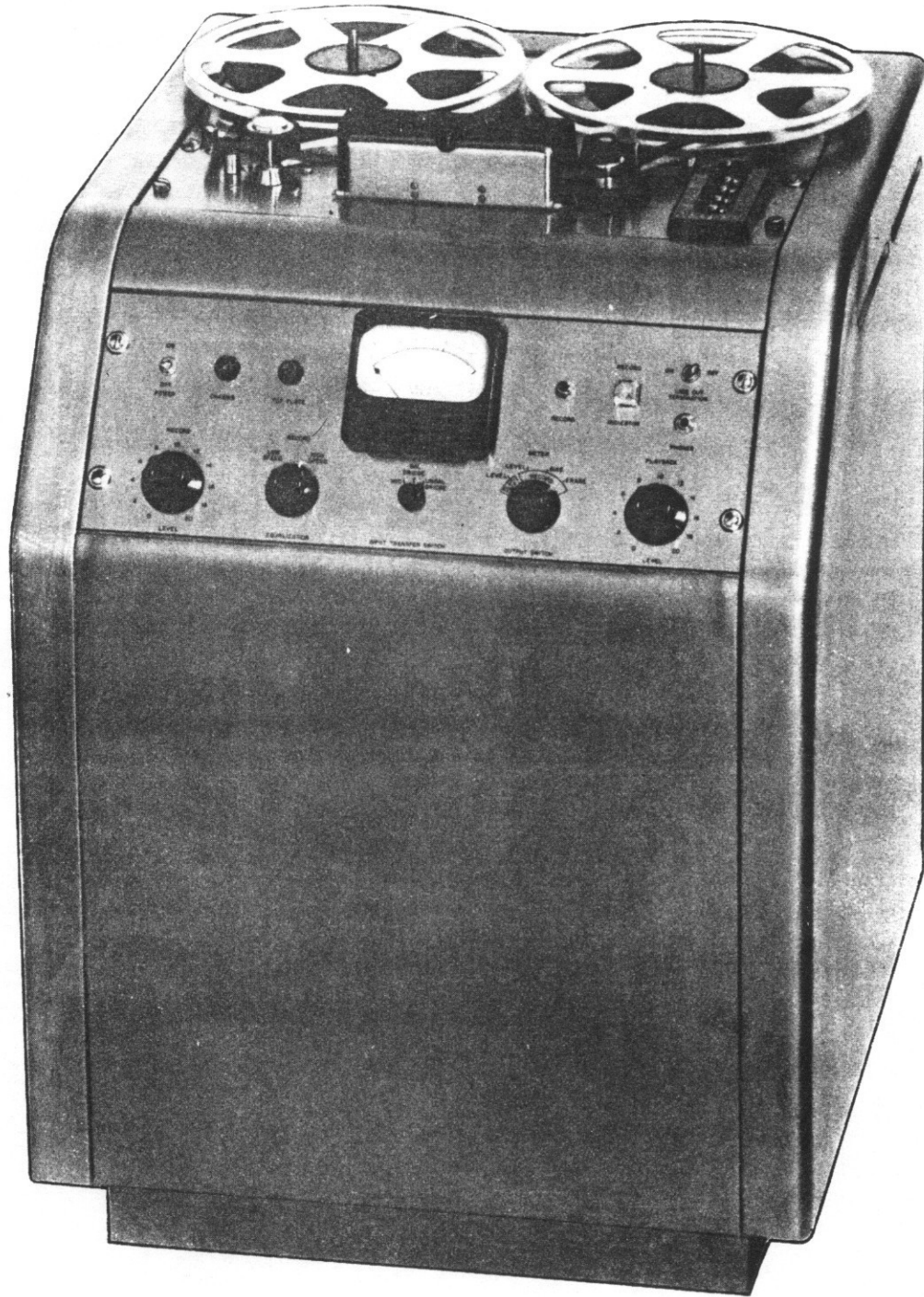


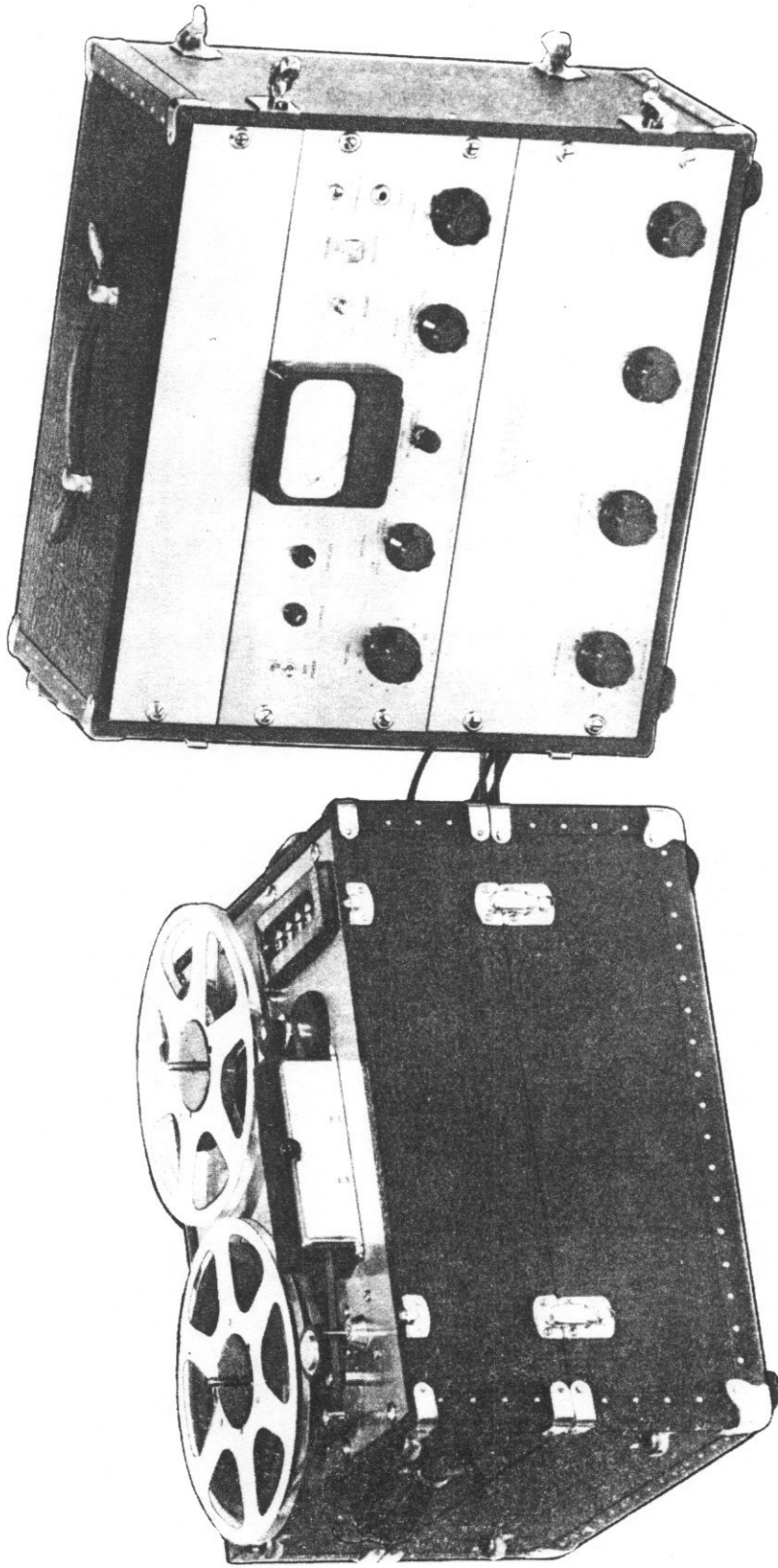
**AMPEX**

**SERIES 400**

**OPERATION AND  
MAINTENANCE MANUAL**



MODELS 402 & 403  
CONSOLE  
AMPEX ELECTRIC CORPORATION  
REDWOOD CITY, CALIFORNIA



MODELS 402 & 403  
TWO CASE PORTABLE  
AMPEX ELECTRIC CORPORATION  
REDWOOD CITY, CALIFORNIA

INSTRUCTION MANUAL  
FOR  
AMPEX MAGNETIC TAPE RECORDER MODELS 400A, 401A,  
402, 403, 404 and 405

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## SECTION 1

### SPECIFICATIONS-MODELS 400A, 401A, 402 & 403

The Ampex Models 400A, 401A, 402 and 403 magnetic tape recorders are audio recorders utilizing the standard 1/4 inch wide tape. Models 400A and 401A are identical in every respect except for the head assembly. Similarly, the Models 402 and 403 are alike except for head assemblies. The main difference between these two groups is the former incorporates an Electronic Assembly designed for single case portable mounting. The 400A and 402 incorporate half track erase, record and playback heads. The 401A and 403 incorporate full track erase record and playback heads.

Half track heads are effective over only one half of the tape width. Thus, a machine having a half track record head can record two separate audio tracks on a standard reel of tape. Machines having half track playback heads can reproduce either full or half track recordings. Machines having full track playback heads can only reproduce tapes on which a single track has been recorded. Head assemblies incorporating full track record and erase heads and half track playback heads are available on special order. This allows recording full track tapes and playing back either full track or half track tapes. All of the models produce a tape frequency characteristic which has been accepted as standard for the exchange of programs by the National Association of Radio and Television Broadcasters.

TAPE SPEED 15 inches per second and 7-1/2 inches per second, with motor speed change and equalization switches conveniently located.

FREQUENCY RESPONSE. At 15 inches  $\pm$  2db 30-15,000 cycles

At 7-1/2 inches  $\pm$  2db 40-10,000 cycles

$\pm$  4db 30-15,000 cycles

SIGNAL-TO-NOISE RATIO. Over 65 db (unweighted noise to maximum recording level). Over 55 db, as defined by NARTB standards. By NARTB definition, the signal-to-noise ratio is the ratio of peak recording level to the total unweighted playback noise when erasing a signal of peak recording level and in the absence of a new signal. Thus, bias and erase noise are included, as well as playback amplifier noise. All frequencies between 50 and 15,000 cycles are measured. The peak recording level is defined as that level at which the overall (input to output) total RMS harmonic distortion does not exceed 3% when measured on a 400 cycle tone.

STARTING TIME. Instantaneous. (When starting, the tape accelerates to full speed in less than 1/10 second because the capstan motor operates whenever the power is on).

STOPPING TIME. When playing at 15 inches per second, the tape moves less than two inches after the stop button is operated.

FLUTTER AND WOW. At 15 inches well under 2/10% RMS measuring all flutter components from 0 to 300 cycles using a tone of 3,000 cycles. At 7-1/2 inches per second under 1/4%.

PLAYBACK TIMING ACCURACY. 2/10% or  $\pm$ 3.6 seconds in a 30 minute recording.

PLAYING TIME. 32 minutes at 15 inch speed with standard NARTB reel; 64 minutes at 7-1/2 inch speed (on each track). The standard RMA reel may also be used on the tape supply turntable. The Models 400A and 402 Magnetic Tape Recorders are designed to record on only one half of the standard 1/4 inch wide tape in accordance with RMA standards. By turning the reel over and recording on the other half, twice the amount of program can be stored on a single reel, thereby affecting a 50% saving in tape.

REWIND TIME. Approximately one and a half minutes for the full 2,400 foot NARTB reel.

CONTROLS. Four buttons control the functions of Start (Play), Fast Forward, Rewind, and Stop. A separate record button energizes the record relay, which drops out when the machine is stopped. Since the functions are relay operated, the control buttons may be placed at a remote location.

COMPLETE PLUG-IN HEAD HOUSING. Erase, record and playback heads are contained in a single plug-in head housing.

SIMULTANEOUS MONITORING. Independent record and playback systems allow the tape to be monitored while recording.

INPUT. A switch allows the recorder to accommodate either microphone level low impedance input or to bridge 600 ohms plus 4 VU line balanced or unbalanced. Minus 70 dbm on microphone input will produce recommended record level.

PLAYBACK AMPLIFIER. Plus 4 VU output into 600 ohms balanced or unbalanced. Will feed high impedance amplifier directly with approximately one volt.

METERING. A 4 inch VU meter is mounted on the front panel and provides for:

- A. Direct monitor of record input signal before or during recording.
- B. Monitor of recorded output signal from playback head while recording or during playback.
- C. Reading bias current.
- D. Reading erase current.

PHONE MONITORING. A phone monitor jack is provided for direct monitor of record input signal before or during recording, and monitor of recorded output signal from playback head while recording or during playback. An A-B switch is incorporated in order that direct comparison can be made between the original program and the recorded program while a recording is being made. The same switch transfers the VU meter for level comparison and monitoring.

MOUNTINGS. Models 400A and 401A are available as a single case portable. Models 402 and 403 are available in a console cabinet, for rack mountings, or as a two case portable.

POWER INPUT REQUIREMENTS. 115 Volts AC 2 Amperes. Recorders are available for either 60 or 50 cycle operation. See serial number plate before operating.

DIMENSIONS.

Single Case Portable -

Complete recorder in single case  
Height - 13-3/4 inches  
Width - 20 inches  
Depth - 17-1/2 inches  
Weight - 83 pounds, approximately

Rack Mounting -

Standard 19" wide panel-Commercial notching  
Mechanical Unit-15-3/4" high panel  
Electronic Unit-7" high panel  
Power Supply-3-1/2" high panel

Studio Console -

Complete recorder in cabinet  
Height - 32 inches  
Width - 23 inches  
Depth - 25-1/2 inches

Two Case Portable -

Mechanical and electronic assemblies in separate cases

Mechanical Assembly:

Width-21 inches  
Depth-18 inches  
Height-15 inches  
Weight-62 pounds

Electronic assembly in large case (has extra space for four-channel mixer or for storage of cables and microphone)

Width - 21 inches  
Depth - 13 inches  
Height - 19 inches  
Weight - (less mixer)-50 pounds

Electronic assembly in small case (space  
for power supply and electronics only-  
no extra space)  
Width-21 inches  
Depth - 13 inches  
Height - 12 inches  
Weight -45 pounds, approximately

#### ACCESSORY ITEMS.

All recorders in the 400 series are available with connectors installed in the Mechanical Assembly for "plug in" of remote controls, the Model 375 Precision 60 cycle Power Supply, or the Model 380 Speed Lock Equipment.

The Model 375 Precision 60 Cycle Power Supply is designed to provide a source of constant frequency to the capstan drive motor in localities where the available 60 cycle power is not stable in frequency.

The Model 380 Speed Lock Equipment is designed to automatically control the playback speed of Series 400 recorders to synchronize with motion picture equipment.

A remote control box is available with five pushbuttons and two indicator lights mounted on a sloping panel in a small wooden case. (Catalog #3766). This unit is wired and ready to operate.

Also available are remote controls on a flat plate for flush mounting in studio control consoles. (Catalog #3766-1). This unit is not wired. Wiring must be done by the purchaser to fit his installation.

A four channel high level Mixer-Preamplifier is available for use with Models 402 and 403 rack mount and portable recorders. (Catalog #3761).

An accessory pedestal is available for Model 402 and 403 Studio Consoles to increase their height to 41 inches. (Catalog #3795).

A set of casters is also available for the Studio Console. (Catalog #3963.)

## SECTION II INSTALLATION

### IMPORTANT:

Before operating the recorder, read the following sections on INSTALLATION and OPERATION.

### CAUTION:

Do not attempt to lengthen the head cables. Additional cable capacity will affect the frequency characteristics.

Console Models: Shipped in ready to operate condition. Connect the input, output, and AC power as follows: Remove the lower screen cover at rear of cabinet. Pull the cables through bottom of cabinet and plug them into rear of Electronics Assembly. For connection instructions, see following paragraphs. Replace protective screen covering to rear of cabinet. IMPORTANT. The console cabinet must be spaced at least 4" from the wall in the rear and at least 3" between a wall or cabinet on either side, otherwise ventilation holes will be obstructed.

Two Case Portable Models: The portable machine is shipped in a ready to operate condition, except for the connection of interconnecting cables.

To operate the recorder place the Mechanical Assembly Case to the left of the Electronic Assembly Case. Unlatch and remove the top cover and cable access door on the right side of the Mechanical Assembly Case. Unlatch and remove the front and rear doors on the Electronic Assembly Case.

Uncoil the interconnecting cables from behind the cable access door and plug them into mating receptacle at the rear of the Electronic Assembly.

Connect the input, output, and AC power to rear of Electronic Assembly.

Single Case Portable Models: These machines are shipped in a ready to operate condition. Remove the front panel cover and the top cover. All connections are readily accessible from the front panel.

NOTE: When storing the portable machines avoid setting the Mechanical Assembly case on either of the handle ends. This will cause the Turntable Motor Tire to rest on the Brake Drum and will produce a flat in the tire if left in this position any appreciable time.

Rack Mounted Models: The rack mounted machine should be mounted on a standard 19 inch relay rack with the Mechanical unit above the main Electronic Panel. The Electronic Power Supply Panel should be mounted directly above the Mechanical Assembly to prevent the possibility of 60 cycle field from entering the Electronic Assembly.

If two Series 400 Recorders are to be mounted on a standard rack, the following placement is recommended (starting at the top of the rack):

1. Install a spacer panel at the top of the rack if desired.
2. Install below this panel the Mechanical Assembly for machine #1.
3. Install the Electronic Assembly for machine #1.
4. Install a spacer panel.
5. Install the Mechanical Assembly for machine #2.
6. Install the Electronic Assembly for machine #2.
7. Install a spacer panel.
8. Install both Power Supply Panels at the bottom.  
(The cable on the power supply for the upper recorder will have to be extended in length. Extension cable #3814 is available for this purpose.)

The numbers set off in parentheses in the following text are reference numbers that refer to the Parts List Section IX and the figures in the rear of this book.

#### I. AC POWER:

Connect the Power Cable, catalog #2413, from the AC Power Input Connector (J409P) on the Electronics Assembly to a source of 115 Volt AC power.

IMPORTANT: This machine is available for either 50 or 60 cycle operation. The power line frequency is indicated on the serial number plate which is located on the Power Supply Panel for rack mounted machines and on the exterior of each case in the portable machine.

#### II. OUTPUT: Refer to Figure 1 or 2.

##### A. For Studio Line:

Plus 4 VU, 600 ohm line output, balanced or unbalanced, is available across Terminals 2 and 3 of the Line Out Connector, (J404P). Pin 1 is the chassis ground. If unbalanced output is desired; tie either side of the line to ground. It is necessary to supply 600 ohm termination to this output at all times in order to maintain correct meter calibration while recording or playing back. Therefore, if the output is not feeding a terminated line or if the output is not connected, such as on remote pickups, the Line Output Termination Switch, (S404), must be switched to ON.

##### B. For Connection to High Impedance Amplifier Input:

Connect pin 3 of the Line Out Connector (J404), to the high side of the amplifier input. Strap pins 1 and 2 of the connector and connect to the ground side of the amplifier input. The Line Output Termination Switch (S404), must be left in the position designated ON at all times, as explained in A above.

### III. INPUT: Refer to Figures 1 or 2 and 6.

The following inputs are provided:

#### A. Microphones:

Any low impedance microphone, the nominal impedance of which is in the range of 30 to 250 ohms can be plugged in directly. Connect the microphone to pins 2 and 3 of the Input Connector, (J401S). Connect cable shield to pin 1. Place the Input Transfer Switch, (S401), in the MIC position.

The microphone input transformer is strapped for the optimum step up for a 150 to 250 ohm source. In the case of microphones having 50 ohms or less impedance, 6 db additional gain can be obtained by strapping the input as shown in Figure 6B. This is not usually necessary, however, and should not be done unless insufficient gain is found to exist. If the input is re-strapped, serious frequency discrimination will exist should the input be fed from a source impedance greater than 50 ohms. IMPORTANT, R402 and R403 will have to be changed to 24 ohms and R401 and R404 to 68,000 ohms to maintain a flat response on Balanced Bridging when the transformer is strapped for 50 ohm source impedance.

High impedance microphones are not recommended for use on this equipment. In general, the quality obtainable from high impedance microphones is not satisfactory for professional work. In the event that it becomes necessary to connect a high impedance microphone, the input circuit will have to be re-wired as shown in Figure 6A.

#### B. Bridging a Balanced Studio Line:

Connect a balanced line to pins 2 and 3 of the Input Connector, (J401S). Pin 1 is ground. Place the Input Transfer Switch, (S401), in the BALANCED BRIDGE position. Input levels of minus 10 to plus 10 VU can be accommodated. The load placed on the line is approximately 300,000 ohms.

For bridging higher or lower level lines, an external bridge can be wired in the line to the machine. This would consist of two resistors, the value of which should be from 15,000 to 30,000 times the RMS program voltage, in series with each side of the line. A 24 ohm  $\pm 5\%$  resistor should terminate each leg of the output side of the two bridging resistors. The junction of the two 24 ohm resistors should go to chassis ground. The output of the bridge must be fed to the microphone input of the recorder. The input of the recorder may be connected for any impedance from 50 to 250 ohm.

#### C. Bridging an Unbalanced Source:

Connect an unbalanced line, radio tuner, etc., to pins 3 and 1 of the Input Connector (J401S). Pin 1 is the ground side. Place the Input Transfer Switch, (S401), in the UNBALANCED BRIDGE position. This connection provides a 60,000 ohm bridging input for any RMS program voltage greater than 1/2 volt.

To increase the input impedance above 60,000 ohms, a series resistance of 330,000 ohms can be wired into the input plug in series with pin 3 and the input cable. This will necessitate an input voltage of at least 2-1/2 volts RMS. It is important that this resistor be physically placed in the cable connector that plugs into the Recorder Input (J401S) in order that the cable capacity be on the input side of the resistor.

#### IV. PHONES:

Any sensitive head phones can be plugged in the Phone Jack (J403S), provided for monitoring the incoming line or playback output.

#### V. REMOTE CONTROL: Refer to Figure 7.

It is possible to remote control the Start, Stop, Fast Forward, Rewind, and Record pushbuttons of this recorder. On standard recorders connect the remote controls shown in Figure 7A to the Remote Control Terminal Strip (TS502) shown in Figure 18. An eight wire cable is required.

If this tape recorder is equipped for "plug in" of remote controls, connect a 10 pin male Jones plug (Jones P-310-CCT-L, AMPEX PL208P) to the 8 wire cable leading to the remote controls. Plug the cable into the Remote Control Connector in the rear of the recorder. If remote control should not be desired, Dummy Plug #3461 must be inserted in this connector. (Jones P-310-CCT-L with 7 and 8 strapped.)

Standard recorders can be modified for the "plug in" of Remote Control and 60 Cycle Amplifier connections by the addition of an 8 and a 10 pin female Jones connector. These connectors can be mounted in the holes provided on the Relay Mounting Bracket (11) in the rear of the Mechanical Assembly. The connectors should be wired to Terminal Strips TS501 and TS502 as shown in Figures 7B and 7D.

#### VI. 60 CYCLE AMPLIFIER: (For Drive Motor Power) Refer to Figure 7.

Connections for AMPEX Model 375, 60 Cycle Amplifier, or Model 380 Speed Lock Equipment are made on the 60 Cycle Amplifier Terminal Strip (TS501) shown in Figure 18, or at the 60 Cycle Amplifier Connector, if the recorder is so equipped. The Control Circuit Power Fuse (F402) must be increased to 5 amperes when either of these units are used. Refer to Figure 7D and the Model 375 or Model 380 Instruction Book for the detailed installation procedure.

NOTE: If this recorder is equipped for "plug in" of the 60 Cycle Amplifier, it is necessary to insert Dummy Plug #567 in the 60 Cycle Amplifier receptacle when the 60 Cycle Amplifier is not used.



## VII. CONVERSION FROM PORTABLE TO RACK MOUNT:

If a portable or console recorder is converted to a rack mount machine, the Takeup Tension Arm Counterbalance Spring (65) must be added. This spring is supplied with the recorder and is hooked to the Feel Meter Thrust Bracket (85). See Figure 17. To install, remove from the bracket and insert between the lug provided on Safety Switch (8501) and the Lug (66) provided on the Takeup Tension Arm Collar (66). The Takeup Tension Arm Counterbalance Spring (65) is shown installed for rack mounted operation on Figure 17. When shipped as a rack mount machine, the spring will be installed. If the conversion is to be permanent, the oiling cups of the Turntable Motor (6), if equipped with sleeve bearings, should be rotated to be accessible for oiling.

## VIII. ACCESS TO CONSOLE CABINET:

WARNING: Before opening the console or portable cases, disconnect AC power.

Complete accessibility for inspection or service is provided to the top and bottom of the Electronic Assembly and bottom of the Mechanical Assembly. See Figure 21 for illustration of Cabinet opened for full accessibility.

