
 2. ALL CONDENSERS IN MICROFARADS AND RATED 400 V UNLESS OTHERWISE SPECIFIED.

351-TT-20

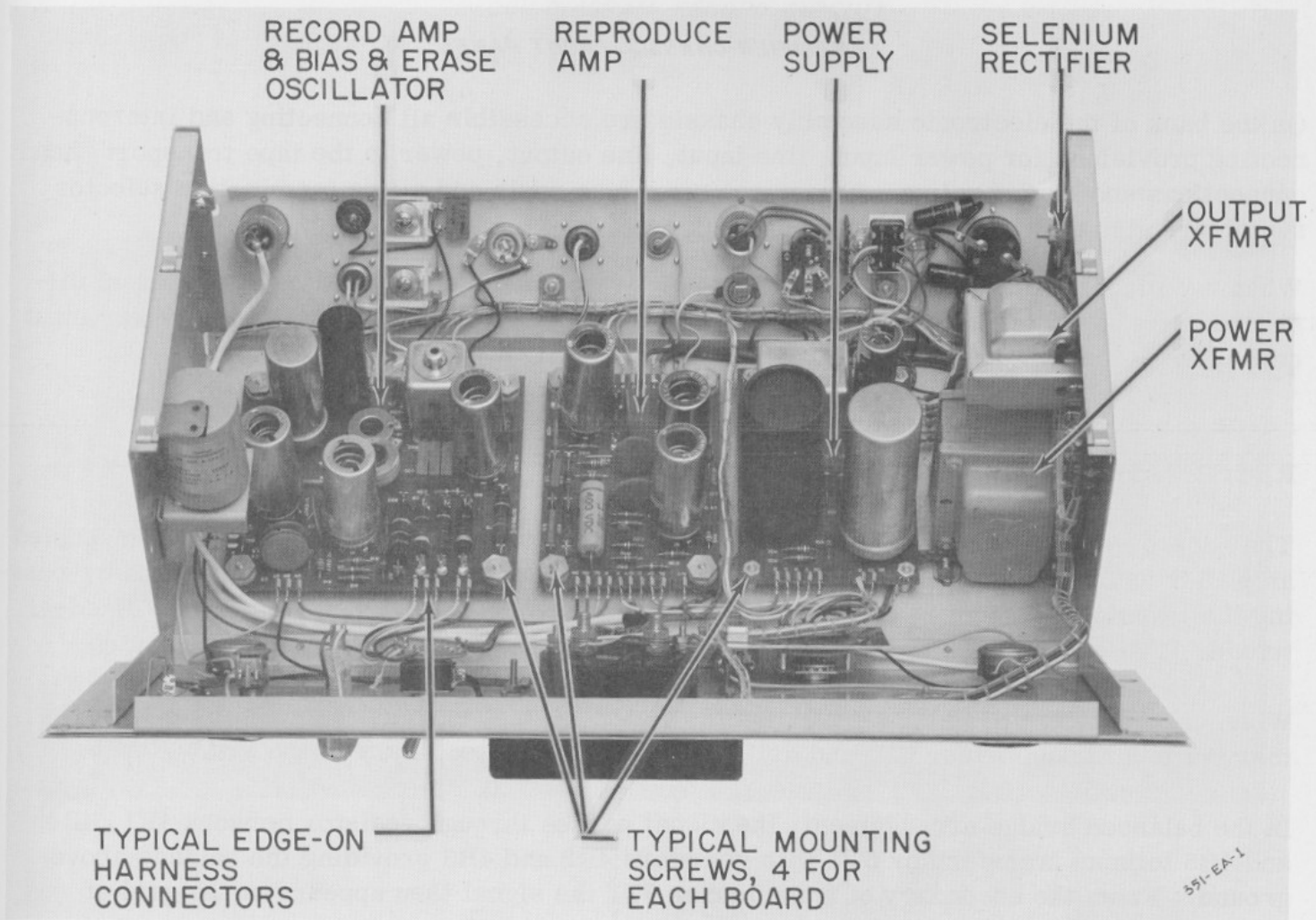
SECTION 5

ELECTRONIC ASSEMBLY

GENERAL

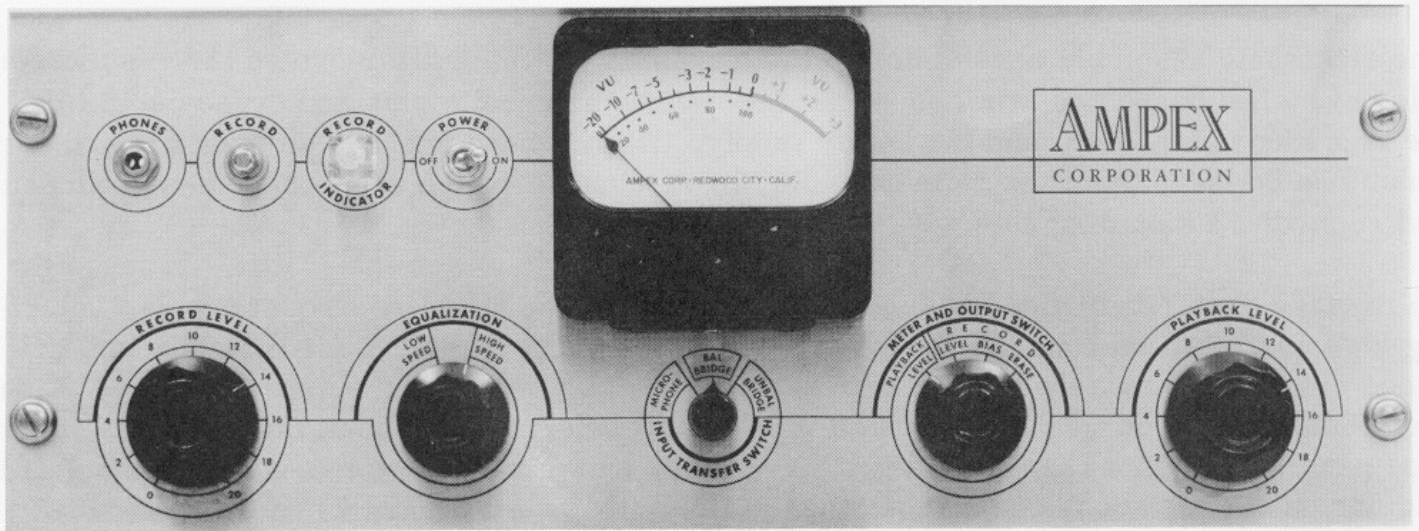
The electronic assembly consists of a single chassis on which are mounted three subassemblies of etched board construction -- the record amplifier with bias and erase oscillator, the reproduce amplifier, and the power supply. Each subassembly is an etched board entity which can be taken from the main assembly by disconnecting the edge-on harness connectors and removing 4 mounting nuts.

On the face panel, facilities are available for setting record and reproduce levels, selecting high or low speed equalization circuitry, making input transfers for microphone, balanced bridge or unbalanced bridge inputs, and switching meter and output circuitry. Visual monitoring of reproduce, record, bias and erase levels can be done at the vu meter on the face panel. Two phone jacks for aural monitoring are provided, one on the face panel and another on the back of the electronic chassis. Power on-off is controlled at the front of



LOCATION OF ELECTRONIC SUBASSEMBLIES

the assembly. A control for the record function, signified by an accompanying indicator light, completes the front panel arrangement.



AMPLIFIER CHASSIS, FRONT PANEL

On the back of the electronic assembly chassis are accessible all connecting and interconnecting provisions for power input, line input, line output, power to the tape transport, head connections and bias coupling. Two screw-type fuse posts and a line termination selector switch are also provided on the chassis back panel.

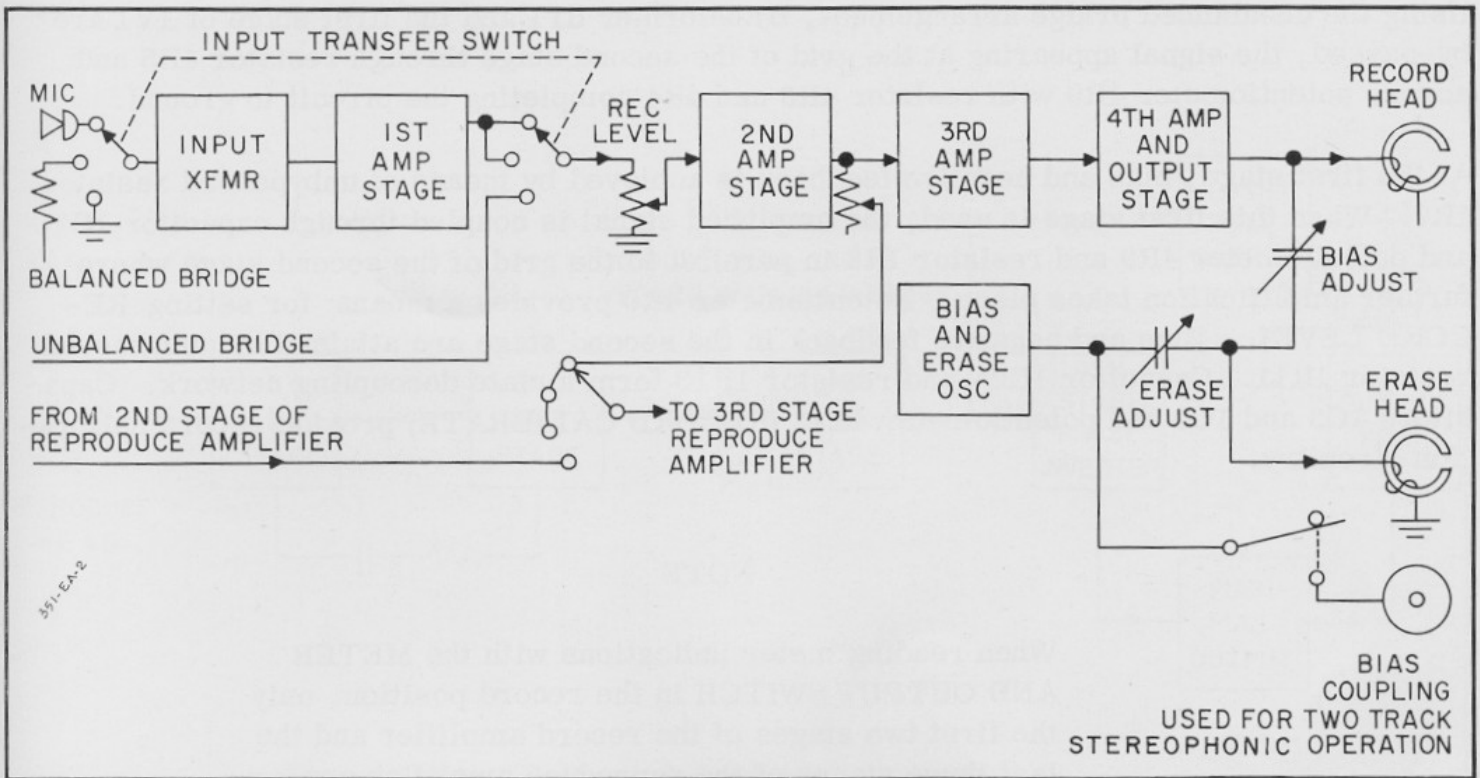
When two electronic assemblies are used for stereophonic operation, the only external differences are that the slave amplifier has one fuse post instead of two and the ac power input connector receptacle position is not furnished.

RECORD AMPLIFIER

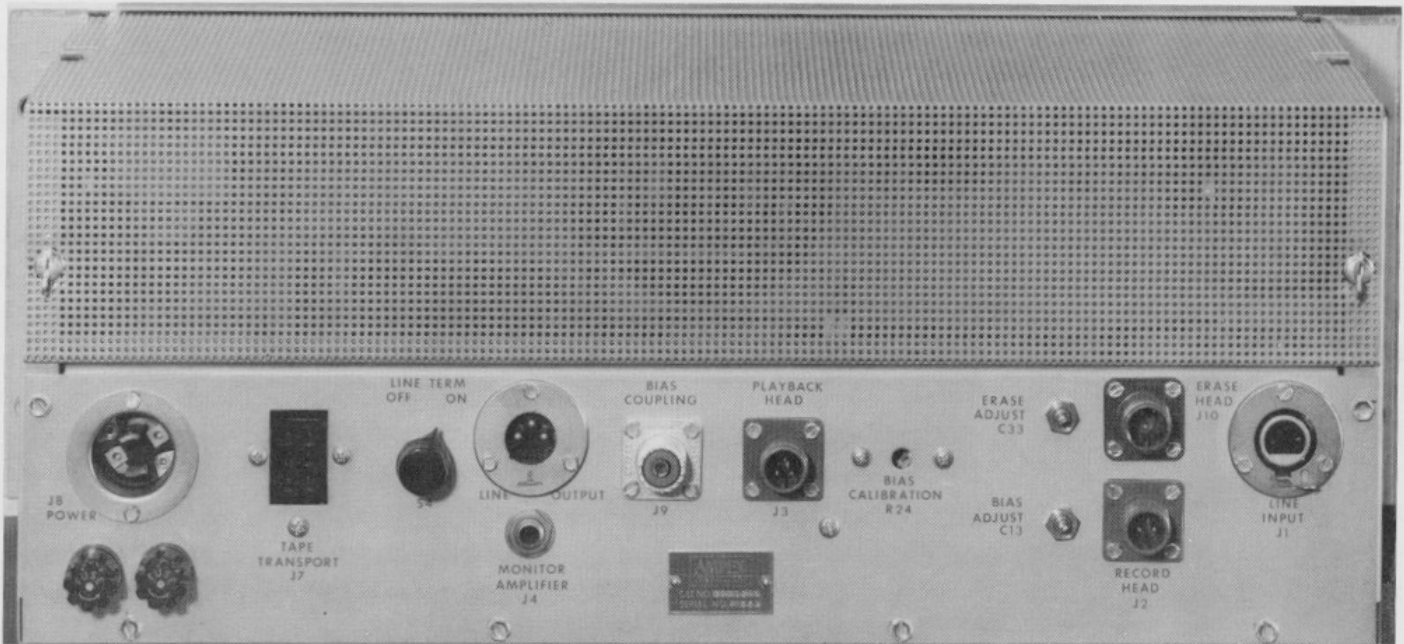
The record section of the electronic assembly is a four stage, high gain, resistance coupled amplifier using transformer coupling for microphone or balanced bridge inputs, and by-passing the transformer and the first stage when unbalanced bridge input is selected. Two dual triodes, 1V1 and 1V2 and their related circuitry, form the four stages of amplification.

When the microphone INPUT is selected the signal from 5J1 is impressed across the primary of input transformer 6T1 and delivered through the secondary to the grid of 1V1.

In the balanced bridge arrangement, the signal passes through resistor network 4R1, 4R4 and 4R5 to input transformer 6T1 with resistors 4R2 and 4R3 providing the balance above ground. From the secondary of transformer 6T1 the signal then appears at the grid of 1V1.



BLOCK DIAGRAM RECORD CIRCUIT



AMPLIFIER CHASSIS, REAR VIEW

Using the unbalanced bridge arrangement, transformer 6T1 and the first stage of 1V1 are by-passed, the signal appearing at the grid of the second stage through resistor 4R5 and across potentiometer 4R9 with resistor 4R3 and 4R4 completing the circuit to ground.

At the first stage, bias and negative feedback is achieved by means of unbypassed resistor 1R7. When this first stage is used, the amplified signal is coupled through capacitor 1C1 and potentiometer 4R9 and resistor 1R8 in parallel to the grid of the second stage where further amplification takes place. Potentiometer 4R9 provides a means for setting RECORD LEVEL. Bias and negative feedback in the second stage are attained by unbypassed resistor 1R11. Capacitor 1C2A and resistor 1R13 form a plate decoupling network. Capacitors 1C3 and 1C4 and potentiometer 4R12 (RECORD CALIBRATE) provide record calibration circuitry.

NOTE

When reading meter indications with the METER AND OUTPUT SWITCH in the record position, only the first two stages of the record amplifier and the last three stages of the reproduce amplifier are connected in the circuit, omitting record pre-emphasis and reproduce equalization circuitry so that meter indications will reflect only the flat portions of each amplifier.

