Tandberg RADIO

Service manual

TANDBERG

Tape recorder models 11 and 11P

TANDBERGS RADIOFABRIKK A/S

Preface

This service manual covers Tandberg Tape Recorder Models 11-1, 11-2 and 11-1P. The Tape Recorders are battery operated, fully transistorized and have 3 speeds and separate heads for record and playback. Model 11-2 is a half track model while 11-1 and 11-1P both are full track models. Model 11-1P is in addition furnished with separate pilot head and electronic circuits enabling synchronizing of sound and film.

All models have the same tape transport mechanism. We hope that this service manual will be a useful aid for those who are using and servicing these tape recorder models.

In a light of future developments, we reserve the right to introduce modifications to electronic circuitry and mechanical design.

Oslo, Aug. 1969

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1.0 TECHNICAL SPECIFICATIONS MODELS 11-1, 11-2 AND 11-1P

Power Requirements:
Battery operated: 15 V (Ten 1.5 V transistor type ore rechargable cells).
Mains operated: Tandberg Battery Eliminator, Model 4 (125 – 140 – 160 – 220 - 240 V, 50/60 Hz) can be installed in battery compartment or used externally connected to ACCESSORY socket.

Power Consumption:
2–3 W. Current drain from batteries: 7½ ips: 220 mA.
3¾ ips: 180 mA, 1⅞ ips: 160 mA.

Motor:
9 V dc, pulse excited.

Tape Speeds:
7½ – 3¾ – 1⅞ ips. Electronic speed control.

Speed Tolerance:
0.2 % relative, 0.5 % absolute.

Playing Time:

	1200 ft. of tape Half track	Full track
7½ ips	2 x 32 min.	32 min.
3¾ ips	2 x 64 min.	64 min.
1⅞ ips	2 x 128 min.	128 min.

	1800 ft. of tape Half track	Full track
7½ ips	2 x 48 min.	48 min.
3¾ ips	2 x 96 min.	96 min.
1⅞ ips	2 x 192 min.	192 min.

Winding Time:
1¾ min. in each direction for 1200 ft. of tape.
2½ min. for 1800 ft. of tape.

Reel Size:
7″ reels when cover is open, 5″ reels when cover is closed.

Tape:
Best standard quality (Not Low Noise).

Momentary Start/Stop:
Mechanical. Starts or stops tape instantaneously in playback and record modes.

Heads:
Model 11-2: Half track erase head and separate half track record- and playback heads. Tachometer head for speed control.
Model 11-1: Full track erase head and separate full track record- and playback heads. Tachometer head for speed control.
Model 11-1P: Full track erase head, separate full track record- and playback heads and Neo-pilot head. Tachometer head for speed control.

Frequency curves:
DIN 45511:

7½ ips	30–18.000 Hz.
3¾ ips	40–12.000 Hz.
1⅞ ips	50– 6.000 Hz.

± 2 dB:

7½ ips	40–16.000 Hz.
3¾ ips	50–10.000 Hz.
1⅞ ips	50– 5.000 Hz.

Used as amplifier: 30–18.000 Hz, ± 3 dB.

Distortion:
Amplifier distortion: < 0.5 %. **Tape distortion:** < 3 %.

Signal/Tape Noise:	**DIN 45511,** peak value at 5 % distortion. Half track 55 dB. Full track 59 dB. **IEC A-curve,** R.M.S. at 5 % distortion. Half track 63 dB. Full track 67 dB.
Wow:	**DIN 45511,** peak value 7½ isp 0.15 % 3¾ ips 0.25 % 1⅞ ips 0.40 % **R.M.S.** 7½ ips 0.10 % 3¾ ips 0.18 % 1⅞ ips 0.30 %
Erase- and bias frequency:	85.5 kHz ± 2 kHz. Distortion less than 0.5 %.
Indicator, switchable:	**Record mode.** Indicates peak value of equalized signal. Calibrated to O dB at 3 % distortion. **Playback mode.** Indicates signal level at LINE OUTPUT. 0 dB corresponds to 1.55 V. **When BATT CHECK-button is depressed.** **Battery voltage.** 0 dB corresponds to 9.5 V battery voltage, which is the minimum operating voltage.
Indicator Pilot: (For Model 11-1P only):	Electro-mechanical. Indicator changes colour from white to red when pilot signal exceeds 0.7 V.
Limiter:	Amplifier with automatic gain control can be connected during recording. Maintains constant recording level for input signals varying over a 25 dB range. Operates on all inputs.
Inputs:	**MIC 200 OHMS.** For 200 ohm dynamic microphone. Sensitivity: 0.1 mV. Maximum signal: 50 mV. **LOW INPUT.** Input impedance: 10 kohm. Sensitivity: 5 mV. Maximum signal: 1 V. **HIGH INPUT.** Input impedance: 200 kohm. Sensitivity: 125 mV. Maximum signal: 10 V. **ACCESSORY.** For connection of Tandberg Battery Eliminator, Model 4 or other power supplies. **PILOT** (on Model 11-1P only). For connection of Tandberg Synchronizer or film camera. Pilot signal, pin 1, 0.7–1.5 V, 50/60 Hz. Pilot signal output, pin 5, 20–50 uV. Start marker signal output, pin 6, + 8 V. Automatic speed control signal from Tandberg Synchronizer, pin 4.
Outputs:	**LINE OUTPUT.** Balanced output for 600 ohm line, 1.55 V for 0 dB indication on the meter. **MONIT OUTPUT.** For 200 ohm headphones.
Speaker:	Internal speaker for monitoring, 2 x 3″, 20 ohm.
Temperature Range:	All specifications apply for the temperature range: – 5 to + 45 centigrades.
Dimensions:	Length 33 cm (13″), height 10 cm (4″), depth 25,5 cm (10″).
Weight, including batteries:	5.25 kg (11.5 lbs).

2.0 OPERATING CONTROLS AND CONNECTIONS

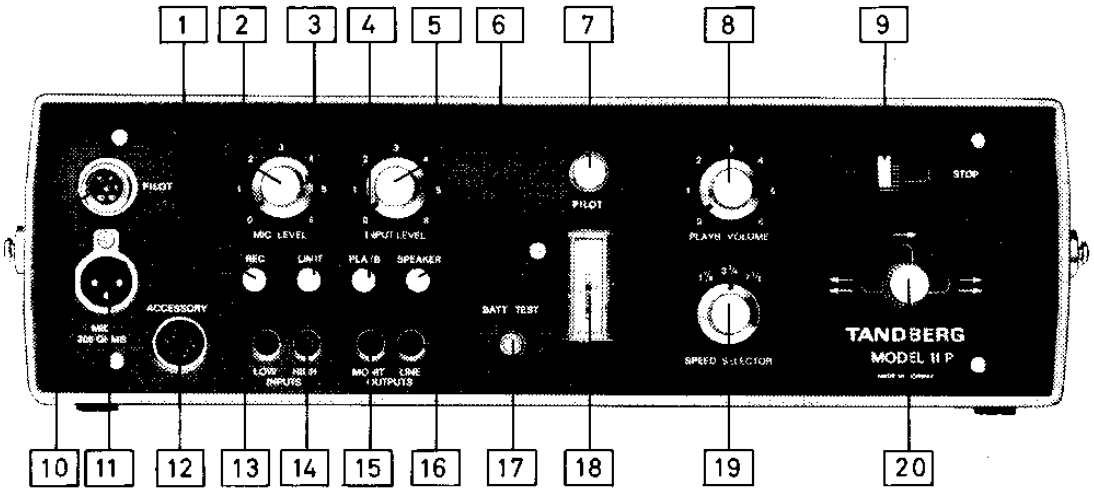


Fig. 2.0. Operating controls and connectors.

1. **Record button:** The recorder is set to record mode when the button is depressed. The button is locked in this position when the operating lever is set to position ⟶.
2. **Microphone level control:** Adjusts signal level when recording from microphone and when the tape recorder is used as a microphone amplifier.
3. **Limiter button:** When the button is depressed a limiting circuit prevents tape saturation for input signals exceeding normal level by 25 dB or less. The limiter operates on all inputs.
4. **Playback button:** The tape recorder is set to playback mode when the button is depressed.
5. **Line level control:** Adjusts signal level when recording from line inputs LOW or HIGH and when the recorder is used as a line amplifier.
6. **Speaker button:** Connects internal speaker and disconnects line and monitor output when the button is depressed.
7. **Pilot indicator:** Indicator changes from white to red when the tape recorder receives pilot signal exceeding 0.7 V from film camera or Tandberg Synchronizer.
8. **Playback volume:** Adjusts signal level in speaker and on line output during playback.
9. **Momentary start/stop:** Starts or stops instantaneously when operating in record or playback modes.
10. **PILOT socket:** Socket for connection of film camera or Tandberg Synchronizer for recording or playback of pilot signals.
11. **MICROPHONE socket:** Socket for connection of dynamic microphone. Impedance: 200 ohm. Maximum signal level: 50 mV. Connector types: DIN, Cannon XL31 or Cannon XL32.
12. **ACCESSORY socket:** For connection of mains power unit. Alternatively supply voltage for external equipment is available at pin 6 when pins 2 and 3 on the mating connector are short-circuited.
13. **LOW INPUT socket:** Miniature jack for signals from low level sources. Impedance: 10 kohm. Maximum input level: 1 V.
14. **HIGH INPUT socket:** Miniature jack for signals from high level signal sources. Impedance: 200 kohm. Maximum input level: 10 V.

15. **MONIT OUTPUT socket:** Miniature jack for connection of headphones 200 ohm (unbalanced).

16. **LINE OUTPUT socket:** Miniature jack for playback into 600 ohm line. An indicator reading of 0 dB corresponds to standardized line level 1.55 V.

17. **Battery check button:** Connects the meter for battery voltage indication when button is depressed.

18. **Indicator:** Meter for indication of record level during recording, output level during playback, or battery voltage when BATT TEST-button is depressed.

19. **Tape speed selector:** For selection of tape speeds $1^{7}/_{8}$, $3^{3}/_{4}$ and $7^{1}/_{2}$ ips.

20. **Operating lever:** Selects the following modes: ⇇: Fast rewinding. ⇉: Fast forward. →: Normal drive for recording or playback.

21. **Tape tension arm:** Provides constant tape tension, irrespective of amount of tape on the reels.

22. **Loudspeaker:** Speaker for monitoring purposes.

23. **Head cover:** Protecting cover which can be removed for cleaning of heads and tape path.

24. **Reels:** When cover is open, 7″ reels can be used, with cover closed, 5″ reels.

25. **Cover:** Dust cover to be removed for cleaning of heads and tape path.

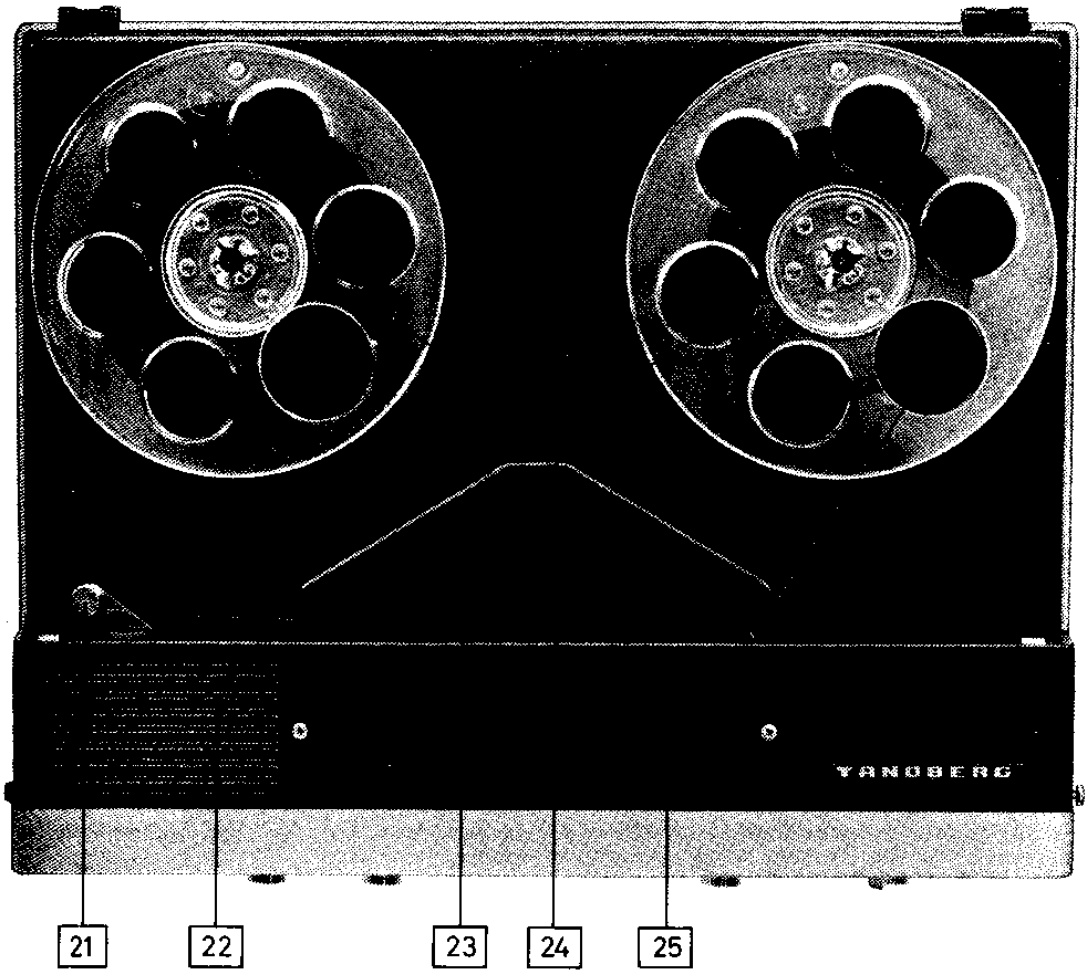


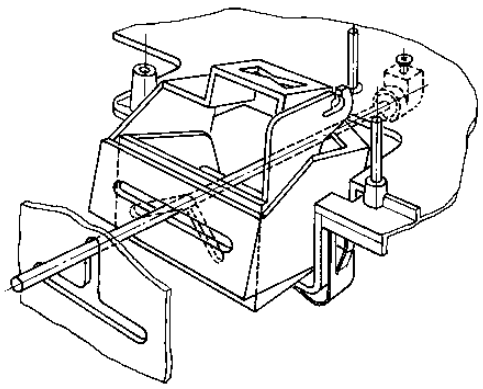
Fig. 2.1. Top view.

3.0 MECHANICAL DESCRIPTION AND ADJUSTMENT PROCEDURE

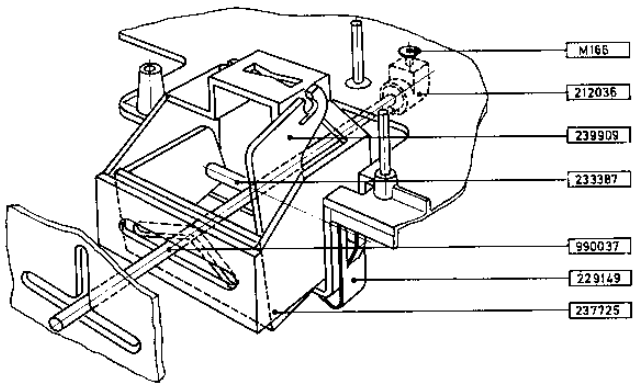
3.1 THE OPERATING LEVER

Operating lever (990037) is attached to the frame structure by means of mounting bracket (212036) located underneath the instantanous start/stop lever.

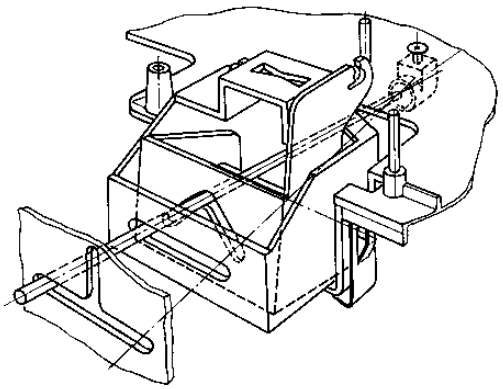
The lever has 4 positions: Neutral, normal forward drive, fast forward winding and faste winding. Fig. 3.0 shows the operating lever in the 4 positions.
For adjustment of operating lever, see paragraph 3.2.1.



