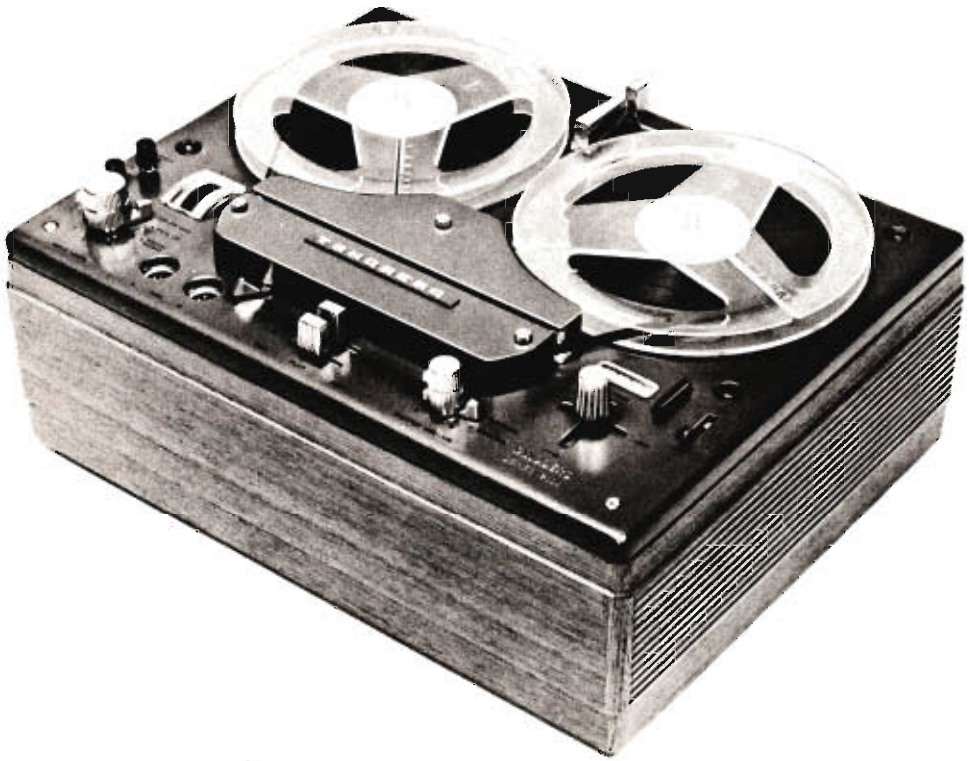
March 1970

Tandberg RADIO

Service manual

TANDBERG

Tape recorder model 1200X



TANDBERGS RADIOFABRIKK A/S

PREFACE

This manual covers the 2-track and 4-track versions of Tandberg Stereo Tape Recorder Series 1200X. The two versions have the same tape transport. All circuits are transistorized. Cross-field biasing technique is utilized. Separate amplifiers for microphone- and line inputs, equalizing amplifiers and output amplifiers are provided for each channel. Units above serial number 2 252 600 are adjusted for Low Noise tape. Pick-up selector was introduced from serial number 2 237 000. The various modifications of Series 1200X since production started are listed in chapter 6.0.

The description of all electric circuits except the power supply is referred to circuit diagram valid from serial no. 2 237 000.

When ordering spare parts, observe that only those parts appearing in the spare parts list are available.

We hope that this manual will be of help to everyone concerned with servicing of Series 1200X.

Oslo, March 1970

TANDBERGS RADIOFABRIKK A/S

CONTENTS

1.0 OPERATING CONTROLS

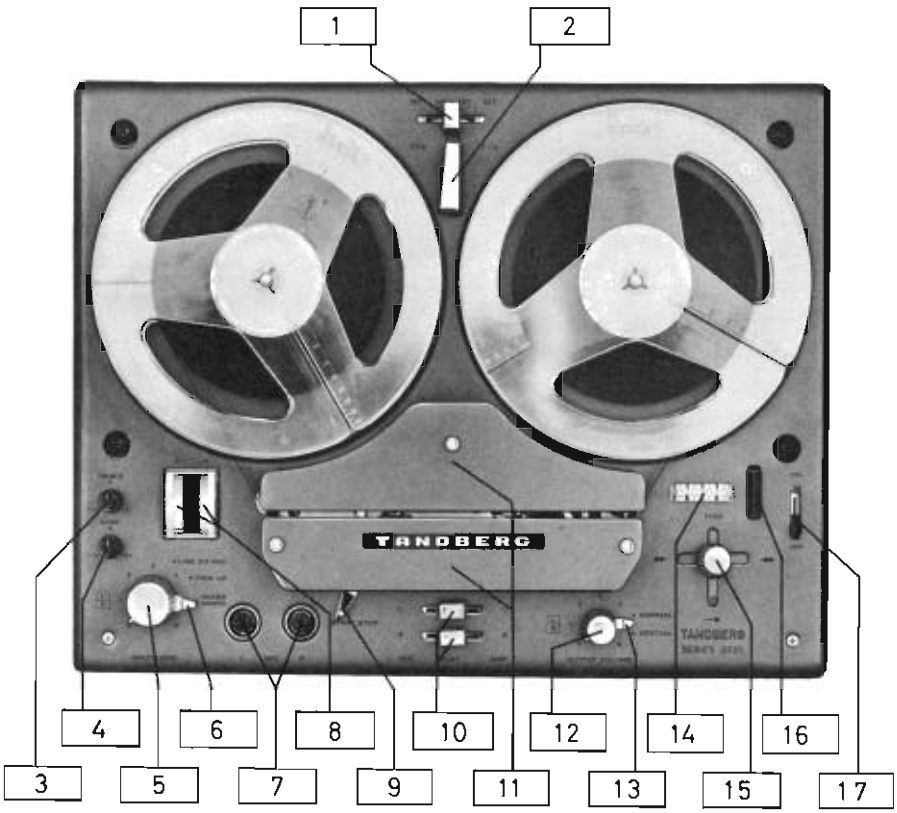


Fig. 1.1 Operating controls

1. Speaker selector. INT: Internal speaker. EXT: External speaker. INT + EXT: All speakers.
2. Speed selector.
3. Treble control.
4. Bass control.
5. Input level. Upper knob: Left channel (L). Lower knob: Right channel (R).
6. Input selector.
7. Microphone sockets. The corresponding line input is disconnected when microphone plug is inserted.
8. Record level indicators.
9. Instantaneous start/stop. Operative in record- and playback modes.
10. Function selector. REC: Recording when operating lever is in normal forward drive position. PLAY: Playback when operating lever is in normal forward drive position. AMP: Amplifier.
11. Dust covers. To be removed for cleaning of heads and tape path.
12. Output volume controls. Upper knob: Left channel. Lower knob: Right channel.
13. NORMAL/SPECIAL-switch. In SPECIAL, both output amplifiers are connected in parallel when both function selectors are in AMP. The switch also enables playback through one channel while the other is used as microphone or line amplifier.
14. 4-digit revolution counter coupled to take-up turntable.
15. Operating lever. → : Normal forward drive. →→ : Fast forward. ←← : Fast rewind. FREE: For tape loading.
16. Counter reset button.
17. Power on/off switch.

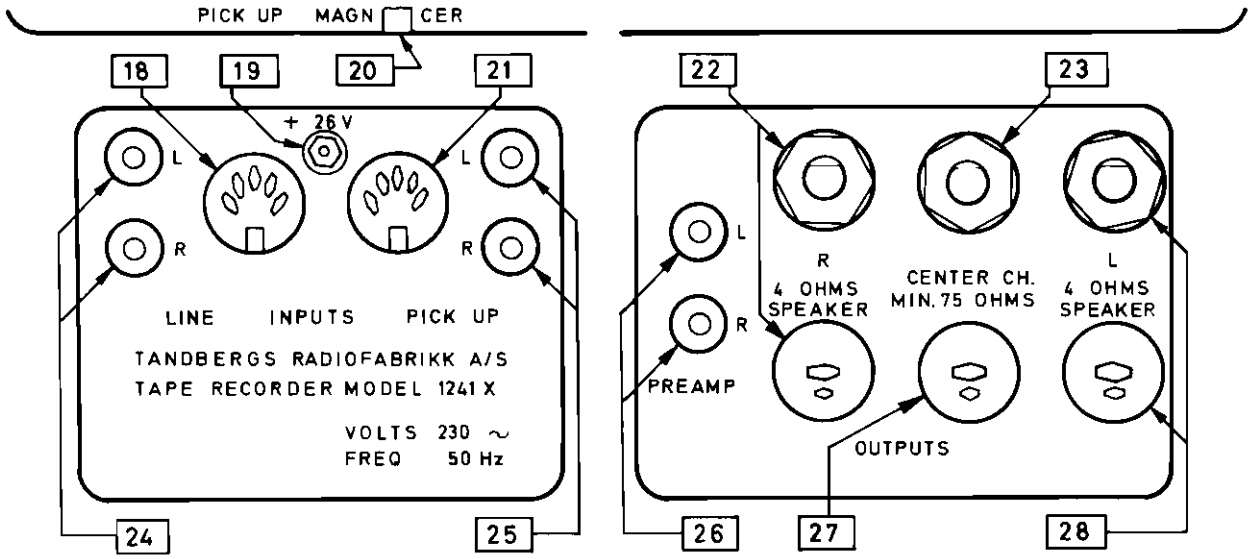


Fig. 1.2 Inputs and outputs

18. LINE DIN socket. For recording and playback via receiver or amplifier.
19. + 26V. Supply voltage for FM-MPX-filter.
20. Pick-up selector.
21. PICK UP DIN socket for connection of magnetic or ceramic/crystal pick-up.
22. 4 OHM SPEAKER. For connection of external speaker, right channel (R). DIN socket and phone jack are connected in parallel.
23. CENTER CH. Connection of stereo headphones.
24. LINE phono sockets, left (L) and right (R)\Connected in parallel with LINE DIN socket pins 1 and 4.
25. PICK UP phono sockets left (L) and right (R). Connected in parallel with PICK UP DIN socket pins 1 and 5, and pin 3.
26. PREAMP phono sockets left (L) and right (R) channels, for connection of auxiliary power amplifier. Connected in parallel with LINE DIN socket pins 3 and 5.
27. CENTER CH. DIN socket for mono headphones.
28. 4 OHMS SPEAKER. For connection of external speaker left (L) channel. DIN socket and phono jack are wired in parallel.

2.0 TECHNICAL SPECIFICATIONS

POWER REQUIREMENTS:	230V, 50 Hz. Can be wired for operation on 115V. Operation on 60 Hz requires a special motor pulley.
POWER CONSUMPTION:	60W at 2 x 1.25 W output power. 100W at 2 x 10W output power.
TAPE:	Maximum reel size 7". Use tape of the very best quality.
TAPE PATH:	Tape motion in record and playback is from left to right.
TAPE SPEEDS:	7 1/2, 3 3/4 and 1 7/8 ips.
SPEED TOLERANCE:	Absolute tolerance: $\pm$ 1.5%.
PLAYING TIMES:	4-track and 1200 ft. reels give the following playing times:

	Mono	Stereo
7 1/2 ips:	4 x 32 minutes	2 x 32 minutes
3 3/4 ips:	4 x 64 minutes	2 x 64 minutes
1 7/8 ips:	4 x128 minutes	2 x 128minutes

WINDING TIME: Approximately 1 2/3 minutes for 1200 ft. reels, 2 1/2 minutes for 1800 ft. reels.

INSTANTANEOUS START/STOP: Active in normal forward drive.

TRANSISTORS: 36.

DIODES: 7 (3 in units below serial no. 2 551 955).

BRIDGE RECTIFIER: 1.

HEADS: Combined record/playback head, erase head and crossfield head (bias).

ERASE- & BIAS FREQUENCY: 85.5 kHz, distortion less than 0.5%.

RECORD LEVEL INDICATOR: Indication to 0 dB corresponds to 5% tape distortion.

INPUTS: Two unbalanced inputs for microphones with impedance less than 600 ohm (3 pin DIN sockets).
Line inputs: Impedance 100 kohm. Sensitivity 6 mV. Maximum signal 10V. (DIN and phono sockets).
Pick up input with switch in position MAGN: Impedance 33 kohm. Sensitivity: 2 mV, maximum signal 3V. With switch in position CER, the impedance is adapted for ceramic/crystal pick up. Sensitivity 10 mV, maximum signal 30V.

OUTPUTS: Power amplifier outputs. Optimum load impedance 4 ohm. Maximum output power 10W, continuous sinus in each channel. DIN-sockets and phone jacks in parallel for connection of remote speakers.
PREAMP output. Output impedance 5 kohm. Output voltage 0.5 - 1V, unloaded, independent of all operating controls. Phono sockets. R and L MONO. For mono headphones with minimum impedance 40 ohm. Output level 0.75 V. 2-pins DIN-socket.
PHONES STEREO: For stereo headphones with minimum impedance 30 ohm. Output level maximum 6V. Standard phone jack.

SIGNAL/TAPE NOISE:

	4-track	2-track
IEC - A-Curve	60 dB	62 dB
IEC, unweighted R.M.S.	55 dB	55 dB
DIN 45511, weighted	53 dB	55 dB
DIN 45511, unweighted	50 dB	50 dB

FREQUENCY RANGE:

	DIN 45511	± 2 dB
7 1/2 ips:	40 - 20 000 Hz	40 - 20 000 Hz
3 3/4 ips:	40 - 16 000 Hz	50 - 16 000 Hz
1 7/8 ips:	40 - 9 000 Hz	50 - 9 000 Hz

WOW:

	R.M.S.	DIN 45511
7 1/2 ips:	0.07%	± 0.1%
3 3/4 ips:	0.14%	± 0.2%
1 7/8 ips:	0.28%	± 0.4%

BASS CONTROL: ± 12 dB at 80 Hz in playback, monitoring and when used as amplifier.

TREBLE CONTROL: ± 12 dB at 8000 Hz in playback, monitoring and when used as amplifier.

INTERNAL SPEAKER: Two 4 x 7", 8 ohm speakers. Maximum power supplied to each internal speaker is 5 W. Maximum output power 2 x 10W can be utilized only in 4 ohm external speakers.

DIMENSIONS: Length 15 1/2" (39 cm), height 6 7/8" (17.5 cm) and depth 11 7/8" (30 cm).

WEIGHT: 23.3 lbs. (10.5 kg).

3.0 TAPE TRANSPORT MECHANISM

Detailed Description and Alignment Procedures

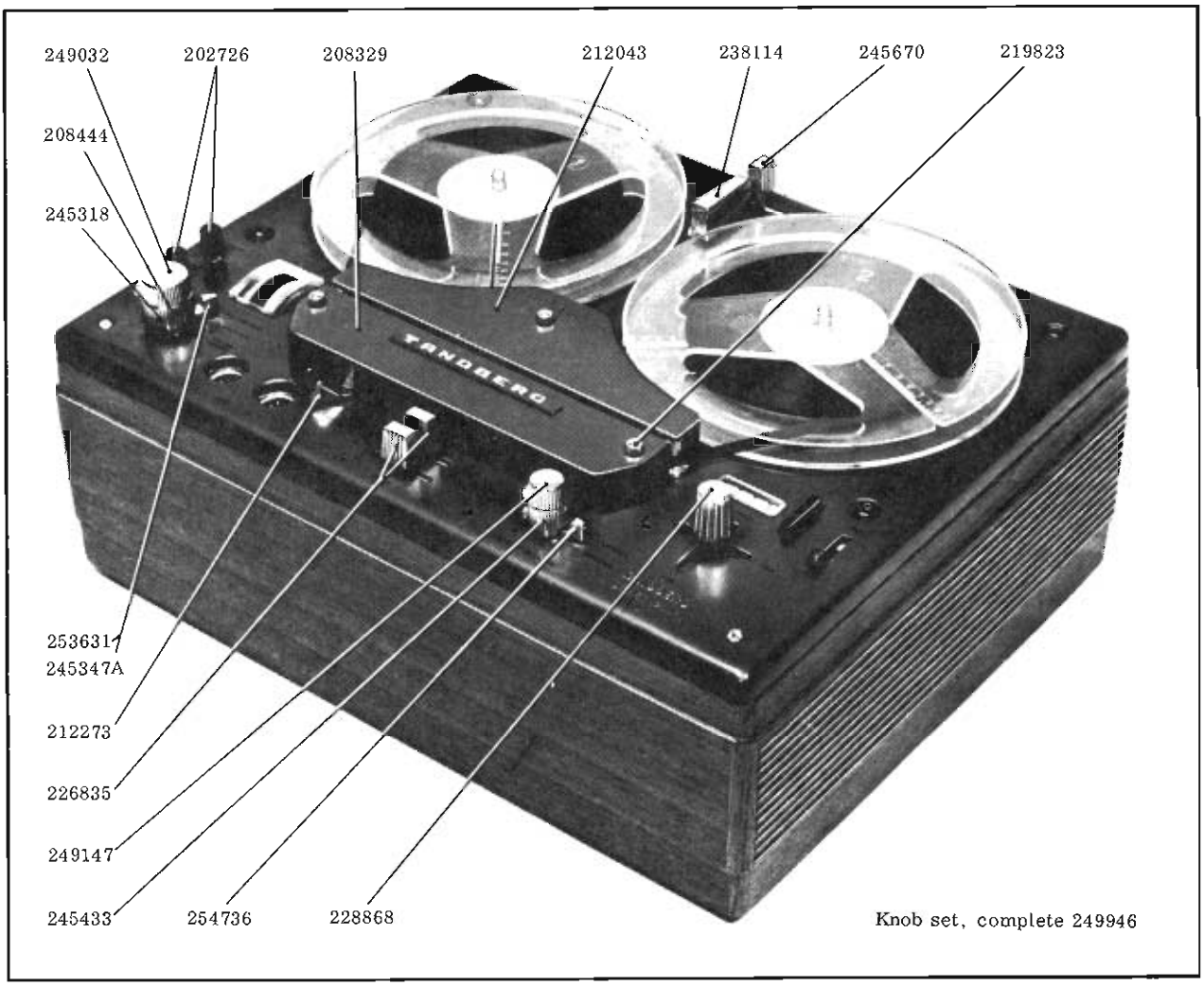


Fig. 3.1 Set of knobs

The purpose of the tape transport mechanism is to accomplish the tape motion for the following modes of operation:

1. Normal forward drive.
2. Fast forward winding.
3. Fast reverse winding.

These modes can be selected by the tape motion lever.

3.1 THE OPERATING LEVER

The operating lever is situated in front of the counter, and is attached to the lower mounting plate 990216D. The lever can be set to the following five positions:

1. Neutral.
2. Normal forward drive.
3. Fast forward winding.
4. Fast reverse winding.
5. Free.

Parts associated with the tape motion lever:

The eccentric segment 990203, which operates the pressure arm 990202, and the lifting arm 990201. The operating arm 248186 operates clutch levers 990229 and 990228, underneath the friction disc 209658.

3.1.1 The Eccentric Segment

The eccentric segment is situated underneath the upper mounting plate, and is linked with the operating lever shaft 990225. The eccentric segment moves the pressure roller arm 990202 with the roller 990234 against the capstan when the operating lever is set to position normal forward drive.

The lifting arm 990201 is linked with the eccentric segment 990203 and lifts the transfer wheel 990233 from the motor pulley 246475 when the operating lever is set to one of the following positions:

* Fast forward winding.
* Fast reverse winding.
* Neutral.
* Free.

The transfer wheel is engaged with the motor pulley in normal forward drive.

Adjustments

Set the operating lever in neutral position, and adjust the resting position of the pressure roller assembly by bending flap A. See fig. 3.2.
Be careful not to destroy the rubber sleeve which is threaded on the flap. Take it off, or grip with the plier underneath the rubber. The flap is in correct position when the pressure roller arm rests in the hindmost position, and the eccentric segment lightly touches the plastic roller 207977.

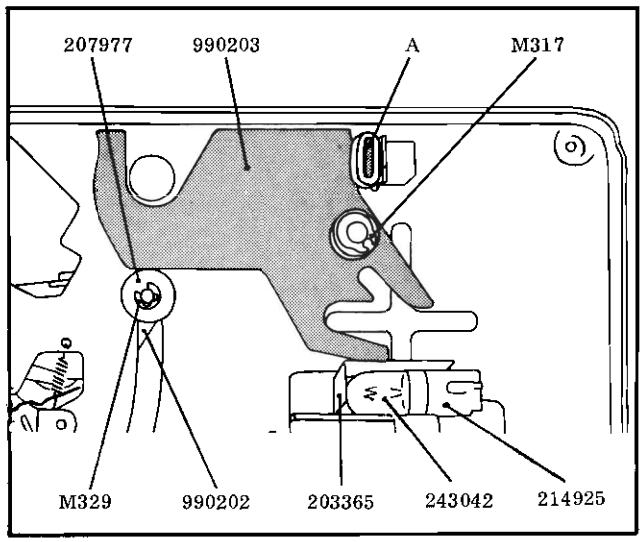


Fig. 3.2 Upper mounting plate, underneath view

3.1.2 Pressure Roller Arm (990202)

The pressure roller assembly is moved against the capstan by the eccentric segment 990203 when the operating lever 990225 is set to position normal forward drive. The pressure roller 990234 is suspended under balanced spring tension as shown in fig. 3.3.

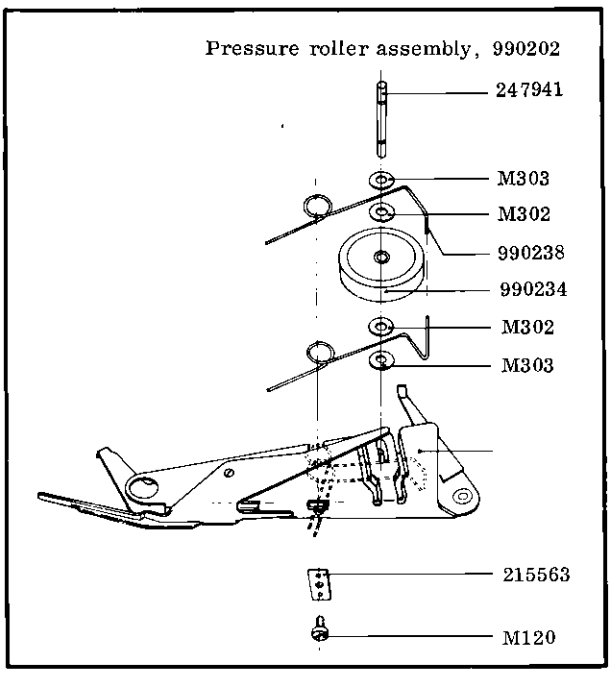


Fig. 3.3 Pressure roller arm complete

Adjustments

The balanced spring tension is adjusted to ensure that the pressure from the pressure roller against the capstan and the tape is evenly distributed across the width of the tape in normal forward drive.
Start the tape recorder in normal forward drive. Twist the latch 215563 clockwise or counterclockwise after first having loosened the screw M120, until the tape moves smoothly over the pressure roller. No air bubbles must be formed between the tape and the rubber pressure ring on the pressure roller.
Ensure that the entire width of the tape is covered by the roller.

3.1.3 The Operating Arm (248186)

The operating arm is attached to the lower mounting plate 990216D, and operates clutch levers 990229 and 990228 underneath the friction discs 209658. See fig. 3.5.
The operating arm is linked with the operating lever 990225.

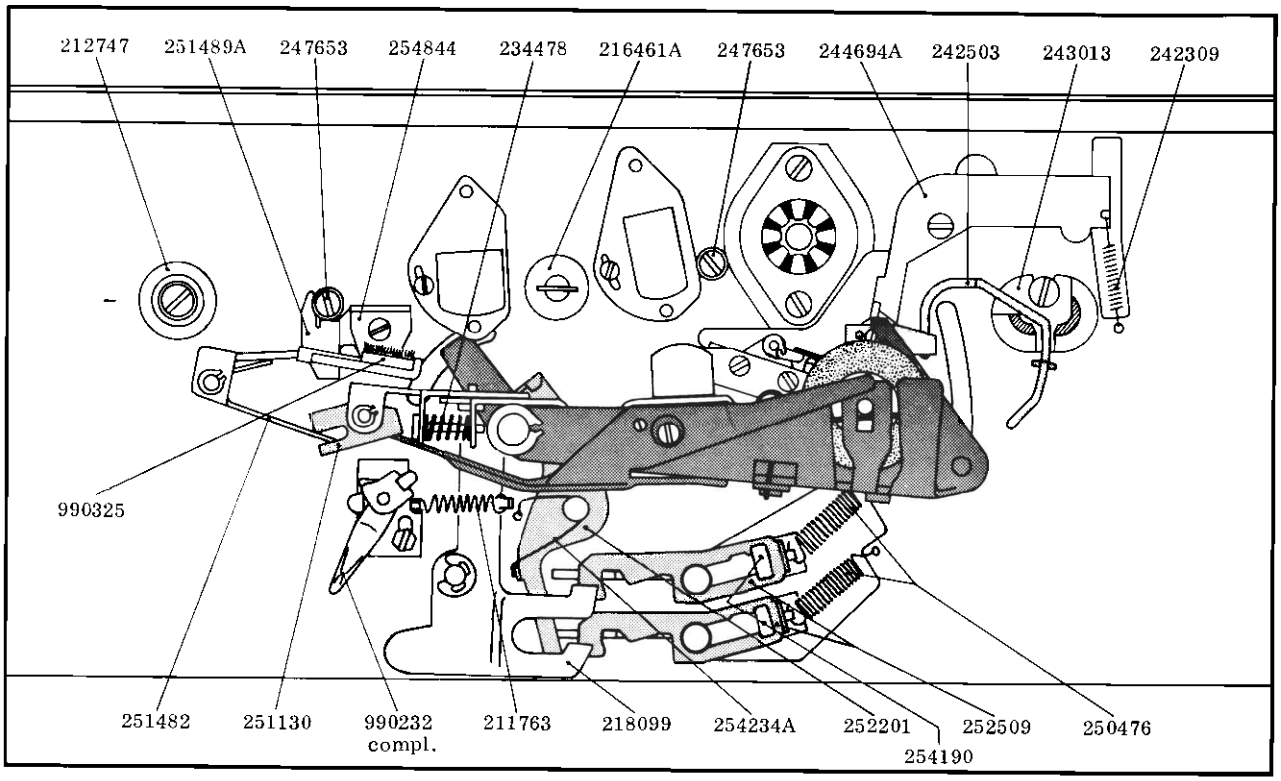


Fig. 3.4 Tape path

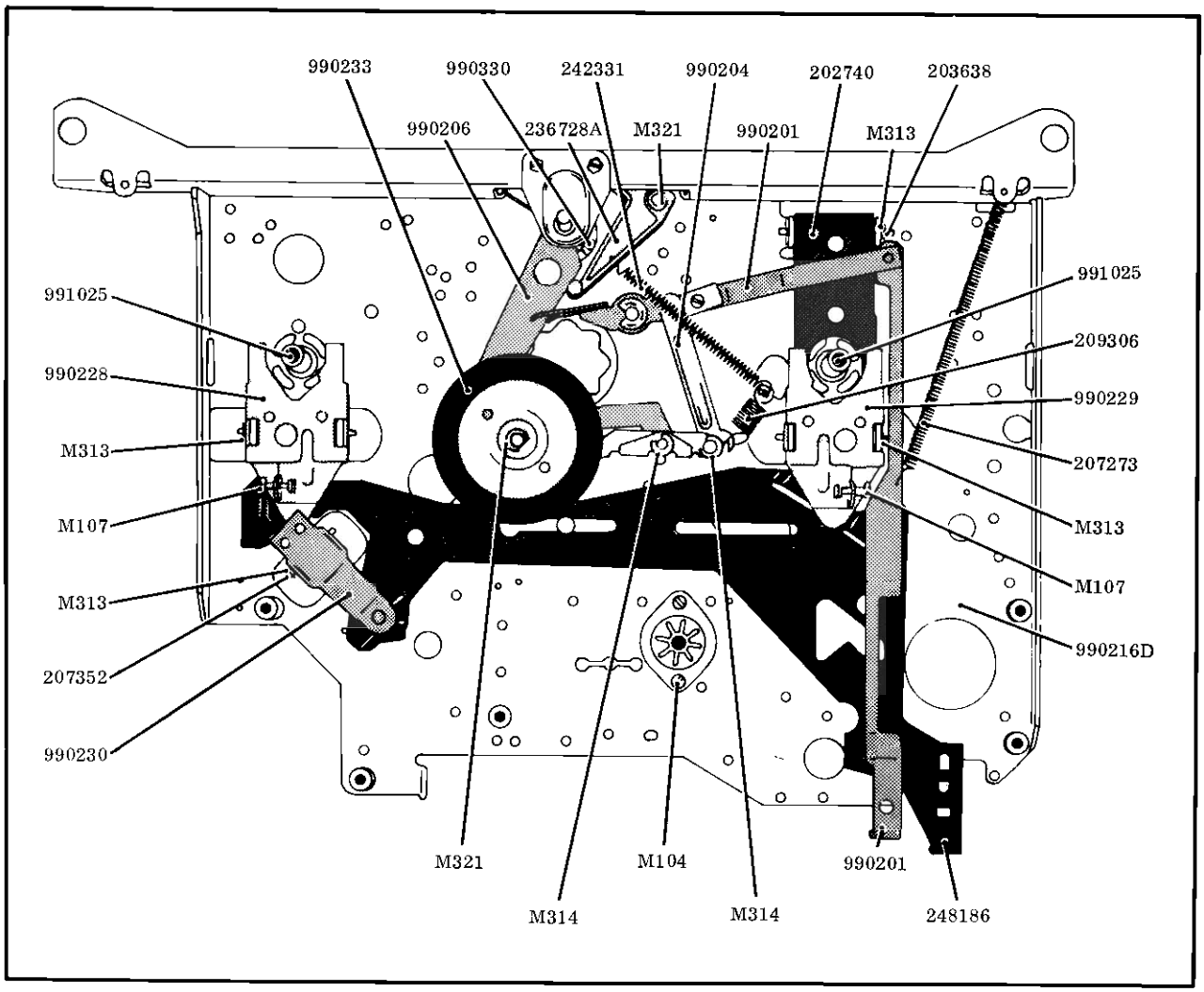


Fig. 3.5 Lower mounting plate

3.2 TURNTABLES

Figures 3.9 and 3.6 show the take-up turntable assembly 990227 and supply turntable assembly 990226 with friction discs 209658 and clutch levers 990229 and 990228.

3.1.2 Supply Turntable

See fig. 3.6. The supply turntable and the friction coupling are assembled as follows:
Place the helical spring 218415 and the friction disc 990236 over the bearing housing 991025 with one end of the spring resting in the sylindrical groove of the housing 202230. The tongue on the bushing should point at the front of the recorder. Push the friction disc down, ensuring that the lugs on the bushing pass between the fingers of the clutch lever 990228. Then turn the bushing 90° clockwise until the tongue fits into the notch on the lever shown in fig. 3.7.
The bushing is now locked in this position. Put on the mylar sheet 215743. Press the flange 200549 down through the upper part of the housing.
Insert the two springs 217510 into the circular recesses in the friction disc. Then place the tape tightening disc on top with its smaller guide pins extending into the springs. Put the turntable shaft through the bearing housing. Set the operating lever 990225 in position fast forward winding. The friction wheel is thereby pressed down by the lever and the turntable rests on the tape tightening disc 219198. Put the teflon washer M355 down on the turntable shaft before the hexagonal delrin bushing 218767 is screwed on. The turntable should now move freely, and the axial slack of the turntable should be approx. 0.1 mm (4 mil).

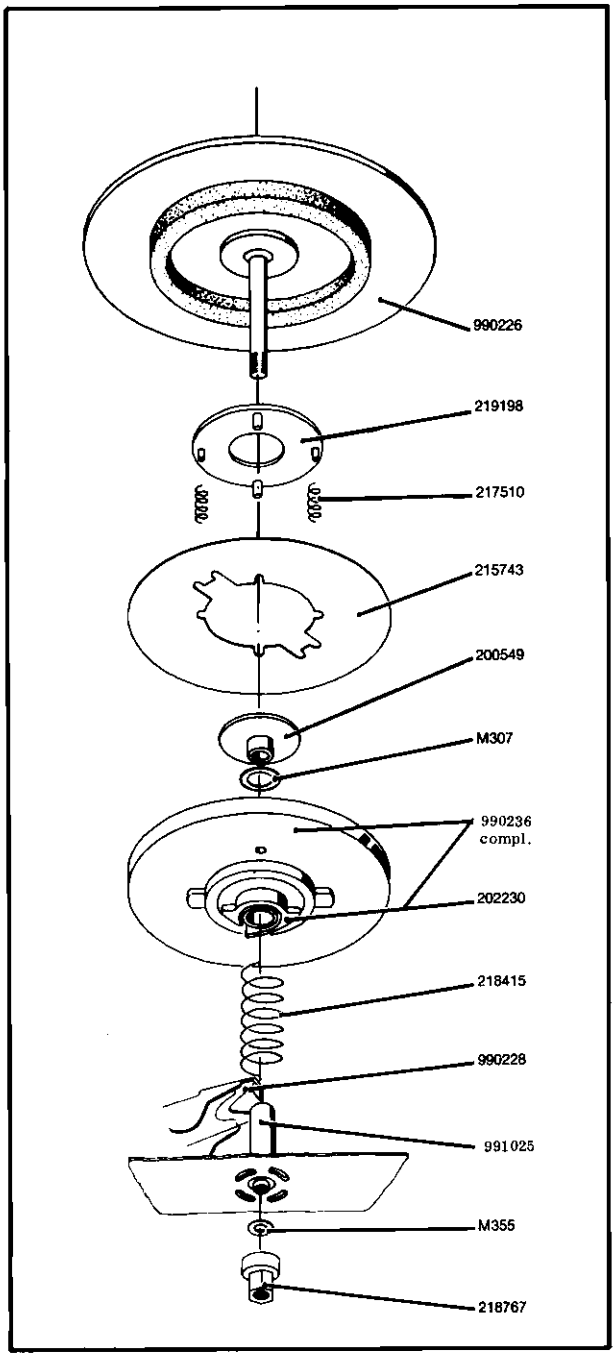


Fig. 3.6 Supply turntable

3.2.2 Tape Tensioner

When the instantaneous start/stop lever is in normal forward drive with a full 7" reel on the supply turntable, there might be a tendency to forming of tape loops between the supply reel and the head covers. In order to avoid this, a slight braking torque is applied on the supply turntable.

Adjustments

Adjustment is accomplished by stretching or cutting the two springs 217510 until the braking torque is sufficient to prevent forming of loops during normal forward drive and when the tape is stopped with the instantaneous start/stop lever. Use a full 7" reel on the supply turntable. Be careful not to stretch the springs too much, as this may cause uneven forward movement of the tape and consequently wow or flutter in the recorded program.

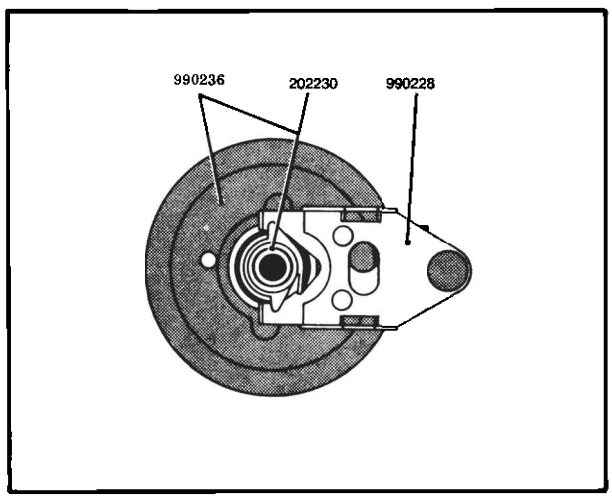


Fig. 3.7 Supply friction disc with lever

3.2.3 Take-Up Turntable (990227)

See fig. 3.9. The take-up turntable assembly is put together as follows:

Place the helical spring 214701 and the friction disc 209658 over the bearing housing 991025 with one end of the spring resting in the sylindrical groove of the bushing 202230. The tongue on the bushing should point at the rear of the tape recorder. Push the friction disc 990236 down, with the delrin studs on the bushing passing through the notch in the upper clutch lever 990229. Press the lower clutch lever 202740 against the lower mounting plate 990216D by means of a screw driver. The spacing between upper and lower levers will now be approx. 6 mm (1/4"). Turn the bushing 90^{o} counterclockwise until the two delrin studs are locked by the two claws on the lower clutch lever.

Put on the mylar washer 215743, press the flange 200549 down into the upper end of the housing and insert the turntable shaft through the housing. Move the operating lever 990225 to position fast reverse winding, whereby the friction disc is pressed down by the upper clutch lever causing the turntable to rest on the flange. Put the teflon washer M355 on the turntable shaft and fasten the counter pulley 211339. The turntable should now move freely with an axial slack of approx. 0.1 mm (4 mil).

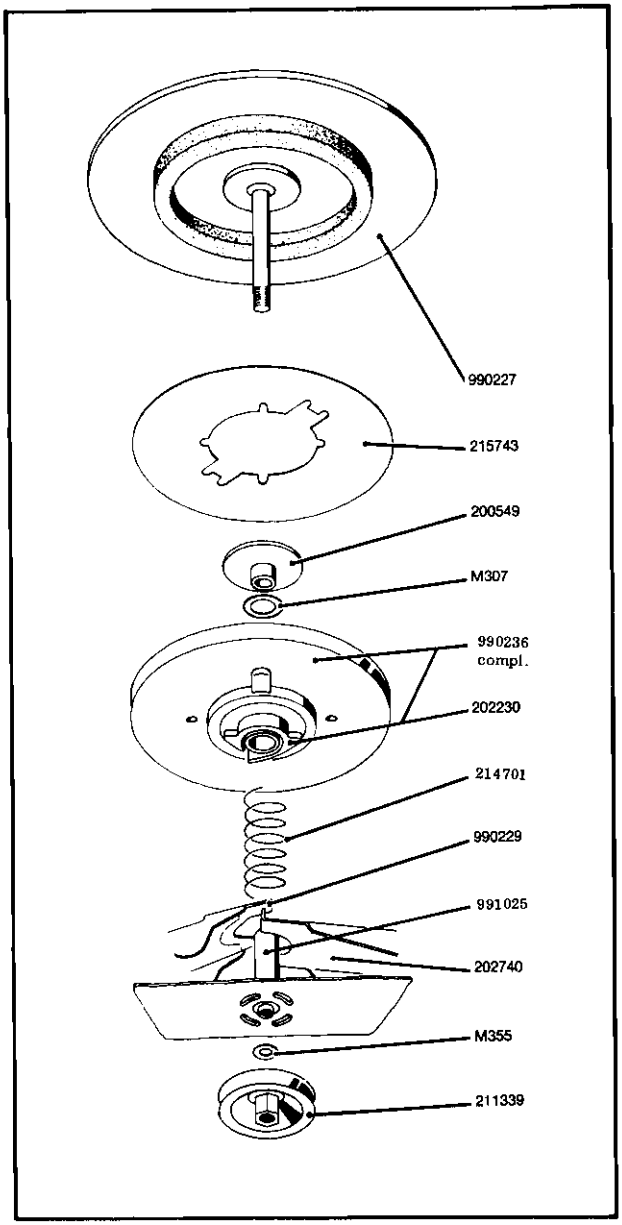


Fig. 3.9 Take-up turntable

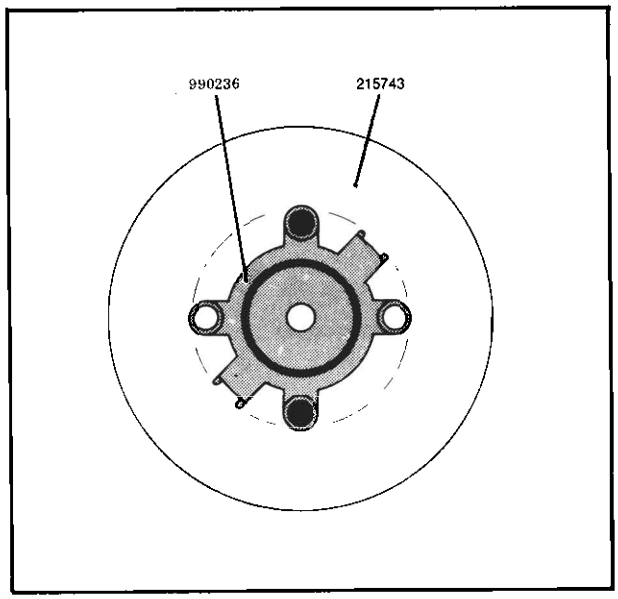


Fig. 3.8 Supply friction disc with mylar sheet

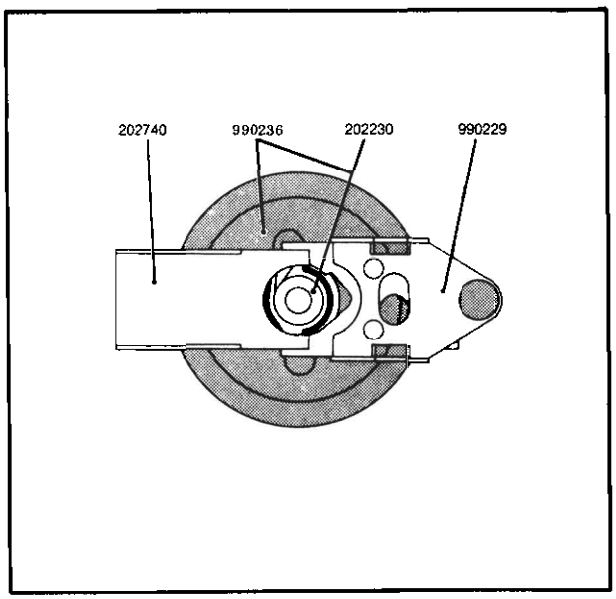


Fig. 3.10 Take-up friction disc with levers

3.2.4 Adjustment of Turntables

Use special tools no. 1, 2 and 3. See fig. at the rear of the manual.