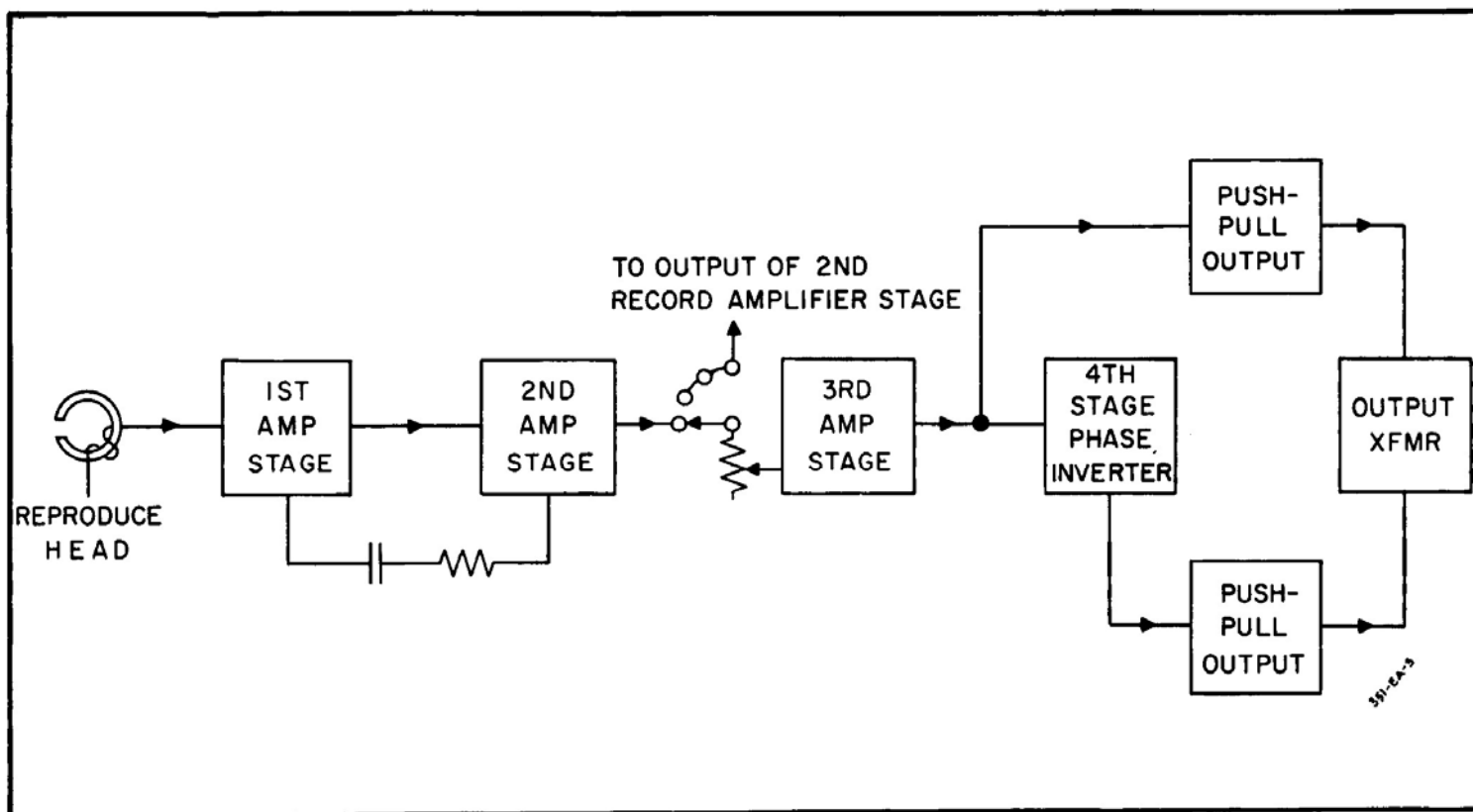
The signal now is coupled to the grid of the third stage by capacitor 1C5, bias and negative feedback is provided through unbypassed resistor 1R16. Further amplification takes place in this third stage and pre-emphasis circuitry for HIGH and LOW tape speeds is provided at capacitors 1C6, 1C7 and 1R17 which provide the necessary high frequency rise. At the low end of the frequency spectrum, an effective 3 db gain is furnished by the resistor/capacitor combination 1R18 and 1C8.

In the fourth stage, coupled to the third stage by capacitor 1C9, the signal is applied to the grid of 1V2. Bias and negative feedback is supplied by unbypassed resistor 1R21. The LC network 1C11, 1C12, 1L1 and 1R22 supplies a high frequency boost by its resonant characteristics. The fourth stage is designed to act as a constant current amplifier in order to feed the reactive load presented by the record head. The output of this fourth stage is mixed with the signal from the bias and erase oscillator and delivered to the record head.

Plate voltage for the first three stages is supplied whenever POWER switch 4S5 is in the ON position. For plate voltage supply to the final stage, the equipment must be in the record mode at which time relay contacts 3K1C complete the necessary circuitry.

REPRODUCE AMPLIFIER

The reproduce section of the electronic assembly is a five stage, resistance coupled, audio amplifier. Three dual triodes are used to provide three stages of amplification, phase inversion and a push-pull output amplifier.



BLOCK DIAGRAM REPRODUCE CIRCUIT

Signals on the moving magnetic tape induce voltages in the reproduce head. When high impedance heads are used, this induced voltage appears across resistor 2R25 and then on the grid of 2V3. When low impedance heads are used the signal is first passed through step-up transformer 6T2. Bias on this first stage is derived from the voltage divider network consisting of resistors 2R26 and 2R28 plus tube current through resistor 2R28. Capacitor 3C16a and resistor 3R32 form a plate decoupling network. The amplifier output of this first stage is coupled to the second stage grid through capacitor 2C14. Capacitor 3C16b and resistor 3R35 form a plate decoupling network. Reproduce equalization is achieved by means of capacitor 2C15 and resistors 2R29, 2R30 and 2R31. For the 3-3/4 and 7-1/2 ips tape speed pair, resistor 2R30 is selected when EQUALIZATION SWITCH 4S2 on the face panel of the electronic assembly is in the LOW position; RESISTOR 2R31 is selected by the HIGH position. For the 7-1/2 and 15 ips tape speed pair, resistor 2R31 serves both speeds.

The signal now is delivered to amplifier stage 2V4, the tube receiving the signal through coupling capacitor 2C17, PLAYBACK LEVEL potentiometer 4R36 and switch 4S3a. The output of 2V4a is coupled through 2C19 to one grid of the push-pull output stage, and a portion of this output is coupled through capacitor 2C18 to phase inverter 2V4b. Both signals, now 180 degrees out of phase with each other, are fed through coupling capacitors to the respective grids of push-pull amplifier 2V5 and then to the primary of center tapped output transformer 6T3.

Plate voltage is supplied to all stages when the POWER switch is in the ON position. The signal can be monitored at the plate of one half of 2V5 before it goes through the output transformer by using phone jack 5J4 MONITOR AMPLIFIER. This position can be useful for feeding such devices as low gain amplifiers, sensing strips, et cetera. After the signal

reaches the secondary of output transformer 6T3, it is delivered to the LINE TERM switch 5S4 for selection of resistor 5R48 to obtain a nominal 600 ohm line output termination.

Again the signal can be monitored at 4J6 PHONES or at the vu meter using the PLAYBACK position of the METER AND OUTPUT SWITCH.

Transformer strapping and cabling connections for various outputs are discussed in SECTION 2 INSTALLATION.

BIAS AND ERASE OSCILLATOR

A dual triode tube 1V6, connected as a push-pull oscillator, provides high frequency bias and erase signal. Both halves of the tube are resistance coupled triode amplifiers, the output of each plate coupled to the grid of the other triode section. Any signal on the grid of either tube will be amplified in the plate circuit and coupled to the grid of the other tube. The signal then will appear at the plate of the second tube and be coupled back to the grid of the first tube in phase with the original signal. Frequency of oscillation is approximately 100 kc.

The oscillator output is fed through variable capacitor 5C33 ERASE ADJUST where erase current adjustments are made. From 5C33 it follows another path through variable capacitor 5C13 BIAS ADJUST where bias current adjustments take place. The bias signal is then mixed with the record signal and delivered to the record head.

NOISE BALANCE control, potentiometer 1R63, in the oscillator grid circuits is adjusted to correct for any asymmetry in wave form which would cause random noise during reproduction and distortion while recording.

Plate voltage is supplied through relay contact K1C only when the equipment is in the record mode.

POWER SUPPLY

Vacuum tube 3V7, connected as a conventional full wave rectifier, supplies plate power for all tubes in the electronic assembly, and it also supplies the record indicator light. Selenium rectifier CR1, connected as a conventional full wave rectifier provides d-c filament voltage for 1V1, 1V2 and 2V3.

The center tap of the 2V3 tube filament provides a ground for the d-c filaments, and this tube must be in its socket for proper operation. A-c power input is connected at 5J8 POWER receptacle and is controlled by switch 4S5 POWER. The power is fed through fuse 5F1 and impressed across the primary of power transformer 6T4 and also through fuse 5F2 to the tape transport.

There are four secondary windings on the power transformer -- three for filament supply and one for high voltage. One filament winding serves rectifier tube 3V7, one center-tapped winding provides 12.6 volt d-c filament voltage after rectification, one winding supplies 12.6 and 6.3 volt a-c voltage, and the other center-tapped winding furnishes high

voltage. An rc network consisting of the four section capacitor 3C16 and resistors 3R54, 3R55 and 3R56 provides filtering action. Relay contact 3K1B shorts resistor 3R54 in the record mode to provide a nearly constant B+ supply in any mode of operation.

Through record relay 3K1C B+ is applied to the bias oscillator and the last stage of the record amplifier. Whenever the PLAY button on the tape transport is depressed, 115 volt d-c is available at pin 3 of 5J7, and when RECORD button 4S6 is depressed, the 115 volt d-c is applied to the record relay coil. As long as 115 volt d-c is available at pin 3 of 5J7, contact 3K1A holds the relay energized. When the STOP button on the tape transport is depressed, the 115 volt d-c no longer reaches pin 3 of 5J7 and relay 3K1 is de-energized and drops out.

ALIGNMENT AND PERFORMANCE CHECKS

Equipment Required

Ampex Standard Alignment Tape

3-3/4 ips

7-1/2 ips

15 ips

A-c Vacuum Tube Voltmeter capable of indicating rms voltages of .004 or less

Audio Oscillator with stable output from 50 cps to 15 kc.

Earphones or Speaker for Monitoring Aurally

Nutdriver number 8 (1/4 inch)

Reel of unrecorded tape

Long Screwdriver (approximately 7 inch bit)

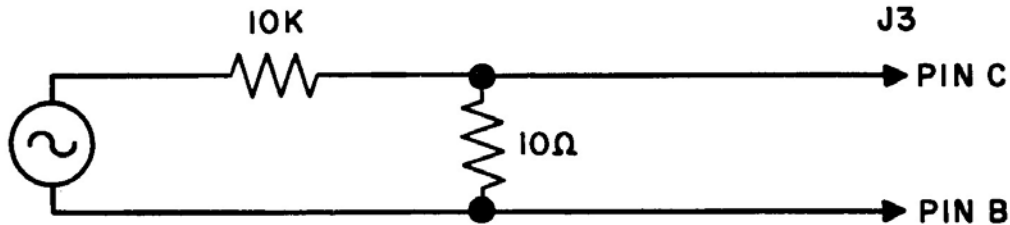
Small Screwdriver

Reproduce Alignment Using Vtvm

Head Alignment

Step 1: With the equipment connected as shown and all power switches in the ON position, thread an Ampex standard tape for the appropriate speed along the prescribed path.

REPRODUCE AMP SET UP



RECORD AMP SET UP

1. SUBSTITUTE 1K RESISTOR FOR RECORD HEAD
2. TIE VTVM ACROSS 1K RESISTOR
3. PULL OUT IV-6
4. PLACE EQUIPMENT IN RECORD MODE

351-EA-7

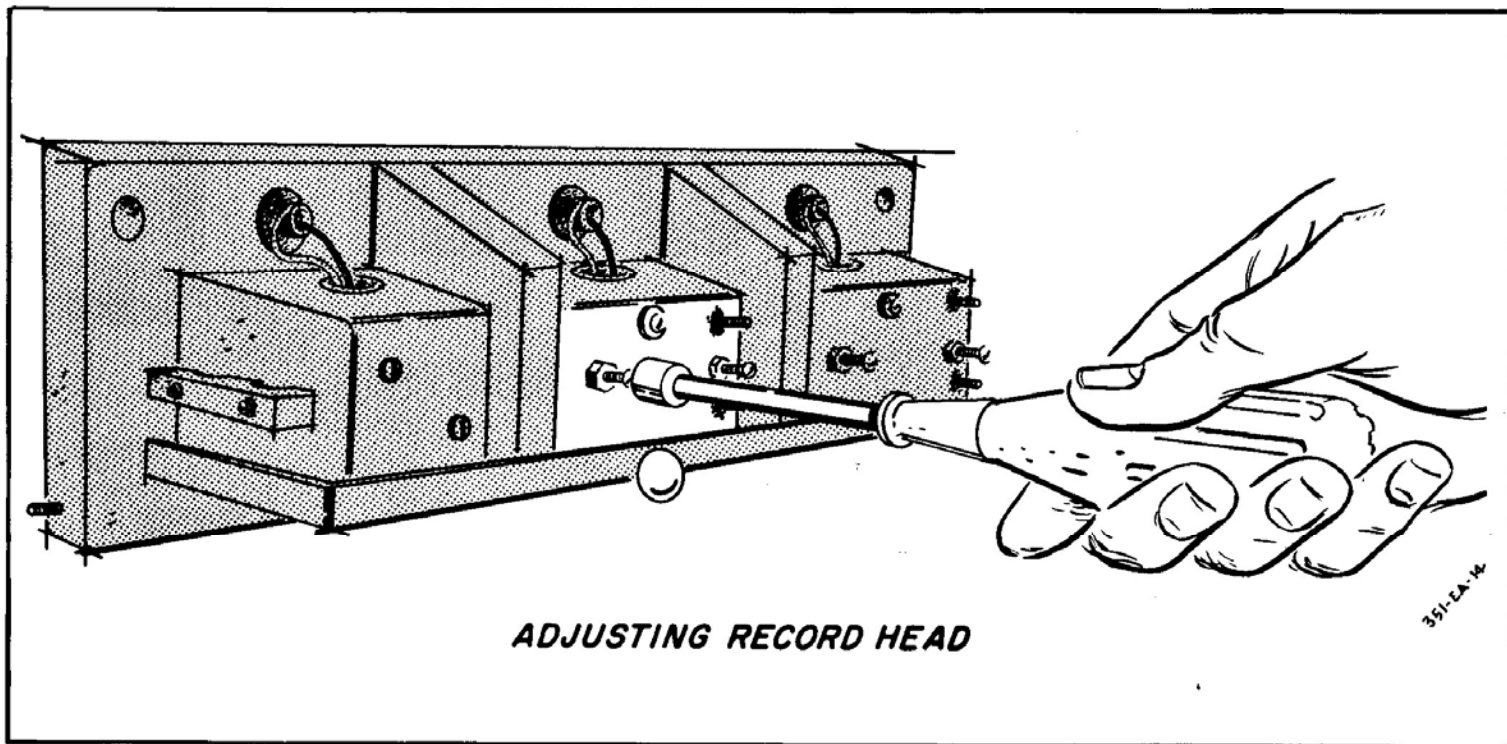
FREQUENCY RESPONSE TEST SET-UP

CAUTION

The standard alignment tape used in the following procedures may be partially erased if the record and reproduce heads are permanently magnetized. Demagnetize the heads before proceeding. Do not replace the head cover on the head assembly.

- Step 2: Set the EQUALIZATION switch to the desired speed.
- Step 3: Place the METER AND OUTPUT switch in the PLAYBACK position.
- Step 4: Place the PLAYBACK LEVEL knob at the number 10 calibration.
- Step 5: Terminate the output in a nominal 600 ohms (LINE TERM switch in the ON position or use a 600 ohm external load).

Step 6: Take the number 8 (1/4 inch) nut driver and adjust the reproduce head azimuth for a maximum reading on the vtm as the appropriate tone on the standard tape is reproduced. The tones will be 7,500 cycles for 3-3/4 ips, 10,000 for 7-1/2 ips and 15,000 cycles for 15 ips.



HEAD AZIMUTH ADJUSTMENT

NOTE

If the head azimuth is far out of alignment (possible if inexperienced personnel without proper equipment have attempted alignment procedures) minor peaks will be observed on both sides of the maximum. The proper setting is 15 to 20 db higher than these peaks.

Reproduce Level Control Calibration

Step 1: As the first 250 cycle tone is reproduced from the standard tape, set the **PLAYBACK LEVEL** control to obtain a +8 dbm (1.95v) reading on the vtm.

Step 2: A reference level 250 cycle tone 10 db below normal operating level follows on the standard tape. If necessary, trim the **PLAYBACK LEVEL** knob so that the vtm reads exactly -2 dbm (.62 v).

FROM THIS POINT ON DO NOT TOUCH ANY ADJUSTMENT CONTROL.

Step 3: Depending on tape speed, tones from 50 cycles to 15,000 cycles now will be reproduced from the standard tape. Check to see that the vtvm readings conform to PERFORMANCE CHARACTERISTICS in SECTION 1. If the performance characteristics are not met, recheck head azimuth alignment.

Reproduce Amplifier Noise Measurement

Step 1: After performing the previous alignment checks, stop the tape motion.

Step 2: Read the stopped tape noise measurement on the vtvm. Noise should be below the level specified in performance characteristics. Inaudible low frequency bounce can cause the meter to read higher than performance characteristics tolerances. Disregard these momentary readings because they are frequencies below the operating range.

Reproduce Amplifier Alignment Using V-u Meter

Step 1: With the POWER switch in the ON position, thread the Ampex standard tape along the prescribed path.

Step 2: Set the EQUALIZATION switch to the desired speed.