Normal forward drive.



Neutral.



Fast wind and rewind.

Fig. 3.0. Operating lever.

3.2 FAST FORWARD WINDING

Fig. 3.2 shows the tape recorder in fast forward winding position.
When operating lever is moved towards the fast forward winding position, it brings along the lever (239909) which in turn operates the arm (990003), the microswitch (990010) and the arm (220693). The spring (234077A) makes the lever (233191) flip over. The flipping action causes (990042) being lifted from the take-up turntable (990034). Simultaneously the brake rod (231620) lifts the brake (990043) from the supply turntable (990040).
The operating lever also operates lever for fast winding (990045) so as to operate another fast winding lever (225801) which in turn brings right transfer wheel (990021) into engagement between stepped pulley (990019) and take-up turntable (990039). The feeler arm link (238193) operates the tape tension feeler (990017) which gives a light braking of supply turntable (990040).

In order to check that the operation of the various mechanical parts occur in the correct sequence, the operating lever is moved slowly from fast forward position to neutral position. The brakes should then first be activated, thereafter large transfer wheel (990021) is disengaged and tape motion stops. If the sequence is not correct, adjustments according to paragraphs 3.2.1, 3.2.2 and 3.2.3 must be performed.

3.2.1 Adjustment of Operating Lever (990037).

When the operating lever is in neutral position it should be centred in the slot of the fast winding lever assembly (990045). Adjustment is made by loosening the screw on the index spring (237726) and moving the fast winding lever back or forth so as to bring the operating lever to the middle of the slot.

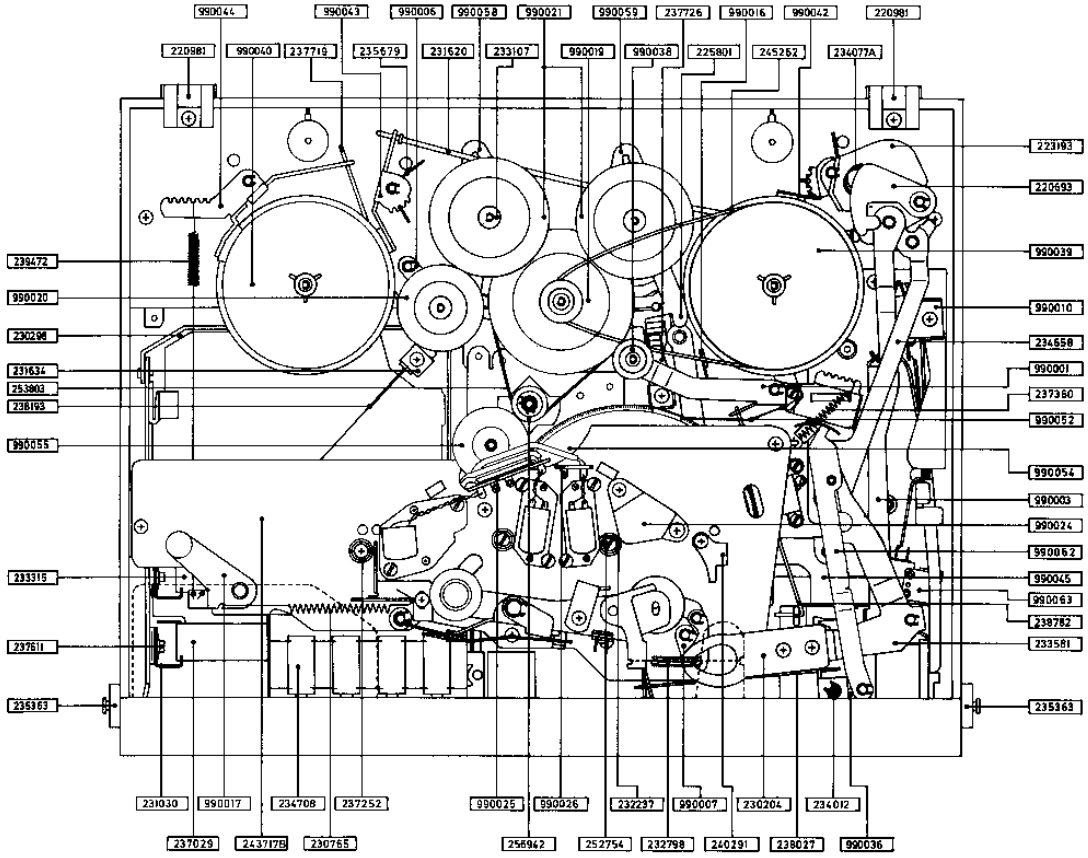


Fig. 3.1. Top view with covers removed.

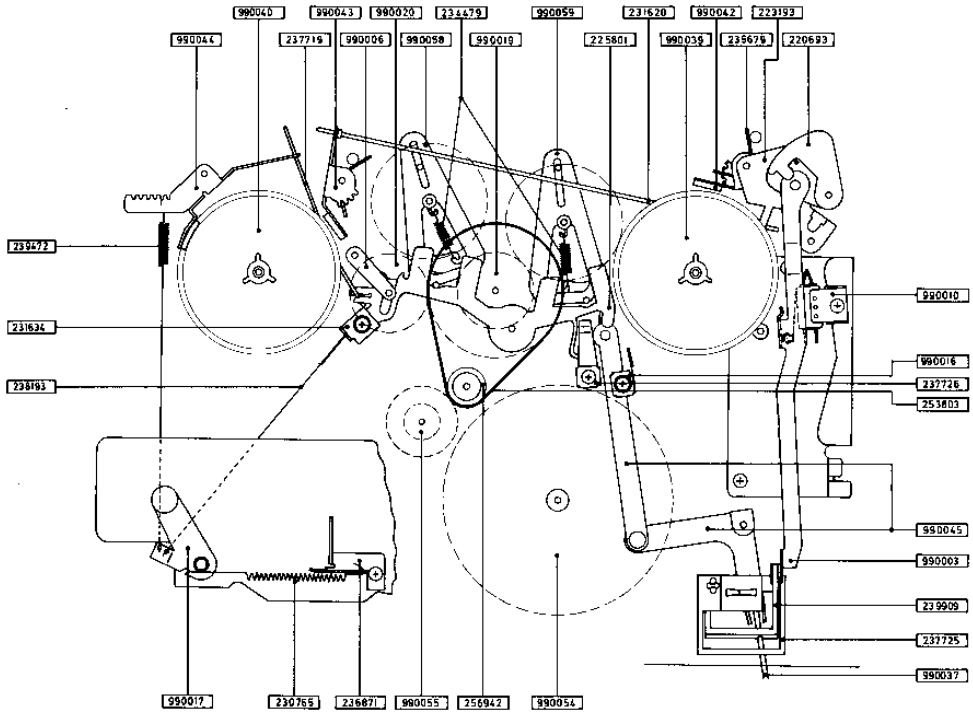


Fig. 3.2. Fast forward winding.

3.2.2 Adjustment of Brakes (990042) and (990043).

Set the operating lever in fast forward position. The clearance between the cork lining and the turntables should be 0.8–1.0 mm ($^1/_{32}$"–$^3/_{64}$"). If neccessary, adjust the clearance by bending the brake arms.

3.2.3 Adjustment of Microswitch (990010).

When the operating lever is moved slowly from fast forward to neutral position, the brakes should engage before the microswitch is turned off. Adjustment is made by loosening the screw on the microswitch and moving it to correct position.

3.2.4 Adjustment of Feeler Arm (238193).

If the tape during fast forward winding is wound too loosely on the reel, or if the winding speed is too low, the feeler arm (238193) must be adjusted by loosening the screw on the feeler arm plate (231634) and slackening or tightening the feeler arm (238193).

3.2.5 Adjustment of Additional Friction Lever Assembly.

Put a 7 inch reel with some tape on the supply turntable, and insert the tape into the tape path. Set the operating lever to forward drive position. Move the momentary stop bar (238027) out from the slot on the pinch roller fork (231476) so as to lift the pinch roller from the capstan. Measure the friction with a gauge as shown in fig 3.3. The force required to pull the tape should be between 40 and 60 gr (14–21 oz).

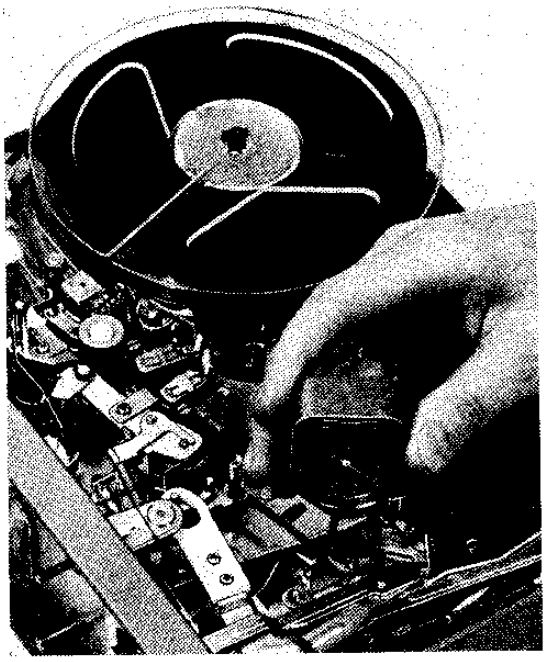


Fig. 3.4. Friction control of supply turntable with full tape reel.

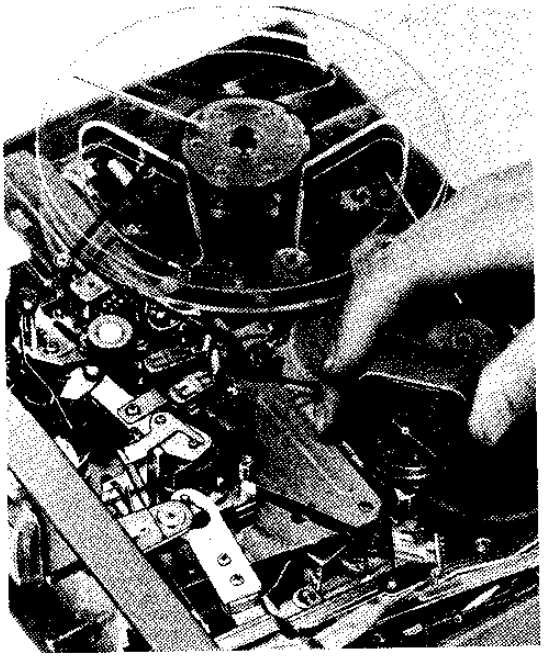


Fig. 3.3. Friction control of supply turntable with some tape on the reel.

Put a full 7 inch reel on the supply turntable and use the gauge as shown in fig. 3.4. The force required to pull the tape should not deviate more than 10 gr. from the previous figure (40–60 gr).
The friction can be increased or decreased by moving the spring (230765) along the arm (236871).
If the friction varies more than 10 gr. from empty to full reel, loosen the screw on arm (236871) and move arm towards the erase head until correct tape tension is obtained. The spring (239472) can be used to check the range of the tape feeler (990017). When the tape is pulled out from a full reel, the tape feeler should not deviate more than approximately 3 mm ($^1/_8$") from its quiescent position. The overall movement can be adjusted by moving the spring (239472) to another notch on the additional friction lever (990044).
Observe that the spring (239472) has no tension when the tape feeler is moved in the direction of the turntable to the end stop.
All the above adjustments interfere with one another. It is therefore necessary to check the tape tension after each adjustment.

3.3 FAST REWIND

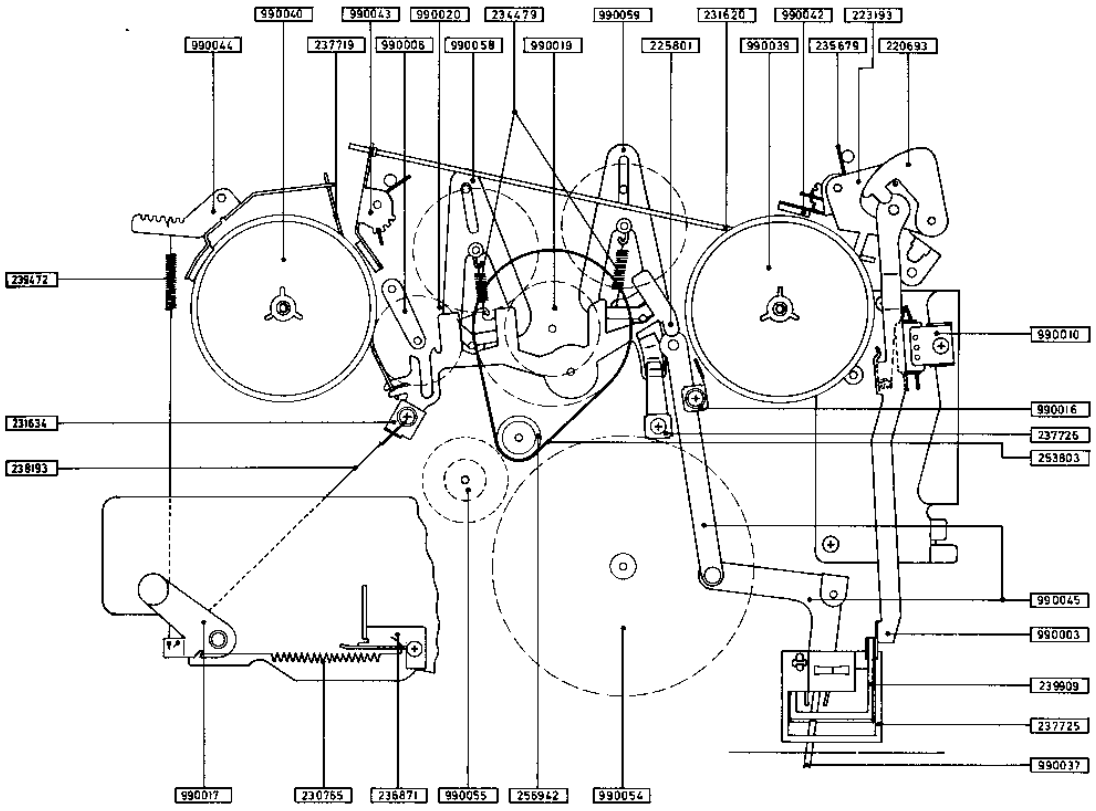


Fig. 3.5. Fast rewind.

Fig. 3.5 shows the tape recorder in fast rewind position.
Move the operating lever from neutral to fast rewind. The following parts are then operated in the same order as they are listed: Levers (237725) and (239909), arm (990003), levers (220693) and (223193). Finally the brakes are lifted off the turntables. (Ref. para. 3.2.2.)

When the fast winding lever assembly (990045) is moved by the operating lever, the following parts are operated in the sequence as they are listed: Fast winding lever (225801) causes the large transfer wheel (990021) to engage with stepped pulley (990019) and the small transfer wheel (990020) which also engages with supply turntable. The additional friction link (237719) lifts the additional brake (990044) from supply turntable. The clearance between additional brake and turntable should be minimum 2 mm ($^5/_{64}$"). The additional friction spring (990016) gives a light braking of take-up turntable. In order to check the correct operating sequence of the various mechanical parts, the operating lever is moved slowly from fast rewind position towards neutral. The brakes should then engage with the turntables before or simultaneously with the transfer wheels (990021 and 990020) leaving supply turntable and the stepped pulley.

3.3.1 Adjustment of Additional Friction Spring (990016).

If the braking of take-up turntable is too heavy during fast rewinding (the tape is too tightly wound) or if the tape is wound too loosely, the additional friction spring tension is adjusted by bending the spring (990016). See chapter on fast forward winding steps 3.2.1 – 3.2.3.

