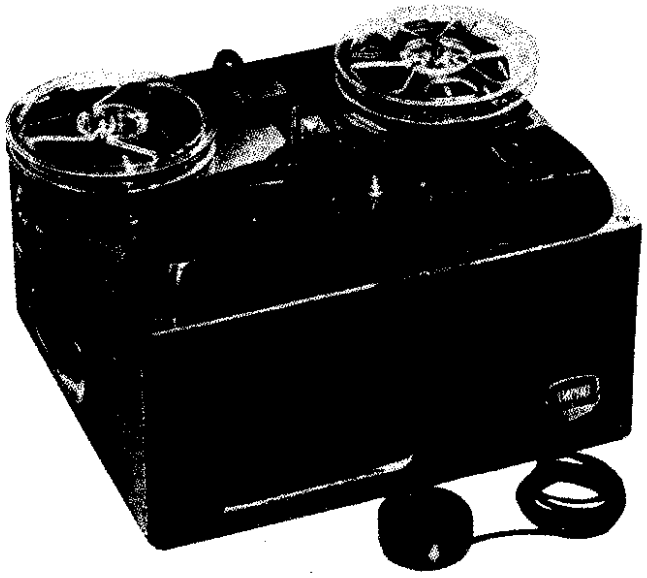

INTRODUCTION

Tape Recorders will be delivered to you for servicing for one of three reasons: one, unsatisfactory performance due to operational errors on the part of the user, two, periodic inspection and maintenance, and three, unsatisfactory performance due to wear or failure of components.

Proper operating procedures are described in detail in the operator's instruction book and need not be repeated in this manual. The first section of this manual deals with the routine inspection and protective maintenance of the device. The second section deals with trouble shooting and refers to the applicable material describing the correction of trouble, which constitutes the third section. The fourth section describes the procedures for inspecting and adjusting the device after the repair work has been completed. The final section contains a parts list and information relative to the procurement of parts.

SECTION I

Periodic Inspection and Protective Maintenance

A. CLEANING

Dirt is the cause of many irregularities in performance. Therefore, it is advisable to clean all parts in the path of the tape before attempting to inspect or test the equipment.

1. Remove the control panel using the procedure described in Section III Par. A.

2. Wipe the tape guide stud (95), guides on tape erase lever (98), erase head (67) (surface which contacts the tape), sound head (81), capstan (52), and the pressure roller (74) with a cloth dampened with carbon tetrachloride.

> WARNING! DO NOT USE FIRE EXTINGUISHER FLUID OR OTHER SOLVENTS; SUCH MATERIALS MAY EITHER LEAVE A COATING ON THE PARTS, DAMAGE THE PARTS OR LOOSEN ADHESIVES USED IN ASSEMBLING PARTS.

3. Wipe the pressure pads (78) with a cloth dampened with carbon

tetrachloride. Wipe in the direction of tape travel and be careful not to catch the cloth on the pressure springs or bend the springs.

4. Blow any dust or dirt out of the exposed mechanism. DO NOT DIRECT A STREAM OF AIR AGAINST THE PRESSURE PADS.

B. INSPECTION AND TESTING

1. Check the exposed mechanism for loose screws. Tighten any loose screws EXCEPT DO NOT DISTURB SCREWS ON THE ERASE HEAD ASSEMBLY OR THE SCREW OR NUT WHICH HOLD THE SOUND HEAD IN PLACE.

2. Thread the recorder with tape and make a test recording using procedure described in the operating instructions.

> NOTE: The owner's previously recorded tape may be used to determine what he is complaining about. However, you should make a separate recording in order to make an actual test of the recorder under controlled conditions and assure yourself that his complaint is not traceable to operational errors. Play back the recording which you made and note any irregularities on tape movement, quality of reproduced sound and unusual background noises if present. Also check operation of the controls. If any irregularities in performance are noted, refer to Section II for probable cause and remedy.

C. LUBRICATION

The operator has been instructed not to lubricate this device and has been referred to the service technician for this service which should be on an annual or 500 operating hour basis.

> WARNING: Do not use lubricants other than those specified or in excess of the amounts specified. Excessive lubrication will cause slippage in the drive system. USE A WATCHMAKER'S OIL APPLICATOR OR A BROOMSTRAW - NEVER USE AN OIL CAN.

1. CAPSTAN SHAFT (52) - Apply one drop of Amproil or pure mineral instrument oil to outer end of each bearing. Allow mechanism to run until oil works into the bearing. Then WIPE EXPOSED PORTIONS OF SHAFT TO REMOVE ANY OIL FROM THEM AND CLEAN FLYWHEEL TIRE AND CAPSTAN WITH CARBON TETRACHLORIDE.

2. MOTOR BEARINGS - Apply two drops of Amproil or pure mineral instrument oil to each motor bearing.

> WARNING: The bearings are equipped with wicks, oil the bearings, not the shaft - oil on the shaft will cause slippage. AFTER OILING, WIPE MOTOR SHAFT AND THE FLYWHEEL TIRE WITH A CLOTH DAMPENED WITH CARBON TETRACHLORIDE.

3. TAKEUP SPINDLE (36) - Apply one drop of Amproil or pure mineral instrument oil to the shaft at the end of the bearing adjacent to the pulley—allow mechanism to run and wipe all oil off of pulley and belt.

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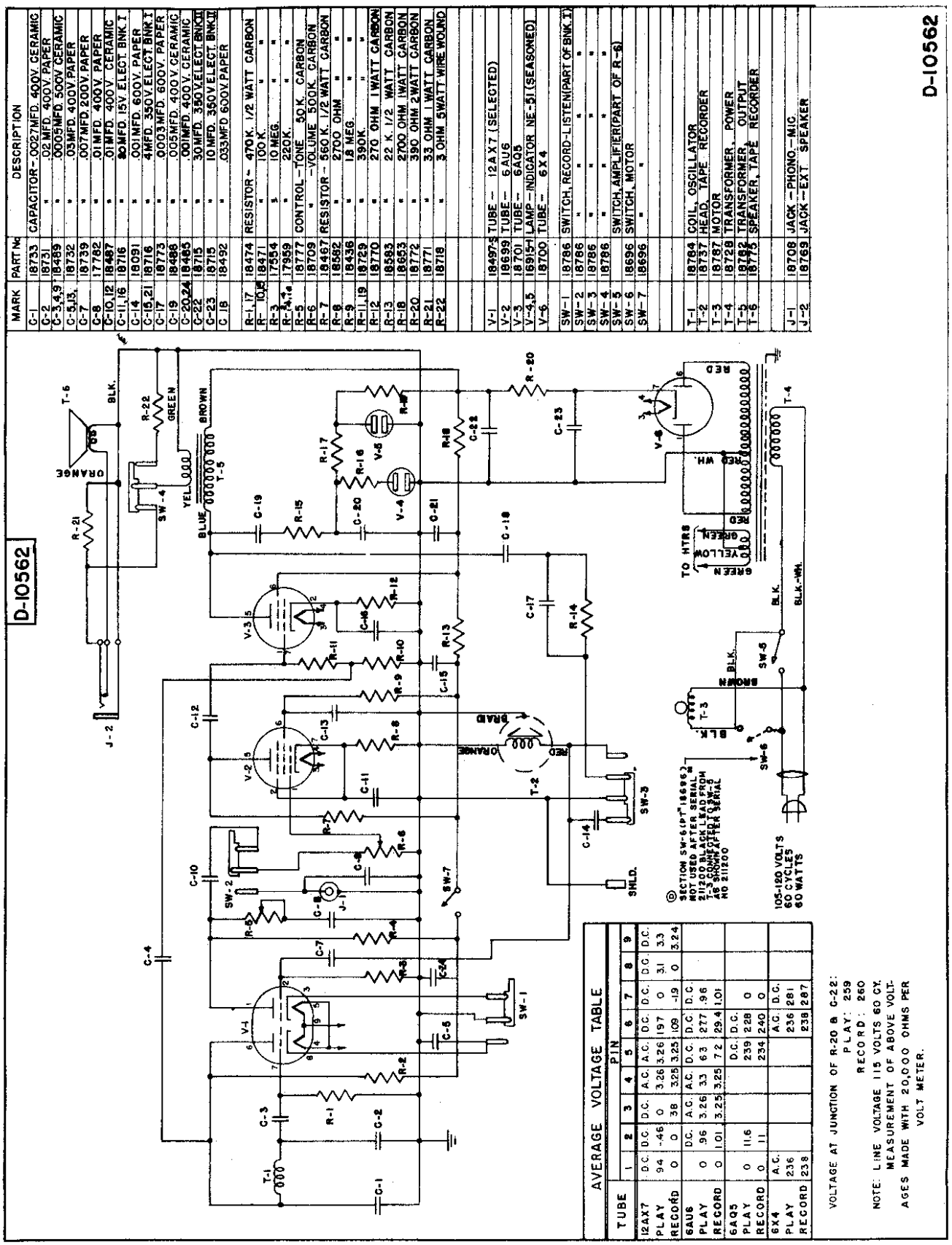