Step 3: Place the METER AND OUTPUT SWITCH in the PLAYBACK position.

Step 4: Set the PLAYBACK LEVEL knob to the number 16 calibration.

Step 5: Reproduce the standard tape and as the 10,000 cycle tone is heard, adjust the reproduce head azimuth to obtain a maximum reading on the vu meter using the number 8 (1/4 inch) nut driver. If the PLAYBACK LEVEL control is set too high, back it off.

Step 6: Let the first 250 cycle tone at maximum operating level on the standard tape reproduce without touching the equipment, but note its location on the tape for later use.

Step 7: Wait for the 250 cycle tone 10 db below normal recording level and adjust the PLAYBACK LEVEL knob to obtain a reading of zero on the vu meter.

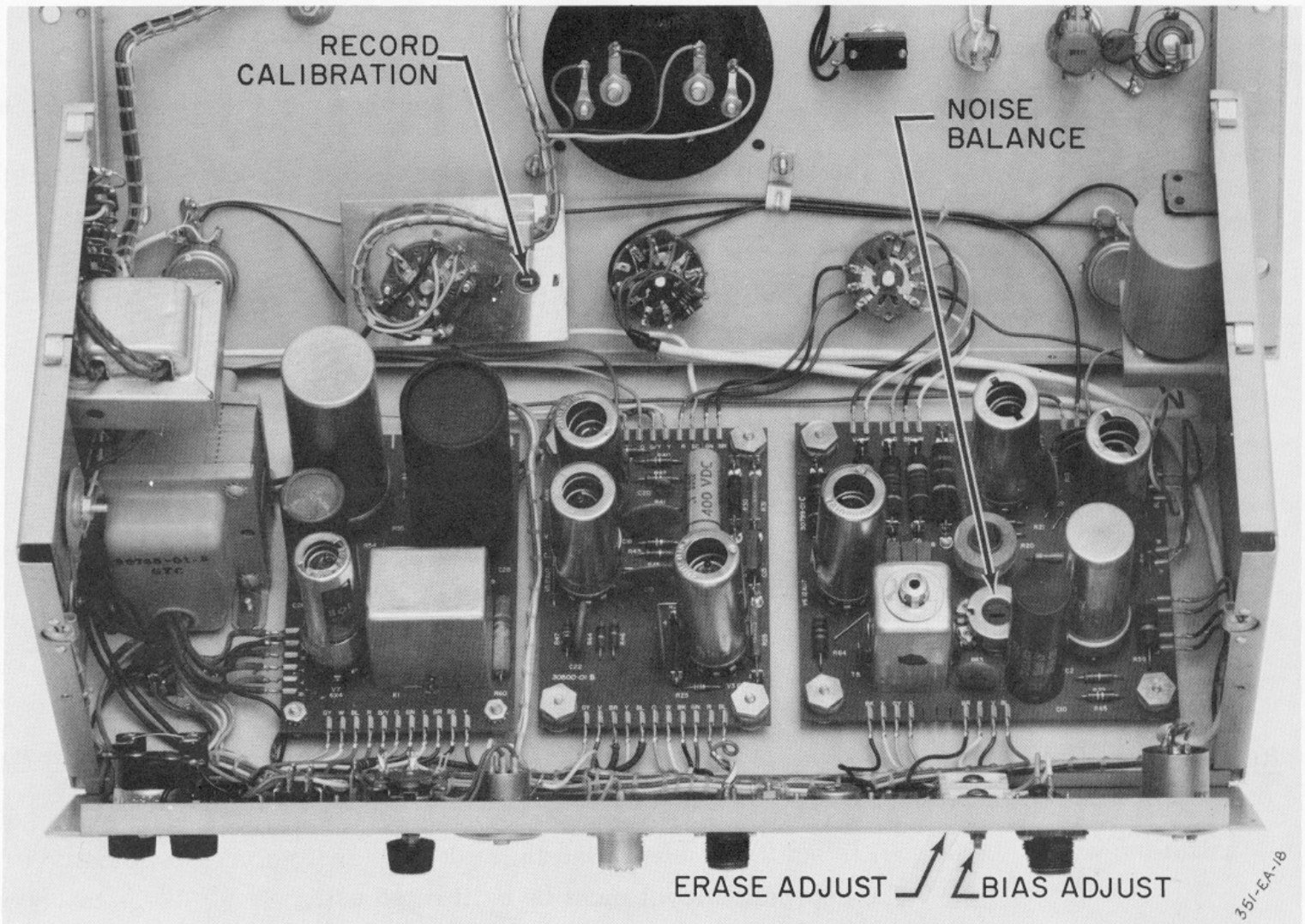
Step 8: Check the frequency response to see that PERFORMANCE CHARACTERISTICS are met.

Step 9: Rewind the standard tape and then reproduce the first 250 cycle tone.

Step 10: Set the PLAYBACK LEVEL knob so that the vu meter reads zero. DO NOT CHANGE THIS SETTING.

Record Amplifier Erase Current Adjustment

- Step 1: After the equipment has been properly installed and connected, and all POWER switches are in the ON position, thread blank tape along the prescribed path.
- Step 2: Place the INPUT TRANSFER SWITCH in the UNBAL BRIDGE position.
- Step 3: Set the METER AND OUTPUT SWITCH to the ERASE function.
- Step 4: Center the noise balance potentiometer. When the user faces the front panel, the slot should parallel the face plate.
- Step 5: Place the equipment in the record mode.
- Step 6: Using a small screwdriver, set the ERASE ADJUST trimmer on the back of the electronic chassis to obtain these vu meter readings at 117 volt ac line voltage:



ADJUSTMENT POINTS FOR RECORD CALIBRATION, NOISE BALANCE, ERASE AND BIAS

Full (Single) Track Equipment

Half Track and Stereophonic Equipment

+1

-1/2

NOTE

Erase current will be directly proportional to line voltage and the vu meter readings will reflect any changes from the 117 volt a-c line voltage.

Record Amplifier Bias Adjustment

NOTE

This adjustment should be made using the brand of tape that normally will be used on the equipment.

- Step 1: Place the METER AND OUTPUT SWITCH in the PLAYBACK position.
- Step 2: Place the equipment in the record mode at the higher of the two tape speeds.
- Step 3: Set the oscillator frequency at 500 cycles per second (cps) and approximately 1 volt for 7-1/2 ips and 1000 cps for 15 ips.

NOTE

Bias is set at a specific wave length. If it is desired to set bias at 15 inch tape speed, use a frequency of 1000 cps.

- Step 4: Place the RECORD LEVEL knob at a position that will obtain an on-scale meter reading.
- Step 5: With a small screwdriver set the BIAS ADJUST trimmer for a maximum reading on the vu meter.

Record Level Calibration

NOTE

The reproduce level must be calibrated using standard tape before calibrating the record level (see Reproduce Level Control Calibration).

- Step 1: Set the audio oscillator to 500 cps. Leave the METER AND OUTPUT SWITCH in the PLAYBACK position.
- Step 2: Set the RECORD LEVEL knob to a position that will obtain a zero reading on the vu meter.
- Step 3: Place the METER AND OUTPUT SWITCH in the RECORD LEVEL position.
- Step 4: Using a long shank screwdriver (to avoid burns from the hot electron tubes), adjust the record level potentiometer for a zero vu reading.

Record Azimuth Adjustment

- Step 1: Set the oscillator to 7,500, 10,000 or 15,000 cycles depending on tape speed.
- Step 2: Place the METER AND OUTPUT SWITCH in the RECORD LEVEL position.
- Step 3: Set the RECORD LEVEL knob to obtain a vu meter reading of approximately -20 (-12 on vtvm).
- Step 4: Place the METER AND OUTPUT SWITCH in the PLAYBACK position.
- Step 5: With the nut driver, rotate the adjustment nut on the left side of the record head (as the user faces the front of the equipment) to obtain a maximum vtvm reading. Several peaks will appear, but the maximum peak is obvious because it is much greater than the minor peaks.

CAUTION

The right hand nuts are factory set. DO NOT ADJUST THEM.

NOTE

If it is desired to make this azimuth adjustment using the vu meter instead of the vtvm, place the PLAYBACK LEVEL control in the full clockwise position and adjust the azimuth nut to obtain a maximum vu meter reading.

Overall Frequency Response

To avoid tape saturation, frequency response at 15 ips tape speed should be made at least 10 db below operating level (-2 dbm); at 3-3/4 and 7-1/2 ips at least 20 db below operating level (-12 dbm).

- Step 1: Place the METER AND OUTPUT SWITCH in the RECORD LEVEL position.

- Step 2: Set the oscillator at 250 cycles and adjust the RECORD LEVEL control to obtain a vtvm reading of approximately -12 dbm (.195v).
- Step 3: Now place the METER AND OUTPUT SWITCH in the PLAYBACK LEVEL position.
- Step 4: Make a response check by sweeping the oscillator through all frequencies from 50 to 15,000 cycles (for 3-3/4 ips up to 7,500 cycles), noting that the response remains within the tolerances specified in SECTION 1 -- PERFORMANCE CHARACTERISTICS.

Because there are variations among tapes of different manufacturers, the high frequency end (10kc) vtvm readings may not conform to tolerances, in which case, proceed as follows:

- Step 1: Set the tape in motion using the tape speed at which flattest response is desired.
- Step 2: Set the audio oscillator at the frequency used for biasing 250 cps 3-3/4 ips, 500 cps 7-1/2 ips, 1000 cps 15 ips. Note the vtvm reading for later reference.
- Step 3: Switch the oscillator to the high end frequency -- 5 kc for 3-3/4 ips, 10 kc for 7-1/2 and 15 ips, and readjust the bias control to bring the equipment within specifications.
- Step 4: Recheck frequency response at the biasing frequency. It should not be more than 1/2 db down from the peak reading noted in Step 2. If it is down more than 1/2 db, over-compensation has been made in Step 3. Repeat the procedure from the beginning.
- Step 5: Check frequency response of the other tape speed.

If tolerances are not met, trouble-shooting is indicated or the tape can be faulty.

Overall Frequency Response Using the V-u Meter

- Step 1: Thread blank tape along the prescribed path.
- Step 2: Place the METER AND OUTPUT SWITCH in the RECORD LEVEL position.
- Step 3: Set the audio oscillator to 250 cps.
- Step 4: Set the record level to approximately -20 reading on the vu meter for 3-3/4 and 7-1/2 ips tape speed, -10 for 15 ips tape speed.
- Step 5: Now place the METER AND OUTPUT SWITCH in the PLAYBACK LEVEL position.

Ampex signal-to-noise ratio specifications on audio instruments define in decibels the ratio existing between the level of a steady 1000 cycle tone, recorded at a level at which distortion produced by the approach of tape saturation equals 3% total rms, and that level of total rms noise, in the band from 30 to 15,000 cycles, which exists in reproduction under the same gain conditions.

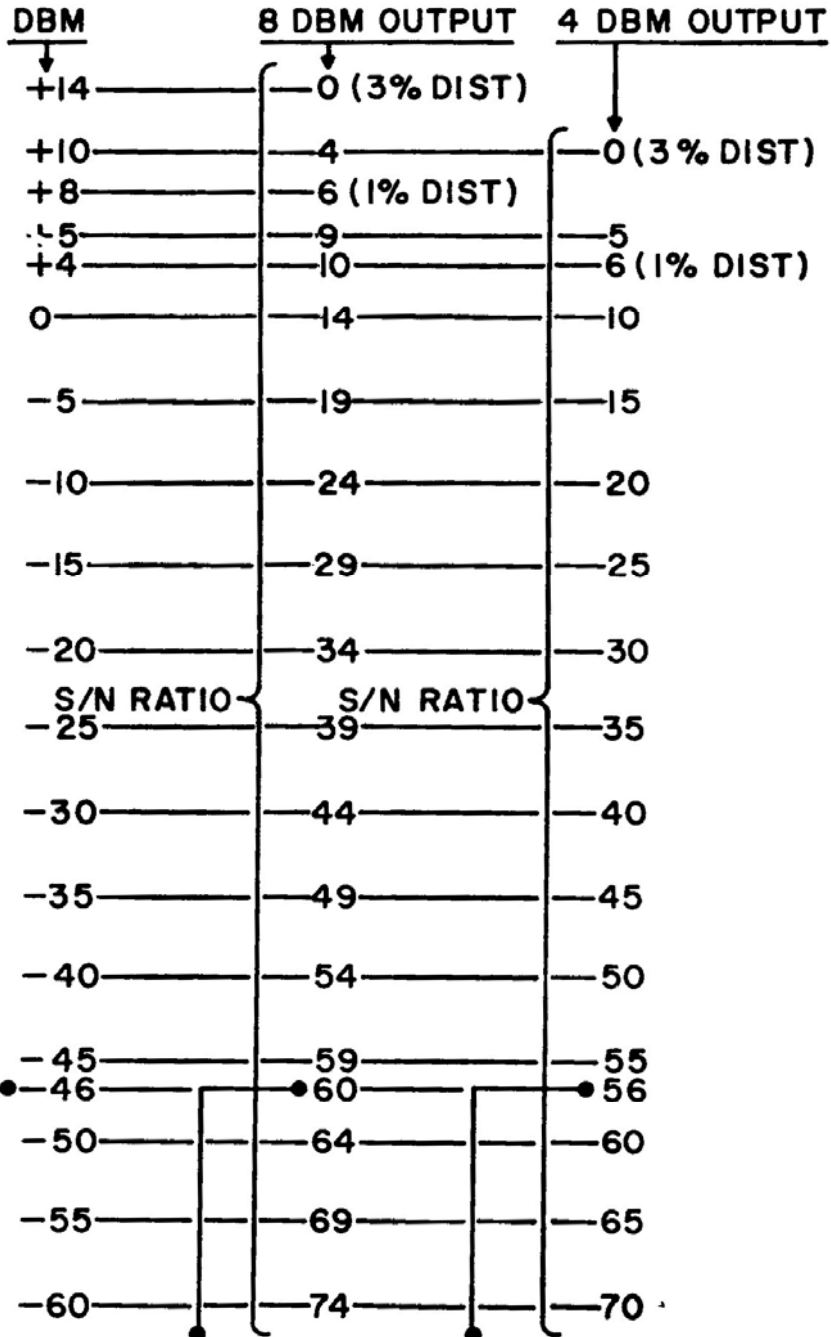
Ampex audio instruments normally are calibrated so that the vu meter reads zero level when reproducing a steady 1000 cycle tone the level of which produces 1% total rms distortion, due to the approach of tape saturation.

A recorded 1000 cycle tone at the 3% distortion level will be 6 db higher in level than a recorded 1000 cycle tape at the 1% level.

Measurement of signal-to-noise ratio must take into account the 6 db difference between the 1% normal calibration level and 3% maximum level. This measurement also must take into account the actual recorder output at an indicated zero on its vu meter scale. Indicated zero can be either +4 dbm (related to 1 mw into 600 ohms) or +8 dbm, at the option of the user. The signal-to-noise ratio will equal the difference between the real level of the 3% distortion 1000-cycle tone, and the real level of noise. A sensitive vtvm, calibrated in dbm relative to 1 mw at 600 ohms, can be used to measure total rms noise. A typical result might be -46 dbm. To compute s/n ratio, this must be compared with the real level of 3% distorted 1000 cycle tone. This would be +4 dbm (if the recorder is so strapped) or +8 dbm plus 6 db (the difference between 1% and 3% level). Thus, if the noise output is -46 dbm, and the machine is calibrated for +8 dbm output at zero indication, the s/n ratio is the difference between +8 dbm +6, or +14 dbm, and -46 dbm, or 60 db s/n ratio.

- Step 1: Place the METER AND OUTPUT SWITCH in the RECORD LEVEL position.
- Step 2: Set the oscillator to 400 cps.
- Step 3: Adjust the RECORD LEVEL control to obtain a vtvm reading 6 db above operating level (+14 dbm for equipment with 8 dbm output).
- Step 4: Record the 400 cps on a section of tape, noting where the recording begins for later reference.
- Step 5: Disconnect the oscillator.
- Step 6: Set the RECORD LEVEL control to zero.
- Step 7: Rewind to the beginning of the 400 cps recording.
- Step 8: Erase the tape by recording with zero signal.
- Step 9: Rewind again to the beginning of the recording.
- Step 10: Read the vtvm and check the reading against the table.