3.4 NORMAL FORWARD DRIVE

Fig. 3.7 shows the tape recorder in normal forward drive position.
Set the operating lever to normal forward drive position. Both levers (237725) and (239909) are simultaneously operated by the operating lever. The lever (239909) activates in sequence as listed: Arm (990003), microswitch (990010), braking system lever (220693) and lower lever (223193) and brake connecting rod (231620). Finally both brakes leave the turntables. The lever (237725) also operates the following parts in sequence as listed: Link (238782), lever (990001) and take-up belt (245262) which is tightened. The lever (990001) also disengages the flywheel brake spring assembly from the flywheel (990054). Simultaneously the transfer wheel push rod (251468) is released, and push rod lever (253501) pushes the transfer wheel (990055) into engagement.

3.4.1 Adjustment of Microswitches (990010).

The click from the microswitches can be heard when the operating lever is moved slowly from neutral to normal forward drive position. The lower microswitch operates first. (See fig. 3.14). Adjustment of the microswitches is performed by loosening the mounting screw in bracket (227662) and moving the microswitch slightly to obtain correct operation.

The microswitches can be checked by moving the operating lever towards normal forward drive position, until lever (230204) for pinch roller assembly starts to move. Both microswitches should then be switched off.

Note: In units with serial number above 2 305 225 the lower microswitch is omitted and another microswitch (990063) is introduced (ref. fig. 3.1).

3.4.2 Adjustment of Flywheel Brake (990052).

The flywheel brake should in normal forward drive position be tangential to the outer circumference of the flywheel. Adjustment is made by bending the brake.

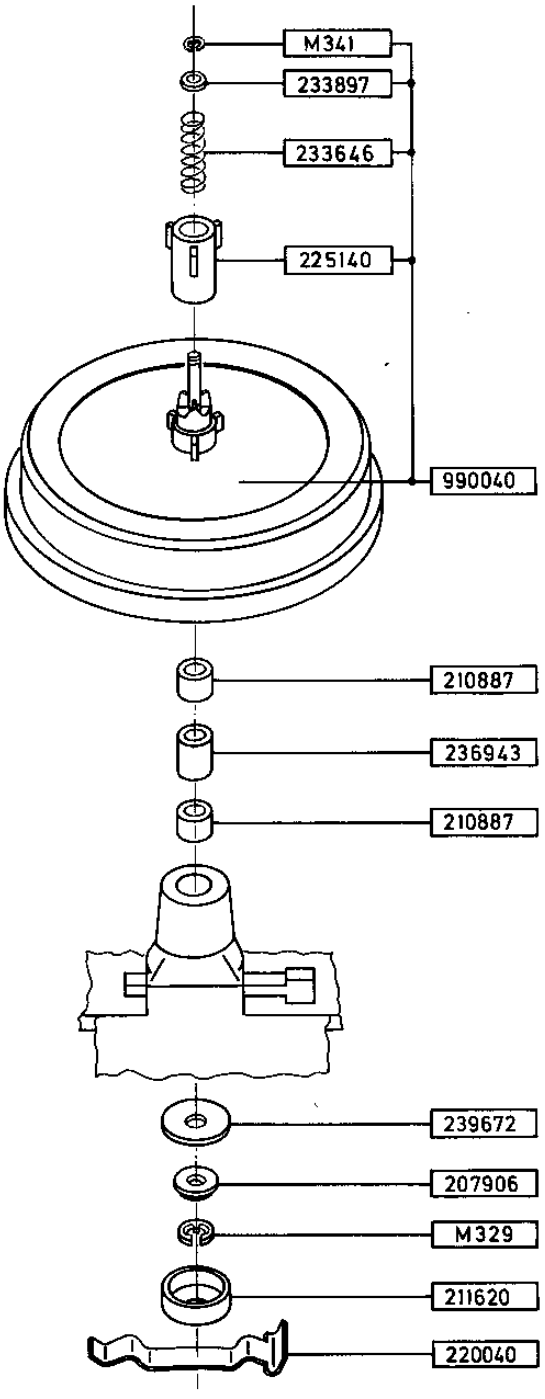


Fig. 3.6. Supply turntable assembly.

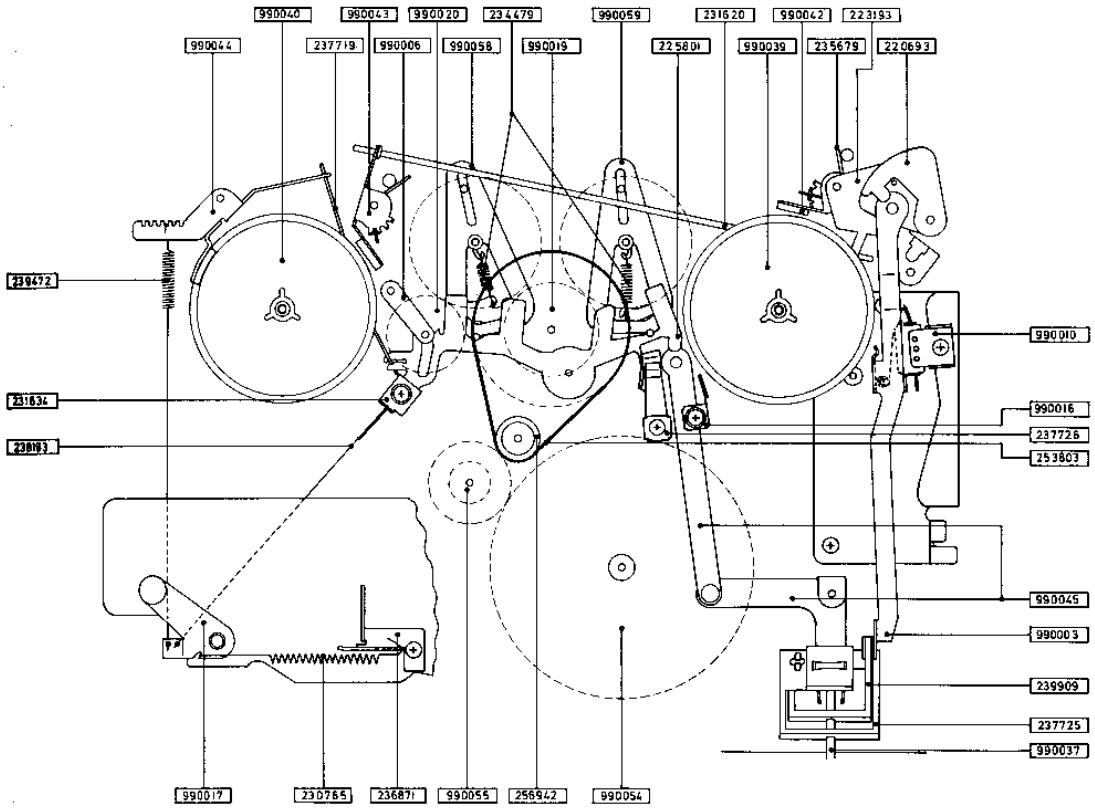


Fig. 3.7. Normal forward drive.

3.4.3 Adjustment of Transfer Wheel (990055).

Adjustment is neccessary if: a) The transfer wheel is not disengaged from motor pulley (236942) and flywheel (990054), when the operating lever is in neutral position. b) If the transfer wheel is not engaged with the motor pulley and flywheel when the operating lever is in normal forward drive position.

Set the operating lever to normal forward drive position. The clearance between transfer wheel push rod adjuster (253149) and rubber mounting (218840) should then be 0.3–0.5 mm (12–20 mil). Adjustment can be made by loosening screw in transfer wheel push rod adjuster (253149), see fig. 3.12.

Height adjustment of transfer wheel (990055) is accomplished by turning the transfer wheel shaft (990056).

3.4.4 Replacement of Transfer Wheel (990055).

Remove retaining ring and turbax washer on transfer wheel (990055) and turn the transfer wheel shaft all the way down. The transfer wheel can now be pulled off.

3.4.5 Checking of Take-up Torque.

Put an empty 7 inch reel on the take-up turntable and measure the take-up torque as shown in figure 3.8. The operating lever must be in normal forward drive position. The torque measured at the hole located approximately 8 cm ($3^1/_8$″) from the reel center, should correspond to a reading between 14 and 18 gr. (0.5–0.63 oz) on the torque meter. Adjustment is performed by moving the spring (237360) until the correct torque is obtained.

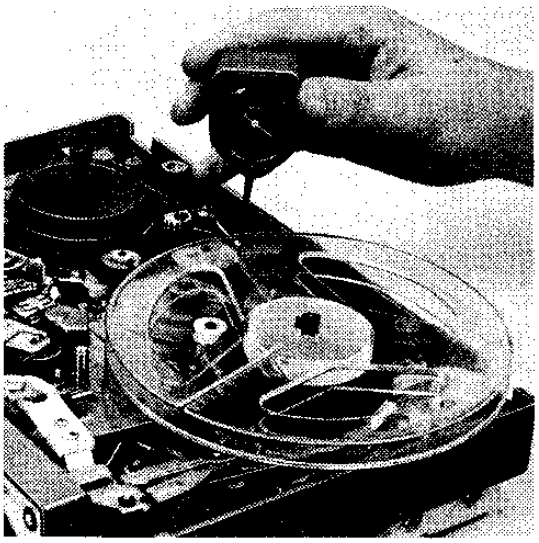


Fig. 3.8. Control of take-up torque.

the spring (232403) which is located underneath the mounting plate (243717B). The spring will then cause the roller (990041) to engage. The pressure roller also operates the interlock arm (229802 A) which locks the REC-button when the operating lever is in normal forward drive.

3.6 MOMENTARY START/STOP LEVER (990036)

When the momentary start/stop lever (990036) is moved towards stop position, while the operating lever is in normal forward drive position, the momentary stop bar (238027) operates, and pushes fork (231476) so as to lift the pinch roller (990050) from the capstan. Simultaneously, operate in sequence as listed: Lever (220693) and brake connecting rod (231620). Brakes are then applied to both turntables. The momentary stop lever also operates microswitch (990063). Check that the pinch roller has a clearance from the capstan of 0.5—1.0 mm (30—40 mils) as the brakes are applied to the turntables.

3.5 PINCH ROLLER ARM ASSEMBLY (990002)

The assembly is shown in fig. 3.9.
The lever (237725) operates lever for pinch roller arm (233581). The knee joint arm (990007) will then flip over and cause the pinch roller (990050) to move against the capstan. As a consequence of this, the lever for pinch roller arm assembly (233581) operates

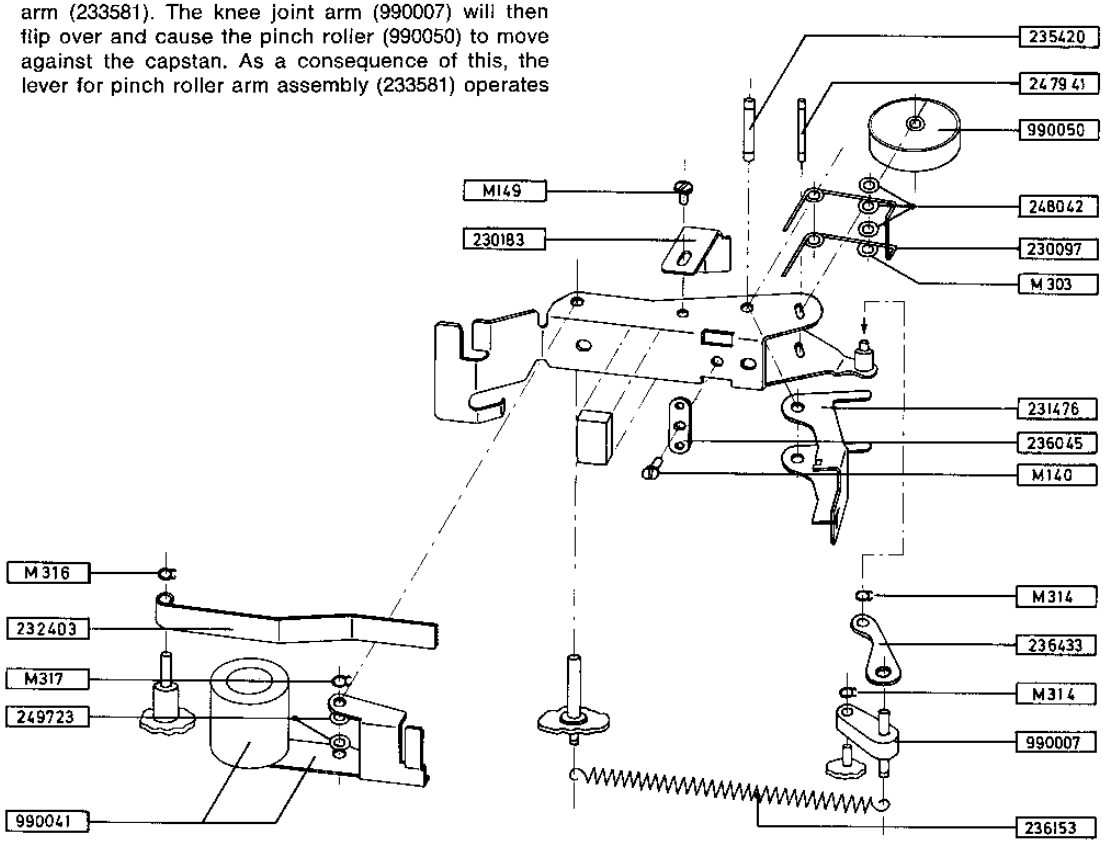


Fig. 3.9. Pinch roller arm assembly.

3.6.1 Checking and Adjustment of Momentary Start/Stop Lever.

If tape loops are formed during slow operation of the momentary start/stop lever, adjustment must be performed. Move the lever slowly towards stop position. The pinch roller should then leave capstan before the turntable brakes are applied.

When the momentary start/stop lever is moved slowly towards start position, the turntable brakes should release before the pinch roller engages with the capstan.

Adjustment is made by bending the fork (231476) until correct operating sequence is obtained.

The microswitch (990063) should switch off before the start/stop lever is in stop position. Adjustment can be performed by loosening the screw on the mounting bracket for the microswitch.

3.7 SERVO BRAKE SYSTEM

When the operating lever is in normal forward drive position, the servo brake system provides constant tape tension irrespective of the amount of tape on the reels. The servo brake system consists of the following parts: Feeler arm (990017) which is pivoted in the bushing for feeler arm shaft (245937) which again is fastened to the mounting plate (243717B). The friction spring (239472) is in one end attached to feeler arm (990017) and in the other to additional friction lever (990044), which is applied against the supply turntable.

Another spring (230765) is attached between the feeler arm and the arm for spring tension adjustment (236871). The feeler arm link (238193) which is attached to the feeler arm, is in operation during fast forward winding only.

3.7.1 Checking of Operating Range for the Feeler Arm (990017).

Put a full 7 inch reel on the supply turntable and start the tape recorder in normal forward drive. Check that the feeler arm does not rest in the left end stop position.

3.7.2 Checking of Additional Brake (990044). See chapter 3.2.5.

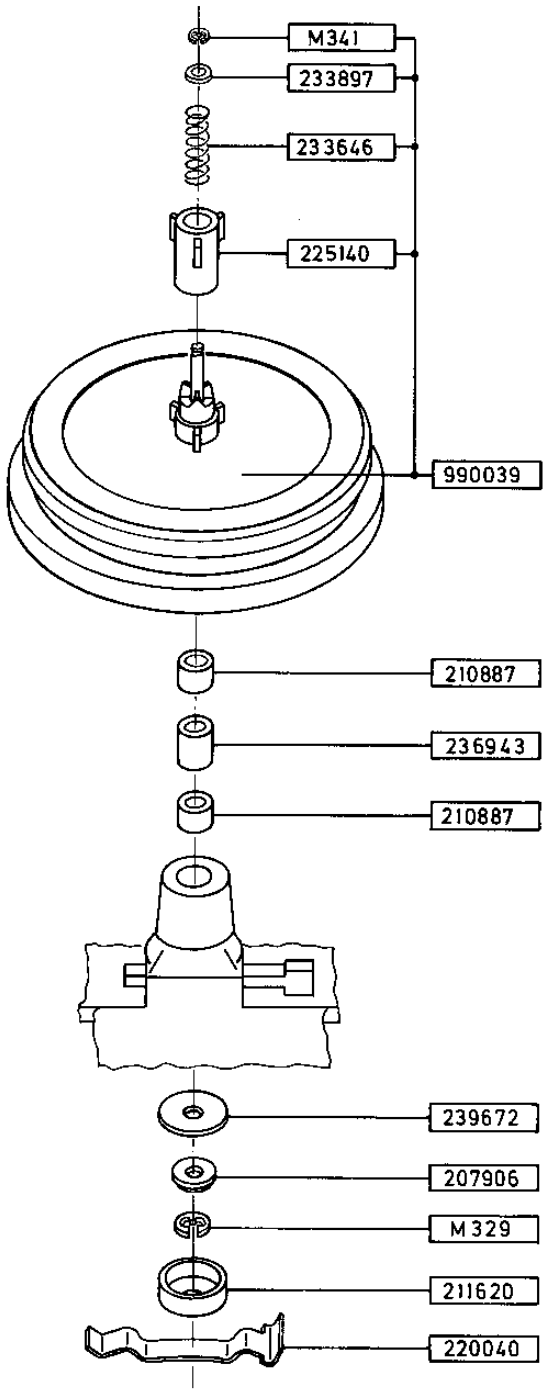


Fig. 3.10. Take-up turntable assembly.