### Opening Procedure

1. Remove the four front panel screws (X), Figure 21, securing Electronic Assembly to cabinet.
2. Pull Electronics Assembly forward in the position illustrated in Figure 21.
3. For access to underside of Electronic Assembly, pivot it back on the hinge provided at rear.
4. Hinge at rear will separate for complete removal of chassis from the cabinet, if desired.
5. The Mechanical Assembly can be raised to a 45° position by removing two front Mechanical Assembly screws, (Y), Figure 21.
6. Use support rod (W) to support Mechanical Assembly.
7. The Mechanical Assembly may also be raised to a vertical position and will be supported by a chain stop.

## IX. ACCESS TO UNDERSIDE OF MECHANICAL ASSEMBLY IN TWO CASE PORTABLE

Stand Mechanical Assembly Case on end as shown in Figure 22. Release latches holding center divisions of case. Open to approximately 90°. Care must be taken to insure that cables can pass through cable compartment into main cabinet freely.

## X. ACCESS TO UNDERSIDE OF MECHANICAL ASSEMBLY IN SINGLE CASE PORTABLE.

Slide the Electronics Chassis out of the case. Remove the head cable

clamp and disconnect all cables from the Electronic Chassis. Remove the Mechanical Assembly by lifting straight up. It may be turned upside down and placed on the case for servicing. When returning the assemblies to the case, make sure the cables are properly clamped and threaded through the cable guides so they will not interfere with moving parts.

XI. OVERALL PERFORMANCE CHECK: (Read Section III on OPERATION before making these checks)

The following procedure is recommended for checking the performance of this recorder at the time of installation and as necessary thereafter.

A. Overall Frequency Response:

Thread a new reel of tape on the machine. Equalization curves for the Record and Playback Amplifiers as shown in Figure 8 and 9 have been established by use of Minnesota Mining and Manufacturing Company Type 111 Tape, Construction 5RBA or later. Slight deviations in performance can be expected when using other tapes, but entirely satisfactory results can be obtained from any professional quality tape.

1. 7-1/2 Inch Response or 3-3/4 Inch Response (Models 404 & 405 only)

DUE TO THE NATURE OF THE PRE-EMPHASIS IN THE RECORD CIRCUIT, TAPE SATURATION WILL OCCUR AT THE HIGH FREQUENCIES UNLESS THE RESPONSE CHECK IS MADE AT LEAST 20 DB BELOW NORMAL OPERATING LEVEL.

Therefore, check the response with a sensitive meter such as a Hewlett-Packard 400C connected to the output. In absence of a sensitive meter, a standard VU Meter preceded by a flat amplifier with at least 20 db gain can be used. Response will be within the limits indicated in the Specifications.

2. 15 Inch Response:

Make the response check approximately 10 db below operating level to avoid saturation effects. Response will be within the limits indicated in the Specifications.

B. Overall Noise Measurements:

Overall wide band noise should be measured with a Vacuum Tube Voltmeter such as Hewlett-Packard 400C while playing back a tape that has previously been erased on the machine. First, erase the tape with the input to the record amplifier shorted. Rewind and play this tape back. At the 7-1/2 inch and 15 inch speeds the wide band noise should be at least 49 db below operating level (point of approximately 1% total harmonic distortion). At the 3-3/4 inch speed for Models 404 and 405, the noise should be at least 44 db below operating level. No attempt should be made to measure wide band

noise while simultaneously recording and playing back as leakage of the 100 KC bias into the playback head may interfere with the measurement.

### C. 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.

### D. Flutter and Wow:

Flutter and Wow are the change of speed over a short time interval in a periodic manner. They can be measured by means of a standard flutter bridge such as W. F. Tatum (Beverly Hills, California) Model 2-A Flutter Meter. 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 .2% at 15 inch, .25% at 7-1/2 inch and .3% at 3-3/4 inch speed.

For more information on alignment or performance checking, refer to SECTION VI - Alignment.

## OPERATING PROCEDURE

I. REEL SIZE:

The turntable on the left side (tape supply) is equipped to handle either the NARTB 10-1/2" reel of tape or the smaller R. M. A. 5" and 7" sizes. On console or portable machines position the small reels on the turntable engaging the turntable keys. For the large 10-1/2" reel, use the black plastic Centering Guide (Catalog #976) that has been provided. On rack mount machines, use the Hold-Down Knob (Catalog #4402) with both small and large reels.

The #4402 reel hold-down knob works in the following manner. A removable pin in the bottom surface of the knob engages a corresponding hole in the turntable. A collet grips the turntable shaft when the top of the knob is rotated. Two spring loaded balls hold the reel to the turntable. A pin in the side of the knob drives the reel. The knob should be positioned on the NARTB reels so that the removable pin engages one of the turntable holes and approximately two thirds of the ball is exposed above the reel. The knob should not be pushed down all the way, but should stick up above the turntable. Once the knob is positioned correctly, the NARTB reels may be removed without removing the knobs. When using the knob with the small RMA reels, unscrew the removable pin. The knob is used only to prevent the reel from falling off the turntable, since three keys in the turntable drive and center the reel. Lock the knob to the shaft, avoiding excess pressure on the reel which could distort the reel flanges.

The turntable on the right side (Takeup Reel) is designed to handle only the NARTB 10-1/2" reel. No attempt should be made to use the small reel sizes on this turntable as the performance of the recorder will be seriously impaired.

II. TAPE THREADING:

Thread the tape as indicated in Figure 16. All new factory wound reels should be unwound and inspected by running through at Fast Forward before using them in the Play mode of operation. 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 of the reel. This will prevent the Safety Switch (S501) from disengaging the Capstan Idler (50) from the Capstan (A) which results in a flat being worn on the Rubber Capstan Idler Wheel. Any adhesive material accumulation on the reel hub must be removed with solvent for the same reason.

III. HALF-TRACK OPERATION:

The handling of half-track tapes on this machine is accomplished in the following manner. The tape is threaded and operated as described under TAFE THREADING and TAFE MOTION. However, only the upper half of the tape will be used on the half-track machine. 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.

#### IV. POWER:

Power is supplied through Power Switch (S406), which must be turned on to operate the Electronic and Mechanical Assemblies. The Mechanical Assembly and Electronic Assembly are individually fused by the 2 ampere Control Circuit Fuse (F402) and the 1 ampere Electronics Fuse (F401).

#### V. SPEED SWITCHES:

There are two switches associated with operating speed. Speed Switch (S502) governs the motor, and the Equalization Speed Switch (S402) corrects the equalization in the amplifiers.

#### VI. TAPE MOTION:

The tape motion is controlled by means of four pushbuttons labeled Stop, Start, Fast Forward, and Rewind.

1. Play or Record: The tape is set into Play motion at the speed selected by the Speed Switch when the Start Button (S507) is depressed. The tape must be completely stopped before starting in this mode. To change from Play mode to the Record mode with the tape in motion, press the Record Button (S403).
2. Stop: To stop the tape motion while it is moving in any mode press the Stop Button (S506). This will occur automatically if the tape should break or run off either reel.
3. Fast Forward: If the tape is in the Play or Record mode, press the Fast Forward Button (S504). If the tape is stopped, first press the Start Button, then the Fast Forward Button or press both at the same time. This provides a Fast Forward speed which is used to arrive rapidly at a point within a reel.
4. Rewind: If the tape is in the Play or Record mode, press the Rewind Button (S505). If the tape is stopped, press the Start Button then the Rewind Button or press both at the same time. This provides a fast reverse to rewind a tape completely or to return to an earlier section. 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. It is not possible to switch from Rewind to Fast Forward or vice versa unless the machine is returned to Stop. Interlocking the machine in this manner provides the least possible wear on the Tape Transport system.

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. Hold down the Stop and Fast Forward or the Stop and Rewind Buttons. Now press the Start Button and control the tape speed with this button. CAUTION: Avoid this operation at high speeds, as it will result in tape breakage if the wrong combination of buttons should be pushed. When the tape is traveling at high speed in the Rewind or Fast Forward mode, the tape will break if the Stop and Start Buttons are pressed in rapid sequence. This is caused because sufficient time is not allowed for the brakes to stop the tape before the Capstan Idler locks the tape to the Capstan.

## VII. PLAYBACK:

To play back a previously recorded tape, turn the Meter and Output Switch, (S405), to the extreme left position designated PLAYBACK. Then start the tape in motion as indicated under PLAY.

For Single Case Portable Models. If the recording was made at the correct level, the VU Meter will peak on O (zero). No attempt should be made to alter the gain of the Playback Amplifier if the meter does not peak on O (zero). Otherwise, the calibration of this meter as a record level indicator will be destroyed. The playback gain will be close when playing any tape recorded to NARTB specifications.

For Rack, Console or Two Case Portable Models. A Playback Level Control has been provided on the front panel to adjust the tape level to plus 4 VU output.

## VIII. RECORD:

To record a new program on previously recorded tape, or on blank tape, turn the Meter and Output Switch (S405) to the second position from the left which is designated RECORD-LEVEL. Turn the Record Level Control (R409) clockwise until the level reads O (zero) on the VU Meter on the most intense program peaks. The program can be audibly monitored through either the Phone Jack (J403S), or the Line Out Connector (J404P) before the tape is in motion. (For correct meter calibration it is important that the Line Out be properly terminated either external to the machine or by use of the Line Out Termination Switch (S404). This direct monitor feature allows the program to be set up through the machine without actually recording during the set up period.

When the program level is properly set, start the tape in motion as indicated under PLAY. Then push the Record Button, (S403). (It is desirable that a delay of at least 1/2 second occur before the Record Button is depressed, as the surge from operating the Start Button may magnetize the record head, thereby increasing the noise level on the tape.) The Record Indicator, (NE401), next to the Record Button will now glow and the machine is recording.

It is desirable to check the record bias and erase currents occasionally. In order to do this, re-position the Meter and Output Switch (S405), to the po-

sitions designated BIAS and ERASE, respectively. The erase is not critical and should read approximately zero on the meter scale. The bias should read between  $-1/2$  and  $+1/2$  on the VU scale. The bias is somewhat critical and must be kept within the indicated range in order to record the higher frequencies at the low tape speed.

The bias is adjusted by means of the Bias Control, (R449) located on the electronic chassis. The meter calibration for bias measurement can be checked as indicated in SECTION VI.

## SECTION IV

### OPERATING THEORY

The purpose of this section is to explain the electrical and mechanical functioning of the Recorder as the machine is operated. An understanding of this functional operation will enable the operator to utilize fully the capabilities of the machine.

I. MECHANICAL ASSEMBLY: Refer to figures in rear of book for circuits and location of parts.

To understand the operation of the Tape Transport Mechanism it is necessary to examine the following assemblies in the various modes of operation:

1. Capstan Drive Motor (24), Figure 18. The Capstan Motor is a synchronous motor whose extended shaft forms the Tape Drive Capstan (A) Figure 16. It has two sets of windings to provide the two tape speeds.
2. Turntable Motor (6) Figure 19. The Turntable Motor is an induction motor which drives either the Tape Supply or Takeup Turntable by means of a Rubber-tired Pulley (7) on its shaft. The motor is positioned to contact either of the turntable Brake Drums (34 and 35), Figure 18, by the Tilt Solenoids (K503 and K504).
3. Capstan Idler (50), Figure 16. The Capstan Idler is positioned by the Capstan Solenoid (K501). In the Play mode of operation the Idler is positioned against the Capstan (A) and drives the tape at a constant speed.
4. Stopping Brakes (36 and 39) Figure 17. The Stopping Brakes are solenoid operated to stop the turntables whenever the machine is stopped.
5. Reel Idler (69), Figure 20. The Reel Idler is provided to smooth out any takeup speed variations in the tape system.
6. Takeup Tension Arm (62), Figure 16. The Takeup Tension Arm provides automatic stop at the end of the reel of tape or if the tape should break.
7. Constant Tension Brake (47), Figure 17. The Constant Tension Brake is mechanically operated by the Constant Tension Arm (44), Figure 16. It



provides constant hold-back tension to the Tape Supply Turntable (27), regardless of the amount of tape on the reel or its size.

When the Power "On-Off" Switch (S406) is thrown, AC voltage is applied to the Electronics Assembly and to the Capstan Motor. Therefore, the Capstan is turning whenever the recorder is turned on, which makes possible the fast start feature. When the tape is threaded the Safety Switch (S501) is actuated by the Takeup Tension Arm (62). This energizes the DC Power Supply which in turn provides power to operate the solenoids and relays.

START: When the Start Button (S507) is pressed the Start Relay (K505) will be energized. It is held energized through its own contacts and the normally closed Stop Button (S506). The Start Relay, through appropriate interlocks, performs the following functions:

1. Energizes the Brake Solenoid (K502) thus releasing the Stopping Brakes (36 and 39).
2. Energizes the Forward Tilt Solenoid (K504) thus positioning the Turntable Motor in the takeup position.
3. Applies AC power through the Takeup Torque Switch (S503) to the Turntable Motor.
4. Energizes the Capstan Solenoid (K501) which positions the Capstan Idler (50) to contact the tape and the Capstan.

The Capstan Solenoid when energized mechanically opens the Takeup Torque Switch which inserts a resistor (R503) in series with the Turntable Motor. This allows the high starting torque to be reduced to a more suitable value for operating conditions. (Full power is utilized in Fast Forward or Rewind.) The recorder is now operating in the Play mode of operation with the tape moving at the speed selected by the Speed Switch (S502).

FAST FORWARD: If the Fast Forward Button (S504) is pressed and the machine is in the Play mode of operation, the Fast Forward Relay (K506) will be energized. The relay performs the following functions:

1. It interlocks the Rewind Relay (K507) so it can not be energized.
2. It breaks the circuit to the Capstan Solenoid.

When the Capstan Solenoid is de-energized the Takeup Torque Switch closes, thus applying full power to the Turntable Motor. Since the Forward Solenoid is still energized the machine is now operating in the Fast Forward mode of operation. If the Rewind Button is pressed nothing will happen and it is necessary to re-

turn to Stop before the mode of operation can again be changed. This interlocking prevents scuffing the Turntable Motor Tire on the Brake Drums.

REWIND: If the Rewind Button (S505) is pressed and the machine is in the Play mode, the Rewind Relay (K507) will be energized. The relay performs the following functions:

1. It interlocks the Fast Forward Relay (K506) so it can not be energized.
2. It breaks the circuit to the Capstan Solenoid (K501) and the Forward Tilt Solenoid (K504).
3. It energizes the Rewind Tilt Solenoid (K503) thus positioning the Turntable Motor in the Rewind position.
4. It reverses the polarity on one winding of the Turntable Motor thus reversing its direction.

When the Capstan Solenoid is de-energized the Takeup Torque Switch closes applying full power to the Turntable Motor. The machine is now operating in the Rewind mode of operation. If the Fast Forward Button is pressed nothing will happen and it is necessary to return to Stop before the mode of operation can again be changed.

STOP: When the Stop Button is pressed during any mode of operation, the Start Relay will be de-energized. This in turn breaks the circuits to the Rewind and Fast Forward Relays and to the circuits described in the paragraph on START. The Stopping Brakes will be applied to both turntables. In addition it applies DC power through a series resistor (R502) to the condenser winding of the Turntable Motor. This brakes the motor and prevents throwing a tape loop when the tape direction is changed.

## II. HEAD ASSEMBLY!

The Head Housing is a die cast assembly which contains the three heads used in the recording process. The heads are respectively Erase, Record and Playback as viewed from left to right when facing the machine. The gate on the housing holds the Playback and Record Shield Covers and the Tape-lifting Fingers. The function of the Tape-lifting Fingers is to remove the tape from the heads when the gate is open during Rewind or Fast Forward position. This reduces head wear considerably. The tape may leave a deposit on the heads if allowed to contact them at high speeds. Such a deposit will seriously impair the performance of the machine and should be guarded against by always opening the gate on Fast Forward or Rewind. If a deposit is left, it may be easily removed with carbon tetrachloride on a soft rag. Never use metal of any kind to touch the head surfaces. The gate should never be allowed to spring shut but should be closed gently.

The Model 400A, 402, and 404 Recorders incorporate half-track Erase, Record, and Playback Heads. These heads function on the upper half of the tape only. In order to use the remaining half of the tape the reels must be turned over as explained in Section III-III. The Head Assembly of the Model 401A, 403 and 405 Recorders incorporate full track Erase, Record, and Playback Heads. This affords maximum performance from the full width of the tape and permits complete interchangeability of tapes recorded on the Models 300, 201 and other full track recorders.

### III. ELECTRONICS ASSEMBLY:

The Electronic Assembly of the Series 400 Recorders consists of a Record Amplifier, a Playback Amplifier and an Erase and Bias Oscillator on one chassis and a Power Supply on a separate chassis.

The Record Amplifier is a four stage, high gain amplifier that feeds the Record Head through the Noise Balance Circuit and Record Relay (R401). The Record Relay is energized by the Record Button (S403) through contacts of the Start Relay (K505) in the energized position and contacts of the Fast Forward Relay (K506) and the Rewind Relay (K507) in de-energized positions. Therefore, the Record mode of operation can only be realized when the tape is traveling at the Play speeds. Whenever the Fast Forward, Rewind or Stop Buttons are depressed, the Record Relay will be de-energized. Three input impedances can be selected by the Input Transfer Switch (S401); low impedance microphone, balanced bridge and unbalanced bridge. The Record Amplifier also provides separate high frequency pre-emphasis for each speed. This change in equalization is made by the Equalization Speed Switch (S402) located on the front panel. The Record Gain Control (R409) is located on the front panel.

The Playback Amplifier is a three stage amplifier which provides a plus 4 VU 600 ohm output at the Line Out Connector (J404). The Playback equalization is the same for the 7-1/2 and 15 inch speeds and is adjusted to the Standard curve (Fig. 1) by R432, located on top of the Electronic chassis. The 3-3/4 inch Playback equalization conforms to the curve in Fig. 2 but is not adjustable. The playback gain on single case portable models is controlled by a fixed screw driver adjustment R437 which should not be varied in the normal operation of the machine. On all other models the gain may be adjusted by the Playback Level Control R437 located on the front panel. An output termination is provided by the Line Out Termination Switch (S404).

Monitoring is provided by a VU Meter and a Phone Jack which is connected to the Playback Amplifier output. The Meter and Output Switch (S405) provides four monitoring checks: Playback Level, Record Level, Bias Current, Erase Current. In the Erase position the VU meter is connected across the 7 ohm resistor (R448) to read erase current. In the Bias position the meter is connected across the adjustable 500 ohm resistor (R450) to read bias current. In both the Record and Playback Level positions the meter is connected across the Playback Amplifier output. In the Playback position the Playback Amplifier functions normally and the output of the tape is monitored. In the Record position the last two stages of the Playback Amplifier are disconnected from the first stage and bridged across the Record Amplifier before pre-emphasis through the Record Level Meter Calibration Control (R413). The Calibration Control is factory adjusted so that the desired record level will be effected on the tape.

The Erase and Bias oscillator provides the 100 KC erase and bias

frequency. It feeds the erase head through the Erase Trimmer (C435) and the record head through the Record Bias Control (R449). The Power Supply provides the 6.3 Volt AC heater power, the 12.6 Volt DC heater power through a full wave selenium rectifier (SR601) and the plate supply through the 5Y3G Full Wave Rectifier (V601).

## SECTION V

### ROUTINE MAINTENANCE

#### I. CLEANING:

The Tape Transport Mechanism should at all times be kept clean and dry. The following parts should be inspected daily before the use of the recorder and cleaned with a soft rag and carbon tetrachloride or alcohol, if necessary. Refer to Figure 16.

1. Head surfaces contacted by tape.
2. Capstan (A).
3. Capstan Idler (50). Cleaning is required only if foreign matter should adhere to the rubber.
4. Capstan Tape Guide (89).
5. Constant Tension Arm Tape Guide (45).
6. Reel Idler Pulley (71).
7. Takeup Tension Arm Tape Guide (J).

#### II. HEAD DEMAGNETIZATION:

Occasionally the heads may become magnetized through an electrical fault in the amplifiers, improper use of the machine, or by the heads coming in contact with a magnetized object. This will result in an increase of noise level from 5 to 10 db. It is especially important that the heads be free of magnetization if you are to realize the dynamic range of the machine. It should be remembered that any phenomena that tends to put an unbalanced pulse through the Record Head will magnetize it. Such pulses can appear in the form of signal or power line pulses. If the following precautions are observed, no difficulty should be experienced:

1. Do not remove any tube from the Record Amplifier while the machine is recording.
2. Do not connect or disconnect input leads or head leads while recording.
3. Do not depress the Record Button until after depressing the Start Button. In other words, allow the transient caused by switching the motors and solenoids to die out before the record head is connected. A one-half second pause is sufficient.

4. Do not saturate the Record Amplifier with an abnormally high input signal. Such a signal would be 10 db greater than tape saturation or approximately 30 db greater than normal operating level.
5. Do not test continuity in the heads with an ohm meter.

Should the heads become magnetized, they can be demagnetized with an AMPEX Head Demagnetizer (Catalog #704). The following Demagnetization Procedure should be performed: Bring the tip of the Demagnetizer in direct contact or close proximity to the head core stack. Run the tip of the Demagnetizer up and down the entire height of the core stack three or four times. Remove the demagnetizer very slowly, allowing the AC field to die off gradually. Repeat this operation on Record and Playback Heads only, as the Erase Head will demagnetize itself. In the event demagnetization is not effected, repeat the process several times.

#### IV. LUBRICATION:

The following places require lubrication once or twice a year depending upon the amount of usage of the machine:

- I. Capstan Drive Motor (24) and Turntable Motor (6).

The motor manufacturers recommend the following lubricants for their respective motors:

Eastern Air Devices-Sacony Vacuum Oil Company-S. A. E. #20

Bodine Electric Company-Gulf Oil & Refining Company-Gulcrest A

Standard Oil Co. of Indiana-Stanoil #18 or #16

Sacony Vacuum Oil Co. -Cargoyle D. T. E.

Light

If equivalent oils are to be used, a representative of the oil company should be contacted to ascertain that the equivalent is miscible with the lubricants listed above. Otherwise, sludging may result.

- A. Capstan Drive Motor. The Upper Sleeve Bearing on this motor requires lubrication. Pry off the Capstan Dust Cap (26) shown in Figure 16. The oil hole on the motor is located near the outside edge of the cutout and in some cases may be partially obscured. Lubricate with 10 drops of the recommended lubricant, preferably using an oil can with flexible spout.
- B. Turntable Motor. The recorder may be equipped with different types of turntable motors. If the turntable motor has oil cups or oiling holes, it requires 10 drops of the recommended lubricant. Raise or remove the Tape Transport Top Plate to expose the oil holes. Refer to Section III for access into the console cabinet or portable case. If the motor is supplied with ball bearings (no oil cups or oiling holes), lubrication is not required.

2. Reel Idler Upper Bearing (72). Refer to Figure 20. Remove the Plug Button (74) and lubricate with one drop of SAE 20 motor oil.

The following places have been lubricated at the factory with Dow-Corning DC-44 Silicone Grease (light consistency). No further lubrication should be necessary unless the grease becomes contaminated with dirt in which case the part should be cleaned and re-lubricated.

1. Capstan Idler Arm Bushing (4), Figure 19.
2. Constant Tension Arm Bushing (5), Figure 19.
3. Capstan Solenoid Eye Bolt (54), Figure 17.
4. Reel Idler Thrust Bearing (86), Figure 20.
5. Safety Switch Level (S501), Figure 17.

The Takeup Tension Arm Bushing (3), Figure 17, has been lubricated at the factory with Dow-Corning DC-200 oil. No further lubrication should be necessary unless the oil becomes contaminated with dirt in which case the part should be cleaned and re-lubricated. If DC-200 oil is not available, SAE 20 motor oil can be used.

The following places require no lubrication and should be left dry:

1. Brake Shoe pivot on the Constant Tension Brake (47), Figure 17.
2. The armatures of all solenoids.
3. Brake Solenoid Link (13), Figure 18.
4. Tilt Solenoid Spade Bolts (14), Figure 18.

#### V. BRAKE LINING:

Periodic inspection should be made of the Brake Linings on the Stopping Brakes, (36 and 39), Constant Tension Brake (47) and the Hold Eack Brake (22), as worn linings will result in damage to the surface of the Brake Drums. These linings are made of high grade felt but they may require replacement after long service. The linings are supplied by the factory cut to size. For ordering information, see Parts List, Section IX.

The recommended method of applying Brake Lining is described below:

1. Remove both Brake Drums (34 and 35) as described in Section VIII-4.
2. Remove old lining and scrape the shoe clean. It is not necessary to remove the brakes to do this.
3. Spread a liberal amount of DuPont Household Cement or equivalent on the brake shoe; excessive cement should be avoided as it will soak through the Brake Lining.