VU METER CALIBRATED SO THAT ZERO EQUALS



WHEN VTVM READS THIS

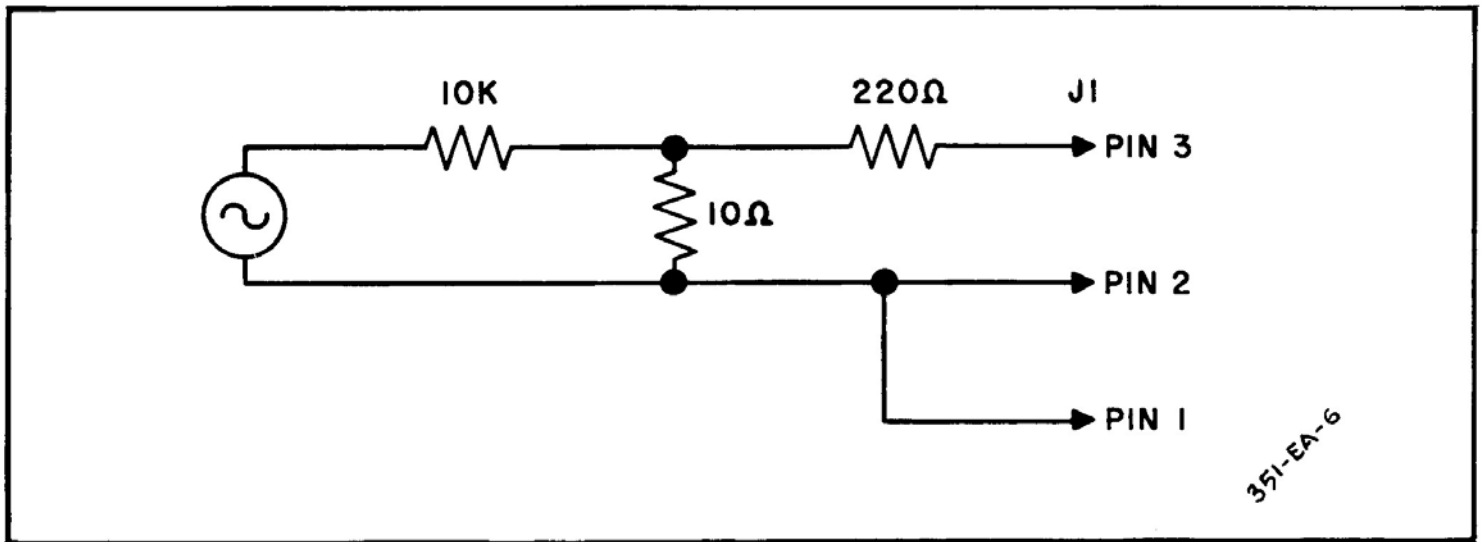
YOUR SIGNAL-TO-NOISE RATIO IN DB IS THIS

351-EA-17

SIGNAL-TO-NOISE RATIO COMPUTATIONS

Microphone Response

Connect an audio oscillator as shown in the illustration and make the response check by sweeping the oscillator through the frequency range to be checked.



MICROPHONE RESPONSE SET-UP

NOTES ON ALIGNING STEREOPHONIC EQUIPMENT

Stereophonic equipment, consisting of two electronic assemblies -- a master and a slave, and two track head assemblies, is aligned in an almost identical fashion to the monaural system by considering and aligning each amplifier separately as in single track operation.

Certain simple differences are outlined for the user's guidance. Before attempting alignment of the two track stereophonic equipment, note the instructions for each category.

Head Azimuth Adjustment

Because there are two heads in each record and reproduce stack, make the azimuth adjustment for an average maximum meter indication, adjusting first one head and then the other, and finally adjusting for the average maximum meter indication.

The vu meter method is handy if two vtvm's are not available.

This compromise azimuth adjustment applies to reproduce and record heads alike. When aligning the record heads, energize the record relays by depressing the record buttons on each electronic assembly.

Record Alignment of Stereophonic Equipment

Treat each amplifier as though aligning for single track operation, and, following the instructions in this section, proceed in this sequence:

1. Center the noise balance (slot parallel to plane of the chassis face panel if it is not within 45° of center position).

2. Set the ERASE ADJUST trimmer for proper indication.

NOTE

When the METER AND OUTPUT SWITCH is in the ERASE position, meter readings must be made with only one amplifier in the record mode because, if both amplifiers are recording, false readings will be taken.

3. Set the BIAS ADJUST trimmer for proper indication.
4. Set the record calibration for proper reading.

Frequency Response

Frequency response checks can be made on both systems simultaneously, using either the vtvm or the vu meter method, or the tracks can be checked individually.

Noise Balance Adjustment

- Step 1: Re-establish the reproduce (PLAYBACK LEVEL) volume control setting of amplifier number one as described under Reproduce Level Control Calibration.
- Step 2: Position the number one amplifier RECORD LEVEL knob at the zero calibration point.
- Step 3: Disconnect any input.
- Step 4: Place amplifier number one ONLY in the record mode.
- Step 5: Plug a set of earphones into the monitor jack and listen for the minimum noise location while adjusting the noise balance control.
- Step 6: Perform steps 1, 2 and 3 on amplifier number two.
- Step 7: Place amplifier number two ONLY in the record mode.
- Step 8: Listen for minimum noise location while adjusting the noise balance control.
- Step 9: Place both amplifiers in the record mode and trim amplifier number one noise balance for minimum noise on amplifier number two.
- Step 10: Now, with both amplifiers still in the record mode, trim amplifier number two noise balance for minimum noise on amplifier number one.

Step 11: Recheck each amplifier for minimum noise while the other amplifier is not recording. Noise balance control slots should be within 45 degrees of a line paralleling the face panel of the chassis.

MAINTENANCE AND TROUBLESHOOTING

General Maintenance Information

Faithful adherence to the recommended ROUTINE MAINTENANCE found in SECTION 4 TAPE TRANSPORT MECHANISM and careful performance checks will insure excellent equipment operation. When the cleaning, lubricating and demagnetizing procedures are followed as prescribed and the system is set up according to the instructions in this manual, equipment performance should meet the high Ampex standards.

Neglect of maintenance procedures, such as failure to clean the capstan, the head faces and the tape guides daily can cause deficiencies that are reflected in the amplifiers. For instance, poor tape-to-head contact, due to tape oxide accumulations, will diminish high end frequency response.

Rewinding or moving the tape in the fast forward mode with the head assembly gate closed eventually will wear grooves in the heads, causing a similar result.

Improper head azimuth adjustment will also affect high frequency response.

When the user suspects amplifier faults, the above information should be considered, and, if satisfied that the cause is in the amplifier, he then can begin troubleshooting.

Progressive Maintenance of the Amplifiers

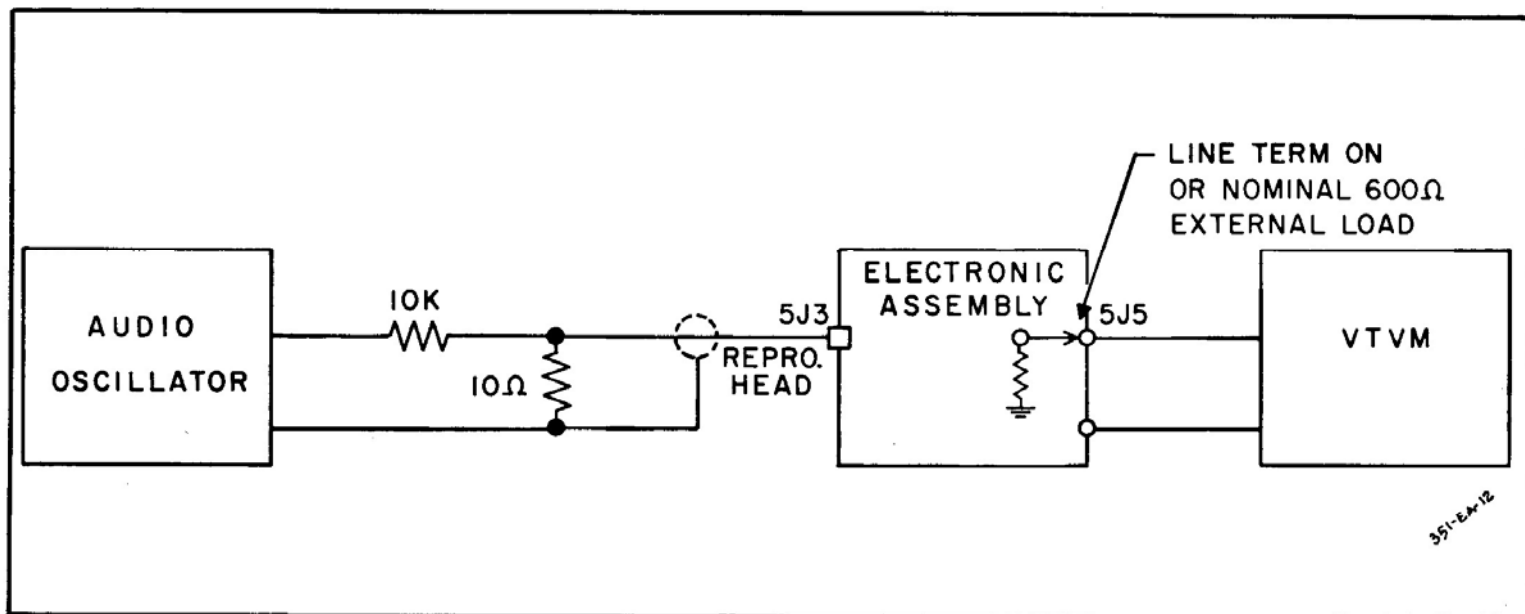
Depending on equipment, check B+ voltage at junction of 3R55 and 3R58 and make a check of tube emission. Make sure tubes are returned to same socket. Check DC filament voltage to note aging of 6CR1. 3R60 may be reduced in value or shorted out as rectifier ages. Clean the relay contacts by inserting a piece of high quality bond paper between contacts and pulling it back and forth several times.

Corrective Maintenance

The first step in any corrective maintenance procedure is localizing the faulty circuit. If a tape recorded on the equipment itself does not reproduce correctly, the trouble can be in either the record or the reproduce circuit. In this case, the faulty circuit can be identified by reproducing a standard alignment tape or a commercially recorded tape; if, while reproducing the standard tape, trouble still exists the fault is in the reproduce circuit, if the reproduce function is normal, the fault is in the record circuit. A run through of the alignment and performance checks for the offending circuit will further isolate the trouble or may rectify it, and the faulty component or mechanical device then should be identified easily.

Troubleshooting the Reproduce Amplifier

A circuit for troubleshooting the reproduce amplifier is shown below (see also, -- PARTS LOCATION POWER SUPPLY AND REPRODUCE AMPLIFIER, and foldout SCHEMATIC DIAGRAM -- ELECTRONIC ASSEMBLIES).



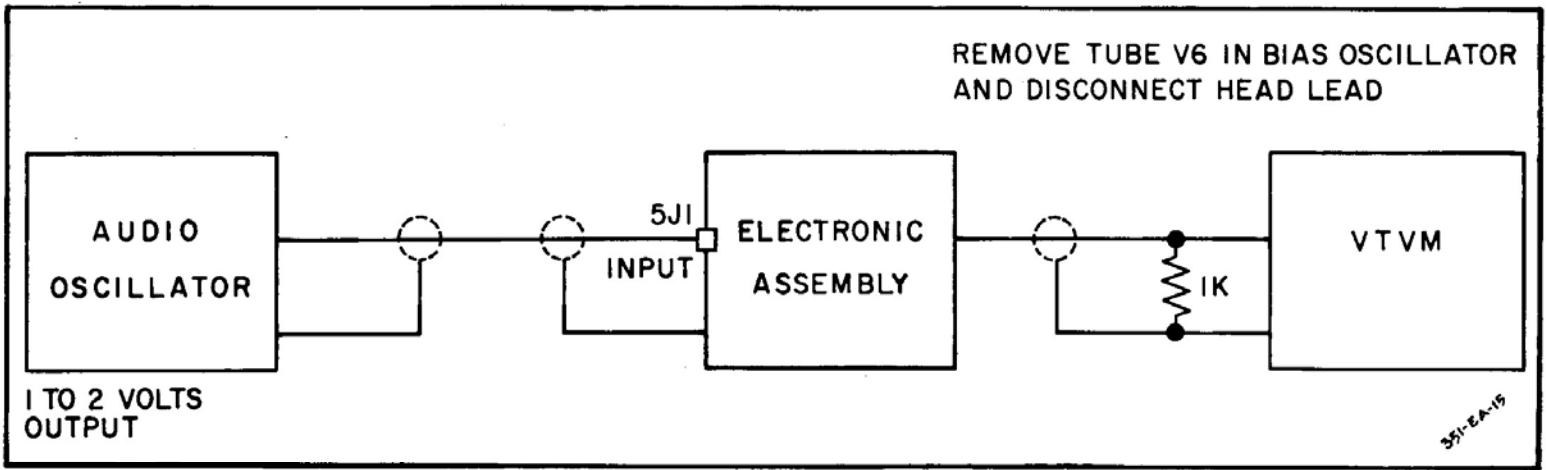
TROUBLESHOOTING THE REPRODUCE AMPLIFIER

Disconnect the head cable at 5J3 when using this circuit. Advance an audio oscillator probe progressively through each stage (checking at the grid and plate of each stage) until the point at which a signal is available at the output. The trouble then could be in the stage immediately preceding that point. When the faulty stage is located, the individual components can be isolated by a check of resistances and voltages. Typical voltage values are shown on the foldout schematic diagram. After the completion of any troubleshooting procedures, using the circuit shown above, check the reproduce amplifier response against the appropriate curve to insure that the equipment conforms to performance characteristics.

Troubleshooting the Record Amplifier

The circuit for troubleshooting the record amplifier is shown below (see also PARTS LOCATION RECORD AMPLIFIER, BIAS AND ERASE OSCILLATOR and foldout SCHEMATIC DIAGRAM -- ELECTRONIC ASSEMBLIES).

Proceed as in troubleshooting the reproduce amplifier. Typical voltage readings are shown on the foldout schematic diagram. Using the circuit below, check the record amplifier against the appropriate response curve. Remove tube 1V6, and disconnect the record head lead before checking amplifier response.



Servicing and Repairing Printed Circuits

Because of the uniform wiring layout and translucent boards, printed circuits can be traced more easily than conventional circuits, troubleshooting is less difficult, and any qualified person will be able to service and repair the equipment including replacement of components by following the instructions, suggestions and procedures in this section. The translucency of the board makes locating connections and test points easier if a light bulb is placed underneath the circuit to be traced. Continuity checks and measurement of resistors, coils and some types of capacitors can be made at the component side of the etched board. Very small breaks in wiring can be located by means of a magnifying glass. The parts location illustrations and the schematic diagram in this section can be used to advantage when tracing circuitry, especially where tube sockets are concerned. Pin numbers are plainly marked.

Equipment and Tools Required

- Diagonal cutters
- Long-nosed pliers
- Pocket knife
- 1/4-inch nut driver
- Solder pick
- Small wire brush
- Pencil soldering iron
- 60/40 resin core solder

Precautions

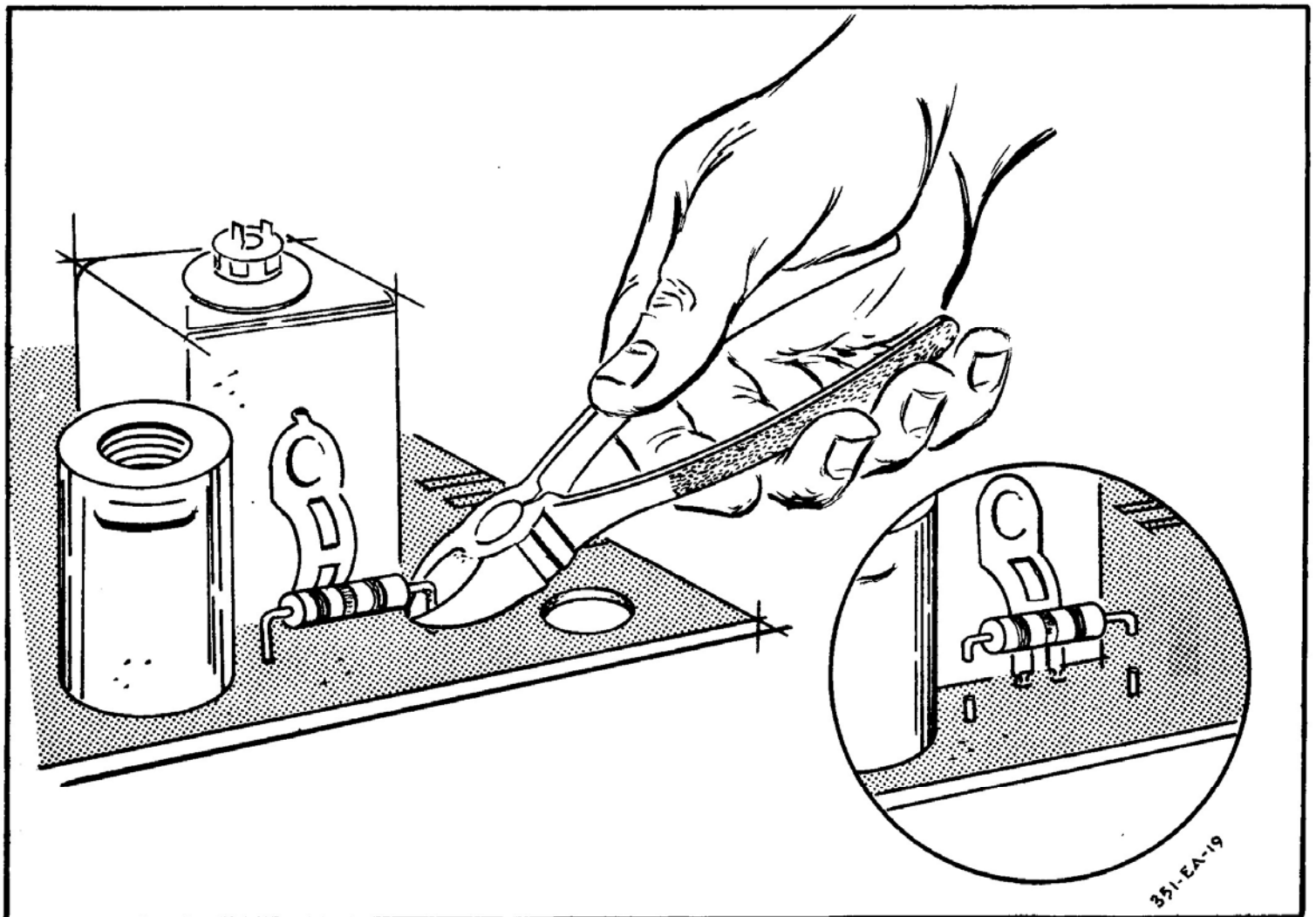
Be careful when removing components from the board to avoid damaging the components themselves or the copper foil wiring. If damage occurs, small breaks can be joined with solder, new foil can be cut to simulate the damaged sections, and large breaks can be repaired with hook-up wire. When applying new foil, first remove all coatings such as flux, grease and wax from the damaged portion and place the adhesive side of the foil toward the board. With the tip of the smooth wedge-shaped soldering iron heat the new foil, sliding the tip slowly along the copper surface for about a minute to cure the bond.