3.8 FLYWHEEL WITH CAPSTAN

The flywheel (990054) is rotating in two selv-lubricating bearings. The end of the flywheel shaft is used as capstan.

3.8.1 Adjustment of Flywheel and Capstan.

Loosen the screws in upper bearing (990024) and measure the distance between flywheel and mounting plate in the three holes indicated in fig. 3.11. Adjust the flywheel shaft until the same clearance is measured in all three holes. Fasten the screws in upper flywheel bearing and recheck the clearance in all three holes.

3.9 TRANSFER WHEEL (990055)

On later models, the transfer wheel (990055) blishes a direct coupling between the flyw (990054) and the motor pulley (254011). The n drive belt operates only the stepped pulley (99(and is therefore shorter than on earlier mo where also the flywheel (990018) was emphasize the drive belt. This improvement implied that orientation of the tachometer head, mounting p (239206) and upper motor bearing (990023) had t altered. A flywheel brake (990052) has been intro ed to retard the flywheel, when operating leve set to neutral position.
Fig. 3.12 shows the assembly of transfer w (990055) and motor pulley (256942).

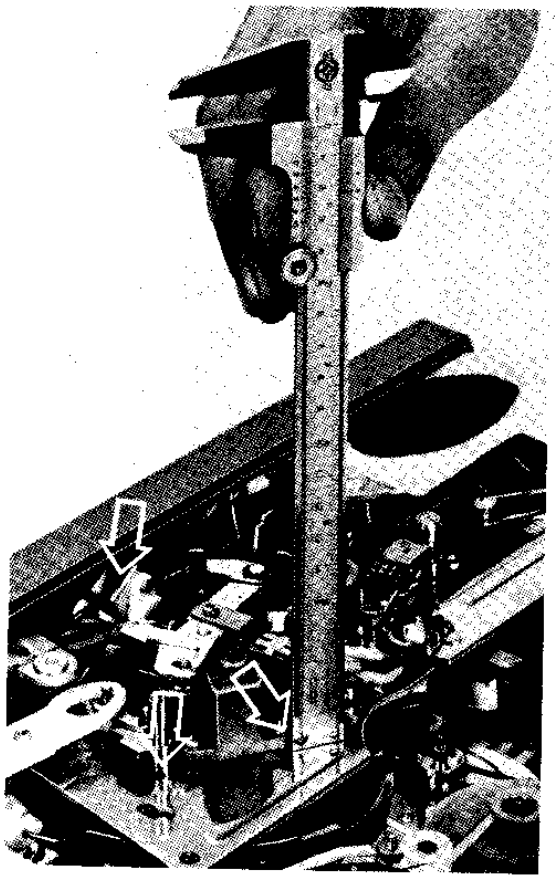


Fig. 3.11. Height adjustment of flywheel and capstan.

3.9.1 Replacement of Drive Belt (990034) in Machi without Transfer Wheel (990055).

To replace the drive belt proceed as follows. screw the tachometer head mounting plate (239 and remove the plate from the motor shaft. Rem the retaining rings (M316) and pull off the tachome wheel. Unscrew the 5 screws in the mounting pl (243717). Remove the acetal plate (230204) a first having removed the fastening screws. Rem momentary stop bar (238027) and the forked le spring (232798), lift off the mounting plate (2437 and remove the take-up belt (245262). Put the n drive belt (990034) around the flywheel (9900 tachometer wheel (233710) and stepped pul (990019) as shown in figure 3.14.

Replace the mounting plate (243717). Ensuring tl the flywheel shaft is correctly positioned in upper l wheel bearing (990024). See chapter on adjustme of capstan and flywheel, 3.8.1. In order not to up the parallel adjustment of the flywheel shaft, t mounting plate (243717) must first be fastened w a screw in the upper right corner (the screw w counter-sink head). Then insert the screw locat extreme left on the mounting plate. Thereafter, the remaining screws can be inserted in any sequenc Finally fasten the mounting plate (239206) for tach meter head and upper motor bearing. Ensure th there is clearing between tachometer head a tachometer wheel.
Mount the acetal plate (230204), momentary bra bar (238027) and pinch roller spring (232798). Pla the take-up belt (235262) around the take-up tur table and stepped pulley.

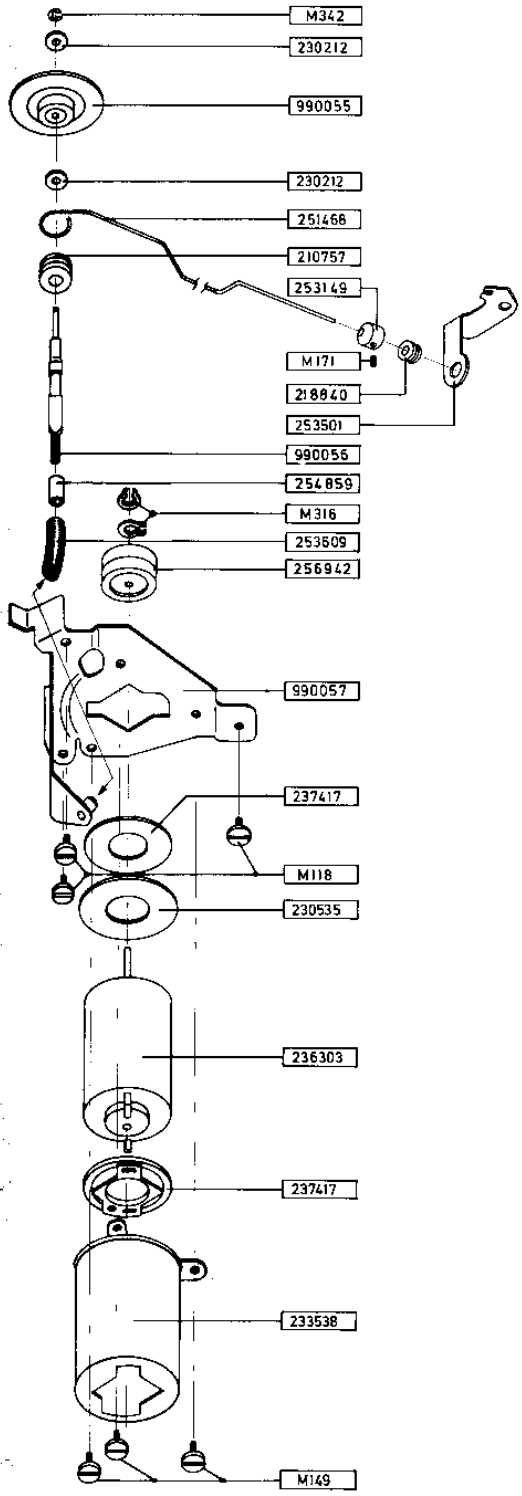


Fig. 3.12. Motor and transfer wheel assembly.

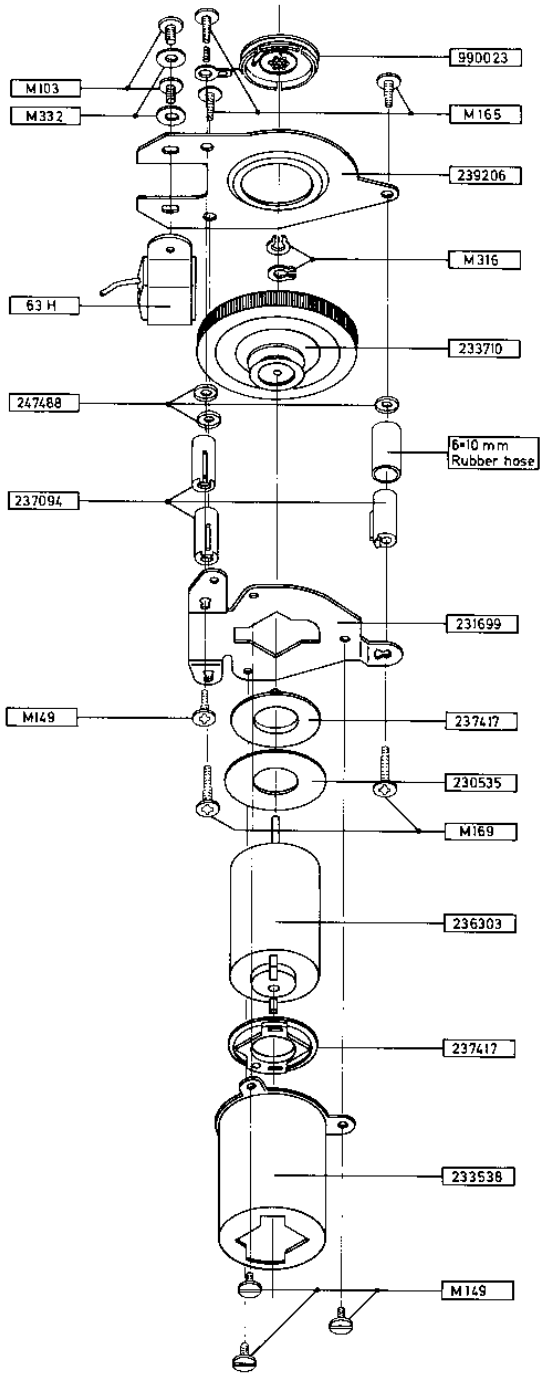


Fig. 3.13. Motor and tachometer wheel assembly on models without transfer wheel (990055).

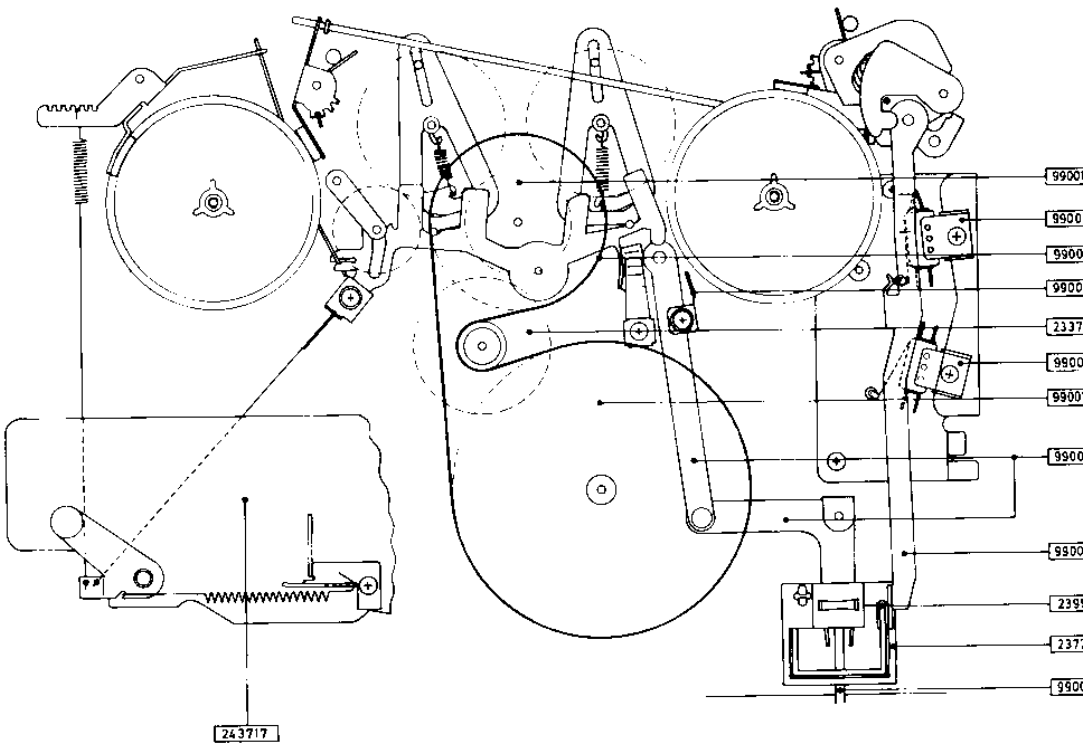


Fig. 3.14. Neutral position. Models without transfer wheel (990055).

3.9.2 Replacement of Drive Belt (253803) in Machines with Transfer Wheel (990055) and Tachometer-wheel (233710).

The procedure is the same as described in paragraph 3.9.1 with the following exception: Mounting plate (243717) does not have to be removed. The drivebelt (253803) is placed around the motor pulley and the stepped pulley. Mount the tachometer wheel and the motor pulley, and fasten with the retaining rings (M316). Then fasten the mounting plate (239206) while ensuring that there is sufficient clearance between motor pulley and tachometer wheel.

3.10 LUBRICATION

3.10.1 Transfer Wheel, Take-up Pulley and Stepped Pulley.

If the transfer wheel, take-up pulley or stepped pulley are replaced, the bottom side of these wheels should be lubricated around the hole with a drop of oil preferably of type WIK500 Deutsche Calypsol Gesellschaft (6.5° E at 50° C, pour point ÷ 40° C), or similar quality.

3.10.2 Capstan and Pinch Roller.

The upper and lower flywheel bearing and the pi roller bearing should be lubricated every 2000 h of operation, or by every replacement of these p The preferred oil is E300 EXTRA, B.W. Aral A gesellschaft (4.2° E at 50° C, pour point ÷ 33° or similar quality.

3.10.3 Motor.

The motor is lubricated with Spinesso 28.

General: Only one drop of oil should be applie each bearing or on each shaft. Excessive oil be wiped off to avoid disturbance of the co friction conditions for the rubber wheels and belts.

4.0 ELECTRICAL CIRCUITS, DETAILED DESCRIPTION

The tape recorder comprises the following major electronic units: Motor speed control, record electronics, playback electronics and power supply. The pilot model 11-1P has the following special units: Start marking electronics, and pilot circuitry.

4.1 MOTOR SPEED CONTROL UNIT
(Above Serial Number 2 305 225.)

4.1.1 Tachometer Head.

Fig. 4.1 shows a simplified drawing of tachometer head and tachometer wheel. The voltage V across the tachometer head varies according to the function:

$$V = N \cdot \frac{d\Phi}{dt} = \text{const.} \frac{dR_m}{dt}$$

R_m is the reluctance of the magnetic circuit. The reluctance fluctuates due to the notched wheel rotating in front of the tachometer head. The voltage across the tachometer head winding will therefore alternate at a frequency determined by the number of notches passing per time unit. The amplitude of the voltage is proportional to the flux variation per time unit. In other words, the amplitude is proportional to the flywheel angular velocity.

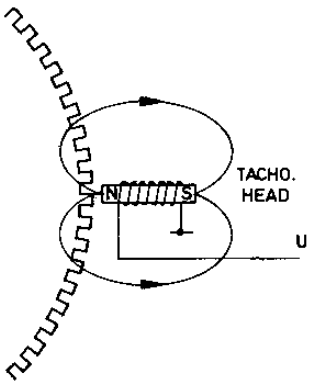


Fig. 4.1. Tachometer head and tachometer wheel.

4.1.2 Tachometer Amplifier and Limiter.

Schematic diagram for tachometer amplifier and limiter is shown in fig. 4.2. The diodes D501—D504 ensure symmetrical limiting. The signal is further amplified in Q503 and has in testpoint C the shape and amplitude as shown in fig. 4.2. The capacitors C504 and C508 prevent undesired high frequency voltages from reaching the differentiating capacitor C510 in the frequency doubler stage.