4. Position the felt carefully so it lines up with the outside edges of the shoe and allow at least 30 minutes for cement to dry.

CAUTION: Be sure that cement is not allowed to remain on working surfaces.

5. Replace the Brake Drums and adjust the turntable and Brake Drum height as described in Section VIII-4. A number of stops may be necessary to bring the stopping energy of the brakes up to normal. Sanding the Brake Drums as described in Section VIII-2 will hasten this process. Do not touch the surface of the Brake Drum after sanding.

In an emergency any good quality 100% wool felt may be cut to size and used as linings. They should, however, be replaced as soon as possible with factory linings. If a felt containing nylon should be used, a brown residue will be deposited on the drums. This should be removed with sandpaper as explained in Section VIII-2 when factory linings are applied.

## SECTION VI

### ELECTRONIC ALIGNMENT

Alignment is the necessary adjustments required to have the Electric Assembly of the tape recorder perform properly. A machine "out of alignment" may be characterized by poor frequency response, high noise, low output, or high distortion. It should not be necessary to align the recorder when it comes to you from the factory. The procedures described on the following pages have been performed at the factor prior to shipment. Further adjustments are not required except as found necessary in routine maintenance.

Alignment consists of the following steps:

- I Head Alignment
- II Playback Circuit Alignment
- III Record Circuit Alignment
  - 1. Bias Adjustment
  - 2. Record Level Meter Calibration
  - 3. Record Equalization
    - A. 15 inch per second
    - B. 7-1/2 inch per second
  - 4. Noise Balance
- IV Erase Adjustment

Standard Alignment Tape #4494 is available for alignment purposes. It is recorded at 15 inches per second, 10 db below 15 inch operating level. It contains a 15 KC tone for head azimuth check, a reference tone for level adjustment, and a series of tones for a playback response check. **IMPORTANT:** Before playing the standard tape, demagnetize the heads with the AMPEX Head Demagnetizer, Catalog #704. Magnetized heads will cause a partial erasure of the high frequencies on the standard tape.

## I. HEAD ALIGNMENT:

The high frequency response of the recorder depends on the correct head alignment. If tapes are to be interchangeable from one machine to another the heads of all machines must have the same azimuth setting. This is accomplished by using a Standard Tape (Catalog #4494 ), for aligning the heads of all machines. Head alignment is independent of tape speed; however, it is recommended that the heads be aligned at 15 inches per second since the standard tape is recorded at this speed.

Remove the top cover from the Head Housing by removing the two screws from the top and pulling cover gently back and up. Looking at the Head Housing from the front the three heads from left to right are: Erase, Record, and Playback.

The azimuth angle of the erase head is not adjustable.

The Record and Playback Heads should be aligned only after reading and fully understanding the procedure under PLAYBACK AND RECORD CIRCUIT ALIGNMENT.

The actual physical alignment of the Record and Playback Heads consists of placing a 1/4" spintite socket wrench on the left hand elastic stop nut in each head and adjusting back and forth until the proper azimuth angle is arrived at.

First adjust the Playback Head azimuth by playing the standard tape at 15 inches per second and adjusting the stop nut for the maximum output of the 15 kc tone ( first tone that appears on the standard tape).

The Record Head azimuth is then aligned with the Playback Head by recording a 15,000 cycle signal from an audio oscillator on a blank tape and adjusting the record stop nut for maximum playback output.

## II. ALIGNMENT OF PLAYBACK CIRCUIT: Refer to Figure 1 or 2.

1. Position the Electronic Assembly so that adjustments can be made on the controls located on the top of the chassis.
2. Set the Tape Speed Switch (S502) and Equalization Speed Switch (S402) to 15 inches per second.
3. Set the meter and Output switch (S405) to the PLAYBACK-LEVEL position.
4. Terminate the line output either by means of the Line Out Termination Switch (S404) or by external termination of 600 ohms.
5. Connect an amplifier and loudspeaker to the output or plug in a pair of high impedance head phones so that voice announcements on the standard tape can be heard.
6. Thread the standard tape on the machine and set the tape in motion in the Play mode of operation.
7. Adjust the playback head azimuth as discussed under HEAD ALIGNMENT.
8. The second tone on the standard tape is used to adjust the playback gain. Adjust the Playback Level Control (R437) for a reading of -10 on the VU meter. On the Model 400A and 401A, R437 is a screw driver control, which should be locked after this adjustment. On the Model 402 and 403, R437 is a front panel control. IMPORTANT: Retain this setting until the Record Level Meter Calibration has been adjusted.
9. PLAYBACK EQUALIZATION: The Playback Amplifier is factory equalized by means of the High Frequency Playback Equalizer (R432) Figure 11 or 14, in accordance with the standard voltage curve shown in Figure 8. The recommended method for adjusting the Playback Amplifier response is to connect an audio oscillator and vacuum tube voltmeter to the Playback Amplifier as shown in Figure 8. Adjust the Playback Equalizer (R432) to give the frequency response of the standard 50 micro-second curve. Deviation from this curve is not recommended. Check the playback level setting with a standard tape if any change is made in the Equalizer.

The above will properly align the playback circuit for operation at both speeds.

The 15 inch standard tape will play back within  $\pm 2$  db to 15,000 cycles when the Playback Amplifier is adjusted to the standard curve. Failure for the standard tape to play back within these tolerances after the Playback Amplifier has been aligned indicates one of the following:

- a. Trouble in the Head Assembly such as worn heads.
- b. A faulty Standard Tape which has been partially erased at high frequencies by passing over magnetized heads, etc.

An overall frequency response check will isolate the trouble. Good overall response indicates a faulty Standard Tape. Poor Overall response indicates one of the following:

- a. Faulty Heads
- b. Tape deficiency
- c. Record or Playback Amplifier improperly equalized.
- d. Incorrect bias

Alignment of the Record Circuits as described in the next sub-section will further aid in isolating trouble.

### III. ALIGNMENT OF THE RECORD CIRCUITS: Refer to Figure 1 or 2.

The 7-1/2 inch and 15 inch per second record alignment should not be attempted until the playback is properly aligned.

Perform the following in order indicated:

1. Bias Adjustment: The record bias current is factory adjusted for optimum overall response and low frequency distortion. However, the optimum value of bias current will vary with different types of tape. The record equalization characteristics on this equipment have been determined for peak bias at 1000 cycles at 15 inch per second tape speed. Peak bias means that the bias current is adjusted so that the 1000 cycle signal is recorded at its maximum level. Adjust the bias in the following manner:
  - a. Thread a blank tape on the machine. Terminate the playback amplifier as in Playback Alignment. Set the Speed Switches (S402 and S502) to 15" per second. Set the meter and Output Switch (S405) to the Playback Level position.
  - b. Connect an audio oscillator to the Input Connector (J401S), set the Input Transfer Switch (S401) for unbalanced bridging input and adjust the frequency to 1000 cycles per second.
  - c. Start the machine in the record mode of operation.
  - d. Adjust the Record Level Control (R409) so the meter reads approximately 0 (zero).
  - e. Adjust Bias Control (R449) for maximum playback level of 1000 cycle tone while recording the playing back simultaneously. It is desirable to be within 1/2 db of the maximum efficiency point in order to achieve wide frequency range recording at 7-1/2" per second.
  - f. The Bias Meter Calibration is adjusted as follows: After the bias is adjusted, meter the bias in the normal fashion and adjust the Meter Shunt (R450) for 0 (zero) reading on the VU scale of the meter.

2. Record Level Meter Calibration: The Record Level Meter Calibration Control (R413), Figure 11 or 14, is adjusted so that the program level as read on the VU meter is the same as monitored from the Playback Head or the incoming line. This is accomplished by recording a 250 cycle tone (or program in the absence of an audio oscillator) at 0 (zero) on the VU meter with the Meter and Output Switch in the PLAYBACK-LEVEL position. Then switch the Meter and Output Switch to the RECORD-LEVEL position and adjust the Record Level Meter Calibration Control for 0 (zero) on the VU meter. IMPORTANT: The Playback Level Control (R437) must be set as described in Playback Alignment before making this adjustment.
3. Record Equalization: The 7-1/2 inch and 15 inch record equalization circuits have been factory adjusted to the curves shown in Figure 9. These curves have been found to produce flat overall response, when recording on Minnesota Mining and Manufacturing Company type 111 tape, construction 5RBA, or later. Other tapes may require resetting or equalization and Bias Control. Badly worn tapes may produce loss in high frequency response at the 7-1/2 inch speed and should not be used.

The adjustment procedure for flat overall response on any tape is as follows:

A. 15 Inch Record Equalization Adjustment

1. Set up the machine as described under Bias Adjustment.
2. Start the machine in the record mode of operation at the 15 inch tape speed.
3. Reset the audio oscillator to 15,000 cycles and adjust the record head azimuth as described under Head Alignment. NOTE: All frequency checks at the 15 inch tape speed should be made 10 db below operating level (-10 on the VU meter monitoring record) to avoid saturation effects caused by the high frequency preemphasis. On the Model 402 and 403 the front panel Playback Level Control may be set for increased gain so the following adjustments can be made in a more sensitive meter range.
4. Reset oscillator to 250 cycles and adjust the Record Level Control (R409) so the VU Meter monitoring playback reads -10.
5. Reset oscillator to 8,000 cycles and adjust the 15 inch Record Equalizer so the VU meter monitoring playback reads -10.
6. Frequency response should be  $\pm 2$  db 30 to 15,000 cycles.

## B. 7-1/2 Inch Record Equalization Adjustment

1. With the machine set up as above, change the Speed Switches (S402 and S502) to the 7-1/2 inch position.
  2. Reset oscillator to 250 cycles and adjust the Record Level Control so the VU meter monitoring playback reads -10.
  3. Reset oscillator to 8,000 cycles and adjust the 7-1/2 inch Record Equalizer so the VU meter monitoring playback reads -10.
  4. Frequency response should be  $\pm 2$  db from 40 to 8,000 cycles. Due to tape saturation, frequency checks can not be made at this level beyond 8,000 cycles. To run response checks beyond 8,000 cycles refer to Overall Performance Check, Section II-XI.
4. Noise Balance: A noise balance control is provided to eliminate excessive low frequency noise and null second harmonic distortion. The noise balance should not be touched unless all heads have been thoroughly demagnetized with an AMPEX Head Demagnetizer or equivalent (See Section V). If noise of a crackling nature is still found to exist in the output of the machine, connect a 1 MFD condenser across the output of the machine and adjust the Noise Balance Control (R424), Figure 11 or 14, for minimum record noise as read on a sensitive meter or heard in a loudspeaker connected to the machine output through a power amplifier.

IV. ERASE ADJUSTMENT: The erase current is factory adjusted and no further adjustment should be necessary unless the Erase Head is replaced. Should this happen, the following procedure must be followed:

- a. Set the Meter and Output Switch (S405) in the Erase position and press the Record Button (S403).
- b. Back off the Erase Trimmer (C435), Figure 11 or 14, to a minimum capacity (clockwise direction).
- c. Increase the capacity until the meter reads 0 (zero).
- d. Check the bias current after making this adjustment since a change in erase current will produce a change in bias current.

## SECTION VII

### MECHANICAL SERVICE GUIDE

This section is a guide to locating irregularities in the operation of the Tape Transport Mechanism of this recorder. Sources of irregularities in the Electronic Assembly have not been included in this book since standard electronic maintenance techniques apply. This section is divided into the following four parts:

- I. Failure to Start.
- II. Irregularities in Play Mode.
- III. Irregularities in Rewind or Fast Forward Mode.
- IV. Miscellaneous.

To use this section first decide into which of the above groups the trouble lies. Check the list of symptoms in the group to further localize the trouble. Investigate each of the parts listed under the appropriate symptoms to detect incorrect adjustments or possible defects. Refer to Section VIII for the correct mechanical adjustment procedures. The numbers in parentheses are reference numbers which refer to the figures in the rear of the book.

#### I. FAILURE TO START.

##### A. Capstan Drive Motor inoperative at one or both speeds. Check the following:

1. AC Power to the recorder.
  - a. Control Circuit Fuse (F402).
  - b. Power Cable from Mechanical Assembly to Electronic Assembly.
  - c. Capstan Drive Motor Connector (J502P).
  - d. Speed Change Switch (S502).
  - e. Jumpers from 1 to 2 and 3 to 4 on 60 Cycle Amplifier Terminal Strip (TS501). NOTE: Machines equipped for "plug in" of 60 Cycle Amplifier must have properly jumpered Dummy Plug (catalog #567) inserted in the 60 Cycle Amplifier Connector (J703S) in absence of the 60 Cycle Amplifier.
2. Head cables interfering with Drive Motor Flywheel.



3. Capstan Drive Motor (24) for binding of shaft, open or shorted winding.
  4. Drive Motor Capacitor (C508).
- B. Machine does not operate or trips itself off when Start Button is depressed. NOTE: Before making these checks read Section III-II on Tape Threading. Check the following:
1. Switches
    - a. Safety Switch (S501). For adjustment, See Section VIII-10.
    - b. Stop Button (S506).
    - c. Start Button (S507).
    - d. Takeup Torque Switch (S503). For adjustment, see Section VIII-7.
  2. DC Relay and Solenoid Power Supply.
    - a. Selenium Rectifier (SR501).
    - b. Resistor (R501).
    - c. Electrolytic Condenser (C502).
  3. Relays.
    - a. Start Relay (K505).
    - b. Rewind Relay (K507).
    - c. Fast Forward Relay (K506).
  4. Solenoids.
    - a. Capstan Solenoid (K501). For adjustment, see Section VIII-1.
    - b. Forward Tilt Solenoid (K504). For adjustment, see Section VIII-8.
    - c. Brake Solenoid (K502). For adjustment, see Section VIII-2.
  5. Play Resistor R503 for an open circuit.
  6. Jumper from Terminal 7 to 8 on the Remote Control Terminal Strip (TS502). NOTE: Machines equipped for "plug in" of Remote Control must have the properly jumpered Dummy Plug (catalog #3461) inserted in the Remote Control Connector (J701S) in absence of a Remote Control System.

7. Binding of Turntable Motor Pivots (18) and (19).
8. Cables interfering with the Brake Drums (34) and (35).
9. Counterbalance Spring (65) in rack mount position on portable machines. See Section II-VII.

## II. IRREGULARITIES IN PLAY MODE.

### A. Unsatisfactory starting in Play Mode. Check the following:

1. Takeup Torque Switch (S503) for adjustment. (May be opening too early.) See Section VIII-7.
2. Binding of Turntable Motor Pivots (18) and (19) may cause late engagement of Turntable Motor.
3. Tilt Solenoids (K503) and (K504) if misadjusted can cause slippage or late engagement of Turntable Motor (B502). See Section VIII-8.
4. Insufficient takeup torque in the Play mode.
  - a. Play Resistor (R503) set too high. See Section VIII-9.
  - b. Cable interfering with Takeup Brake Drum (35).
5. Stopping Brakes (36) and (39).
  - a. Dragging brakes.
  - b. Brake Clearance adjustment too great so that brakes are slow in releasing. See Section VIII-2.
6. Capstan Idler pressure adjustment. See Section VIII-1.
7. Takeup Tension Arm (62) sluggish.
8. Constant Tension Brake (47) adjustment. See Section VIII-3.
9. Low relay and solenoid supply voltage which would slow down the relay and solenoid operation time.

### B. High flutter. The low flutter specifications on this equipment are rigidly met. Any noticeable flutter can probably be traced to one of the following:

1. Cable dragging on
  - a. Takeup Brake Drum (35).
  - b. Reel Idler Flywheel (78).
  - c. Capstan Drive Motor Flywheel.
2. Foreign material such as deposit left by the tape on
  - a. Capstan (A), Figure 16.
  - b. Reel Idler Pulley (71), Figure 20.
  - c. Capstan Idler (50), Figure 16.
  - d. Turntable Motor Tire (7), Figure 19.
  - e. Takeup Brake Drum (35), Figure 18.
  - f. Head Surfaces.
  - g. Tape Guides (45), (89), and (J), Figure 16.
3. Excessive drag in Reel Idler (69). If Reel Idler is quiet and turns freely, it is not likely to contribute to the flutter and should not be disassembled. If the Reel Idler will not turn freely or is noisy, check the following. Refer to Figure 20.
  - a. Reel Idler Adjustment. See Section VIII-6.
  - b. Top Bearing (72) insufficiently lubricated. See Section V-IV.
  - c. Thrust Bearing (86) worn.
  - d. Foreign material in Lower Bearing (75).
4. Capstan Drive Motor (24).
  - a. Top Bearing insufficiently lubricated. Do not over-lubricate. See Section V-IV.
  - b. Bent Capstan (A).
  - c. Motor windings partially open or shorted.
5. Capstan Idler (50) defective.
6. Takeup Torque Switch (S503) (not opening). See Section VIII-7 for adjustment.
7. Bad Tape (worn, ragged, or of poor quality).
8. Recorder subjected to excessive external vibration.

C. Recorder fails to shut off when tape runs out. Check the following:

1. Takeup Tension Arm (62) sluggish due to:
  - a. Dirt between Takeup Tension Arm (62) and Bushing (3).
  - b. Takeup Tension Arm Return Spring (64) disconnected or broken.
  - c. Safety Switch (S501) inoperative or out of adjustment. See Section VIII-10.
  - d. Safety Switch Condenser (C501) shorted.

D. Instability of Tape on Capstan. Check the following:

1. Oil on Capstan (A) or Capstan Idler (50).
2. Takeup Torque Switch (S503) not opening causing excessive takeup tension. See Section VIII-7 for adjustment.
3. Capstan Idler Pressure Adjustment. See Section VIII-1.
4. Capstan Solenoid (K501) (not seating).
5. Constant Tension Brake Spring (49) disconnected or broken.
6. Constant Tension Arm (44) binding in Bushing (5).
7. Bad Tape (stretched edges or bad splices).

E. Recorder goes into Fast Forward Mode when Start Button is depressed. Check the following:

1. Capstan Idler Pressure Adjustment. See Section VIII-1.
2. Capstan Solenoid (K501) for defect.

III. IRREGULARITIES IN FAST FORWARD OR REWIND MODE.

A. Recorder stops when Fast Forward or Rewind Buttons are depressed. Check the following:

1. Fast Forward Button (S504).
2. Rewind Button (S505).
3. Fast Forward Relay (K506).
4. Rewind Relay (K507).
5. Rewind Tilt Solenoid (K503). For adjustment, see Section VIII-8.

B. Recorder sluggish in Fast Forward or Rewind. Check the following:

1. Takeup Torque Switch (S503) (stays open). See Section VIII-7 for adjustment.
2. Cable Dragging on either Brake Drum (34 or 35).
3. Stopping Brakes (36 and 39).
  - a. Dragging Brakes.
  - b. Brake Solenoid (K502) loose or inoperative. See Section VIII-2.
4. Turntable Motor (6) for insufficient lubrication. See Section V-IV.
5. Slippage between Turntable Motor Tire (7) and Brake Drums (34 or 35).
  - a. Tilt Solenoid (K503 and K504). For adjustment see Section VIII-8.
  - b. Oil on Brake Drums (34 or 35) or Turntable Motor Tire (7).
  - c. Binding of Turntable Motor Pivots (18 and 19).

IV. MISCELLANEOUS IRREGULARITIES

A. Braking too severe causing breaking or deformation of tape.

1. Binding of Brake Arm Pivot, Figure 17 point G. See Section VIII-2A for adjustment.
2. Brake Solenoid Stop (67) deformed. See Section VIII-2B.

B. Braking insufficient causing tape slack to be thrown when the machine is stopped.

1. Brake Drum contaminated with oil or grease. See Section VIII-2F, for cleaning procedure

C. Braking rotationally uneven.

1. Brake Drum contaminated with oil or grease. See Section VIII-2F for cleaning procedure.

## SECTION VIII

### MECHANICAL ADJUSTMENTS

The mechanical adjustments described below have been made at the factory prior to shipment of the machine. No further adjustments should be necessary except as required by routine maintenance if irregularities should occur in the operation of the machine. CAUTION: When returning the Mechanical Assembly to the portable case after making adjustments, make sure the cables do not interfere with moving parts.

The following mechanical adjustments are described:

1. Capstan Idler Pressure Adjustment
2. Adjustment of Braking System.
3. Constant Tension Brake Adjustment.
4. Turntable and Brake Drum Height.
5. Rewind Holdback Brake Adjustment.
6. Reel Idler Adjustment.
7. Takeup Torque Switch Adjustment.
8. Forward and Rewind Tilt Solenoids Adjustment
9. Play Takeup Torque Adjustment.
10. Safety Switch Adjustment.

The numbers in the parentheses are reference numbers and refer to the figures in the rear of the book.

1. Capstan Idler Pressure Adjustment.

The Capstan Idler (50) is positioned to contact the Capstan (A) by the Capstan Solenoid (K501). The pressure is adjusted by a lock nut on the Capstan Solenoid Eye Bolt (54). See Point B, Figure 17. Tightening this nut causes greater pressure until a point is reached where the Capstan Solenoid will not seat or bottom. At this point the pressure is very low and the nut must be backed off. Excessive pressure should also be avoided as it throws unnecessary load on the Upper Drive Motor Bearing.

The recommended method for adjusting this solenoid is to take up on the adjusting nut (B) until the Capstan Idler (50) just touches the Capstan (A) when the Capstan Solenoid (K501) is bottomed. Then turn the nut an additional 2-1/2 turns. CAUTION: Make sure the solenoid will bottom after this adjustment. If not, the solenoid or linkage is defective. When adjusted as above, sufficient drive force exists under all operating conditions to prevent tape slippage unless the Capstan Idler should become contaminated with oil or foreign matter.

## 2. Adjustment of Braking System.

The braking system in this machine is designed to retain its adjustments over extremely long periods of time. The following explanation and adjustment information will be of value if it becomes necessary to replace parts in the braking system or to clean the Brake Drums.

It is necessary that each reel have considerably more braking force in one direction than the other. This is often referred to as "Brake Differential". The braking force can be easily measured by attaching a piece of string about 30 inches long to the hub of the NARTB reel, the other end being attached to a spring scale (0 to 64 oz. preferred) Wind the string around the hub and pull the scale evenly. Take the reading only while the turntable shaft is in steady motion as the force required to overcome the static friction of the system will be considerably higher than that of the actual braking force. Most scales when operated in the horizontal plane will show a zero setting different from the normal scale zero. The scale readings should be corrected accordingly. In measuring forces on the Tape Supply Reel, hold the Constant Tension Arm (44) firmly in the direction of the Capstan (A) as this is also a brake and should not be included in the reading of Tape Supply braking force.

The following braking forces are optimum:

Tape Supply Reel (with Constant Tension Arm held "off")

Clockwise	3 oz. / 1 oz.
Counterclockwise	18 oz. / 2 oz.

Takeup Reel

Clockwise	28 oz. / 3 oz.
Counterclockwise	8 oz. / 1 oz.

The following adjustments should be performed in the sequence indicated if a part in the braking system is replaced.

#### A. Brake Arm Pivot.

The Brake Arm Pivots are adjusted by a lock nut, Figure 17, Point G, so the Brake Arms (38 and 39) will slide freely in their slots. Considerable vertical play can be tolerated at the end of the Brake Arm. Tighten the lock nut down until it bottoms on the Arm. Then back off 1/8 turn or more as required to eliminate any drag or bind in the Brake Arm. An excessively high brake differential can usually be traced to this adjustment.

#### B. Brake Supply Brake Shoe Clearance.

1. Loosen or fasten the Takeup Tension Arm (62) in the operating position. Place the Mechanical Assembly in a position so that the Brake Shoes can be observed and start the recorder.
2. Loosen the two screws that secure the Brake Solenoid (K502) to the Solenoid Mounting Bracket. See Figure 18, Point C. Slide the Solenoid in the required direction to establish a clearance of 1/64 to 1/32 inch between the Brake Lining and the Brake Drum. Tighten the Solenoid screws securely when the adjustment is correct. As Brake Linings wear the clearance will increase slightly, but this will not affect the performance of the machine.

#### C. Takeup Brake Shoe Clearance.

The Takeup Brake Clearance is adjusted by the Brake Rod Adjusting Clamp (43) to provide a clearance of 1/64 to 1/32 inch between the Brake Lining and the Brake Drum when the Brakes are released (Brake Solenoid energized). Tighten the set screw (43) securely. The Brake Rod Retaining Ring (100) is placed on the Brake Rod to prevent the Rod being detached from the Brake. Be sure there is at least 5/32 inch clearance between this Ring and the Brake Arm.