MARK	PART No	DESCRIPTION
C-1	18733	CAPACITOR - .0027MFD. 400V CERAMIC
C-2	18731	" .02 MFD. 400V PAPER
C-3,4,9	18489	" .0005MFD. 500V CERAMIC
C-5,13	18732	" .03MFD. 400V PAPER
C-7	18739	" .007MFD. 200V PAPER
C-8	17782	" .01MFD. 400V PAPER
C-10,12	18487	" .01MFD. 400V CERAMIC
C-11,16	18716	" 20MFD. 15V. ELECT. BNK. I
C-14	18091	" .001MFD. 600V. PAPER
C-15,21	18716	" 4MFD. 350V. ELECT. BNK. I
C-17	18773	" .0003MFD. 600V. PAPER
C-19	18488	" .005MFD. 400 V. CERAMIC
C-20,24	18485	" .001MFD. 400 V. CERAMIC
C-22	18715	" 30MFD. 350 V. ELECT. BNK. II
C-23	18715	" 10 MFD. 350 V. ELECT. BNK. II
C-18	18492	" .033MFD 600V. PAPER
R-1, 17	18474	RESISTOR - 470K. 1/2 WATT CARBON
R-10,15	18471	" 100 K. " "
R-3	17554	" 10 MEG. " "
R-4,14	17959	" 220K. " "
R-5	18777	CONTROL - TONE 30 K. CARBON
R-6	18709	" - VOLUME 500K. CARBON
R-7	19467	RESISTOR - 560 K. 1/2 WATT CARBON
R-8	18582	" 2700 OHM " "
R-9	18436	" 1.8 MEG. " "
R-11,19	18729	" 390K. " "
R-12	18770	" 270 OHM 1 WATT CARBON
R-13	18583	" 22 K. 1/2 WATT CARBON
R-18	18653	" 2700 OHM 1WATT CARBON
R-20	18772	" 390 OHM 2 WATT CARBON
R-21	18771	" 33 OHM 1 WATT CARBON
R-22	18718	" 3 OHM 5WATT WIRE WOUND
V-1	18497-S	TUBE - 12AX7 (SELECTED)
V-2	19699	TUBE - 6AU6
V-3	18701	TUBE - 6AQ5
V-4,5	16915-1	LAMP - INDICATOR NE-51 (SEASONED)
V-6	18700	TUBE - 6X4
SW-1	18786	SWITCH, RECORD-LISTEN (PART OF BNK. I)
SW-2	18786	" " " " " "
SW-3	18786	" " " " " "
SW-4	18786	" " " " " "
SW-5	18786	SWITCH, AMPLIFIER (PART OF R-6)
SW-6	18696	SWITCH, MOTOR
SW-7	18696	" "
T-1	18784	COIL, OSCILLATOR
T-2	18737	HEAD, TAPE RECORDER
T-3	18787	MOTOR
T-4	18728	TRANSFORMER, POWER
T-5	18782	TRANSFORMER, OUTPUT
T-6	18775	SPEAKER, TAPE RECORDER
J-1	18708	JACK - PHONO - MIC
J-2	18769	JACK - EXT SPEAKER

AVERAGE VOLTAGE TABLE

TUBE		1	2	3	4	5	6	7	8	9
		PIN								
12AX7	D.C.	D.C.	D.C.	A.C.	A.C.	D.C.	D.C.	D.C.	D.C.	D.C.
PLAY	94	-46	0	3.26	3.26	197	0	3.1	3.3	
RECORD	0	0	38	3.25	3.25	109	-19	0	3.24	
6AU6		D.C.	A.C.	A.C.	D.C.	D.C.	D.C	D.C.		
PLAY	0	.96	3.26	33	63	277	.96			
RECORD	0	1.01	3.25	3.25	7.2	29.4	1.01			
6AQ5					D.C.	D.C.	D.C.			
PLAY	0	11.6			239	228	0			
RECORD	0	11			234	240	0			
6X4		A.C.				A.C.	D.C.			
PLAY		236				236	281			
RECORD		238				238	287			

VOLTAGE AT JUNCTION OF R-20 & C-22:
PLAY: 259
RECORD: 260

NOTE: LINE VOLTAGE 115 VOLTS 60 CY.
MEASUREMENT OF ABOVE VOLTAGES MADE WITH 20,000 OHMS PER VOLT METER.

4. PRESSURE ROLLER SHAFT (pt. of assem. #74) - Wash with carbon tetrachloride then dry thoroughly and apply one drop of Amproil and rotate roller to work into the bearing. Wipe surplus oil off of roller and bracket.

5. ACTUATING COLLARS (16 & 63) - Use a toothpick to apply a thin film of " Lubriplate" or light graphite grease to those surfaces where sliding action occurs.

6. CONTACT SURFACE BETWEEN PRESSURE PAD BRACKET (78) AND PRESSURE ROLLER BRACKET (74) - Use a toothpick to apply a thin film of " Lubriplate" or light graphite grease to the working surfaces.

SECTION II

Trouble Shooting

In this recorder, like any other electro-mechanical device, many things could happen which would affect performance. The purpose of the following table is to group the troubles which may be encountered in as few groups as possible and indicate the probable cause and corrective action to be taken.