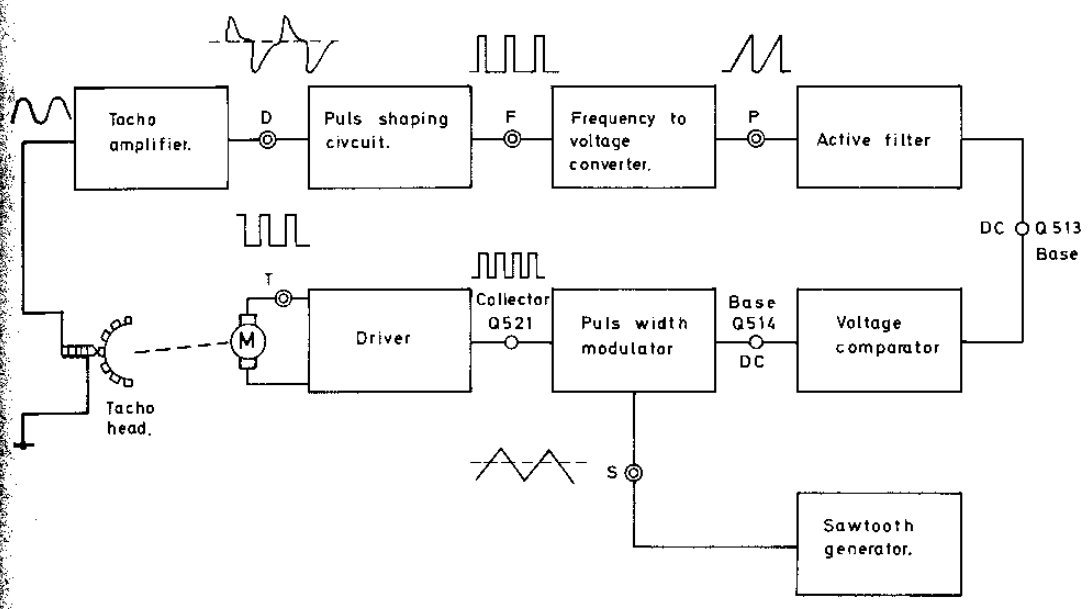


Fig. 4.0. Block diagram, motor speed control unit in models above serial no. 2 305 225.

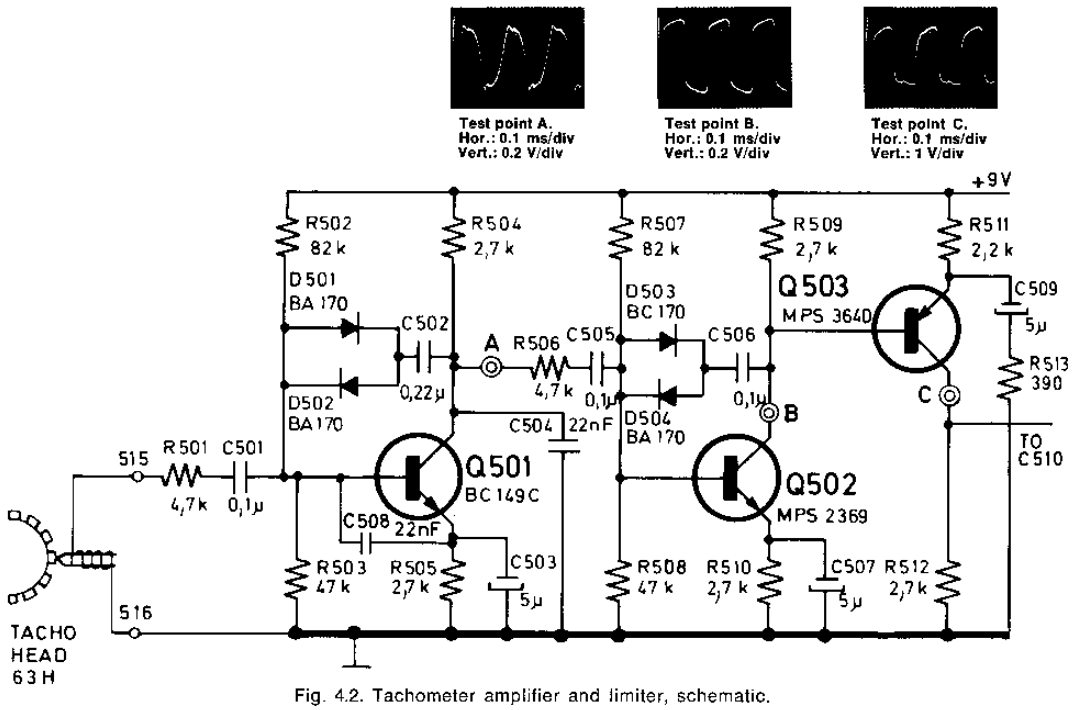


Fig. 4.2. Tachometer amplifier and limiter, schematic.

4.1.3 Differentiator and Frequency Doubler.

Schematic diagram for the differentiator and frequency doubler is shown in fig 4.3. The square wave voltage in testpoint C is differentiated in C510 and then applied to the monostable multivibrator consisting of transistors Q504 and Q505 so as to result in triggering at negative as well as positive slopes of the signal. This gives a signal of the double frequency in testpoint E. Each time Q504 is on, Q506 is off due to the negative voltage step being propagated through C512. The collector of Q506 will therefore go positive. After approximately 10 µs, C512 has charged to a voltage high enough to switch Q506 on again, and its collector goes to zero. The signal is further amplified in Q507 which provides a low impedance in testpoint F, where the waveform will be as shown in fig. 4.3. The interval between positive pulses decreases with increasing tachometer frequency (motor speed).

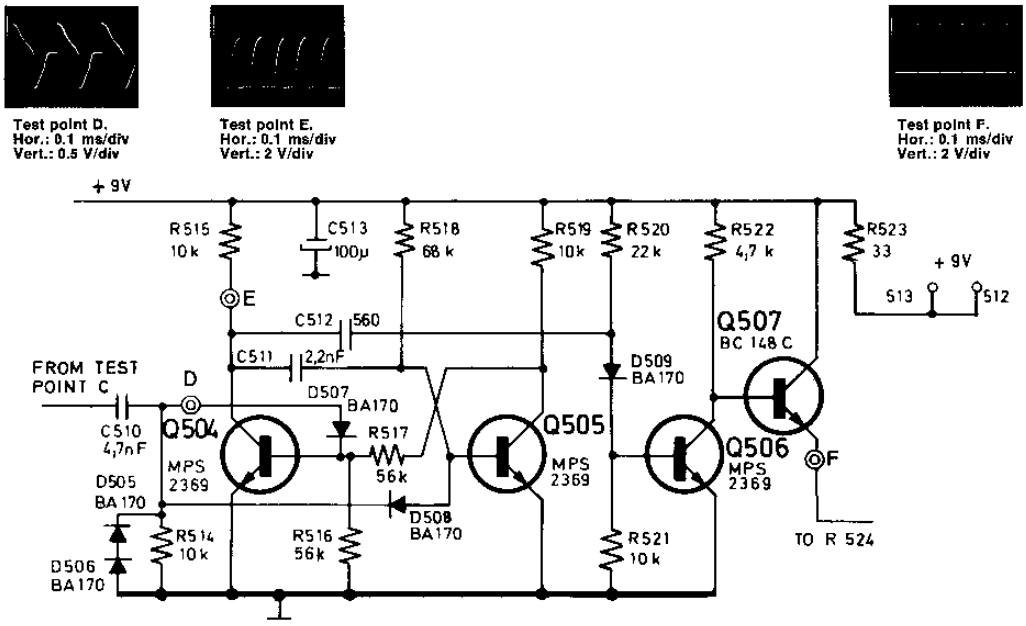


Fig. 4.3. Differentiator and frequency doubler, schematic.

4.1.4 Frequency Meter.

Fig. 4.4 shows the circuit diagram for the frequency meter.

Transistors Q508 and Q509 are connected as a current generator, the magnitude of the current being determined by R526 and R527 in the collector of Q508. The current is also dependent on R530–R534 in the emitter circuit of Q509. The emitter resistor is connected to the speed selector, and the correct current for the three speeds is set by resistors R526, R533 and R534 respectively.

The current generator is temperature compensated due to Q508 and Q509 being of the same type, and having approximately the same collector current. Capacitor C514 is short-circuited when the signal in testpoint F is positive. In the interval when the signal is zero, C514 is charged by the constant current through Q509. The capacitor voltage at the end of the charging interval is therefore inversely proportional to the motor speed.

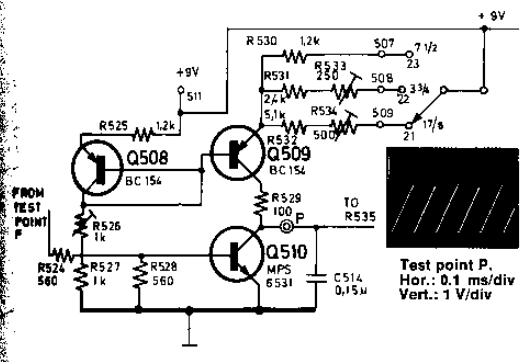


Fig. 4.4. Frequency meter, schematic.

4.1.5 Low Pass Filter.

The filter network consists of transistors Q511, Q512, resistors R535–R537 and capacitors C515–C517. The cut-off frequency of the filter is 200 Hz. The voltage on the emitter of Q511 is the average of the sawtooth voltage in testpoint P, and is therefore dependent on the motor speed.

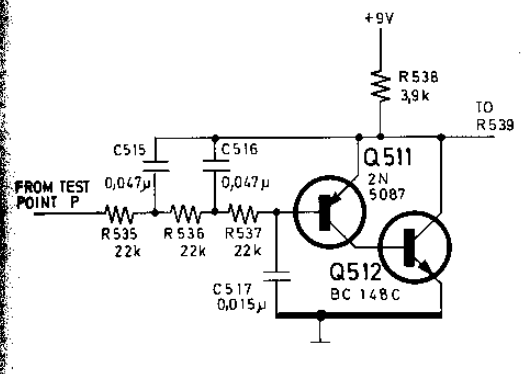


Fig. 4.5. Low pass filter, schematic.

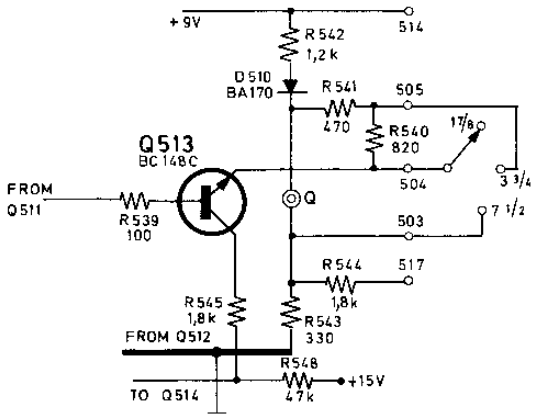


Fig. 4.6. Comparator, schematic.

4.1.6 Comparator.

The purpose of the comparator is to compare the voltage from the low pass filter with a reference voltage being fed to the emitter of Q513 via the speed selector. The schematic diagram of the comparator is shown in fig. 4.6. When the base voltage on Q513 exceeds the voltage in testpoint Q, the transistor will act as an amplifier. If the base voltage is lower, the transistor is blocked. Diode D510 compensates the voltage in testpoint Q against variation in supply voltage. Q513 amplifies the difference between the average of the voltage in testpoint P and the reference voltage in testpoint Q. The amplified difference appeares across R548. The speed can be altered by applying a voltage in testpoint Q. The signal from Q513 is fed to the base of transistor Q514.

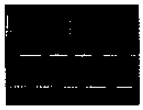
4.1.7 Pulse Width Modulator and Motor Drive Circuits.

The astable multivibrator consisting of Q515 and Q516 generates a square wave voltage which is transformed into a sawtooth voltage in the Miller integrator circuit Q517, and then applied to the input of the differential comparator Q518–Q519. The other input of the comparator is fed from the collector of Q514. When this voltage exceeds the sawtooth voltage in testpoint F, Q519 will conduct. The driver transistors Q520 and Q521 will then drive the power transistor Q522 into saturation so as to connect the motor to the negative terminal of the battery.

As long as the sawtooth voltage exceeds the voltage from the collector of Q514 the full supply voltage is applied to the motor. Assuming that the speed decreases, the error voltage will decrease and the duration of the voltage pulse to the motor is extended. The average current in the motor winding will become higher, and the motor speed will increase until it corresponds to the selected speed. Feedback is applied from the motor to Q514 through

Test point R.
Hor.: 20 us/div
Vert.: 2 V/div

Test point S.
Hor.: 20 us/div
Vert.: 1 V/div



Test point T.
Hor.: 20 us/div
Vert.: 5 V/div

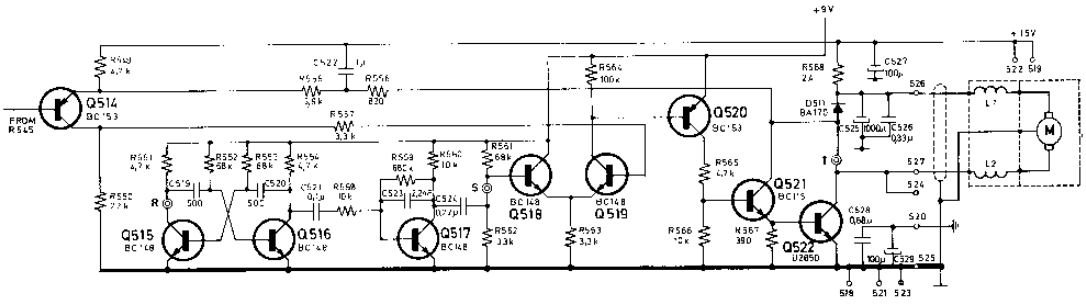


Fig. 4.7. Pulse width modulator and motor drive circuits, schematic.

the phase compensating and smoothing network concisting of R556 and C522. D511 prevents induced voltage in the motor from damaging Q522. The voltage gain from the base of Q514 to testpoint T is approximately 2. The open loop gain, however, exceeds 100.

4.1.8 Summary of the Motor Speed Control Operation.

The approximately sinusoidal signal from the tachometer head is transformed into short pulses, one for each zero crossing.
During the presence of a pulse, a capacitor C514 is charged by constant current from a current generator. The average value of the sawtooth voltage on the capacitor will depend on the angular velocity of the motor. The ripple voltage is removed in a filter, and the resulting DC voltage is compared to a reference. The error signal is amplified in Q514 and applied to a pulse width modulator that will switch the motor supply voltage on and off so as to give required average current in the motor winding to maintain motor speed at nominal value.

4.2 MOTOR SPEED CONTROL UNIT

(Below Serial Number 2 305 225.)

4.2.1 Amplifier and Limiter.

Fig. 4.8 shows the circuit diagram for the tachometer amplifier. The induced voltage from the tachometer head is supplied to Q101. The diodes D101 and D102 ensure symmetrical limiting, resulting in a square wave voltage of 1 V amplitude in testpoint A, as shown in fig. 4.8. This signal is amplified in the single ended push-pull amplifier Q103 and Q104 and is fed via C105 to the frequency discriminator.

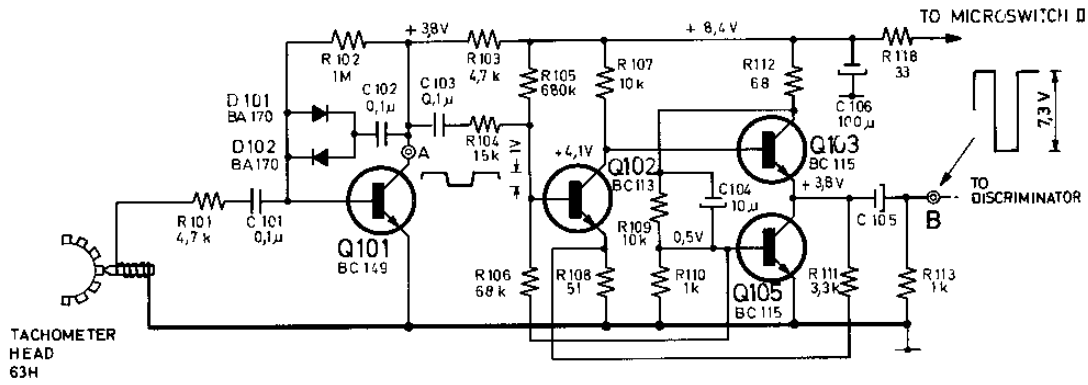


Fig. 4.8. Tachometer amplifier and limiter, schematic.