#### D. Brake Pivot Spring Position.

Three holes are located in each Brake Arm to anchor the Brake Pivot Spring (98). Anchoring this spring in the middle hole will normally provide the optimum braking forces previously listed. If this is not the case, move the spring to the hole required to produce the correct braking forces. If the forces should be considerably lower than the optimum values and do not change when the Pivot Spring is moved, contamination of the Brake Drums or Brake Linings is indicated. Clean the Drums as described on the next page under F.



### E. Brake Solenoid Stop (67).

The clearance between the end of the Brake Solenoid plunger and the Stop should be 3/16 inch when the plunger is bottomed. Adjustment is accomplished by bending the Stop Bracket (67) to provide the aforementioned clearance. Be sure that the Stop catches the plunger of the Solenoid but does not drag on the linkage. Improper adjustment will result in excess braking differential.

### F. Brake Drum Cleaning Procedure.

In servicing the recorder the Brake Drums (34 and 35) may become contaminated by handling, or by oil or grease getting on them. Mild cases of contamination will soon disappear through the normal operation of the machine. The Brake Shoe may chatter until the contamination wears off. In such cases cleaning is not necessary if the recorder handles the tape satisfactorily. If operation is unsatisfactory, clean both brake drums as follows:

1. Hold a piece of #320 wet-or-dry sandpaper firmly against the braking surface of the Brake Drum.
2. Rotate the Brake Drum four or five revolutions by turning the turntable. It is not necessary to release the brakes for this operation. Shift the sandpaper to a clean spot frequently to avoid contamination of the paper.
3. If this does not cure the condition, the Brake Linings have become contaminated and should be replaced. See Section V-V.

### 3. Constant Tension Brake Adjustment:

The Constant Tension Brake (47) is adjusted for minimum clearance between the Constant Tension Brake Lining (48) and the Tape Supply Brake Drum (34) when the Brake is released. The adjustment is made by the Brake Stop, a set screw and lock nut shown in Figure 17, Point D. As the Brake Lining wears, readjustment of the Stop is desirable.

- a. Loosen the lock nut. With both the Stopping Brakes and Constant Tension Brakes released, screw in the set screw until a slight drag is noticed on the Brake Drum.
- b. Back off the set screw until the drag just disappears.
- c. Tighten the lock nut and re-check for drag. The drum should spin freely with both Brakes released. The Constant Tension Arm (44) should have a very short travel - approximately 1/8 inch at the end of the arm.

NOTE: It is important that the force applied to the Constant Tension Brake (47) by the Constant Tension Brake Spring (47) be in the correct direction; otherwise the Brake Lining may wear unevenly and the Brake may oscillate or chatter causing high flutter. This should not be confused with the normal motion of the arm to compensate for discontinuities in the reels. If the Spring is attached to the Takeup Torque Switch (S503) with a solder lug, this lug should be positioned at right angles to the edge of the Switch. See Figure 17.

#### 4. Turntable and Brake Drum Height.

The height of both the Turntables (27 or 28) and their respective Brake Drums (34 and 35) must be carefully adjusted whenever they are removed. Their removal should be avoided unless absolutely necessary. When removing Brake Drums, first loosen the Turntable Set Screws, Figure 17, Point E. Loosen the Brake Drum set screws, Figure 18, Point F, backing them off far enough to prevent galling of the Turntable Shaft. Lift the Turntable from the Brake Drum. Carefully mark the Brake Drums so they will be returned to the same shafts. If it is necessary to replace either a Brake Drum or a Turntable, they must be replaced as a pair.

When replacing Brake Drums, place a little oil on the Turntable Shaft and work the Drum on the shaft. Adjust the Turntable Height so that the top surface of the Turntable Pad (30) Figure 19, is 0.635 inches from the surface of the Mechanical top plate. Be sure to tighten the set screws.

After the correct Turntable Height is set, adjust the Brake Drum height so that the lower spoke side of the Brake Drum lines up with the Turntable Motor Tire. Approximately 1/32 inch of the Drum should show below the tire. Tighten the set screws, being sure that they line up with the flats on the Turntable Shaft. Clean the braking surface of the Brake Drum thoroughly as explained in Section VIII-2F as it will become contaminated by handling.

#### 5. Rewind Holdback Brake Adjustment.

The Rewind Holdback Brake (22) is adjusted to give a slight tension during rewind. It should only require adjustment if it is accidentally bent. With the Takeup Brake Drum (35) removed, the lining of the Holdback Brake should assume a position 2-5/8 inches from the edge of the Takeup Turntable Shaft.

#### 6. Reel Idler Adjustment.

Should the Reel Idler (69) be removed, it must be reassembled as shown in Figure 20. Vertical play in the Reel Idler Pulley and Shaft Assembly (71) is provided by the Reel Idler Thrust Bearing (86).

- a. Assemble the Reel Idler Housing (70) to the Mechanical Top Plate as shown in Figure 20.
- b. Place a spacer 1/16 inch thick between the top of the Reel Idler Pulley (71) and the Reel Idler Housing (70).
- c. Make sure that the Reel Idler Ball Bearing is in place. Slide the Reel Idler Spacer (84) on the shaft. Holding the Reel Idler Flywheel (78) by the Square Hub, bottom it against the Spacer and Ball Bearing. Then tighten the set screw.
- d. Remove the 1/16 inch spacer between the Reel Idler Pulley and Housing.
- e. Insert the Reel Idler Thrust Ball (87), using a little light grease to hold it in place in the center of the Reel Idler Shaft. Attach the Reel Idler Thrust Bracket (85).
- f. Screw in the Thrust Bearing (86) until the vertical play in the Reel Idler Shaft and Pulley (71) is between .010 and .020 inches. Tighten the Lock Nut (88). In the case of rack mounted machines, it is desirable to reduce the play to .003 to .005 inches.
- g. Re-check to see that the play still exists after the Lock Nut is tightened. Insufficient clearance will prevent the proper operation of the idler. It should spin without drag.

#### 7. Takeup Torque Switch Adjustment.

The Takeup Torque Switch (S503) plays an important role in starting the recorder in the Play mode. It allows full voltage to be applied to the Turntable Motor until the Capstan Idler engages the tape, facilitating fast starting without throwing tape slack. The adjustment is made by bending the tongue of the micro switch. To check for correct adjustment, activate the armature of the Capstan Solenoid (K501) by hand. The Takeup Torque Switch should "click" or open after the Capstan Idler (70) has made firm contact with the Capstan (A) but slightly before the armature of the Solenoid seats. Allow approximately 1/32 inch over travel for safety. Check the Play Takeup Torque as explained in Part 9 of this Section. If the torque is considerably more than 7 ounces, the Takeup Torque Switch is not opening. Severe deformation of tape may result and the Turntable Motor may overheat to the point of destruction.

#### 8. Forward and Rewind Tilt Solenoid Adjustment.

The Forward Tilt Solenoid (K504) and the Rewind Tilt Solenoid (K503) position the Turntable Motor (6) to engage the proper Brake Drum depending upon the mode of operation. Adjustment is made by the lock nuts shown in Figure 16, Point H. They should be adjusted sufficiently tight to prevent any slippage between the Turntable Motor Tire and the Brake Drums.

The adjustment consists of the following:

- a. Remove the Turntable Motor Positioning Spring (68).
- b. Back off the Solenoid Adjusting Nuts (H) until the Turntable Tire will not touch the Brake Drums when either Solenoid is bottomed.
- c. Tighten either Solenoid Adjusting Nut until the Tire just touches the Drum with the Solenoid bottomed. Then tighten the nut one full turn after this contact, In order to bottom Solenoid and indicate tire contact with the Drum, fasten the Takeup Tension Arm (62) in the operating position and start the recorder in the Rewind or Fast Forward mode as required.
- d. Repeat Step C with the other Solenoid.

9. Play Takeup Torque Adjustment.

The voltage to the Turntable Motor (6) is reduced through the Play Resistor (R503) in the Play mode of operation. Moving the slide on this resistor toward the Mechanical Top Plate increases the voltage to the Turntable Motor and its torque. To check for proper torque:

- a. Fasten the Takeup Tension Arm (62) in the operating position.
- b. Attach a piece of string about 30 inches long to hub of the 10 1/2 inch Takeup Reel with the other end attached to a spring scale (0 to 16 oz. preferred).
- c. Place the recorder in Play mode.
- d. The Takeup tension should be 7 to 7 1/2 ounces as the scale is allowed to move slowly in the direction of pull.

10. Safety Switch Adjustment.

The Safety Switch (S501) is factory adjusted and should not require attention unless the switch or Takeup Tension Arm (62) is removed. The Safety Switch is actuated by the pin that holds the Takeup Tension Collar (63) to the Takeup Tension Arm (62). The tongue of the Safety Switch should be bent so the micro switch opens slightly before the end of travel of the Takeup Tension Arm. Allow 1/4 inch over-travel of the arm for dependability.

## SECTION IX

### PARTS LIST

The purpose of this Parts List is to aid the owner of an Ampex Recorder in ordering replacement parts. The majority of the components in the Recorder are listed. The Parts List contains the following four sub-sections:

- I. Mechanical Assembly.
- II. Head Assembly.
- III. Electronic Assembly.
- IV. Miscellaneous.

Each sub-section contains a column of Reference Numbers, a Description of the part, and the Ampex Catalog Number. The Reference numbers are an aid to identifying the parts and refer to the schematic diagrams and photographs in the rear of the book. The numbers apply to this instruction book only, and should not be used for ordering parts. The Ampex Catalog Number is the exact designation of all parts used in Ampex equipment. THIS IS THE NUMBER YOU SHOULD USE WHEN ORDERING REPLACEMENT PARTS.

The following information should be included when ordering parts:

Machine Type.

Machine Serial Number.

Ampex Catalog Number.

Description of Material.

#### EXAMPLE:

- 1 - #2216 Drive Motor Assembly for Model 400A, Serial Number 5020.
- 3 - CO-33 .1 MFD Condenser for Model 401A, Serial Number 5016.

ALWAYS INCLUDE THE AMPEX CATALOG NUMBER.

Reference Number	Description	Ampex Catalog Number
<b>I. MECHANICAL ASSEMBLY - Catalog #2109</b>		
1	Top Plate Casting	2694
2	Top Plate Facing Plate	2110
3	Bushing - Takeup Tension Arm	2093
4	Bushing - Capstan Idler Arm	2094
5	Bushing - Constant Tension Arm	2092
6	Turntable Motor Assembly, complete with Motor, Bracket, Pulley and Condenser	2102
7	Rubber Tired Pulley	934
8	Bracket	932
9	Spacers	2680
10	Solenoid Mounting Bracket	2101
11	Relay Mounting Bracket	3311
12	Turntable Motor Mounting Bracket	2107
13	Solenoid Link	335
14	Solenoid Spade Bolt	2081
15	Solenoid Cotter Pin	CP-1/16-2
16	Solenoid Clevis Pin	CC-1/8-15
17	Terminal Strip Standoff	2349
18	Turntable Motor Pivot - Front	930
19	Turntable Motor Arm and Pivot Assembly	3370
20	Felt Washer	928
21	Tilt Solenoid Return Spring	2237
22	Rewind Holdback Brake	3359
23	Brake Lining	3853
24	Capstan Drive Motor Assembly-60 Cycle, complete with Flywheel and Condenser. See Note 1	2216
24	Capstan Drive Motor Assembly-50 Cycle, complete with Flywheel and Condenser. See Note 2	3380
25	Drive Motor Fan	FA-1
26	Capstan Dust Cap	3506
27	Tape Supply Turntable Assembly	2229
28	Takeup Turntable Assembly	2229
29	Turntable and Shaft Sub-Assembly	974
30	Turntable Pad	958
31	Ball Bearing	BC-7
32	Bearing Housing	2226
33	Retaining Ring	RR-1-3
34	Tape Supply Brake Drum	977
35	Takeup Brake Drum	977
36	Tape Supply Stopping Brake	2098
37	Brake Lining	3853
	NOTE 1: 60 Cycle Motor Assembly for Model 404 & 405	5585
	NOTE 2: 50 Cycle Motor Assembly for Model 404 & 405	5585-2
	<b>NOTE: ORDER PARTS BY AMPLEX CATALOG NUMBER ONLY!</b>	

Reference Number	Description	Ampex Catalog Number
38	Tape Supply Brake Spring	3851
39	Takeup Stopping Brake	2105
40	Brake Lining	3853
41	Takeup Brake Spring	3850
42	Brake Rod	2091
43	Brake Adjusting Clamp	967
44	Constant Tension Arm Assembly	2099
45	Tape Guide	3357
46	Tape Guide Hook	355
47	Constant Tension Brake	2104
48	Brake Lining	3853
49	Constant Tension Brake Spring	1024
50	Capstan Idler Assembly - See Note 1	995
51	Capstan Idler Arm	2197
52	Capstan Solenoid Arm	2084
53	Capstan Solenoid Stop	388
54	Capstan Solenoid Eye Bolt	396-2
55	Solenoid Felt Washer	PW-6-1/4-416-816
56	Solenoid Terminal Strip	2372
57	Solenoid Cotter Pin	CP-1/16-2
58	Solenoid Clevis Pin	CO-1/8-17
59	Capstan Idler Pressure Spring	389
60	Capstan Idler Return Spring	3808
61	Takeup Torque Switch Engaging Washer	2075
62	Takeup Tension Arm	2103
63	Takeup Tension Collar	2085
64	Takeup Tension Return Spring	3809
65	Counterbalance Spring	3689
66	Counterbalance Spring Anchor	3683
67	Brake Solenoid Stop Bracket	3807
68	Turntable Motor Positioning Spring	3850
69	Reel Idler Assembly	2213
70	Reel Idler Housing	2207
71	Reel Idler Pulley and Shaft Assembly	2215
72	Upper Bearing	2209
73	Felt Washer	2248
74	Plug Button	PB-1-516
75	Ball Bearing	BC-7
76	Rubber Bearing Housing	BD-1
77	Bearing Adapter	2210
78	Reel Idler Flywheel Assembly	2223
79	Flywheel	2221

NOTE 1: Capstan Idler for Model 404 & 405 4429

NOTE: ORDER PARTS BY AMPEX CATALOG NUMBER ONLY!

Reference Number	Description	AmpeX Catalog Number
80	Hub and Dampener Assembly	2220
81	Limit Stop	2219
82	Ball Bearing	BC-7
83	Retaining Ring	RR-2-4
84	Reel Idler Spacer	352
85	Reel Idler Thrust Bracket	2222
86	Reel Idler Thrust Bearing	2208
87	Reel Idler Thrust Ball	BC-18
88	Reel Idler Jam Nut - 1/2-20	NU-16-816
89	Capstan Tape Guide	257
90	Capstan Tape Guide Spacer	1402
91	Capstan Tape Guide Shimming Washers	923
92	Motor Condenser Clamp	1098
93	Pushbutton Escutcheon Plate	2691
94	Selenium Rectifier Terminal Board	2371
95	Selenium Rectifier Insulating Strip	2373
96	Brake Pivot Washer	910
97	Terminal Strip Insulation	3439
98	Brake Pivot Spring	3582
99	Brake Spring Link	3603
100	Brake Rod Retaining Ring	RR-4X-2
101	Motor Pivot Washer	PW-1-1016
C501	.1 MFD 600 V. Tubular Condenser	CO-33
C502	80 MFD 150 V. Electrolytic Condenser	CO-105
C503	.1 MFD 600 V. Tubular Condenser	CO-33
C504	.1 MFD 600 V. Tubular Condenser	CO-33
C505	.1 MFD 600 V. Tubular Condenser	CO-33
C506	Motor Start Condenser supplied with Motor See Note 1.	
C507	.1 MFD 600 V. Tubular Condenser	CO-33
C508	Motor Start Condenser supplied with Motor See Note 1.	
C509	.1 MFD 600 V. Tubular Condenser	CO-33
C510	.1 MFD 600 V. Tubular Condenser	CO-33
C511	.1 MFD 600 V. Tubular Condenser	CO-33
C512	.1 MFD 600 V. Tubular Condenser	CO-33
C513	.1 MFD 600 V. Tubular Condenser	CO-33
J501P	Jones P-304-CCT-L Cable Connector	PL-99P
J502P	Jones P-306-CCT-L Cable Connector	PL-101P
J503S	Jones S-306-CCT-K Cable Connector	PL-102S
J504P	Jones P-304-CCT-L Cable Connector	PL-99P
J505S	Jones S-304-CCT-K Cable Connector	PL-100S

NOTE 1: When ordering Motor Start Condensers, include the serial number of the Recorder, whether the motor is the Turntable Motor or Drive Motor, the manufacturer of the motor, and the manufacturer's type number found on the motor name plate.



Reference Number	Description	Amplex Catalog Number
K501	Capstan Solenoid DC	670
K502	Brake Solenoid DC	337
K503	Rewind Tilt Solenoid DC	337
K504	Forward Tilt Solenoid DC	337
K505	Start Relay 3PDT 115 V. DC	RL-26
K506	Fast Forward Relay 3PDT 115 V. DC	RI-26
K507	Rewind Relay 3PDT 115 V. DC	RL-26
R501	20 Ohm 10 Watt Wire Wound Resistor	RE-309
R502	1000 Ohm 25 Watt Wire Wound Resistor	RE-113
R503	150 Ohm 50 Watt Adjustable Resistor	RE-259
S501	Safety Switch - Micro Switch	3604
S502	Speed Switch - DPDT Toggle	SW-5
S503	Takeup Torque Switch - Micro Switch	SW-2
S504	Fast Forward Pushbutton-SPST Normally Open	SW-34
S505	Rewind Pushbutton-SPST Normally Open	SW-34
S506	Stop Pushbutton-SPST Normally Closed	SW-35
S507	Start Pushbutton-SPST Normally Open	SW-34
SR501	Selenium Rectifier-Half Wave	SR-4
TS501	60 Cycle Amplifier Terminal Strip Jones 8-170	TS-2-8
TS502	Remote Control Terminal Strip Jones 8-170	TS-2-8

## II. HEAD ASSEMBLY

Half Track Head Assembly for Single Case Portable, Rack or Console	475-14
Full Track Head Assembly for Single Case Portable, Rack or Console	475-16
Half Track Head Assembly for Two-Case Portable	475-17
Full Track Head Assembly for Two Case Portable	475-18
Gate Spring	438
Gate Pins	DR-2-3-10
Glass Rod Tape Guides	457

NOTE: ORDER PARTS BY AMPEX CATALOG NUMBER ONLY!

Reference Number	Description	Ampex Catalog Number
C601	20 MFD 450 V. Electrolytic Condenser	CO-57
C602	20 MFD 450 V. Electrolytic Condenser	CO-57
C603	30-30-20 MFD 475 V. Electrolytic Condenser	CO-244
C604	20 MFD 450 V. Electrolytic Condenser	CO-57
F401	1 Ampere "Slo-Blo" Type 3AG Fuse	FU-7
F402	2 Ampere Type 3AG Fuse	FU-2
J401S	Cannon XL-3-13 Chassis Connector	PL-58S
J402P	AN-3102-10S-3P Box Mount Connector	PL-59P
J403S	Phone Jack - Open Circuit	JA-3
J404P	Cannon XL-3-14 Chassis Connector	PL-4P
J405P	AN-3102-10S-4P Box Mount Connector	PL-61P
J406P	AN-3102-10S-2P Box Mount Connector	PL-62P
J407S	Jones S-304-AB Chassis Connector	PL-56S
J408S	Jones S-308-AB Chassis Connector	PL-54S
J409P	Hubbell #7466 Chassis Connector	PL-104P
J601P	Jones P-308-CCT-L Cable Connector	PL-103P
J411S	Phone Jack - Open Circuit	JA-3
K401	Record Relay 3PDT 115 V. DC	RL-8
L401	20 MH R. F. Choke	CH-8
L601	8 Hy. 80 Ma. Filter Choke	1155
L602	8 Hy. 80 Ma. Filter Choke	1155
M401	VU Meter	
NE401	Record Pilot Lamp	DL-4
R401	150,000 OHM 1 Watt Composition Resistor	RE-27
R402	100 OHM 1 Watt Composition Resistor 5%	RE-38
R403	100 OHM 1 Watt Composition Resistor 5%	RE-38
R404	150,000 OHM 1 Watt Composition Resistor	RE-27
R405	1 Megohm 1 Watt Composition Resistor	RE-32
R406	1,200 OHM 1 Watt Composition Resistor	RE-261
R407	330,000 OHM 1 Watt Composition Resistor	RE-30
R408	100,000 OHM 1 Watt Composition Resistor 1%	RE-205
R409	100,000 OHM Audio Taper Potentiometer	RE-227
R410	2,200 OHM 1 Watt Composition Resistor	RE-7
R411	47,000 OHM 1 Watt Composition Resistor	RE-22
R412	1 Megohm 1 Watt Composition Resistor 5%	RE-48
R413	100,000 OHM Audio Taper Potentiometer	RE-227
R414	100,000 OHM 1 Watt Composition Resistor	RE-26

NOTE: ORDER PARTS BY AMPEX CATALOG NUMBER ONLY!

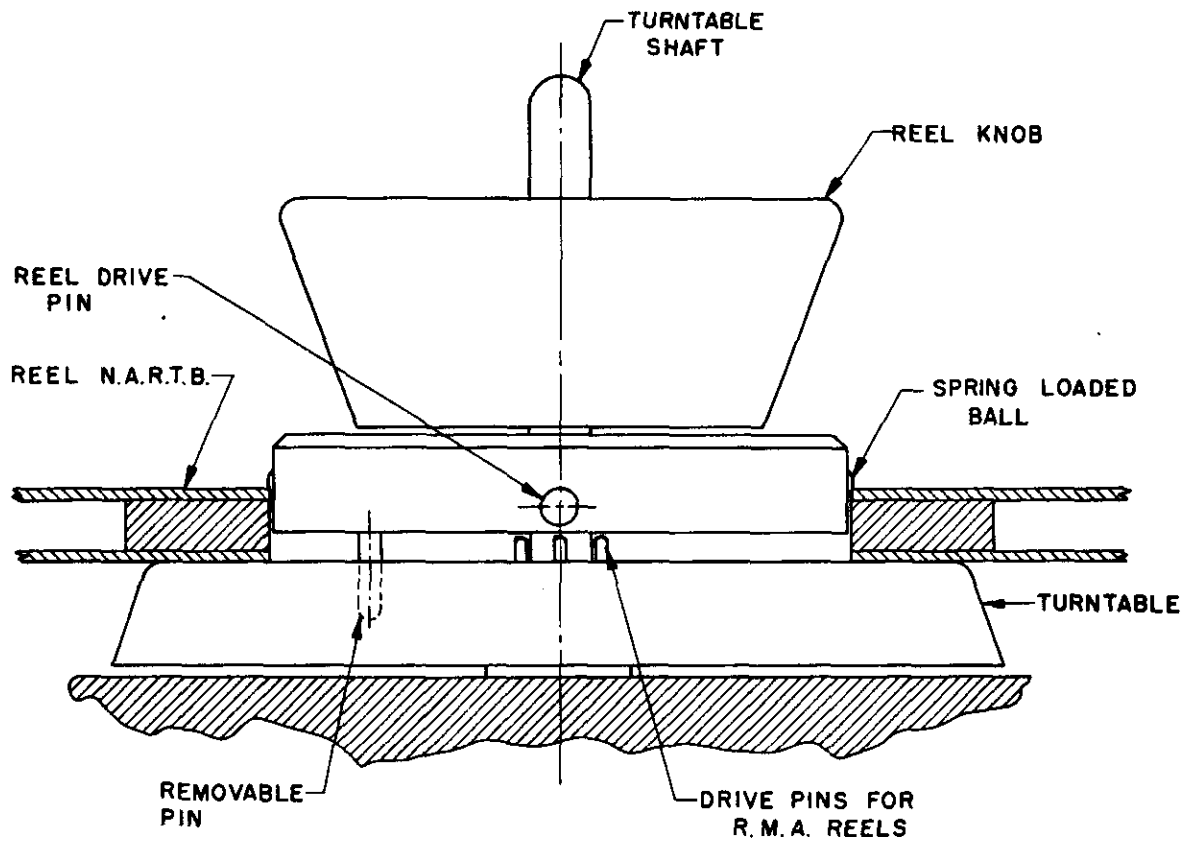
Reference Number	Description	Ampex Catalog Number
R415	39,000 OHM 1 Watt Composition Resistor 5%	RE-44
R416	2,200 OHM 1 Watt Composition Resistor	RE-7
R417	47,000 OHM 1 Watt Composition Resistor	RE-22
R418	470,000 OHM 1 Watt Composition Resistor	RE-31
R419	2,200 OHM 1 Watt Composition Resistor	RE-7
R420	470 OHM 1 Watt Composition Resistor	RE-2
R421	22,000 OHM 2 Watt Composition Resistor	RE-171
R422	47,000 OHM 1 Watt Composition Resistor	RE-22
R423	1 Megohm 1 Watt Composition Resistor	RE-32
R424	50,000 OHM Linear Taper Potentiometer	RE-226
R425	470,000 OHM 1 Watt Composition Resistor	RE-31
R426	15,000 OHM 10 Watt Wire Wound Resistor	RE-92
R427	100,000 OHM 1 Watt Composition Resistor	RE-26
R428	1 Megohm 1 Watt Composition Resistor 1%	RE-211
R429	330,000 OHM 1 Watt Composition Resistor 1%	RE-209
R430	2,200 OHM 1 Watt Composition Resistor	RE-7
R431	1 Megohm 1 Watt Composition Resistor 1%	RE-211
R432	20,000 OHM Audio Taper Potentiometer	RE-240
R433	22,000 OHM 2 Watt Composition Resistor	RE-171
R434	1 Megohm 1 Watt Composition Resistor	RE-32
R435	330,000 OHM 1 Watt Composition Resistor	RE-30
R436	2,700 OHM 1 Watt Composition Resistor	RE-8
R437	1 Megohm Audio Taper Potentiometer	RE-232
R438	560 OHM 1 Watt Composition Resistor	RE-3
R439	47,000 OHM 1 Watt Composition Resistor	RE-22
R440	1 Megohm 1 Watt Composition Resistor	RE-32
R441	1 Megohm 1 Watt Composition Resistor	RE-32
R442	2,200 OHM 1 Watt Composition Resistor	RE-7
R443	560 OHM 1 Watt Composition Resistor	RE-3
R444	100 OHM 1 Watt Composition Resistor	RE-260
R445	10,000 OHM 2 Watt Composition Resistor	RE-168
R446	47,000 OHM 1 Watt Composition Resistor	RE-22
R447	47,000 OHM 1 Watt Composition Resistor	RE-22
R448	7 OHM 1 Watt Composition Resistor 1% (2-14 OHM in Parallel)	RE-257
R449	40,000 OHM Wire Wound Potentiometer	RE-278
R450	500 OHM 10 Watt Wire Wound Resistor-Adjustable	RE-277
R451	3600 OHM 1 Watt Composition Resistor 1%	RE-258
R452	100 OHM 1 Watt Composition Resistor	RE-260
R453	100 OHM 1 Watt Composition Resistor	RE-260
R454	470,000 OHM 1 Watt Composition Resistor	RE-31
R455	470 OHM 1 Watt Composition Resistor 5%	RE-365
R456	680,000 OHM 1 Watt Composition Resistor	RE-480
R457	2,000 OHM 10 Watt Wire Wound Resistor	RE-82

NOTE: ORDER PARTS BY AMPEX CATALOG NUMBER ONLY!