Horizontal Adjustment

See fig. 3.11. Check the horizontal position of the turntable with reference to a line parallel to the front of the tape recorder by means of special tool no. 1 placed on both turntables. There should be no spacing between the tool and the ribs on the turntables.

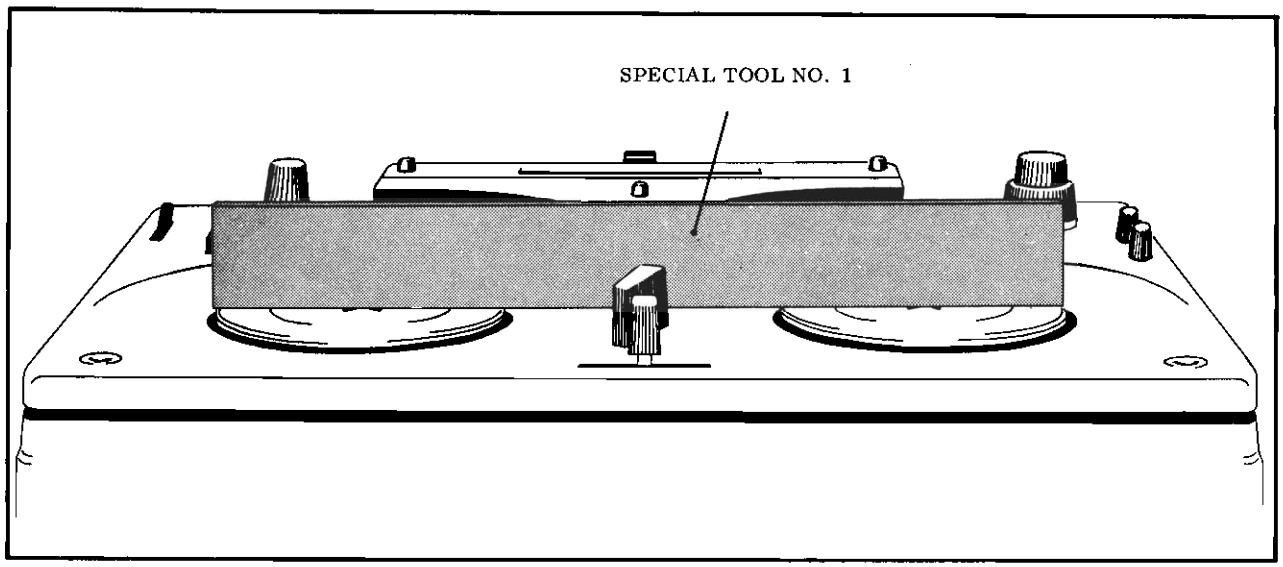


Fig. 3.11 Control of position of turntables

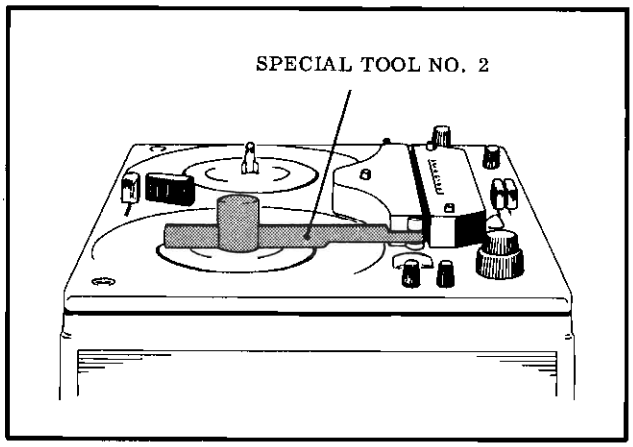


Fig. 3.12 Control of position of turntables

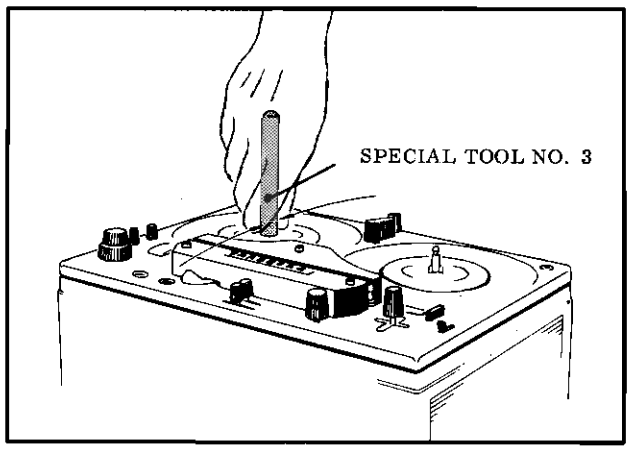


Fig. 3.13 Adjustment of turntables

Check the horizontal position of the turntables along a line perpendicular to the front of the tape recorder by placing special tool no. 2 on supply turntable and take-up turntable respectively as shown in fig. 3.12. The end of the tool should pass freely through the slot in the tape guide post when the operating lever is in neutral position. Adjustment of the turntable bearing is in both cases performed with special tool no 3 which is put down on the center pin of the turntable. In order not to risk any bending of the turntable shaft, grip the tool just above the turntable. See fig. 3.13.

Height Adjustment

When the horizontal adjustment has been performed, the vertical position of the turntable is checked with 7" reels on both turntables, and the tape correctly inserted in the tape path. Check that the tape runs freely between the flanges of the reels in all positions of the operating lever. The turntables can be raised or lowered by adding or removing turbax washers type M307 between the flange 200549 and housing 200628, see fig. 3.6 and 3.9. Recheck the horizontal position of both turntables.

3.3 CLUTCHES

The motor torque is transferred to the turntables by means of the friction discs and the felt ring which is glued on to the bottom side of the turntables. The amount of friction is determined by the clutches which are operated by the operating arm 248186. The operating arm is linked with the operating lever 990225.

3.3.1 Neutral

The motor current is switched off by the switch 202151 and both friction discs are stationary.

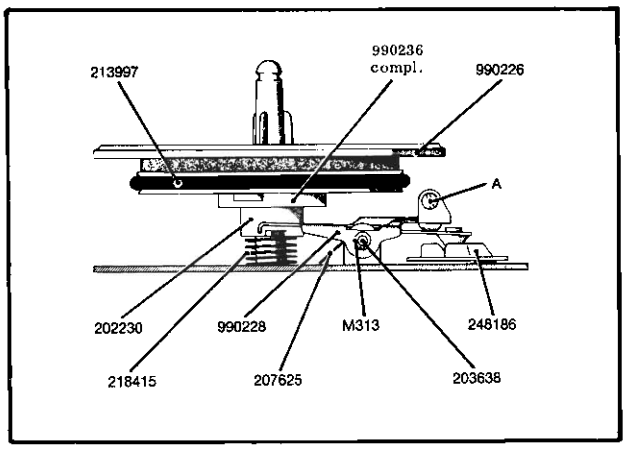


Fig. 3.14 Supply turntable

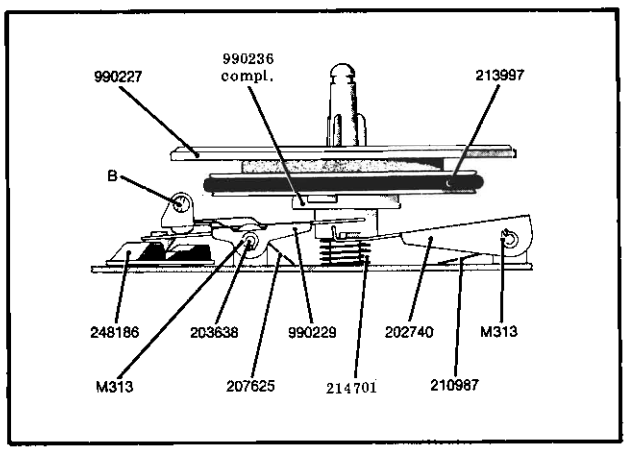


Fig. 3.15 Take-up turntable

Supply Turntable (990226), fig. 3.14

In neutral position the friction between the turntable and the friction disc 990236 is at maximum. The friction disc is pressed against the felt ring underneath the turntable by the spring 218415. The operating arm 248186 is in a position that allows the delrin knob on the lever 990228 to rest in the lower position. The delrin studs on bushing 202230 are disengaged from the clutch lever.

Adjustments

Adjust screw A until the spacing between the lever and the delrin studs on the bushing is 0.5 - 1 mm (20 - 40 mil). Check the lever position in all operating modes and seal screw A.

Take-Up Turntable (990227), fig. 3.15

When the operating lever is in neutral position, maximum friction excists between the friction discs 990236 and the take-up turntable. The friction disc is pressed against the felt ring underneath the turntable by the spring 214701, and by the spring loaded lower clutch lever 202740 which excerts pressure against the delrin bushing 202230 from underneath. The operating arm 248186 is in a position so as to leave the delrin knob on the upper clutch lever 990229 in the lower position.

Adjustments

Adjust screw B until the spacing between upper and lower clutch levers is approx. 0.5 mm (20 mil). Check the lever positions in all operating modes and seal screw B.

3.3.2 Normal Forward Drive

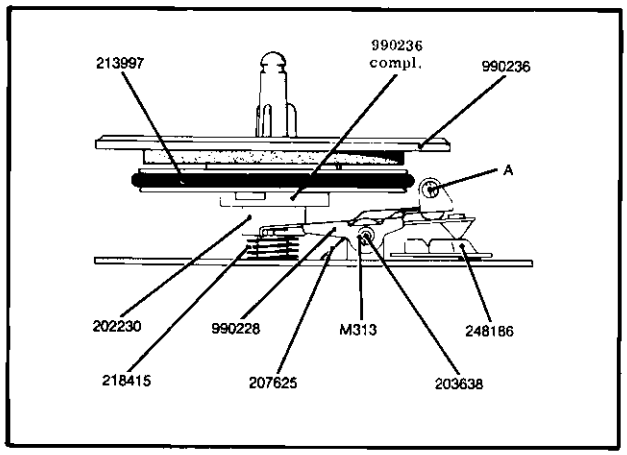


Fig. 3.16 Supply turntable

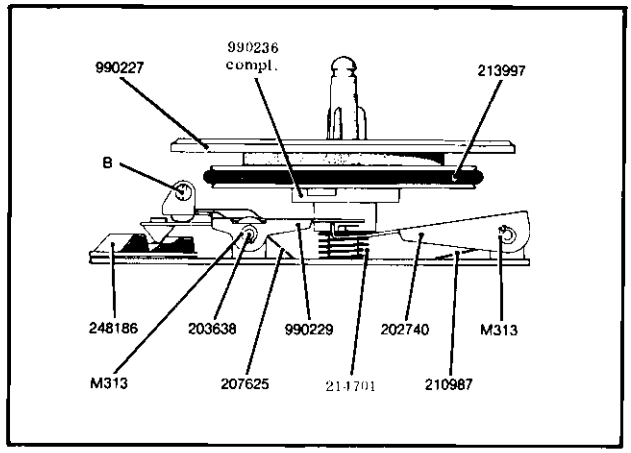


Fig. 3.17 Take-up turntable

The Supply Turntable, fig. 3.16

The supply turntable is released in normal forward drive mode. The delrin knob on the clutch lever 990228 is held in upper position by the operating lever 248186. The delrin bushing 202230 and the friction disc 990236 are pressed down.

Adjustments

Adjust the screw A until the spacing between the friction disc and the felt ring underneath the turntable is between 0.5 and 1 mm (20 - 40 mil). Check clutch lever positions in all operating modes, and seal screw A.

Take-Up Turntable, fig. 3.17

In normal forward drive the take-up turntable has a winding torque which is just sufficient to wind the tape in record and playback mode. The operating arm holds the delrin knob on the lever in an intermediate position. The upper clutch lever 990229 will press down the lower clutch lever 202740 thereby releasing the pressure of the friction disc against the turntable. The friction disc is pressed against the turntable felt ring by spring 214701

Adjustments

By means of screw B, bring the studs of the bushing 202230 to a position half-way between upper and lower clutch levers. The winding torque should amount to 120-200 g cm (1.7-2.8 oz.in). Check the position of the levers in all operating modes and seal screw B.

3.3.3 Fast Forward Winding

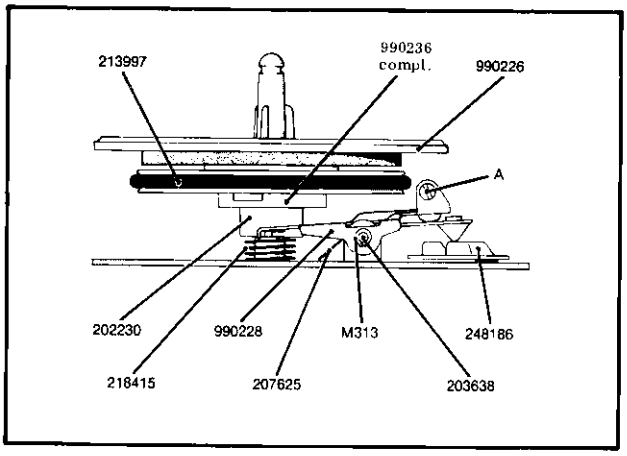


Fig. 3.18 Supply turntable

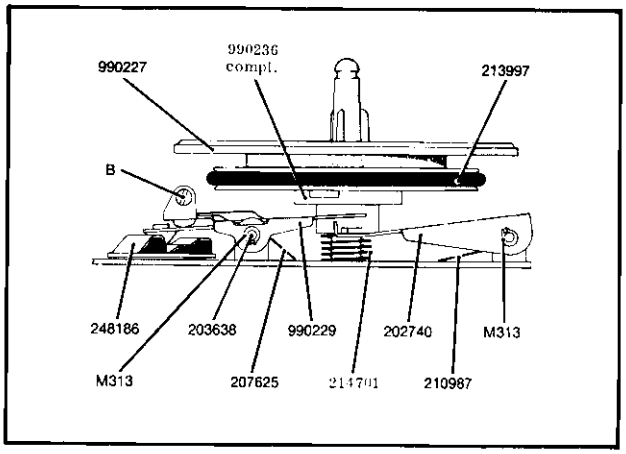


Fig. 3.19 Take-up turntable

Supply Turntable, fig. 3.18

This turntable is released in fast forward winding. The delrin knob on the clutch lever 990228 is held in its uppermost position by the operating arm 248186, and depresses bushing 202230 and friction disc 990236.

Adjustments

By means of screw A, adjust the clearance between the friction disc and the felt ring on the turntable to 0.5 - 1 mm (20 - 40 mil). Check the position of the clutch lever in all operating modes, and seal screw A.

Take-Up Turntable, fig. 3.19

This turntable has maximum torque in fast forward winding. The operating arm is in a position that allows the delrin knob on the upper clutch lever 990229 to rest in its bottom position. The upper and lower clutch levers are disengaged. The friction disc is pressed against the felt ring underneath the turntable by the spring 214701 and the spring loaded clutch lever is pressed against the delrin bushing.

Adjustments

By means of screw B, adjust the clearance between the upper and lower levers to approx. 0.5 mm (20 mil). The winding torque should amount to minimum 520 g cm (7.2 oz. in.). Check the position of the clutch levers for all positions of the operating lever and seal screw B.

3.3.4 Fast Reverse Winding

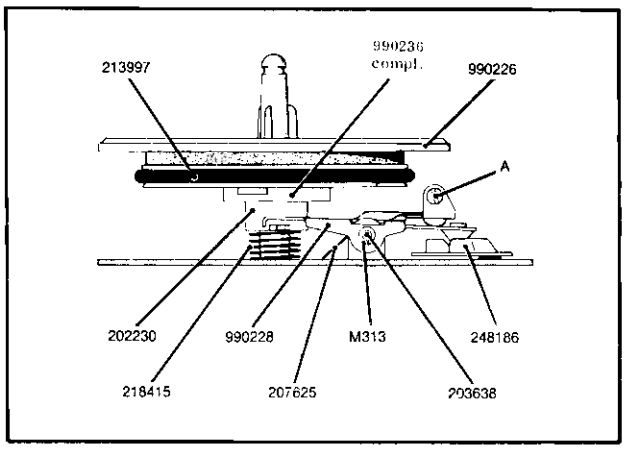


Fig. 3.20 Supply turntable

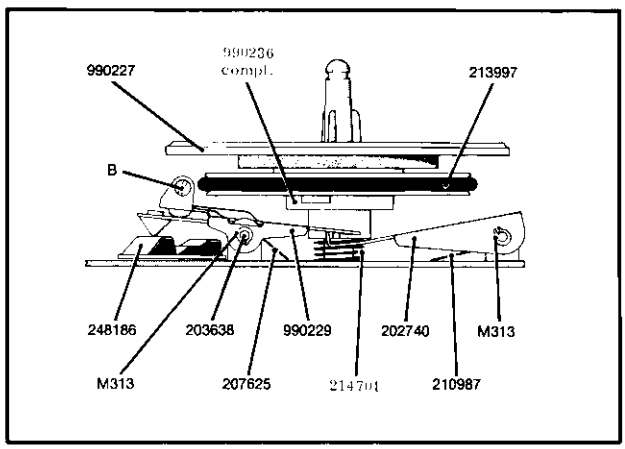


Fig. 3.21 Take-up turntable

Supply Turntable, fig. 3.20

This turntable has a maximum torque in fast reverse winding. The operating arm is in a position that allows the delrin knob on the clutch lever to rest in its lower position. The studs on the bushing 202230 are disengaged from the clutch lever and the friction disc is pressed against the felt ring underneath the turntable by the spring 218415.

Adjustments

By means of screw A, adjust the clearance between the studs on the delrin bushing and the clutch lever to 0.5-1 mm (20 - 40 mil). The winding torque should be minimum 600 g cm (8.3 oz. in.). Check the position of the clutch levers for all positions of the operating lever and seal screw A.

Take-Up Turntable, fig. 3.21

The take up turntable is released in fast reverse winding. The delrin knob on the upper clutch lever 990229 depresses the lower clutch lever 202740, and the bushing with the friction disc.

Adjustments

By means of screw B adjust the clearance between the friction disc and the felt ring underneath the turntable to 0.5 - 1 mm (20 - 40 mil). Check the position of the clutch levers for all positions of the operating lever and seal screw B.

3.3.5 FREE

The motor is switched off by the switch 202151 and both friction discs are stationary.

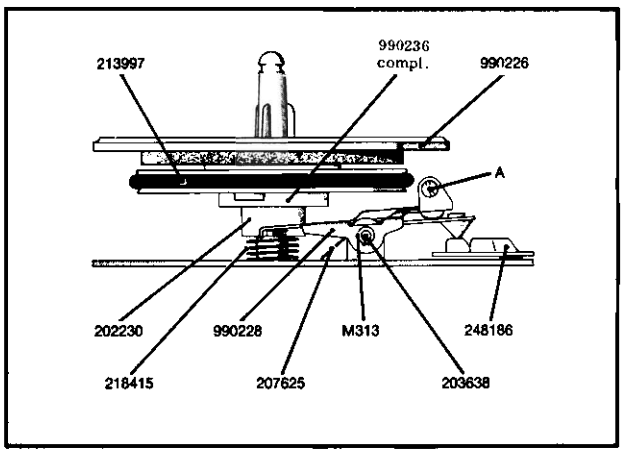


Fig. 3.22 Supply turntable

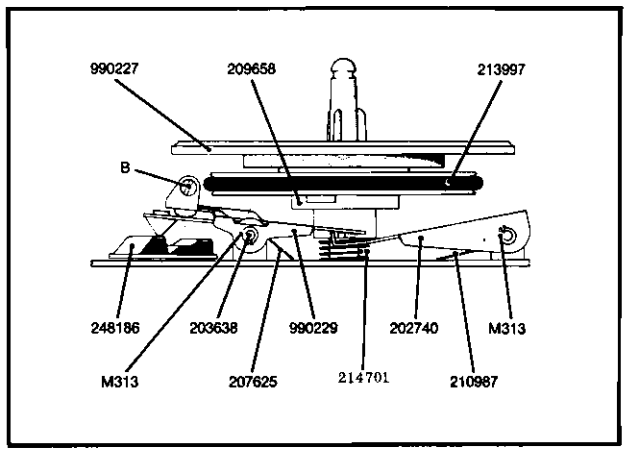


Fig. 3.23 Take-up turntable

Supply Turntable, fig. 3.22

The supply turntable is released. For adjustment, see chapter 3.3.3.

Take-Up Turntable, fig. 3.23

The take-up turntable is released. For adjustment see chapter 4.3.4.

3.4 MOTOR PULLEY (246475)

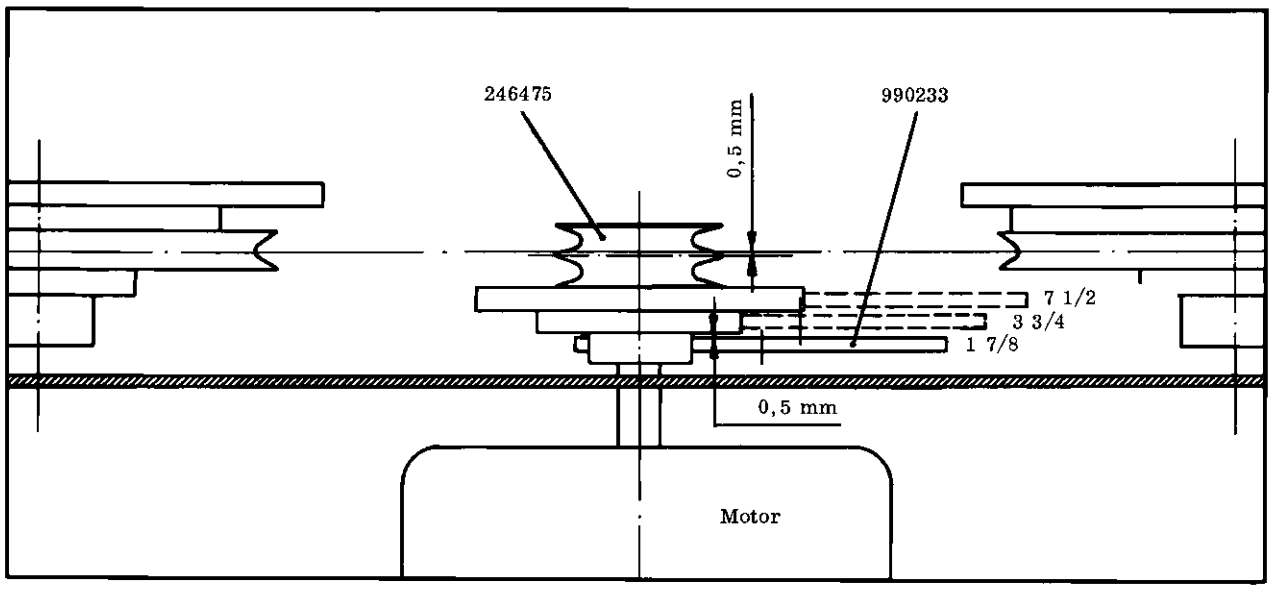


Fig. 3.24 Motor pulley with turntables, rear view

The model 1200X has three tape speeds: 1 7/8, 3 3/4 and 7 1/2 ips, as determined by the diameter of the motor pulley track. Fig. 3.24 is a rear view of the drive mechanism with the transfer wheel 990233 engaged with the motor pulley track for 1 7/8 ips.

Adjustments

The vertical position of the motor pulley can be adjusted when the operating lever is in neutral position (center position). The dividing rib on the motor pulley should lie 0.5 mm (20 mil) below an imaginary line drawn between the bottom of the belt grooves on the friction discs.

3.5 DRIVE BELT (213997)

The drive belt is cross threaded, so as to run in the upper track at the front side of the motor pulley and in the lower track at the rear side. The belt crossing should lie between the supply turntable and the motor pulley.

3.6 TRANSFER WHEEL (990233)

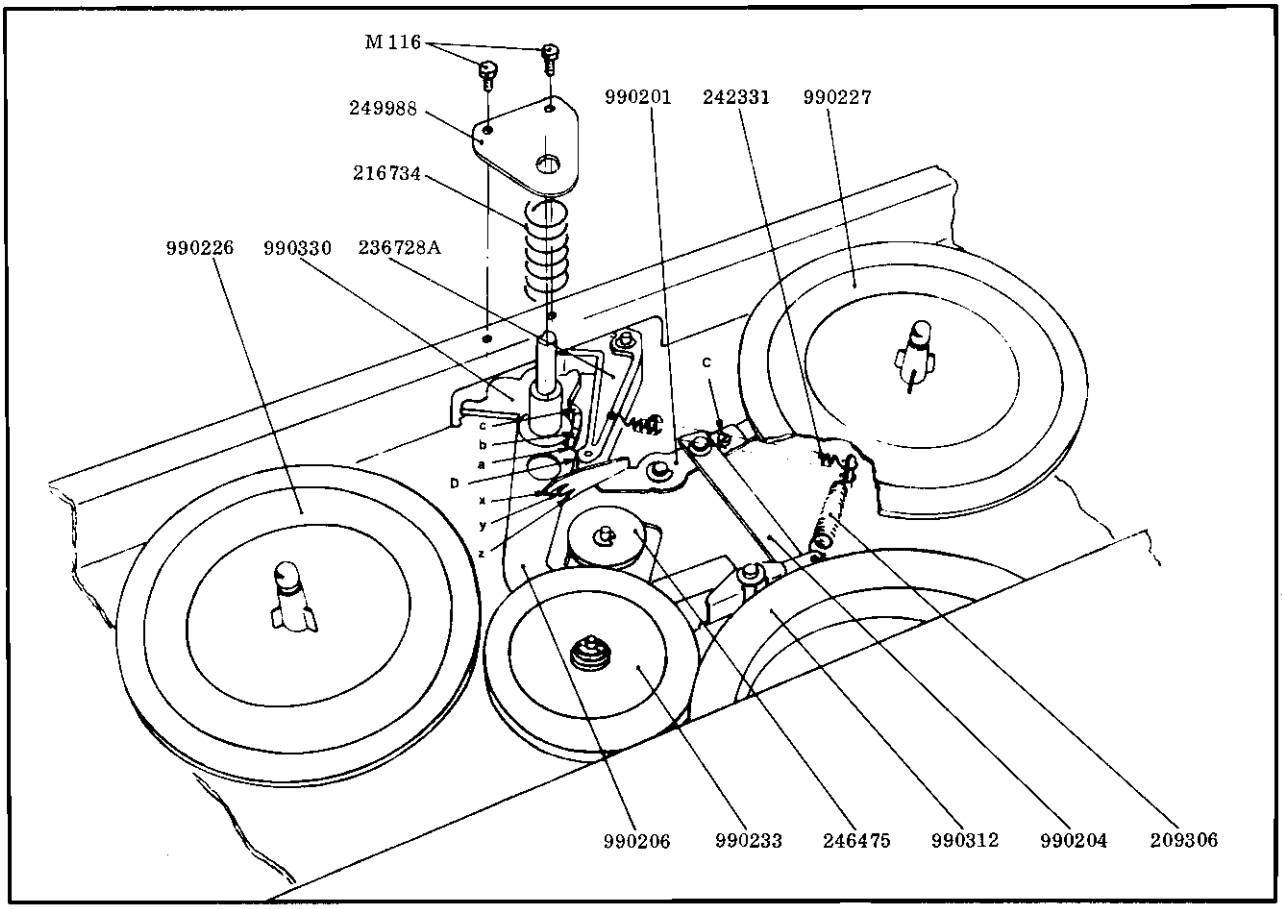


Fig. 3.25 Tape speed mechanism

The transfer wheel is attached to the mounting arm 990206 and serves as the speed transfer medium between the motor pulley and the flywheel. The spring 209306 provides the required pressure against these two wheels. See fig. 3.25.

Adjustments

Set the speed selector to position 1 7/8 ips. Loosen the screws M116, and adjust the speed selector bracket 209816 for a clearance of 1 mm (40 mil) between the mounting arm and the lower mounting plate. Ensure that the mounting arm is parallel with the lower mounting plate. The clearance between the transfer wheel and the 3 3/4 ips track on the motor pulley should be approx. 0.5 mm (30 mil). If necessary, adjust the vertical position of the transfer wheel by adding or removing turbax washers in the upper or lower flywheel bearing respectively. Set the speed selector to 3 3/4 ips and 7 1/2 ips. The full width of the transfer wheel should engage with the motor pulley and the flywheel in both positions.

3.7 LIFTING ARM (990201)

The lifting arm (consisting of parallel arm and adjustment arm) is located on the lower mounting plate and is linked with the eccentric segment 990203. See fig. 3.25. The lifting arm disengages the transfer wheel 990233 from the motor pulley when the operating lever is set to position fast forward winding, reverse winding, free, or neutral. The transfer wheel should engage with the motor pulley in normal forward drive mode only.

Adjustments

For each one of the tape speeds the transfer wheel should leave the motor pulley as soon as the operating lever is moved from normal forward drive position to neutral position, and reach maximum clearance before the motor is switched off by the microswitch 202151. The minimum clearance in neutral position should be 3 mm (1/8"). If necessary, adjust by bending the lifting arm fingers x, y, and z for relevant speeds. Set the speed selector for 1 7/8 ips and the operating lever to neutral position. Loosen screw C and adjust the parallel arm 990204 for 0.5 mm (20 mil) clearance between the transfer wheel and the flywheel. Set the speed selector for 3 3/4 ips and 7 1/2 ips and check that the clearance is the same. Readjust if necessary, tighten and seal screw C.

3.8 FLYWHEEL WITH CAPSTAN (990312)

The flywheel and the capstan comprise one integral part with the flywheel shaft serving as capstan. The unit is mounted in selflubricating bearings 208250, see fig. 3.27.

Adjustments

For vertical adjustment of the capstan, use special tool no. 5 as shown in fig. 3.26. Loosen the two screws M125 in the washer 990222 in the upper flywheel bearing. Push the tool cautiously down on to the capstan until all three legs rest against the upper mounting plate. Then tighten the screws M125, and remove the tool. Wipe off any impurities on the capstan by means of a clean piece of cloth.

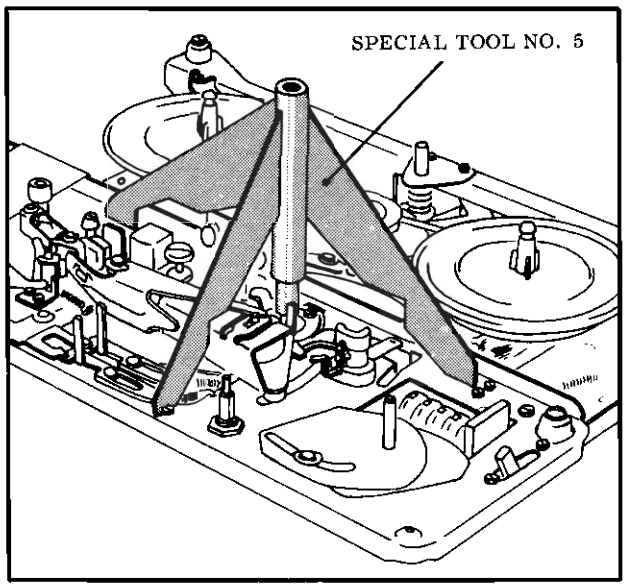


Fig. 3.26 Adjustment of capstan

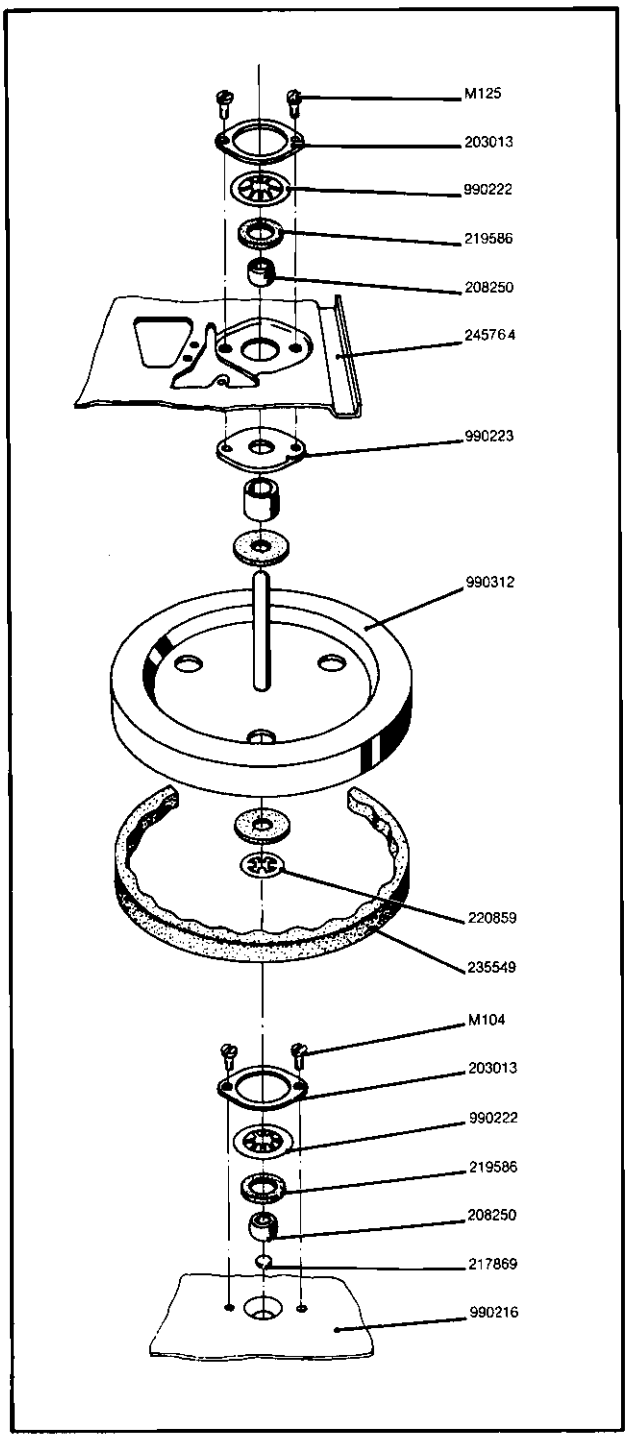


Fig. 3.27 Flywheel with bearings

3.9 SPEED SELECTOR

Fig. 3.25 shows the design and operation of the speed selector. The transfer wheel is shown in engagement with the 1 7/8 ips track on the motor pulley 246475. The mounting arm 990206 is engaged with the lowest step on the cam disc 990330 , and the arm 236728A rests aginst the curved edge of the cam disc. When the speed selector is moved towards the 3 3/4 ips position, the arm presses against the mounting arm at point D. and moves the arm and the transfer wheel approx. 1 cm (3/8") horizontally to the left. The vertical movement of the mounting arm occurs simultaneously and is controlled by the slope between steps a and b on the cam disc. The transfer wheel moves horizontally towards the 3 3/4 ips track on the motor pulley. When the movement is completed, the cam disc arm returns to normal position. No adjustments are provided for the speed selector mechanism.

3.10 INSTANTANEOUS START/STOP MECHANISM

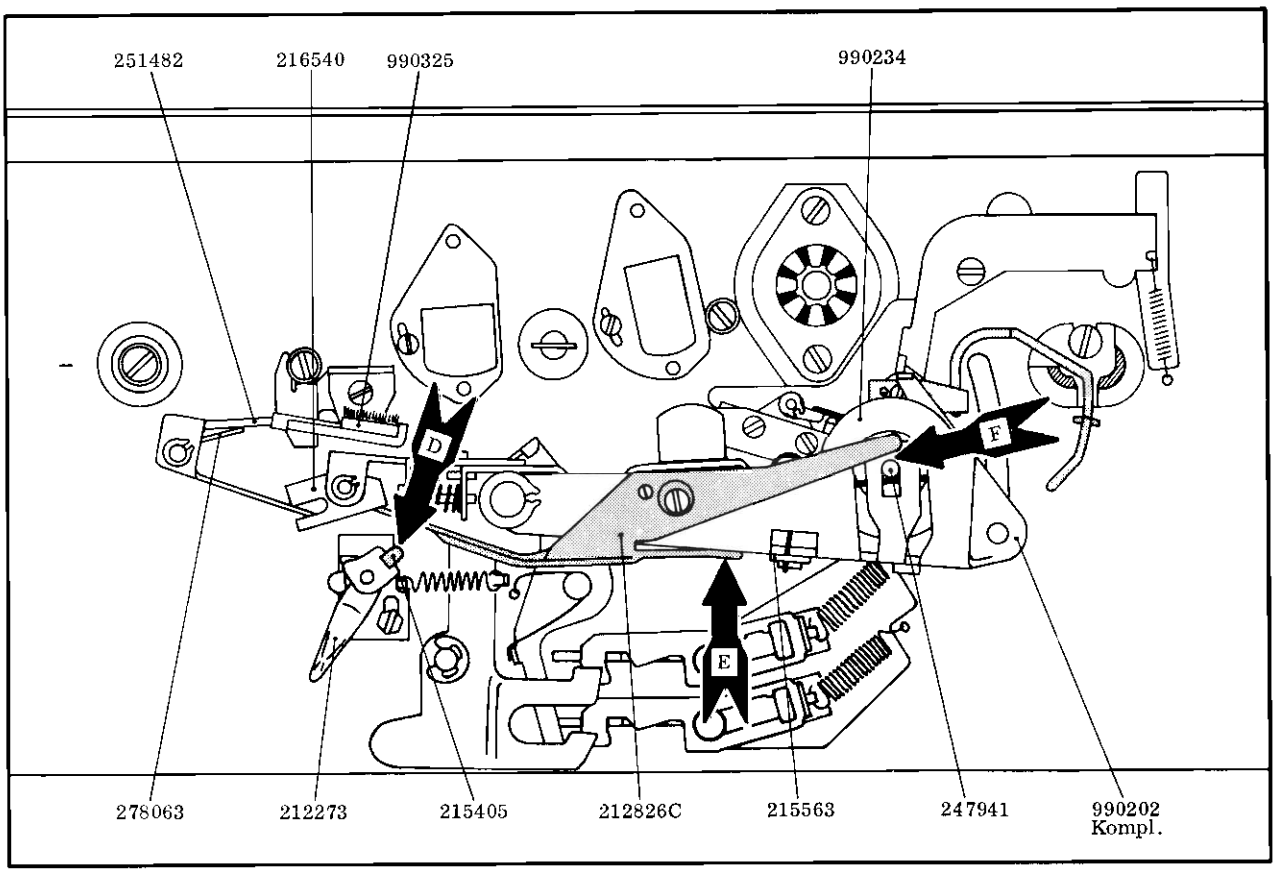


Fig. 3 28 Adjustment of start/stop mechanism

See fig. 3.28. When the start/stop lever 212273 is moved towards the stop position, the delrin part 215405 is pressed against the pressure roller lever 212826C at point D. The lever moves the pressure roller away from the capstan, and the tape stops.

Adjustments

Set the operating lever to normal forward drive position and the start/stop lever to STOP position. Adjust the pressure roller lever by bending flap E to obtain a clearance of 0.5 mm (20 mil) between capstan and the pressure roller. Check that the clearance between the pressure roller lever and linkage 251130 is approx. 0.2 mm (8 mil). Start the tape by moving the start/stop lever to the left. Adjust the clearance at point F between the pressure roller lever and the pressure roller shaft approx. 1 mm (40 mil) by bending tongue E. Finally check that the clearance between the pressure roller lever and the delrin part 215405 is approx. 0.5 mm (20 mil).