4.2.2 Frequency Discriminator.

The frequency discriminator which is shown in fig. 4.9, consists of a high-Q resonance circuit tuned to a frequency corresponding to one of the nominal tape speeds. The tuning is determined by the speed selector which connects the appropriate capacitance across the circuit. Resistors R114–R116 provide the correct damping of the circuit for the relevant tape speed. The output voltage of the discriminator is a dc voltage proportional to the difference between the tachometer and the resonance frequencies.

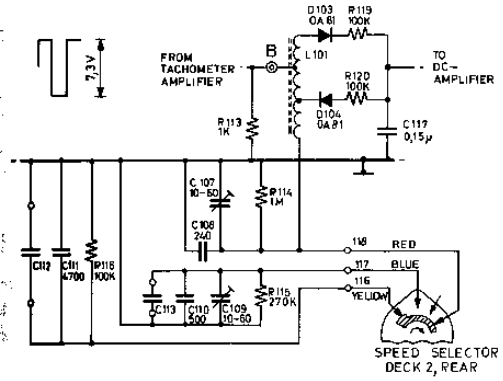


Fig. 4.9. Frequency discriminator, schematic.

4.2.3 DC Amplifier.

The circuit diagram of the dc amplifier is shown in fig. 4.10. The output voltage from the amplifier is fed to base of Q110 via the resistor R128.

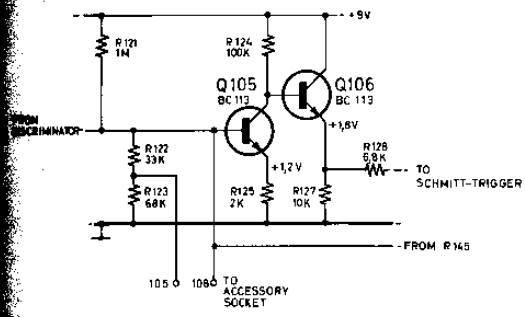


Fig. 4.10. DC amplifier, schematic.

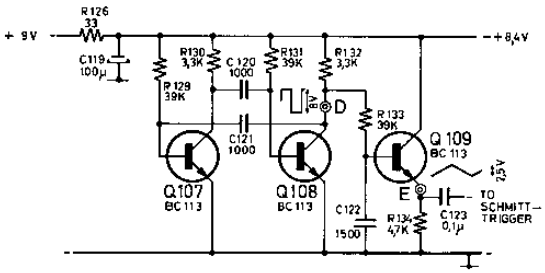


Fig. 4.11. Multivibrator and integrator, schematic.

4.2.4 Multivibrator and Integrator.

The multivibrator consisting of transistors Q107, Q108 and Q109 is shown in fig. 4.11. The output signal, a 20 kHz square wave voltage, is applied to the integrating network consisting of R133 and C122 where charging and discharging of capacitor C122 will give a sawtooth waveform on the base of Q109. The sawtooth signal is added to the dc signal from Q106 at base of Q110. The waveform in testpoint E is shown in fig. 4.11.

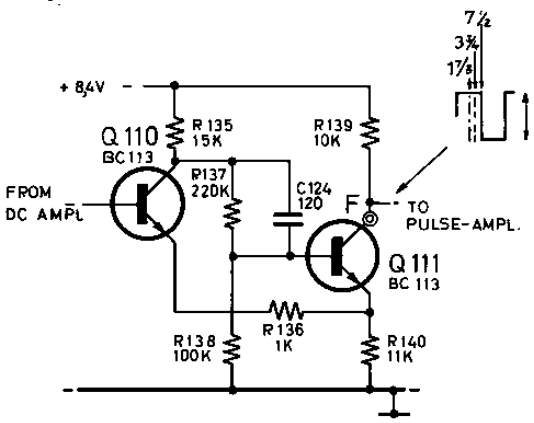


Fig. 4.12. Schmitt trigger, schematic.

4.2.5 Schmitt Trigger.

The circuit for the Schmitt trigger is shown in fig. 4.12. The input signal is a sawtooth voltage superimposed the dc voltage at testpoint E. When the signal is below the triggering level, Q110 is on and Q111 is off. As the input signal exceeds the triggering level, the circuit switches to the inverse state where it remains until the input signal again is below the triggering level, and another switching brings the circuit back to its initial state. The output signal of the Schmitt trigger is therefore a pulsewidth modulated waveform in testpoint F, as shown in fig. 4.12.

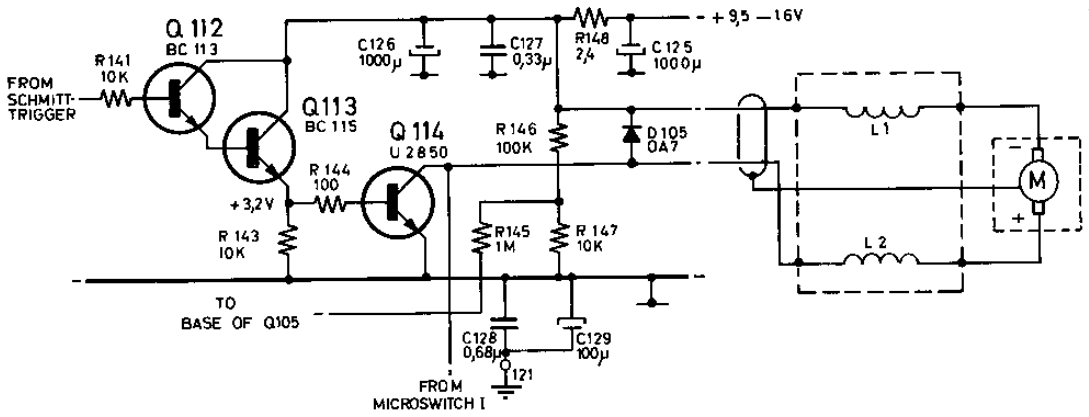


Fig. 4.13. Pulse amplifier and motor drive circuits, schematic.

4.2.6 Pulse Amplifier and Motor Drive Circuit.

The circuit is shown in fig. 4.13. Transistor Q114 operates as a switch connecting the motor supply voltage during the positive interval of the pulse width modulated signal amplified by Q112 and Q113. The average current in the motor winding is therefore determined by the selected tape speed and is varying proportionally to the deviation from the nominal tape speed.

Diode D105 prevents voltages induced in the motor from damaging Q114. A filter network consisting of D125, C126, C127 and R148 prevents induced voltages from disturbing the amplifier.

4.3 RECORD ELECTRONICS

4.3.1 Microphone Amplifier.

The microphone amplifier comprises transistors Q201, Q202 and Q203 is shown in fig. 4.14. Transformer T201 provides balanced input. Amplification is adjusted by means of potentiometers R1 and R2 which are connected in tandem.

4.3.2 Line Amplifier.

Schematic diagram of the line amplifier is shown in fig. 4.15. The overall gain of the amplifier is adjusted by means of a tandem potentiometer having one section across the output and the other at the input. The output signal is fed to the booster amplifier where it can be mixed with signal from the microphone amplifier.

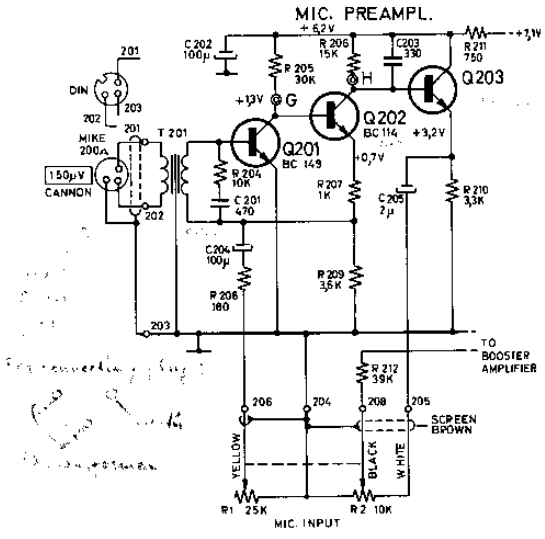


Fig. 4.14. Microphone amplifier, schematic.

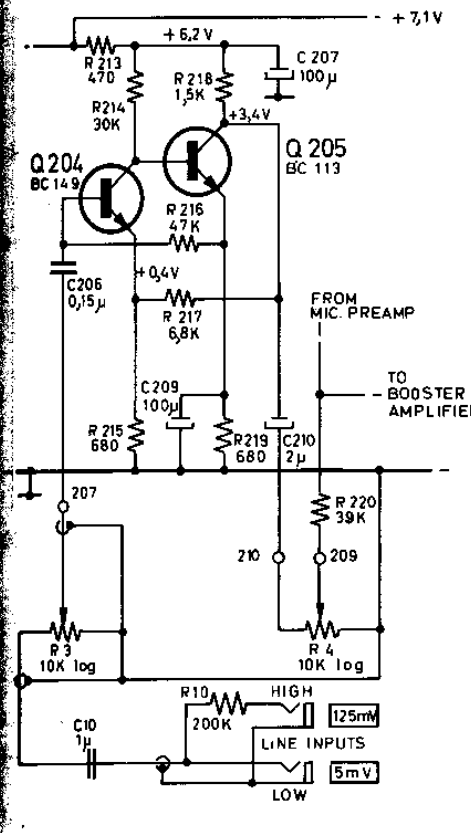


Fig. 4.15. Line amplifier, schematic.

4.3.3 Booster Amplifier and Limiter.

Fig. 4.16 shows the schematic diagram for booster and limiter. The booster amplifier comprising transistors Q207 and Q208 provides sufficient gain to drive the limiter which consists of transistors Q209, Q210 and Q211 and diodes D201, D202, zener diode D203 and field effect transistor Q206.

The limiter can be connected in the circuit by means of the switch SII. The signal from Q208 is then tapped of the variable resistor R238 and fed to Q211 via C221.

After amplification, the signal is rectified in D202 and fed via the switch SII to the dc amplifier Q210–Q209. The signal is filtered in C215 and R270 and applied to the gate of the field effect transistor which acts as a variable resistor in the lower part of the input voltage divider. The input level to Q207 will therefore be kept at a nearly constant level. R222 and C212 reduce distortion when the limiter is operating.

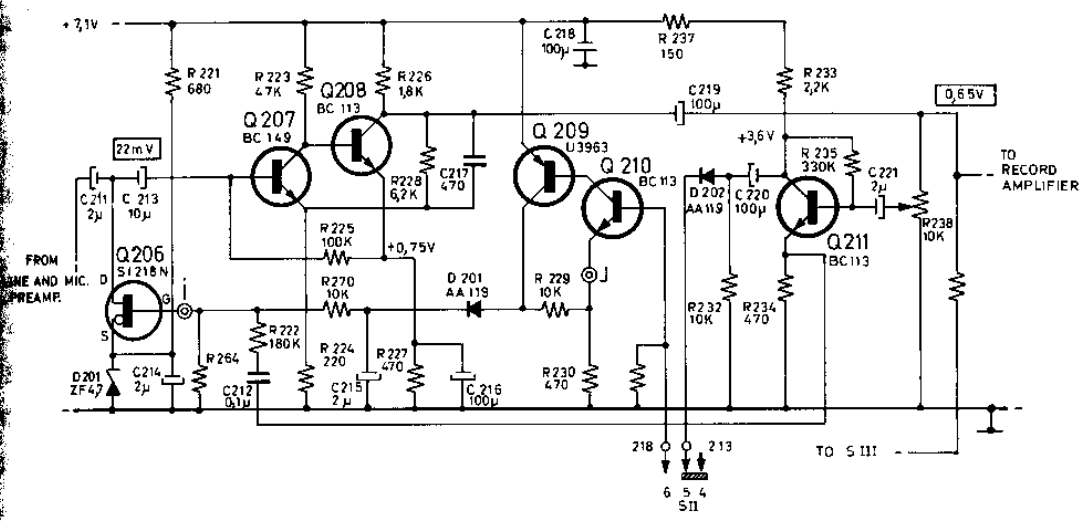


Fig. 4.16. Booster amplifier and limiter, schematic.

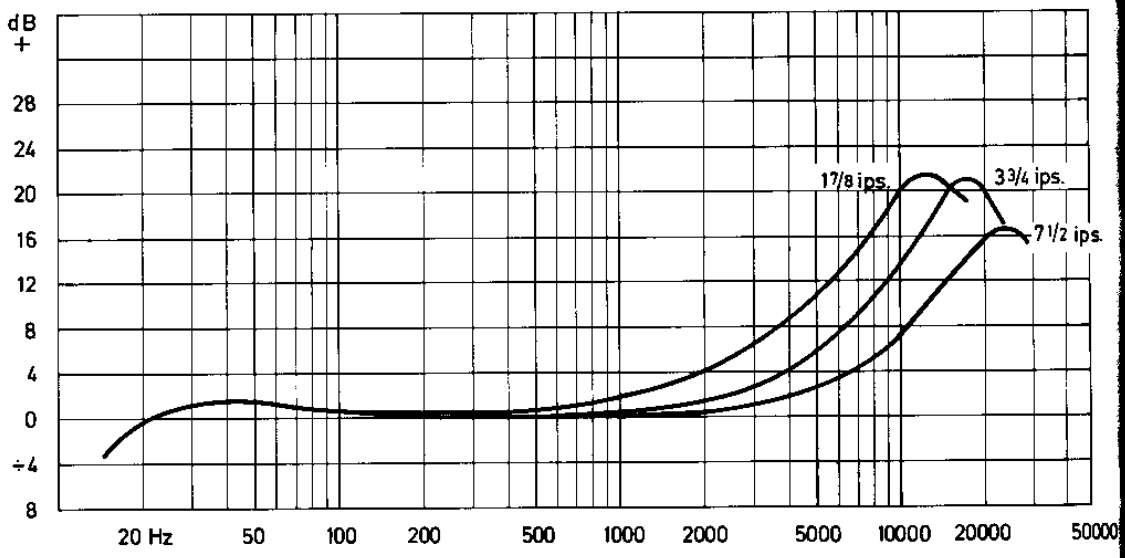


Fig. 4.17. Record equalizing curves.

4.3.4 Record equalizing Amplifier.

Circuit diagram is shown in fig. 4.18. Transistors Q212 and Q213 and the components C224, C226, C227, C228, R247, R248 and L201 form an active filter that provides the desired equalization curves at $1^{7}/_{8}$ ips. At $3^{3}/_{4}$ ips the speed selector disconnects C227 and at $7^{1}/_{2}$ ips also C228 is disconnected.

The parallel circuit C233, L202 is a bias frequency trap.

The recorded signal level is set by R241.

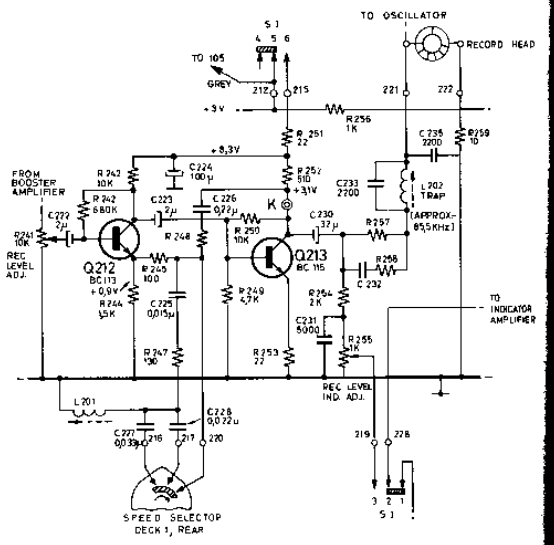


Fig. 4.18. Record equalizing amplifier, schematic.

4.3.5 Oscillator, Erase- and Bias Circuit.

The circuit diagram is shown in fig. 4.19. The oscillator comprises transistors Q115 and Q116 which are connected in push-pull. The supply voltage is filtered in C134 and applied to the center-tap of the transformer. The frequency of the oscillator is approximately 85.5 kHz, adjustable by means of C131.