TROUBLE AND REMEDY TABLE

Trouble	Probable Cause	Remedy
1. Low pitch	Tape speed is below 3 3/4" sec.	Check Drive (Sec III C-4) Check pressure pads (Sec III C-3) Check Capstan Follower Check Feed Spindle
2. No high frequencies and distortion	Tape not in contact with sound head. Improper Azmuth adjustment Amplifier trouble Improper Guiding Pressure roller actuator has slipped	Damaged head Worn Pressure pad See Sec. IV A Check Amp. (Sec III C-1)

Trouble	Probable Cause	Remedy
3. Varying pitch (Wows)	Feed reel jerks Worn or loose feed guide Worn Capstan bearings Worn or improperly adjusted pressure pads Bent or worn erase lever Eccentric Capstan or Flywheel Tire Bent motor shaft Sound head loose in shield Dirty or worn takeup mechanism Improper guiding Worn takeup drive belt Rewind lever engaged Worn guide surfaces in soundhead	Check felt feed spindle disc Rotate or replace, or tighten (Sec. III C-4) Replace Replace (Sec. III C-3) Replace or repair Replace or exchange (Sec. III C-4) Replace motor (Sec. III C-4) Tighten Clean or replace (Sec. III C-4) Check tape for weaving Replace (Sec. III C-4) See operating instructions Replace
4. Takeup doesn't operate	Dirty or worn friction washer Takeup drive belt off pulleys Takeup drive belt broken or worn out	Clean or replace spindle (Sec. III C-4) Replace Replace
5. Can't thread recorder	Loose pressure roller actuator collar Bent pressure pad springs	Adjust or tighten (Sec. III C-3) Adjust
6. No sound on playback	Loose erase lever actuator collar Amplifier trouble	Adjust and tighten (Sec. III C-3) Plug in mike, switch to "Record" position, turn on motor switch if feedback occurs, check T-2 and input section of V-1. If no feedback, check SW-4, "B" supply & SW-2.
7. Playback OK-won't record	Damaged mike, cable or receptacle Failure of SW-1, 2, 3, or 7 Oscillator section of V-1 not functioning C-4, 17 or 18 open V-4 damaged	Repair Repair or replace (Sec. III C-1) Check and repair Check Replace BOTH V-4 and 5 (Matched set)

Trouble	Probable Cause	Remedy
8. Excessively noisey recordings	C-18 leaking Worn erase pad Recording level too low Weak oscillator or C-4 off value Loose connections in amplifier Damaged mike or mike receptacles Noisey switches Erase head not properly adjusted	Replace Replace (Sec. III C-3) Check V-4 (Replace V-4 & 5 Matched set) Check Check all connections Check Check switch contacts Adjust (Sec. III C-2)
9. Excessive 120 cycle hum	Open filter capacitor Hum shield not bearing on sound head	Check C-15, 21, 22, 23 Check spring
10. Excessive 60 cycle hum	Damaged tube Hum shield not bearing on sound head	Check tubes for heater to cathode leakage Check springs
11. Low gain and distortion	C-18 leaking Damaged 6AQ5 Damaged coupling or decoupling capacitors Poor contact in switches Incorrect recording bias Open cathode bypass capacitor Damaged output transformer Erase head requires adjustment	Replace Check tubes Check Clean or replace Check recording bias Check capacitors Replace Adjust (Sec. III C-2)
12. Microphonics	Sustained (defective 12AX7 or 6AU6)	Replace with selected tube
13. Oscillation	Damaged 12AX7 C-11 or C-16 open	Replace Replace

SECTION III

Service Procedures

A. EXPOSURE OF WORKING COMPONENTS

1. Removal of control panel - loosen the setscrews and lift off the four control knobs (9), then take out the three panel retaining screws (11) and lift off the control panel (10).

2. Removal of recorder from case.

   a. Take out the six screws which hold the tape reel panel (7) in place.

   b. Take out the six retaining screws (8).

   c. Lift recorder assembly out of case.

   d. Remove hex nut, "External Speaker" nameplate, and speaker jack (24).

   e. Remove the four hex nuts, lockwashers and burr washers and lift out the speaker (2).

3. Removal of Amplifier Cover.

   a. Take out the seven cover screws (13) and remove the amplifier cover (12).

B. REMOVAL OF THE MAJOR UNITS

1. Removal of Amplifier Assembly

   a. Complete procedure A.

   b. Loosen setscrew (17) and remove erase lever actuator collar assembly (16) and spring (18).

   c. Place recorder on its side (controls down).

   d. Unsolder recording head cable from the two terminals on the "Play - Record" switch. Mark the terminals.

   e. Remove the three nuts and washers from the amplifier stop screws.

   f. Remove the four screws (26) and grommets (25) which hold the amplifier to the mechanism plate.

   g. Pull the amplifier back away from the mechanism plate and disconnect the amplifier leads from the terminals of the motor control switch.

   h. Disconnect the two motor leads from the amplifier (one was connected to SW-6 in the initial run).

   i. Disconnect the ground wire from the upper flywheel bracket.

2. REMOVAL OF TAPE RECORDER DRIVE ASSEMBLY

   a. Complete procedures A-1, A-2, and A-3.

   b. Remove the motor lock shaft stud (5), lock key (4) and spring.

   c. Remove hex nut (31) and washer (30) then remove the motor plate actuator assembly (27).

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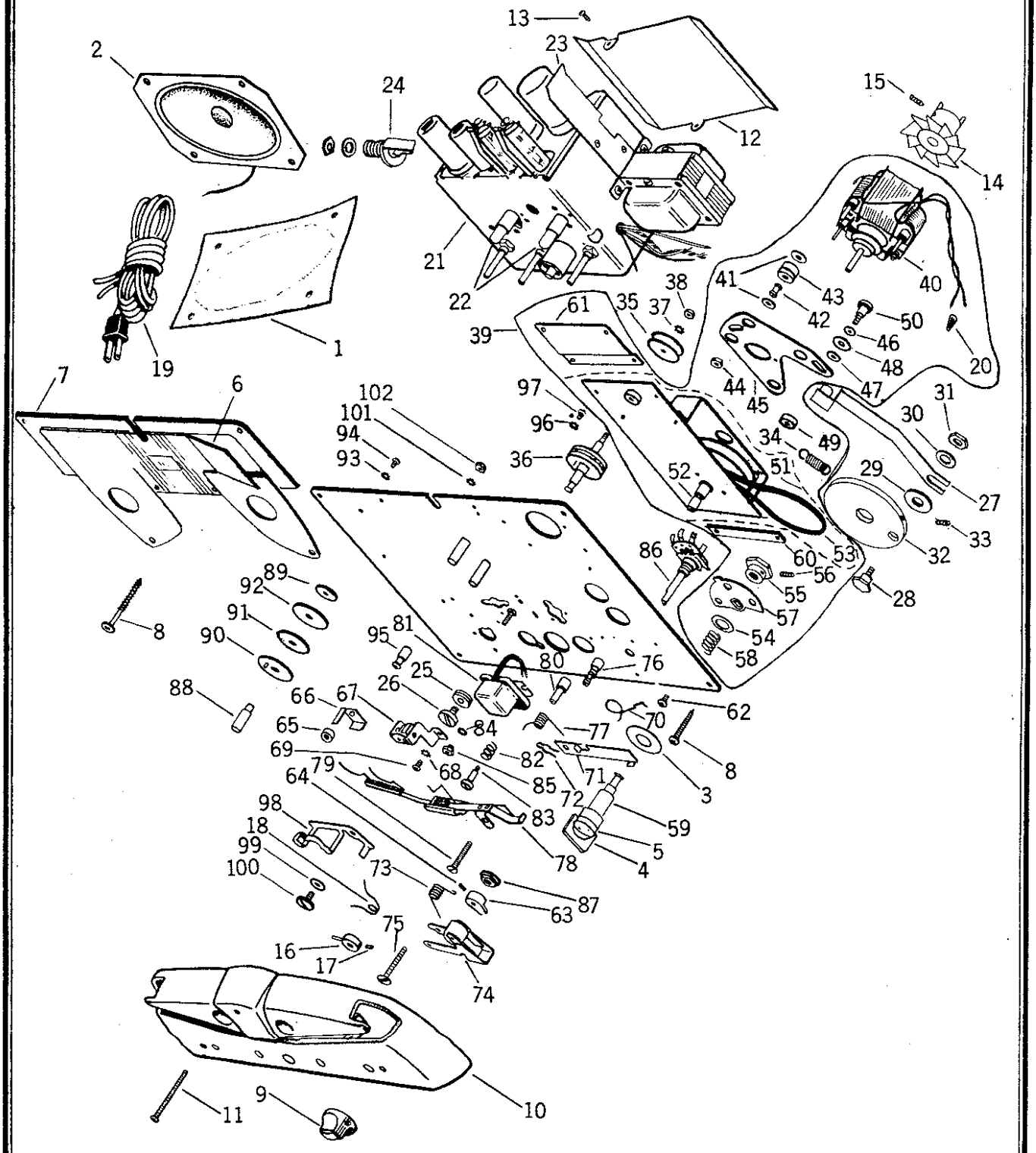