3.11 PRESSURE PAD SPRING

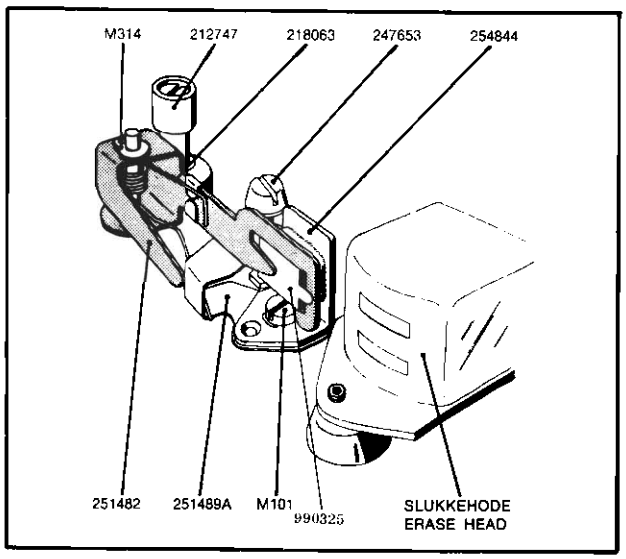


Fig. 3.29 Pressure pad mechanism

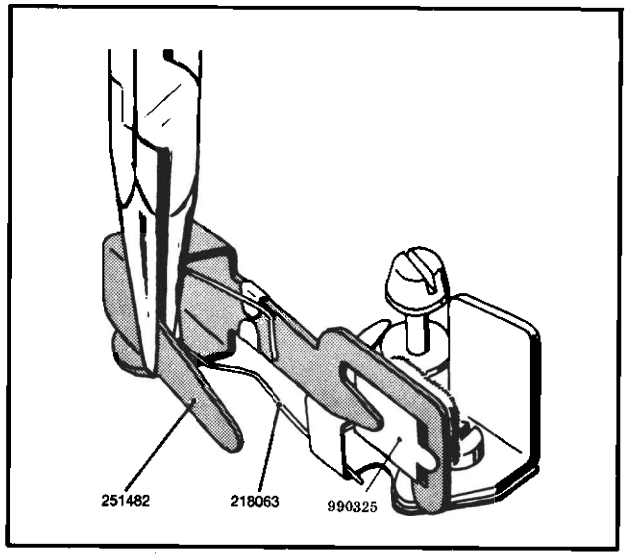


Fig. 3.31 Adjustment of pressure pad

The bracket 253163 holding the pressure pad is attached to the pressure arm 251482. The pressure pad is pressed against the tape rest 254844, and ensures constant tape tension in normal forward drive mode. See fig. 3.29. When the operating lever is in one of the other positions, the pressure pad is kept at a distance from the tape.

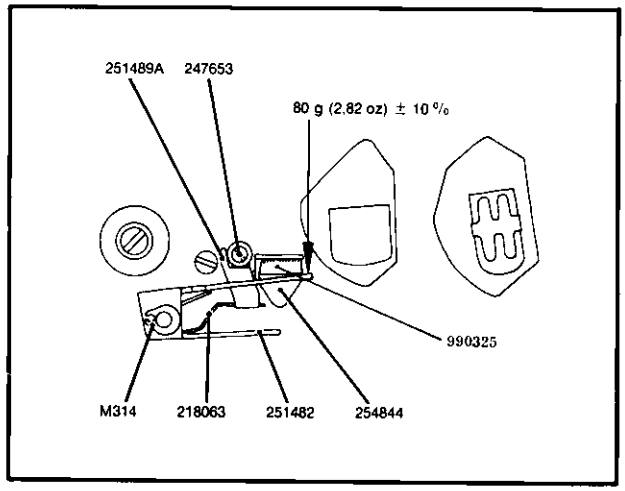


Fig. 3.32 Pressure pad tension

Adjustments

Set the operating lever to neutral position. The clearance between the pressure pad and the tape rest should be approx. 6.5 mm (1/4") as shown in fig. 3.30. If necessary, adjust by bending the arm 210520 as shown in fig. 3.31.

Set the operating lever to normal forward drive position. The pressure against the tape rest should be 80 g (2.8 oz) ± 10%, see fig. 3.32. If necessary, adjust by bending the spring 218063 as shown in fig. 3.33.

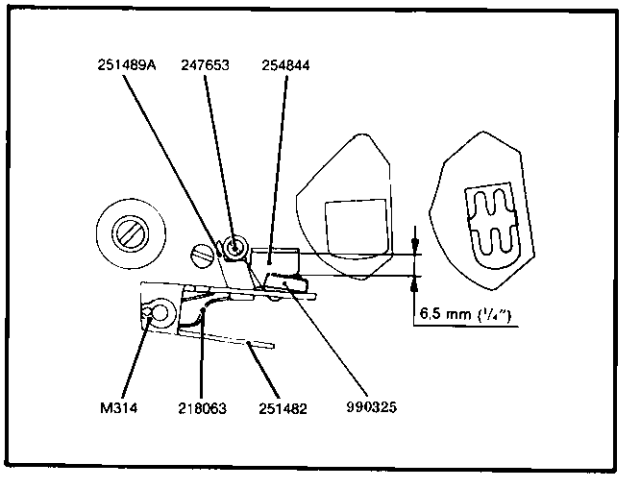


Fig. 3.30 Position of pressure pad

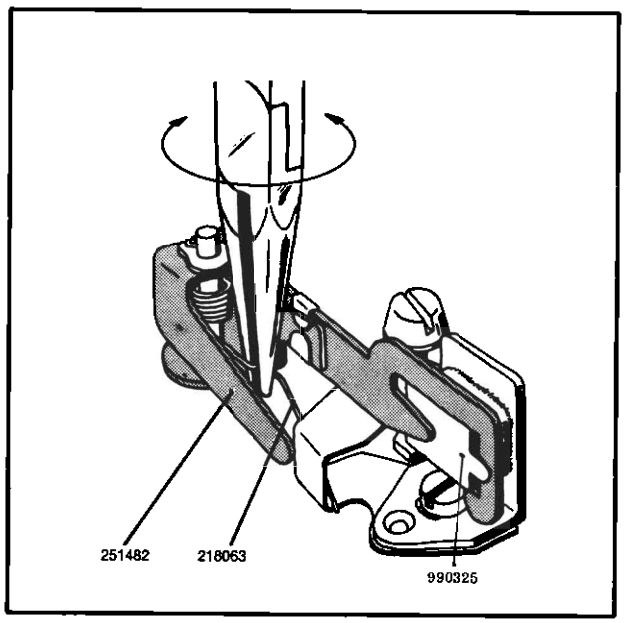


Fig. 3.33 Adjustment of pressure pad tension

Note: The pressure pad should be brushed clean at regular intervals to avoid incorrect friction being caused by dust and other impurities. The pad must not be dampened in any way, as this will alter the surface structure and properties of the pad.

3.12 END STOP MECHANISM

The purpose of the automatic end stop mechanism is to switch off the motor at the end of the tape or in case of tape breakage. The end stop feeler 242503 is located on the upper mounting plate and extends through the cross-shaped hole in right hand guide post 243013. The feeler operates microswitch 202151 via lever 244342A, and rests with a light spring tension against the tape when the operating lever is in normal forward drive and winding positions.

3.12.1 Neutral

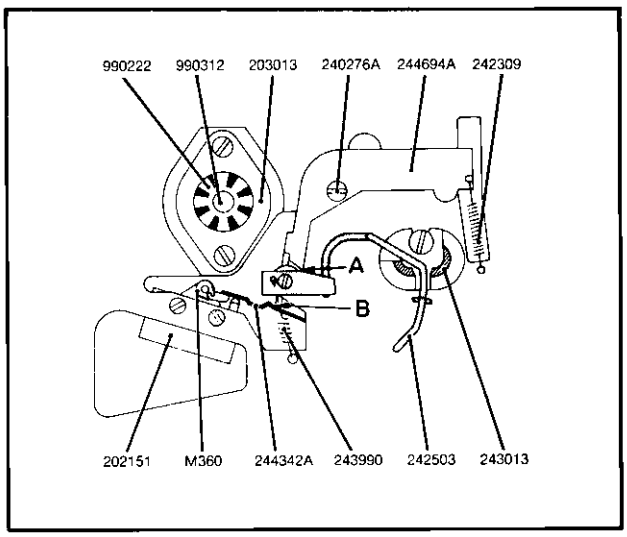


Fig. 3.34 Neutral

Figure 3.34 shows the position of the relevant parts when the operating lever is in neutral (stop). The arm 244694A has a flap extending through the upper mounting plate, and is held in an intermediate position by the operating lever. The arm attacks the tape feeler at point A and keeps the feeler clear of the guide post. The arm 244694A excerts pressure on the lever 244342A at point B and the microswitch is depressed to its OFF position.

3.12.2 Normal Forward Drive

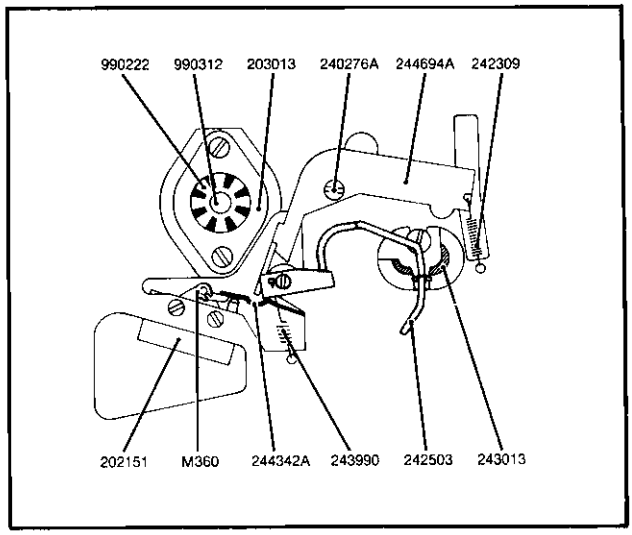


Fig. 3.35 Normal forward drive and fast winding

Fig. 3.35 shows the situation when the operating lever is set to normal forward drive, forward or reverse winding, with a tape properly inserted in the tape path. The arm 244694A is now moved by the operating lever in the forward direction, and the pressure against the tape feeler at point A ceases. Simultaneously, the pressure at point B ceases, because the arm 244694A, which rests in a groove of the lever 244342A, is released. The microswitch returns to closed position and the motor starts. The tape feeler rests gently against the tape, due to the tension of spring 243990.

3.12.3 End Stop or Tape Breakage

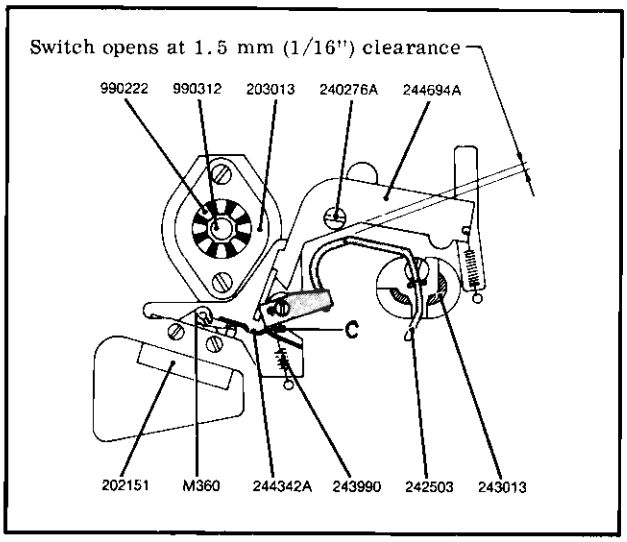


Fig. 3.36 End stop or tape breakage

Fig. 3.36 shows the situation when the tape has run out, or in a case of tape breakage.
The spring 243990 pulls the delrin part of the feeler fully in and the feeler activates the microswitch so as to switch off the motor.

3.12.4 FREE

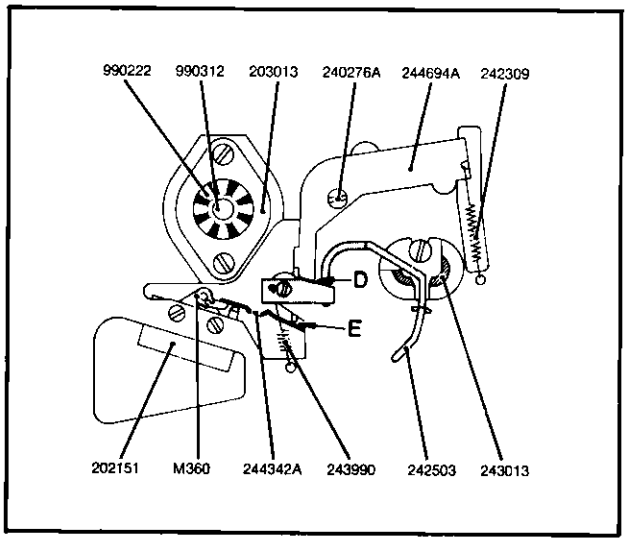


Fig. 3.37 Free

Fig. 3.37 shows the position of the relevant parts when the operating lever is in position FREE. The arm 244694A is moved in a direction away from the normal forward drive position. The tape feeler is locked in open position at point D and the tape can be inserted. The lever 244342A is locked in position E, holding the microswitch depressed (motor switched off).

Tape Feeler Tension

The feeler tension against the tape should be between 8 and 10 gr. (0.28 - 0.35 oz.) in drive and winding modes. Adjustment of the tension is accomplished by tightening or slackening the spring 243990

Adjustment of Tape Feeler Movement

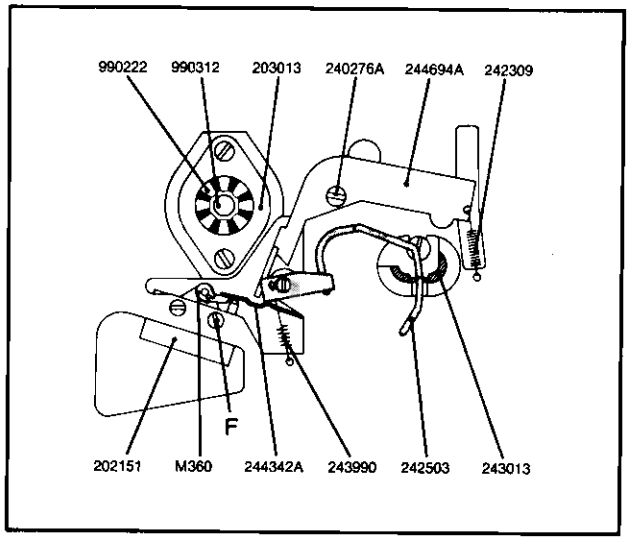


Fig. 3.38 Adjustment of operating positions

For the adjustment of the tape feeler movement refer to fig. 3.38. Set the operating lever in normal forward drive position, or forward or reverse winding. The mains switch is set to ON. No tape should be inserted. The tape feeler will therefore rest in the position where the motor is switched off.
Push the feeler slowly through the guide post. When the contact surface (polished) of the feeler is 0.5 - 1.0 mm (20-40 mil), from the polished contact surface of the guide post, the microswitch should close and start the motor. If not, loosen screw F, and move the microswitch slowly until the motor starts when the tape feeler is in the position specified above. Then tighten the screw. When the tape feeler is released, the microswitch should open, and stop the motor when the spacing between the tape feeler and the arm 244694A is maximum 1.5 mm (60 mil). See fig. 3.36.

4.0 ELECTRICAL CIRCUITS. DETAILED DESCRIPTION.

The following description is referred to left (L) channel but is valid also for right channel.

4.1 MICROPHONE AMPLIFIER

Transistor Q701 and associated components comprise the microphone amplifier which has a flat frequency response.

4.2 PREAMPLIFIER

Transistors Q703, Q705 and Q707 with associated components comprise the preamplifier. Q703 is dc stabilized by the bias supplied from the emitter circuit of Q705. Negative feedback from collector of Q705 is applied to emitter of Q703 through a network switchable by the input selector. When the input selector is in position PICK UP, the components R725, C715, R723 and C713 in the feedback loop, make the feedback frequency dependent. The resulting response for the amplifier is shown in fig. 4.1. With the input selector in position LINE OR MIC or MIXER MONO, (right channel only), the feedback network consists of R721 only, and the frequency response is flat. The signal path when the input selector is in MIXER MONO is indicated with heavy shaded lines on the detail diagram in fig. 4.2. Fig. 4.3 is a block diagram representation for the same condition.

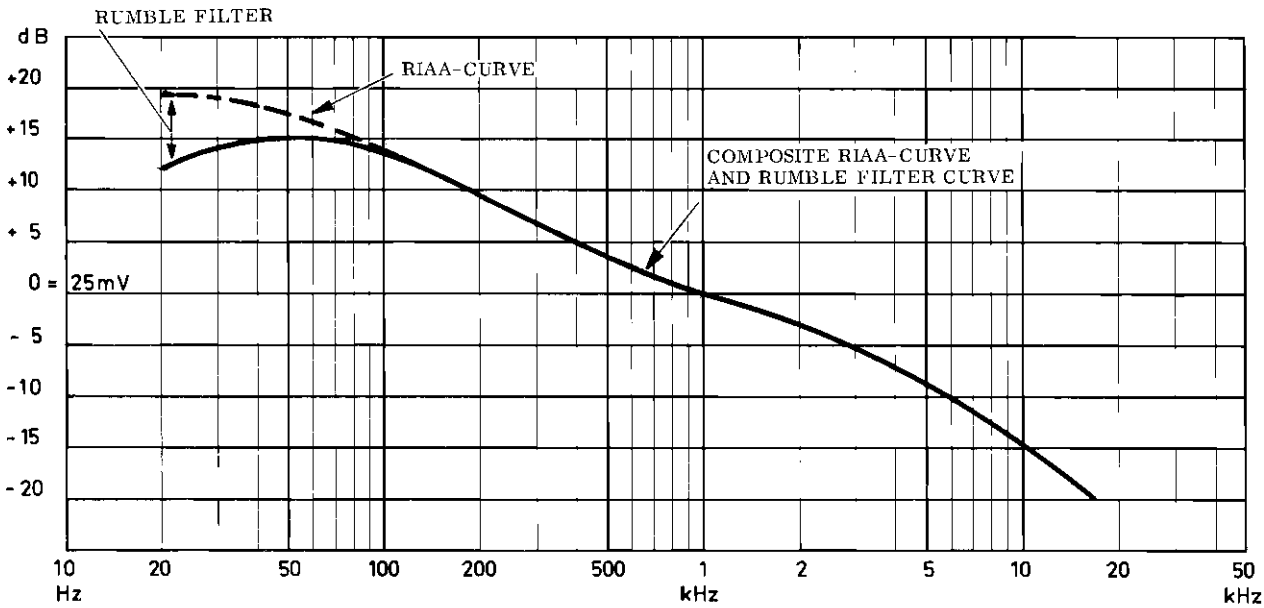


Fig. 4.1 Preamplifier. Equalizing curve for magnetic pick-up

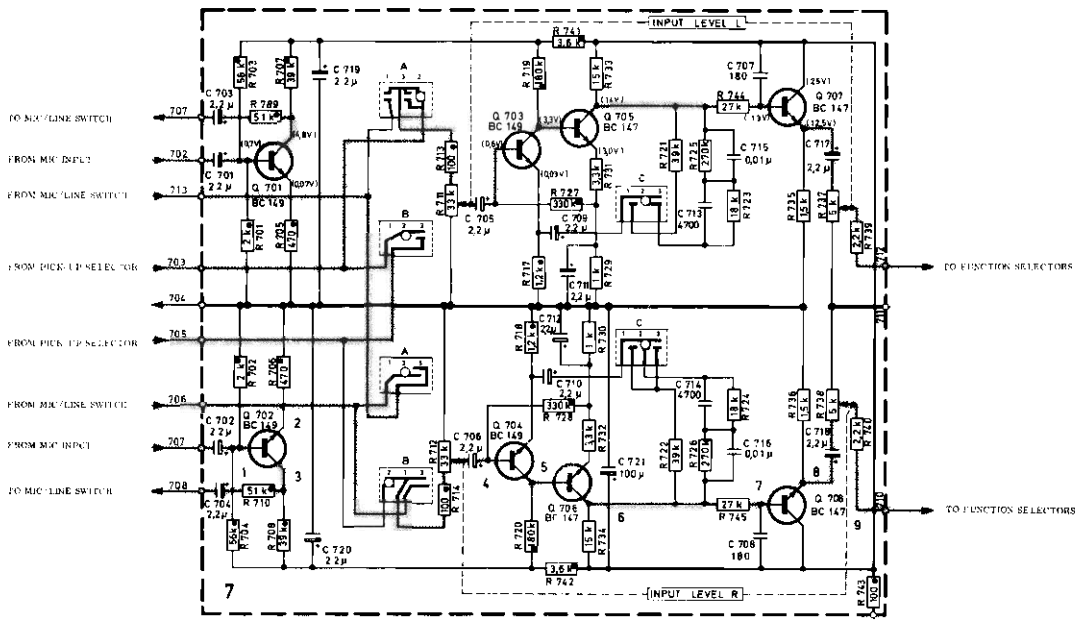


Fig. 4.2 Preamplifier. Signal path with input selector in position MIXER MONO

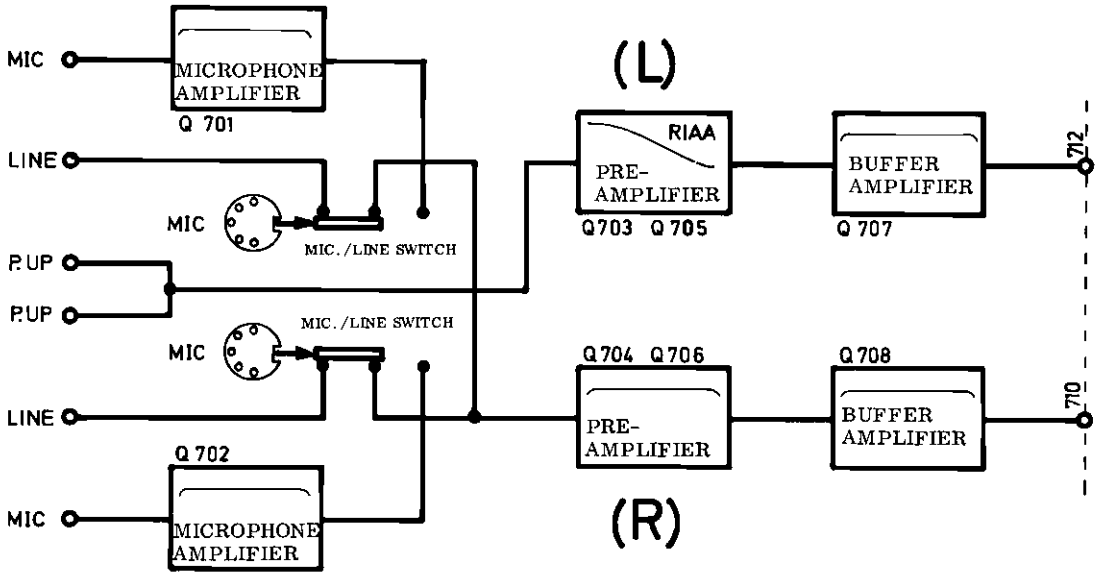


Fig. 4.3 Preamplifier with input selector in position MIXER MONO

4.3 EQUALIZING AMPLIFIER

Q101 through Q103 comprise the equalizing amplifier with negative feedback applied through a frequency dependent network connected between the emitters of Q103 and Q101. C103, C104, and C105 are decoupling capacitors for RF interference. Bias for Q101 is supplied from emitter of Q102 also providing dc stabilization.

4.3.1 Equalizing Network in Record Mode

Fig. 4.4 shows a simplified diagram of the feedback network for recording. At 7 1/2 ips, the frequency response in the lowest frequency range is determined by C108 and R116, in the middle range by C112 and R120, and in the upper range by C111, R114 and the series resonant circuit C115, L101, R125.

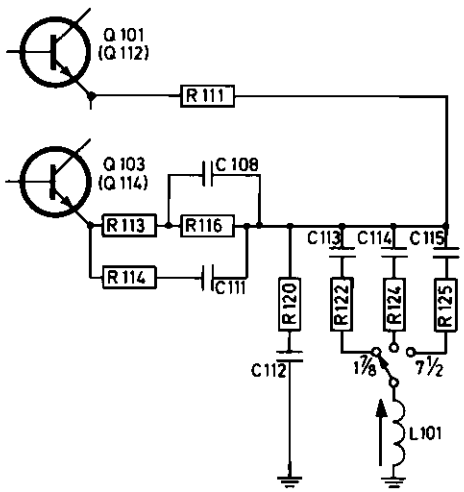


Fig. 4.4 Equalizing network in record mode

At 3 3/4 ips and 1 7/8 ips, the upper frequency range is equalized by C114, R124, L101 or C113, R122, L101 respectively. The resulting frequency curves are shown in fig. 4.5. The signal path through the equalizing amplifier in record mode is indicated with heavy shaded lines in fig. 4.6.

4.3.2 Equalizing Network in Playback Mode

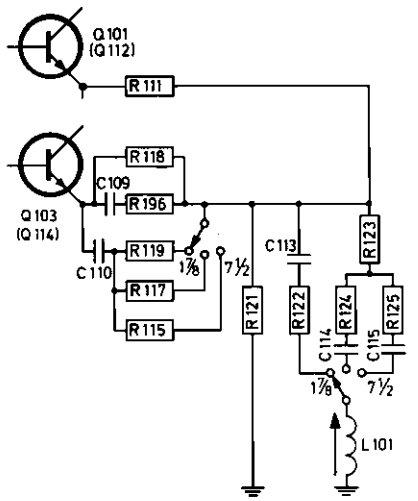


Fig. 4.7 Equalizing network in playback mode

A simplified diagram for the equalizing network is shown in fig. 4.7. The response in the middle frequency range at 7 1/2 ips is determined by C110 and R115, at 3 3/4 ips by C110 and R117. At 1 7/8 ips, R119 determines the frequency response.

The upper part of the frequency curve is at 7 1/2 ips determined by R196, C109 and series resonant circuit L101, C115, R125, R123. At 3 3/4 and 1 7/8 ips, the corresponding components are L101, C114, R124, R123 and L101, R122, C113 respectively.

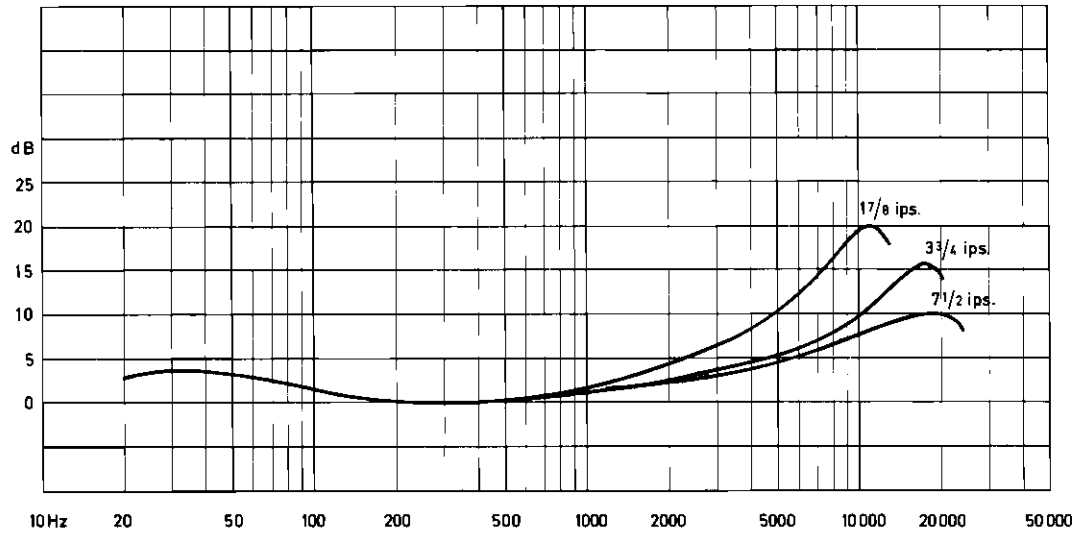


Fig. 4.5 Equalizing curves in record mode

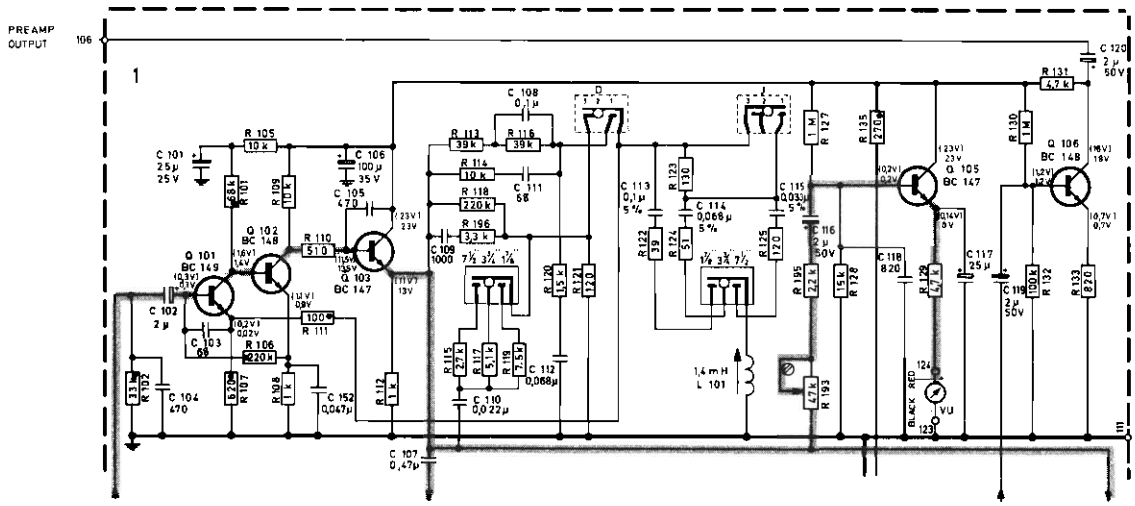


Fig. 4.6 Equalizing amplifier. Signal path in record mode

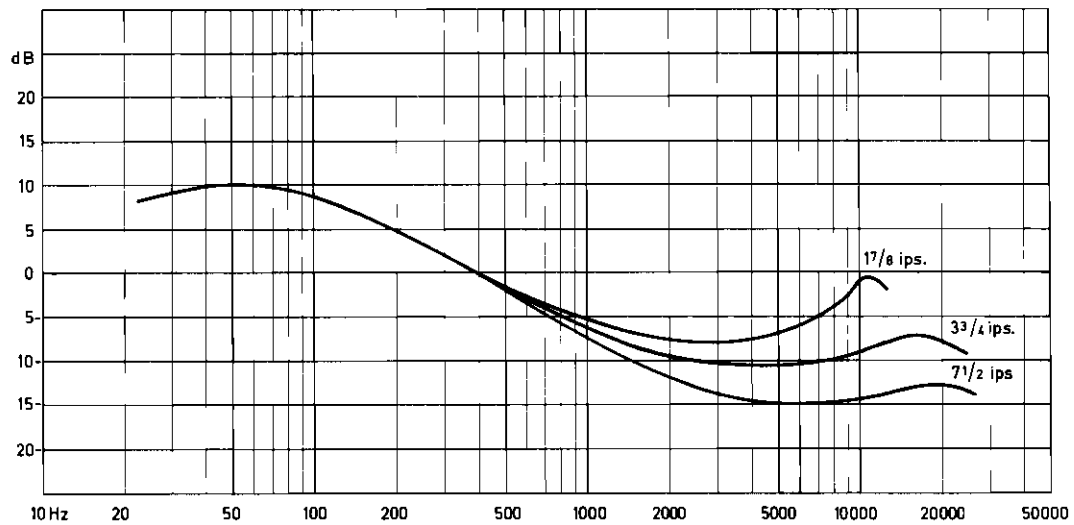


Fig. 4.8 Equalizing curves in playback mode

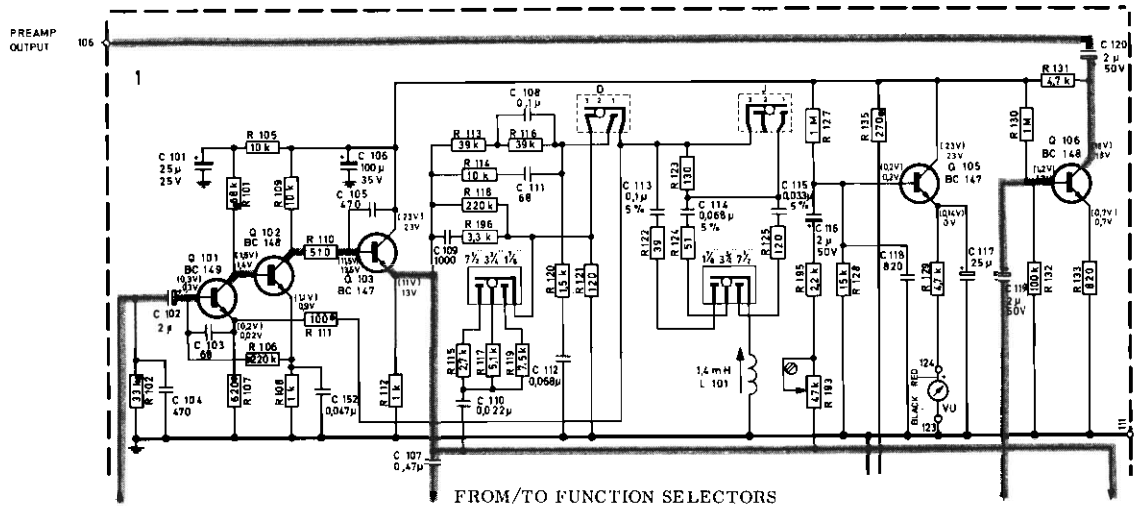


Fig. 4.9 Equalizing amplifier. Signal path in playback mode

4.4 LINE OUTPUT AMPLIFIER

Q106 with associated components comprise the line output amplifier which has a flat frequency response.

4.5 INDICATOR AMPLIFIER

Q105 with associated components comprise the indicator amplifier. The input signal is applied to the base of the transistor via the calibration potentiometer R193. The indicator is connected in the emitter circuit of the transistor which is biased so as to conduct during the positive half-cycles of the signal only. C117 will charge rapidly when the transistor is conducting. If the signal decreases, the transistor will go cut-off, and C117 will discharge through R129 and the meter at a relatively slow rate. C118 serves as decoupling for RF signals.

4.6 OUTPUT AMPLIFIER

Transistors Q301 through Q306 with associated components comprise the output amplifier. The quiescent current in the driver transistors and hence in the output transistors Q305 - Q306 , is adjusted with R313. The balance is adjusted with R303 which determines the operating point for Q302 and thus the relative magnitude of bias voltages for the driver transistors.

From serial no. 2 251 955 the emitter resistors have been increased from 0.47 ohm to 2.4 ohm to improve stability of quiescent current. To maintain sufficient output power, the emitter resistors are shunted by diodes IN 4002, or similar type.

The frequency response is flat when the tone controls are in centre position. The signal path through the output amplifier is shown in fig. 4.10 in heavy shaded lines.

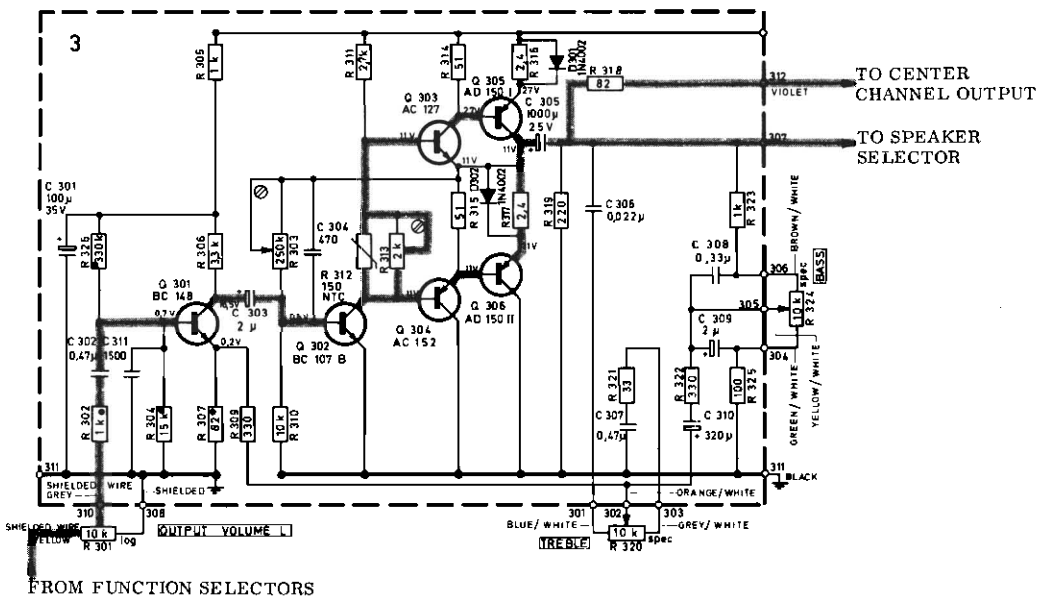


Fig. 4.10 Output amplifier. Signal path

4.7 OSCILLATOR AND AMPLIFIER

Erase- and bias voltage is generated in the push-pull oscillator consisting of transistors Q107 and Q108. The oscillator frequency 85.5 kHz is determined by transformer T101 and capacitors C125 and C126. Operating voltage for the oscillator is supplied via the function selector when in REC position. When only one channel is set for recording, the diode D101 (or D102) prevents the second indicator from being illuminated.

The oscillator voltage is fed via transformer T101 to push-pull amplifier Q109, Q110, Q111. In units below serial no. 2 247 000 the quiescent current in Q110 and Q111 is adjusted with R149. Above the same serial no. R149 is replaced by a diode D103 (IN 4148 or similar silicon diode), which eliminates the need for adjustment.

From the amplifier, the voltage is fed via C129 and function selector sections M and N to erase- and bias-heads. Fig. 4.8 shows the circuit configuration for left channel. Function selector (sections M, N, K) is shown in position 1 (Recording).

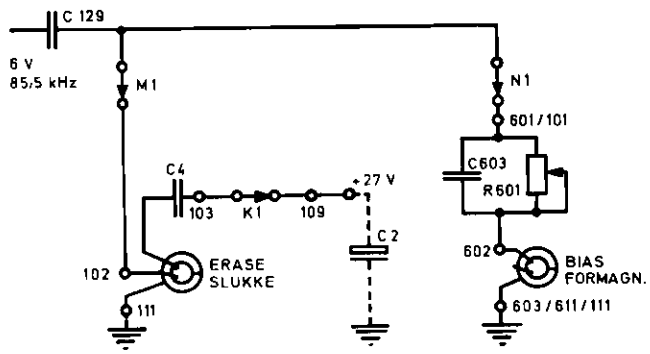


Fig. 4.18 Wiring of erase- and bias heads

The 6V supply voltage for the erase head is supplied via a tap and the voltage across the head is 80 - 120V. The erase head and C4 constitute a parallel resonance circuit tuned to 85.5 kHz (oscillator frequency). The erase head is tuned to serial resonance at 85.5 kHz by means of C603. The circuit is damped by R601 to obtain correct voltage across the head (approx. 25V). The wiring terminals indicated on the figure have the same numbers as on the main circuit diagram.

4.8 POWER SUPPLY

The voltage from the secondary of the mains transformer is full-wave rectified and applied to the voltage regulator, comprising transistors Q501 through Q505, with the zener diode D501 as voltage reference. The motor is via a microswitch connected to a separate winding on the transformer. This switch is closed when tape is properly inserted in the tape path, and the operating lever is in one of the following positions:

* Normal forward drive
* Fast forward
* Fast rewind.

NOTE: From serial no. 2 251 955 the power supply was redesigned. The new power supply is not short-circuit proof.

4.9 MUTING SWITCH

The purpose of the muting switch is to short-circuit the record/playback head in all positions of the operating lever, except in normal forward drive. The switch is mechanically linked to the operating lever.

4.10 EXTERNAL FM-MPX FILTER

When recording stereo broadcast programmes, insufficient supression of the pilot tone can give annoying interference. A separate Tandberg FM-MPX filter should be used. Connect the DIN cable on the filter to the LINE socket on the tape recorder and the voltage plug to the + 26V input. Connect socket DIODE or TAPE on the receiver to the filter via a DIN cable. The filter is also furnished with phono sockets for inputs and outputs.

4.11 OPERATION ON EXTERNAL DC SOURCE

The tape recorder can be used in amplifier mode if an external DC source is connected between the + 26V output and chassis. Two 12V car batteries connected in series can be used. Lower voltage will result in reduced output power.