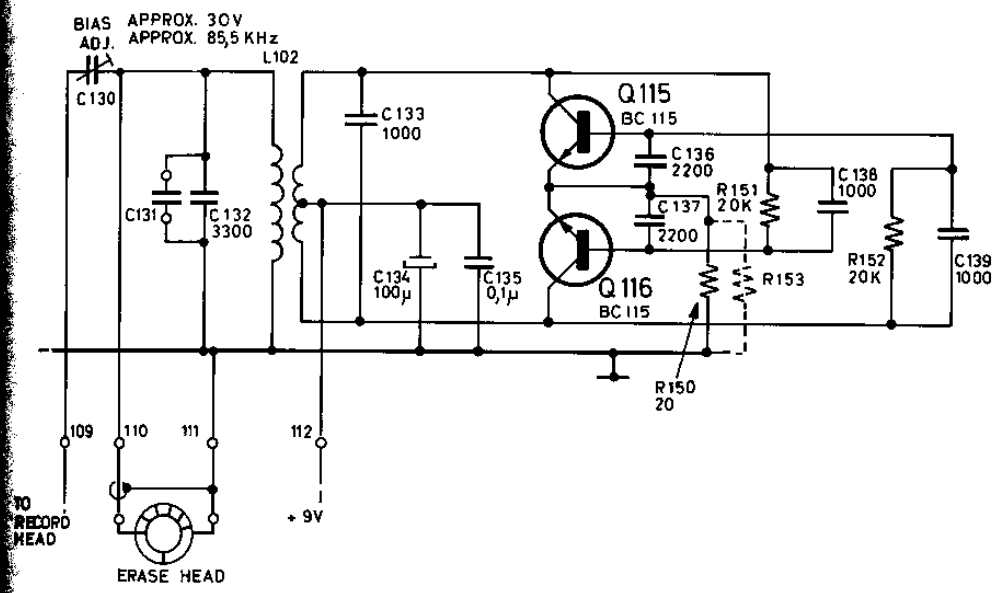


Fig. 4.19. Oscillator, erase- and bias circuit, schematic.

PLAYBACK ELECTRONICS

Playback Equalizing Amplifier.

4.21 shows the playback equalizing amplifier. lators Q301, Q302 and Q303 comprise an active with R300, R304, R308, R309, R310, R311, C304 320 as the frequency determining components ips. At 3¾ ips, R310 is short-circuited and the parallel combination R300, C320 is disconnected. At 7½ ips R311 is short-circuited and also C321 is disconnected. The diode D301 serves as decoupling for radio and oscillator frequency signals. The output signal from the amplifier is fed via the preset potentiometer R314 and switch SIII to the playback volume control R5.

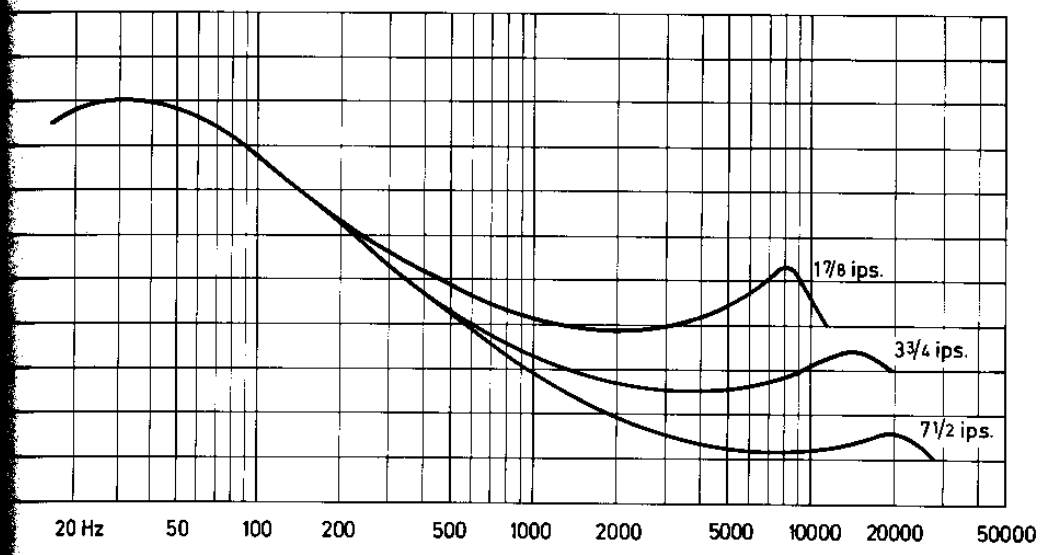


Fig. 4.20. Playback equalizing curves.

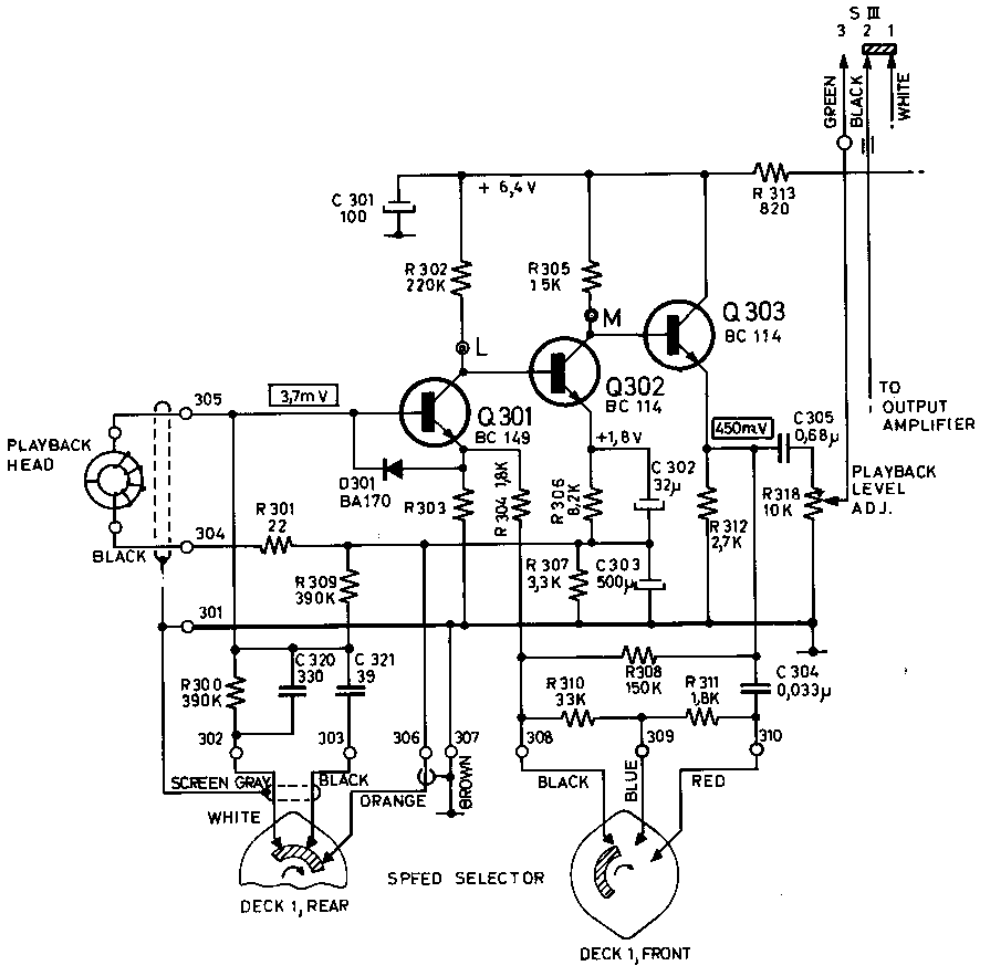


Fig. 4.21. Playback equalizing amplifier, schematic.

4.4.2 Output Amplifier.

Circuit diagram is shown in fig. 4.22. The output amplifier comprises transistors Q304, Q305, Q306 and Q307, where Q306 and Q307 are connected in push-pull. The quiescent current in the push-pull stage is set by the variable resistor R321, and the balance is adjusted by R319. Diodes D302 and D303 stabilize the quiescent current in the output transistors. The output signal from the amplifier is fed via switch S IV which allows selection of speaker output or line and monitor outputs.

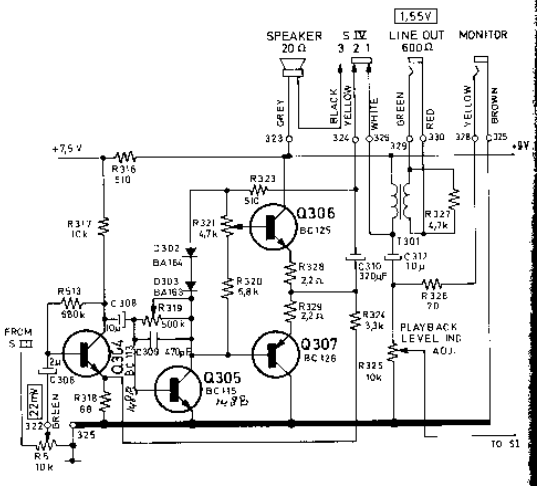


Fig. 4.22. Output amplifier, schematic.

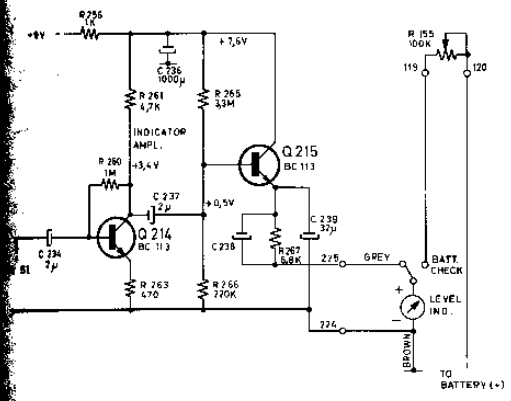


Fig. 4.23. Indicator amplifier, schematic.

INDICATOR AMPLIFIER

4.23 shows the circuit diagram for indicator amplifier which comprises transistors Q214 and Q215. The signal from the record equalizing amplifier is fed to the input of Q214 via the potentiometer R255. The amplified signal is rectified in Q215. C238 which is connected in series the meter in emitter circuit of Q215, will charge rapidly when the transistor is on, and then discharge more slowly when the transistor is off. The meter will therefore to a good approximation read the peak value of the signal.

The input signal to Q214 is taken from the output of amplifier or the record amplifier depending on the position of the switch S I.

4.6 POWER SUPPLY

The circuit diagram is shown in fig. 4.24. The voltage regulator comprises transistors Q308, Q309 and Q310. The output voltage is determined by the zener diode D304 and cannot be adjusted. If, for some reason the zener diode is replaced, it is important that its zener break-down voltage is as specified. The voltage regulator supplies 9 V to all circuits except the motor drive transistor Q114 on the motor control board, which is powered directly from the batteries. A Tandberg Mains Power Unit (Battery Eliminator Mod. 4) or other suitable supply can be connected to the accessory socket.

4.7 PILOT ELECTRONICS

4.7.1 Pilot Head and Indicator

Circuit diagram for the pilot electronics is shown in fig. 4.25. Signals from PILOT socket, pin 1, operate the pilot indicator while being simultaneously on the tape. The resistor network R353, R355 ensures equal signal amplitudes in phase opposition on the two tracks so as to obtain pilot signal cancelling in the playback head.

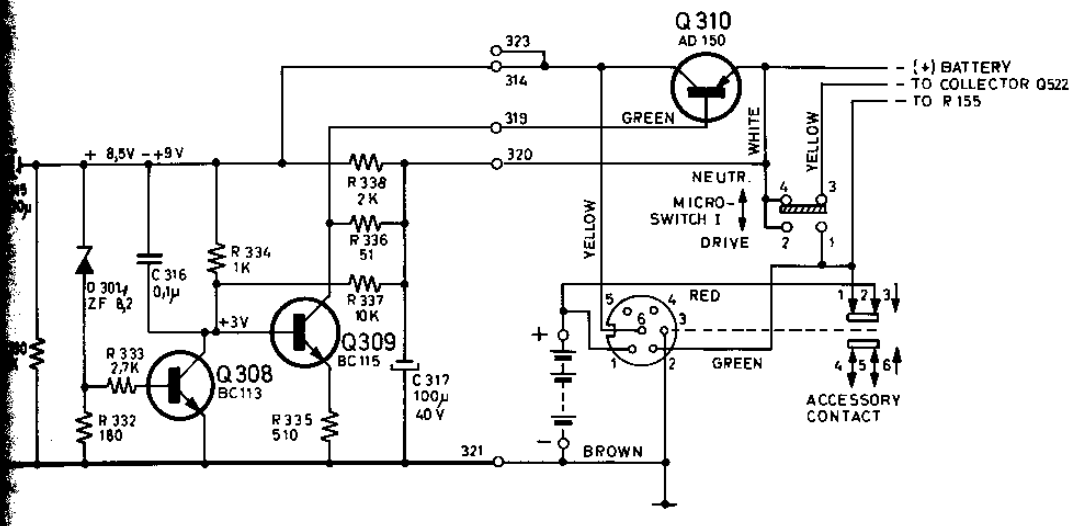


Fig. 4.24. Power supply, schematic.

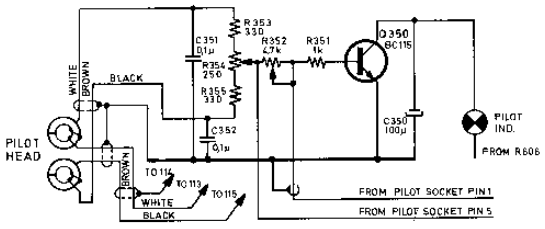


Fig. 4.25. Pilot head and indicator, schematic.

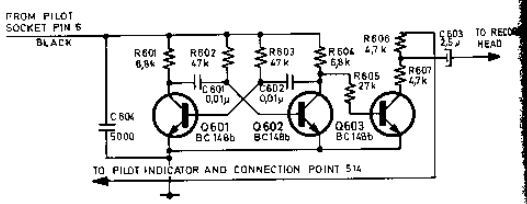


Fig. 4.26. Start marker electronics, schematic.

4.7.2 Start Marker Electronics

Fig. 4.26 shows the circuit diagram of the start marker circuit comprising transistors Q601—Q603. The start marker pulses are generated in the astable multivibrator Q601 and Q602, and are amplified in Q603 before being fed to the record head. The operating voltage (+ 8 V) for the multivibrator is fed from camera or synchronizer via PILOT socket, pin 6, while the operating voltage for Q605 is furnished from the motor control board.

5.0 ALIGNMENT OF ELECTRICAL CIRCUITS AND TAPE PATH

5.1 TAPE PATH ALIGNMENT

Set the speed selector to $7^1/_2$ ips and run a new (erased) tape. Check that the pressure wheel and the capstan have parallel axis of rotation and ensure that the tape is tracking within the rims of the rubber surface on the pressure wheel, and the flutter filter is parallel to the tape. Check that the tape runs free in the flanges on the tape guides when moving the operating lever to normal forward drive position. If necessary, adjust the height of the tape guides.

5.1.1 Height Alignment of the Heads.

Half track version:
During normal forward drive, the tape shall run flush to upper playback and record headhalves' upper edge and lower headhalves' lower edge (fig. 5.0). The erase head shall be visible 0.1 mm (9 mils) above the tape (fig. 5.0).

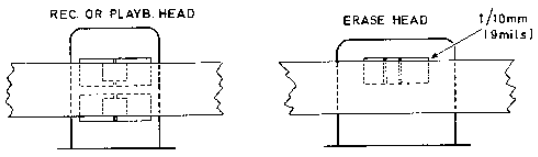


Fig. 5.0.

Full track version:
The tape shall run in the middle of the record- and playback heads so as to be completely covered by the head gap. Equal parts of the erase head gap shall be visible above and below the tape.

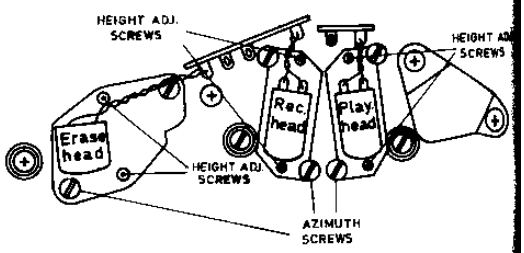


Fig. 5.1.