d. Disconnect the motor leads from the amplifier (one lead was connected to SW-6 in the initial run).

e. Disconnect the ground lead from the upper flywheel bracket.

f. Remove the three screws (62) which hold the drive assembly (39) to the mechanism plate.

g. Lift off the drive unit.

C. SERVICING THE MAJOR UNITS

WARNING: NEVER APPLY DIRECT CURRENT TO THE RECORDING HEAD.

1. Servicing the Amplifier and Recording Head.

a. D.C. Voltage Checks - Check all socket voltages—if voltages vary by more than 10% from those indicated on schematic diagram, check tubes (preferably by substitution) and check associated capacitors and resistors. Bear in mind that a leaking filter capacitor may upset voltages on several stages and that a leaking coupling capacitor will upset voltages on the following stage.

b. Bias Current Check - Disconnect the grounded lead from the recording head at the "Play - Record" switch, switch to "Record" position. Insert a D.C. microameter and check for current, if current exceeds 1 microampere, replace C-18. Measure the bias current by inserting a 20 ohm non-inductive (or carbon) resistor between the recording head lead and the switch terminal from which it was disconnected and connect a VT voltmeter across the resistor. The bias current will produce .015 volts ± 10%. Voltages are also subject to the same tolerance as the specific resistor being used in the test circuit. If the current is not within the limits specified, check the oscillator and associated resistors and capacitors. If component values are correct, then push plate and grid leads of 6AQ5 together to reduce current or separate them to increase current.

c. Recording Current Check - Disconnect either lead from the oscillator coil, thereby stopping the oscillator. Connect an audio oscillator to the input jack. Place the "Play-Record" switch in the "Mic" position and turn the "Volume-Control" to the maximum clockwise position. Set the audio oscillator for 400 cycles/sec and adjust the output so that V-4 flashes faintly (NOT A SUSTAINED GLOW). A VT voltmeter and a 20 ohm resistor (when connected as described in Par. b.) will indicate .001-.002 volts (plus or minus tolerance on resistor). The wave form (when viewed on an oscillascope connected across R-22) will be free from distortion. If the current is not correct, change V-4 and V-5 (supplied as a matched and aged set) and recheck. If current is low, increase oscillator level to produce proper current and check wave form. If wave is free from distortion, check all resistors and condensers in the neon lamp circuits. If wave is distorted, in-

dicator lamp circuit can be assumed to be correct and recording head or associated supply network is at fault

d. Gain and Distortion Check - Restore recording head circuit to normal—leave oscillator circuit open. Load the output of an audio oscillator with a non-inductive resistor of the proper value and connect the ground terminal of the oscillator output to the amplifier chassis. Connect a 20,000 ohm carbon resistor between the "hot" terminal on the oscillator output and the ungrounded lead from the recording head (resistor and connecting lead should be shielded and shield should be grounded). Turn "Volume" control to maximum clockwise position and "Play-Record" control to "Play" position. Turn "Motor" switch "ON". Adjust oscillator to 400 cycles/sec and .01 volts (measured across oscillator load resistor). An output meter connected across the speaker terminals should read 2. to 3.5 volts and the output wave form should be free from visible distortion. If distortion is present or output is low, first check the tubes (substituting one at a time) then starting at the output stage, check the wave form at each plate and grid in order to locate the stage in which the distortion is occuring. When the bad stage is located, check all associated resistors, condensers, and connections. If switches are a part of the circuit be sure to check them.

e. Noise Check - Tap each tube with a pencil or other small object and check for microphonics. Any tubes which produce a sustained ringing or crashing noise should be replaced. Operate all switches and check for crashing noises which continue after switch movement has stopped (caused by dirty or worn contacts).

2. Servicing the Erase Mechanism

The erase head consists of a permanent magnet and magnet shield held in place on the mounting bracket by a socket head setscrew and a binder head screw. The proper adjustment of the magnet and shield requires special equipment which is not usually available in a service shop. Therefore, we do not recommend disturbing the two screws referred to. If positioning of the head and erase lever as described herein does not produce satisfactory erasure, or if recordings are noisy and distorted and the cause of the trouble is not traceable to other sources, then a fair adjustment can be made by using the procedures described in paragraph c. The factory service department and certain Authorized Service Stations are equipped to make precision adjustments.

a. Positioning Erase Head - Turn "Play - Record" control to either "Record" or "Mic" position, thereby moving tape erase lever (98) away from the erase pad. Loosen the two screws (69) which hold the erase head to the panel. Rotate the "Motor Control" knob slowly and check to be sure that the erase pad bears evenly on the face of the head. If it does not, rotate the head slightly to correct the condition. Tighten the two screws. Make sure that the tape is pressed firmly against both the magnet and the guard.

b. Positioning the Erase Lever - Turn the "Play - Record" control to the "Play" position. Loosen the setscrew (17) which holds the erase lever actuator collar assembly (16) to the control shaft. Turn the collar clockwise until a straight-edge placed across the erase lever fingers is 1/8" to 3/16" in front of the magnet poles. Move the collar up or down as required so that the actuating arm bears fully upon the ear on the erase lever, then tighten the setscrew. Be sure that the erase lever spring (18) is not pinched between the collar and control bushing. Drop the control panel in place and make sure that the ends of the erase lever fingers are covered by the panel when the control is in the "Play" position and the threading track is clear.