Excessive pressure can crack the boards. Access to certain components may not be possible when the boards are in the chassis. To remove the board from the chassis, remove the four mounting nuts carefully. When disconnecting the edge-on harness connectors, make certain that the diagonal pliers grasping the individual connector will not strike and break an adjacent component. To prevent this type of damage, insert a screw driver or similar protective device between the diagonal pliers and the vulnerable component. A vise with protected jaws can be used to hold the boards while servicing. Avoid excessive pressure against the boards when using the vise.

Another source of damage can come from overheating during the soldering process. Excessive heat can cause breaks in the bond between the board and foil, necessitating costly repair of the foil connections. Use 60/40 resin core solder, the melting point of which is 375 degrees F. Some soldering irons are available with tip temperature of 650 degrees F., but the more skilled repair man can speed up the soldering process by using an iron with a tip temperature in the neighborhood of 750 degrees F.

Removing a Resistor

A convenient method of removing resistors is to clip the leads with cutters, leaving sufficient wire at each point so that wiring terminals remain. New components can be soldered to these remnant leads.



REMOVING RESISTOR

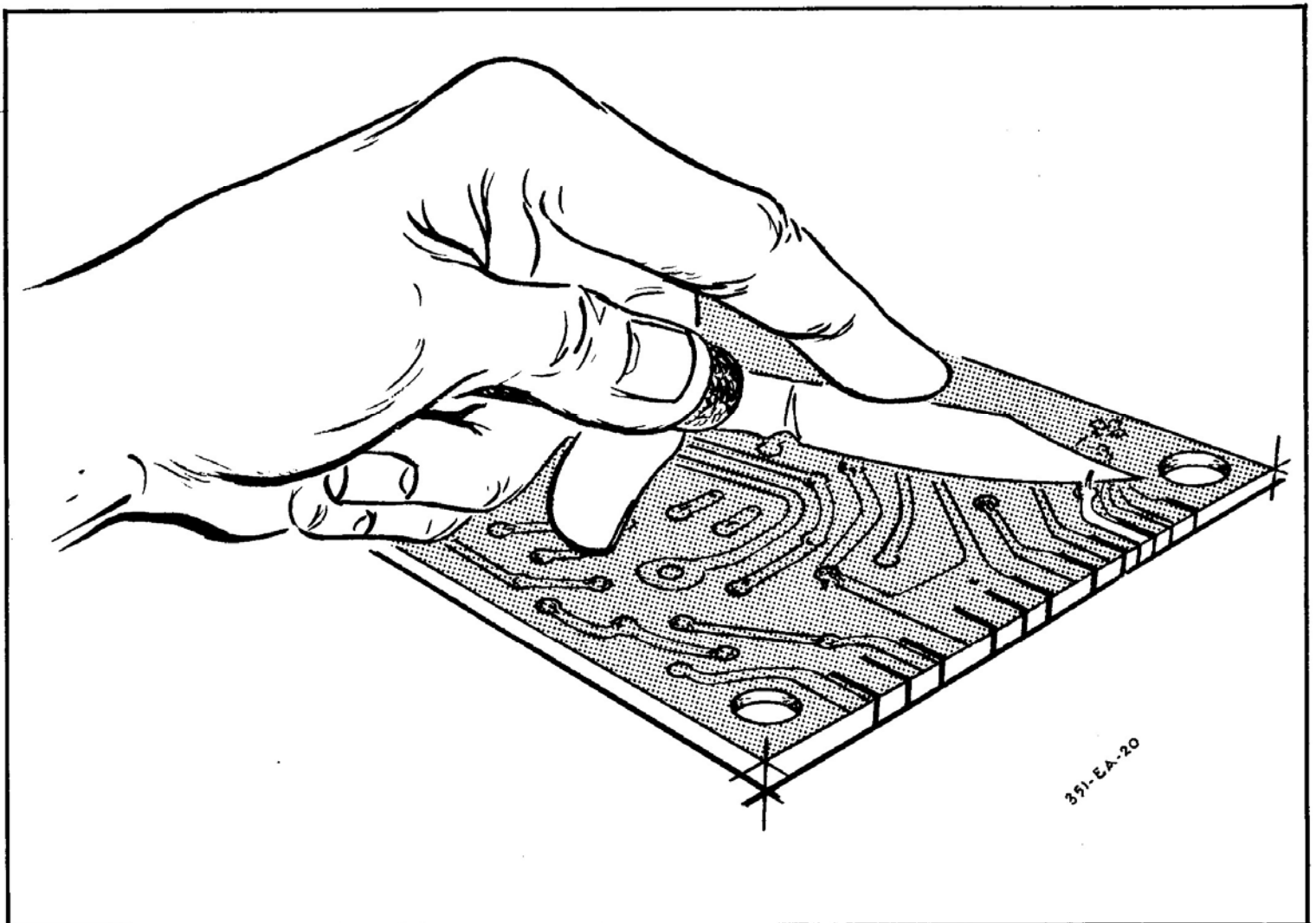
Replacing the Resistor

Make mechanical joints by wrapping a turn of each new resistor wire around the remnant wires left from the old component. Perform the soldering quickly and efficiently.

Solder Method of Removing and Replacing Components

On the wiring side of the board at the component to be replaced, heat the connections with an iron until the solder melts. Quickly remove the iron and brush away the solder using the wire brush. Two or more heating passes may be required; but take special care to avoid excessive heat.

Now the mechanical joint will be revealed. Insert a knife blade between the board and the exposed wire, and carefully raise the wire until it is perpendicular to the board and will come free in the next step. Again apply the soldering iron to the connection point while simultaneously moving the lead back and forth until it breaks free of the molten solder.



RELIEVING MECHANICAL JOINT OF COMPONENT

Take the replacement component, cut the leads to the desired length, insert them into the holes, bending the leads against the board to make mechanical connections, and solder the connections.

Replacing Electrolytic Capacitors, Relays and Coils

The replacement of these types of components can be accomplished as follows:

- Step 1: With the soldering iron, heat each connection and brush away melted solder. Some parts may require prying the mounting lugs perpendicular to the board in order to brush away the melted solder.
- Step 2: Trim the lugs as close as possible to the board.
- Step 3: Again apply the soldering iron to the connections, brush away the melted solder.
- Step 4: Insert replacement component and solder the connections.

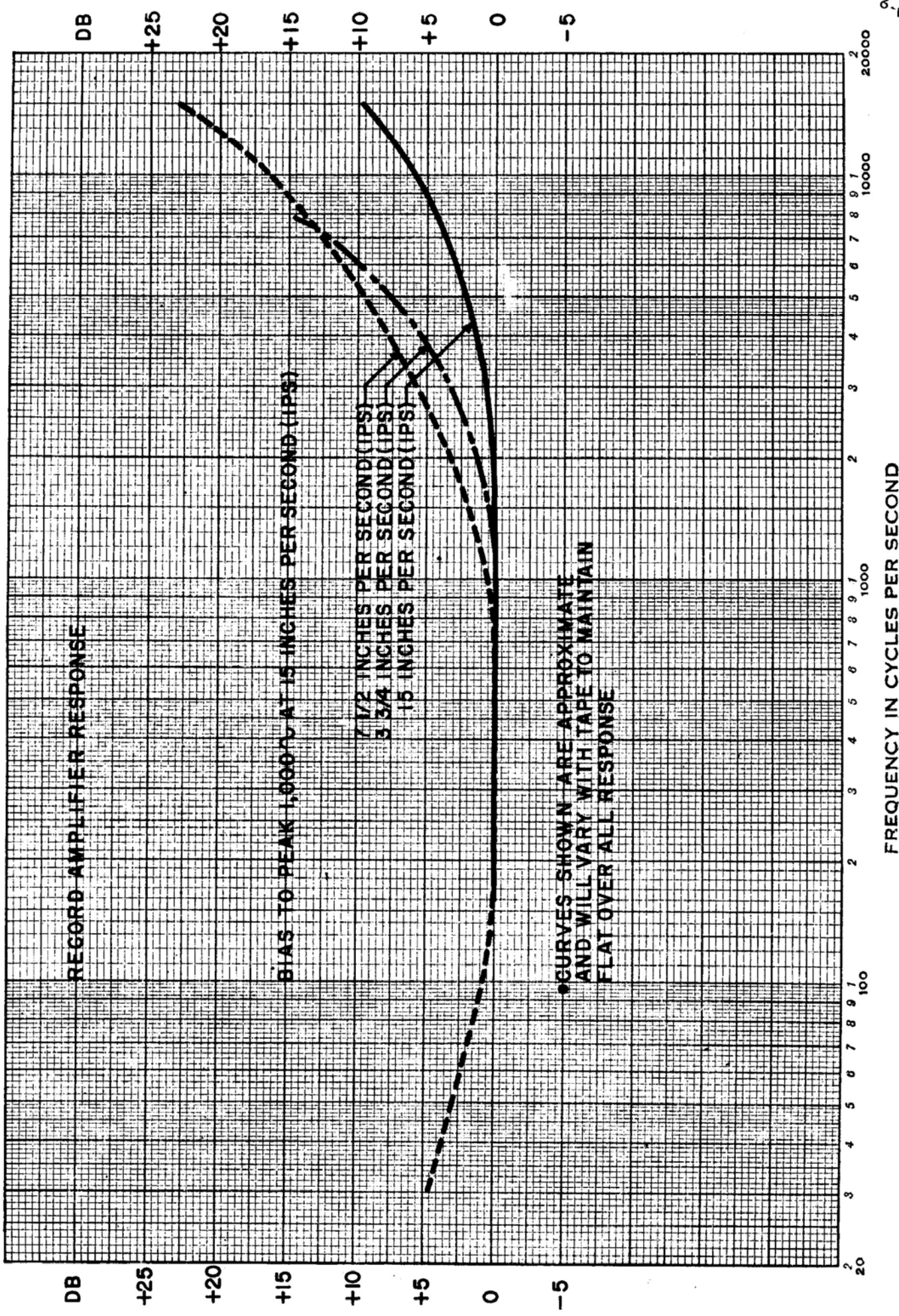
Replacing of Tube Sockets

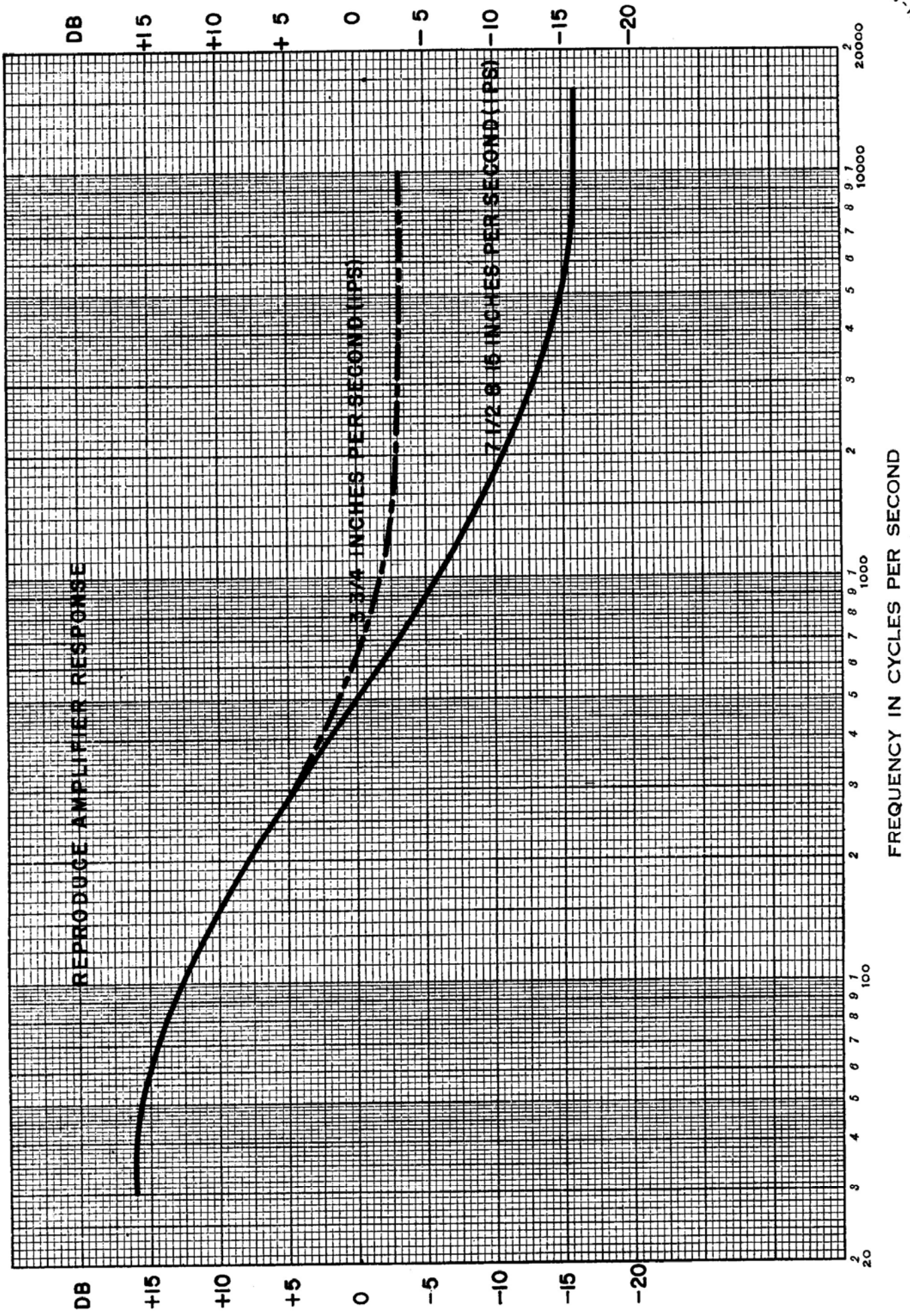
- Step 1: With the soldering iron, heat each connection and brush away melted solder. If the connections do not come free on the first pass, repeat the heating process until connections are broken.
- Step 2: With a pen knife inserted between the socket lug and wiring foil, bend each lug upward - except the grounding lug.
- Step 3: When all socket lugs have been freed from the wiring foil, heat the grounding lug until the solder melts and slowly pull the socket away from the board.