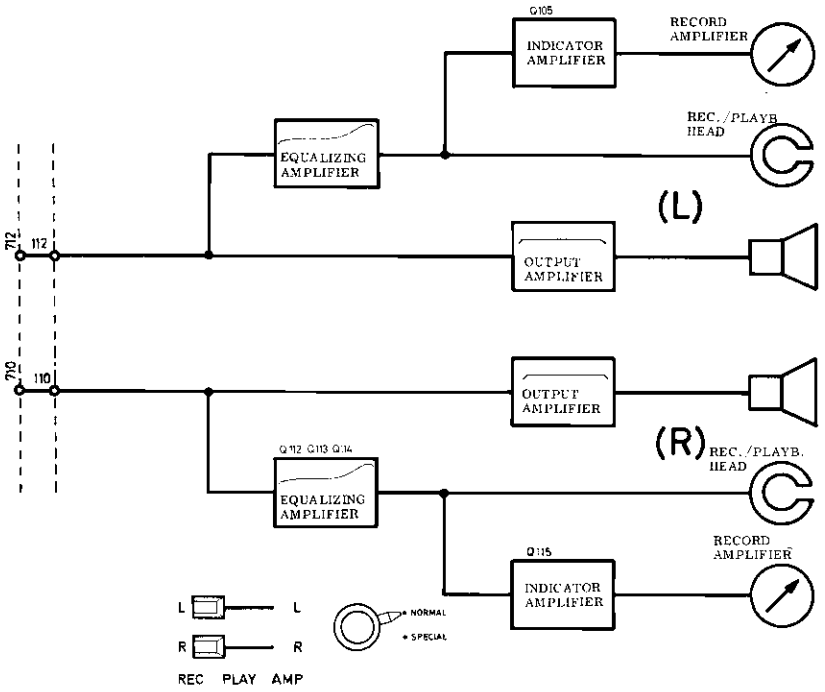
NOTE: The external supply must not have a voltage exceeding 26V. The ON/OFF switch has no effect when the tape recorder is powered via the +26V output.

4.12 FUNCTION SELECTORS AND NORMAL/SPECIAL SWITCH

Fig. 4.11 - 4.17 show block diagrams and signal paths from the output of the preamplifiers and through the various switches for some combinations of the function selector and the NORMAL /SPECIAL switch.

The switch functions are equivalent for the two channels. The combination L:AMP, R:PLAY, SPECIAL give the same result as the combination L:PLAY, R:AMP, SPECIAL, except that the channels are interchanged.

The switch sections in figures 4.11 through 4.17 are shown in position 2 (PLAY). On diagrams illustrating REC, or AMP, the signal path is drawn as if the switch sections were set to these positions.



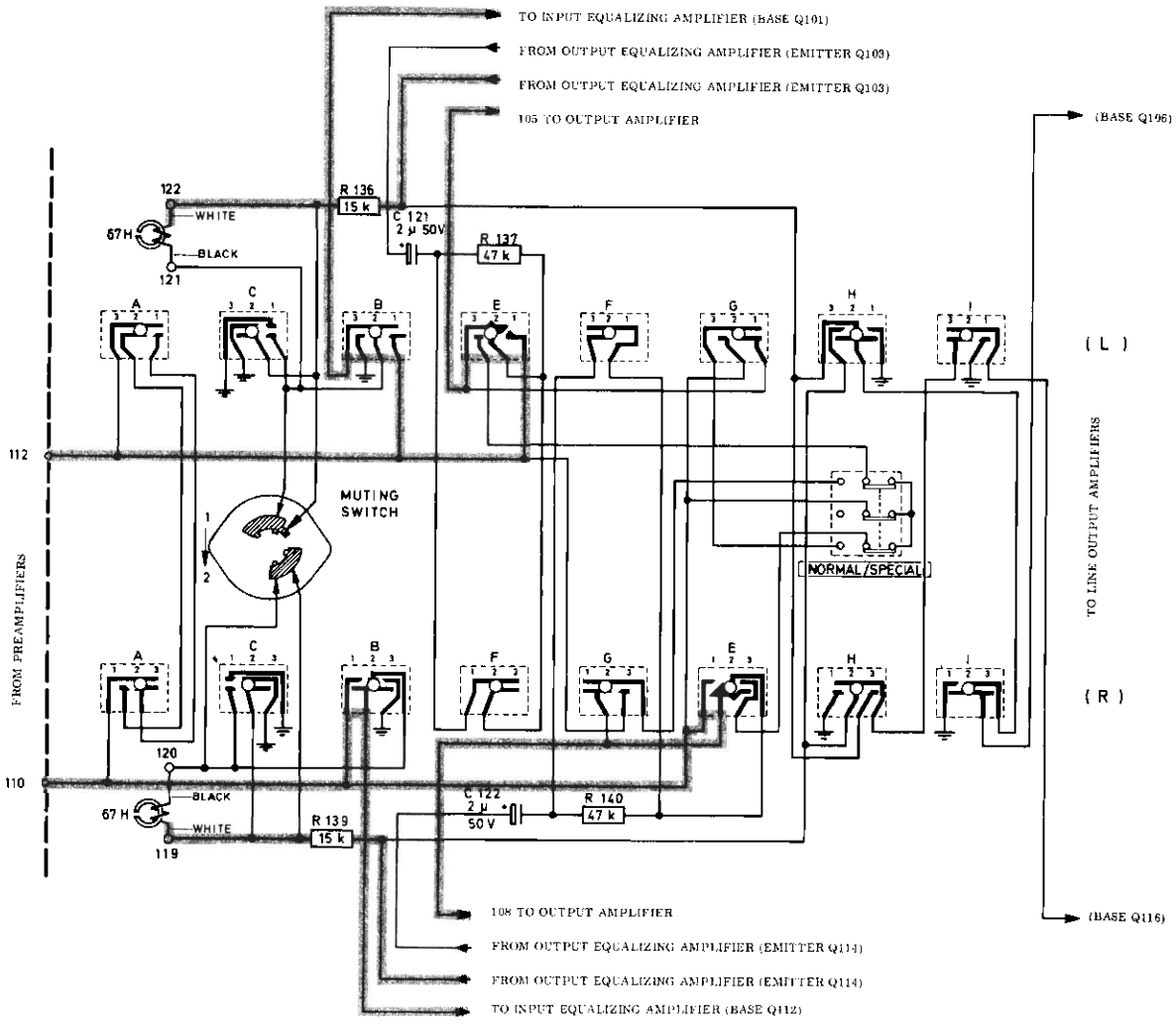
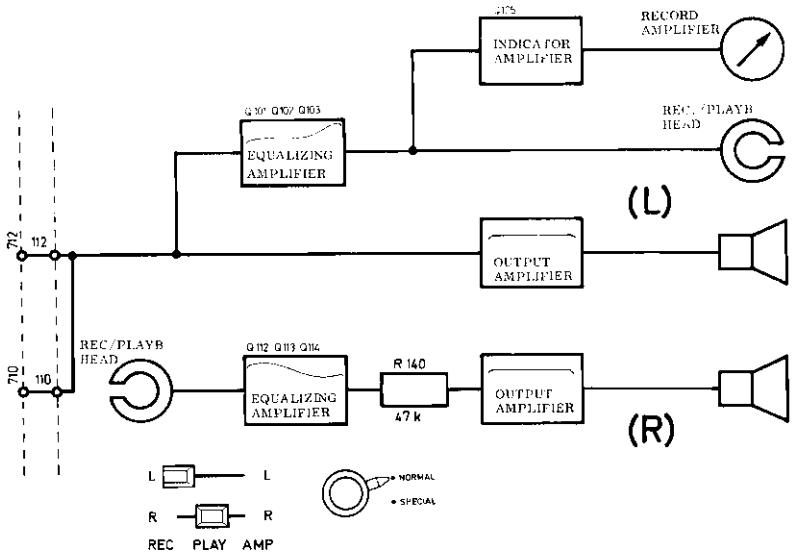


Fig. 4.11 Block diagrams and signal path through the switches, L:REC, R:REC, NORMAL



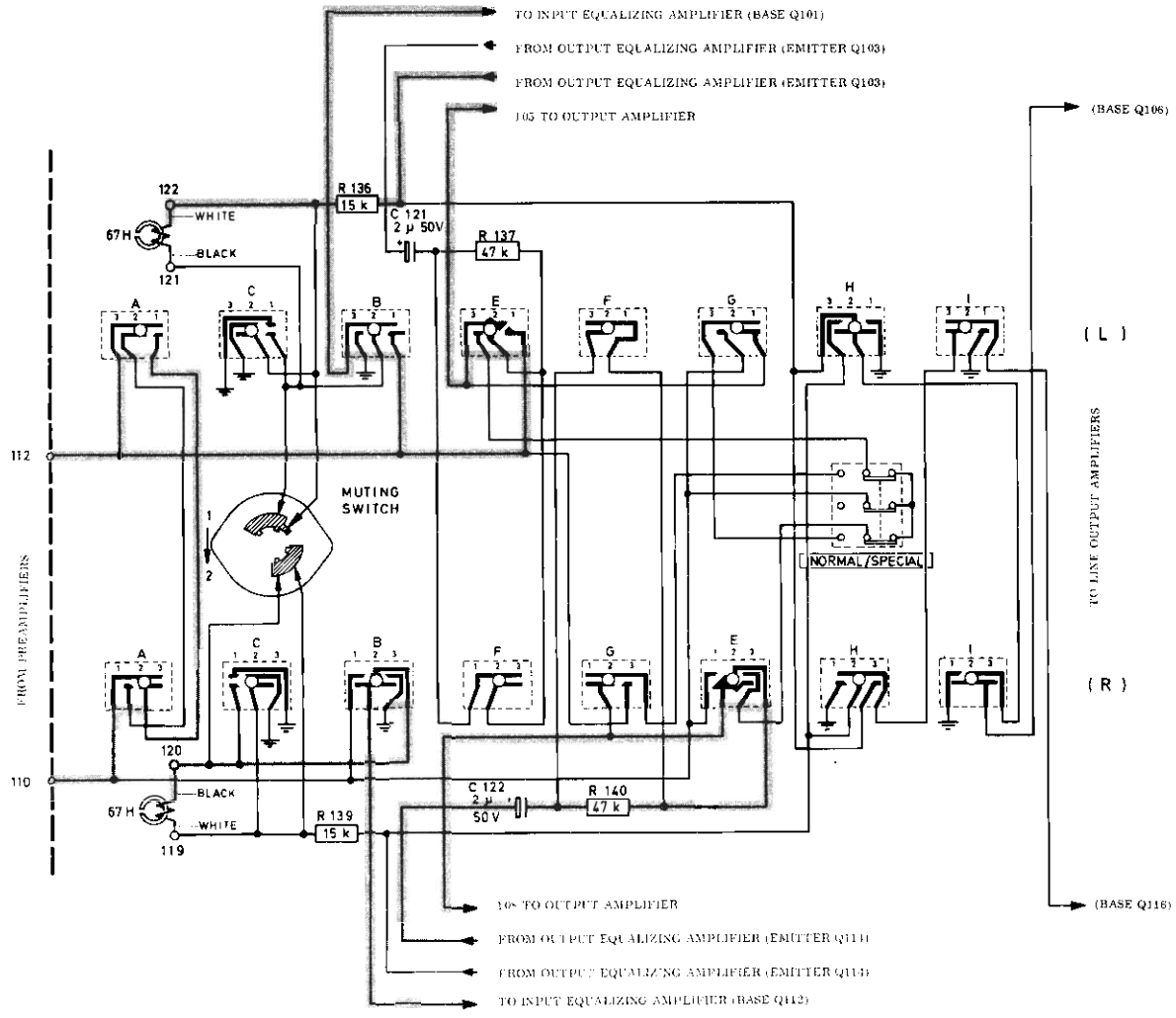
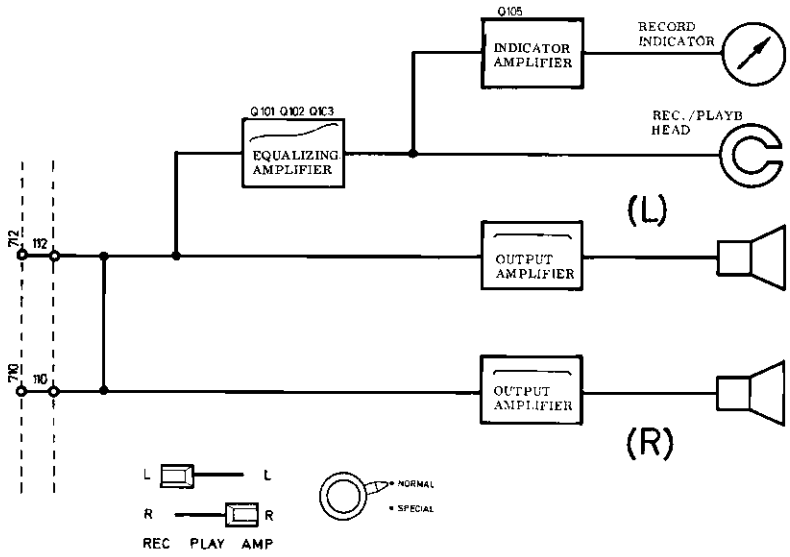


Fig. 4.12 Block diagram and signal path through the switches, L:REC, R:PLAY, NORMAL



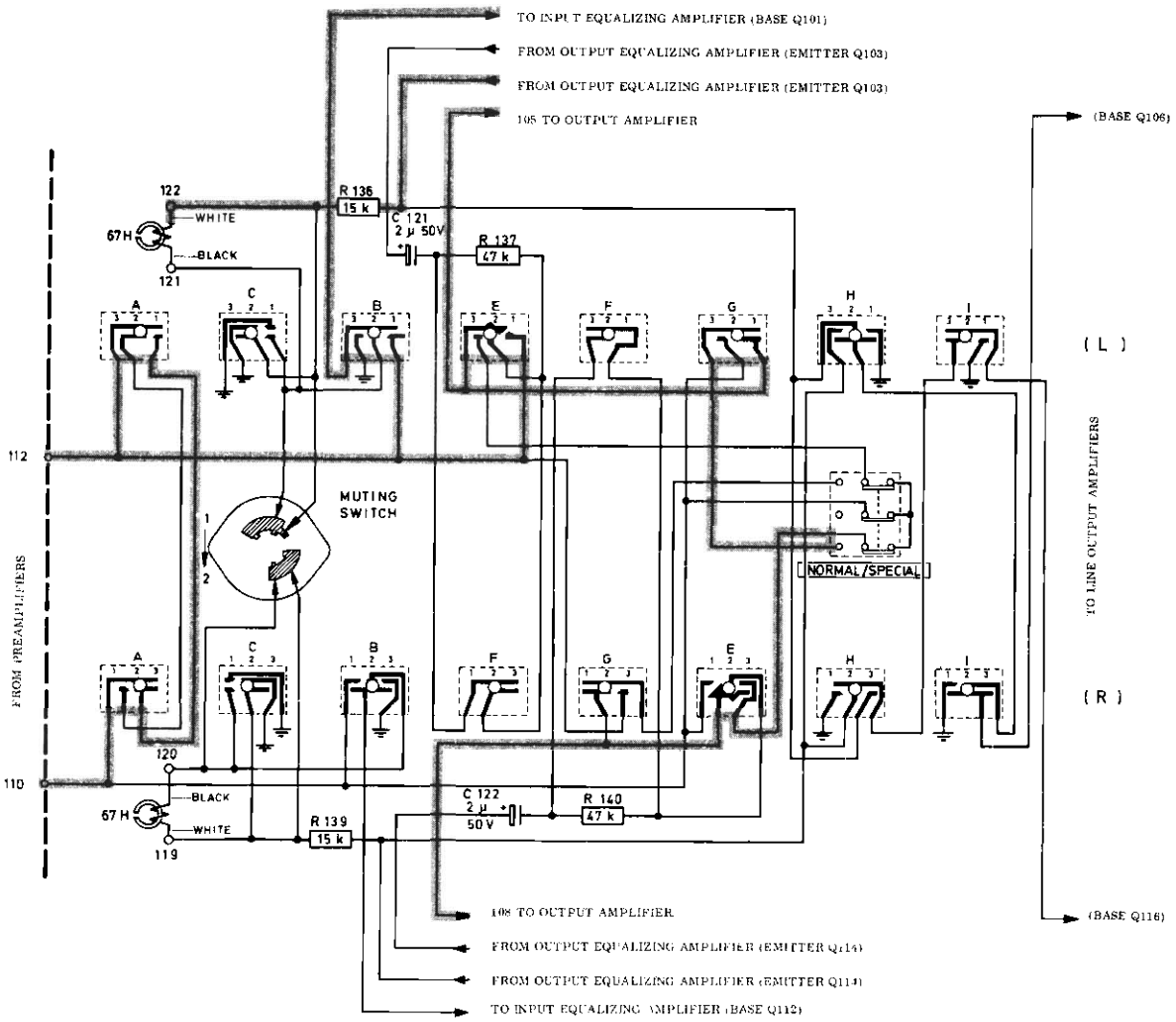
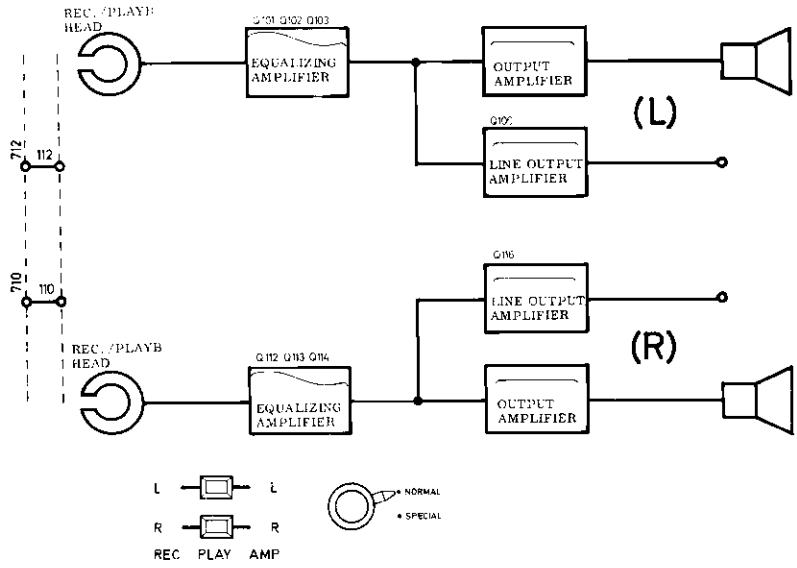


Fig. 4.13 Block diagram and signal path through the switches, L:REC, R:AMP, NORMAL



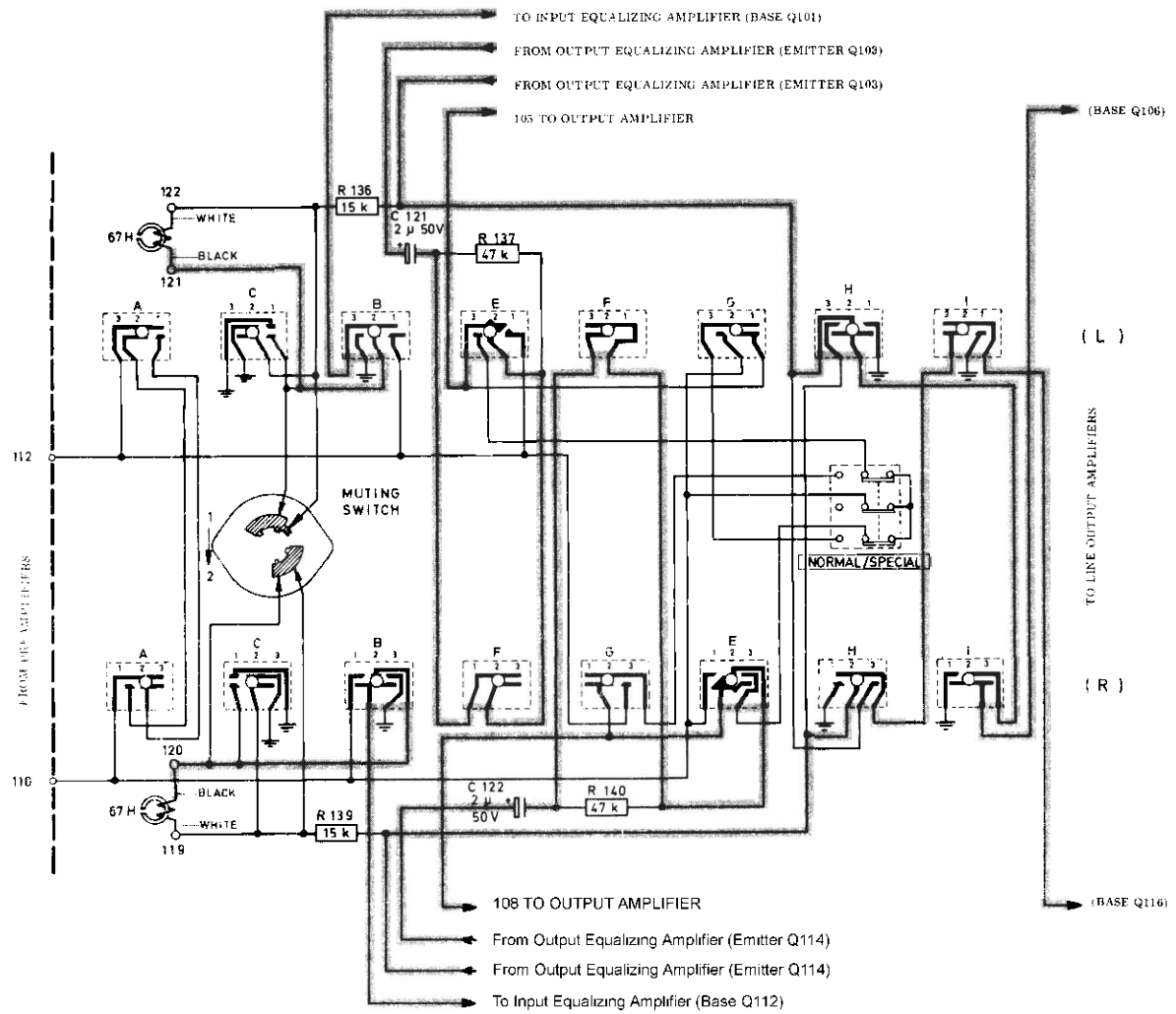
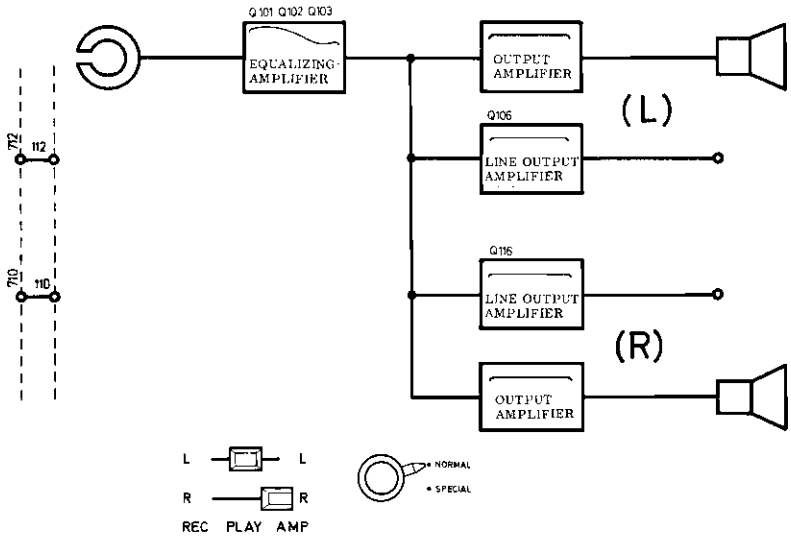


Fig. 4.14 Block diagram and signal path through the switches.
L:PLAY, R:PLAY, NORMAL



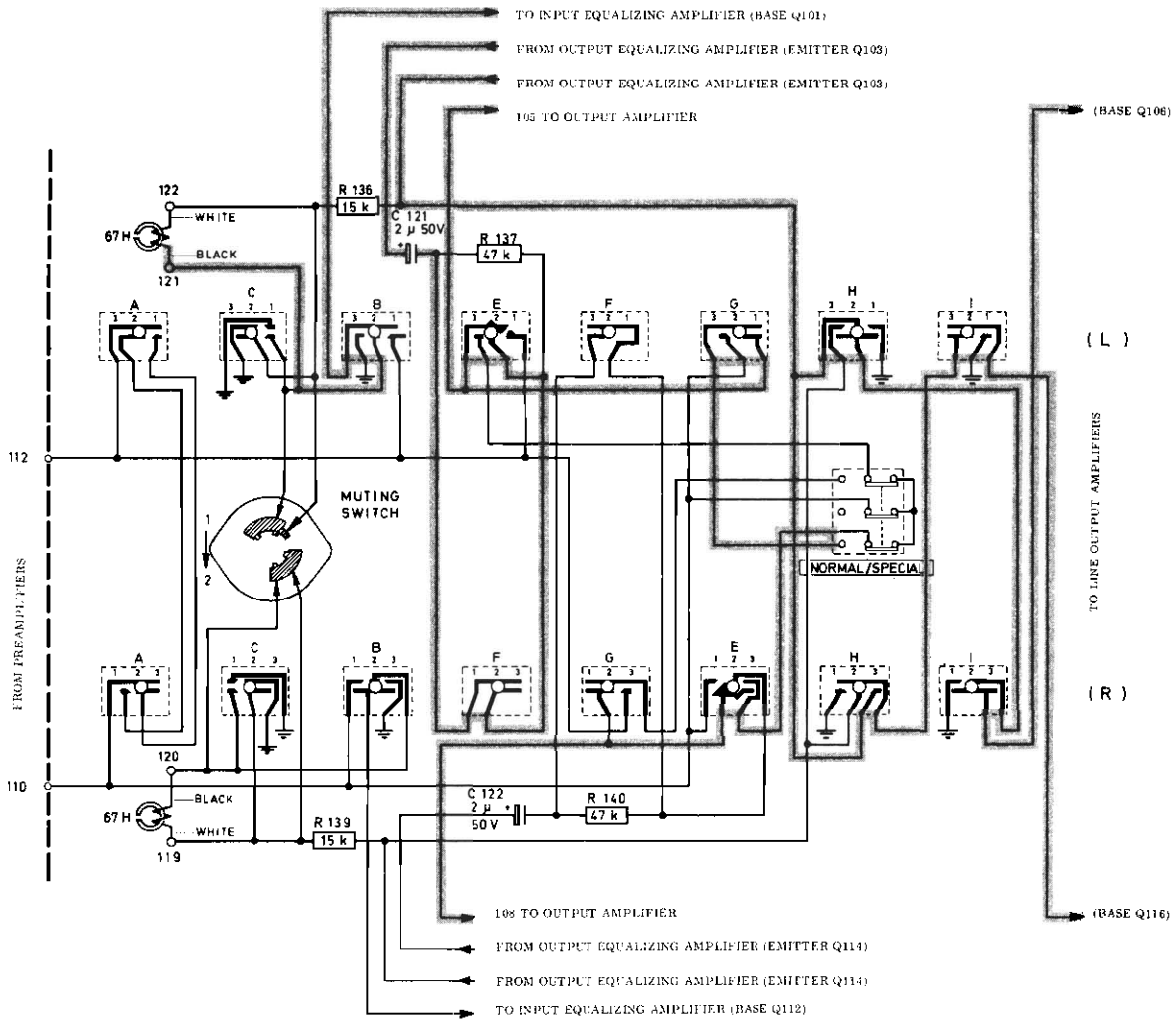
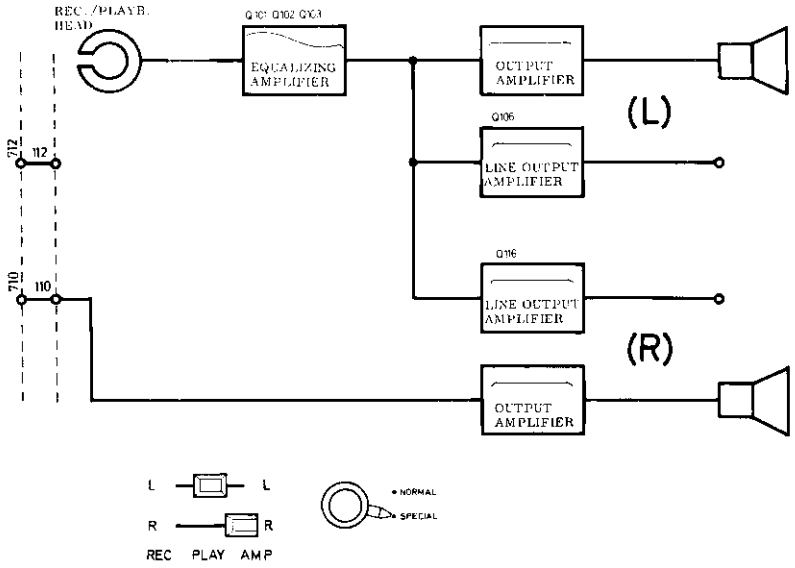


Fig. 4.15 Block diagram and signal path through the switches, L:PLAY, R:AMP, MORMAL



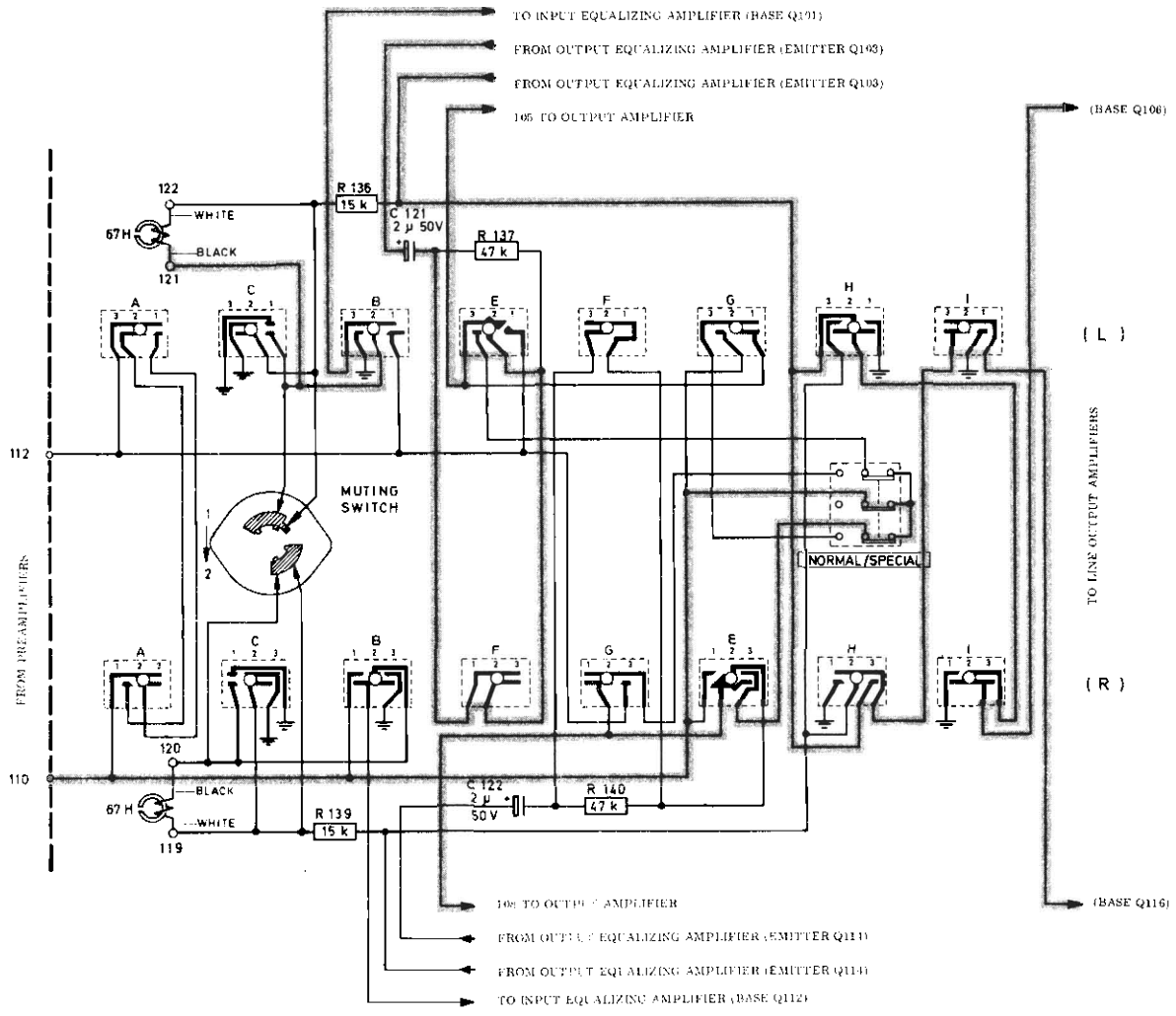
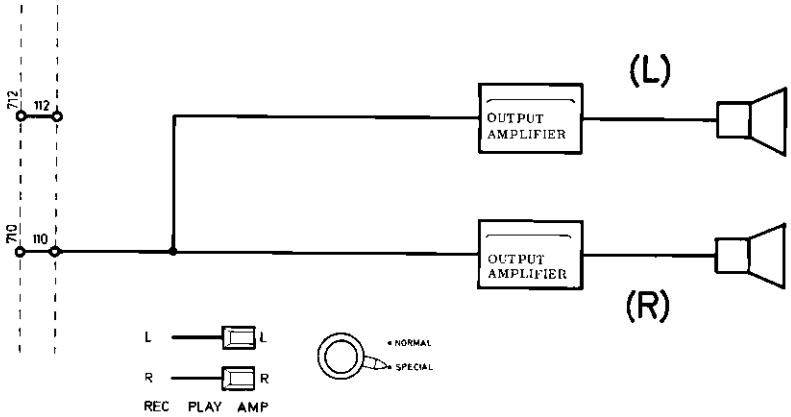


Fig. 4.16 Block diagram and signal path through the switches, L:PLAY, R:AMP, SPECIAL



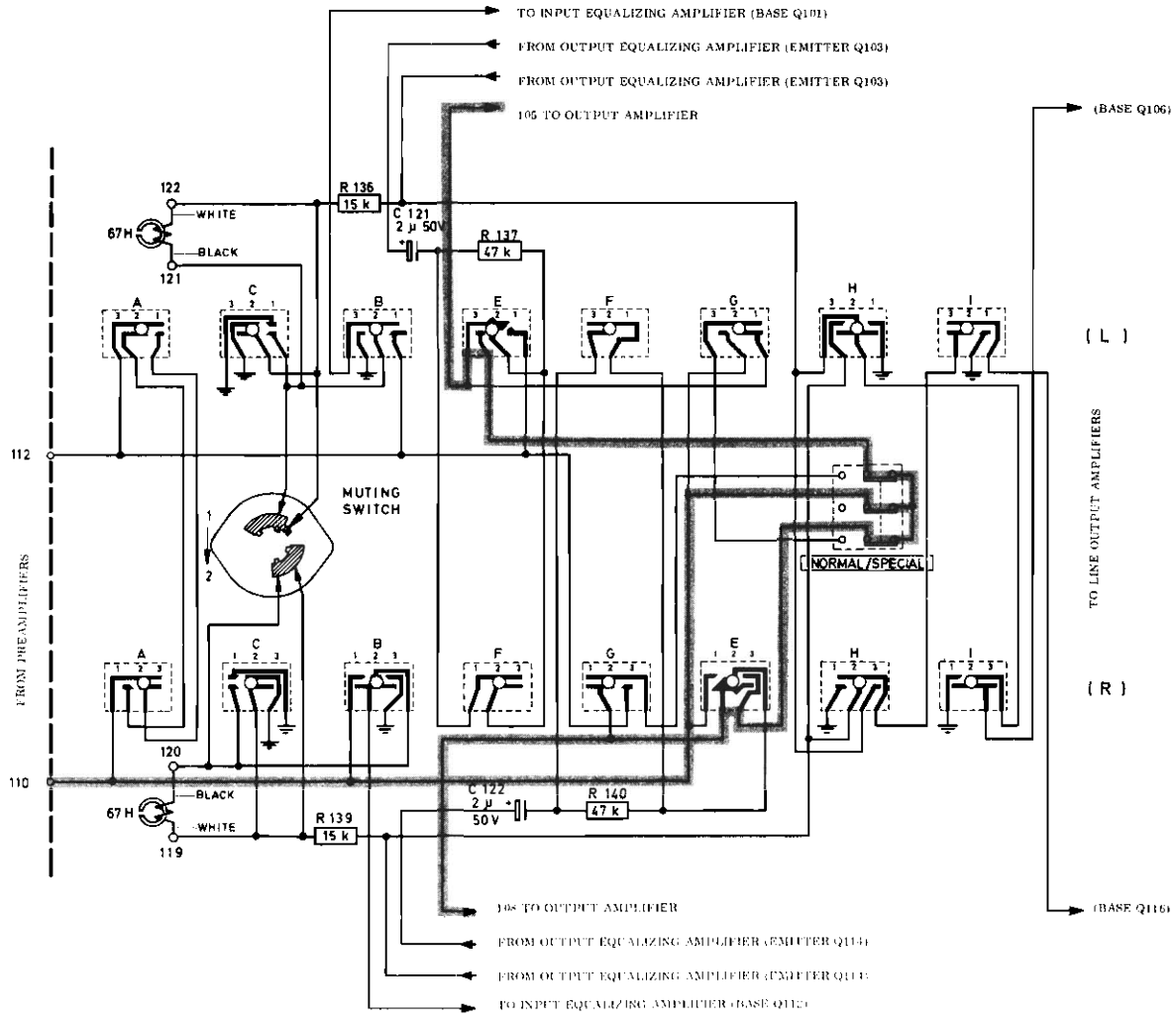


Fig. 4.17 Block diagram and signal path through the switches, L:AMP, R:AMP, SPECIAL

5.0 HEAD ALIGNMENT AND TRACK MEASUREMENT. ELECTRICAL CHECK AND ALIGNMENT

5.1 HEAD ALIGNMENT AND TRACK MEASUREMENT USING TANDBERG TEST TAPE

5.1.1 Four-Track Model

1. Demagnetize heads and adjacent parts before and after adjustment.
2. Insert tape in the tape path and set the operating lever to normal forward drive position. Adjust the height position of the tape guide posts (247653) and (212461A) until the tape passes freely between the flanges on the screws. See fig. 5.1.
3. Play back test tape no. 1. This is a full track tape with 1 000 Hz recorded at 7 1/2 ips. The recording level in the area corresponding to track 3 has been reduced by approx. 30 dB. Adjust the height of the combined record/playback head until minimum output is obtained from track 3.
4. Play back test tape no. 2. This is a full track tape recorded with 15 000 Hz at 7 1/2 ips. Adjust the azimuth position of the combined record/playback head until maximum voltage is obtained at both outputs. See paragraph 5.2.3.
5. Play back test tape no. 3. This is a full track tape where the frequencies 250 - 10 000 - 5 000 - 1 000 and 50 Hz have been recorded at 7 1/2 ips.
   Output level tolerances are as follows:
   At 10 000 Hz: 0 to + 4 dB, at 5 000 Hz: -1 to +3 dB, and at 1 000 Hz and lower frequencies: ± 2 dB. The difference between the output levels of the two channels, should be less than 4 dB.
6. Set the erase head preliminary to a position where approx. 0.25 mm (10 mil) of the ferrite core is visible above the upper edge of the tape. Insert test tape no. 9 and record a 1 000 Hz signal well above normal level on channel R (track 3). Cut off a piece of the tape and dip it in Magna See solution (a mixture of alcohol and iron oxyde powder). The recorded part of the track will then be visible in the middle of the erased track if the head is correctly adjusted. If necessary, adjust the height position of the erase head. Check that erasure of any of the adjacent tracks does not occur. See paragraph 5.2.4.
7. See paragraph 5.5.8 on alignment of bias head.
8. See paragraph 5.2.3 and 5.2.4 regarding lateral adjustment.

5.1.2 Two-Track Model

All alignments explained in 5.5.1 apply also for the two-track model except items 3 and 6. Item 3 should be replaced by paragraph 5.4.2 and item 6 by paragraph 5.4.1.

NOTE: The final adjustment of erase head and record/playback head should be an azimuth adjustment. Any adjustment of the record/playback head should be succeeded by adjustment of the bias head, paragraph 5.5.8.

5.2 HEAD ALIGNMENT AND TRACK MEASUREMENT NOT USING TANDBERG TEST TAPE

5.2.1 Demagnetizing

Always demagnetize heads and adjacent parts before and after alignments.

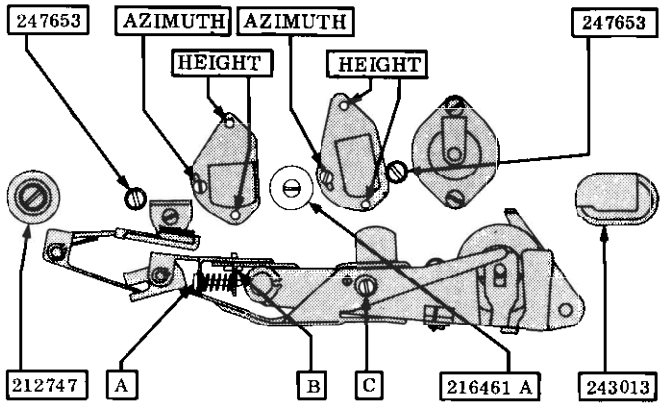


Fig. 5.1 Heads and tapa path, adjustment screws

5.2.2 Tape Guide Posts

See fig. 5.1.1, screws 247653 and 216461A.
Insert a tape in the tape path and set the operating lever to normal forward drive. Adjust the height position of the tape guide posts until the tape runs freely between the flanges of the screws.