c. Adjusting the Erase Head - The erase head must perform two functions, one, completely remove all previously recorded material, and two, leave the tape in a demagnetized state. Erasure is accomplished by passing the tape thru a strong magnetic field (note that the tape from the supply reel actually is in contact with the leading pole of the permanent magnet). Demagnetization is accomplished by passing the tape through a weaker field of reversed polarity (note that the tape is separated from the trailing pole of the magnet by means of an adjustable non-magnetic guard). If the guard is moved in against the pole of the magnet, the tape passes through a very strong magnetic field which will neutralize the charge placed upon the magnetic coating by the leading pole of the magnet and probably will set up a charge of opposite polarity (this charge will produce excessive tape noise in the recording and also introduce even order harmonic distortion). If the guard is moved as far as possible away from the pole, then the charge placed upon the tape by the erase pole will not be completely neutralized and the remaining charge will again cause excessive tape noise and even order harmonic distortion. Therefore, the placement of the erase guard governs the degree of demagnetization of the tape and proper adjustment will result in the tape leaving the erase head in the desired condition.

1. Adjustment by noise level method (Emergency procedure) - Connect an output meter across the voicecoil of the speaker. Run the recorder and adjust the volume control to produce a low reading on the meter (this will be the system noise for the particular setting of the control). Thread the recorder with a loop of new brown oxide tape which has neither been used for recording or erased. Switch to the "Play" position. Loosen the setscrew (17) and release the erase lever actuator collar (16). Run the recorder and note the output meter reading and listen to the noise.
   Loosen the screw which holds the magnet guard in place and move the guard about .005" in either direction. Note the meter reading and apparent increase or decrease in noise. If the latest reading is less than the previous reading, repeat the process after moving the guard a little farther in the same direction. If the reading is more than

the previous reading, move the guard in the opposite direction. When the position is found at which the output meter gives the lowest reading and the listening test indicates the lowest level, this will be the best adjustment attainable by this procedure. Due to the changing nature of the noise, a trained ear may note a more definite minimum noise level than is indicated by the output meter.

2. Adjustment by Harmonic Distortion Method (Preferred Procedure) - This procedure requires the following test equipment:

   Audio frequency oscillator producing 400 C.P.S. free from second harmonic distortion or equipped with filter to attentuate 800 C.P.S. harmonic by at least 75 D. B.

   Matching transformer or network to couple oscillator to input of recorder.

   Distortion meter (harmonic)

   Check the audio oscillator with the distortion meter to be sure that the 400 C.P.S. tone is free from harmonic distortion. Use a filter if necessary. Match the oscillator to the input of the recorder. Connect the distortion meter to the output of the recorder using the procedure recommended by the manufacturer for connecting to a 3.75 ohm source.

   Turn on the recorder, switch to "Phono - Radio" position and adjust the volume control to produce a faint flash from the recording lamp. Check the output of the recorder to be sure that the level being used produces negligible harmonic distortion. If the output is distorted, service the amplifier before attempting to adjust the erase head.

   Thread the recorder with brown oxide tape and record about 5' of tape. Rewind the tape, switch to "Play" position and measure the harmonic distortion.

   Loosen the screw which holds the magnet guard in place and move the guard about .005" in either direction. Repeat the recording and playback operation and again measure the distortion. If the distortion has decreased, continue moving the guard in the same direction and repeating the test until a position which produces minimum distortion has been located. As the point of minimum distortion is approached, move the guard approximately .001" per step (this can be accomplished by only loosening the retaining screw slightly and tapping the guard with a light tool).

   If a considerable number of recorders are to be serviced, the process can be speeded up by placing a second recorder (known to be in good condition) along side of the one being adjusted and using it as a continuous playback unit to monitor a loop of tape upon which a recording is

being made continuously by the unit being adjusted. Slack should be left in the tape as it passes between the two recorders. This produces an additional lag in the record-reproduce process but prevents spurious readings which might be caused if the tape was under abnormal tension in the monitor unit.

Special test equipment can be built for this specific purpose, however, the volume of work to be done will seldom justify the cost of assembling a test device which can only be used for one type of operation.

3. SERVICING THE PRESSURE PADS, PRESSURE ROLLER AND ACTUATING MECHANISM

a. Pressure Pads - If the pressure pads are worn down to a thickness of less than 1/16", lift the end of the pressure pad spring (77) over the end of the "Motor Control" shaft. Take out the screw (79) which holds the pressure pad bracket assembly (78) in place and lift off the assembly and the pressure pad bracket stud (80). Use Petroleum Naptha (140-210F.) as a solvent to remove the old pad. Use Minnesota Mining & Mfg. Co. Cement #EC-104 to cement the new pad in place (Be sure that the edges of the pads are parallel to the edges of the springs and that the ends of the pads are flush with the ends of the springs). Reassemble and install the pressure pad bracket assembly, place the end of the pressure pad spring below the pressure roller actuator (63) and turn the motor control knob slowly. Check to be sure that the pressure pads enter the slots in the sound and erase heads and bear firmly on the proper surfaces of the heads. Turn the "Motor Control" to the "On" position. Loosen the setscrews (64) which hold the pressure roller actuator (63) in place. Turn the "Motor Control" switch to "Off", then turn the actuator collar in a counter clockwise direction until the sound head pressure pad clears the sound head by at least 1/8". Tighten the setscrews and place a speck of "Lubriplate" on the side of the actuator which comes in contact with the end of the pressure pad bracket.

b. Pressure Roller Assembly (74) - Rotate the capstan pressure roller and check for binding. If the roller does not revolve freely, immerse it in carbon tetrachloride and rotate the roller until free. Dry the parts and apply 1 drop of Amproil to the edge of the roller and work it into the bearing. Wipe off any surplus oil.

Check the clearance between the heel of the pressure roller bracket and the body of the pressure pad bracket when the "Motor Control" is "ON". If the clearance is less than .005" file the surfaces to increase the clearance.

4. SERVICING THE RECORDER DRIVE ASSEMBLY

a. Concentricity of Capstan and Flywheel Tire - Use an indicator to check these parts for runout. If the runout exceeds 0.0002" full indicator reading, or the bearings are loose, an

objectionable wow will be produced. If the runout exceeds 0.0002", remove the motor (40) as per sub-paragraph b of this paragraph and replace the flywheel and capstan (52) and the bearings if required (See sub-paragraph d). Organizations not equipped to work to close tolerances may find it to their advantage to send the drive sub-assembly (51) to the factory for replacement with a factory rebuilt unit.

b. Separation of Motor Unit from the Capstan and Takeup As-

1. Remove drive assembly from mechanism plate as per procedure B-2.

2. Loosen setscrew and remove fan.

3. Unhook motor pressure spring (34).

4. Remove the three motor mounting shoulder screws (50), felt washer (48), plain washers (46 & 47) and spacers (49).

5. Lift off the motor unit.

WARNING: When placing the motor on the bench, do not allow the shaft to strike the bench (this might spring the shaft).

c. Servicing the Motor

1. If the motor does not drive the capstan at the proper speed, take off the three nuts (44), and plain washers (41) and remove the motor from the mounting plate (45). Disassemble the motor and clean and relubricate the bearings. Use 3 speaker cone shims as spacers to center the rotor when re-assembling.