Reference Number	Description	Ampex Catalog Number
R461	22, 000 Ohm 1 Watt Composition Resistor	RE-18
S401	Input Switch - 3P3T Selector Switch	SW-7
S402	Equalization Switch - 3P2T Selector Switch	SW-8
S403	Record Pushbutton SPST - Normally Open	SW-34
S404	Line Termination Switch - SPST Toggle	SW-9
S405	Meter and Output Switch - 3P4T Selector Switch	SW-13
S406	AC Power Switch - SPST Toggle	SW-9
SR601	Selenium Rectifier - Full Wave	SR-3
T401	Microphone Input Transformer	1153
T402	Output Transformer	1154
T403	Erase Transformer	1011
T601	Power Transformer	3953
V401	12SJ7 Vacuum Tube	TU-11
V402	12SJ7 Vacuum Tube	TU-11
V403	12SJ7 Vacuum Tube	TU-11
V404	6C5 or 6J5 Vacuum Tube	TU-3
V405	VR 150/0D3 Vacuum Tube	TU-2
V406	12SJ7 Vacuum Tube (Selected)	TU-12
V407	12SJ7 Vacuum Tube	TU-11
V408	6C5 or 6J5 Vacuum Tube	TU-3
V409	6SN7-GT Vacuum Tube	TU-13
V601	5Y3-G Vacuum Tube	TU-14
	AC Power Cable	2413
	Power Supply Cable	2435
	Octal Tube Socket	SO-8
	Turret Tube Socket	1208
	Fuse Extractor Post	FE-1
	Equalization and Meter Switch Knobs	KN-3
	Record and Playback Gain Knobs	KN-4
	Input Switch Knob	KN-8

Reference Number	Description	Ampex Catalog Number
<u>IV. MISCELLANEOUS</u>		
A701	Remote Record Lamp - 120 V. 6 Watt Lamp Base - Red	LA-6 DL-7
A702	Remote Tape Motion Lamp-120 V. 6 Watt Lamp Base - Green	LA-6 DL-8
C701	.1 MFD 600 V. Tubular Condenser	CO-33
J701S	Remote Chassis Connector - Jones S-310-AB	PL-207S
J702P	Remote Cable Connector -Jones P-310-CCT-L Remote Dummy Plug	PL-208P 3461
J703S	60 Cycle Amplifier Chassis Connector - Jones S-308-AB	PL-54S
J704P	60 Cycle Amplifier Cable Connector - Jones P-308-CCT-L 60 Cycle Amplifier Dummy Plug	PL-103P 567
S701	Fast Forward Pushbutton-SPST Normally Open	SW-34
S702	Rewind Pushbutton-SPST Normally Open	SW-34
S703	Stop Pushbutton-SPST Normally Closed	SW-35
S704	Start Pushbutton-SPST Normally Open	SW-34
S705	Record Pushbutton-SPST Normally Open	SW-34
	Case for Single Case Portable	1193
	Mechanical Assembly Case for Two-Case Portable	3692
	Electronic Assembly Case for Two Case Portable with extra space	3693
	Electronic Assembly Case for Two-Case Portable without extra space	4101
	Console Cabinet	3663
	Power Interconnecting Extension Cable	3768
	Power Supply Extension Cable	3814
	Remote Control Box	3766
	Four Channel Mixer-Pre-Amplifier	3761
	Reel Centering Adapter (Portable and Console)	976
	Reel Hold Down Knob (Rack)	4402
	10-1/2" NARTB Reel	539
	Standard Alignment Tape	4494
	Head Demagnetizer	704

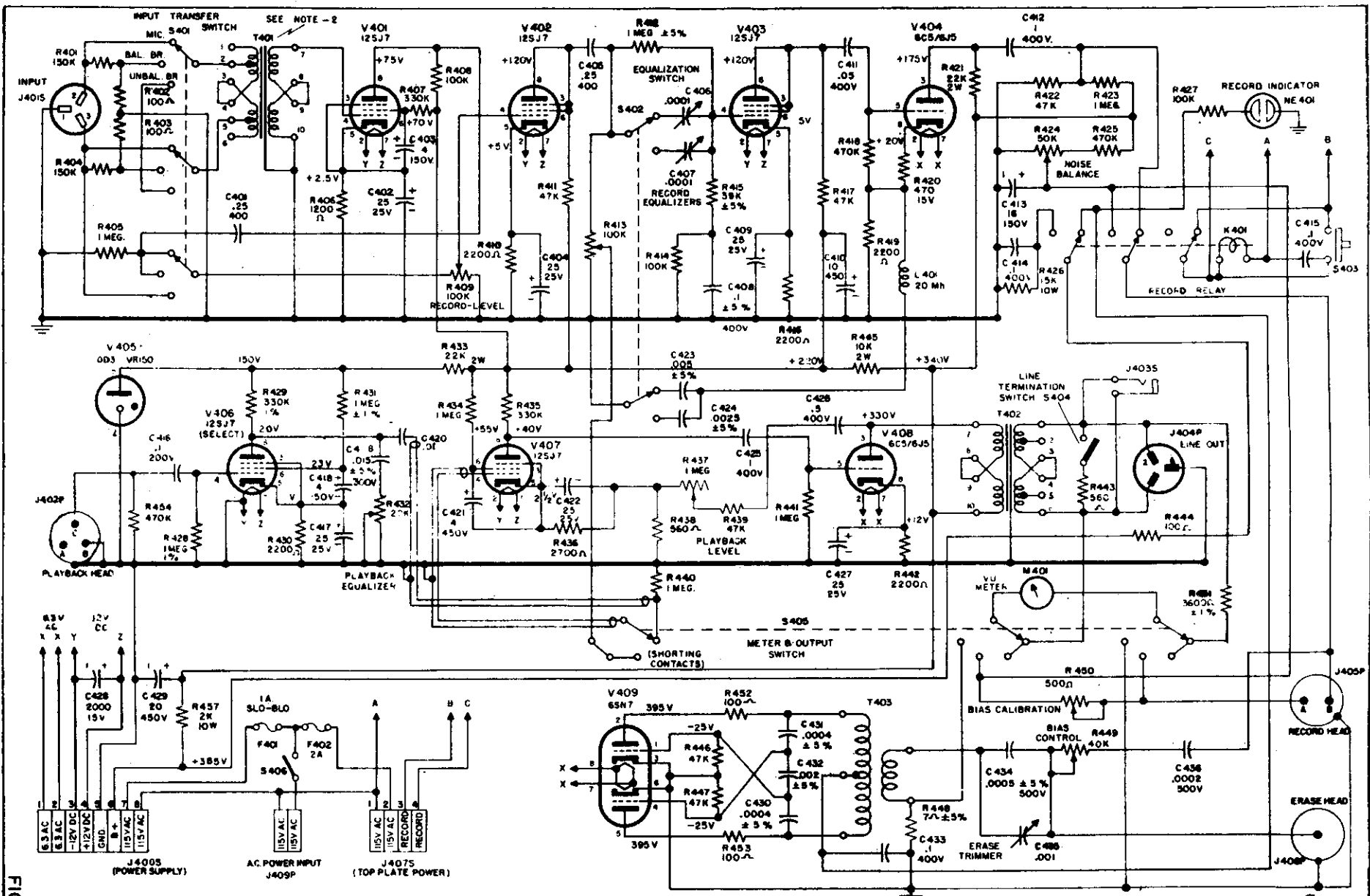
NOTE: ORDER PARTS BY AMPEX CATALOG NUMBER ONLY!



CAUTION- DO NOT PUSH KNOB ALL THE WAY DOWN TO THE TURNTABLE OR SPRING LOADED BALLS WILL NOT HOLD REEL IN PLACE.

REEL HOLD-DOWN KNOB  
 AMPEX ELECTRIC CORPORATION  
 REDWOOD CITY, CALIFORNIA.

FIG. O

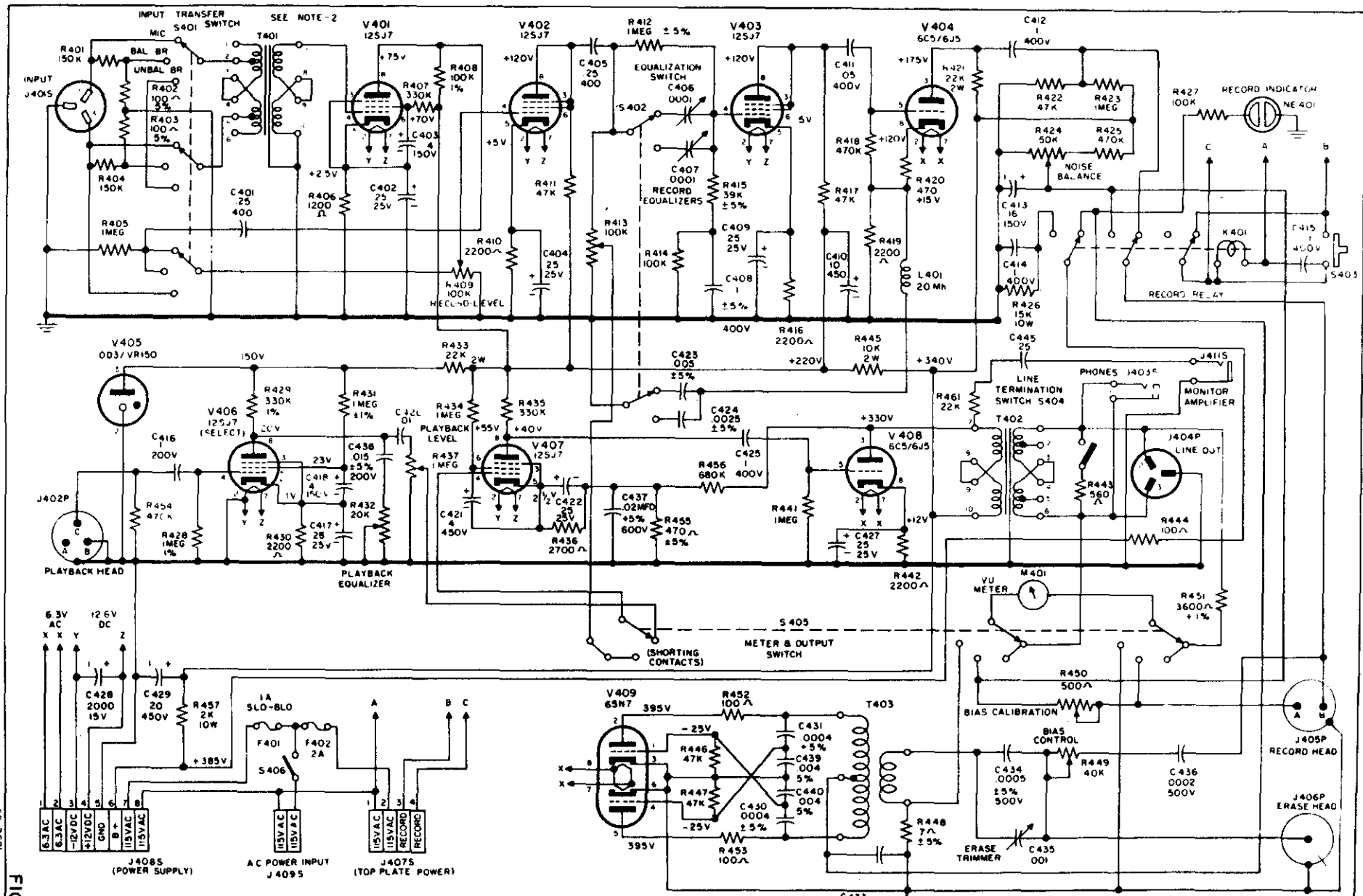


- NOTES:**
- 1- ALL CAPACITIES IN MICROFARADS
  - 2- FOR 30 & 50 OHMS MICROPHONE  
SEE INSTALLATION
  - 3- ALL VOLTAGES MEASURED WITH 20,000 OHMS PER VOLT METER WITH 117V AC LINE VOLTAGE. ALL READING EXCEPT V409 OSCILATOR VOLTAGES TAKEN WITH K401 DE-ENERGIZED.

**ELECTRONICS  
MODEL-400A  
AMPEX ELECTRIC CORPORATION  
REDWOOD CITY, CALIFORNIA**

- T402 TRANSFORMER IMPEDANCE CONNECTIONS—**  
R445 MUST BE ADJUSTED FOR OUTPUT IMPEDANCE—
- 500 to 600 OHMS CONNECT TO 1 B 5, JOIN 3 TO 4
  - 333 OHMS CONNECT TO 1 B 5, JOIN 3 TO 4
  - 200 to 250 OHMS CONNECT TO 2 B 5, JOIN 3 TO 4
  - 125 to 150 OHMS CONNECT TO 1 B 4, JOIN 1 TO 3 B 4 TO 6
  - 50 OHMS CONNECT TO 2 B 4, JOIN 2 TO 3 B 4 TO 5

FIG. 1



**NOTES**

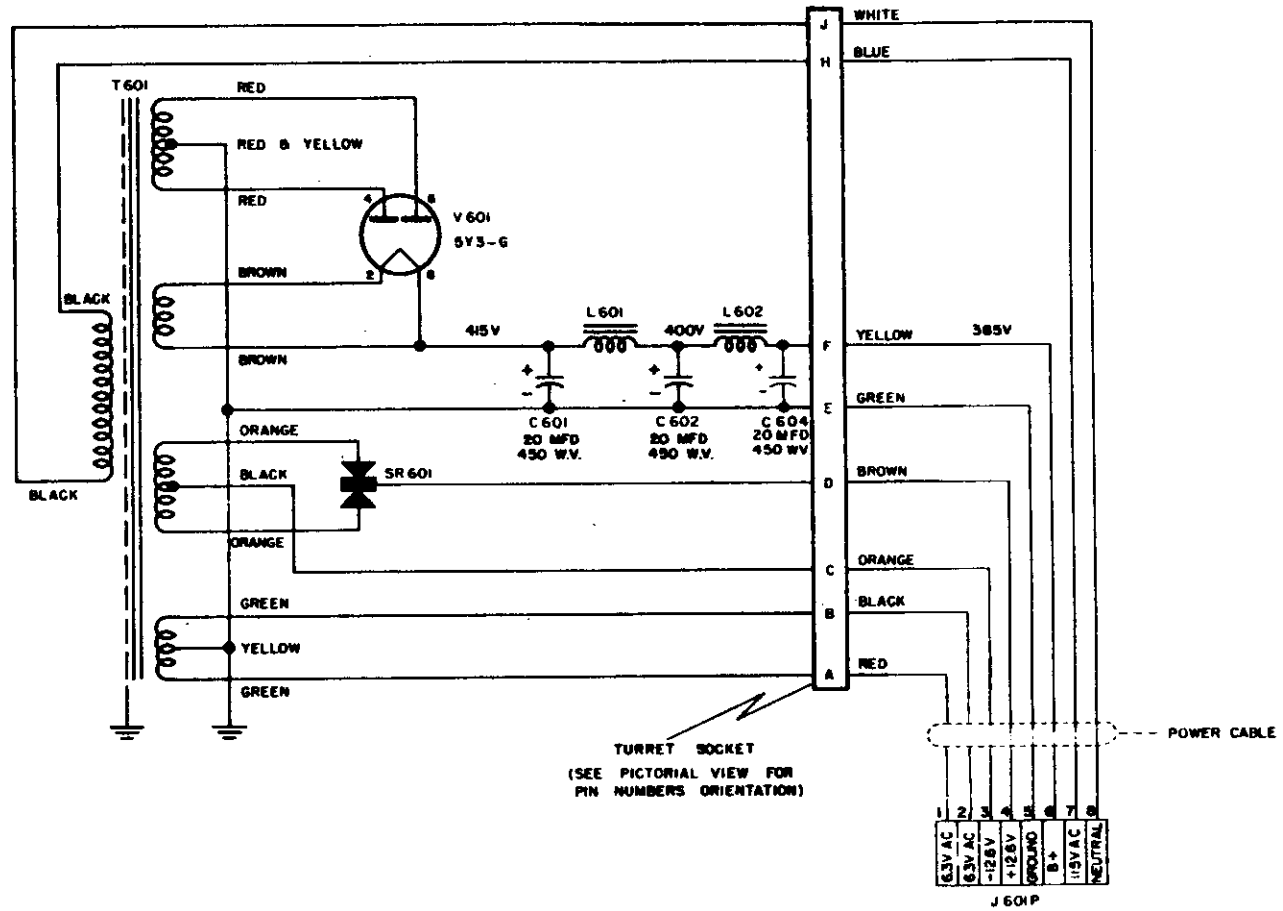
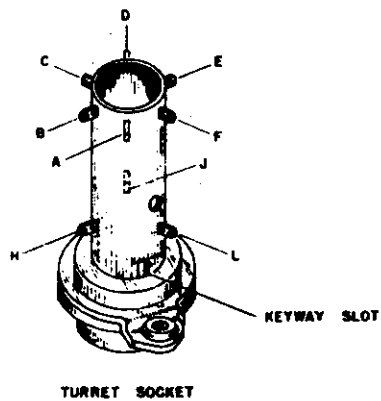
- 1-ALL CAPACITIES ARE IN MICROFARADS
- 2-FOR 30 & 50 OHMS MICROPHONE SEE INSTALLATIONS
- 3-ALL VOLTAGES MEASURED WITH 20,000 OHMS PER VOLT METER WITH 117V AC LINE VOLTAGE. ALL READING EXCEPT V409 OSCILATOR VOLTAGES TAKEN WITH K401 DE-ENERGIZED

**ELECTRONICS  
MODEL 402-403  
AMPEX ELECTRIC CORPORATION  
REDWOOD CITY, CALIFORNIA**

**T402 TRANSFORMER IMPEDANCE CONNECTIONS**  
 R443 MUST BE ADJUSTED FOR OUTPUT IMPEDANCE  
 500 TO 600 OHMS CONNECT TO 1 & 6, JOIN 3 TO 4  
 333 OHMS CONNECT TO 1 & 5, JOIN 3 TO 4  
 200 TO 250 OHMS CONNECT TO 2 & 5, JOIN 3 TO 4  
 125 TO 150 OHMS CONNECT TO 1 & 4, JOIN 1 TO 3 & 4 TO 6  
 50 OHMS CONNECT TO 2 & 4, JOIN 2 TO 3 & 4 TO 5

**FIG 2**





**POWER SUPPLY**  
**SERIES 400 SINGLE CASE PORTABLE**  
**AMPEX ELECTRIC CORPORATION**  
 REDWOOD CITY, CALIFORNIA

NOTE: ALL VOLTAGES MEASURED WITH  
 20,000 OHMS PER VOLT METER WITH  
 117V AC POWER INPUT. J 601P IS  
 CONNECTED TO THE ELECTRONICS WITH  
 THE RECORD RELAY DE-ENERGIZED



FIG 6A

INPUT FOR HIGH IMPEDANCE MICROPHONE  
(SEE INSTALLATION)

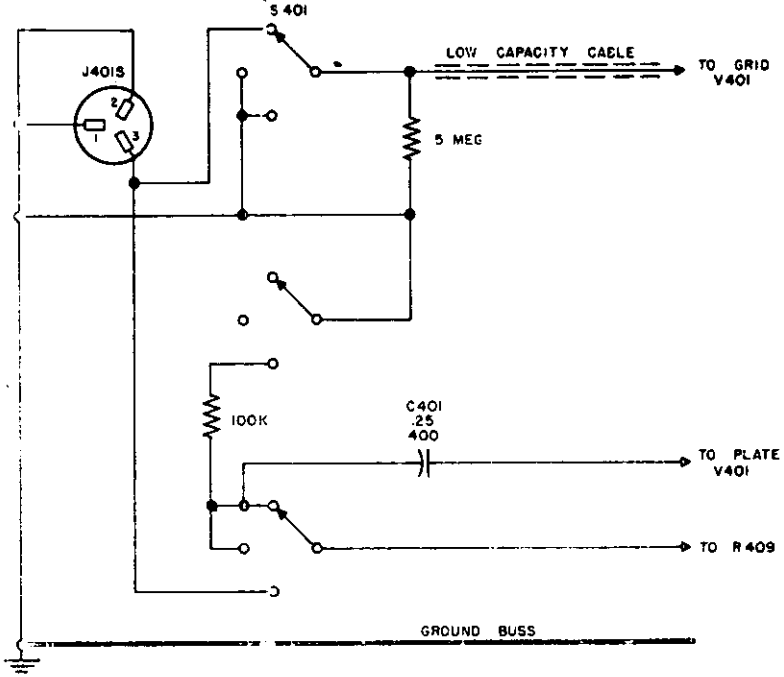
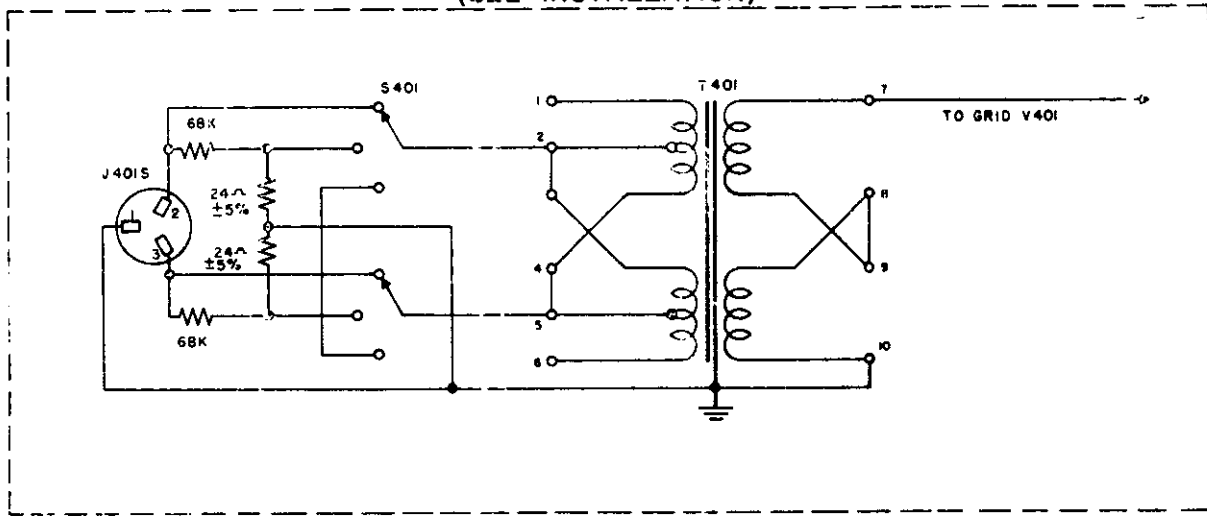