5.2.3 Record/Playback Head Height Adjustment

Adjust the height of the record/playback head with the height adjustment screws. See fig. 5.1. The tape should run flush with the upper edge of the upper head-half. See chapters 5.3.1 and 5.4.2 regarding track measurement of record/playback head.

Azimuth Adjustment

Set the speaker selector in position EXT. Play back a standard azimuth test tape and connect a VTVM to each one of the external speaker outputs. Adjust the position of the record/playback head with the azimuth adjustment screw (see fig. 5.1) until maximum indication on the voltmeters is obtained.

Lateral Adjustment

Pull the plush pad away from the tape rest while the azimuth test tape is played back. The output level should not decrease more than 3 dB. If necessary, adjust the lateral position of the record/playback head by turning the baseplate of the head.

5.2.4 Erase Head Height Adjustment

With the height adjustment screws shown in fig. 5.1, adjust the height of the head until approx. 0.25 mm (10 mil) of the ferrite core for the upper track of the erase head is visible above the edge of the tape. See paragraphs 5.3.2 and 5.4.1 regarding track measurement of the erase head.

Lateral Adjustment

Adjust the head laterally by turning the head base plate until the head front is parallel with the tape.

Azimuth Adjustment

Adjust the azimuth position by means of the azimuth screws as shown in fig. 5.1. The head base plate and upper mounting plate should be parallel. The azimuth position of the erase head is not critical.

NOTE: 1. The final adjustment of the erase head or the record/playback head should always be an azimuth adjustment.

2. Readjustment of the bias head (paragraph 5.5.8) should always succeed any adjustment of the record/playback head.

5.3 TRACK MEASUREMENT ON 4-TRACK MODEL NOT USING TANDBERG TEST TAPE

5.3.1 Record/Playback Head

Record a 1 000 Hz signal in stereo at a level well above normal (maximum indication on the record level meters) on tracks 1 and 3. Record for approx. 5 sec. Turn the tape around and make a similar recording on tracks 2 and 4. Cut off a piece of the tape and dip it in Magna See Solution (alcohol and iron oxyde powder). The tracks which then become visible should be evenly distributed across the width of the tape, and the spacing between the tracks should be equal. If necessary, readjust the height position and check the azimuth position.

5.3.2 Erase Head

On a tape with a full track recording of a continuous signal at normal level, record a 1 000 Hz signal well above normal level on track 3 (right channel). Cut off a piece of the tape and dip it in Magna See Solution. Check that the recorded track is centered in the erased track. If necessary, adjust the height position of the erase head.

5.4 TRACK MEASUREMENT ON 2-TRACK MODEL NOT USING TANDBERG TEST TAPE

5.4.1 Erase Head

Adjust the height position of the erase head with the adjustment screws (fig. 5.1). The upper edge of the tape should run flush with the upper edge of the active area of the erase head.

See paragraph 5.4.2 regarding azimuth and lateral alignments.

5.4.2 Record/Playback Head

Adjust the height position of the record/playback head with the adjustment screws (fig. 5.1). Record a 1000 Hz signal in stereo well above normal level on a tape which has a full track recording of a continuous signal. Dip the tape in Magna See Solution and check that the tracks are symmetrically distributed across the width of the tape. Check that the recorded area lies within the erased track. Adjust the erase- and record/playback heads if necessary. See paragraph 5.2.3 regarding azimuth and lateral adjustments.

5.5 ELECTRICAL CHECKS AND ADJUSTMENTS

5.5.1 Adjustment of Output Amplifier

Connect an audio generator to the input terminal LINE L (R) and adjust the frequency to 1 000 Hz. Set the input selector to LINE OR MIC and connect a 4 ohm resistor (15W), an oscilloscope and a VTVM in parallel to the output terminal 4 OHMS SEPAKER L (R). Set both function selectors to AMP, the speaker selector to EXT, bass and treble controls to centre position and both volume controls (INPUT LEVEL and OUTPUT VOLUME) to maximum.

Symmetrical Clipping

Increase the audio generator signal until clipping of the waveform can be observed on the oscilloscope. Adjust R303 (R403 - right channel) until the clipping is equal for positive and negative half-cycles.

Reduce the input signal below the clipping level. The VTVM should then indicate 6.3V for both channels, corresponding to 10W in 4 ohm.

The difference between the output levels in the two channels should not exceed 4 dB.

Quiescent Current

Set OUTPUT VOLUME to minimum. Adjust the quiescent current with R313 (R413 - right channel) until the DC voltage measured across the emitter resistor R317 (R417 - right channel) is approx. 83 mV. In output amplifiers where the emitter resistor is 0.47 ohm, the voltage should be 16 mV. This voltage corresponds to approx. 35 mA for the total quiescent current in the output amplifier board.

5.5.2 Bass Control

Connect test equipment as in paragraph 5.5.1. Set the signal generator to 1 000 Hz and adjust the output until the VTVM indicates 0.5V. Then alter the frequency to 80 Hz. Turn the bass control fully clockwise (counterclockwise) and check that the output increases (decreases) by approx. 12 dB.

5.5.3 Treble Control

Connect test equipment as in paragraph 5.5.1. Adjust the generator frequency to 1000 Hz and set the output level for 0.5V indication on the VTVM. Then alter the frequency to 10 000 Hz. Turn the treble control fully clockwise (counterclockwise). Check that the output level increases (decreases) by approx. 12 dB.

5.5.4 Adjustment of Quiescent Current in Oscillator Amplifier (before serial no. 2 242 000)

Short-circuit the secondary of the oscillator transformer T101. Adjust R149 to obtain 19 mV DC between emitters of Q110 and Q111.

If R149 is replaced by a silicon diode BA 130 or similar type, adjustment will not be necessary.

5.5.5 Adjustment of Oscillator Frequency, Bias Current and Erase Voltage

Using Frequency Meter (Counter)

Connect the frequency meter directly or inductively to the erase head, (degree of coupling depends on the meter, voltage approx. 80 - 120V). Start the tape recorder in playback and adjust C126 for an oscillator frequency of 85.5 kHz.

Using Signal Generator and Receiver

Tune the receiver to 256.5 kHz (third harmonic of 85.5 kHz). Wind the antenna wire for the receiver into a coil with 10 turns and approx. 2" diameter, and place the coil in the vicinity of or around the erase head. Connect the signal generator tuned to 256.5 kHz via a similar coil. Start the tape recorder in record and adjust C126 for zero beat in the receiver speaker or headphones.

Bias Current

Set the tape recorder for recording. Connect a VTVM to wiring terminal 602 (605 - right channel). Adjust R601 (R602) for an indication of approx. 25V on the VTVM.

Erase Voltage

Set the tape recorder for recording. Connect a VTVM to the yellow lead from the erase head. Use low capacitance probe or unshielded test cable. Check that the voltage is approx. 80 - 120V. The difference in voltage between mono and stereo recording should not exceed 10V.

5.5.6 Initial Adjustment of Record Current and Indicator

Set the function selectors in REC position. Connect a signal generator to the LINE input and set the frequency at 400 Hz. Set the input selector to LINE OR MIC. Connect a VTVM to wiring terminal 112 (110) and adjust INPUT LEVEL for a voltmeter reading of 40 mV. Adjust R193 (R192) for 0 dB indication on the record level meter. See also paragraph 5.5.10, adjustment using test tape.

5.5.7 Adjustment of Equalizing Coils L1 and L2

Set the function selectors in REC and the tape speed selector in 3 3/4 ips. Connect a signal generator tuned to 18 000 Hz to the LINE input and set the input selectors to MIC OR LINE. Short-circuit C150 and connect a VTVM to emitter of Q103 (Q114) wiring terminal 13. Adjust INPUT LEVEL for a voltmeter reading of approx. 0.5V. Adjust L101 (L102) for maximum reading on the VTVM.

5.5.8 Adjustment of Bias Head

This adjustment will normally only be required when other adjustments have been made, or after replacement of one or more heads. Adjustments of oscillator frequency and bias current must first be performed (see paragraph 5.5.5). Set the function selectors in position REC. Connect the VTVM to wiring terminal 122 (record/playback head), range 10V or 3V. Loosen screw B approx. one half turn (fig. 5.1). Turn the adjustment screw A for maximum indication on the VTVM. Then adjust the height adjustment screw C also for max. reading. Turn the adjustment screw A to move the bias head in the opposite direction of the tape motion until the VTVM indication has decreased 5-20%. Tighten screw B. Finally demagnetize heads and tape path.

5.5.9 Verification of Overall Frequency Curves

Connect the audio generator tuned to 400 Hz to the line inputs. Set the input selectors to position LINE OR MIC, and insert a tape of good quality in the tape path. Set the function selectors to position REC (stereo recording). Adjust INPUT LEVEL for 0 dB indication on the record level meter. Then reduce the output from the generator by 30 dB. Record signals at frequencies in the range 40 - 18 000 Hz at 7 1/2 ips. Rewind the tape and play back with a VTVM connected to each one of the PREAMP outputs. The difference between the output levels of the two channels should not at any frequency exceed 4 dB. If a departure from specified response at high frequencies is observed, increase or decrease the bias by means of R601 (channelL or R602 (channel R). Check the response at all three tape speeds.

NOTE: If the bias is altered, check distortion according to paragraph 5.5.11.

5.5.10 Adjustment of Record Current and Indicator using Test Tape

Play back 400 Hz from test tape no. 4 in 7 1/2 ips, while measuring the voltage at both preamp outputs. Then record on a new tape 400 Hz at an amplitude giving at least 2 dB higher output than the test tape (at least 1.5 dB if Low Noise Tape is used).

It may be necessary to repeatedly alternate between recording and playback to obtain the desired result. Adjust R193 (R192 - right channel) for 0 dB indication, when recording at the level required to give the required output level in playback.

Check the distortion according to paragraph 5.5.11.

5.5.11 Distortion

Record a 400 Hz signal on both channels, stereo recording, with INPUT LEVEL set for 0 dB indication on the record level meters. Rewind the tape and play back in stereo while measuring the distortion. If the distortion exceeds 5%, readjust record current, paragraph 5.5.10.

5.5.12 Speed Check

Using a Known Length of Tape

Load the tape recorder with a tape that has been cut to 450" (1144 cm), and run the tape through with the operating lever in normal forward drive position. The correct times taken for the tape to pass the record/playback head are the following:

7 1/2 ips: 1 minute
3 3/4 ips: 2 minutes
1 7/8 ips: 4 minutes.

Speed tolerance: $\pm$ 1.5% for all tape speeds.

Using VTVM

Connect a transformer with the primary to the mains, and the secondary (0.5 - 6.3V) in series with a VTVM to EXT SPKR output L or R as shown in fig. 5.2. Play

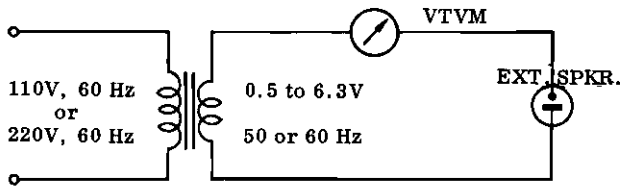


Fig. 5.2 Set-up for tape speed check using VTVM voltmeter.

Tandberg test tape 10a (50 Hz), or test tape no. 19a (60 Hz) in 7 1/2 ips. Adjust OUTPUT VOLUME to give an output voltage of the same magnitude as the voltage across the secondary of the transformer. Departure from correct tape speed will give a beat signal across the VTVM, causing a pendling of the VTVM needle. Clock the time for 10 complete excursions of the meter needle. Read the speed deviation in % corresponding to this particular time from the nomogram in fig. 5.3.

Determine wether the speed is too high or too low by braking the supply turntable lightly. If the beat frequency increases, the tape speed is too low.

Test tape no 10 contains 50 Hz recorded in a) 7 1/2 ips, and b) 3 3/4 ips. Test tape no. 19 contains 60 Hz recorded in a) 7 1/2 ips and b) 3 3/4 ips.

For verification of the tape speed 3 3/4 ips, use test tape no. 10b (19b). The procedure is otherwise as outlined above. Tape speed tolerance: $\pm$ 1.5%.

Using Frequency Meter (Counter)

Connect a frequency meter (counter) to output terminal and play back Tandberg Test Tape no. 11, containing a 1 000 Hz signal at tape speed 7 1/2 ips. The frequency meter (counter) indicates directly the speed deviation in ‰ . Tape speed tolerance: $\pm$ 1.5%.

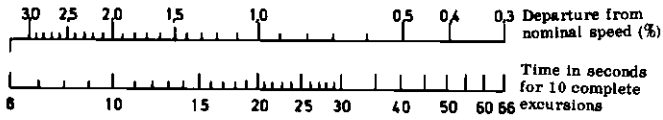


Fig. 5.3 Nomogram for tape speed check using VTVM

5.5.13 Verification of Playback Equalizing Curves

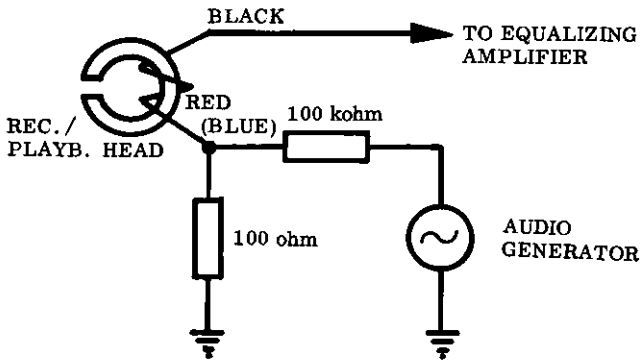


Fig. 5.4 Set-up for verification of playback curves

Connect a 100 ohm resistor in series with upper and lower record/playback heads to ground. (Red and blue wires). Connect the audio generator in series with a 100 kohm resistor to the junction between the 100 ohm resistor and head. See fig. 5.4. Connect a VTVM and the oscilloscope to the output socket PREAMP L (R). Set function selectors in position PLAY. (Stereo playback).

Use the level at 400 Hz as reference, and check the frequency curves for all three tape speeds. See fig. 4.8.

NOTE: Avoid clipping of the output waveform. The tolerance should be within $\pm$ 2 dB of the reference level at all frequencies.

5.5.14 Verification of Frequency Curves for Recording

Connect the audio generator to the input socket LINE L and R. Set the input selector to LINE OR MIC. Connect a VTVM across the 100 ohm resistor connected in series with each record/playback head (L and R) to ground (black lead). Short-circuit C150 (secondary winding of oscillator transformer T1). Set function selectors in position REC (stereo recording). Set the frequency of the audio generator to 400 Hz and adjust the output level to give a recording level 30 dB below normal. Check the frequency curve according to fig. 4.5. The departure from the level at the reference frequency should be within $\pm$ 2.5 dB at all frequencies. The difference between the output levels of the two channels should be within 4 dB for all frequencies. Check the frequency curves for all three tape speeds.

5.5.15 Verification of the Equalizing Curve for Magnetic Pick-Up

Connect the audio generator to the input socket PICK UP L (R). Set the input selectors to PICK UP and the pick-up selector to MAGN. Connect a VTVM and oscilloscope to wiring terminal 112 (110 - right channel). Adjust the output of the audio generator and INPUT LEVEL of the tape recorder to give 20 dB below clipping level at 1 000 Hz. Check the frequency curve according to fig. 4.1.

When the pick-up selector is in position CER, the input circuit together with the impedance of the pick-up itself give a flat response. When the frequency curve is checked in this position with a low impedance audio generator, a departure from the reference level of approx. + 4 dB at 100 Hz and approx. - 5 dB at 9 000 Hz will occur.

6.0 ELECTRICAL CHANGES AND SPECIAL VERSIONS

6.1 ELECTRICAL CHANGES INTRODUCED IN PRODUCTION

The greater part of the changes listed below should be performed groupwise as indicated by brackets and group numbers in table on the next two pages.

Group	Modification	From serial no. approx.
1.	Quiescent current in oscillator amplifier.	2 242 000
2.	Voltage regulator. Improved regulation, but not short-circuit proof.	2 251 955
3.	Output amplifier. Reduced loss at high output power. Changes in group 2 must preceed group 3.	2 251 955
4.	Output amplifier. Alternative NTC resistor.	
5.	Speakers. Increased impedance and power output. Series resistor deleted.	2 251 955
6.	Bias. Series resistor for current measurement removed.	2 252 600
7.	Bias at 1 7/8 ips.	2 252 600
8.	Voltage regulator. Reference voltage	2 252 600
9.	Equalization amplifier. Bass compensation	2 252 600
10.	Oscillator.	2 252 600
11.	Line output amplifier. Increased amplification.	2 256 000
12.	Bias.	2 256 000
13.	Oscillator amplifier. Alternative transistor types.	
14.	Click-filter (PMR).	

Group	Ref. no.	Original part	New part
1	R149	300 ohm, adjustment potm.	
	D103		1N 4148 (BA 130)
2	Rectifier board	11202 - 6	11417
	Q501	TI 3030	
	Q502	U 2848	
	Q503	U 2848	
	D501	ZF 27	
	R502	820 ohm, 2W, 10%	
	R503	3.9 kohm, 1W, 10%	
	R504	0.5 Mohm, 1/2W, 10%	
	R505	150 ohm, Philips, NTC	
	R506	1 kohm, 1/2W, 10%	
	R507	5.1 kohm, 1/2W, 10%	
	R508	510 ohm, 1/2W, 10%	
	C503	0.1 µF, 250V, 20%, Polyester	
	C505	0.1 µF, 250V, 20%, Polyester	
	C506	0.01 µF, 250V, 20%, Met. paper	
	C507	0.68 µF, 100V, 20%, Polyester	
	Q901		2N 5034
	Q902		BC 140 (U2848)
	Q903		BC 147A (BC 107)
	D901		ZF 27
	R901		3.3 kohm, 1/3W, 10%
	R902		100 ohm, 1/3W, 10%
	R903		1 kohm, 1/3W, 10%
	C903		0.1 µF, 200V, 10%, Met.paper
	C904		100 µF, 40V, electrolytic
	C905		0.1 µF, 200V, 10%, met. paper
	C906		1 000 pF, 500V, 20/50%, ceramic
	C907		0.68 µF, 100V, 10%, polyester
3	R316	0.47 ohm, 3W, wirewound	2.4 ohm, 1W, wirewound
	R317	0.47 ohm, 3W, wirewound	2.4 ohm, 1W, wirewound
	R416	0.47 ohm, 3W, wirewound	2.4 ohm, 1W, wirewound
	R417	0.47 ohm, 3W, wirewound	2.4 ohm, 1W, wirewound
	D301		1N 4002 (MR 2065)
	D302		1N 4002 (MR 2065)
	D401		1N 4002 (MR 2065)
	D402		1N 4002 (MR 2065)
4	R312	150 ohm, Philips, NTC	150 ohm, Siemens, NTC k24
	R412	150 ohm, Philips, NTC	150 ohm, Siemens, NTC, k24
	R311	3.9 kohm, 1/3W, 10%	2.7 kohm, 1/3W, 10%
	R411	3.9 kohm, 1/3W, 10%	2.7 kohm, 1/3W, 10%
5		Speakers HT 111, 3 ohm	Speakers HT 123, 8 ohm
	R6	3.9 ohm, 5W, wirewound	
	R7	3.9 ohm, 5W, wirewound	
6	R603	10 ohm, 1/3W, 10%	Shorting strap
	R604	10 ohm, 1/3W, 10%	Shorting strap
7	R153	51 ohm, 1/2W, 10%	Shorting strap
	R154	51 ohm, 1/3W, 10%	Shorting strap
8	R508	510 ohm, 1/3W, 10%	270 ohm, 1/2W, 10%
9	C136	0.47 µF, 100V, electrolytic	2.2 µF, 100V, electrolytic
	C107	0.47 µF, 100V, electrolytic	2.2 µF, 100V, electrolytic
	R116	39 kohm, 1/3W, 5%	68 kohm, 1/3W, 5%
	R167	39 kohm, 1/3W, 5%	68 kohm, 1/3W, 5%
	R118	220 kohm, 1/3W, 10%	82 kohm, 1/2W, 5%
	R172	220 kohm, 1/3W, 10%	82 kohm, 1/3W, 5%

Group	Ref. no.	Original part	New part
10	R144	3,9 kΩ, 1/3W, 10%	3,3 kΩ, 1/3W, 10%
	R194	3,9 kΩ, 1/3W, 10%	3,3 kΩ, 1/3W, 10%
11	R133	820 Ω, 1/3W, 10%	680 Ω, 1/3W, 10%
	R187	820 Ω, 1/3W, 10%	680 Ω, 1/3W, 10%
12	R601	47 kΩ, adjustm. potm.	250 kΩ, adjustm. potm.
	R602	47 kΩ, adjustm. potm.	250 kΩ, adjustm. potm.
13	Q110/Q111	BC 144/BC 139	BC 140/BC 160
14	PMR	68 Ω/0,1 μF	47 Ω/0,1 μF

6.2 MODIFICATION FROM 230V/50 Hz to 115V/60 Hz

Connect the input of the mains transformer according to fig. 6.1 or wiring diagram on transformer can. To compensate for the higher line frequency, the motor pulley must be replaced (see paragraph 3.4). The part number for the 50 Hz pulley is 246475 and for the 60 Hz pulley 248156. Alter the motor capacitor from 1.2 μF (50 Hz) to 1.1 μF (60 Hz) by removing the connection between the two capacitors contained in the same can. See wiring diagram on the capacitor can.

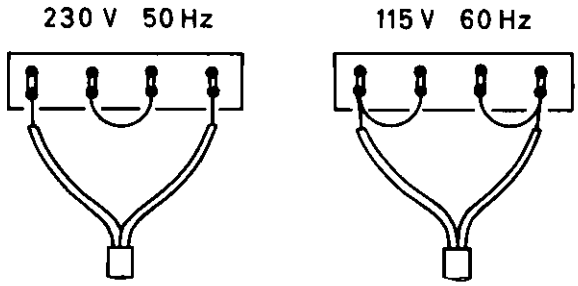


Fig. 6.1 Mains transformer connection.

6.3 MODIFICATION FROM MODEL 1241X to MODEL 1221X

The following components have different values in the two versions.

Ref.no.	4-track	2-track
R136	15 kΩ, 1/3W, 10%	12 kΩ, 1/3W, 10%
R139	15 kΩ, 1/3W, 10%	12 kΩ, 1/3W, 10%
R133	680 Ω, 1/3W, 10%	1,2 kΩ, 1/3W, 10%
R150	2,2 kΩ, 1/3W, 10%	1 kΩ, 1/3W, 10%
R187	680 Ω, 1/3W, 10%	1,2 kΩ, 1/3W, 10%
Q109	BC 147 B	BC 140 Group 10 or better
Q110/Q111*	BC 144/BC 139	BC 140/BC 160
	(BC 140/BC 160)	(BC 140/BC 139)
		(BC 144/BC 139)
		(2N 4921/2N 4918)
C603	3 300 pF, 180V, 2,5%	3 300 - 4 700 pF, 160V, 2,5%, styroflex
C604	3 300 pF, 160V, 2,5%	3 300 - 4 700 pF, 160V, 2,5%, styroflex
C4	250 pF, 630V, 2,5%	330 - 500 pF, 160V, 5%, styroflex
C5	250 pF, 630V, 2,5%	330 - 500 pF, 160V, 5%, styroflex
Rec./playb. head	614 - 18 C (67 H)	A27- 20 C (76 H)
Crossfield head	615 - 03 B (68 H)	A28- 04 B (77 H)
Erase head	695 - 18 E (70 H)	A26- 20 E (75 H)

*Q110/Q111 must have h_{fe} greater than 100. The transistors are delivered in matched pairs.

7.0 SPARE PARTS LIST

Mechanical parts

The numbers of the mechanical parts on the figures are identical with the numbers on the parts in store. Parts shown on the figures without existing in the parts list are not available as spare parts.

Part no.	Name	Description	Fig. ref.	Notes
200384	Insulation shield	Mains switch		
200549	Flange	Take up turntable housing (delrin)	3.6,3.9	
201957	Shaft	Arm, pressure pad		
202102	Phono connector	PREAMP/LINE		
202151	Switch	Motor microswitch RX1	3.34,3.35,3.36,3.37,3.38	
202303	Mounting tube	Rubber		
202309	Shaft	Eccentric lever		
202726	Knob	Bass and treble control	3.1	
202740	Lever	Additional friction	3.5,3.9,2.10,3.15,3.17,3.19 3.21,3.23	
203013	Retaining washer	Flywheel bearing	3.35,3.36,3.37,3.34	
203078	Terminal strip	W/soldering lug for C2		
203365	Shield	Lamp, revolution counter	3.2	
203559	Spring	Index lever, supply turntable		
203638	Shaft	Clutch lever	3.5,3.14,3.15,3.17,3.18,3.16 3.19,3.20,3.21,3.22	
203990	Spacer	Lower mounting plate		
204184	Mains switch	ON-OFF		
204918	Clamp	Driver transistors AC 127/AC 152		
205671	Stud	Parallel arm and cover plate		
206017	Rubber washer	Top cover		
206296	Window	Revolution counter		
207273	Spring	Linkage arm	3.5	
207352	Shaft	Index lever		
207625	Spring	Clutch lever	3.14,3.15,3.16,3.17,3.18,3.19 3.20,3.21,3.22,3.23	
207977	Roller	Pressure roller bracket	3.2	
208250	Bearing	Selflubricating, flywheel	3.27	
208329	Cover	Heads, front	3.1	
208444	Felt washer	Knob		
209306	Spring	Transfer wheel holder	3.1	
209385	Stud	Eccentric lever	3.5,3.35	
210283	Rubber belt	Revolution counter		
210987	Spring	Lower clutch lever	3.15,3.16,3.19,3.21,3.23	
211066	Shaft	Pressure roller forked lever	3.3	
211145	Lever	Index		
211339	Pulley	Revolution counter	3.9	
211418	Shaft	Clutch lever		
211612	Rubber mounting	Lower		
211763	Spring	Interlock arm		
212043	Rear trim cover	Heads	3.1	
212273	Operating lever	Start/stop	3.28	
212747	Tape guide post	Left	3.29,3.4	
212826	Forked lever	Pressure roller assembly	3.3,3.28	
213099	Stud	W/groove for circlip		
213602	Bracket	Operating lever		
213997	Drive belt	Rubber	3.14,3.15,3.16,3.17,3.18,3.19	
214155	Clip	Operating Lever		
214701	Spring	Right friction disc	3.9,3.15,3.17,3.21,3.23	
214925	Socket	Lamp, rev.-counter	3.2	
215053	Pulley	Revolution counter (turntable)		
215326A	Rubber mounting	Upper		

Part no.	Name	Description	Fig. ref	Notes
215405	Delrin part	Momentary stop	3.28	
215563	Adjuster	Spring, pressure wheel	3.3,3.28	
215678	Bearing	Selflubricating, turntable		
215743	Mylar sheet	Friction disk	3.6,3.8,3.9	
216109	Rivet	Linkage arm		
216461A	Adjustable tape guide	Middle	3.4	
216599	Cooling fin	Transistors Q110/Q111		
216734	Spring	Speed selector	3.25	
216957	Terminal strip	Motor		
217086	Delrin button	Clutch levers		
217510	Spring	Tape tightening disk	3.6	
217783	Holder	Tape reel		
217869	Thrust washer	Lower flywheel bearing	3.27	
218063	Spring	Pressure pad arm	3.29,3.30,3.31,3.32,3.33	
218099	Arm	Interlock	3.4	
218415	Spring	Left friction disk	3.6,3.9,3.14,3.15,3.16,3.17 3.18,3.19	
218494	Rivet	Parallel arm and trip bar		
218767	Delrin nut	Hexagon, turntable shaft (left)	3.6	
219198	Disk	Tape tightening	3.6	
219234	Shaft	Pressure roller bracket		
219277	Retainer	Flywheel bearing		
219586	Felt ring	Flywheel bearing	3.27	
219816	Flange	Supply turntable housing (delrin)		
219823	Screw	Covers	3.1	
220155	Stud	Lifting arm, bias head		
220377	Clamp	Capacitor C1		
220384	Revolution counter			
222044	"Tandberg" emblem			
222374	Lever	Function selector CH 1		
223466A	Bracket	Function selector arms		
223488	Connector	Printed circuit board 5-pins		
224386	Arm	Slide, function selector switch		
224795	Stud	Switches		
225384A	Bracket	Mains transformer		
225916	Connector	Printed circuit boards, 7-pins		
226397	Terminal strip	Mains transformer		
226835	Knob	Function selector	3.1	
227432	Rubber mounting	Motor		
227769	Lever	Function selector CH 2		
228286	Mounting	Plastic, components		
228868	Knob	Operating lever	3.1	
229565	MICROPHONE connector	DIN		
229616	Motor			
230629B	Roller	Cam disk arm		
230225	Connector	Printed circuit board, 9-pins		
234478	Spring	Adjustment screw, bias head	3.4	
234960	Washer	Knob, speed selector		
235599	Felt	Flywheel (selfadhesive)	3.27	
236728A	Cam disk arm		3.5,3.25	
238114	Knob	Speed selector	3.1	
239738	Shaft	Cam disk arm		
240276A	Stud	End stop transfer arm		
240879	Plate	Transfer wire, equalization switch		

Part no.	Name	Description	Fig. ref.	Notes
241469	Spring	Bias head		
241877	Jack	EXT. SPEAKER output		
242244	Connector	Inputs, LINE and P UP		
242288A	Lever	Bias head		
242309	Spring	End stop	3.34,3.35,3.37,3.38,3.4	
242331	Spring	Cam disk arm	3.5,3.25	
242503	Arm	End stop feeler	3.34,3.35,3.36,3.37,3.38 3.4	
242633	Heat sink	Power amplifier		
243013	Post	Tape guide, right	3.34,3.35,3.36,3.37,3.38,3.4	
243042	Lamp	Revolution counter	3.2	
243150	Bracket	Bias head lever		
243925	Retaining ring	DIN connectors		
243990	Spring	End stop feeler arm	3.36,3.37,3.38	
244342	Lever	End stop (microswitch operation)	3.34,3.35,3.36,3.37,3.38	
244694	Arm	End stop transfer	3.34,3.35,3.36,3.37,3.38 3.4	
245002	Bracket	Amplifier board support		
245024	Shield	Amplifier board		
245297	Heat sink	Rectifier board		
245318	Knob	Input level control, lower (CH 2)	3.1	
245347A	Operating lever	Input selector	3.1	Below ser.no. 2 237 000
245354	Suppressor	Motor switch (C3, R10)		
245369	Bracket	Motor mounting		
245433	Knob	Output volume control, lower (CH 2)	3.1	
245670	Knob	Speaker selector	3.1	
245721	Clamp	Motor capacitor		
245858A	Equalization switch			
245915A	Index spring	Input selector		
245972	Tube	Input selector (hexagon)		
246145	Plate	Equalization switch stator		
246209	Spring retainer	Input selector		
246231	Plate	Retainer, wires to motor switch		
246303B	Top cover			
246360	Connector	Power ampl. board 6-pins		
246425	Transformer	Mains 115/230V (No. 717)		
246475	Motor pulley 50 Hz		3.24,3.25	
246698	Boss	Input switch		
246705	Shield	Microphone connector		
246720	Cabinet	Teak		
246777A	Board	Stator, function selector switch (CH 1)		
246835	Switch	Loudspeaker selector		
246935A	Clamp	Norm/Spec. switch		
246978A	Chassis	Input		
247035	Frame	Amplifier board		
247050	Transfer arm	Norm./Spec. switch		
247065	Connector	Bias board		
247653	Tape guide	Adjustable, outer	3.29,3.30,3.32,3.4	
247697B	Switch	Function selector CH 1, complete		
247833	Bushing	Bearing, transfer arm Norm./Spec. switch		
247912	Clamp	Transfer wire, equalization switch		
247941	Shaft	Pressure roller		
247948A	Index arm	Input switch		
248027	Insulation	Microswitch		
248041	Contact spring	Connector, power amplifier		
248156	Pulley	Motor 60 Hz		
248157	Bushing	Adjustable tape guides		
248186	Trip bar			

Part no.	Name	Description	Fig. ref.	Notes
248199	Connector	DIN, EXT. LOUDSPEAKER		
248336A	Terminal strip	Bias		
248393	Connector	Power amplifier board, 9-pins		
248401	Cabinet	Rosewood		
248458A	Board	Stator, function selector switch CH 2		
248495	Connector	+26V		
248502	Connector MICROPHONE	DIN		From ser.no. 2 237 001
248638	Terminal strip	Heads		
248659	Chassis	Output		
248716A	Support	Chassis		
248746	Connector	Preamp. board		
248752A	Brake lock	Tape brake		
248825	Clamp	Capacitor C-2		
249011	Shield	Input chassis		
249032	Knob	Input level control, upper (CH 1)	3.1	
249147	Knob	Output volume control, upper (CH 1)	3.1	
249378C	Switch	Function selector, CH 2, complete		
249514	Bushing	Bearing, function selector arm		
249551	Guide	End stop transfer arm		
249593	Arm	Norm./Spec. switch		
249629	Roller	Index, input selector		
249630	Jack	PHONES STEREO		
249722	Meter	Record indicator		
249845	Insulator	Chassis support		
249946	Set of knobs		3.1	
249959	Switch	Norm./Spec.		
249966	Spring	Tape brake		
249988	Plate	Bearing, speed selector shaft	3.25	
250111	Spacer	Bias board		
250476	Spring	Index arm, function selector		
250520	Shaft	Lifting arm, bias head		
250865	Handle	Input selector		From ser.no. 2 237 001
251130	Transfer lever	Pressure pad		
251482	Lever	Pressure pad	3.28,3.29,3.20,3.31,3.32 3.33,3.4	
251489	Tape guide	Below pressure pad	3.29,3.30,3.32,3.4	
251663	Plate	Connector fixing, preamp. board		
251857	Switch	P UP		From ser.no. 2 237 001
252201	Lever	Lifting, bias head	3.4	
252509	Index arm	Function selector	3.4	
252610	Bracket	Revolution counter		
253631	Arm	Input selector	3.1	From ser.no. 2 237 001
254190	Counterweight	Index arm, function selector		
254234	Spring	Lifting lever, bias head	3.4	
254291	Plate	Fixing, revolution counter		
254614	Insulator plate	Preamp. board connector		
254736	Handle	Norm./Spec. switch	3.1	
254844	Support	Pressure pad/tape	3.4	
990201	Lifting arm	Transfer wheel, complete	3.5,3.25	
990202	Pressure roller arm	Assembly	3.2,3.3,3.28	By requiring use no. 990302
990203	Eccentric segment		3.2	
990204	Parallel arm	Complete	3.5,3.25	
990207	Bracket	Front trim cover, left		
990208	Bracket	Front trim cover, right		
990209	Thrust spring	with delrin knob		
990213	Transfer wheel	Holder		

Part no.	Name	Description	Fig. ref.	Notes
990214	Cover plate 1			
990215	Cover plate 2			
990217	Bracket w/shaft	Momentary stop		
990222	Spring washer	Upper flywheel bearing	3.27,3.34,3.35,3.36,3.37	
990223	Retainer	Upper flywheel bearing, threaded		
990225	Operating lever shaft w/delrin ball			
990226	Supply turntable	Left	3.6,3.14,3.18,3.20,3.22 3.25	
990227	Take up turntable	Right	3.9,3.15,3.17,3.19,3.21 3.23,3.25	
990228	Clutch lever	Supply friction disk	3.5,3.6,3.7,3.14,3.18,3.20 3.22	
990229	Upper clutch lever	Take up friction disk	3.5,3.9,3.10,3.15,3.16,3.17	
990230	Index lever	Trip bar	3.5	
990231	Bracket	Rear trim cover		
990232	Momentary stop assembly		3.4	
990233	Transferwheel		3.5,3.24,3.25	
990234	Pressure roller	(pinch roller)	3.3,3.28	
990236	Friction disk	Left and right		
990238	Spring	Pressure wheel bracket	3.3	
990305	Transferwheel arm			
990306	Arm	Norm./Spec. switch w/bearing		
990312	Flywheel	Complete	3.25,3.27,3.34,3.35,3.36 3.37,3.38	
990319	Brake	Flywheel, complete		
990320	Power amplifier board	Complete		
990321	Rectifier board	Complete		
990322	Input amplifier board	Complete		
990323	Equalization/VU-meter	Preamplifier board 2-track comp.		
990324	Equalization/VU-meter	Preamplifier board 4-track comp.		
990325	Pressure pad		3.4,3.28,3.29,3.30,3.31 3.32,3.33	
990326	Transfer wire	Equalization switch, complete		
990327	Bias board	Complete		
990330	Cam disc w/shaft		3.5,3.25	
990335	Input switch	Complete		
990336	Input switch	Complete		From ser.no. 2 237 001
990339	Slide	Function selector switch CH 1		
990340	Slide	Function selector switch CH 2		
990341	Slide	Equalization switch		
990342	Socket	VU-meter lamp		
990343	Input amplifier board	Complete		From ser.no. 2 237 001
990344	Equalization/VU-meter	Preamplifier board 4-track, complete		From ser.no. 2 237 001
990345	Line input circuit board	Complete		From ser. no. 2 237 001
990346	Plate w/shaft	End stop switch		
990347	Lamp	VU-meter		
990348	Equalization/VU-meter	Preamplifier board 2-track		From ser.no. 2 237 001
990349	Equalization/VU-meter	Preamplifier board 4-track		From ser.no. 2 252 601
990350	Equalization/VU-meter	Preamplifier board 2-track		From ser.no. 2 252 601
990351	Rectifier board	Complete		From ser.no.2 251 955
990352	Power amplifier board			From ser.no. 2 251 955
990353	Bias board			From ser.no. 2 247 876
991025	Housing w/bearing		3.5,3.6,3.9	

Screws and Washers

M101 Screw 3 x 4 mm cyl. head
M102 Screw 3 x 4.5 mm cyl. head
M104 Screw 3 x 6 mm cyl. head
M107 Screw 3 x 8 mm cyl. head
M112 Screw 4 x 6 mm cyl. head
M113 Screw 4 x 8 mm cyl. head
M114 Screw 4x10 mm cyl. head
M116 1/4" no. 4, self-threading
M120 Screw 2.6 x 4 mm cyl. head
M121 Screw 2.3 x 12 mm cyl. head
M122 Screw 4 x 22 mm cyl. head
M125 Screw 3 x 6 mm 1.5 mm head
M130 Screw 3 x 8 mm counter sink head
M132 Unbrako screw 1/8" x 3.5 mm
M301 Turbax washer 7.5 x 4.2 x 0.2 mm
M302 Turbax washer 7.5 x 4.2 x 0.3 mm
M303 Turbax washer 11 x 6.5 x 0.5 mm
M307 Turbax washer 11 x 6.5 x 0.5 mm
M313 Lock washer 2.5 mm
M314 Lock washer 3 mm
M315 Lock washer 3.5 mm
M317 Lock washer 5 mm
M318 Lock washer 6 mm
M321 Lock washer 4 x 0.6 mm
M325 Washer 16 x 4.2 x 1.65 mm
M329 Lock washer 2.3 mm
M331 Bakelite washer 18 x 10 x 0.5 mm
M333 Spring washer 1/8"
M348 Teflon washer 6.5 x 4.2 x 0.2 mm
M349 Lock washer 4 mm
M355 Teflon washer 6.5 x 4.2 x 0.5 mm
M360 Lock ring 2.0 mm

Electrical Parts

In the following lists the designation 1200X in the reference number indicates a part common for 2-track and 4-track models. A part denoted by 1241X is used in the 4-track model only, whereas 1221X denotes a part exclusive for the 2-track model.

The modification introduced from serial no. approximately 2 237 000 implied that board no. 2 was replaced by board no. 7. The corresponding parts are identified by 200-series and 700-series numbers respectively. The same applies for components in the voltage regulator where board no. 5 was replaced by board no. 9 from serial no. approximately 2 251 955.

Minor changes introduced in production are denoted by a reference to the respective modification groups listed on the preceeding page.

When ordering electric parts, always specify the reference number. If the table on the preceeding page indicates that a modification has been introduced in production, also specify the serial number of the recorder.