2. Concentricity of motor shaft. Use an indicator to check the part of the motor shaft which drives the flywheel. If the runout exceeds 0.0005" full indicator reading, replace the motor.

d. Servicing Capstan and Takeup Assembly

1. Replacing the takeup drive belt (53).

(a) Remove the four screws and lockwashers, the reinforcing strip (60) and plate (61).

(b) Pull off the flywheel lower bracket assembly.

(c) Install the new belt and reassemble the unit. If the Capstan shaft does not revolve freely, tap the two frame members lightly with a screw driver handle in order to line up the bearings.

2. Repair of Flywheel and Capstan

If the runout of either the capstan or flywheel tire exceeds

the tolerance indicated in paragraph 4 a, the flywheel assembly will require replacement. Disassemble as per sub-paragraph 1 and install a new flywheel and bearings if required. Warning! When removing the rivets which hold the bearing retainers in place, be careful not to distort the aluminum frame members.

3. Servicing the takeup spindle assembly

   If takeup jerks or fails to operate, proceed in the following manner:

   (a) Remove drive belt (53) from the takeup pulley (35).

   (b) Remove hex nut (38), lockwasher (37) and spindle pulley (35).

   (c) Remove takeup spindle (36) from the bearing.

   (d) Immerse spindle in carbon tetrachloride and spin reel drive disc to wash dirt out of felt washer.

   (e) Allow carbon tetrachloride to evaporate, then soak the felt washer with Amproil. Gently press the drive disc against the washer to squeeze out the surplus oil. Place the spindle on a blotter and allow it to stand for 20-30 minutes, then wipe excess oil off of shaft and reassemble.

4. Servicing the motor lock - It will seldem be necessary to remove these parts. Should it be necessary to remove them, proceed in the following manner:

   (a) Loosen the setscrew (56) and slide the cam (55) and detent (57) off of the end of the shaft.

   (b) Remove the lock shaft (59), spring (58), and washer (54).

   (c) When reassembling the parts, make the final timing adjustment after the motor assembly and the drive are installed in the recorder. Turn on the motor switch and turn the lock to "Run". Loosen the setscrew (56) and rotate the cam so that the motor shaft is in contact with the flywheel tire and the working side of the cam is not bearing against the motor mounting plate. Tighten the setscrew and turn to "Lock" and check to be sure that the motor shaft is lifted off of the flywheel tire.

SECTION IV

Final Adjustments and Testing

A. MECHANICAL

1. Check operation of felt pressure pads and be sure that they are clean.

2. Check operation of the erase lever and actuating mechanism.

3. Check the feed tension.—Tension should be just great enough to cause tape to follow groove in tape guide at start of 7" reel. If excessive tension is noted, clean or replace friction disc.

4. Check takeup tension—Tension should be great enough to wind tape evenly on the takeup reel, (Watch out for warped reels.) but not great enough to pull tape through the capstan.

5. Check rewind time—5" reel of tape should rewind in 3 minutes.

6. Check tape velocity—Unwind about 10' of tape from start of reel, place a mark on the light or glossy side of the tape, then measure 36 3/4" and place another mark on the tape. Measure an additional $1\frac{1}{2}$" and place a third mark on the tape. Thread the tape in the recorder. Hold a watch (type with sweep second hand preferred) near the tape guide with the face of the watch vertical. Start the recorder and note the position of the second hand on the watch, when the first mark passes over the guide. If the second mark on the tape reaches the guide within 10 seconds and the third mark does not pass the guide, the speed of the recorder is acceptable. If the speed is low the drive is slipping, pressure on pressure pads is too great, or feed tension is too high. If the speed is high, the flywheel tire is worn.

7. Check the tape passage—Look for weaving of the tape or creeping on the capstan (caused by worn or misaligned pads, tape not guiding properly in head, drive unit loose on mechanism plate, or worn pressure roller).

8. Azmuth adjustment—Thread the recorder with Azmuth adjustment tape, connect an output meter across the speaker voicecoil and rotate the hex nut (85) until maximum output is obtained. Two peaks may be encountered. Adjust for the stronger one.

B. AMPLIFIER

1. Gain Test - Disconnect bias oscillator, connect an audio oscillator to the input jack and adjust the oscillator output to .06 volts at 400 cycles/sec. Connect an output meter and oscillascope across the speaker voice coil. Place the "Play - Record" control in the "Record" position and advance the "Volume" control to a point just below where the wave appears to distort. The output voltage should be at least 2 volts. Restore bias oscillator circuit.

C. FREQUENCY RESPONSE

1. Connections - Connect an audio oscillator to the input jack of the recorder. Connect a VT Voltmeter across the oscillator output. Connect a 3 ohm 5 watt resistor in place of the speaker and connect an output meter across the resistor. Turn tone control to "Treble" position.

2. Tests - Set oscillator to 1000 C.P.S. and set recorder volume control at normal recording position. Adjust oscillator output so that recording indicator flashes very faintly. Record about 10' of tape. Change oscillator frequency to 200 C.P.S. and adjust oscillator output to the same level used at 1000 C.P.S. Record about 10' of tape. Change oscillator frequency to 3000 C.P.S. and adjust oscillator output to 1000 cycle level. Record about 10' of tape. Switch recorder to "Play" position and rewind tape. Start the recorder and adjust volume control to suitable level (not in excess of 2 volts). The output at 200 C.P.S. will usually be within 3DB of the level (maximum permissable variation 7DB), the 3000 cycle will normally be within 3DB of the 1000 cycle level (maximum permissable variation $8\frac{1}{2}$DB).

SECTION V

Assembly Parts List

Ampro Magnetic Tape Recorder

Model 731

Item	Part Number	Quantity Required	NOMENCLATURE 1 2 3 4 5 6 7 8 9
	16929	1	Carton, Recorder Shipping
	A-731	1	Book, Instruction
	20444	1	Recorder Assembly, Magnetic Tape
	111	1	Reel, Tape Recorder
	14112	1	Nut, Wing #10-24
	102	1	Microphone Assembly
	106	1	Cable Assembly, Radio Speaker
1	18779	1	Grille, Speaker
2	18775	1	Speaker, Tape Recorder (T-6)
	1462	4	Washer, Burr
	1679	4	Washer, Lock #8 Ext.
	14975	4	Screw, Rosette Hd. #8-32 x 1" Stl. F-110
	1453	4	Nut, Hex #8-32 Stl. N. P.
	18785	1	Button, Plug
	18698	1	Nameplate, Recorder Case
	14140	2	Screwnail, #15 x 3/8
	18788	1	Nameplate, External Speaker
	18778	1	Case Assembly, Tape Recorder
8	14102	6	Screw, Wood Phillips Oval Hd. #6 x 1-1/4
3	18842	1	Nameplate, Motor Lock
	13465	1	Spring, Motor Lock Key
4	13464	1	Key, Motor Lock
5	12888	1	Stud, Motor Lock Shaft
6	16952	1	Cover, Compartment
	13876	1	Spring, Compartment Cover Retaining
	14141	2	Nut, Speed
	18776	1	Nameplate, Tape Recorder (available only upon certification of loss and serial # of unit)
	14106	2	Rivet, Tub. Oval Hd. .051 x 9/64
7	16951	1	Panel, Tape Reel
8	14102	2	Screw, Wood Phillips Oval Hd. #6 x 1-1/4
	14109	1	Washer, Plain
	14991	4	Screw, Phillips Bd. Hd. #6-32 x 1/4
	13462	1	Bracket, Tape Reel Panel
	14199	1	Screw, Wood Phillips Rd. Hd. #6 x 3/8
9	16926	4	Knob, Control
10	16950	1	Panel, Control
	14107	1	Screw, Phillips Oval Hd. #6-32 x 1-1/2
11	14136	2	Screw, Phillips Oval Hd. #6-32 x 1-3/8
12	13839	1	Cover, Recorder Amplifier
13	14996	6	Screw, Sheet Metal Phillips Bd. Hd. #4 x 1/4 Type Z
14	20446	1	Fan Assembly, Recorder
15	14780	1	Screw, Hdlss. Socket Set #6-32 x 1/8 Cup Pt.