FIG 6B

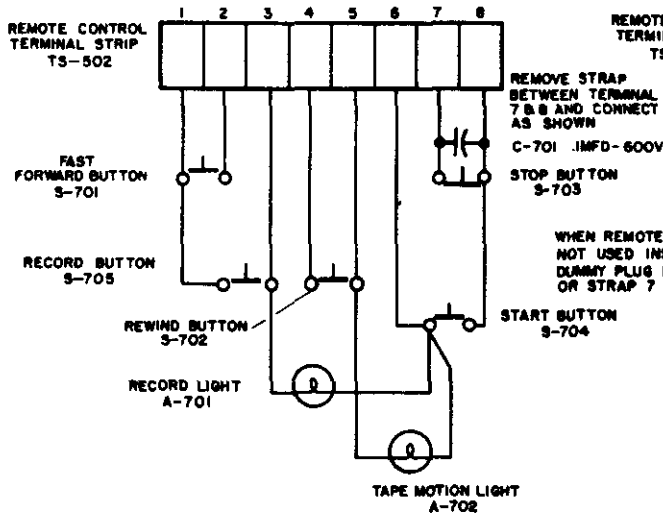
INPUT TRANSFORMER CONNECTION FOR  
30 & 50 OHMS MICROPHONES  
(SEE INSTALLATION)



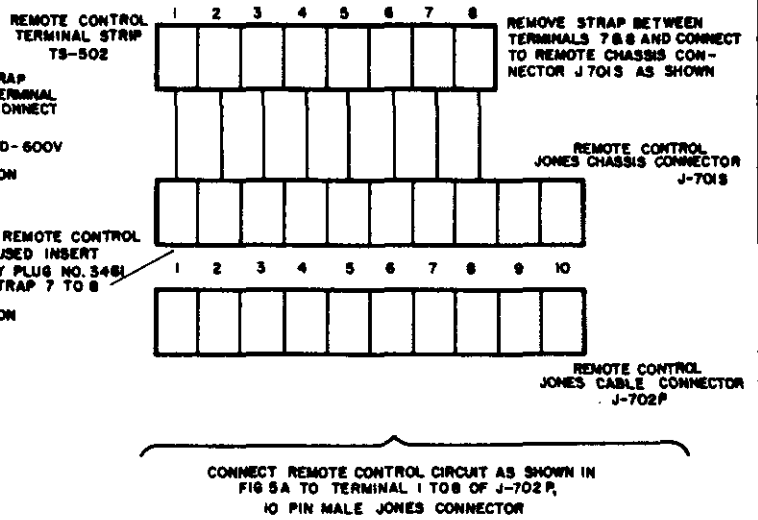
SERIES 400  
AMPEX ELECTRIC CORPORATION  
REDWOOD CITY CALIFORNIA

FIG 6

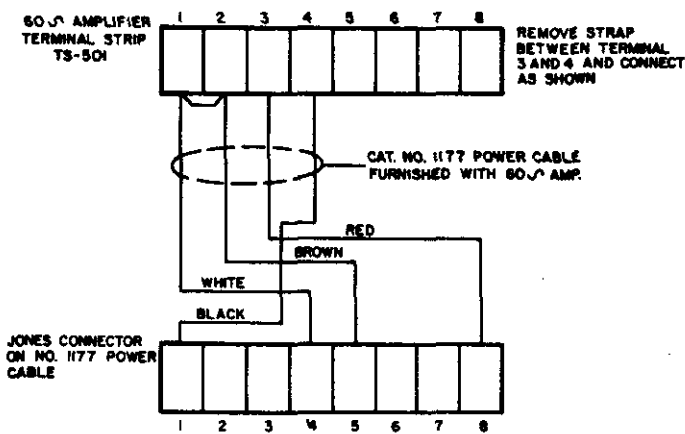
**FIG 7A**  
**REMOTE CONTROL CIRCUITS**



**FIG 7B**  
**REMOTE CONTROL CIRCUIT PLUG IN**

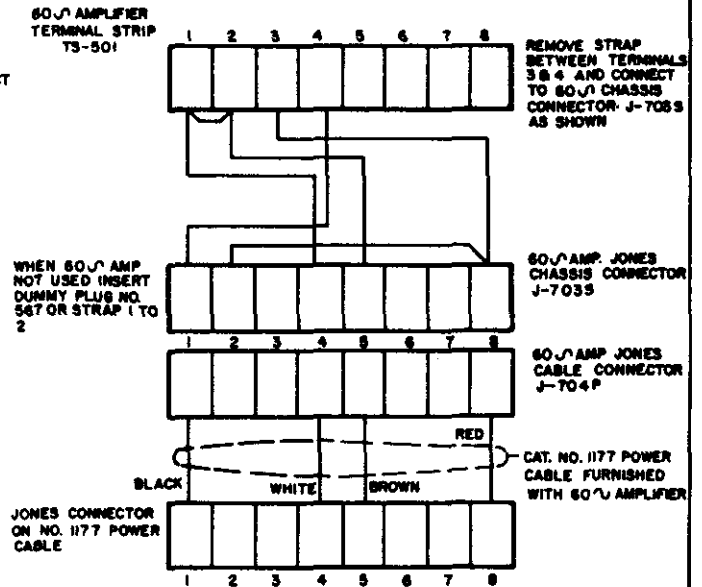


**FIG 7C**  
**60 $\omega$  AMPLIFIER CONNECTIONS**  
(SEE NOTE)



NOTE:  
THE 60 $\omega$  AMPLIFIER IS A SUPPLY OF 115V 60 $\omega$  FOR OPERATING THE DRIVE MOTOR WHEN THE POWER LINE FREQUENCY STABILITY IS INADEQUATE.

**FIG 7D**  
**60 $\omega$  AMPLIFIER CONNECTIONS PLUG IN**

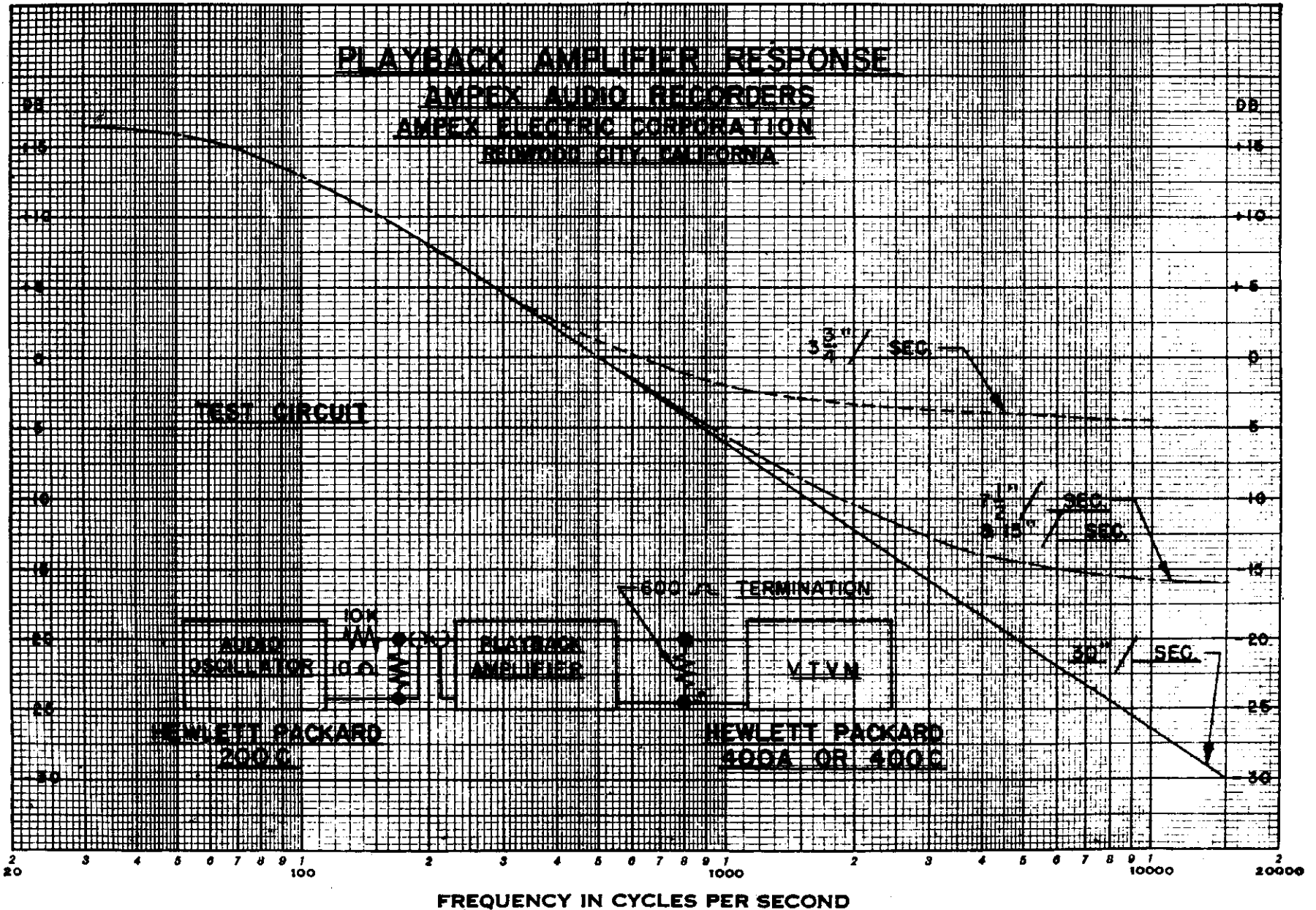


**REMOTE CONTROL & 60 $\omega$  AMPLIFIER CONNECTIONS**  
**SERIES 400**  
**AMPEX ELECTRIC CORPORATION**  
**REDWOOD CITY, CALIFORNIA**

**FIG. 7**

DWG A-4477 9-5-52

FIG 8



**RECORD AMPLIFIER RESPONSE**  
**AMPEX AUDIO RECORDERS**  
**AMPEX ELECTRIC CORPORATION**  
**REDWOOD CITY, CALIFORNIA**

STAS TO PEAK LEVEL AT 15"/SEC  
 CURVES BASED ON CENTER  
 LINE MINIMUM IN TAPE

DWG. A-4478

11-20-52

FIG. 9

400/SEC ONLY

TEST CIRCUIT

REMOVE BIAS OSCILLATION TUBE



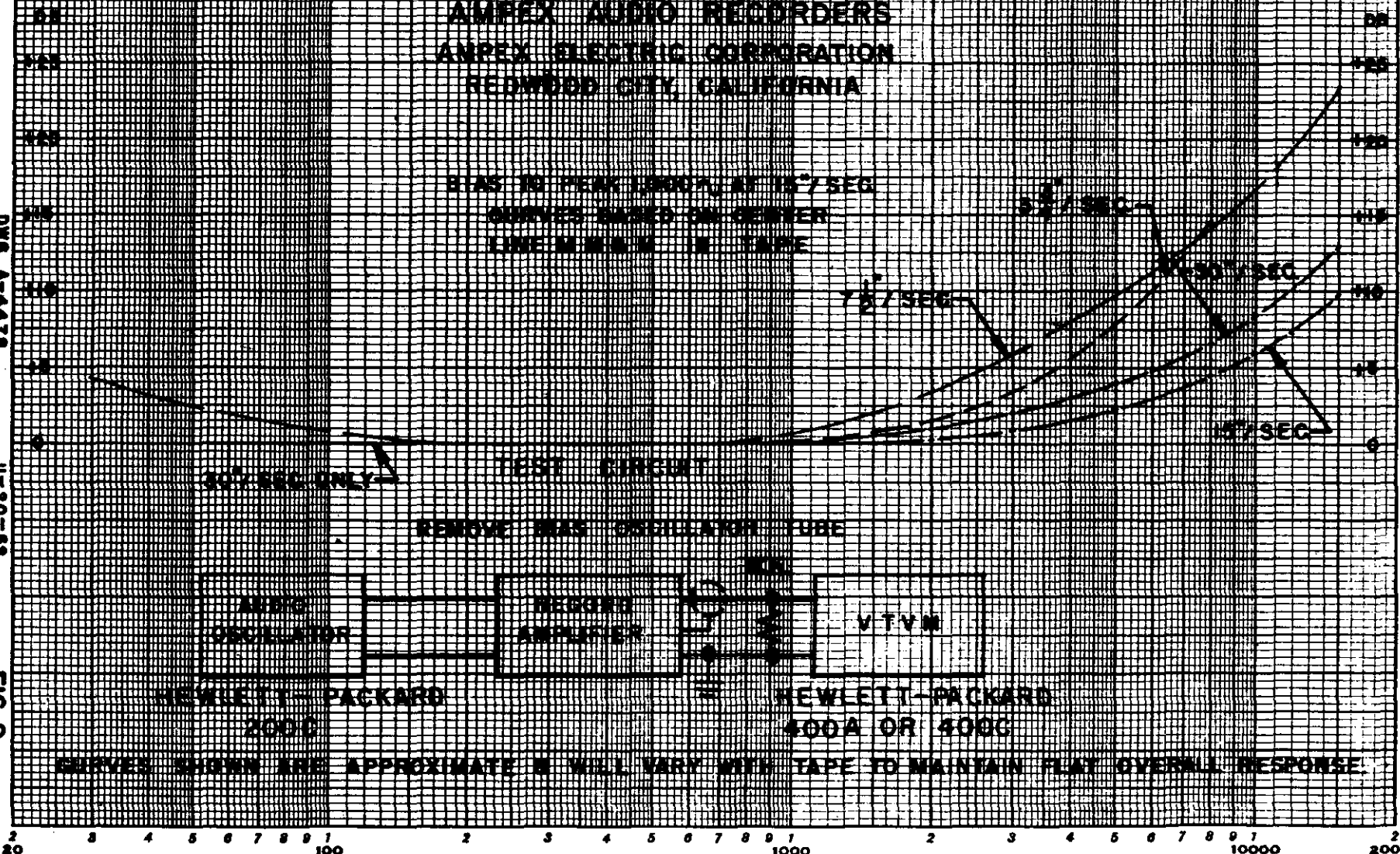
HEWLETT-PACKARD  
200C

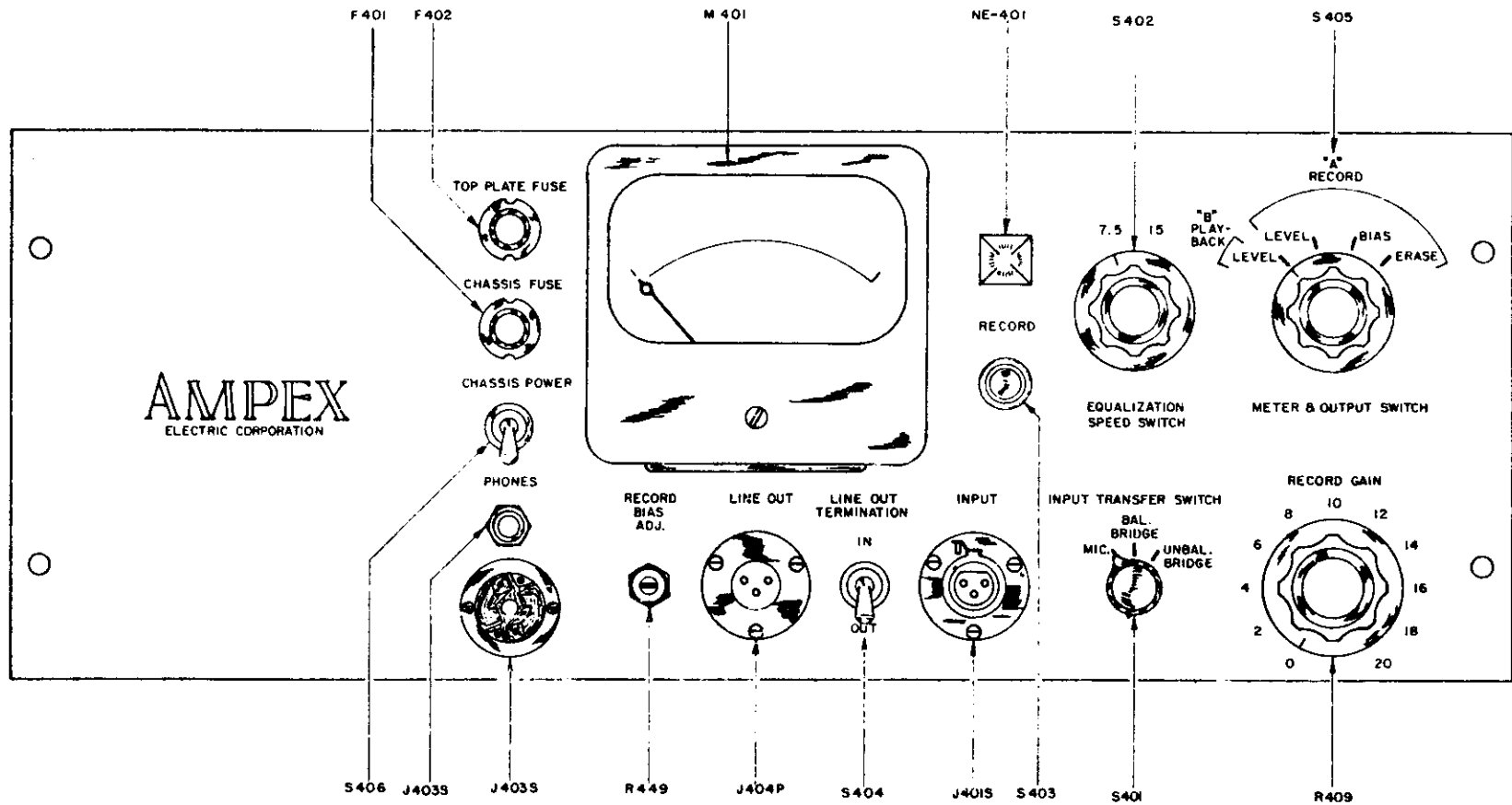
HEWLETT-PACKARD  
400A OR 400C

CURVES SHOWN ARE APPROXIMATE & WILL VARY WITH TAPE TO MAINTAIN FLAT OVERALL RESPONSE.

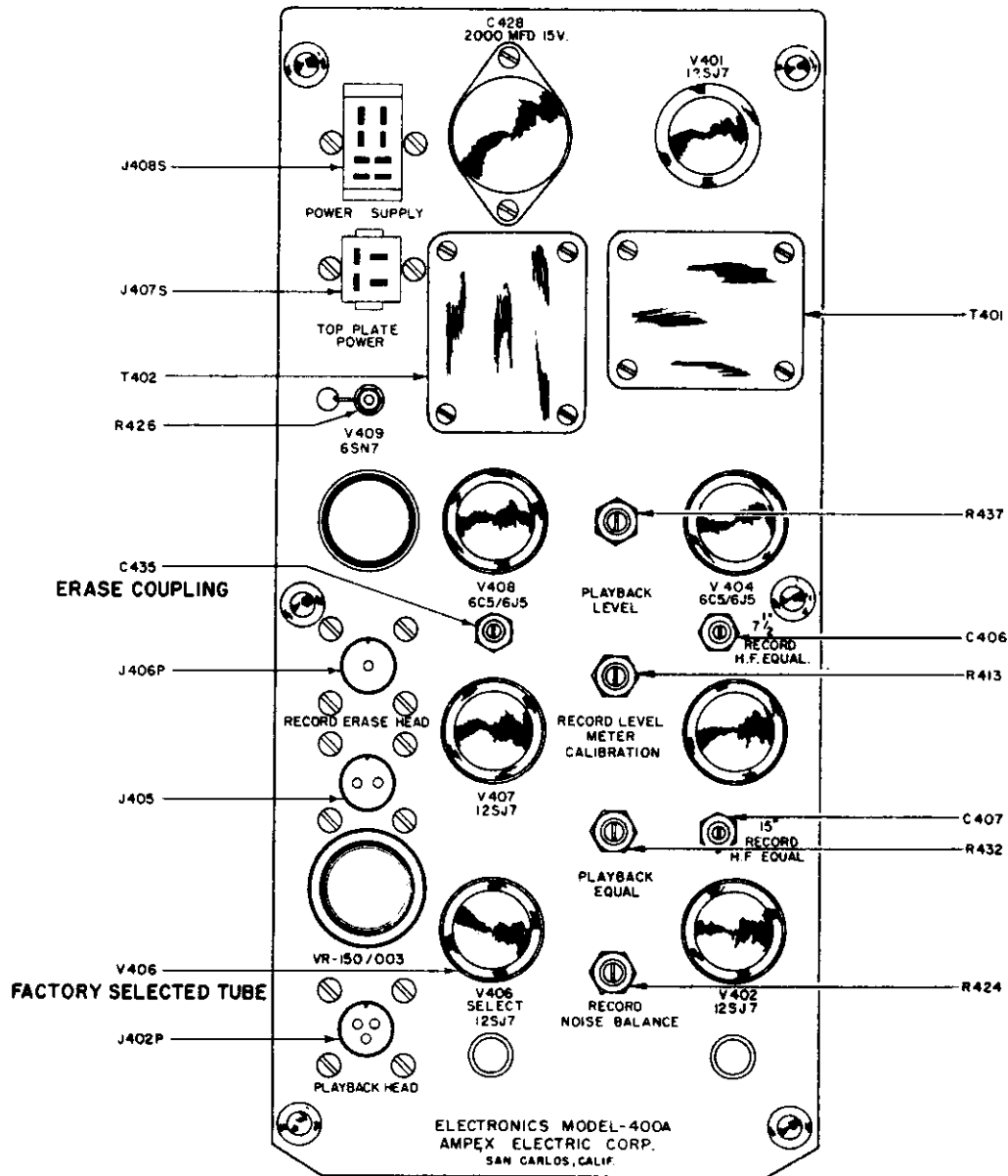
20 3 4 5 6 7 8 9 1 100 2 3 4 5 6 7 8 9 1 1000 2 3 4 5 6 7 8 9 1 10000 2 20000

FREQUENCY IN CYCLES PER SECOND





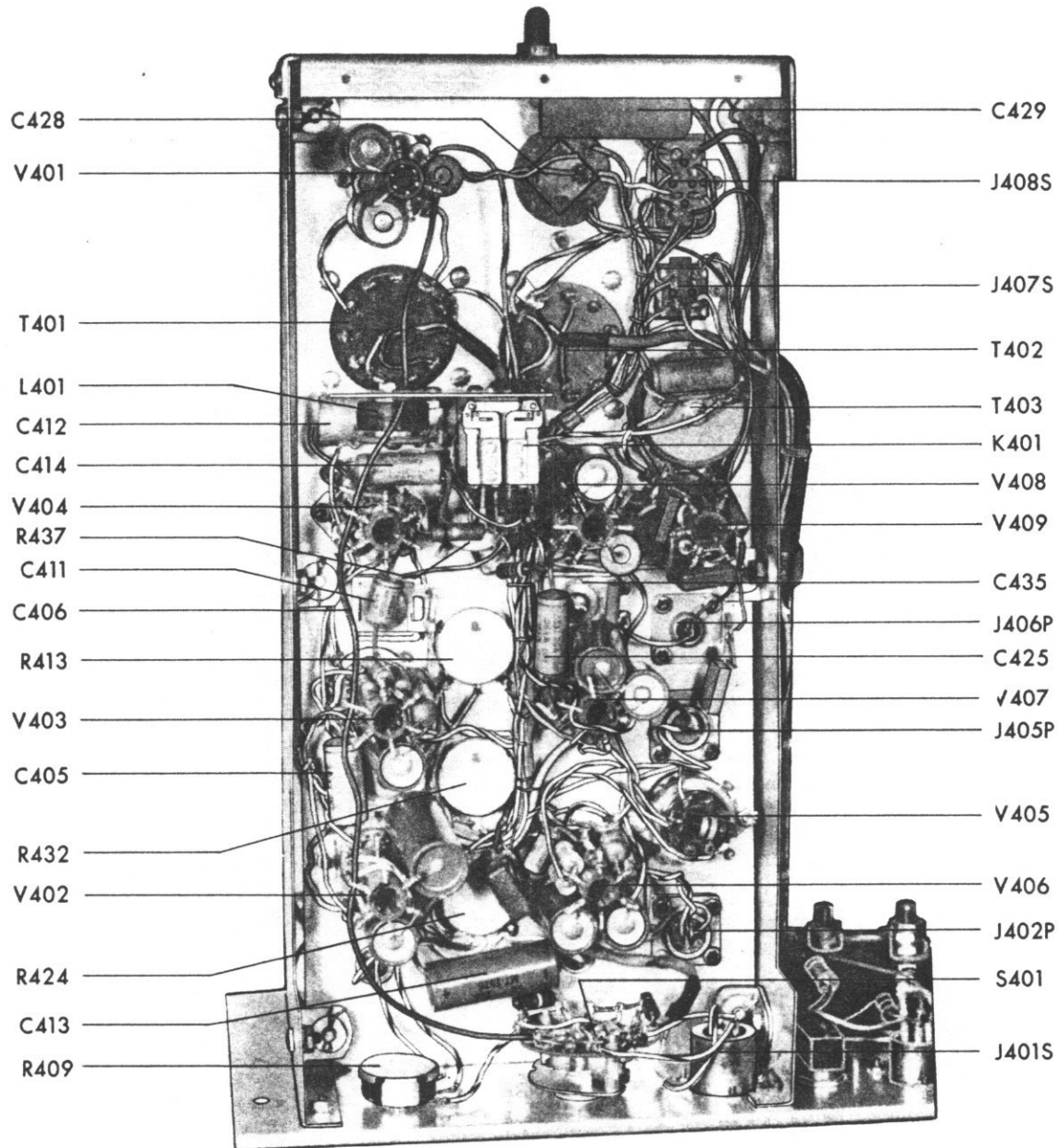
**ELECTRONICS-FRONT PANEL**  
**SERIES 400 SINGLE CASE PORTABLE**  
**AMPEX ELECTRIC CORPORATION**  
 REDWOOD CITY, CALIFORNIA