Transistors

Ref. no.	Type	Notes
Q101 - 1200X	BC 149B	
Q102 - 1200X	BC 148B	
Q103 - 1200X	BC 147B	
Q105 - 1200X	BC 147B	
Q106 - 1200X	BC 148A	
Q107 - 1200X	BC 147B	
Q108 - 1200X	BC 147B	
Q109 - 1241X	BC 147B	
Q109 - 1221X	BC 140 - 10	Pair, h_{fe} minimum 90
Q110/Q111 - 1200X	BC 140/BC 160	Modification group 13
Q112 - 1200X	BC 149B	
Q113 - 1200X	BC 148B	
Q114 - 1200X	BC 147B	
Q115 - 1200X	BC 147B	
Q116 - 1200X	BC 148A	
Q201 - 1200X	BC 149B	
Q202 - 1200X	BC 149B	
Q203 - 1200X	BC 148A	
Q204 - 1200X	BC 148A	
Q205 - 1200X	BC 147A	
Q206 - 1200X	BC 147A	
Q301 - 1200X	BC 148A	
Q302 - 1200X	BC 107B	
Q303 - 1200X	AC 127	) Must be designated
Q304 - 1200X	AC 152	) with the same letter
Q305/Q306 - 1200X	2X AD 150	Pair
Q401 - 1200X	BC 148A	
Q402 - 1200X	BC 107B	
Q403 - 1200X	AC 127	) Must be designated
Q404 - 1200X	AC 152	) with the same letter
Q405/Q406 - 1200X	2X AD 150	Pair
Q501 - 1200X	T1 3030	
Q502 - 1200X	U 2848/1	
Q503 - 1200X	U 2848/1	
Q701 - 1200X	BC 149B	
Q702 - 1200X	BC 149B	
Q703 - 1200X	BC 149B	
Q704 - 1200X	BC 149B	
Q705 - 1200X	BC 147B	
Q706 - 1200X	BC 147B	
Q707 - 1200X	BC 147B	

Transistors:

Ref. no.	Type	Notes
Q708 - 1200X	BC 147B	
Q901 - 1200X	2N 5034	
Q902 - 1200X	BC 140 - 10	
Q903 - 1200X	BC 147A	

Diodes:

Ref. no.	Type	———	Notes
D101 - 1200X	1N 4148		
D102 - 1200X	1N 4148		
D103 - 1200X	BA 130		Mod. group 1 (page 40)
D301 - 1200X	MR 2065		Mod. group 3 (page 40)
D302 - 1200X	MR 2065		Mod. group 3 (page 40)
D401 - 1200X	MR 2065		Mod. group 3 (page 40)
D402 - 1200X	MR 2065		Mod. group 3 (page 40)
D501 - 1200X	ZF 27, ZENER		
D901 - 1200X	ZF 27, ZENER		

Rectifier:

Comp. no.	Type	Application	Notes
B40 C2200	B 40 C 2200	Voltage regulator	Bridge-connected

Fuse:

Comp. no.	Type	Application	Notes
2A	2A, slow-blow, 5 x 20 mm	Voltage regulator	

Heads:

Ref. no. 4-track	Ref. no. 2-track	Application	Notes
695-18E (70H)	A26-20E (75H)	Erase head	
614-18C (67H)	A27-20C (76H)	Record/playback head	
615-03B (68H)	A28-04B (77H)	Crossfield bias head	

Coils:

Ref. no.	Value	Application	Notes
L101 - 1200X	1,4 mH	Equalizing amplifier, left	
L102 - 1200X	1,4 mH	Equalizing amplifier, right	

Transformers:

Ref. no.	———	Application	Notes
T101 - 1200X		Oscillator	

Speakers:

———	Specification	———	Notes
	HT 123		Mod. group 5 (page 40)

Potentiometers:

Ref. no	Value	Notes
R149 - 1200X	300 Ω	Adjustm. Mod. group 1(page 40)
R192 - 1200X	47 kΩ	Adjustm.
R193 - 1200X	47 kΩ	Adjustm.
R214 - 1200X	10 kΩ	)
R235 - 1200X	5 kΩ	) Double
R216 - 1200X	10 kΩ	) tandem
R236 - 1200X	5 kΩ	)
R301 - 1200X	10 kΩ	
R303 - 1200X	250 kΩ	Adjustm.
R313 - 1200X	2 kΩ	Adjustm.
R320 - 1200X	10 kΩ	Tandem with R420
R324 - 1200X	10 kΩ	Tandem with R424
R401 - 1200X	10 kΩ	
R403 - 1200X	250 kΩ	Adjustm.
R413 - 1200X	2 kΩ	Adjustm.
R420 - 1200X	10 kΩ	Tandem with R320
R424 - 1200X	10 kΩ	Tandem with R324
R601 - 1200X	250 kΩ	Adjustm. Mod. group 12 (page 41)
R602 - 1200X	250 kΩ	Adjustm. Mod. group 12 (page 4 1)
R711 - 1200X	33 kΩ	)
R737 - 1200X	5 kΩ	) Double
R712 - 1200X	33 kΩ	) tandem
R738 - 1200X	5 kΩ	)

Resistors:

Ref. no.	Specification			Notes
R1 - 1200X	0,1 MΩ	1/2W	10%	
R2 - 1200X	22 kΩ	1/2W	10%	
R3 - 1200X	22 kΩ	1/2W	10%	
R4 - 1200X	0,1 MΩ	1/2W	10%	
R5 - 1200X	47 Ω	1/2W	10%	Mod. group 14 (page 41)
R6 - 1200X	3,9 Ω	5W **	10%	Mod. group 5 (page 40)
R7 - 1200X	3,9 Ω	5W **	10%	Mod. group 5 (page 40)
R8 - 1200X	82 Ω	1/2W	10%	
R9 - 1200X	82 Ω	1/2W	10%	
R101 - 1200X	68 kΩ	1/4W *	5%	
R102 - 1200X	33 kΩ	1/3W *	5%	
R105 - 1200X	10 kΩ	1/3W	10%	
R106 - 1200X	220 kΩ	1/2W *	5%	
R107 - 1200X	620 Ω	1/2W *	5%	
R108 - 1200X	1 kΩ	1/3W	10%	
R109 - 1200X	10 kΩ	1/3W	10%	
R110 - 1200X	510 Ω	1/3W	10%	
R111 - 1200X	100 Ω	1/3W	10%	
R112 - 1200X	1 kΩ	1/3W	10%	
R113 - 1200X	39 kΩ	1/2W *	5%	
R114 - 1200X	10 kΩ	1/3W	10%	
R115 - 1200X	2,7 kΩ	1/3W *	5%	
R116 - 1200X	39 kΩ	1/4W *	5%	Mod. group 9 (page 40)
R117 - 1200X	5,1 kΩ	1/3W *	5%	
R118 - 1200X	82 kΩ	1/3W *	5%	Mod. group 9 (page 40)
R119 - 1200X	7,5 kΩ	1/3W *	5%	
R120 - 1200X	1,5 kΩ	1/3W	10%	
R121 - 1200X	120 Ω	1/4W *	5%	

* Low noise (deposited carbon) ** Wirewound *** Metal film

Ref. no.	Specification			Notes
R122 - 1200X	39 Ω	1/2W *	5%	
R123 - 1200X	82 Ω	1/3W *	5%	
R124 - 1200X	68 Ω	1/3W *	5%	
R125 - 1200X	180 Ω	1/3W	10%	
R127 - 1200X	1 MΩ	1/3W	10%	
R128 - 1200X	15 kΩ	1/3W	10%	
R129 - 1200X	4,7 kΩ	1/3W	10%	
R130 - 1200X	1 MΩ	1/3W	10%	
R131 - 1200X	4,7 kΩ	1/3W	10%	
R132 - 1200X	100 kΩ	1/3W	10%	
R133 - 1241X	820 Ω	1/3W	10%	Mod. group 11 (page 41)
R133 - 1221X	1,2 kΩ	1/3W	10%	
R135 - 1200X	270 Ω	1/3W *	5%	
R136 - 1241X	15 kΩ	1/3W	10%	
R136 - 1221X	12 kΩ	1/3W	10%	
R137 - 1200X	47 kΩ	1/3W	10%	
R138 - 1200X	270 Ω	1/3W *	5%	
R139 - 1241X	15 kΩ	1/3W	10%	
R139 - 1221X	12 kΩ	1/3W	10%	
R140 - 1200X	47 kΩ	1/3W	10%	
R141 - 1200X	2,2 MΩ	1/3W *	5%	
R142 - 1200X	2,2 MΩ	1/3W	10%	
R143 - 1200X	47 kΩ	1/4W *	5%	
R144 - 1241X	3,3 kΩ	1/3W	10%	Mod. group 10 (page 41)
R144 - 1221X	2,7 kΩ	1/3W	10%	
R145 - 1200X	1 kΩ	1/3W	10%	
R146 - 1200X	1 kΩ	1/3W	10%	
R147 - 1200X	33 kΩ	1/4W *	5%	
R150 - 1241X	2,2 kΩ	1/3W	10%	
R150 - 1221X	1 kΩ	1/3W	10%	
R151 - 1200X	4,7 Ω	0,7W ***	20%	
R152 - 1200X	4,7 Ω	0,7W ***	20%	
R153 - 1221X	10 Ω	1/3W	10%	Mod. group 7 (page 40)
R154 - 1221X	10 Ω	1/3W	10%	Mod. group 7 (page 40)
R155 - 1200X	68 kΩ	1/4W *	5%	
R156 - 1200X	33 kΩ	1/3W *	5%	
R157 - 1200X	10 kΩ	1/2W *	5%	
R158 - 1200X	10 kΩ	1/3W	10%	
R159 - 1200X	620 Ω	1/2W *	5%	
R160 - 1200X	220 kΩ	1/2W *	5%	
R161 - 1200X	510 Ω	1/3W	10%	
R162 - 1200X	100 Ω	1/3W	10%	
R163 - 1200X	1 kΩ	1/3W	10%	
R164 - 1200X	1 kΩ	1/3W	10%	
R165 - 1200X	39 kΩ	1/4W *	5%	
R166 - 1200X	10 kΩ	1/4W *	5%	
R167 - 1200X	68 kΩ	1/4W *	5%	Mod. group 9 (page 40)
R168 - 1200X	2,7 kΩ	1/3W *	5%	
R169 - 1200X	5,1 kΩ	1/3W *	5%	
R170 - 1200X	7,5 kΩ	1/3W *	5%	
R171 - 1200X	1,5 kΩ	1/3W	10%	
R172 - 1200X	82 kΩ	1/3W *	5%	Mod. group 9 (page 40)
R173 - 1200X	120 Ω	1/3W *	5%	
R174 - 1200X	39 Ω	1/2W *	5%	
R176 - 1200X	68 Ω	1/3W *	5%	
R177 - 1200X	82 Ω	1/3W *	5%	
R178 - 1200X	180 Ω	1/3W	10%	

* Low noise (deposited carbon) ** Wirewound *** Metal film

Ref. no.	Specification			Notes
R181 - 1200X	2,2 kΩ	1/3W	10%	
R182 - 1200X	1 MΩ	1/3W	10%	
R183 - 1200X	4,7 kΩ	1/3W	10%	
R184 - 1200X	1 MΩ	1/3W	10%	
R185 - 1200X	100 kΩ	1/3W	10%	
R186 - 1200X	4,7 kΩ	1/3W	10%	
R187 - 1241X	680 Ω	1/3W	10%	Mod. group 11 (page 41)
R187 - 1221X	1/2 kΩ	1/3W	10%	
R189 - 1200X	15 kΩ	1/3W	10%	
R190 - 1200X	680 Ω	1W *	10%	
R191 - 1200X	680 Ω	1W *	10%	
R194 - 1241X	3,3 kΩ	1/3W	10%	Mod. group 10 (page 41)
R194 - 1221X	2,7 kΩ	1/3W	10%	
R195 - 1200X	2,2 kΩ	1/3W	10%	
R196 - 1200X	3,3 kΩ	1/2W	10%	
R197 - 1200X	3,3 kΩ	1/2W	10%	
R201 - 1200X	2,2 kΩ	1/2W *	5%	
R202 - 1200X	33 kΩ	1/2W *	5%	
R203 - 1200X	2,2 kΩ	1/2W *	5%	
R204 - 1200X	33 kΩ	1/2W *	5%	
R205 - 1200X	1 MΩ	1/2W *	5%	
R206 - 1200X	150 kΩ	1/2W *	5%	
R207 - 1200X	1 MΩ	1/2W *	5%	
R208 - 1200X	150 kΩ	1/2W *	5%	
R209 - 1200X	68 kΩ	1/4W *	5%	
R210 - 1200X	10 kΩ	1/2W *	5%	
R211 - 1200X	68 kΩ	1/4W *	5%	
R212 - 1200X	10 kΩ	1/2W *	5%	
R213 - 1200X	220 Ω	1/2W *	5%	
R215 - 1200X	220 Ω	1/2W *	5%	
R217 - 1200X	0,1 MΩ	1/3W	10%	
R218 - 1200X	47 kΩ	1/3W	10%	
R219 - 1200X	3,3 kΩ	1/3W	10%	
R220 - 1200X	470 Ω	1/3W	10%	
R221 - 1200X	0,1 MΩ	1/3W	10%	
R222 - 1200X	47 kΩ	1/3W	10%	
R223 - 1200X	3,3 kΩ	1/3W	10%	
R224 - 1200X	470 Ω	1/3W	10%	
R225 - 1200X	4,7 kΩ	1/3W	10%	
R226 - 1200X	560 Ω	1/3W	10%	
R227 - 1200X	4,7 kΩ	1/3W	10%	
R228 - 1200X	560 Ω	1/3W	10%	
R229 - 1200X	3,3 kΩ	1/3W	10%	
R230 - 1200X	2,2 MΩ	1/3W	10%	
R231 - 1200X	3,3 kΩ	1/3W	10%	
R232 - 1200X	2,2 MΩ	1/3W	10%	
R233 - 1200X	1,5 kΩ	1/3W	10%	
R234 - 1200X	1,5 kΩ	1/3W	10%	
R237 - 1200X	100 Ω	1/2W *	5%	
R238 - 1200X	2,2 kΩ	1/3W	10%	
R239 - 1200X	2,2 kΩ	1/3W	10%	
R302 - 1200X	1 kΩ	1/2W *	5%	
R304 - 1200X	12 kΩ	1/2W *	5%	
R305 - 1200X	1 kΩ	1/3W	10%	
R306 - 1200X	3,3 kΩ	1/3W	10%	
R307 - 1200X	82 Ω	1/3W *	5%	

* Low noise (deposited carbon) ** Wirewound *** Metal film

Ref. no.	Specification			Notes
R309 - 1200X	330 Ω	1/3W	10%	
R310 - 1200X	10 kΩ	1/3W	10%	
R311 - 1200X	3,9 kΩ	1/3W	10%	Mod. group 4 (page 40)
R312 - 1200X	150 Ω	NTC	20%	Mod. group 4 (page 40)
R314 - 1200X	51 Ω	1/3W	10%	
R315 - 1200X	51 Ω	1/3W	10%	
R316 - 1200X	2,4 Ω	1W **	10%	Mod. group 3 (page 40)
R317 - 1200X	2,4 Ω	1W **	10%	Mod. group 3 (page 40)
R318 - 1200X	82 Ω	1/3W	10%	
R319 - 1200X	220 Ω	1/3W	10%	
R321 - 1200X	33 Ω	1/3W	10%	
R322 - 1200X	330 Ω	1/3W	10%	
R323 - 1200X	1 kΩ	1/3W	10%	
R325 - 1200X	100 Ω	1/3W	10%	
R326 - 1200X	330 kΩ	1/2W *	5%	
R402 - 1200X	1 kΩ	1/2W *	5%	
R404 - 1200X	12 kΩ	1/2W *	5%	
R405 - 1200X	1 kΩ	1/3W	10%	
R406 - 1200X	3,3 kΩ	1/3W	10%	
R407 - 1200X	82 Ω	1/3W *	5%	
R409 - 1200X	330 Ω	1/3W	10%	
R410 - 1200X	10 kΩ	1/3W	10%	
R411 - 1200X	3,9 kΩ	1/3W	10%	Mod. group 4 (page 40)
R412 - 1200X	150 Ω	NTC	20%	Mod. group 4 (page 40)
R414 - 1200X	51 Ω	1/3W	10%	
R415 - 1200X	51 Ω	1/3W	10%	
R416 - 1200X	2,4 Ω	1 W **	10%	Mod. group 3 (page 40)
R417 - 1200X	2,4 Ω	1 W **	10%	Mod. group 3 (page 40)
R418 - 1200X	82 Ω	1/3W	10%	
R419 - 1200X	220 Ω	1/3W	10%	
R421 - 1200X	33 Ω	1/3W	10%	
R422 - 1200X	330 Ω	1/3W	10%	
R423 - 1200X	1 kΩ	1/3W	10%	
R425 - 1200X	100 Ω	1/3W	10%	
R426 - 1200X	330 kΩ	1/2W *	5%	
R502 - 1200X	820 Ω	1W *	10%	
R503 - 1200X	3,9 kΩ	1W *	10%	
R504 - 1200X	150 kΩ	1/2W *	5%	
R505 - 1200X	150 Ω	NTC	20%	
R506 - 1200X	1 kΩ	1/2W *	5%	
R507 - 1200X	5,1 kΩ	1/2W *	5%	
R508 - 1200X	510 Ω	1/2W *	5%	Mod. group 8 (page 40)
R603 - 1200X	10 Ω	1/2W	10%	Mod. group 6 (page 40)
R604 - 1200X	10 Ω	1/2W	10%	Mod. group 6 (page 40)
R701 - 1200X	2 kΩ	1/3W *	5%	
R702 - 1200X	2 kΩ	1/3W *	5%	
R703 - 1200X	56 kΩ	1/3W *	5%	
R704 - 1200X	56 kΩ	1/3W *	5%	
R705 - 1200X	470 Ω	1/4W *	5%	
R706 - 1200X	470 Ω	1/4W *	5%	
R707 - 1200X	39 kΩ	1/3W *	5%	
R708 - 1200X	39 kΩ	1/3W *	5%	
R709 - 1200X	51 kΩ	1/3W *	5%	
R710 - 1200X	51 kΩ	1/3W *	5%	
R713 - 1200X	100 Ω	1/3W *	5%	
R714 - 1200X	100 Ω	1/3W *	5%	

* Low noise (deposited carbon) ** Wirewound *** Metal film

Ref. no.	Specification			Notes
R717 - 1200X	1 kΩ	1/3W *	5%	
R718 - 1200X	1 kΩ	1/3W *	5%	
R719 - 1200X	180 kΩ	1/3W *	5%	
R720 - 1200X	180 kΩ	1/3W *	5%	
R721 - 1200X	39 kΩ	1/3W	10%	
R722 - 1200X	39 kΩ	1/3W	10%	
R723 - 1200X	18 kΩ	1/3W	10%	
R724 - 1200X	18 kΩ	1/3W	10%	
R725 - 1200X	270 kΩ	1/3W	10%	
R726 - 1200X	270 kΩ	1/3W	10%	
R727 - 1200X	330 kΩ	1/3W	10%	
R728 - 1200X	330 kΩ	1/3W	10%	
R729 - 1200X	1,2 kΩ	1/3W	10%	
R730 - 1200X	1,2 kΩ	1/3W	10%	
R731 - 1200X	3,3 kΩ	1/3W	10%	
R732 - 1200X	3,3 kΩ	1/3W	10%	
R733 - 1200X	15 kΩ	1/3W	10%	
R734 - 1200X	15 kΩ	1/3W	10%	
R735 - 1200X	1,5 kΩ	1/3W	10%	
R736 - 1200X	1,5 kΩ	1/3W	10%	
R739 - 1200X	2,2 kΩ	1/3W	10%	
R740 - 1200X	2,2 kΩ	1/3W	10%	
R741 - 1200X	3,6 kΩ	1/3W *	5%	
R742 - 1200X	3,6 kΩ	1/3W *	5%	
R743 - 1200X	100 Ω	1/3W *	5%	
R744 - 1200X	27 kΩ	1/3W *	5%	
R745 - 1200X	27 kΩ	1/3W *	5%	
R750 - 1200X	33 kΩ	1/3W *	5%	
R751 - 1200X	33 kΩ	1/3W *	5%	
R801 - 1200X	68 kΩ	1/4W *	5%	
R801 - 1200X	39 kΩ	1/2W *	5%	U.S. Model
R802 - 1200X	68 kΩ	1/4W *	5%	
R802 - 1200X	39 kΩ	1/2W *	5%	U.S. Model
R803 - 1200X	220 kΩ	1/4W *	5%	
R804 - 1200X	220 kΩ	1/4W *	5%	
R901 - 1200X	3,3 kΩ	1/3W	10%	
R902 - 1200X	100 Ω	1/3W	10%	
R903 -1200X	1 kΩ	1/3W	10%	
R904 - 1200X	1 kΩ	1/3W	10%	

Capacitors:

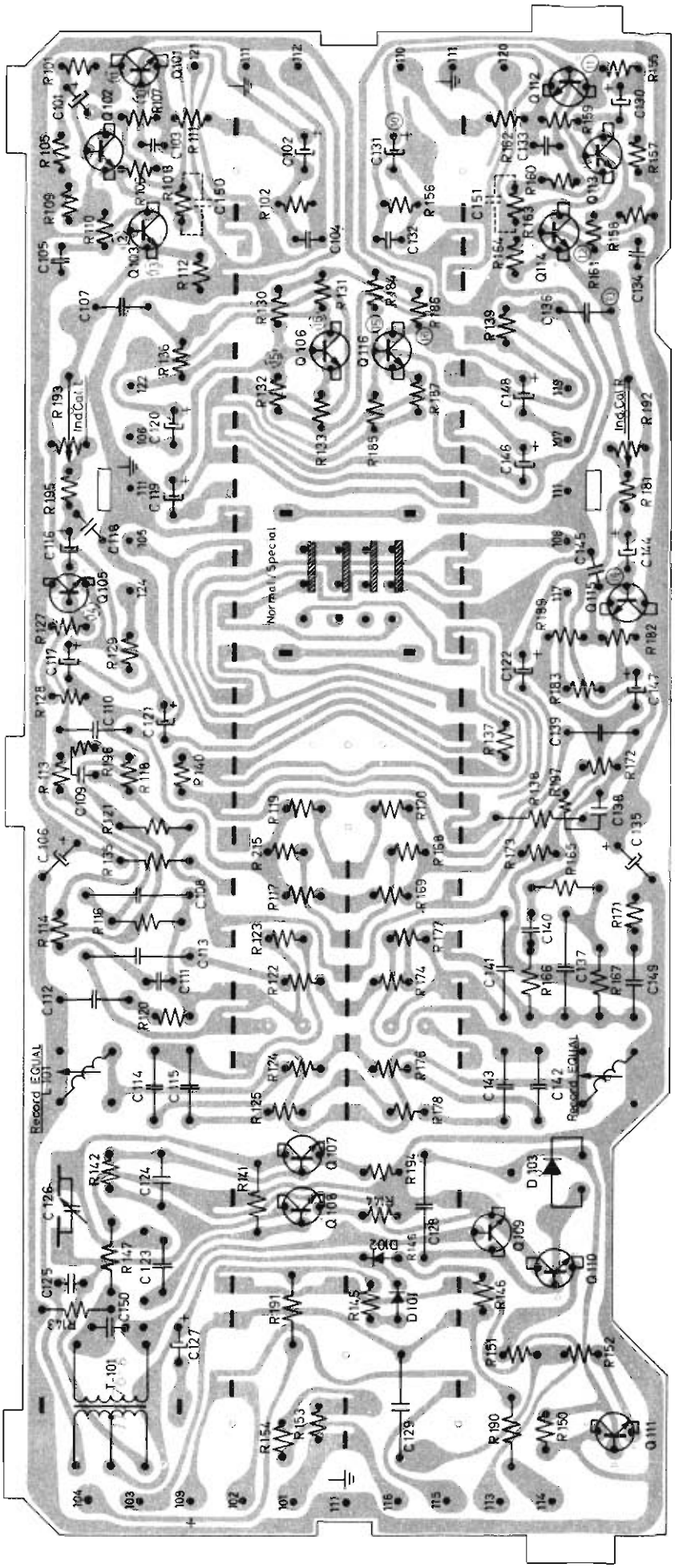
Ref. no.	Specification				Notes
C1 - 1200X	2500 μF	64V		Electrolytic	
C2 - 1200X	2000 μF	35V		Electrolytic	
C3 - 1200X	1,1 μF 5% + 0,1 μF 20%	380V		Oil paper	Same can. At 60 Hz use 1.1μF only
C4 - 1241X	250 pF	630V	2,5%	Polystyrene	
C4 - 1221X	330-500 pF	160V	5%	Polystyrene	Capacitor value marked on head
C5 - 1241X	250 pF	630V	2,5%	Polystyrene	
C5 - 1221X	330-500 pF	160V	5%	Polystyrene	Capacitor value marked on head
C6 - 1200X	0.1μF	400V	20%	Oil paper	Mod. group 14 (page 41)
C101 - 1200X	25 μF	25V		Electrolytic	
C102 - 1200X	2 μF	50V		Electrolytic	
C103 - 1200X	68 pF	500V	10%	Ceramic	
C104 - 1200X	470 pF	500V	10%	Ceramic	

* Low noise (deposited carbon) ** Wirewound *** Metal film

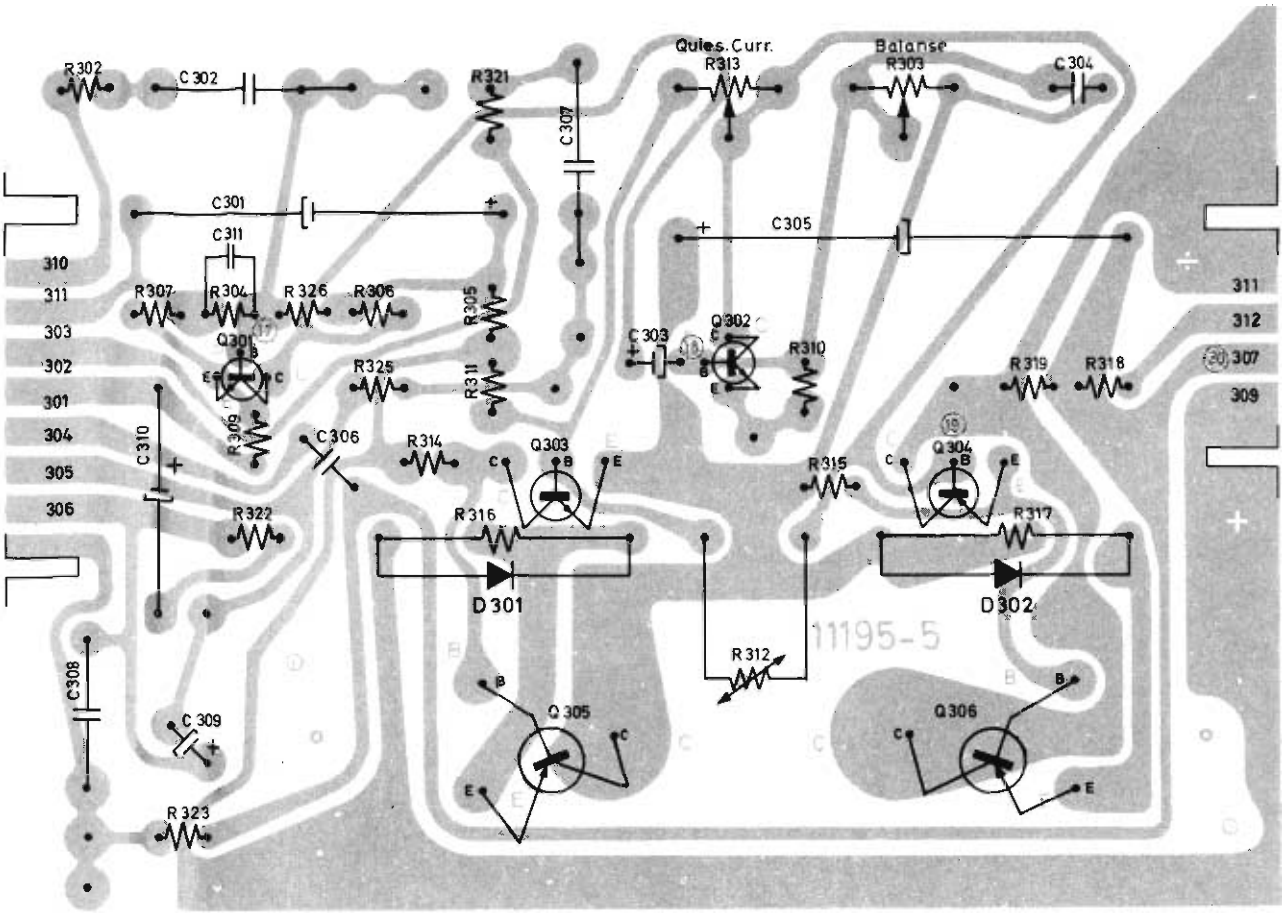
Ref. no.	Specification				Notes
C105 - 1200X	470 pF	500V	10%	Ceramic	
C106 - 1200X	100 µF	35V		Electrolytic	
C107 - 1200X	2,2 µF	100V		Electrolytic	Mod. group 9 (page 40)
C108 - 1200X	0.068 µF	100V	10%	Polycarbonat	
C109 - 1200X	1000 pF	160V	10%	Polyester	
C110 - 1200X	0.022 µF	160V	5%	Polyester	
C111 - 1200X	68 pF	500V	10%	Ceramic	
C112 - 1200X	0.068 µF	100V	10%	Polycarbonate	
C113 - 1200X	0.1 µF	200V	10%	Met. paper	Other values may occur
C114 - 1200X	0.047 µF	250V	10%	Polyester	
C115 - 1200X	0.022 µF	250V	10%	Polyester	Other values may occur
C116 - 1200X	2 µF	70V		Electrolytic	
C117 - 1200X	25 µF	25V		Electrolytic	
C118 - 1200X	1000 pF	500V	20/50%	Ceramic	
C119 - 1200X	2 µF	70V		Electrolytic	
C120 - 1200X	2 µF	70V		Electrolytic	
C121 - 1200X	2 µF	70V		Electrolytic	
C122 - 1200X	2 µF	70V		Electrolytic	
C123 - 1200X	0.01 µF	400V	10%	Polyester	
C124 - 1200X	0.01 µF	400V	10%	Polyester	
C125 - 1200X	470 pF	63V	5%	Ceramic	) Connected in
C125 - 1200X	560 pF	63V	2%	Ceramic	) parallel
C125 - 1200X	1000 pF	63V	2%	Ceramic	Alternatively
C126 - 1200X	150-750 pF	Trimming capacitor		Mica	
C127 - 1200X	2.2 µF	100V		Electrolytic	
C128 - 1200X	0.1 µF	200V	10%	Met. paper	
C129 - 1200X	1 µF	100V	20%	Polycarbonate	
C130 - 1200X	25 µF	25V		Electrolytic	
C131 - 1200X	2 µF	50V		Electrolytic	
C132 - 1200X	470 pF	500V	10%	Ceramic	
C133 - 1200X	68 pF	500V	10%	Ceramic	
C134 - 1200X	470 pF	500V	10%	Ceramic	
C135 - 1200X	100 µF	35V		Electrolytic	
C136 - 1200X	2,2 µF	100V		Electrolytic	Mod. group 9 (page 40)
C137 - 1200X	0,068 µF	100V	10%	Polycarbonate	
C138 - 1200X	1000 pF	160V	10%	Polyester	
C139 - 1200X	0,022 µF	160V	5%	Polyester	
C140 - 1200X	68 pF	500V	10%	Ceramic	
C141 - 1200X	0,1 µF	200V	10%	Met. paper	Other values may occur
C142 - 1200X	0,047 µF	250V	10%	Polyester	
C143 - 1200X	0,022 µF	250V	10%	Polyester	Other values may occur
C144 - 1200X	2 µF	70V		Electrolytic	
C145 - 1200X	1000 pF	500V	20/50%	Ceramic	
C146 - 1200X	2 µF	70V		Electrolytic	
C147 - 1200X	25 µF	25V		Electrolytic	
C148 - 1200X	2 µF	70V		Electrolytic	
C149 - 1200X	0,068 µF	100V	10%	Polycarbonate	
C150 - 1200X	120 pF	500V	5%	Ceramic	
C151 - 1200X	0,047 µF	250V	5%	Polyester	
C152 - 1200X	0,047 µF	250V	5%	Polyester	
C201 - 1200X	25 µF	25V		Electrolytic	
C202 - 1200X	25 µF	25V		Electrolytic	
C203 - 1200X	15 µF	12V		Electrolytic	
C204 - 1200X	15 µF	12V		Electrolytic	
C205 - 1200X	2 µF	50V		Electrolytic	
C206 - 1200X	100 µF	3V		Electrolytic	

Ref. no.	Specification				Notes
C207 - 1200X	2 µF	5V		Electrolytic	
C208 - 1200X	100 µF	3V		Electrolytic	
C209 - 1200X	0,1 µF	250V	10%	Polyester	
C210 - 1200X	0,068 µF	250V	10%	Polyester	
C211 - 1200X	0,022 µF	400V	10%	Polyester	
C212 - 1200X	100 pF	630V	10%	Polycarbonate	
C213 - 1200X	0,1 µF	250V	10%	Polyester	
C214 - 1200X	0,068 µF	250V	10%	Polyester	
C215 - 1200X	0,022 µF	400V	10%	Polyester	
C216 - 1200X	100 pF	630V	10%	Polycarbonate	
C219 - 1200X	100 µF	35V		Electrolytic	
C220 - 1200X	25 µF	25V		Electrolytic	
C221 - 1200X	25 µF	25V		Electrolytic	
C222 - 1200X	180 pF	630V	10%	Polycarbonate	
C223 - 1200X	180 pF	630V	10%	Polycarbonate	
C301 - 1200X	100 µF	40V		Electrolytic	
C302 - 1200X	0,47 µF	200V	10%	Met. paper	
C303 - 1200X	2,2 µF	100V		Electrolytic	
C304 - 1200X	470 pF	500V	10%	Ceramic	
C305 - 1200X	1000 µF	25V		Electrolytic	
C306 - 1200X	0,022 µF	400V	10%	Polyester	
C307 - 1200X	0,47 µF	200V	10%	Met. paper	
C308 - 1200X	0,33 µF	200V	10%	Met. paper	
C309 - 1200X	2 µF	100V		Electrolytic	
C310 - 1200X	320 µF	6,4V		Electrolytic	
C311 - 1200X	1500 pF	500V	20%	Ceramic	
C401 - 1200X	100 µF	40V		Electrolytic	
C402 - 1200X	0,47 µF	200V	10%	Met. paper	
C403 - 1200X	2,2 µF	100V		Electrolytic	
C404 - 1200X	470 pF	500V	10%	Ceramic	
C405 - 1200X	1000 µF	25V		Electrolytic	
C406 - 1200X	0,022 µF	400V	10%	Polyester	
C407 - 1200X	0,47 µF	200V	10%	Met. paper	
C408 - 1200X	0,33 µF	200V	10%	Met. paper	
C409 - 1200X	2 µF	100V		Electrolytic	
C410 - 1200X	320 µF	6,4V		Electrolytic	
C411 - 1200X	1500 pF	500V	20%	Ceramic	
C503 - 1200X	0,1 µF	200V	10%	Met. paper	
C505 - 1200X	0,1 µF	200V	10%	Met. paper	
C506 - 1200X	0,01 µF	400V	10%	Polyester	
C507 - 1200X	0,68 µF	100V	10%	Polyester	
C601 - 1200X	250 pF	160V	2,5%	Polystyrene	
C602 - 1200X	250 pF	160V	2,5%	Polystyrene	
C603 - 1241X	3300 pF	180V	2,5%	Polystyrene	
C603 - 1221X	4700 pF	160V	2,5%	Polystyrene	Other values may occur
C604 - 1241X	3300 pF	180V	2,5%	Polystyrene	
C604 - 1221X	4700 pF	160V	2,5%	Polystyrene	Other values may occur
C701 - 1200X	22 µF	25V		Electrolytic	
C702 - 1200X	22 µF	25V		Electrolytic	
C703 - 1200X	2,2 µF	100V		Electrolytic	
C704 - 1200X	2,5 µF	64V		Electrolytic	
C705 - 1200X	2,2 µF	100V		Electrolytic	
C706 - 1200X	2,2 µF	100V		Electrolytic	
C707 - 1200X	180 pF	500V	10%	Ceramic	
C708 - 1200X	180 pF	500V	10%	Ceramic	
C709 - 1200X	2,2 µF	100V		Electrolytic	

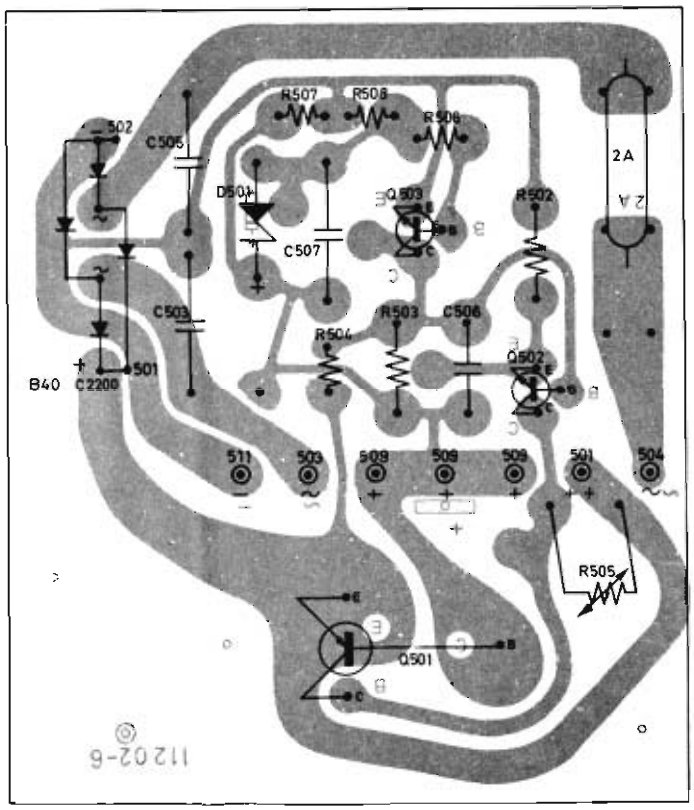
Ref. no.	Specification				Notes
C710 - 1200X	2,2 µF	100V		Electrolytic	
C711 - 1200X	2,2 µF	100V		Electrolytic	
C712 - 1200X	2,2 µF	100V		Electrolytic	
C713 - 1200X	4700 pF	630V	10%	Met. paper	
C714 - 1200X	4700 pF	630V	10%	Met. paper	
C715 - 1200X	0,01 µF	400V	10%	Met. paper	
C716 - 1200X	0,01 µF	400V	10%	Met. paper	
C717 - 1200X	2,2 µF	100V		Electrolytic	
C718 - 1200X	2,2 µF	100V		Electrolytic	
C719 - 1200X	22 µF	25V		Electrolytic	
C720 - 1200X	22 µF	25V		Electrolytic	
C721 - 1200X	100 µF	40V		Electrolytic	
C801 - 1200X	400 pF	160V	10%	Polystyrene	
C802 - 1200X	400 pF	160V	10%	Polystyrene	
C903 - 1200X	0,1 µF	200V	10%	Met. paper	
C904 - 1200X	100 µF	40V		Electrolytic	
C905 - 1200X	0,1 µF	200V	10%	Met. paper	
C906 - 1200X	1000 pF	500V	20/50%	Ceramic	
C907 - 1200X	0,68 µF	100V	10%	Polyester	



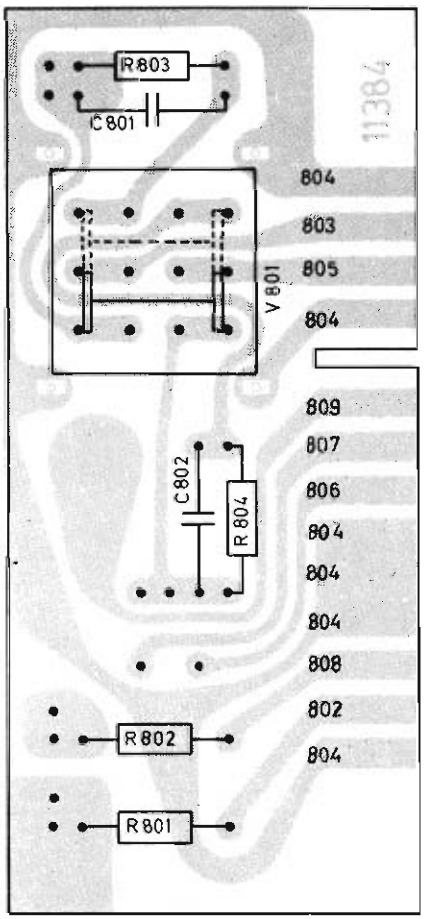
Board for equalizing amplifiers, preamplifiers, indicator amplifiers and oscillator, printed side



Output amplifier board, seen from printed side



Rectifier board, seen from printed side.
Before serial no. approx. 2 251 955



Line input circuit board.
printed side.