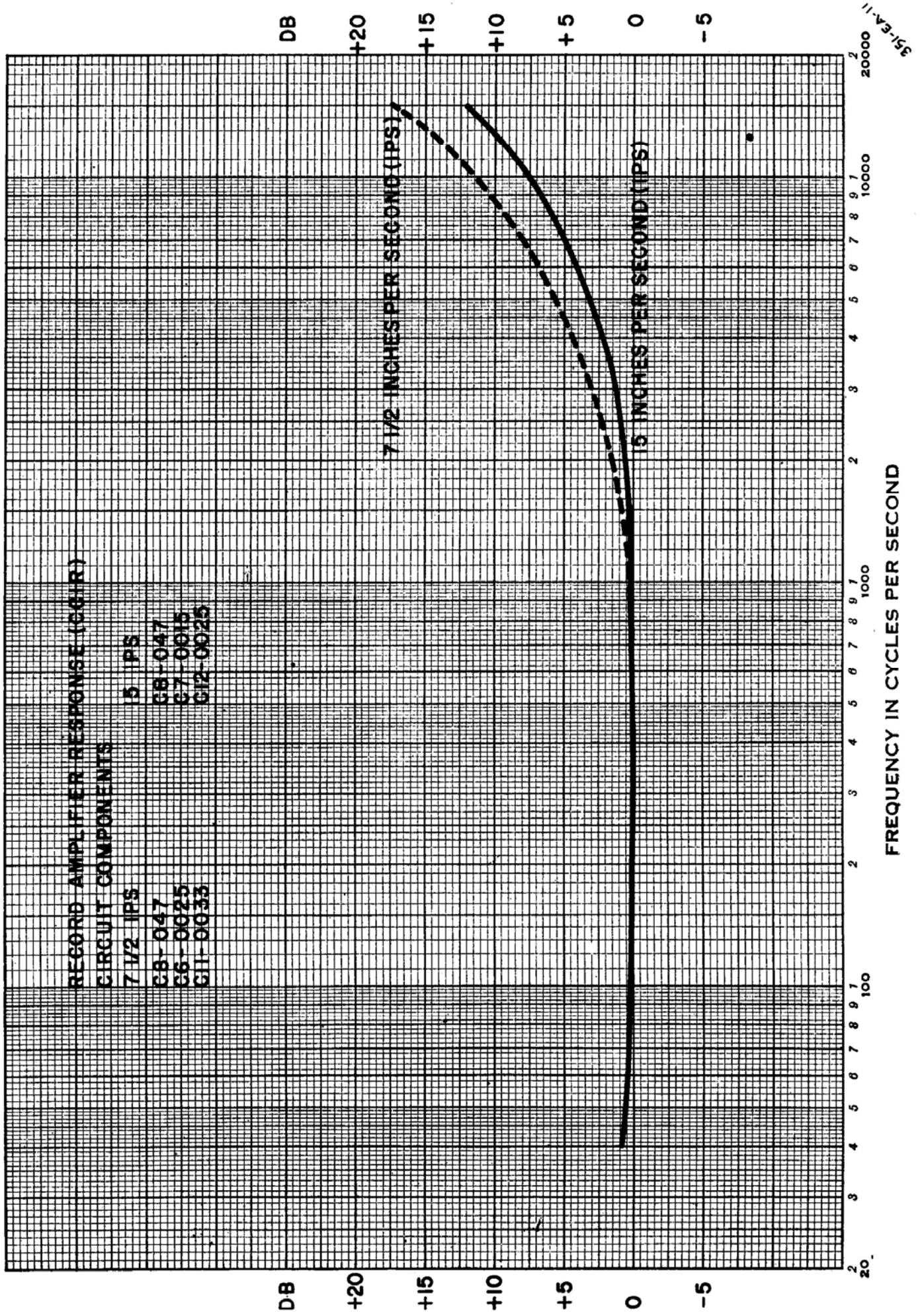
ORDERING PARTS

The purpose of the parts list is to aid you in ordering replacement parts. Ampex can offer fast and efficient service in providing normally replaceable parts of the components in the system when proper information is furnished. Parts are listed according to the schematic reference symbol, a description of the part and the Ampex part number. The Ampex Corporation offers some replacement parts that are not necessarily exact replicas of those used on the original version of the equipment; but these parts are interchangeable with the original parts. The description column names the part, its composition, electrical value and manufacturer's number (or military specification when available) -- and the AMPEX PART NUMBER.

Ampex part numbers are the exact designation for all parts used in Ampex equipment. For example, CAPACITOR, fixed: ceramic, .02 uf + 80% - 20%, 500 vdcw; Sprague Part No. 36C205 will always bear the Ampex catalog number 030-059. THIS IS THE NUMBER YOU SHOULD USE WHEN ORDERING REPLACEMENT PARTS. The schematic reference number should NOT be used for ordering purposes as it will vary with different equipment types. Include the following information when ordering parts: Equipment Type, Equipment Serial Number, Ampex Part Number, Description of Part. Example: 4-030-059 capacitors for Series 351.







DB +20 +15 +10 +5 0 -5 -10 -15 -20

REPRODUCE AMPLIFIER RESPONSE (GGIR)
 CIRCUIT COMPONENTS
 7 1/2 IPS
 C15-0015
 R30-58K
 R29-(OUT)

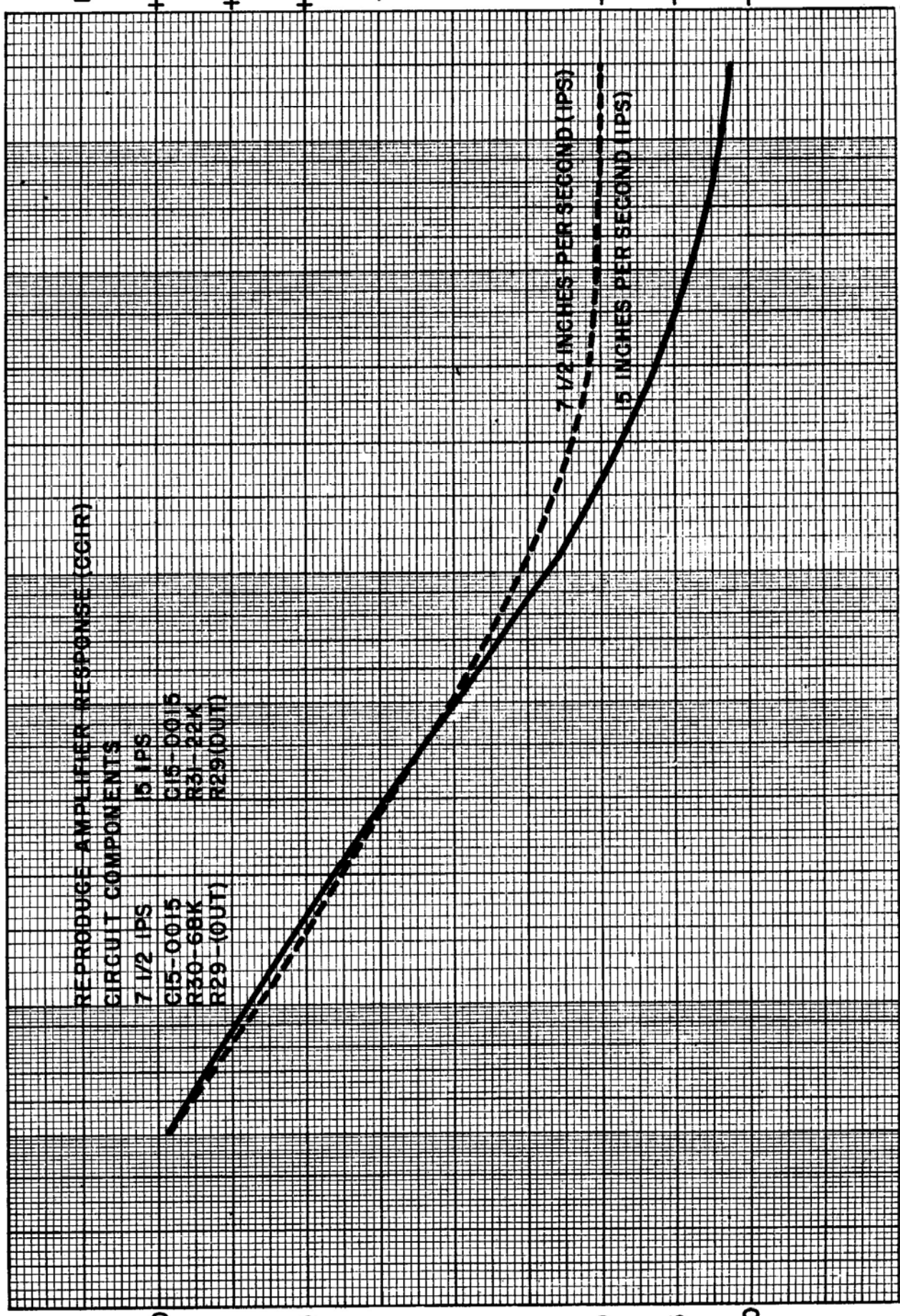
15 IPS
 C15-0015
 R31-22K
 R29(DUT)

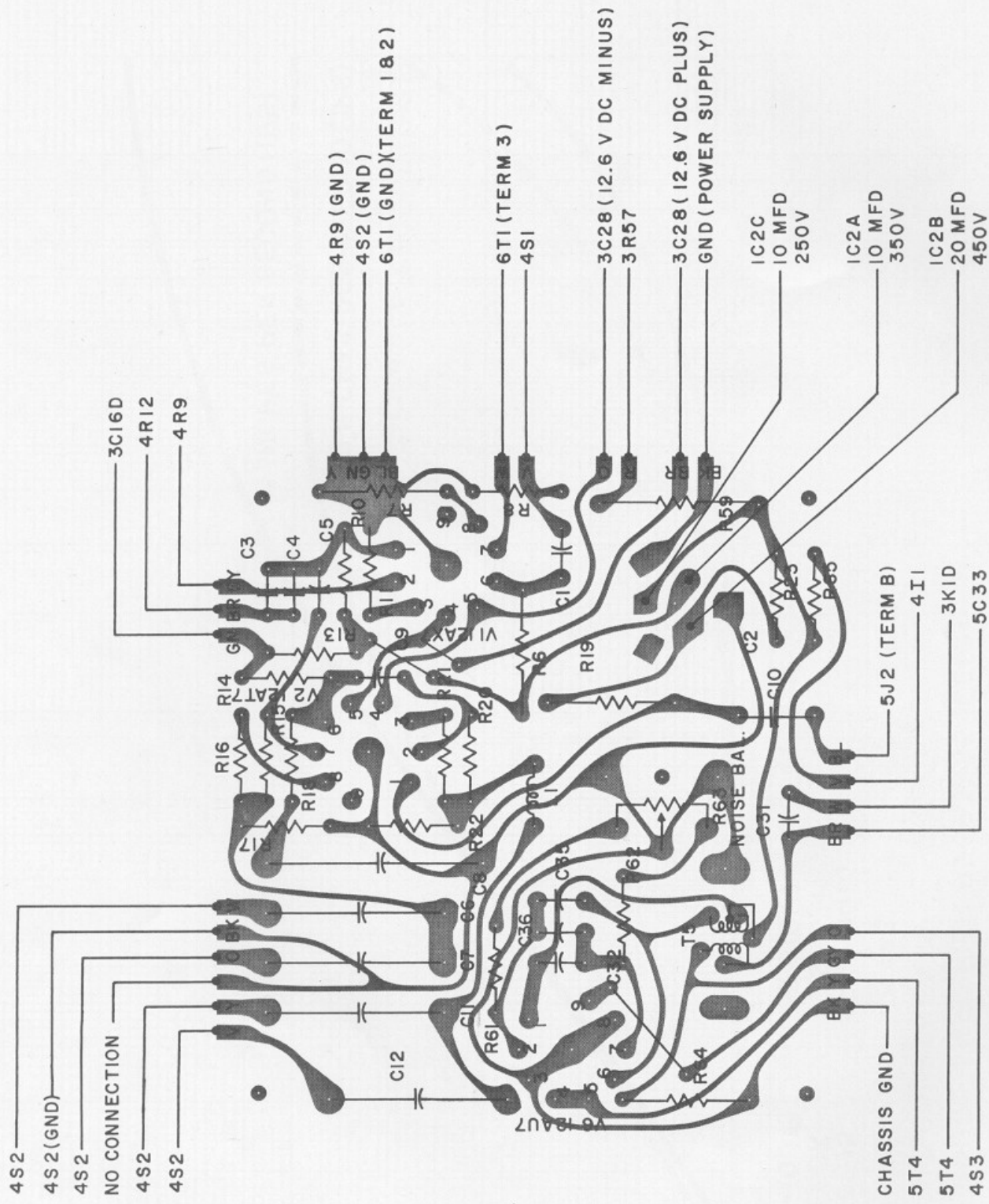
7 1/2 INCHES PER SECOND (IPS)
 15 INCHES PER SECOND (IPS)

FREQUENCY IN CYCLES PER SECOND

DB +20 +15 +10 +5 0 -5 -10 -15 -20

20 100 1000 20000





LEGEND

- THE FIRST NUMBERS SIGNIFY THE LOCATION.
- 1. RECORD AMPLIFIER BOARD.
 - 2. REPRODUCE AMP. BOARD.
 - 3. POWER SUPPLY BOARD.
 - 4. FRONT PANEL OF AMP. CHASSIS.
 - 5. BACK PANEL OF AMP. CHASSIS.
 - 6. SIDES AND BOTTOM.

ELECTRONIC ASSEMBLY, PARTS LIST

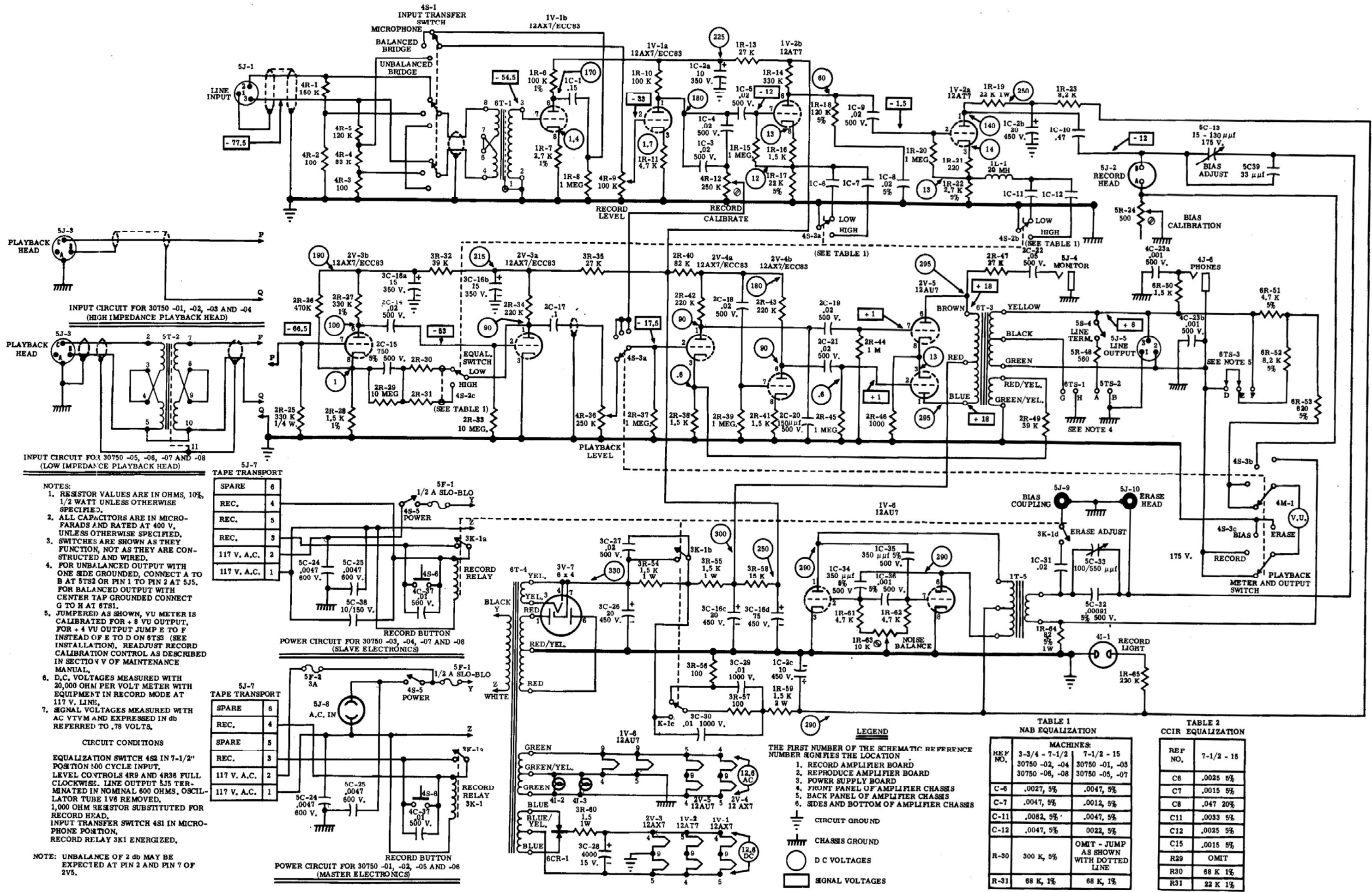
REF. NO.	PART DESCRIPTION	AMPEX PART NO.
351 SERIES COMPLETE EQUIPMENT		
	Rack Mount, 7-1/2 - 15 ips, Full Track, 60 Cycle Power	30700-01
	Rack Mount, 7-1/2 - 15 ips, Full Track, 50 Cycle Power	30700-02
	Rack Mount, 7-1/2 - 15 ips, Half Track, 60 Cycle Power	30700-07
	Rack Mount, 7-1/2 - 15 ips, Half Track, 50 Cycle Power	30700-08
	Rack Mount, 3-3/4 - 7-1/2 ips, Full Track, 60 Cycle Power	30700-13
	Rack Mount, 3-3/4 - 7-1/2 ips, Full Track, 50 Cycle Power	30700-14
	Rack Mount, 3-3/4 - 7-1/2 ips, Half Track, 60 Cycle Power	30700-19
	Rack Mount, 3-3/4 - 7-1/2 ips, Half Track, 50 Cycle Power	30700-20
	Console, 7-1/2 - 15 ips, Full Track, 60 Cycle Power	30700-03
	Console, 7-1/2 - 15 ips, Full Track, 50 Cycle Power	30700-04
	Console, 7-1/2 - 15 ips, Half Track, 60 Cycle Power	30700-09
	Console, 7-1/2 - 15 ips, Half Track, 50 Cycle Power	30700-10
	Console, 3-3/4 - 7-1/2 ips, Full Track, 60 Cycle Power	30700-15
	Console, 3-3/4 - 7-1/2 ips, Full Track, 50 Cycle Power	30700-16
	Console, 3-3/4 - 7-1/2 ips, Half Track, 60 Cycle Power	30700-21
	Console, 3-3/4 - 7-1/2 ips, Half Track, 50 Cycle Power	30700-22
	2 Case Portable, 7-1/2 - 15 ips, Full Track, 60 Cycle Power	30700-05
	2 Case Portable, 7-1/2 - 15 ips, Full Track, 50 Cycle Power	30700-06
	2 Case Portable, 7-1/2 - 15 ips, Half Track, 60 Cycle Power	30700-11
	2 Case Portable, 7-1/2 - 15 ips, Half Track, 50 Cycle Power	30700-12
	2 Case Portable, 3-3/4 - 7-1/2 ips, Full Track, 60 Cycle Power	30700-17
	2 Case Portable, 3-3/4 - 7-1/2 ips, Full Track, 50 Cycle Power	30700-18
	2 Case Portable, 3-3/4 - 7-1/2 ips, Half Track, 60 Cycle Power	30700-23
	2 Case Portable, 3-3/4 - 7-1/2 ips, Half Track, 50 Cycle Power	30700-24
351-2 EQUIPMENT		
	Rack Mount, 7-1/2 - 15 ips, 60 Cycle Power	30810-01
	Rack Mount, 7-1/2 - 15 ips, 50 Cycle Power	30810-02
	Rack Mount, 3-3/4 - 7-1/2 ips, 60 Cycle Power	30810-05
	Rack Mount, 3-3/4 - 7-1/2 ips, 50 Cycle Power	30810-06
	2 Case Portable, 7-1/2 - 15 ips, 60 Cycle Power	30810-03
	2 Case Portable, 7-1/2 - 15 ips, 50 Cycle Power	30810-04
	2 Case Portable, 3-3/4 - 7-1/2 ips, 60 Cycle Power	30810-07
	2 Case Portable, 3-3/4 - 7-1/2 ips, 50 Cycle Power	30810-08
The prefix number of the following component reference symbols designates physical location (see LEGEND on the schematic diagram).		
1C1	CAPACITOR, fixed: paper, .15 uf ± 20%, 400 vdcw; C.D. Part No. BC4P15±20%	035-205
1C2	CAPACITOR: electrolytic -- 10 uf, 450 volt; 20 uf, 450 volt; 10 uf, 350 volt --	30770-01
1C3	CAPACITOR, fixed: ceramic, .02 uf +80% -20%, 500 vdcw; Sprague Part No. 36C205	030-059
1C4	Same as C3	
1C5	Same as C3	
1C6	CAPACITOR, fixed: paper, .0047 uf ± 5%, 400 vdcw; C.D. Part No. ST4D47 Used in 7-1/2 - 15 ips Equipment	035-026
1C6	CAPACITOR, fixed: paper, .0027 uf ± 5%, 400 vdcw; Sprague Part No. 109P27254 Used in 3-3/4 - 7-1/2 ips Equipment	035-238
1C7	CAPACITOR, fixed: paper, .0012 uf ± 5%, 400 vdcw; Sprague Part No. 109P12254 Used in 7-1/2 - 15 ips Equipment	035-203
1C7	Same as C6 (.0047) Used in 3-3/4 - 7-1/2 ips Equipment	
1C8	CAPACITOR, fixed: paper, .02 uf ± 5%, 400 vdcw; C.D. Part No. Type FJ	035-020
1C9	Same as C3	
1C10	CAPACITOR, fixed: paper, .47 uf ± 20%, 400 vdcw; C.D. Part No. BC4P47±20%	035-206
1C11	Same as C6 (.0047) Used in 7-1/2 - 15 ips Equipment	
1C11	CAPACITOR, fixed: paper, .0082 uf ± 5%, 200 vdcw; C.D. Part No. 109P Used in 3-3/4 - 7-1/2 ips Equipment	035-030
1C12	CAPACITOR, fixed: paper, .0022 uf ± 5%, 400 vdcw; Sprague Part No. 109P22254 Used in 7-1/2 - 15 ips Equipment	035-204
1C12	Same as C6 (.0047) Used in 3-3/4 - 7-1/2 ips Equipment	
5C13	CAPACITOR, variable: mica, 15-130 uuf, 175 vdcw; El Menco Part No. 302 (type 30)	038-002
2C14	Same as C3	