ELECTRONICS - TOP PLATE  
 SERIES 400 SINGLE CASE PORTABLE  
 AMPEX ELECTRIC CORPORATION  
 REDWOOD CITY, CALIFORNIA

FIG 11

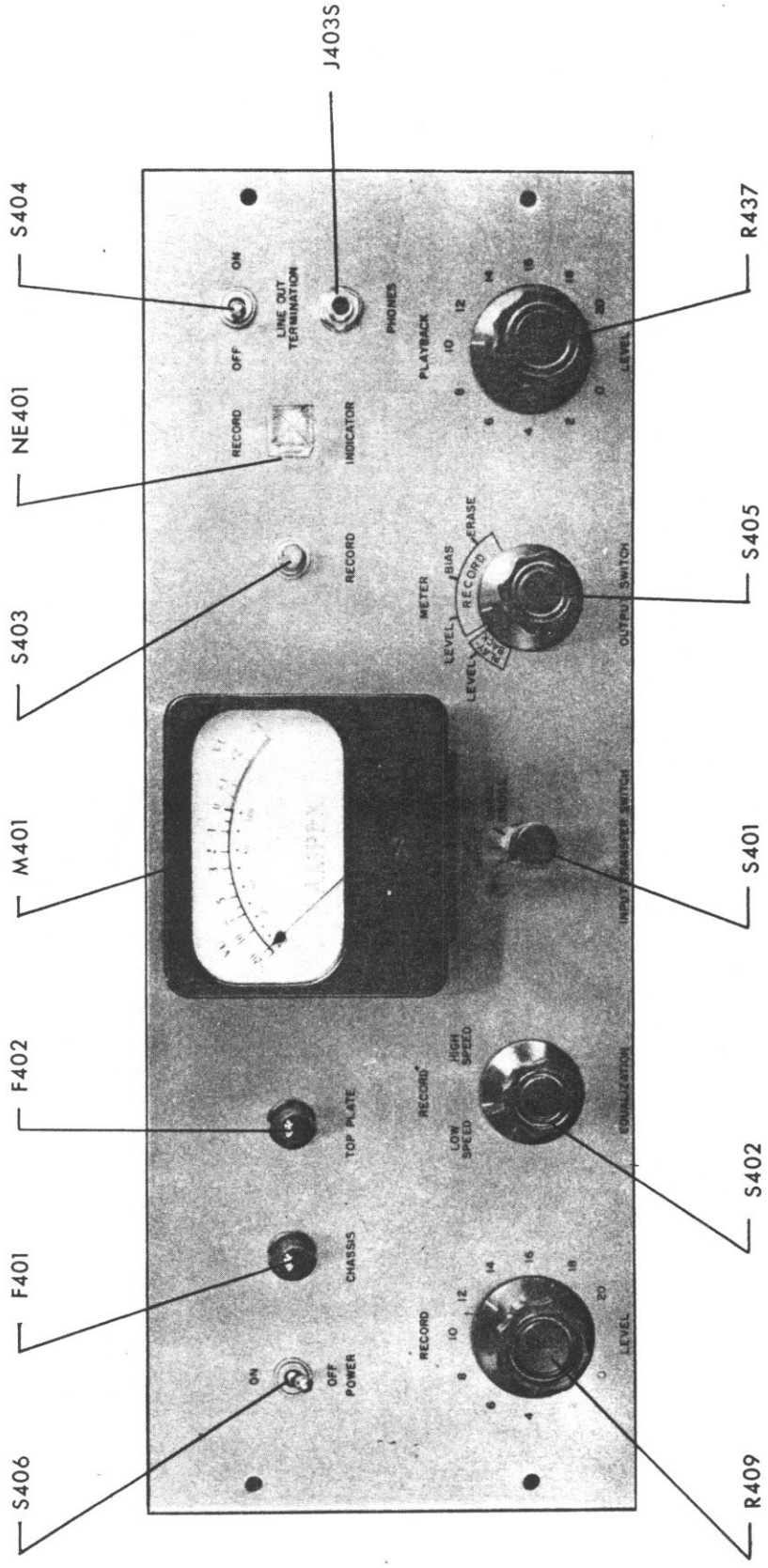




ELECTRONIC ASSEMBLY - BOTTOM VIEW

SERIES 400 SINGLE CASE PORTABLE  
 AMPEX ELECTRIC CORPORATION

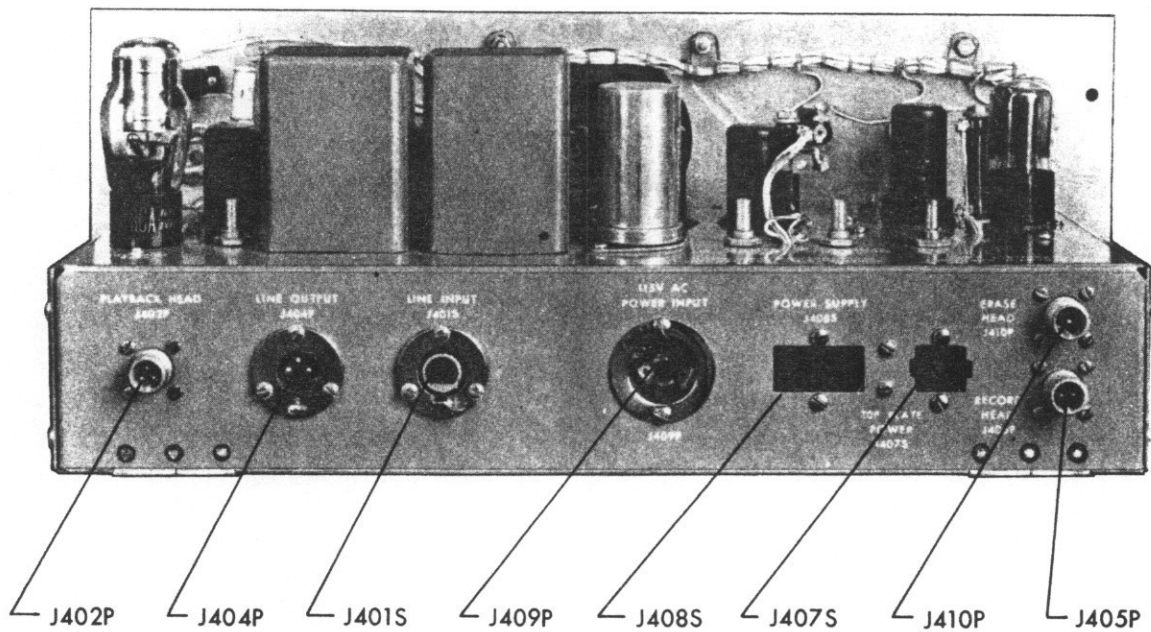
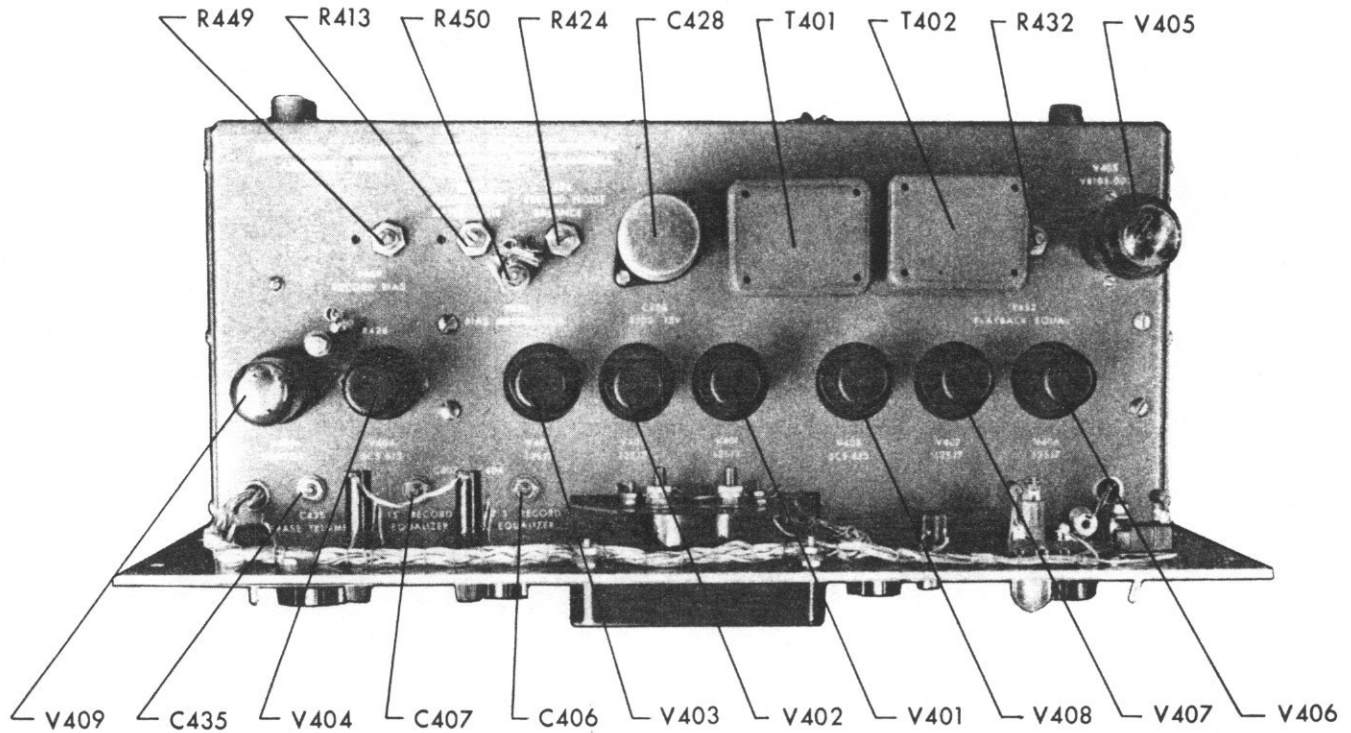
REDWOOD CITY, CALIFORNIA



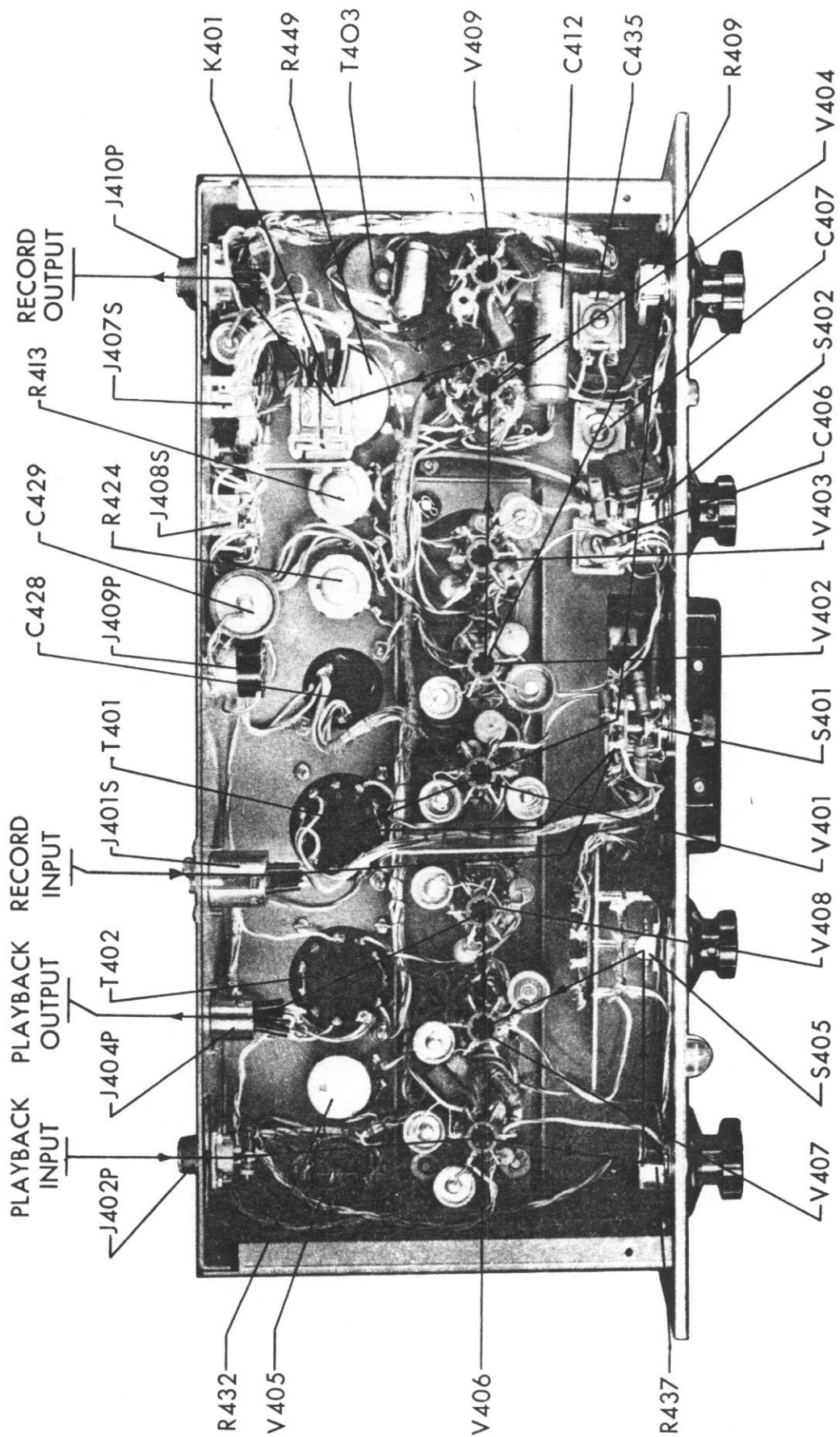
ELECTRONIC ASSEMBLY  
FRONT PANEL

SERIES 400  
AMPEX ELECTRIC CORPORATION  
REDWOOD CITY, CALIFORNIA

FIG 13

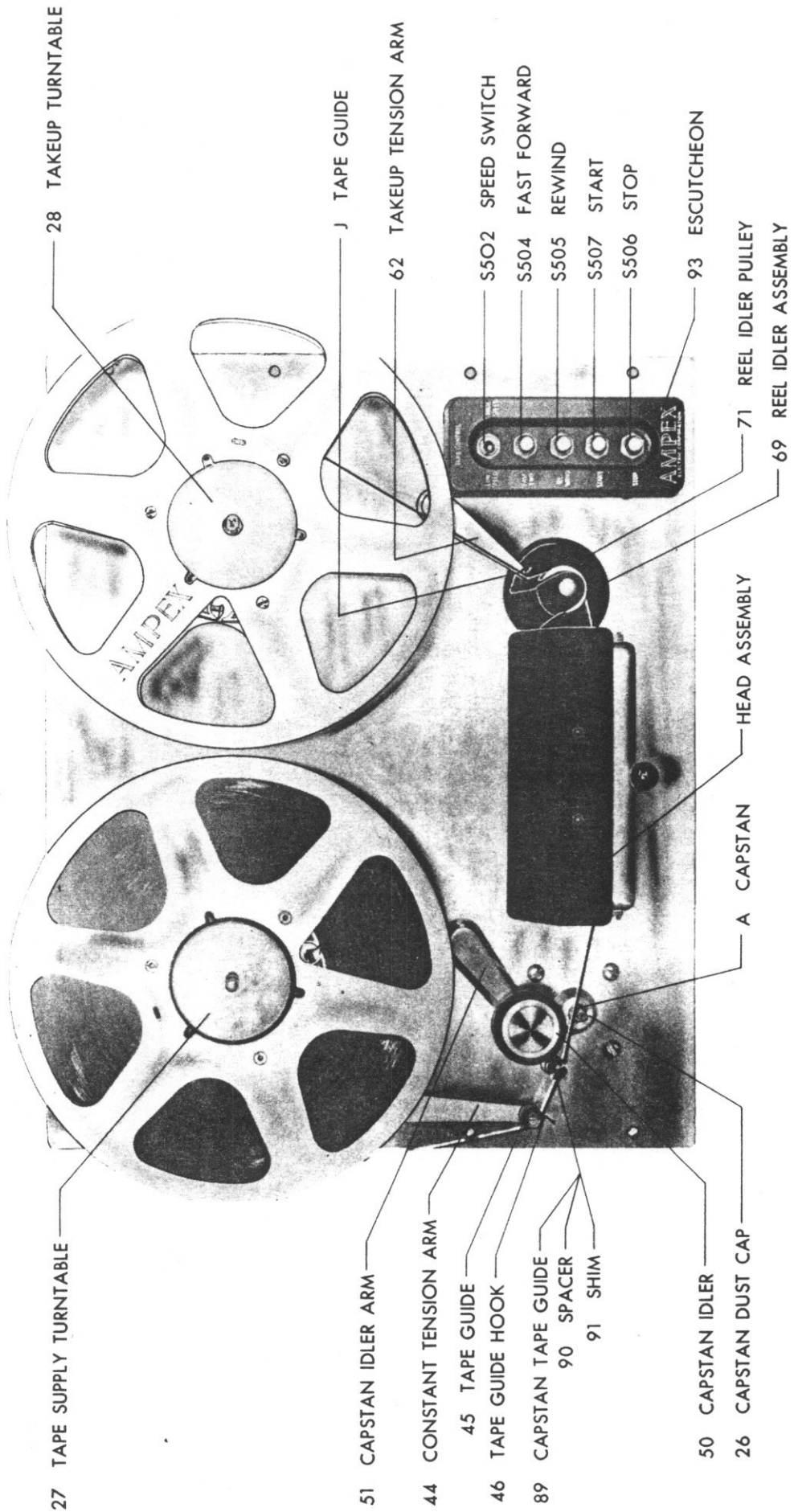


ELECTRONIC ASSEMBLY  
 TOP & REAR VIEWS  
 SERIES 400  
 AMPEX ELECTRIC CORPORATION  
 REDWOOD CITY, CALIFORNIA



ELECTRONIC ASSEMBLY  
BOTTOM VIEW

SERIES 400  
AMPEX ELECTRIC CORPORATION  
REDWOOD CITY, CALIFORNIA

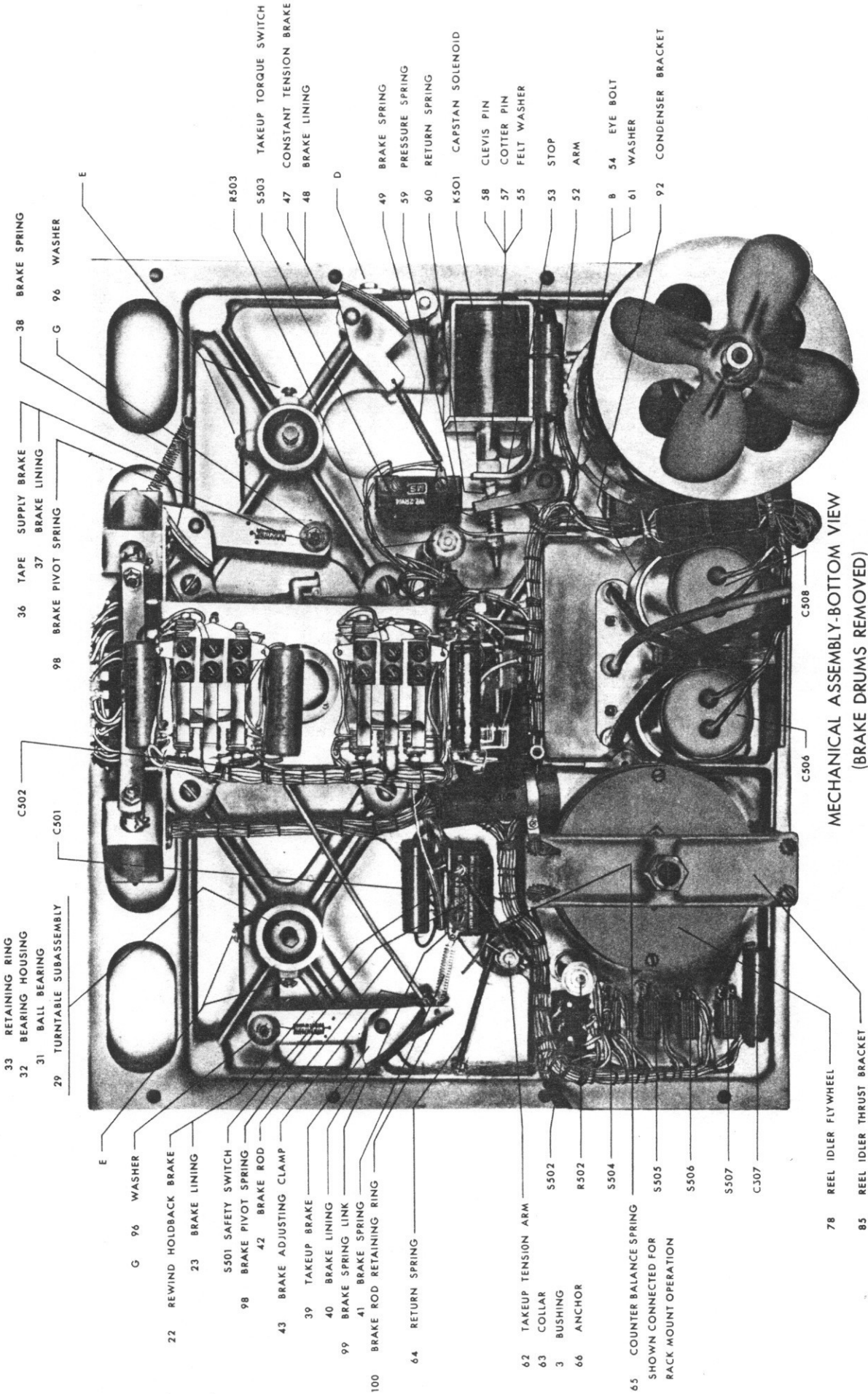


- 27 TAPE SUPPLY TURNTABLE
- 28 TAKEUP TURNTABLE
- 51 CAPSTAN IDLER ARM
- 44 CONSTANT TENSION ARM
- 45 TAPE GUIDE
- 46 TAPE GUIDE HOOK
- 89 CAPSTAN TAPE GUIDE
- 90 SPACER
- 91 SHIM
- 50 CAPSTAN IDLER
- 26 CAPSTAN DUST CAP
- A CAPSTAN
- HEAD ASSEMBLY
- 62 TAKEUP TENSION ARM
- J TAPE GUIDE
- S502 SPEED SWITCH
- S504 FAST FORWARD
- S505 REWIND
- S507 START
- S506 STOP
- 93 ESCUTCHEON
- 71 REEL IDLER PULLEY
- 69 REEL IDLER ASSEMBLY