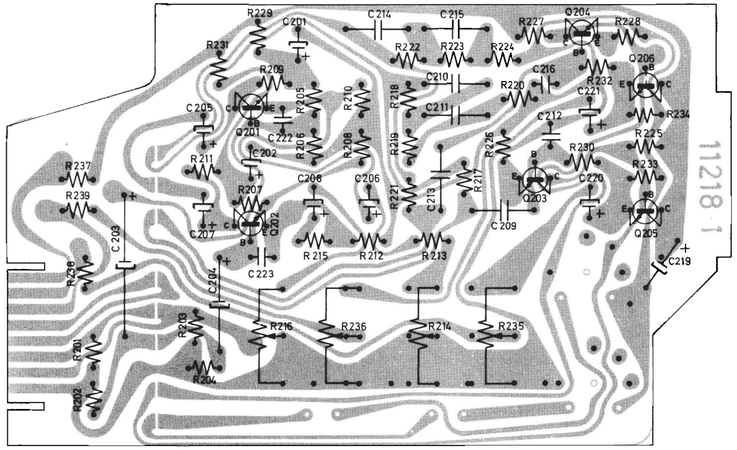
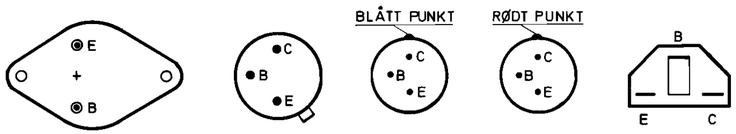
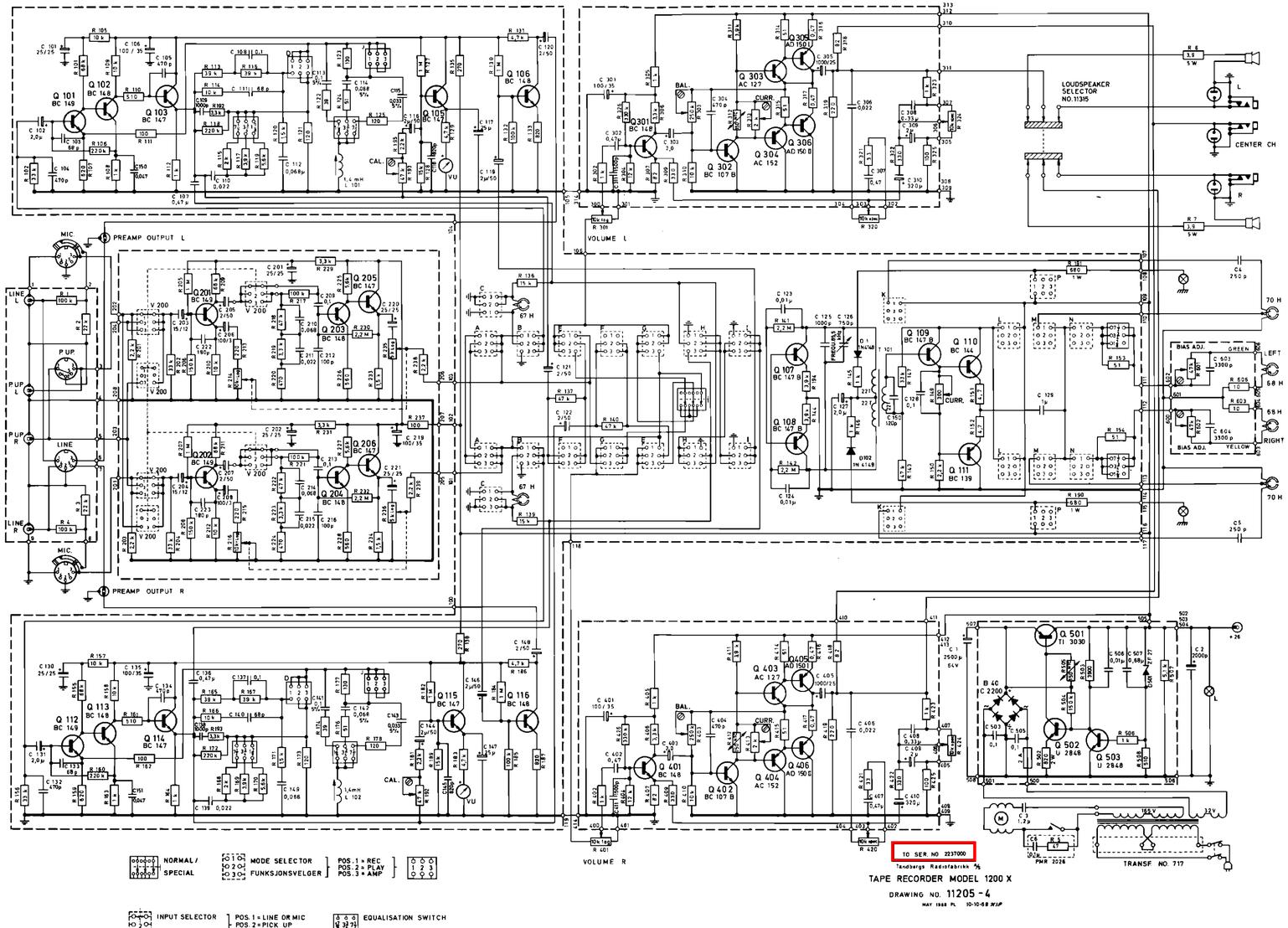


Plate for inngangsforsterkerne, sett fra foliesiden. Før serienr. ca. 2 237 000
Input amplifier board, seen from printed side. Before serial no.approx. 2 237 000



Transistorene, sett fra undersiden
Transistors, seen from underneath



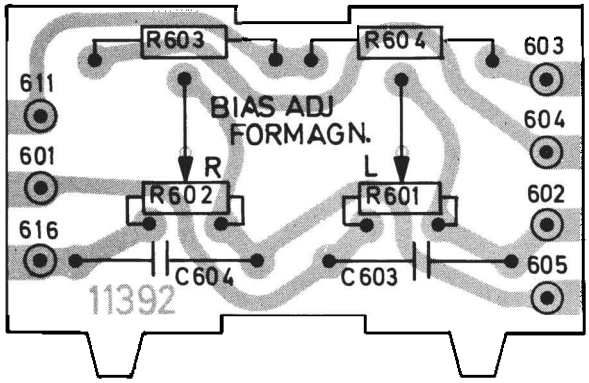


Plate for justering av formagnetiseringen, sett fra foliesiden.
Fra serienr. ca. 2 247 876

Bias adjustment board, printed side.
From serial no. approx. 2 247 876

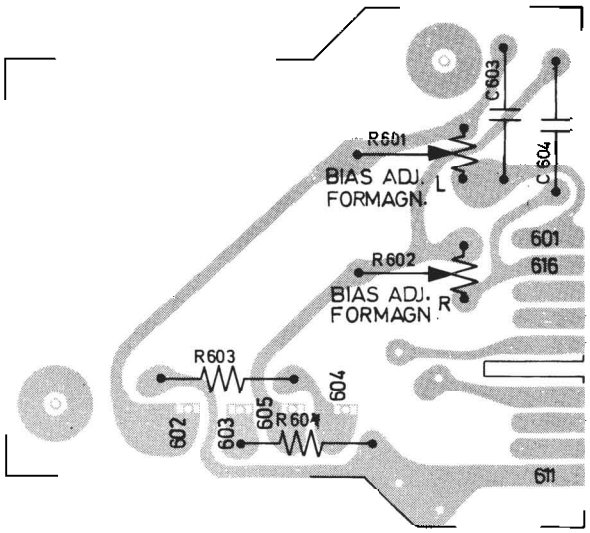
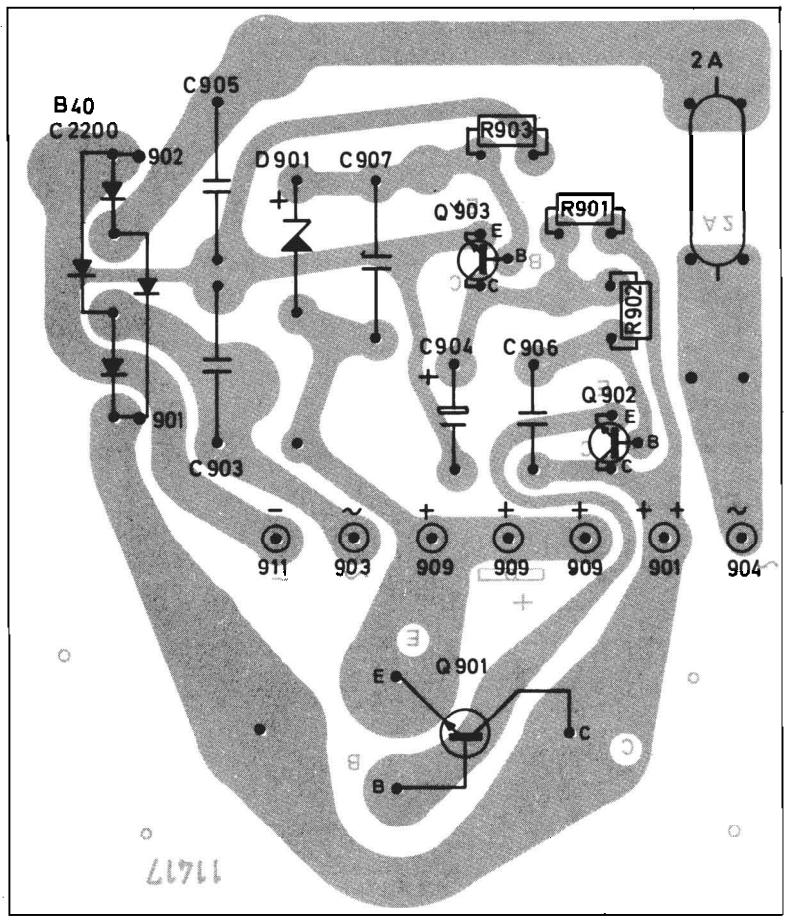


Plate for justering av formagnetiseringen, sett fra foliesiden. Før serienr. 2 247 876

Bias adjustment board, printed side.
Before serial no. 2 247 876



Likeretterplaten, sett fra foliesiden.
Fra serienr. ca. 2 251 955.

Rectifier board, seen from printed side. From serial no. approx. 2 251 955.

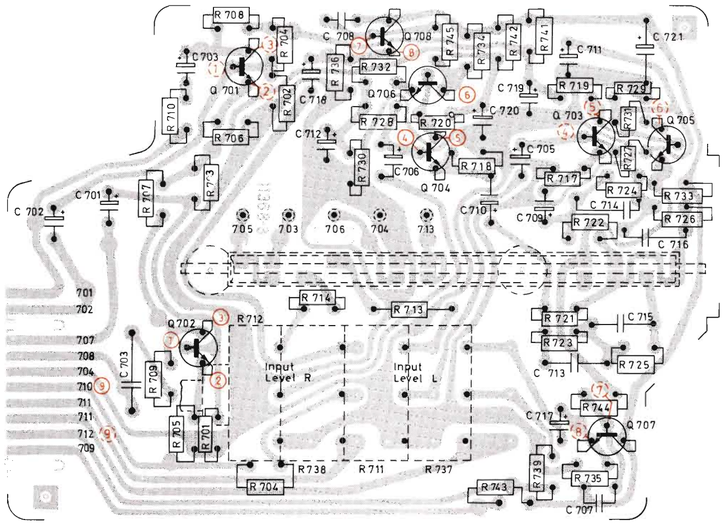
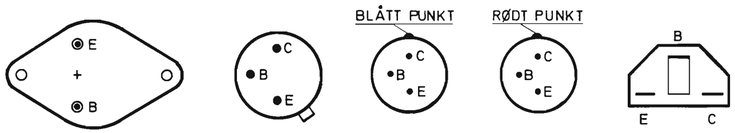


Plate for inngangsforsterkerne, sett fra foliesiden. Fra serienr. ca. 2 237 000
Input amplifier board, seen from printed side. From serial no.approx. 2237000



AD 150
TI 3030
2N3055
AUY 21
2N5034

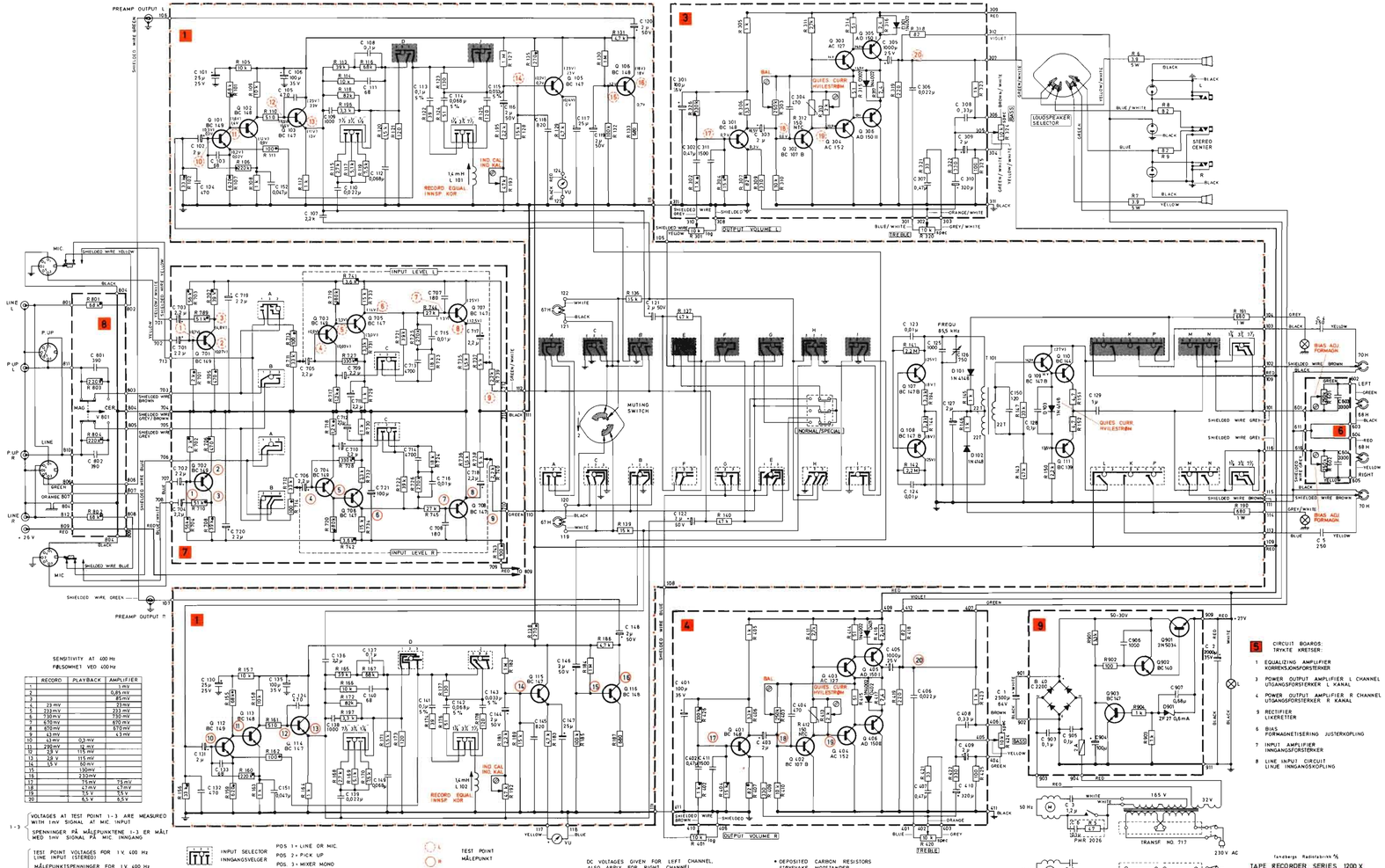
U 2848
BC107
BC139
BC140
BC144
BC160

AC 127

AC 152

BC 147
BC 148
BC 149

Transistorene, sett fra undersiden
Transistors, seen from underneath



SENSITIVITY AT 400 Hz
FØLSOMHET VED 400 Hz

	RECORD	PLAYBACK	AMPLIFIER
1			1 mV
2			0,85 mV
3			85 mV
4	23 mV		23 mV
5	233 mV		233 mV
6	330 mV		330 mV
7	670 mV		670 mV
8	870 mV		870 mV
9	43 mV		43 mV
10	43 mV	0,3 mV	
11	290 mV	16 mV	
12	0,9 V	115 mV	
13	2,8 V	115 mV	
14	3,5 V	150 mV	
15		150mV	
16		230mV	
17		75 mV	75 mV
18		67mV	67mV
19		5,5 V	5,5 V
20		6,5 V	6,5 V

1 - 3 VOLTAGES AT TEST POINT 1-3 ARE MEASURED WITH 1mV SIGNAL AT MIC INPUT
SPENNINGER PÅ MÅLEPUNKTENE 1-3 ER MÅLT MED 1mV SIGNAL PÅ MIC INNGANG

4 - 20 TEST POINT VOLTAGES FOR 1 V, 400 Hz LINE INPUT (STEREO)
MÅLEPUNKTSPENNINGER FOR 1V, 400 Hz SIGNAL PÅ LINE INNGANG (STEREO)

INPUT POTENTIOMETER ADJUSTED FOR 43 mV IN TEST POINT 9
INNGANGSPOTMETER INNSTILT TIL 43 mV I PUNKT 9

INPUT SELECTOR
INNGANGSVELGER
POS. 1 = LINE OR MIC
POS. 2 = PICK UP
POS. 3 = MIXER MONO

EQUALIZATION SWITCH
KORREKSJONSVENDER

MODE SWITCH, LEFT
FUNKSJONSVELGER, VENSTRE

MODE SWITCH, RIGHT
FUNKSJONSVELGER, HØYRE

POS. 1 = RECORD
POS. 2 = PLAYBACK
POS. 3 = AMPLIFIER

TEST POINT
MÅLEPUNKT

BOARD NO.
KORT NR

BIAS ADJ

PRESET CONTROL
FAST INNSTILT REGULERING

INPUT LEVEL

OPERATING CONTROL
REGULERINGSORGAN

DC VOLTAGES GIVEN FOR LEFT CHANNEL. ALSO APPLY FOR RIGHT CHANNEL. VOLTAGE MAGNITUDE IN PARANTHESIS REFER TO RECORD MODE

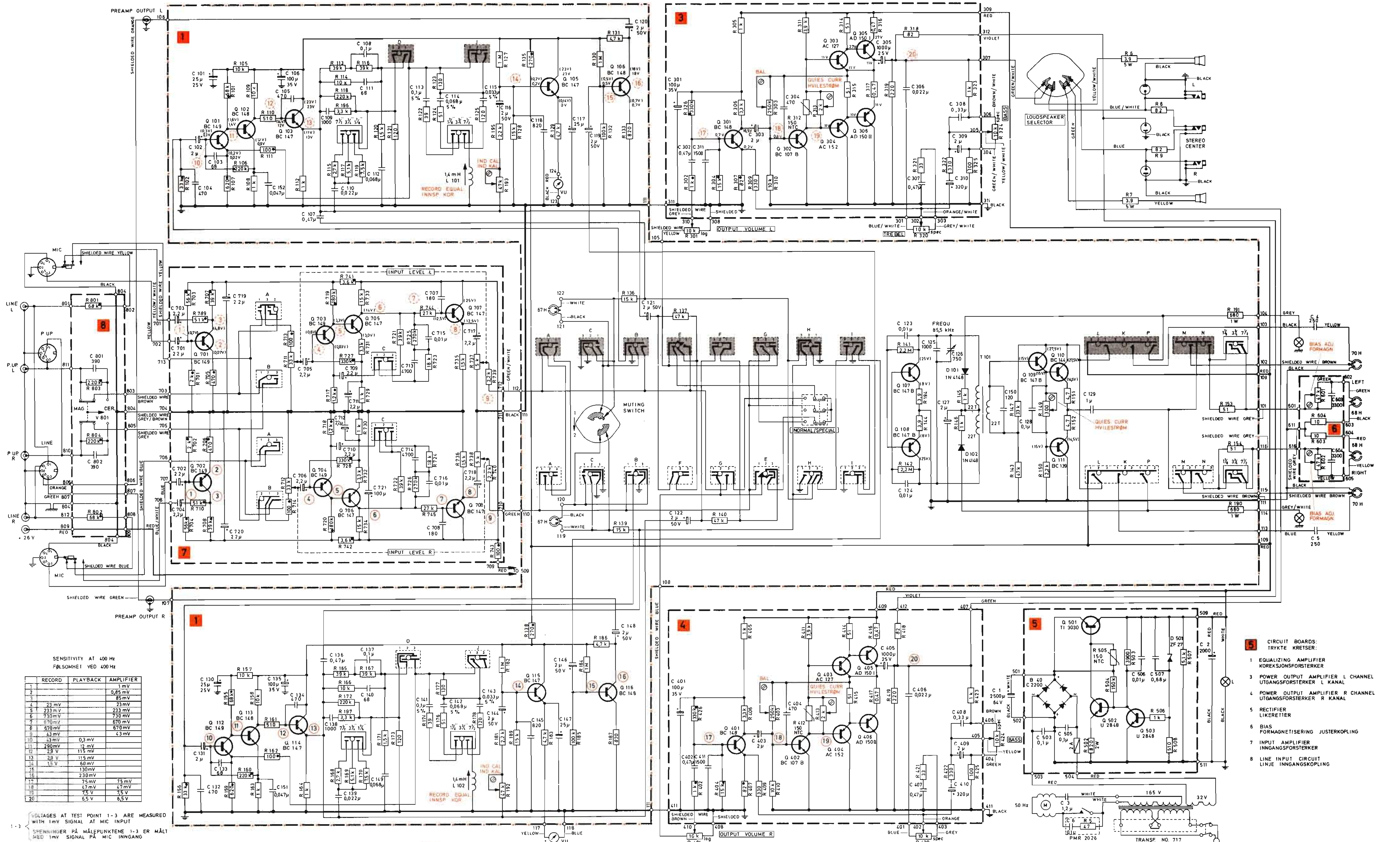
LIKESPENNINGER ANGITT FOR VENSTRE KANAL. GJELDER OGSÅ FOR HØYRE KANAL. SPENNINGSVERDIER I PARENTES REFERER SEG TIL INNSPILLING

* DEPOSITED CARBON RESISTORS
STØYSVAKE MOTSTANDER

CHASS GND.
SJASSI JORD

5 CIRCUIT BOARDS:
TRYKTE KRETSER:

1 EQUALIZING AMPLIFIER
KORREKSJONSFORSTERKER
3 POWER OUTPUT AMPLIFIER L CHANNEL
UTGANGSFORSTERKER L KANAL
4 POWER OUTPUT AMPLIFIER R CHANNEL
UTGANGSFORSTERKER R KANAL
9 RECTIFIER
LIKERETTER
6 BIAS
FORMAGNETISERING JUSTERKOPLING
7 INPUT AMPLIFIER
INNGANGSFORSTERKER
8 LINE INPUT CIRCUIT
LINJE INNGANGSKOPLING



SENSITIVITY AT 400 Hz
FØLSOMHET VED 400 Hz

	RECORD	PLAYBACK	AMPLIFIER
1			1 mV
2			0,85 mV
3			85 mV
4	23 mV		23 mV
5	233 mV		233 mV
6	730 mV		730 mV
7	670 mV		670 mV
8	670 mV		670 mV
9	43 mV		43 mV
10	43 mV	0,3 mV	
11	290 mV	12 mV	
12	2,9 V	115 mV	
13	2,9 V	115 mV	
14	1,5 V	60 mV	
15		130 mV	
16		230 mV	
17		75 mV	75 mV
18		47 mV	47 mV
19		7,5 V	7,5 V
20		6,5 V	6,5 V

1 - 3: VOLTAGES AT TEST POINT 1 - 3 ARE MEASURED WITH 1 mV SIGNAL AT MIC INPUT
SPENNINGER PÅ MÅLEPUNKTENE 1 - 3 ER MÅLT MED 1 mV SIGNAL PÅ MIC INNGANG

4 - 20: TEST POINT VOLTAGES FOR 1 V, 400 Hz LINE INPUT (STEREO)
MÅLEPUNKTSPENNINGER FOR 1 V, 400 Hz SIGNAL PÅ LINE INNGANG (STEREO)
INPUT POTENTIOMETER ADJUSTED FOR 43 mV IN TEST POINT 9
INNGANGSPOTMETER INNSTILT TIL 43 mV I PUNKT 9

INPUT SELECTOR / INNGANGSVELGER — POS 1 = LINE OR MIC, POS 2 = PICK UP, POS 3 = MIXER MONO

EQUALIZATION SWITCH / KORREKSJONSVENDER

MODE SWITCH, LEFT / FUNKSJONSVELGER, VENSTRE
MODE SWITCH, RIGHT / FUNKSJONSVELGER, HØYRE
— POS 1 = RECORD, POS 2 = PLAYBACK, POS. 3 = AMPLIFIER

TEST POINT / MÅLEPUNKT

BOARD NO / KORT NR.

BIAS ADJ — PRESET CONTROL / FAST INNSTILT REGULERING

INPUT LEVEL — OPERATING CONTROL / REGULERINGSORGAN

DC VOLTAGES GIVEN FOR LEFT CHANNEL, ALSO APPLY FOR RIGHT CHANNEL. VOLTAGE MAGNITUDE IN PARANTHESIS REFER TO RECORD MODE

LIKESPENNINGER ANGITT FOR VENSTRE KANAL, GJELDER OGSÅ FOR HØYRE KANAL. SPENNINGSVERDIER I PARENTES REFERER SEG TIL INNSPILLING

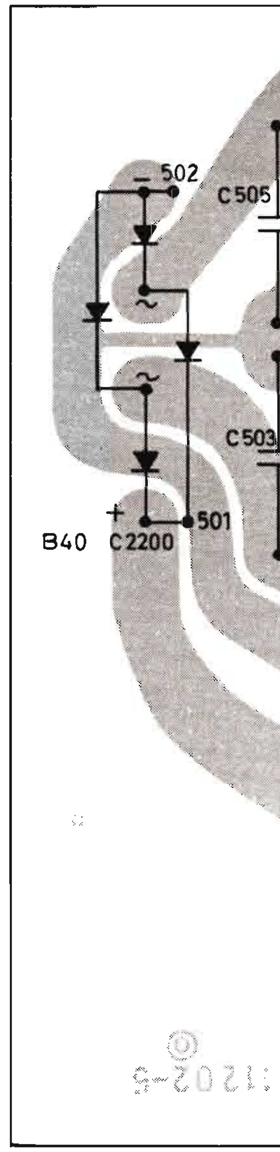
• DEPOSITED CARBON RESISTORS / STØYSVAKE MOTSTANDER

CHASS GND. / SJASSI JORD

CIRCUIT BOARDS: / TRYKTE KRETSER:

1. EQUALIZING AMPLIFIER / KOREKSJONSFORSTERKER
3. POWER OUTPUT AMPLIFIER L CHANNEL / UTGANGSFORSTERKER L KANAL
4. POWER OUTPUT AMPLIFIER R CHANNEL / UTGANGSFORSTERKER R KANAL
5. RECTIFIER / LIKERETTER
6. BIAS / FORMAGNETISERING JUSTERKOPLING
7. INPUT AMPLIFIER / INNGANGSFORSTERKER
8. LINE INPUT CIRCUIT / LINJE INNGANGSKOPLING

Tandbergs Radiofabrikk A/S
TAPE RECORDER SERIES 1200 X
FROM SER. NO. 2237000
DRAWING NO. 11205 -7
DECEMBER 1968
APRIL 1969



Likeretterplate, sett fra foliesiden

Rectifier board, seen from printed side

CIRCUIT DIAGRAM AND PRINTED CIRCUIT BOARDS TANDBERG TAPE RECORDER MODEL 1200 X

No. 617 - 4 - 69 - 256145. SEM & STENERSEN A/S

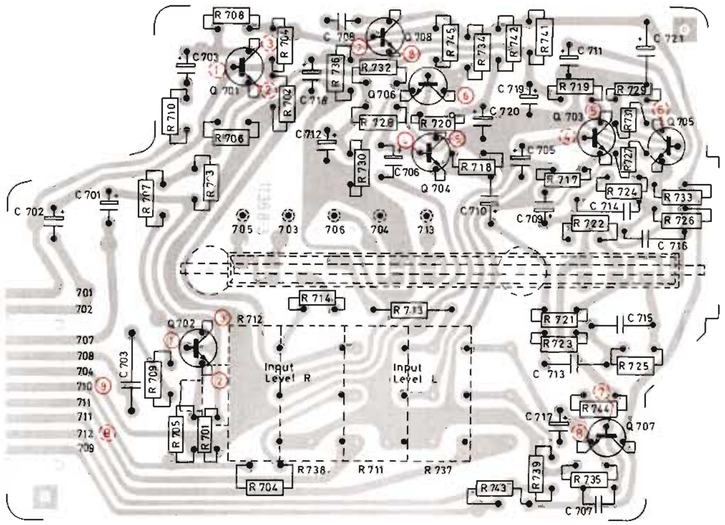


Plate for inngangsforsterkere, sett fra foliesiden

Input amplifier board, seen from printed side

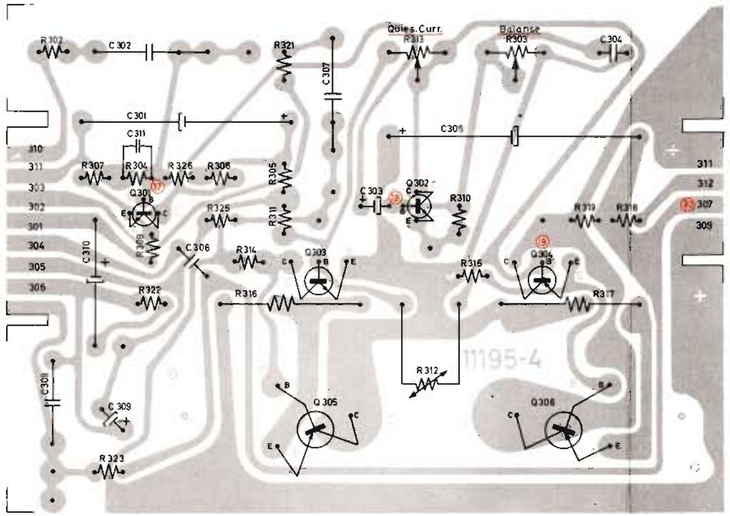


Plate for utgangsforsterkere, sett fra foliesiden

Output amplifier board, seen from printed side

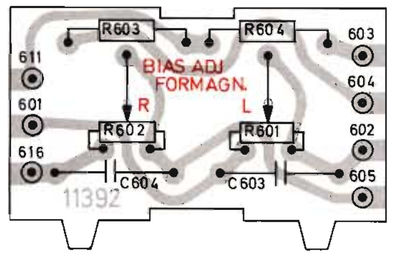


Plate for justering av formagnetisering, foliesiden. Fra serienr. 2247876.

Bias adjustment board printed side, from serial no. approx. 2247876.

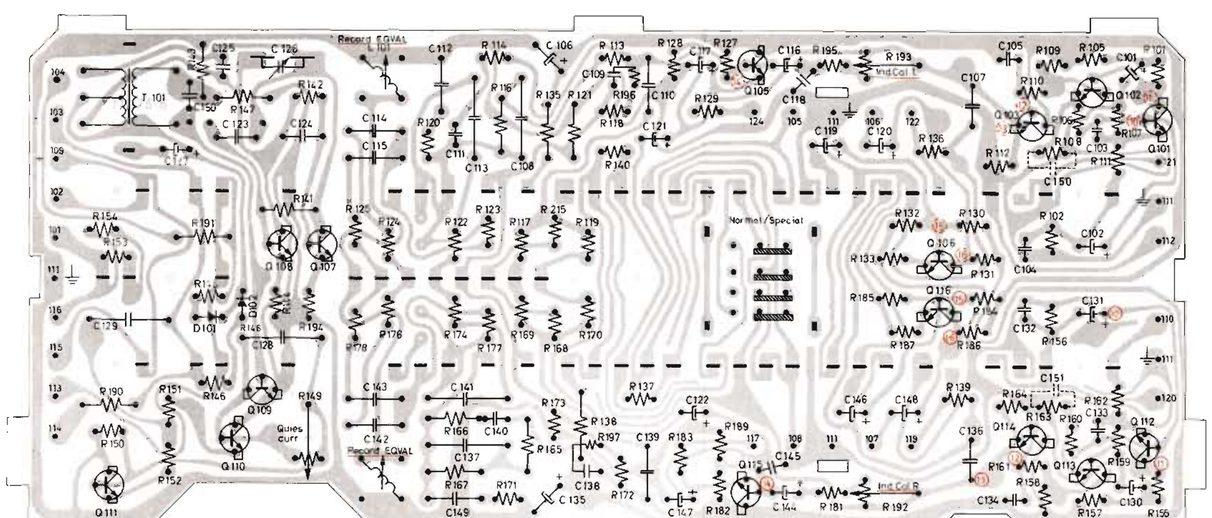
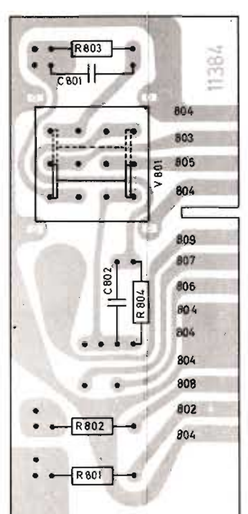


Plate for korreksjonsforsterkere, forforsterkere, indikatorforsterkere og oscillator, sett fra foliesiden

Board for equalising amplifiers, preamplifier, bias oscillator and indicator amplifier, seen from printed side



Kort for linje inngangskopling, sett fra foliesiden

Board for line input circuit, seen from printed side

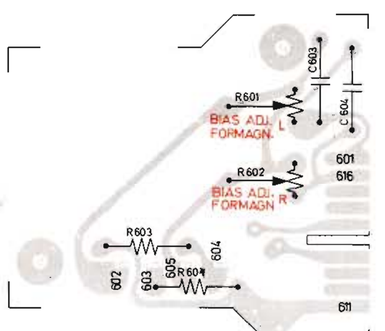


Plate for justering av formagnetisering, foliesiden. Før serienr. 2247876.

Bias adjustment board printed side, before serial no. approx. 2247876.

LUBRICATING

The motor:

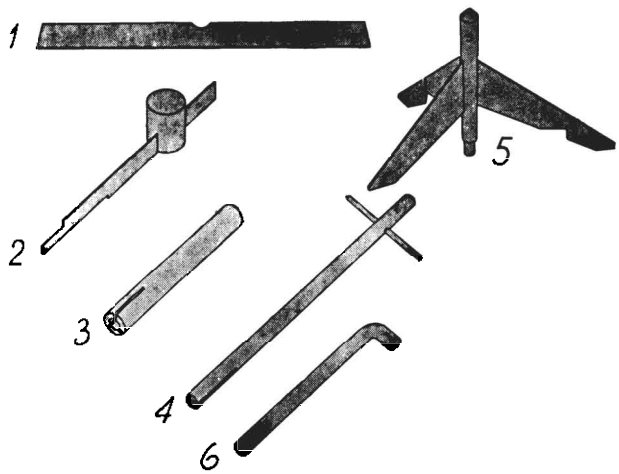
The motor should be lubricated after approx. every 3000 hours of use.

The upper and the lower bearing should be lubricated with a Teresso oil 43 or 47 from Esso.

The self-lubricating bearings:

The turntables, the flywheel, and the speed transfer wheel are mounted in self-lubricating bearings and should usually not be lubricated. If, however, it should be necessary to lubricate the bearings for any reason, use Teresso oil 43 or 47 from Esso.

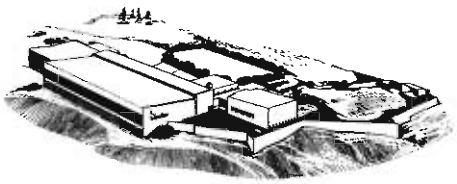
Note: Utmost care must be taken while lubricating, use only one fractional drop of oil for each bearing. Excessive oil might seriously affect the friction drive.



Set of special tools.

Tandberg RADIO

Tandbergs Radiofabrikk A/S, Kjelsås.



Tandbergs Radiofabrikk A/S, avd. Kjeller.

TANDBERGS RADIOFABRIKK A/S

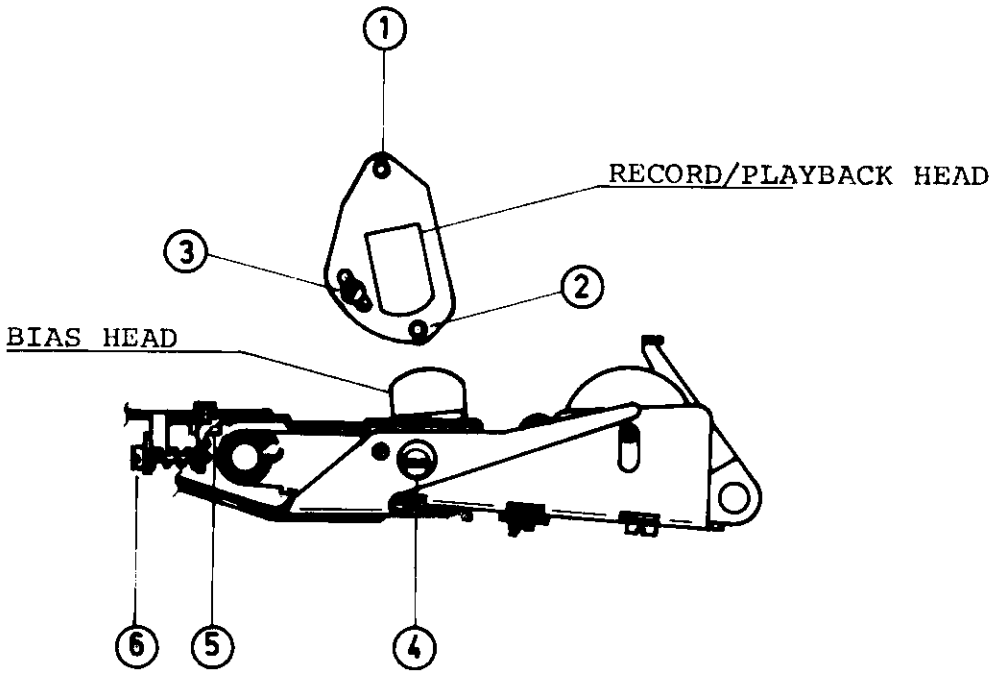
P. O. B. 9, Korsvoll, Oslo 8, Norway

713 - 2 - 70 Sem & Stenersen

No. 79
Oslo, 13th December 1968

Series 1200x

Alignment of record/playback head, bias head, record current and record level indicator



1.0 Record/playback head

1.1 Side position

Check by visual inspection that the tape appears to touch the head in the middle of the curved surface, i.e. both sides of the head should form the same angle with the tape.

FEBRUARY 1969

TANDBERG SERVICE BULLETIN NO. 79

MODEL 1200X

1.2 Height

Adjust the height of the head by means of the two height adjustment screws (1 and 2) in such a way that the tape and the upper track on the head coincide along the upper edge.

1.3 Azimuth

Play back a tape containing a 10.000 Hz signal recorded at constant amplitude. Turn the azimuth screw (3) until maximum voltage is measured at the PREAMP output.

1.4 Final side adjustment

Brake the supply (left) reel lightly. This should not cause more than .5 dB increase of the voltage measured at the PREAMP output. If this tolerance is exceeded, turn the head to one side or the other until an increase of the tape tension (imposed by braking) does not cause an output voltage increase by more than .5 dB. Avoid turning the head too much to the right, as this may cause poor recording quality. Dependence of tape tension on output voltage may also be caused by the head front being obliquely positioned with respect to the capstan, low pressure wheel tension, or tape tracking over to one side of the guide posts.

1.5 Height adjustment by means of track measurement

Using any type of signal, record in stereo, first in one direction and then in the other. Check by means of ferrite oxyde powder that the tracks are correctly distributed across the width of the tape. (Equal spacings between the tracks 1, 2 and 3, and the half of that spacing from tracks 1 and 4 to the edges of the tape. If the tracks are not correctly distributed, readjust head height by means of screws 1 and 2. Be careful not to upset the parallel position of the head front with respect to the capstan. Repeat azimuth alignment (1.3).

2.0 Bias head

2.1 Bias current

Measure the voltage across the 10 ohm resistors R603 and R606. Adjust R601 and R602 for a voltage of 500 mV corresponding to 50 mA bias current.

2.2 Alignment of bias head

Set tape recorder in RECORD mode and unscrew the locking screw (5), about 1/2 turn. Connect a vacuum tube voltmeter to each one of the head halves, using black lead as common. Set the adjustment screw (6) for highest possible voltmeter reading. Then adjust the height screw (4) for maximum voltage which should be between 2 and 4 volts. Finally turn the screw (6) clockwise until the voltage has dropped by about 10% (5-15%), and tighten the locking screw (5). Demagnetize heads and tape path.

Note! Any use of tools in the vicinity of heads and tape path must be succeeded by careful demagnetization.

3.0 Verification of frequency curves

Start tape recorder in RECORD mode at 3-3/4 ips, and record a 400 Hz signal from a generator. Set INPUT LEVEL for 0 dB indication on the record level meters. Reduce the generator voltage by 25 dB and record 400 Hz, 5kHz, 10 kHz and 15 kHz.