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Item	Part Number	Quantity Required	NOMENCLATURE 1 2 3 4 5 6 7 8 9
16	20414	1	Collar Assembly Erase Lever Actuator
17	14999	1	Screw, Hdlss. Socket Set #4-40 x 3/16
18	15032	1	Spring, Tape Erase Lever
19	18774	1	Cord, Recorder Line, 8 Ft. long
20	18671	2	Connector, Wire
	18697	1	Shield, Motor Switch
21	20445	1	Amplifier Assembly, Tape Recorder
22	16915-1	2	Lamp, Neon (seasoned) (V-4,5)
	18714	1	Shield, Tube Cover
	18497-S	1	Tube, 12AX7 (selected) (V-1)
	18699	1	Tube, 6AU6 (V-2)
	18700	1	Tube, 6X4 (V-6)
	18701	1	Tube, 6AQ5 (V-3)
23	13873	1	Shield, Motor
	14658	1	Screw, Sheet Metal Phillips Rd. Hd. #8 x 3/8 Type Z
	16984	1	Clamp, Cable
	14972	1	Washer, Lock #6 Ext.
	14100	1	Screw, Phillips Bd. Hd. #6-32 x 5/16
	1452	1	Nut, Hex #6-32
	17782	1	Capacitor, .01 mfd. 400 V Paper (C-8)
	18091	1	Capacitor, .001 mfd. 600 V Paper (C-14)
	18485	2	Capacitor, .001 mfd. 400 V Ceramic (C-20, 24)
	18487	2	Capacitor, .01 mfd. 400 V Ceramic (C-10, 12)
	18488	1	Capacitor, .005 mfd. 400 V Ceramic (C-19)
	18489	3	Capacitor, .0005 mfd. 500 V Ceramic (C-3, 4, 9)
	18492	1	Capacitor, .003 mfd. 600 V Paper (C-18)
	18715	1	Capacitor, 10-30 mfd. Elect. (C-22, 23)
	18716	1	Capacitor, 4-4-80-80 mfd. Elect. (C-15, 21, 11, 16)
	18731	1	Capacitor, .02 mfd. 400 V Paper (C-2)
	18732	2	Capacitor, .03 mfd. 400 V Paper (C-5, 13)
	18733	1	Capacitor, .0027 mfd. 400 V Ceramic (C-1)
	18739	1	Capacitor, .007 mfd. 200 V Paper (C-7)
	18773	1	Capacitor, .0003 mfd. 600 V Paper (C-17)
	17554	1	Resistor, 10 megohms, 1/2 watt carbon (R-3)
	17959	4	Resistor, 220 K ohms, 1/2 watt carbon (R-4, 14, 16, 2)
	18436	1	Resistor, 1.8 megohms, 1/2 watt carbon (R-9)
	18467	1	Resistor, 560 K ohms, 1/2 watt carbon (R-7)
	18471	2	Resistor, 100 K ohms, 1/2 watt carbon (R-10, 15)
	18474	2	Resistor, 470 K ohms, 1/2 watt carbon (R-1, 17)

Item	Part Number	Quantity Required	1 2 3 4 5 6 7 8 9
	18582	1	Resistor, 2700 ohms, 1/2 watt carbon (R-8)
	18583	1	Resistor, 22 K ohms, 1/2 watt carbon (R-13)
	18653	1	Resistor, 2700 ohms, 1 watt carbon (R-18)
	18718	1	Resistor, 3 ohms, 5 watt wire wound (R-22)
	18729	2	Resistor, 390 K ohms, 1/2 watt carbon (R-11, 19)
	18770	1	Resistor, 270 ohm, 1 watt carbon (R-12)
	18771	1	Resistor, 33 ohm, 2 watt carbon (R-21)
	18772	1	Resistor, 390 ohm, 2 watt carbon (R-20)
24	18769	1	Jack - External Speaker (J-2)
	18707	1	Board, Terminal
	18773	2	Screw, Sheet Metal Phillips Bd. Hd. #6 x 1/4 Type Z
	18722	1	Socket, Miniature Tube (9-pin)
	18706	1	Base, Miniature Socket Shield
	1466	2	Rivet, Tub. Oval Hd. .085 x 7/32
	18525	1	Clamp, Tube
	18721	1	Socket, Miniature Tube (7-pin)
	14871	1	Rivet, Tub. Oval Hd. .085 x 3/16
	14908	1	Rivet, Tub. Oval Hd. .088 x 1/4
	18720	2	Socket, Miniature Tube (7-pin)
	18524	2	Clamp, Tube
	14871	2	Rivet, Tub. Oval Hd. .085 x 3/16
	14908	2	Rivet, Tub. Oval Hd. .088 x 1/4
	13845	2	Bracket, Resistor Board Mtg.
	14773	2	Screw, Sheet Metal Ph. Bd. Hd. #6 x 1/4 Type Z
	18702	1	Terminal, Locking #4 Double
	1474	1	Rivet, Tub. Oval Hd. 1/8 x 1/8
	13840	1	Platform, Recorder Amplifier Tube
	12540	3	Spacer (Tube Plateform)
	14729	3	Washer, Plain
	14992	3	Screw, Phillips Bd. Hd. #4-40 x 3/8
	18708	1	Connector, Female (J-1)
	12832	1	Base, Microphone Jack
	14993	2	Screw, Phillips Fil. Hd. #4-40 x 1-1/8
	18728	1	Transformer, Power (T-4)
	14994	4	Screw, Phillips Bd. Hd. #8-32 x 1/4 (Sems Unit)
	18782	1	Transformer, Output (T-5)
	14117	2	Nut, Speed #6-32 Type U
	14991	2	Screw, Phillips Bd. Hd. #6-32 1/4
	18784	1	Coil, Oscillator (self-fastening) (T-1)
	18709	1	Control, Volume (R-6)
	14854	1	Nut, Hex. 3/8-32 Washer Type
	18777	1	Control, Tone (R-5)
	16523	1	Washer, Lock 3/8 Int.
	14854	1	Nut, Hex. 3/8-32 Washer Type
	18786	1	Switch, Record-Listen (SW-1, 2, 3, 4)
	14773	2	Screw, Sheet Metal Phillips Bd. Hd. #6 x 1/4 Type Z
	17593	3	Grommet, Rubber
	16910	2	Socket, Neon Lamp
	1474	4	Rivet, Tub. Oval Hd. 1/8 x 1/8
	12886	3	Spacer, Amp. Shock Control
	1698	3	Washer, Plain