MECHANICAL ASSEMBLY - TOP VIEW

SERIES 400  
 AMPEX ELECTRIC CORPORATION  
 REDWOOD CITY, CALIFORNIA



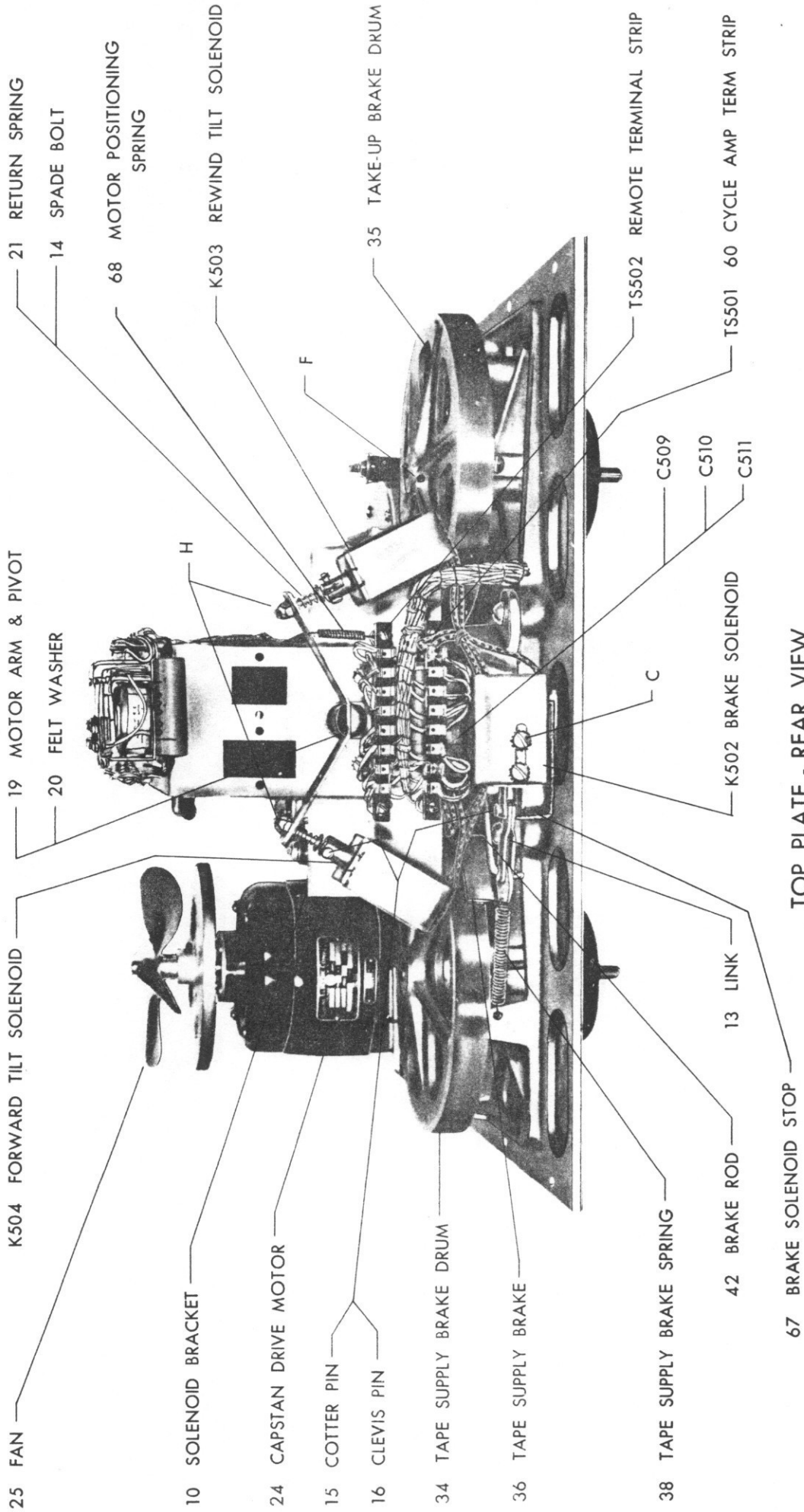


- 33 RETAINING RING
- 32 BEARING HOUSING
- 31 BALL BEARING
- 29 TURNABLE SUBASSEMBLY
- 22 REWIND HOLDBACK BRAKE
- 23 BRAKE LINING
- S501 SAFETY SWITCH
- 98 BRAKE PIVOT SPRING
- 42 BRAKE ROD
- 43 BRAKE ADJUSTING CLAMP
- 39 TAKEUP BRAKE
- 40 BRAKE LINING
- 99 BRAKE SPRING LINK
- 41 BRAKE SPRING
- 100 BRAKE ROD RETAINING RING
- 64 RETURN SPRING
- 62 TAKEUP TENSION ARM
- 63 COLLAR
- 3 BUSHING
- 66 ANCHOR
- 65 COUNTER BALANCE SPRING
- SHOWN CONNECTED FOR RACK MOUNT OPERATION
- 78 REEL IDLER FLYWHEEL
- 85 REEL IDLER THRUST BRACKET
- 36 TAPE SUPPLY BRAKE
- 37 BRAKE LINING
- 98 BRAKE PIVOT SPRING
- 38 BRAKE SPRING
- 96 WASHER
- 22 REWIND HOLDBACK BRAKE
- 23 BRAKE LINING
- S501 SAFETY SWITCH
- 98 BRAKE PIVOT SPRING
- 42 BRAKE ROD
- 43 BRAKE ADJUSTING CLAMP
- 39 TAKEUP BRAKE
- 40 BRAKE LINING
- 99 BRAKE SPRING LINK
- 41 BRAKE SPRING
- 100 BRAKE ROD RETAINING RING
- 64 RETURN SPRING
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- 63 COLLAR
- 3 BUSHING
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- 23 BRAKE LINING
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- 98 BRAKE PIVOT SPRING
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- 43 BRAKE ADJUSTING CLAMP
- 39 TAKEUP BRAKE
- 40 BRAKE LINING
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- 41 BRAKE SPRING
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- 64 RETURN SPRING
- 62 TAKEUP TENSION ARM
- 63 COLLAR
- 3 BUSHING
- 66 ANCHOR
- 65 COUNTER BALANCE SPRING
- SHOWN CONNECTED FOR RACK MOUNT OPERATION
- 78 REEL IDLER FLYWHEEL
- 85 REEL IDLER THRUST BRACKET

- R503
- S503 TAKEUP TORQUE SWITCH
- 47 CONSTANT TENSION BRAKE
- 48 BRAKE LINING
- D
- 49 BRAKE SPRING
- 59 PRESSURE SPRING
- 60 RETURN SPRING
- K501 CAPSTAN SOLENOID
- 58 CLEVIS PIN
- 57 COTTER PIN
- 55 FELT WASHER
- 53 STOP
- 52 ARM
- B 54 EYE BOLT
- 61 WASHER
- 92 CONDENSER BRACKET
- C502
- C501
- C506
- C508
- E
- G 96 WASHER
- 22 REWIND HOLDBACK BRAKE
- 23 BRAKE LINING
- S501 SAFETY SWITCH
- 98 BRAKE PIVOT SPRING
- 42 BRAKE ROD
- 43 BRAKE ADJUSTING CLAMP
- 39 TAKEUP BRAKE
- 40 BRAKE LINING
- 99 BRAKE SPRING LINK
- 41 BRAKE SPRING
- 100 BRAKE ROD RETAINING RING
- 64 RETURN SPRING
- 62 TAKEUP TENSION ARM
- 63 COLLAR
- 3 BUSHING
- 66 ANCHOR
- 65 COUNTER BALANCE SPRING
- SHOWN CONNECTED FOR RACK MOUNT OPERATION
- 78 REEL IDLER FLYWHEEL
- 85 REEL IDLER THRUST BRACKET
- 36 TAPE SUPPLY BRAKE
- 37 BRAKE LINING
- 98 BRAKE PIVOT SPRING
- 38 BRAKE SPRING
- 96 WASHER
- 22 REWIND HOLDBACK BRAKE
- 23 BRAKE LINING
- S501 SAFETY SWITCH
- 98 BRAKE PIVOT SPRING
- 42 BRAKE ROD
- 43 BRAKE ADJUSTING CLAMP
- 39 TAKEUP BRAKE
- 40 BRAKE LINING
- 99 BRAKE SPRING LINK
- 41 BRAKE SPRING
- 100 BRAKE ROD RETAINING RING
- 64 RETURN SPRING
- 62 TAKEUP TENSION ARM
- 63 COLLAR
- 3 BUSHING
- 66 ANCHOR
- 65 COUNTER BALANCE SPRING
- SHOWN CONNECTED FOR RACK MOUNT OPERATION
- 78 REEL IDLER FLYWHEEL
- 85 REEL IDLER THRUST BRACKET

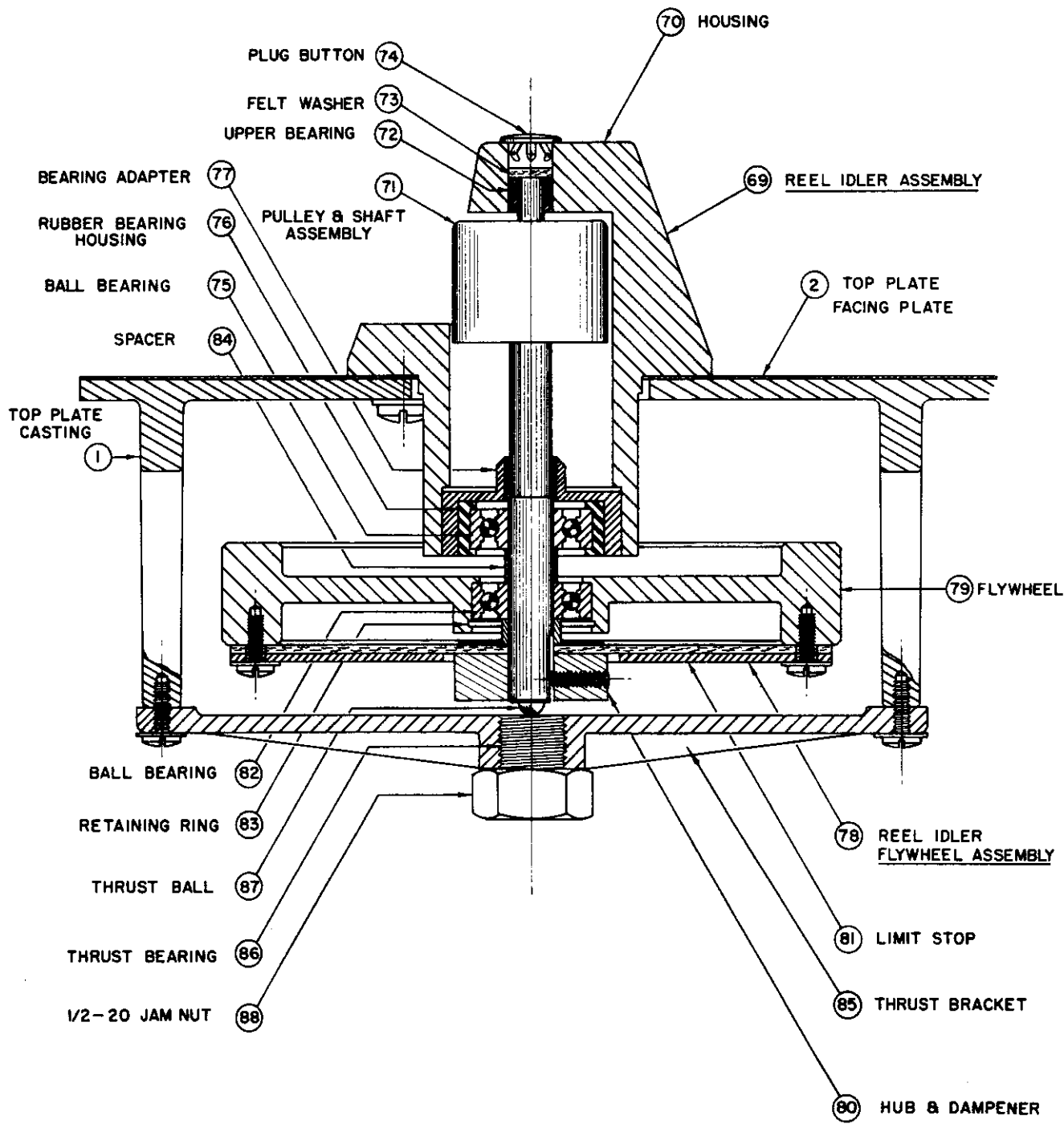
MECHANICAL ASSEMBLY-BOTTOM VIEW  
(BRAKE DRUMS REMOVED)

SERIES 400  
AMPEX ELECTRIC CORPORATION  
REDWOOD CITY, CALIFORNIA



TOP PLATE - REAR VIEW

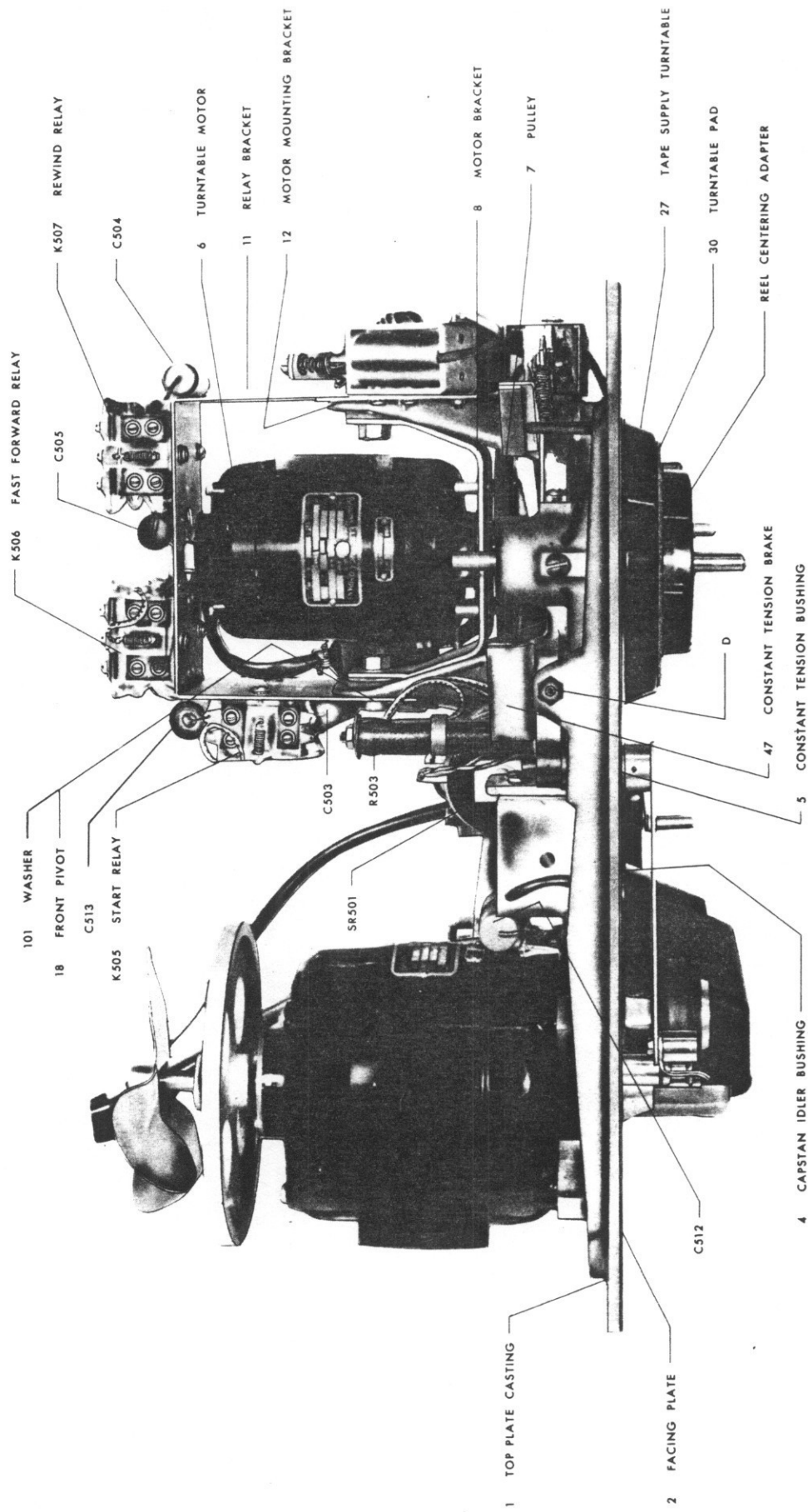
SERIES 400  
 AMPEX ELECTRIC CORPORATION  
 REDWOOD CITY, CALIFORNIA



**REEL IDLER & FLYWHEEL**  
**SERIES 400**  
**AMPEX ELECTRIC CORPORATION**  
 REDWOOD CITY, CALIFORNIA

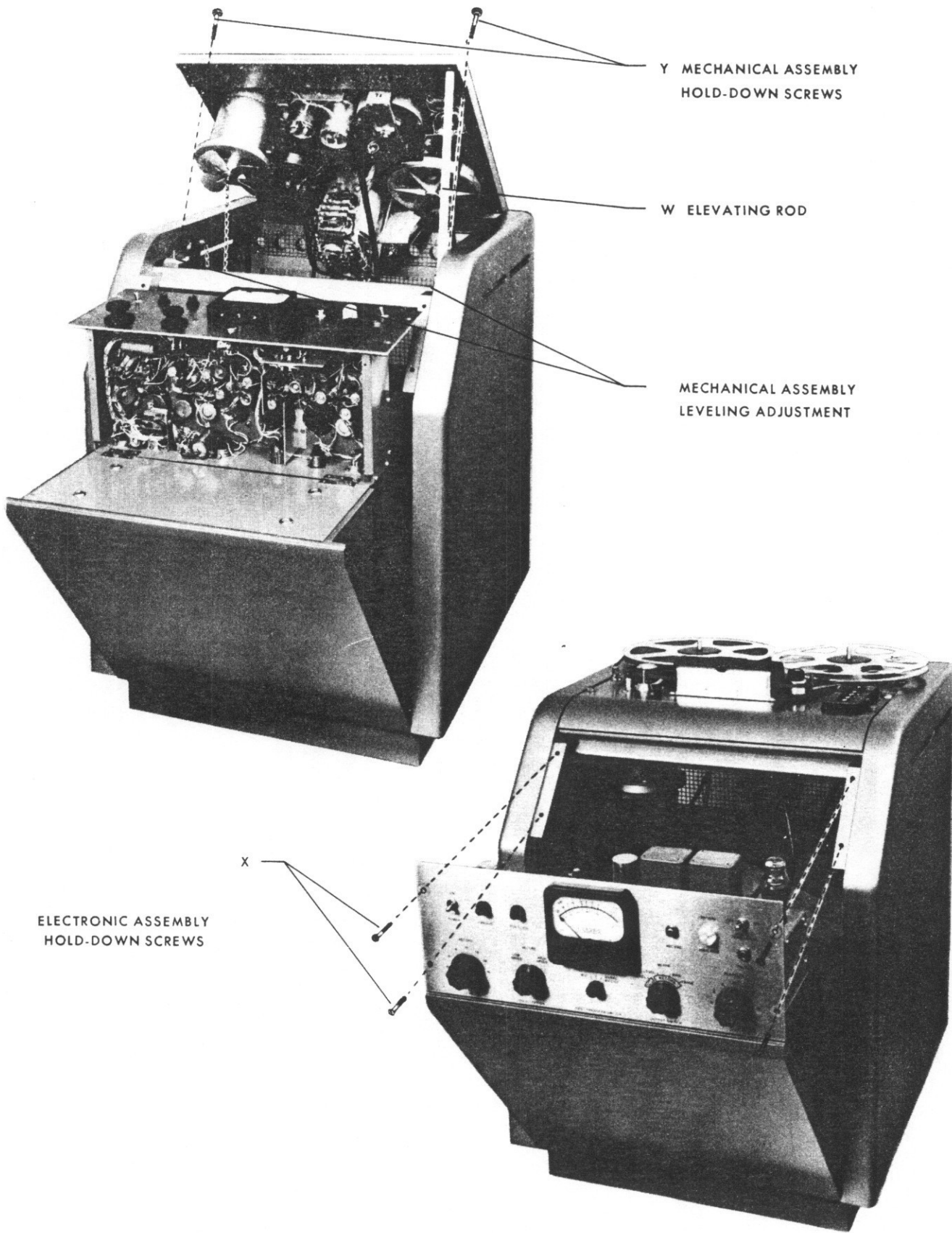
FIG 20



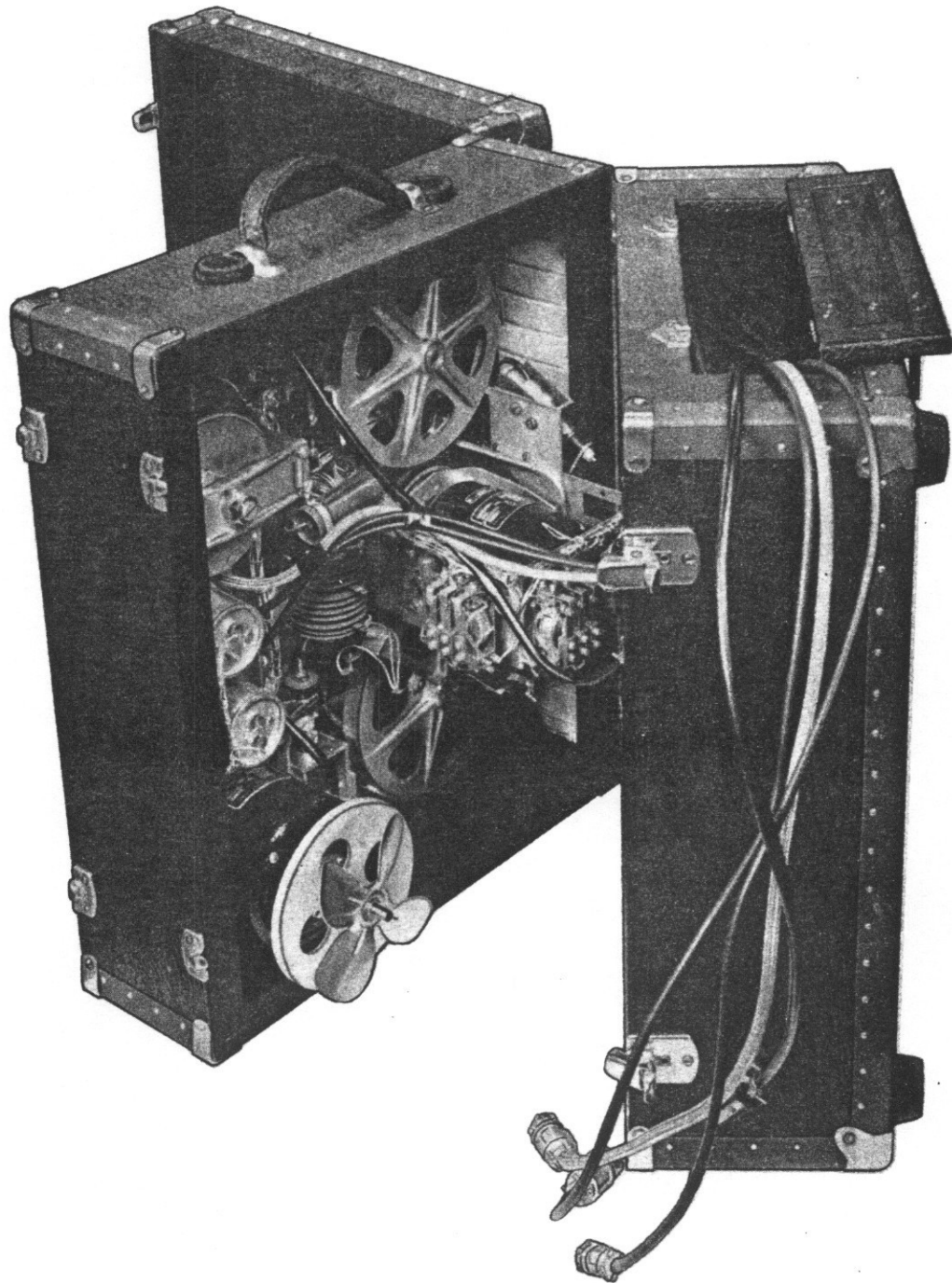


MECHANICAL ASSEMBLY-SIDE VIEW  
(BRAKE DRUMS REMOVED)

SERIES 400  
AMPEX ELECTRIC CORPORATION  
REDWOOD CITY, CALIFORNIA



CONSOLE CABINET  
MODELS 402 & 403  
AMPEX ELECTRIC CORPORATION  
REDWOOD CITY, CALIFORNIA



MECHANICAL ASSEMBLY CASE  
SERIES 400  
TWO CASE PORTABLE  
AMPEX ELECTRIC CORPORATION  
REDWOOD CITY, CALIFORNIA