Play back the recorded signals and measure the voltage at PREAMP-output, taking the voltage at 400 Hz as 0 dB reference. Check that the frequency curve is flat within ± 2 dB up to 15 kHz. If this is not so, the bias current should be increased or decreased by trial and error until a satisfactory frequency curve is obtained. The bias current must under no circumstances be less than 40 mA (400 mV) measured across R603 and R606. Check the frequency response also at the two other tape speeds.

4.0 Calibration of the record level meters

Play the test tape containing 400 Hz 1.5 V at 7-1/2 ips, and measure the voltage at both PREAMP-outputs. Make a note of the dB readings.

Record on a new tape Scotch 215 a 400 Hz signal of an amplitude resulting in 2 dB more than the 1.5V test tape when played back. It may be necessary to record and play back several times to obtain the desired result. Check that distortion is less than 5%. Finally set R192 and R193 for 0 dB indication on the record level meter when recording at this level.

No. 81

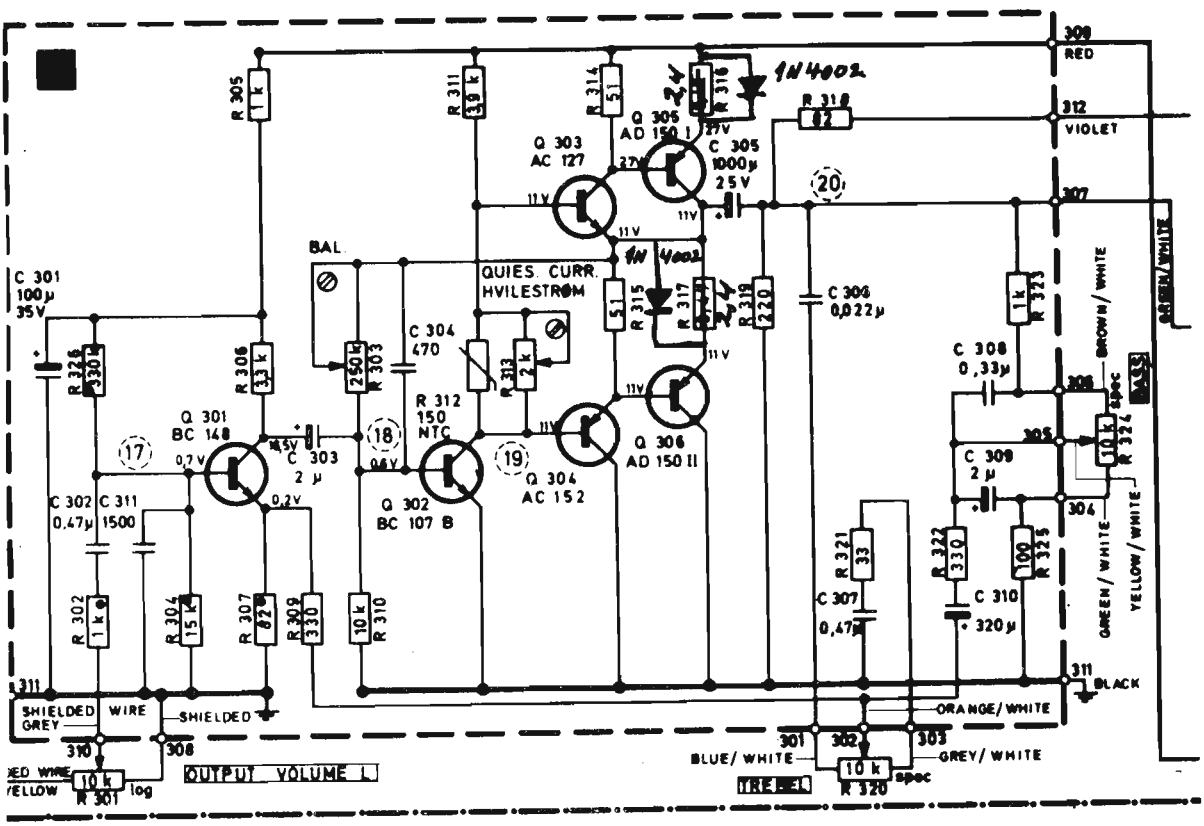
Oslo, 4th June 1969

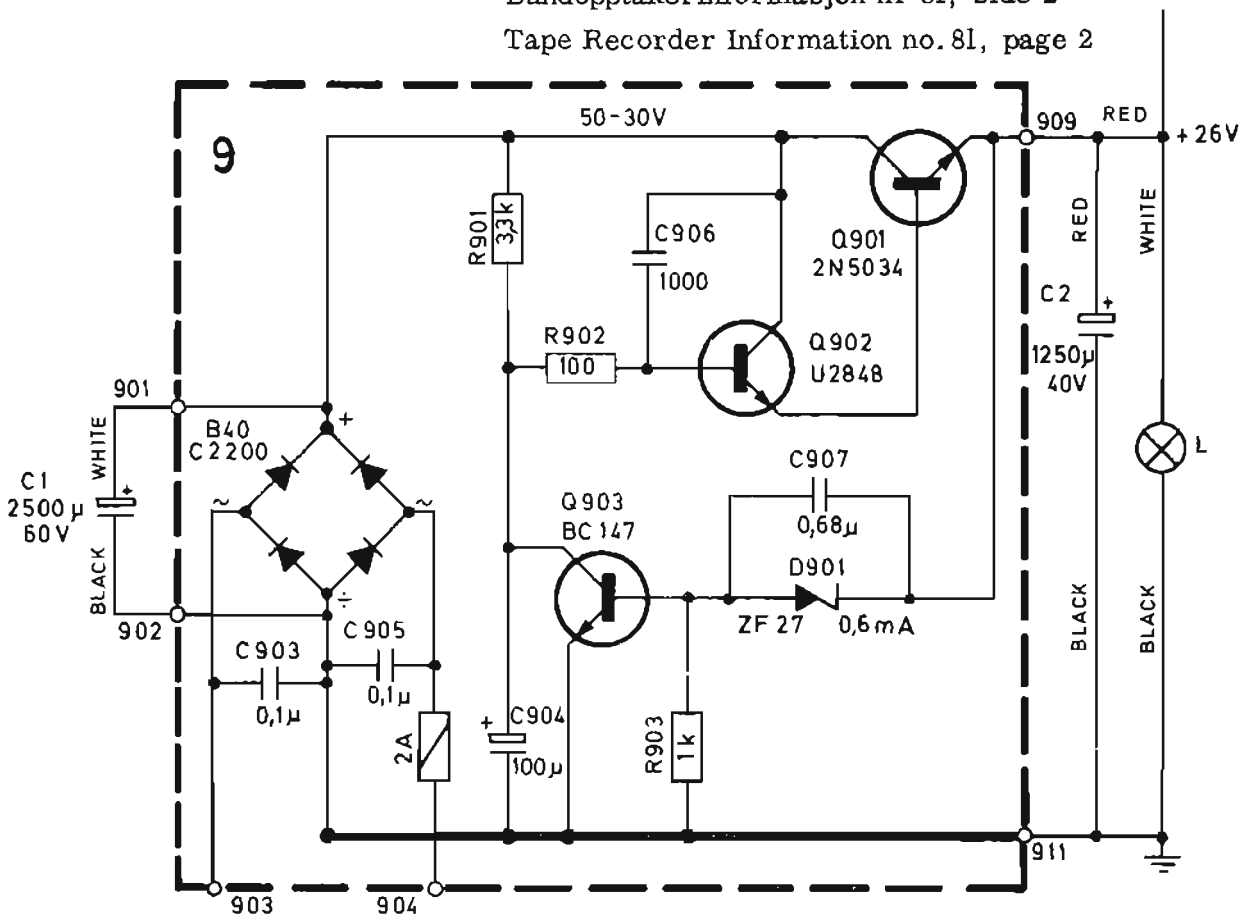
Series 1200X

New Power Supply

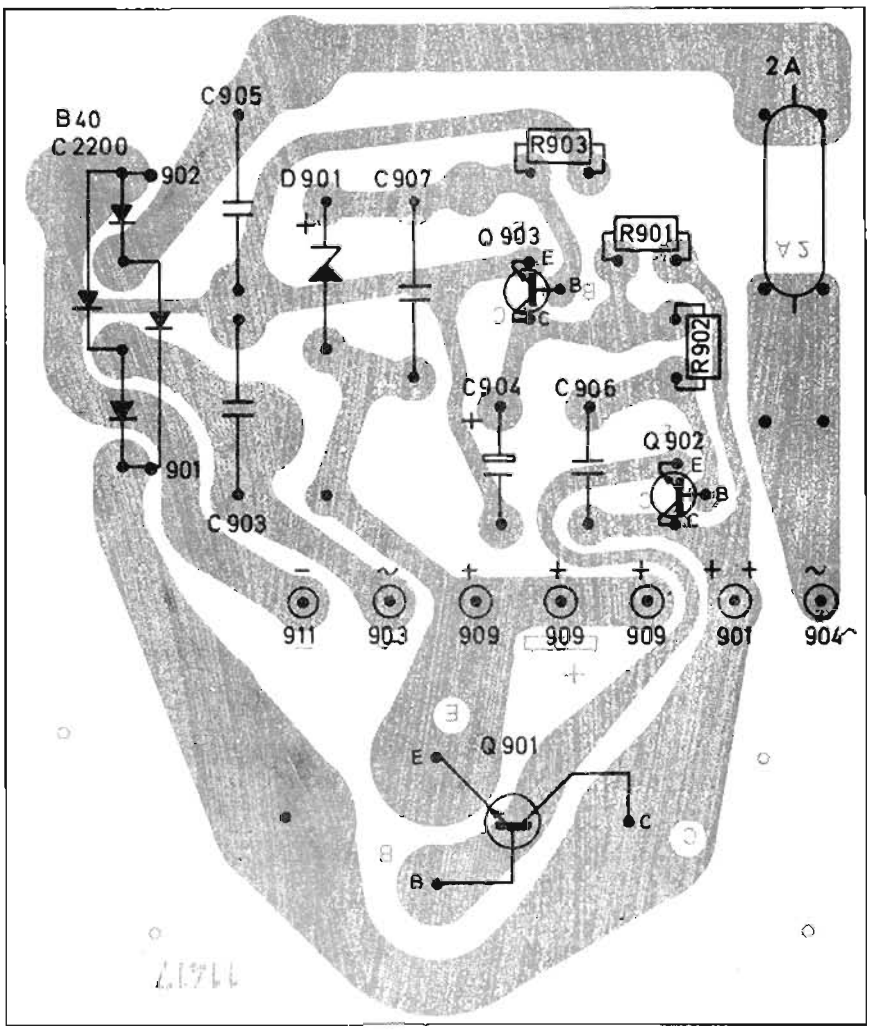
From serial number 2 251 955 the design of the power supply has been altered. The circuit diagram and component board are shown on the attached sheet. Transistor type 2N 3055 is temporarily used in position Q901

Simultanously the value of the emitter resistors R316, R317, R416 and R417 have been increased from 0.47 ohm to 2.4 ohm, and a 1N 4002 diode has been connected in parallel with each one of the emitter resistors. See circuit diagram below.





Skjema for strømforsyning
Circuit diagram for power supply



Komponentplate sett fra foliesiden
Component board seen from print side

No. 89

Oslo, 12th November 1969

Series 1200X

2-track and 4-track versions

From serial number 2256701, a number of 2-track machines are produced. These diverge from the 4-track models in the following:

Component	2-track
Q110	2N 4921) Matched
Q111	2N 4918) pair
Q109	BC 140
R150	1 kohm
Record/playback head	76 H, art. no. A27
Cross-Field head	77 H, art. no. A28
Erase head	75 H, art. no. A26

(Ref. wiring diagram, Model 1200X, part no. 267401).

To ensure sufficient heat conduction from the transistors Q110/Q111, these are in the 2-track model located on a separate board (no. 11427). The board is mounted directly on the chassis, and wired to the oscillator board. On fig. 1 and 2, the board is shown in its true size. To enhance thermal conductivity and provide electrical isolation, mica washers , coated with silicon grease, are placed between the transistor housing and chassis.

The 2-track model is also equipped with individually tuned bias- and erase heads. The values of C603, C604 (bias head),and C4, C5 (erase head) are labeled on the bias- and erase heads, respectively. The capacitances are given in pF. Upper number refers to upper track. (Also ref. Tape Recorder Information no. 88, "Too low bias voltage").

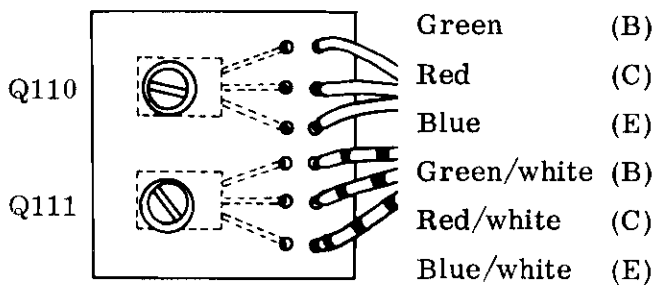


Fig. 1.

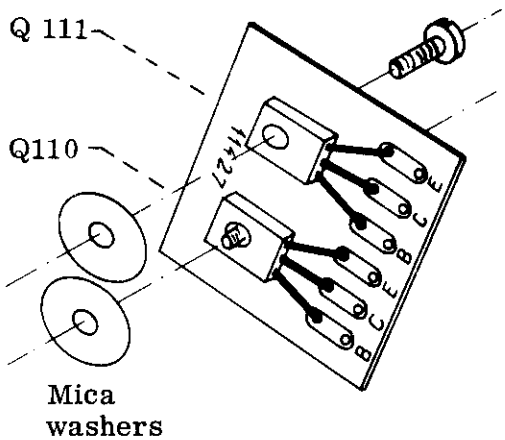


Fig. 2.

No. 93
Oslo, 26th May 1970

Series 1200X

Erratic operation of function selectors.

In the first few units of series 1200X, a failure characterized by strong noise and intermittant signal can occur. This trouble is likely to be caused by erratic contact closure in the function selectors, particularly sections D in both channels.

Procedure for replacement of contact springs.

Remove the tape deck from the cabinet and place tape recorder on the front side so that bottom of the tape recorder is accessible. See fig. 1.

Location of the D-contacts is shown on fig. 2.

Remove the two screws which hold the selector bar and the sliding contact strip together. Then remove the D-contacts. Clean the contact surfaces on the selector thoroughly and lubricate with a thin film of anti-corrosion contact oil.

Install the new contact spring. Ensure by visual inspection and functional check, that the contact spring aligns perfectly with the printed contacts in all three positions of the selector.

If the operation is still erratic, give the B- and C-contacts the same treatment.

Fig. 1

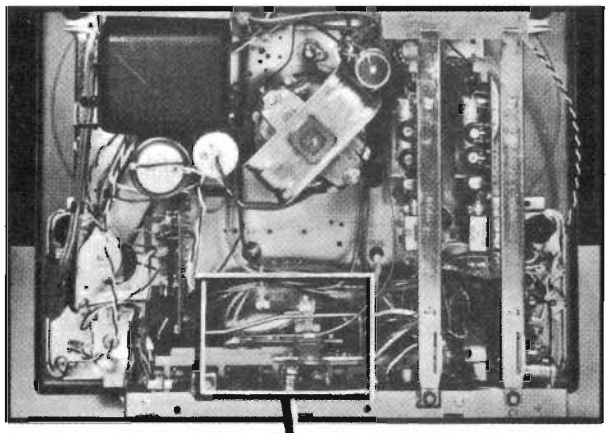
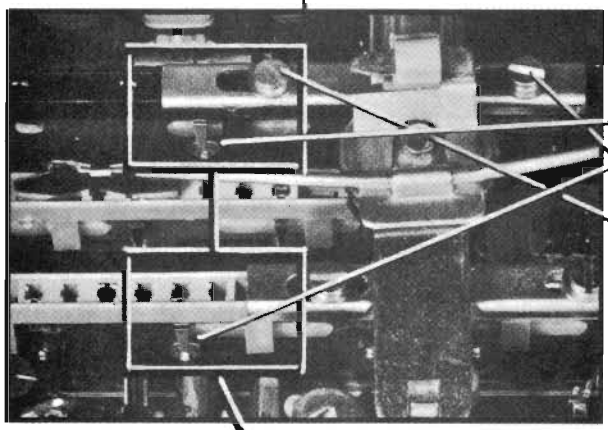


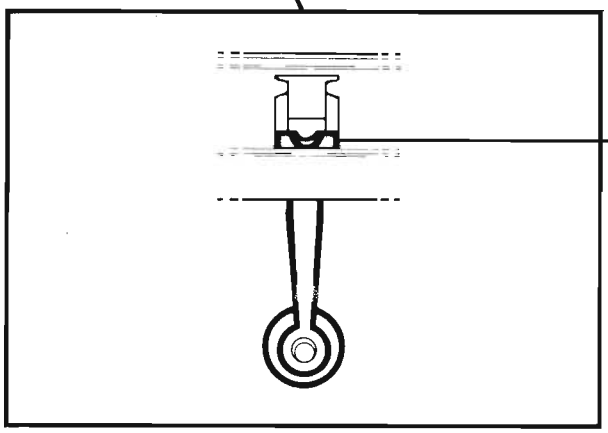
Fig. 2



D-contacts L and R.

Remove these screws.

Fig. 3



Bend up the flap and remove the contact spring.

TANDBERG OF AMERICA, INC.
8 THIRD AVE.
PELHAM, N. Y. 10803

PRICE LIST

SPARE PARTS FOR TANDBERG TAPE RECORDER 1200X

Mechanical Parts

	Ref. No.	Description	List Price
(6C)	33.17 200384-12X	Insulation Shield, Mains Switch	.30
(6C)	72.1 200549-12X	Flange for Take Up Turntable Housing (Delrin)	.30
(X)	201957-12X	Shaft, Arm, Pressure Pad	.30
(6C)	33.22 202102-12X	Phono Connector, PREAMP/LINE	.85
	30.16	Switch, Microswitch Rx1	4.20
(7)	31.5 202303-12X	Rubber Mounting Tube	.15
	50.17 202309-12X	Shaft, Eccentric Lever	.15
(12)	32.3 202726-12X	Knob, Bass and Treble Control	.15
	50.12 202740-12X	Lever, Additional Friction	.55
	70.35 203013-12X	Retaining Washer, Flywheel Bearing	.15
(X)	203078-12X	Terminal Strip w/soldering lug for C2	.05
(6)	44.3 203365-12X	Shield, lamp, revolution counter	.30
(6C)	59.31 203559-12X	Spring for index lever, supply turntable	.55
(6C)	59.11 203638-12X	Shaft for Clutch Lever	.15
	203990-12X	Spacer, lower mounting plate	1.40
(6)	33.9	Mains Switch (ON-OFF)	1.40
(12)	18.14	Clamp, driver transistors AC127/AC152	.30
	205671-12X	Stud, Parallel Arm and Cover Plate	.05

	Ref. No.	Description	List Price
	74.6 206017-12X	Rubber Washer, Top Cover	.15
(6)	79.25 206296-12X	Window, Revolution Counter	.85
(7)	59.16 207273-12X	Spring for Lingage Arm	.15
(6C)	59.29 207352-12X	Shaft for Index Lever	.15
	60.6 207625-12X	Spring, Clutch Lever	.15
(6C)	51.9 207977-12X	Roller, Pressure Wheel Bracket	.30
	60.3 208250-12X	Bearing, Self-Lubricating, Flywheel	.55
(6)	73.2 208329-12X	Cover, Heads, Front	5.60
(6C)	32.14 208444-12X	Felt Washer, Knob	.30
(6C)	53.5-2 209306-12X	Spring, transfer wheel holder	.15
(6)	209385-12X	Stud, Eccentric Lever	.05
(6C)	69.3 210283-12X	Rubber Belt, Revolution Counter	1.40
(6C)	59.14 210987-12X	Spring for Lower Clutch Lever, Take-Up Friction Disc	.15
(F)	51.6 211066-12X	Shaft for Pressure Wheel Forked Lever	.55
	211145-12X	Index Lever	.55
(6)	69.2 211339-12X	Pulley For Revolution Counter (On Turn-Table Shaft)	.55
(X)	211418-12X	Shaft, Clutch Lever	.30
(6C)	74.7 211612-12X	Rubber Mounting, Lower	.30
(7)	39.9 211763	Spring, Interlock Arm	.30
(6)	73.1 212043-12X	Trim Cover (Heads)	4.20
	212273-12X	Operating Lever, Start-Stop	.85

	Ref. No.	Description	List Price
(7)	79.13 212747-12X	Tape Guide Post, Left	1.40
	212826-12X	Forked Lever, Pressure Roller Assembly	.85
	213099-12X	Stud w/Groove for Circlip	.05
	213602-12X	Bracket, Operating Lever	.85
(6C)	62.2 213997-12X	Rubber Drive Belt	2.80
(6C)	54.11 214155-12X	Clip, Operating Lever	.15
(6C)	61.3 214701-12X	Spring, Right Friction Disc	.15
(6)	44.2 214925-12X	Socket, Lamp, Revolution Counter	.30
(6C)	69.1 215053-12X	Pulley For Revolution Counter (Turntable)	.55
(6C)	74.8 215326A-12X	Rubber Mounting, Upper	.30
	215405-12X	Momentary Stop, Delrin Part	.15
(7)	51.7 215556-12X	Spring for Pressure Wheel Bracket	.30
	70.19 215563-12X	Adjuster, Spring, Pressure Wheel	.15
	215678-12X	Bearing, Self-Lubricating, Turntable	.30
(6C)	61.6-1 215743-12X	Mylar Sheet, Friction Disc	.55
	216109-12X	Rivet, Linkage Arm	.05
	70.16 217461A-12X	Adjustable Tape Guide, Middle	1.40
(X)	216599-12X	Cooling Fin, Transistors Q110/111	.15
(3C)	70.39 216734-12X	Spring, Speed Selector	.15
(X)	216957-12X	Terminal Strip, Motor	.15
(6C)	59.32 217086-12X	Delrin Button, Clutch Levers	.15
(6C)	61.11 217510-12X	Spring, Tape Tight Disc	.05

	Ref. No.	Description	List Price
(6C)	65.4 217783-12X	Tape Reel Holder	.55
	66.12 217869-12X	Thrust Washer, Lower Flywheel Bearing	.15
(7X)	59.14 218063-12X	Spring, Pressure Pad Arm	.30
(7)	39.6 218099-12X	Arm, Interlock	.55
	61.3 218415-12X	Spring, Left Friction Disc	.15
(7)	39.6 218099-12X	Arm, Interlock	.55
	61.3 218415-12X	Spring, Left Friction Disc	.15
	218494-12X	Rivet, Parallel Arm and Trip Bar	.05
(6C)	65.5 218967-12X	Delrin Nut, Hexagon, Turntable Shaft (Left)	.15
(6C)	61.9-1 219198-12X	Tape Tight Disc	.55
	50.2 219234-12X	Shaft, Pressure Wheel Bracket	.55
	70.17 219277-12X	Retainer, Flywheel Bearing	.15
	66.6 219586-12X	Felt Ring for Flywheel Bearing	.15
(6C)	72.2 219816-12X	Flange for Supply Turntable Housing (Delrin)	.15
	70.1 219823-12X	Screw, Covers	.30
	220155-12X	Stud, Lifting Arm, Bias Head	.15
(12)	79.21 220377-12X	Clamp for Capacitor C1	.30
(6C)	79.14-1 220384-12X	Revolution Counter	14.00
(6C)	79.23-1 222044-12X	TANDBERG Emblem	1.40
(12)	39.4	Lever, Function Selector CH1	.55

	Ref. No.	Description	List Price
(12)	39.11 223466A-12X	Bracket, Function Selector Arms	.55
(11)	223488-12X	Connector, Printed Circuit Board 5-Pins	1.40
(12)	39.7 224386-12X	Arm, Slide, Function Selector Switch	.55
(X)	224795-12X	Stud, Switches	.15
(12)	11.3 225384A-12X	Bracket, Mains Transformer	1.40
(X)	225916-12X	Connector, Printed Circuit Boards, 7-Pins	1.40
(X)	226397-12X	Terminal Strip, Main Transformer	.30
(12)	39.2 226835-12X	Knob, Function Selector	1.40
(6C)	14.4 227432-12X	Rubber Mounting, Motor	.55
(12)	39.3 227769-12X	Lever, Function Selector CH2	.55
(X)	228286-12X	Mounting, Plastic, Components	.05
(12)	54.2 228868-12X	Knob, Operating Lever	1.40
(12)	45.1-1 229565-12X	MICROPHONE Connector (DIN)	1.40
(12)	14.1 229616-12X	Motor	50.40
(X)	230629B-12X	Roller, Cam Disc Arm	.55
(X)	230225-12X	Connector, Printed Circuit Board, 9-Pins	1.40
(X)	234478-12X	Spring, Adjustment Screw, Bias Head	.15
(12)	79.34 234960-12X	Washer, Knob, Speed Seclector	.15
(6C)	66.17-1 235599	Felt, Flywheel (Self-Adhesive)	.30
(X)	235728A-12X	Cam Disc Arm	.30
(12)	53.4 238114-12X	Knob, Speed Selector	1.40
(X)	239738-12X	Shaft, Cam Disc Arm	.30
(X)	240376A-12X	Stud, End Stop Transfer Arm	.05

	Ref. No.	Description	List Price
(X)	240879-12X	Plate, Transfer Wire, Equalization Switch	.15
(X)	241469-12X	Spring, Bias Head	.30
(X)	241877-12X	Jack EXT. SPEAKER Output	.85
(X)	242244-12X	Connector, Inputs, LINE and P. UP	1.40
(X)	242288A-12X	Lever, Bias Head	.85
(X)	242309-12X	Spring, End Stop	.15
(X)	242331-12X	Spring, Cam Disc Arm	.15
(X)	242503-12X	Arm, End Stop Feeler	1.40
(X)	242633-12X	Heat Sink, Power Amplifier	.55
(X)	243013-12X	Post, Tape Guide, Right	1.40
(X)	243042-12X	Lamp, Revolution Counter	.85
(X)	243150-12X	Bracket, Bias Head Lever	.30
(X)	243925-12X	Retaining Ring, DIN Connectors	.05
(X)	243990-12X	Spring, End Stop Feeler Arm	.30
(X)	244342-12X	Lever, End Stop (Microswitch Operation)	.30
(X)	244694-12X	Arm, End Stop Transfer	.55
(X)	245002-12X	Bracket, Amplifier Board Support	.85
(X)	245024-12X	Shield, Amplifier Board	.85
(X)	245297-12X	Heat Sink, Rectifier Board	.85
(X)	245318-12X	Knob, Input Level Control, Lower (Ch2)	1.40
(X)	245347A-12X	Operating Lever Input Selector	.40
(X)	245354-12X	Suppressor, Motor Switch (C3, R10)	1.40
(X)	245369-12X	Bracket, Motor Mounting	.85
(X)	245433-12X	Knob, output Volume Control, Lower (Ch2)	1.40
(X)	245670-12X	Knob, Speaker Selector	.85
(X)	245721-12X	Clamp, Motor Capacitor	.30
(X)	245858A-12X	Equalization Switch	.05
(X)	245915A-12X	Index Spring, Input Selector	.15

	Ref. No.	Description	List Price
(X)	245972-12X	Tube, Input Selector (Hexagon)	.55
(X)	246145-12X	Plate, Equalization Switch Stator	2.80
(X)	246209-12X	Spring retainer, Input selector	.15
(X)	246231-12X	Plate, Retainer, Wires to Motor Switch	.15
(X)	246303B-12X	Top Cover	14.00
(X)	246360-12X	Connector, Power Amplifier Board 6-Pins	1.40
(X)	246425-12X	Transformer, Main 115/230V (No. 717)	33.60
(X)	246475-12X	Motor Pulley 50 Hz	8.40
(X)	246698-12X	Boxx, Input Switch	.05
(X)	246705-12X	Shield, Microphone Connector	.30
(X)	246720-12X	Cabinet, Teak	33.60
(X)	246777A-12X	Board, Stator, Function Selector Switch Ch1	2.80
(X)	246835-12X	Switch, Loudspeaker Selector	2.80
(X)	246935-12X	Clamp, Norm./Spec. Switch	.15
(X)	246978A-12X	Chassis, Input	2.80
(X)	247035=12X	Frame, Amplifier Board	1.40
(X)	247050-12X	Transfer Arm, Norm./Spec. Switch	.40
(X)	247065-12X	Connector, Bias Board	1.40
(X)	247653-12X	Tape Guide, Adjustable, Outer	1.40
(X)	247697B-12X	Switch, Function Selector Ch1, Complete	11.20
(X)	247833-12X	Bushing, Bearing, Transfer Arm, Norm./Spec. Switch	.30
(X)	247912-12X	Clamp, Transfer Wire, Equalization Switch	.30
(X)	247941-12X	Shaft, Pressure Roller	.40
(X)	247948A-12X	Index Arm, Input Switch	.30
(X)	248027-12X	Insulation, Microswitch	.15
(X)	248041-12X	Contact Spring, Connector, Power Amplifier	.15
(X)	248156-12X	Motor Pulley 60 Hz	8.40
(X)	248157-12X	Bushing, Adjustable Tape Guides	.15

	Ref. No.	Description	List Price
(X)	248186-12X	Trip Bar	1.40
(X)	248199-12X	Connector, DIN, EXT. LOUDSPEAKER	.85
(X)	248336A-12X	Terminal Strip, Bias	.55
(X)	248393-12X	Connector, Power Amplifier Board, 9-Pins	1.40
(X)	248401-12-41X	Cabinet, Rosewood	50.40
(X)	248458A-12X	Board, Stator, Function Selector Switch Ch2	2.80
(X)	248495-12X	Connector, +26V	.85
(X)	248502-12X	Connector MICROPHONE, DIN (From Ser. No. 2237001)	2.80
(X)	248638-12X	Terminal Strip, Heads	.85
(X)	248659-12X	Chassis, Output	2.80
(X)	248716A-12X	Support, Chassis	.55
(X)	248746-12X	Connector, Preamp. Board	1.40
(X)	248752A-12X	Brake Block, Tape Brake	.15
(X)	248825-12X	Clamp, Capacitor C-2	.30
(X)	249011-12X	Shield, Input Chassis	.30
(X)	249032-12X	Knob, Input Level Control, Upper (Ch1)	1.40
(X)	249147-12X	Knob, Output volume control, upper (Ch1)	1.40
(X)	249378C-12X	Switch, Function Selector, Ch2, Complete	11.20
(X)	249514-12X	Bushing, Bearing, Function Selector Arm	.30
(X)	249551-12X	Guide, End Stop Transfer Arm	.05
(X)	249593-12X	Arm. Norm./Spec. Switch	.30
(X)	249629-12X	Roller, Index, Input Selector	.30
(X)	249630-12X	Jack, PHONES STEREO	1.40
(X)	249722-12X	Meter, Record Indicator	22.40
(X)	249845-12X	Insulator, Chassis Support	.15
(X)	249946-12X	Set of Knobs	8.40
(X)	249959-12X	Switch, Norm./Spec.	1.40
(X)	249966-12X	Spring, Tape Brake	.15

	Ref. No.	Description	List Price
(X)	249988-12X	Plate, Bearing, Speed Selector Shaft	.15
(X)	250111-12X	Spacer, Bias Board	.30
(X)	250476-12X	Spring, Index Arm, Function Selector	.30
(X)	250520-12X	Shaft, Lifting Arm, Bias Head	.30
(X)	250865-12X	Handle, Input Selector From Serial No. 2237001	.85
(X)	251130-12X	Transfer Lever, Pressure Pad	.30
(X)	251482-12X	Lever, Pressure Pad	.40
(X)	251489-12X	Tape Guide (Below Pressure Pad)	.55
(X)	251663-12X	Plate, Connector Fixing, Preamp. Baord	.15
(X)	251857-12X	Switch, P.-UP, From Serial No. 2237001	1.40
(X)	252201-12X	Lever, Lifting, Bias Head	.30
(X)	252509-12X	Index Arm, Function Selector	.30
(X)	252610-12X	Bracket, Revolution Counter	.30
(X)	253631-12X	Arm, Input Selector, From Serial No. 2237001	.40
(X)	254190-12X	Counterweight, Index Arm, Function Selector	.15
(X)	254234-12X	Spring, Lifting Lever, Bias Head	.15
(X)	254291-12X	Plate, Fixing, Revolution Counter	.05
(X)	254614-12X	Insulator Plate, Preamp, Board Connector	.15
(X)	254736-12X	Handle, Norm./Spec. Switch	.85
(X)	254844-12X	Support, Pressure Pad/Tape	.55
(X)	990201-12X	Lifting Arm, Transfer Wheel, complete	1.40
(X)	990302-12X	Pressure Roller Arm Assembly	11.20
(X)	990203-12X	Eccentric Segment	1.40
(6C)	990204-12X	Parallel Arm, complete	1.40
(6C)	990207-12X	Bracket for Front Trim Cover, Left	.55
(6C)	990208-12X	Bracket for Front Trim Cover, Right	.55
(6C)	990209-12X	Thrust Spring with Delrin Knob	1.40
(6C)	990213-12X	Transfer Wheel Holder	2.80

	Ref. No.	Description	List Price
(6C)	990214-12X	Cover Plate 1	1.40
(6C)	990215-12X	Cover Plate 2	1.40
(X)	990217-12X	Bracket w/Shaft, Momentary Stop	1.40
(2)	990222-12X	Spring Washer, Upper Flywheel Bearing	.30
(X)	990223-12X	Retainer, Upper Flywheel Bearing, Threaded	.30
(X)	990224-12X	Cam Disc w/Shaft	2.80
(12)	990225-12X	Operating Lever Shaft with Delrin Ball	1.40
(6C)	990226-12X	Supply Turntable (Left)	4.20
(6C)	990227-12X	Take Up Turntable (Right)	4.20
(6C)	990228-12X	Clutch Lever for Supply Friction Disc	1.40
(6C)	990229-12X	Upper Clutch Lever For Take-Up Friction Disc	1.40
(X)	990230-12X	Index lever, trip bar	1.40
(6C)	990231-12X	Bracket for Rear Trim Cover	.55
(7)	990232-12X	Momentary Stop Handle Assembly	2.80
(2)	990233-12X	Transfer Wheel	4.20
(2)	990234-12X	Pressure Roller (Pinch Roller)	2.80
(6C)	990236-12X	Friction Disc, Left and Right	8.40
(X)	990305-12X	Transfer Wheel Arm	1.40
(X)	990306-12X	Arm, Norm./Spec. Switch w/Bearing	1.40
(6C)	990312-12X	Flywheel, Complete	14.00
(x)	990319-12X	Brake, Flywheel, Complete	.30
(X)	990320-12X	Power Amplifier Board, Complete	44.80
(X)	990321-12X	Rectifier Board, Complete	33.60
(X)	990322-12X	Input Amplifier Board, Complete	44.80
(X)	990323-122X	Equalization/VU-Meter/Preamplifier Board 2-Track Comp.	112.00
(X)	990324-124X	Equalization/VU-Meter/Preamplifier Board 4-Track Comp.	112.00
(X)	990325-12X	Pressure Pad	1.40

	Ref. No.	Description	List Price
(X)	990326-12X	Transfer Wire for Equalization Switch, Complete	1.40
(X)	990327-12X	Bias Board, Complete	4.20
(X)	990335-12X	Input Switch, Complete	8.40
(X)	990336-12X	Input Switch, Complete (From Serial No. 2237001)	5.60
(X)	990339-12X	Slide, Function Selector Switch Ch1	5.60
(X)	990340-12X	Slide, Function Selector Switch Ch2	5.60
(X)	990341-12X	Slide, Equalization Switch	2.80
(X)	990342-12X	Socket, VU-Meter Lamp	.55
(X)	990343-12X	Input Amplifier Board, Complete (From Serial No. 2237001)	44.80
(X)	990344-124X	Equalization/VU-Meter/Pre-Amplifier Board 4-Track (From Serial No. 2237001) Complete	112.00
(X)	990345-12X	Line Input Circuit Board, complete (Introduced From Serial No. 2237001)	11.20
(X)	990346-12X	Plate w/Shaft, End Stop Switch	1.40
(X)	990347-12X	Lamp, VU-Meter	.85
(X)	990348-122X	Equalization/VU-Meter/Pre-Amplifier Board 2-Track (From Serial No. 2237001)	112.00
(X)	990349-124X	Equalization/VU-Meter/Pre-Amplifier Board 4-Track (From Serial No. 2252601)	112.00
(X)	990350=122X	Equalization/VU-Meter/Pre-Amplifier Board 2-Track (From Serial No. 2252601)	112.00
(X)	990351-12X	Rectifier Board, Complete (From Serial No. 2251955)	33.60
(X)	990252-12X	Power Amplifier Board (From Serial No. 2251955)	33.60
(X)	990353-12X	Bias Board (From Serial No. 2247876)	5.60

Electrical Parts

	Ref. No.	Description	List Price
HEADS			
(X)	67H-124X	Record/Playback Head	39.20
(X)	68H-124X	Bias Head	22.40
(X)	70H-124X	Erase Head	39.20
DIODES			
(X)	D101-12X	Diode IN 4148	1.95
(X)	D102-12X	Diode IN 4148	1.95
(X)	D301-12X	Diode IN 4002 (From Serial No. 2251955)	1.95
(X)	D302-12X	Diode IN 4002 (From Serial No. 2251955)	1.95
(X)	D401-12X	Diode IN 4002 (From Serial No. 2251955)	1.95
(X)	D402-12X	Diode IN 4002 (From Serial No. 2251955)	1.95
(X)	D501-12X	Diode, Zener ZF 27	2.80
RECTIFIER			
(12)	223761-12X	Rectifier B40 C2200	7.80
TRANSISTORS			
	Q101-12X	Transistor BC 149B	2.80
	Q102-12X	Transistor BC 148A	2.80
	Q103-12X	Transistor BC 147A	2.80
	Q105-12X	Transisfor BC 147A	2.80
	Q106-12X	Transistor BC 148A	2.80
	Q107-12X	Transistor BC 148A	2.80
	Q108-12X	Transistor BC 148A	2.80
	Q109-12X	Transistor BC 147A	2.80
	Q110-111-12X	Transistor BC 139/BC 144	6.70
	Q112-12X	Transistor BC 149B	2.80
	Q113-12X	Transistor BC 148A	2.80
	Q114-12X	Transistor BC 147A	2.80
	Q115-12X	Transistor BC 147A	2.80
	Q116-12X	Transistor BC 148A	2.80
	Q201-12X	Transistor BC 149B	2.80
	Q202-12X	Transistor BC 149B	2.80
	Q203-12X	Transistor BC 148A	2.80
	Q204-12X	Transistor BC 148A	2.80
	Q205-12X	Transistor BC 147A	2.80
	Q206-12X	Transistor BC 147A	2.80
	Q301-12X	Transistor BC 148A	2.80
	Q302-12X	Transistor BC 107B	3.90
	Q303-304-12X	Transistor AC 127/AC 152	6.70
	Q305-306-12X	Transistor 2-AD 150	15.70
	Q401-12X	Transistor BC 148A	2.80
	Q402-12X	Transistor BC 107B	3.90
	Q403-404-12X	Transistor AC 127/AC 152	6.70
	Q405-406-12X	Transistor 2-AD 150	15.70
	Q501-12X	Transistor TI 3030	8.75
	Q502-12X	Transistor U2848/1	3.90
	Q503-12X	Transistor U2848/1	3.90
	Q707-12X	Transistor BC 147B	2.80
	Q708-12X	Transistor BC 147B	2.80

	Ref. No.	Description	List Price
POTENTIOMETERS			
(X)	R149-12X	Trimming, 300 Ohm	.85
(X)	R192-12X	Trimming, 47 KOhm From Serial No. 2237001	.85
(X)	R193-12X	Trimming, 47 KOhm From Serial No. 2237001	.85
(X)	R214-216-235-236-12X	10+5+10+5 K Ohm, Input Level	8.40
(X)	R301-401-12X	2x10 K Ohm, Log, Output Volume	4.20
(X)	R303-12X	Trimming, 0.25 M Ohm	.85
(X)	R313-12X	Trimming, 2 K Ohm	.85
(X)	R320-420-12X	2x10 K Ohm, Treble	4.20
(X)	R324-424-12X	2x10 K Ohm, Bass	4.20
(X)	R403-12X	Trimming, 0.25 M Ohm	.85
(X)	R413-12X	Trimming, 2 K Ohm	.85
(X)	R601-12X	Trimming, 47 K Ohm	.85
(X)	R602-12X	Trimming, 47 K Ohm	.85
(X)	R711-712-737-738-12X	33+5+33+5 K Ohm, Input Level (From Serial No. 2237001)	8.40
COILS			
(X)	L101-12X	Coil L101	4.20
(X)	L102-12X	Coil L102	4.20
(X)	R101-12X	Trafo, Oscillator	5.60