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Item	Part Number	Quantity Required	1 2 3 4 5 6 7 8 9
	14972	3	Washer, Lock #6 Ext.
	14153	3	Screw, Phillips Bd. Hd. #6-32 x 1/2
	18702	1	Terminal Locking, #4 Double
	1474	1	Rivet, Tub. Oval Hd. 1/8 x 1/8
	1767	1	Eyelet, Brass
	16824	1	Eyelet, Brass
	1475	11	Rivet, Tub. Truss Hd. .085 x 1/8
25	18794	2	Shock-Mount, Rubber (orange)
	18795	2	Shock-Mount, Rubber (blue)
26	12783	4	Screw, Shoulder, Amplifier Mtg.
	13825	3	Washer, Plain
	14972	3	Washer, Lock #6 Ext.
	1452	3	Nut, Hex #6-32
27	20436	1	Actuator Assembly, Motor Plate
28	12859	1	Screw, Shoulder, Motor Plate Actuator
29	1693	1	Washer, Plain
30	13020	1	Washer, Plain
31	14916	1	Nut, Hex #6-32
32	12858	1	Collar, Motor Plate Actuator
33	14135	1	Screw, Hdlss. Socket Set #8-32 x 7/16 Cup Pt.
	14171	1	Screw, Hdlss. Set Hex Socket #8-32 x 3/8 Cone Pt.
34	15036	1	Spring, Motor Pressure
35	12824	1	Pulley, Takeup
36	20409	1	Spindle Assembly, Takeup
	13827	1	Lever, Tape Rewind
	14130	1	Washer, Plain
37	14972	1	Washer, Lock #6 Ext.
38	1452	1	Nut, Hex. #6-32
39	20447-1	1	Drive Assembly, Tape Recorder
40	18787	1	Motor Assembly, Tape Recorder (T-3)
41	14131	5	Washer, Plain
	1693	1	Washer, Plain
42	12834	3	Sleeve, Motor Mtg.
43	16904	3	Grommet, Rubber
44	14916	3	Nut, Hex #6-32 Brass, N. P.
45	13872	1	Plate, Motor Mtg.
46	1313-10	3	Washer, Plain
47	13940	3	Washer, Plain
48	16923	3	Washer, Felt
49	12838	3	Washer, Motor Mtg. Spacing
50	12837	3	Screw, Shoulder, Motor Mtg.
51	6002	1	Drive Sub Assembly, Tape Recorder
	20406-1	1	Bracket Assembly, Flywheel Upper
	16905-1	1	Bearing, Flywheel
	16906	1	Washer, Felt, Flywheel Brg. Oil
	13846	1	Retainer, Flywheel Bearing
	14105	3	Rivet, Tub. Truss Hd. .098 x 7/64
	20416-1	1	Bracket Sub Assembly, Flywheel Upper
52	20434	1	Shaft & Flywheel Assembly Recorder
53	16912	1	Belt, Takeup Drive
	20407	1	Bracket Assembly, Flywheel Lower
	16905-1	1	Bearing, Flywheel
	16906	1	Washer, Felt, Flywheel Brg. Oil
	13846	1	Retainer, Flywheel Bearing
	14108	3	Rivet, Tub. Truss Hd. .098 x 9/64
	18593	1	Lug, Solder
	14972	3	Washer, Lock #6 Ext.
	14100	4	Screw, Phillips Bd. Hd. #6-32 x 5/16

Item	Part Number	Quantity Required	1 2 3 4 5 6 7 8 9
54	14104	2	Washer, Plain
55	12887	1	Cam, Motor Lock
56	14935	2	Screw, Hdlss Set Hex Socket #8-32 x 1/4 Cup Pt.
57	13463	1	Detent, Motor Lock
	14838	1	Washer, Plain
58	15097	1	Spring, Motor Lock Shaft
59	12889	1	Shaft, Motor Lock
60	13897	1	Strip, Drive Assembly Reinforcing
61	13898	1	Plate, Drive Assembly Reinforcing
	14972	3	Washer, Lock #6 Ext.
62	14153	3	Screw, Phillips Bd. Hd. #6-32 x 1/2
63	12847	1	Actuator, Pressure Roller
64	14780	2	Screw, Hdlss. Socket Set #6-32 x 1/8
65	16871	1	Damper, Tape Erase Pressure Spring
66	13891	1	Stop, Tape Erase Lever
67	20401	1	Magnet Assembly, Tape Erase (adjust after installation)
68	14972	2	Washer, Lock #6 Ext.
69	14991	2	Screw, Phillips Bd. Hd. #6-32 x 1/4
70	15068	1	Spring, Foot Control Lever
71	13877	1	Lever, Pressure Roller Retractor
72	15043	1	Retainer, Pressure Roller Retractor
73	15034	1	Spring, Pressure Roller
74	20404	1	Bracket Assembly, Pressure Roller
75	14101	1	Screw, Phillips Truss Hd. #6-32 x 1"
76	12830	1	Stud, Pressure Roller Bracket
77	15033	1	Spring, Pressure Pad Assembly
78	20439	1	Bracket Assembly Pressure Pad
	16903	1	Pad, Sound Head Pressure
	16920	1	Pad, Tape Erase Pressure
79	14101	1	Screw, Phillips Truss Hd. #6-32 x 1"
80	12823	1	Stud, Pressure Pad Bracket
81	20424	1	Head Assembly, Tape Recorder
82	15035	1	Spring, Recording Head Adjustment
83	12842	1	Screw, Shoulder, Recording Head
84	13208	1	Washer, Plain
85	14103	1	Nut, Lock #6-40
	14109	1	Washer, Plain
86	18696	1	Switch, Rotary (SW-6, 7)
87	14854	1	Nut, Hex 3/8-32 Washer Type
88	12820	1	Stud, Feed Reel
89	13822	1	Spacer, Feed Reel
90	13821	1	Disc, Reel Drive
91	16909	1	Washer, Felt, Reel Spindle
92	13820	1	Disc, Tape Feed Reel Friction
93	14972	1	Washer, Lock #7 Ext.
94	14991	1	Screw, Phillips Bd. Hd. #6-32 x 1/4
95	12821	1	Stud, Tape Guide
96	14972	1	Washer, Lock #6 Ext.
97	14100	1	Screw, Phillips Bd. Hd. #6-32 x 5/16
98	13823	1	Lever, Tape Erase
99	13825	1	Washer, Plain
100	12822	1	Screw, Shoulder, Tape Erase Lever
101	14972	1	Washer, Lock #6 Ext.
102	1452	1	Nut, Hex #6-32
	14313	1	Pin, Grooved, 3/32 x 5/16
	12851	2	Stud, Tape Rewind Guide
	12836	1	Stud, Recording Head Adjustment
	13871	1	Plate, Tape Recorder Mechanism