REF. NO.	PART DESCRIPTION	AMPEX PART NO.
2C15	CAPACITOR, fixed: mica, 760 uuf ± 5%, 500 vdcw; El Menco Part No. CM20C751J	034-144
3C16	CAPACITOR: electrolytic -- 15 uf, 350 volt; 15 uf, 350 volt; 75 uf, 450 volt; 20 uf, 450 volt --	30769-02
2C17	CAPACITOR, fixed: paper, .1 uf ± 20%, 400 vdcw; CDST4P1(20%)	035-069
2C18	Same as C3	
2C19	Same as C3	
2C20	CAPACITOR, fixed: ceramic, 150 uuf, ± 20%, 500 vdcw; Sprague Part No. 40C218	030-048
2C21	Same as C3	
2C22	CAPACITOR, fixed: ceramic, .05 uf +80% -20%, 500 vdcw; Sprague Part No. 5HK-S5	030-031
4C23	CAPACITOR, fixed: ceramic, 2 x .001 uf, 500 vdcw; Erie Part No. 612-.001	030-004
5C24	CAPACITOR, fixed: ceramic, .0047 uf, ± 2%, 500 vdcw; JAN-C-20A: CC36CH470G	035-028
5C25	Same as C24	
3C26	CAPACITOR, fixed: electrolytic, 20 uf, 450 vdcw; C.D. Part No. BR10422	031-144
3C27	Same as C3	
3C28	CAPACITOR: electrolytic, 4000 uf, 15 volt	30769-01
3C29	CAPACITOR, fixed: ceramic, .01 uf, ± 20%, 1000 vdcw; Sprague Part No. 33C35A	030-045
3C30	Same as C29	
1C31	Same as C3	
5C32	CAPACITOR, fixed: mica, 910 uuf, ± 5%, 500 vdcw; C.D. Part No. 5A5T91	034-145
5C33	CAPACITOR, variable: mica, 100-550 uuf, 175 vdcw; El Menco Part No. 304 Type 30	038-009
1C34	CAPACITOR, fixed: mica, 350 uuf, ± 5%, 500 vdcw; C.D. Part No. 5A5T35	034-146
1C35	Same as C34	
1C36	CAPACITOR, fixed: mica, .001 uf ± 5%, 500 vdcw; C.D. Part No. 5A5T35	034-147
4C37	CAPACITOR, fixed: ceramic, .01 uf, 500 vdcw; Erie Part No. 811-.01	030-002
5C38	CAPACITOR, electrolytic: 10 uf, 150 vdcw; C.D. Part No. BBR-10-150	031-157
5C39	CAPACITOR, fixed: mica, 33 uuf, 500 vdcw; 5%; C.D. Part No. 22A5233	034-168
6CR1	RECTIFIER, selenium: single phase, center tap, 25 volt ac rms max. in -- 1.26 amp dc max. out; G.E. Part No. 6RS5WH5	581-001
5F1	FUSE: 1/2 amp, 250 volt, slow blow; Littlefuse Part No. 313.500	070-026
5F2	FUSE: 3 amp, 250 volt, fast blow; Littlefuse Part No. 312003 Master only	070-001
4I1	POST LIGHT: 1/4 watt neon without internal resistor; Drake Mfg. Part No. 105	132-003
5J1	CONNECTOR, receptacle: female, 3 contact; Cannon Part No. XL-3-13	146-007
5J2	CONNECTOR, receptacle: male, 2 contact; AN3102A-10SL-4P	143-009
5J3	CONNECTOR, receptacle: male, 3 contact; AN3102A-10S-3P	143-008
5J4	PHONE JACK, open circuit type, 2 conductor; Switchcraft Part No. 11	148-015
5J5	CONNECTOR, receptacle: male, 3 contact; Cannon Part No. XL-3-14	147-004
4J6	Same as J4	
5J7	CONNECTOR, receptacle: female, 6 contact; Jones Part No. S-306-AB Master only	146-004
5J7	CONNECTOR, receptacle: male, 6 contact; Jones Part No. P-306-AB Slave only	147-011
5J8	CONNECTOR, receptacle: male, 2 contact; Hubbel Part No. 7466 Master only	147-013
5J9	CONNECTOR, receptacle: female, 1 contact; Amphenol Part No. 83-1R	146-067
5J10	CONNECTOR, receptacle: male, 1 contact; AN3102A-10S-2P	143-010
3K1	RELAY, record: 115v dc	30763-01
1L1	CHOKE, rf: 20 mh, 125 ma	30767-01

REF. NO.	PART DESCRIPTION	AMPEX PART NO.
4M1	METER, vu: frosted lamps 6.3 volt, .3 amp	30667-01
4R1	RESISTOR, fixed: composition, .15 meg, 1/2 watt; MIL-R-11A, RC20GF154K	041-074
4R2	RESISTOR, fixed: carbon, 100 ohm, 1/2 watt, 10%; MIL-R-11A, RC20GF101K	041-038
4R3	Same as R2	
4R4	RESISTOR, fixed: carbon, 33K ohm, 1/2 watt, 10%; MIL-R-11A, RC20GF333K	041-066
4R5	RESISTOR, fixed: carbon, .12 meg, 1/2 watt, 10%; MIL-R-11A, RC20GF124K	041-073
1R6	RESISTOR, fixed: film, .1 meg ± 1%, 1/2 watt; Electra Part No. Type DC-1/2	042-092
1R7	RESISTOR, fixed: film, 2700 ohm, 1/2 watt, 10%; MIL-R-10509A, RN15R2701F	042-123
1R8	RESISTOR, fixed: composition, 1 meg, 1/2 watt; MIL-R-11A, RC20GF105K	041-031
4R9	RESISTOR, variable: composition, .1 meg, 2 watts; AB Part No. JA1041	044-015
1R10	RESISTOR, fixed: composition, .1 meg, 1/2 watt; MIL-R-11A, RC20GF104K	041-072
1R11	RESISTOR, fixed: carbon, 4700 ohm, 1/2 watt, 10%; MIL-R-11A, RC20GF472K	041-066
4R12	RESISTOR, variable: carbon, .25 meg, 1/4 watt, 20%; CTS Part No. type PM-45	044-179
1R13	RESISTOR, fixed: carbon, 27K ohm, 1/2 watt, 10%; MIL-R-11A, RC20GF273K	041-065
1R14	RESISTOR, fixed: composition, .33 meg, 1/2 watt; MIL-R-11A, RC20GF334K	041-078
1R15	Same as R8	
1R16	RESISTOR, fixed: composition, 1500 ohm, 1/2 watt; MIL-R-11A, RC20GF152K	041-050
1R17	RESISTOR, fixed: carbon, 22K ohm, 1/2 watt, 5%; MIL-R-11A, RC20GF223J	041-016
1R18	RESISTOR, fixed: carbon, .12 meg, 1/2 watt, 5%; MIL-R-11A, RC20GF124J	041-318
1R19	RESISTOR, fixed: carbon, 22K ohm, 1 watt, 10%; MIL-R-11A, RC32GF223K124J	041-162
1R20	Same as R8	
1R21	RESISTOR, fixed: carbon, 220 ohm, 1/2 watt, 10%; MIL-R-11A, RC20GF221K	041-040
1R22	RESISTOR, fixed: carbon, 2700 ohm, 1/2 watt, 5%; MIL-R-11A, RC20GF272J	041-278
1R23	RESISTOR, fixed: carbon, 8200 ohm, 1/2 watt, 10%; MIL-R-11A, RC20GF822K	041-059
5R24	RESISTOR, variable: wirewound, 500 ohm, 2 watts, 20%; Claro Part No. 39-500	044-178
2R25	RESISTOR, fixed: carbon, .33 meg, 1/4 watt, 10%; Allen Bradley Part No. Type CB	041-325
2R26	RESISTOR, fixed: carbon, .47 meg, 1/2 watt, 10%; MIL-R-11A, RC20GF474K	041-080
2R27	RESISTOR, fixed: film, .33 meg ± 1%, 1/2 watt; Electra Part No. Type DC-1/2	042-100
2R28	RESISTOR, fixed: film, 1500 ohm, 1/2 watt, 1%; Electra Part No. DC-1/2	042-076
2R29	RESISTOR, fixed: film, 10 meg, 1/2 watt, 10%; MIL-R-11 RC20GF106K	041-090
2R30	RESISTOR, fixed: carbon, .30 meg, 1/2 watt, 5%; MIL-R-11A, RC20GF304J 3-3/4 - 7-1/2 ips Equipment	041-326
2R31	RESISTOR, fixed: film, 68K ohm, 1/2 watt, 1%; Electra Part No. Type DC-1/2	042-088
3R32	RESISTOR, fixed: carbon, 39K ohm, 1/2 watt, 10%; MIL-R-11A, RC20GF393K	041-067
2R33	Same as R29	
2R34	RESISTOR, fixed: carbon, .22 meg, 1/2 watt, 10%; MIL-R-11A, RC20GF224K	041-076
3R35	Same as R13	
4R36	RESISTOR, variable: carbon, .25 meg, 2 watts, 10%; AB Part No. CA2541, SD3056	044-128
2R37	Same as R8	
2R38	Same as R16	
2R39	Same as R8	
2R40	RESISTOR, fixed: carbon, 82K ohm, 1/2 watt, 10%; MIL-R-11A, RC20GF823K	041-071
2R41	Same as R16	
2R42	Same as R34	
2R43	Same as R34	
2R44	Same as R8	
2R45	Same as R8	
2R46	RESISTOR, fixed: carbon, 1K ohm, 1/2 watt, 10%; MIL-R-11A, RC20GF102K	041-048

REF. NO.	PART DESCRIPTION	AMPEX PART NO.
2R47	Same as R13	
5R48	RESISTOR, fixed: carbon, 560 ohm, 1/2 watt, 10%; MIL-R-11A, RC20GF561K	041-045
2R49	Same as R32	
6R50	RESISTOR, fixed: carbon, 1.5K ohm, 1/2 watt, 10%; MIL-R-11A, RC20GF152K	041-050
6R51	RESISTOR, fixed: carbon, 4.7K ohm, 1/2 watt, 10%; MIL-R-11A, RC20GF472J	041-013
6R52	RESISTOR, fixed: carbon, 8.2K ohm, 1/2 watt, 5%; MIL-R-11A, RC20GF822J	041-309
6R53	RESISTOR, fixed: carbon, 820 ohm, 1/2 watt, 5%; MIL-R-11A, RC20GF82J	041-317
3R54	RESISTOR, fixed: carbon, 1.5K ohm, 1 watt, 10%; MIL-R-11A, RC32GF152K	041-148
3R55	Same as R54	
3R56	Same as R2	041-055
3R57	Same as R2	
3R58	RESISTOR, fixed: carbon, 15K ohm, 1/2 watt, 10%; MIL-R-11A, RC20GF153K	041-062
1R59	RESISTOR, fixed: carbon, 1.5K ohm, 2 watts, 10%; MIL-R-11A, RC42GF152K	041-204
3R60	RESISTOR, fixed: wirewound, 1.5 ohm, 1 watt, 10% IRC Type BW-1	043-286
1R61	Same as R11	
1R62	Same as R11	
1R63	RESISTOR, variable: carbon, 10K ohm, 044-171, 1/4 watt, 30%; CTS Part No. UPM-45 SPEC3471	044-171
1R64	RESISTOR, fixed: carbon, 8.2 ohm, 1 watt, 5%; MIL-R-11A, RC32GF825J	041-319
1R65	Same as R34	041-076
4S1	SWITCH, rotary: INPUT TRANSFER, 3 position	30760-01
4S2	SWITCH, rotary: EQUALIZATION, 2 position	30761-01
4S3	SWITCH, rotary: METER AND OUTPUT, 4 position	30762-01
5S4	SWITCH, rotary: LINE TERM, 3P4T; Oak Part No. 59016-23	122-016
4S5	SWITCH, toggle: POWER, SPST; Carling Part No. 110-B-73	120-005
4S6	SWITCH, rotary: RECORD, pushbutton SPST, normally open; A H and H Part No. 3391BSA	120-013
6T1	TRANSFORMER, microphone input	17331-01
5T2	TRANSFORMER, input Low Impedance Heads Only	6299
6T3	TRANSFORMER, output	30633-01
6T4	TRANSFORMER, power	30634-01
1T5	TRANSFORMER, oscillator	30766-01
1V1	TUBE, electron: 12AX7	012-105
1V2	TUBE, electron: 12AT7	012-034
2V3	Same as V1	
2V4	Same as V1	
2V5	TUBE, electron: 12AU7	012-107
1V6	Same as V5	
3V7	TUBE, electron: 6X4	012-050
	*BOARD ASSEMBLY, power supply	30754-01
	*BOARD ASSEMBLY, record: 3-3/4 - 7-1/2 ips	30755-02
	*BOARD ASSEMBLY, record: 7-1/2 - 15 ips	30755-01
	*BOARD ASSEMBLY, reproduce: 3-3/4 - 7-1/2 ips	30756-02
	*BOARD ASSEMBLY, reproduce: 7-1/2 - 15 ips	30756-01
	FACING PANEL	5711-2
	HARNESS ASSEMBLY, master	30819-01
	HARNESS ASSEMBLY, slave	30819-02
	KNOB, large, skirted: Reproduce and Record Level Control	230-004
	KNOB, small, skirted: Equalization and Output	230-003
	KNOB, small with pointer: Input and Line Termination	230-008
	POST fuse; F1 and F2	085-001
	SHIELD, tube, for all except V7	160-012
	SHIELD, tube; V7	160-043
	SHOCKMOUNT	350-015
	SOCKET, tube: 7 pin	150-067
	SOCKET, tube: 9 pin	30818-01
	*Etched board assemblies are complete with all mounted components including tubes.	

REF. NO.	PART DESCRIPTION	AMPEX PART NO.
	ACCESSORIES	
	CABINET, console	5797
	CABLE ASSEMBLY, power interconnecting for rack mounted equipment	30812-01
	CABLE ASSEMBLY, power interconnecting for portable equipment	30812-02
	CABLE, bias interconnecting for dual track equipment	14943-02
	CABLE, extension	5795
	CABLE, power	2413
	CASE, portable, Electronic Assembly, single unit	4100
	CASE, portable, Electronic Assembly, dual track unit	3935
	CASE, tape transport	5727
	REEL ADAPTOR	978
	EDITING KNOB, console and portable	1917
	HOLD-DOWN KNOB, reel, for rack	9093
	REMOTE CONTROL UNIT, single track, complete with 30 foot cable	5763-0
	Remote Control Unit Parts	
	J701P CONNECTOR, receptacle: male, 10 contact; Jones Part No. P-310-AB	132-007
	A702 LAMP, REMOTE TAPE MOTION: Same as A701	
	LAMP BASE, green	132-007
	LAMP BASE, red	132-006
	A701 LAMP, REMOTE RECORD: 120 volts, 6 watts	060-006
	S701 PUSHBUTTON, fast forward	120-013
	S702 Same as S701, rewind	
	S703 PUSHBUTTON, STOP	120-014
	S704 Same as S701, START	
	S705 Same as S701, RECORD	
	REMOTE CONTROL UNIT, dual track, complete with 30 foot cable	5763-2
	REMOTE CONTROL PANEL, single track, unwired, less cable and box	5763-1
	REMOTE CONTROL PANEL, dual track, unwired, less cable and box	5763-3
	WOODBBOX, grey	3661-0



- NOTES:**
1. RESISTOR VALUES ARE IN OHMS, 10%, 1/2 WATT UNLESS OTHERWISE SPECIFIED.
 2. ALL CAPACITORS ARE IN MICRO-FARADS AND RATED AT 400 V, UNLESS OTHERWISE SPECIFIED.
 3. SWITCHES ARE SHOWN AS THEY FUNCTION, NOT AS THEY ARE CONSTRUCTED AND WIRED.
 4. FOR UNBALANCED OUTPUT WITH ONE SIDE GROUNDED, CONNECT A TO B AT 5TS2 OR PIN 1 TO PIN 2 AT 5J5. FOR BALANCED OUTPUT WITH CENTER TAP GROUNDED CONNECT G TO H AT 6TS1.
 5. JUMPED AS SHOWN, VU METER IS CALIBRATED FOR + 8 VU OUTPUT, FOR + 4 VU OUTPUT JUMP E TO F INSTEAD OF E TO D ON 6TS3 (SEE INSTALLATION). READJUST RECORD CALIBRATION CONTROL AS DESCRIBED IN SECTION V OF MAINTENANCE MANUAL.
 6. D.C. VOLTAGES MEASURED WITH 20,000 OHM PER VOLT METER WITH EQUIPMENT IN RECORD MODE AT 117 V. LINE.
 7. SIGNAL VOLTAGES MEASURED WITH AC VTVM AND EXPRESSED IN db REFERRED TO .78 VOLTS.

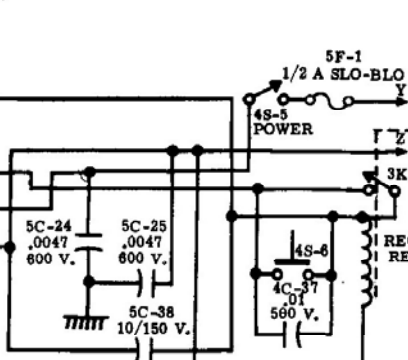
CIRCUIT CONDITIONS

EQUALIZATION SWITCH 4S2 IN 7-1/2" POSITION 100 CYCLE INPUT.
 LEVEL CONTROLS 4R9 AND 4R36 FULL CLOCKWISE. LINE OUTPUT 5J5 TERMINATED IN NOMINAL 600 OHMS. OSCILLATOR TUBE 1V6 REMOVED.
 1,000 OHM RESISTOR SUBSTITUTED FOR RECORD HEAD.
 INPUT TRANSFER SWITCH 4S1 IN MICROPHONE POSITION.
 RECORD RELAY 3K1 ENERGIZED.

NOTE: UNBALANCE OF 2 db MAY BE EXPECTED AT PIN 2 AND PIN 7 OF 2V5.

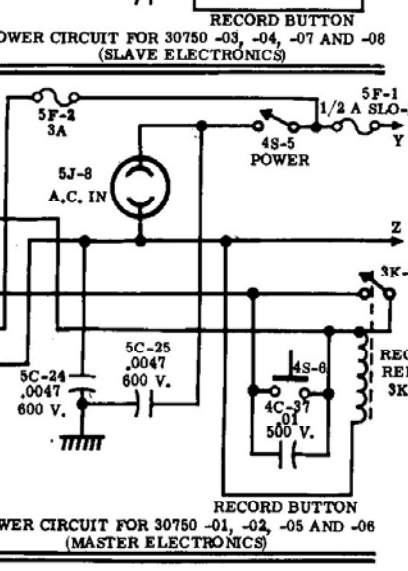
5J-7 TAPE TRANSPORT

SPARE	6
REC.	4
REC.	5
REC.	3
117 V. A.C.	2
117 V. A.C.	1



5J-7 TAPE TRANSPORT

SPARE	6
REC.	4
SPARE	5
REC.	3
117 V. A.C.	2
117 V. A.C.	1



- LEGEND**
- THE FIRST NUMBER OF THE SCHEMATIC REFERENCE NUMBER SIGNIFIES THE LOCATION
1. RECORD AMPLIFIER BOARD
 2. REPRODUCE AMPLIFIER BOARD
 3. POWER SUPPLY BOARD
 4. FRONT PANEL OF AMPLIFIER CHASSIS
 5. BACK PANEL OF AMPLIFIER CHASSIS
 6. SIDES AND BOTTOM OF AMPLIFIER CHASSIS
- ⊖ CIRCUI T GROUND
 - ⊖ CHASSIS GROUND
 - D C VOLTAGES
 - SIGNAL VOLTAGES

TABLE 1 NAB EQUALIZATION

REF. NO.	MACHINES:	
	3-3/4 - 7-1/2	7-1/2 - 15
C-6	.0027, 5%	.0047, 5%
C-7	.0047, 5%	.0012, 5%
C-11	.0082, 5%	.0047, 5%
C-12	.0047, 5%	.0022, 5%
R-30	300 K, 5%	OMIT - JUMP AS SHOWN WITH DOTTED LINE
R-31	68 K, 1%	68 K, 1%

TABLE 2 CCIR EQUALIZATION

REF. NO.	7-1/2 - 15
C6	.0025 5%
C7	.0015 5%
C8	.047 20%
C11	.0033 5%
C12	.0025 5%
C15	.0015 5%
R29	OMIT
R30	68 K 1%
R31	22 K 1%

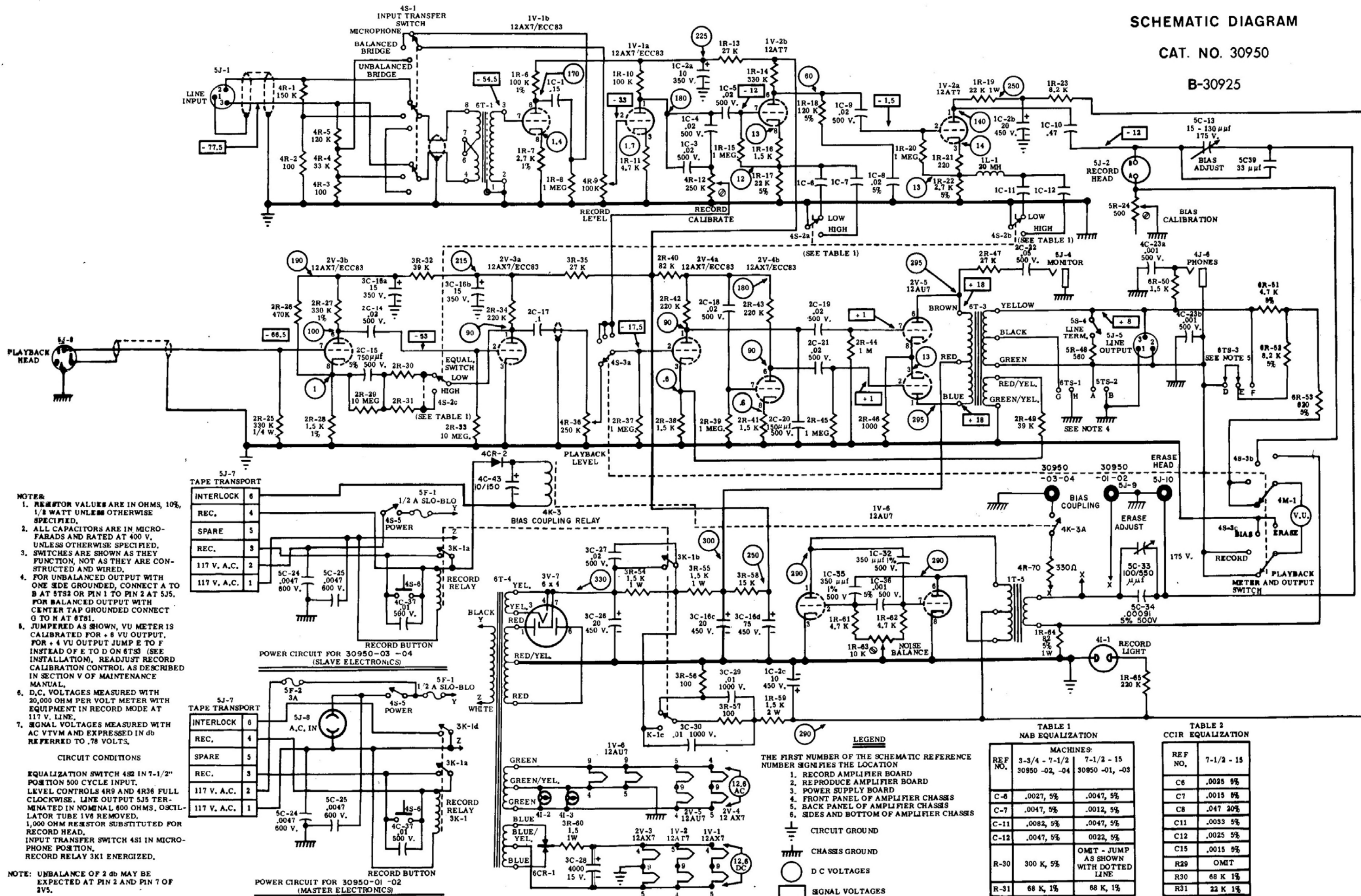
ERRATA

REF NO.	PART DESCRIPTION	AMPEX PART NO.
	(DELETIONS)	
1c-31	CAPACITOR, fixed: ceramic, .02 uf + 80%-20% 500 V dcw	030-059
	(CHANGES)	
	BOARD ASSEMBLY, record: 3-3/4--7-1/2 ips	30755-05
	BOARD ASSEMBLY, record: 7-1/2--15 ips	30755-04
	HARNESS ASSEMBLY; master	30819-04
	HARNESS ASSEMBLY; slave	30819-05
	(ADDITIONS)	
4K3	RELAY, bias coupling	020-066
4C43	CAPACITOR: electrolytic, tubular, 10 uf, 150 volt CD Part No. --BRR--10--150	031-157
4R70	RESISTOR, Fixed: carbon, 330 ohm, 1/2 watt, 10% MIL-R-11A, RC20GF331J	041-042
4CR2	RECTIFIER, silicon	582-031

SCHEMATIC DIAGRAM

CAT. NO. 30950

B-30925



- NOTE:**
1. RESISTOR VALUES ARE IN OHMS, 10%, 1/8 WATT UNLESS OTHERWISE SPECIFIED.
 2. ALL CAPACITORS ARE IN MICRO-FARADS AND RATED AT 400 V, UNLESS OTHERWISE SPECIFIED.
 3. SWITCHES ARE SHOWN AS THEY FUNCTION, NOT AS THEY ARE CONSTRUCTED AND WIRED.
 4. FOR UNBALANCED OUTPUT WITH ONE SIDE GROUNDED, CONNECT A TO B AT 5TS2 OR PIN 1 TO PIN 2 AT 5J5. FOR BALANCED OUTPUT WITH CENTER TAP GROUNDED CONNECT G TO H AT 6T81.
 5. JUMPED AS SHOWN, VU METER IS CALIBRATED FOR +8 VU OUTPUT. FOR +4 VU OUTPUT JUMP E TO F INSTEAD OF E TO D ON 6TS3 (SEE INSTALLATION). READJUST RECORD CALIBRATION CONTROL AS DESCRIBED IN SECTION V OF MAINTENANCE MANUAL.
 6. D.C. VOLTAGES MEASURED WITH 20,000 OHM PER VOLT METER WITH EQUIPMENT IN RECORD MODE AT 117 V. LINE.
 7. SIGNAL VOLTAGES MEASURED WITH AC VTVM AND EXPRESSED IN db REFERRED TO .78 VOLTS.

CIRCUIT CONDITIONS

EQUALIZATION SWITCH 4S2 IN 7-1/2" POSITION 500 CYCLE INPUT. LEVEL CONTROLS 4R9 AND 4R36 FULL CLOCKWISE. LINE OUTPUT 5J5 TERMINATED IN NOMINAL 800 OHMS. OSCILLATOR TUBE 1V6 REMOVED. 1,000 OHM RESISTOR SUBSTITUTED FOR RECORD HEAD. INPUT TRANSFER SWITCH 4S1 IN MICROPHONE POSITION. RECORD RELAY 3K1 ENERGIZED.

NOTE: UNBALANCE OF 2 db MAY BE EXPECTED AT PIN 2 AND PIN 7 OF 2V5.

5J-7 TAPE TRANSPORT

INTERLOCK	6
REC.	4
SPARE	5
REC.	3
117 V. A.C.	2
117 V. A.C.	1

5J-7 TAPE TRANSPORT

INTERLOCK	6
REC.	4
SPARE	5
REC.	3
117 V. A.C.	2
117 V. A.C.	1

POWER CIRCUIT FOR 30950-03-04 (SLAVE ELECTRONICS)

POWER CIRCUIT FOR 30950-01-02 (MASTER ELECTRONICS)

LEGEND

- THE FIRST NUMBER OF THE SCHEMATIC REFERENCE NUMBER SIGNIFIES THE LOCATION
1. RECORD AMPLIFIER BOARD
 2. REPRODUCE AMPLIFIER BOARD
 3. POWER SUPPLY BOARD
 4. FRONT PANEL OF AMPLIFIER CHASSIS
 5. BACK PANEL OF AMPLIFIER CHASSIS
 6. SIDES AND BOTTOM OF AMPLIFIER CHASSIS
- ⊖ CIRCUIT GROUND
 - ⊖ CHASSIS GROUND
 - D C VOLTAGES
 - SIGNAL VOLTAGES

TABLE 1
NAB EQUALIZATION

REF NO.	MACHINES:	
	3-3/4 - 7-1/2	7-1/2 - 15
C-6	.0027, 5%	.0047, 5%
C-7	.0047, 5%	.0012, 5%
C-11	.0082, 5%	.0047, 5%
C-12	.0047, 5%	.0022, 5%
R-30	300 K, 5%	OMIT - JUMP AS SHOWN WITH DOTTED LINE
R-31	68 K, 1%	68 K, 1%

TABLE 2
CCIR EQUALIZATION

REF NO.	7-1/2 - 15
C6	.0025 5%
C7	.0015 5%
C8	.047 20%
C11	.0033 5%
C12	.0025 5%
C15	.0015 5%
R29	OMIT
R30	68 K 1%
R31	22 K 1%



934 CHARTER STREET REDWOOD CITY CALIFORNIA EMERSON 9-1481

*professional
products division*