Adjustments.
The height adjustment screws (fig. 5.1) must be adjusted according to the above criteria.
Observe that a correction of the front azimuth screw is necessary after the height adjustment.

Demagnetization of Heads, Capstan and Flywheel.

e the demagnetizing coil slowly past the head at short distance. The head surface must on no ount be touched, as scratches are detrimental to performance. Hold the demagnetizing coil near capstan for a few seconds.
t the tape recorder and hold the demagnetizing right above the flywheel.
: Do not switch off the demagnetizer until it is at least 3 feet away from the tape recorder.

Azimuth Alignment of the Playback Head.

back Tandberg test tape no. 2, 15.000 Hz. A V.M. which is connected in parallel to a 600 ohm tor shall be connected to the LINE OUTPUT. the V.T.V.M. to the 100 mV range and adjust the uth position (fig. 5.1) of the playback head to imum deflection on the V.T.V.M. The playback ume is controlled by the PLAYB VOLUME knob. ke the supply tape reel lightly. If the reading on V.T.V.M. is increased, the tape path is not rectly adjusted.

following sources of error may exist:
The flutter filter is not parallel with the tape.
The tape does not run correctly between the flanges of the tape guides.
The pressure wheel and/or the flywheel may be obliquely positioned.
Impurities on the headfronts.
The playback head could be positioned obliquely so that the headfront is not parallel with the tape.
When the source of trouble has been determined, the azimuth position has to be readjusted. A maximum deflection of + 1.5 dB on the V.T.V.M. is allowed when braking the tape.

5.1.4 Azimuth Alignment of the Record Head.

Connect a signal generator to HIGH INPUT, and set the generator output level to 10 mV, 15.000 Hz. A V.T.V.M. connected in parallel with a 600 ohm resistor shall be connected to LINE OUTPUT. Play a new or erased tape in record/playback position (B-test). Set INPUT LEVEL to position 6 (maximum). Adjust PLAYB VOLUME for mid-scale reading of the V.T.V.M. (100 mV range).
Adjust the record head azimuth position for maximum deflection on the V.T.V.M.
Follow the procedure as under para 5.1.3 concerning braking of the supply tape reel.

5.2 OUTPUT AMPLIFIER

5.2.1 Adjustment of Symmetrical Clipping and Quiescent Current.

Connect a signal generator to HIGH INPUT and set the frequency to 1.000 Hz. Connect an oscilloscope to MONIT OUTPUT and insert a mA-meter in series with the batteries. Stop the motor by short-circuiting C514 and turn R321 fully counterclockwise (seen from the bottom of the tape recorder).
To stop motor on models below serial no. 2 305 225, short circuit base of Q110 to ground.
Set the operating lever to fast wind or fast rewind position. The current drawn from the batteries should be 30—40 mA. Adjust successively R319 and R5 (PLAYB VOLUME) until symmetrical clipping is observed on the oscilloscope.
Remove the input signal and check current drain from the batteries. Adjust R321 until the current has increased approximately 2 mA.

Note: Do not alter potentiometer setting of R319 after finishing this adjustment procedure.

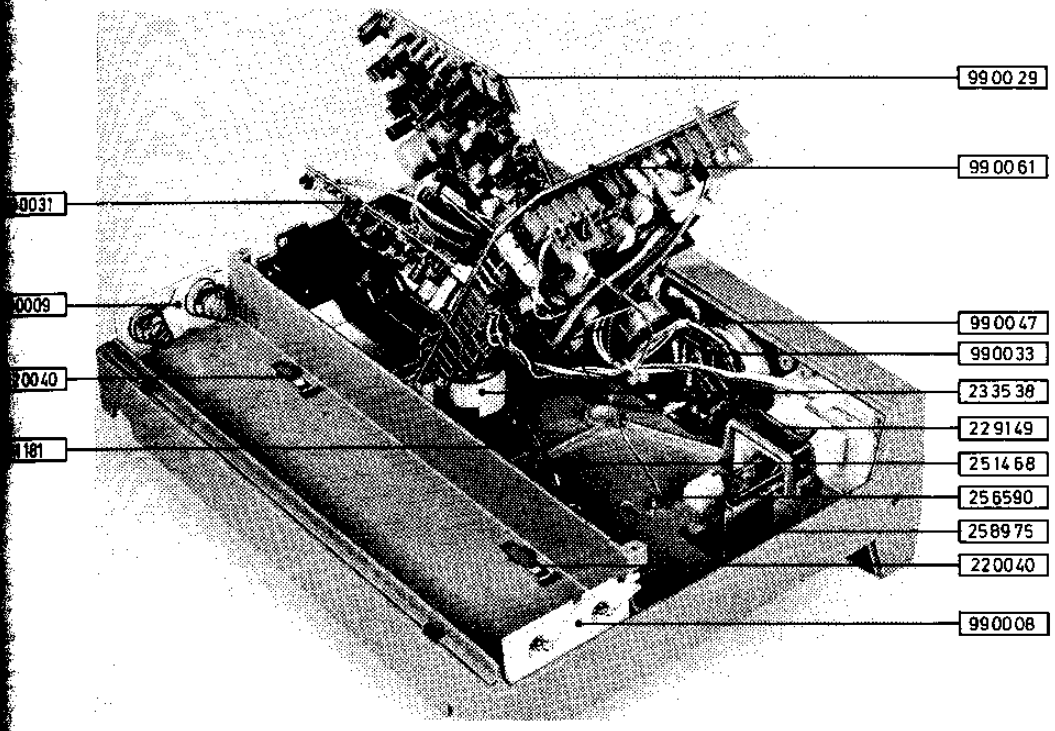


Fig. 5.2. Bottom view with cover removed.

5.3 ADJUSTMENT OF BATTERY VOLTAGE INDICATOR

The voltage from external power supply must be connected to the ACCESSORY socket, pin 2 (+) and pin 3 (−).
The voltage is set exactly to 9 V. Depress the BATT TEST button and hold. Adjust potentiometer R155 until the meter indicates zero.

5.4 ADJUSTMENT OF OSCILLATOR FREQUENCY

5.4.1 Using Signal Generator and Radio Receiver.

Tune the receiver to 256.5 kHz (3rd harmonic of 85.5 kHz) and connect a wire loop between antenna and ground terminals.
Tune the signal generator to 256.5 kHz. Form the radio input lead in to a pick-up loop close to the erase head and inject the generator signal from a similar loop connected to the generator output.
The voltage from external power supply is set to 14 V and fed to the ACCESSORY socket pins 2 and 3, the former being the positive terminal. Set capacitor C130 to middle position. Start the tape recorder in record mode. Replace the capacitor C131 with another value until approximately zero beat is obtained.
Tolerances: 85.5 kHz ± 2 kHz (Beat signal ± 6 kHz).

5.4.2 Using Frequency Counter or Frequency Meter.

Connect a frequency counter or a frequency meter to the record head directly or inductively. (The degree of coupling depends on input characteristics of the instrument). The voltage from external power supply is set to 14 V and fed to the ACCESSORY socket pins 2 and 3. Set the capacitor C130 to middle position. Start the tape recorder in RECORD mode. Read the oscillator frequency on the frequency meter or frequency counter. If frequency tolerance is exceeded, replace C131 with a capacitor of different value.
Tolerances: 85.5 kHz ± 2 kHz.

5.4.3 Using Vacuum Tube Voltmeter (V.T.V.M.)

If adjustment of the trap L202, C233 has not been upset, this circuit may be used as reference for the determination of oscillator frequency. Connect a V.T.V.M. between the junction of R257/L202 and ground. Voltage from external power supply is set to 14 V and fed to the ACCESSORY socket, pins 2 and 3. Start the tape recorder in record mode. Change the value of capacitor C131 until a defined minimum is obtained on the V.T.V.M. The oscillator frequency is then approx. 85.5 kHz.
Tolerances: 85.5 kHz ± 2 kHz.

5.5 CHECKING AND ADJUSTMENT OF TAPE SPEED

5.5.1 Using Frequency Counter.

Connect a frequency counter to MONIT OUTPUT and play Tandberg Test Tape no. 11.

7½ ips. Adjust for a frequency counter indication of 1000 Hz ± 5 Hz by means of:
C107 in units below serial number 2 305 225.
R526 in units above serial number 2 305 225.
Adjustment of R526 also influences the speeds 3¾ and 1⅞ ips.
3¾ ips. Adjust for a frequency counter indication of 500 ± 2.5 Hz by means of:
C109 in units below serial number 2 305 225,
R533 in units above serial number 2 305 225.
1⅞ ips. In units below serial number 2 305 225 adjust for a frequency counter indication of 250 Hz ± 1.2 Hz by altering the value of C112. In units above serial number 2 305 225 adjust R534 for 1000 Hz ± 5 Hz.

5.5.2 Using Transformer and Vacuum Tube Voltmeter.

Connect a transformator 230/0.5 or 115/0.5 V, 50/60 Hz and a voltmeter shunted with 200 ohm to the mains and the MONIT OUTPUT as shown in fig. 5.3.
Playback at 7½ ips using test tape 10a if the line frequency is 50 Hz and test tape 19a if the line frequency is 60 Hz.

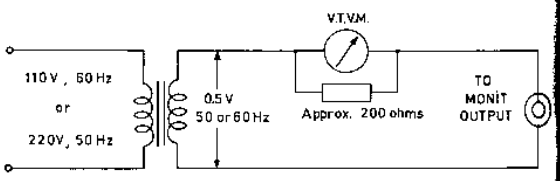


Fig. 5.3.

Deviation from correct tape speed will give a beat signal across the voltmeter. Turn up PLAYB VOLUME to obtain adequate meter deflection. Clock the time for 10 complete excursions of the meter needle. Read the speed deviation in per cent corresponding to this particular time from the nomogram in fig. 5.4.
In units below serial number 2 305 225 adjust C107 for a maximum deviation of 0.5 % from nominal speed.
In units above serial number 2 305 225 adjust R526.
At 3¾ ips play Tandberg test tape no 10b (50 Hz signal) if the line frequency is 50 Hz, or test tape 19b (60 Hz signal) if the line frequency is 60 Hz.
Then proceed as for 7½ ips to find speed accuracy. If deviation from nominal tape speed exceeds 0.5 %, adjust C109 in units below serial number 2 305 225 or R533 in units above serial number 2 305 225.
At 1⅞ ips, frequency adjustment is accomplished by altering the value of C112 in units below serial number 2 305 225 or by means of potentiometer R534 in units above serial number 2 305 225.

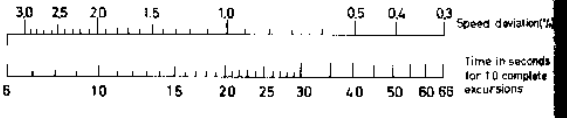


Fig. 5.4.

5.6 CONTROL OF ERASE VOLTAGE

Connect a low-capacitance probe from the V.T.V.M. to the red wire on the erase head. Start the tape recorder in record mode. The V.T.V.M. should read ≥ 30 V.

5.7 ADJUSTMENT OF BIAS

Connect a signal generator to HIGH INPUT and set the level of the generator to 10 mV, 1.000 Hz. Connect a V.T.V.M. loaded with a 600 ohm resistor to LINE OUTPUT. The INPUT LEVEL control is set to position 7 (maximum). Play a new (erased) tape in record/playback mode (B-test). Adjust PLAYB VOLUME until the reading on the V.T.V.M. is approximately 50 mV. Adjust C130 until maximum deflection on the V.T.V.M. is obtained.

5.8 CONTROL OF TAPE SPEEDS AT 9.5 V OPERATING VOLTAGE

The voltage from external power supply is set to 9.5 V and fed to the ACCESSORY socket pins 2 and 3. The tape speeds are controlled as under para. 5.5.1 or 5.5.2. Check all tape speeds.
Deviation from nominal tape speed must not exceed ±3 %.

5.9 CONTROL OF PLAYBACK CURVE AT TAPE SPEED $7^1/_2$ ips.

A V.T.V.M. in parallel with a 600 ohm resistor is connected to LINE OUTPUT. Play back Tandberg Test Tape no. 3. The test tape contains the following frequencies: 250, 10.000, 5.000, 1.000, 100, 50, 250 Hz. When playing back 250 Hz, adjust PLAYB VOLUME until the V.T.V.M. reads approx. 150 mV which is the reference level. The signal tolerances are as follows at 10.000 Hz: 0 to + 4 dB, at 5.000 Hz: −1 to + 3 dB. The reason for these particular tolerances is that Tandberg Test Tape no. 3 is recorded according to NAB standard, 50 μs, while Tandberg series 11 has playback equalization according to 60 μs at tape speed $7^1/_2$ ips. This is an average value of NAB and IEC standards. The IEC standard specifies 70 μs.

5.10 ADJUSTMENT OF BIAS TRAP

Turn the potentiometers INPUT LEVEL and MIC LEVEL to zero. Connect a V.T.V.M. between the junction of R257/L202 and ground. Start the tape recorder in record mode.
Adjust the core in L202 to minimum deflection on the V.T.V.M. (less than 100 mV).

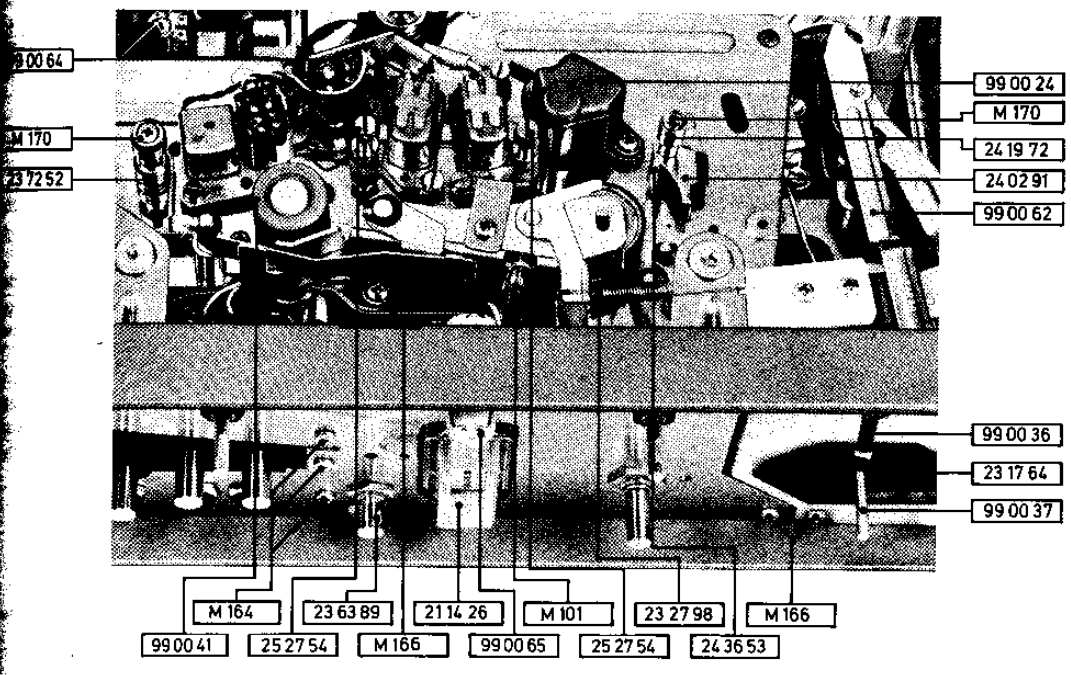


Fig. 5.5. Heads, tape path and pinch roller assembly.

5.11 ADJUSTMENT OF PLAYBACK OUTPUT LEVEL

5.11.1 A-test.

Connect a signal generator to HIGH INPUT and adjust the signal to exactly 125 mV, 400 Hz. Connect a V.T.V.M. in parallel with a 600 ohm resistor to LINE OUTPUT. Turn INPUT LEVEL to position 6 (maximum). Start the tape recorder, leaving all push-buttons unoperated. Adjust playback output level with PLAYB VOLUME until the V.T.V.M. indicates 1.55 V.

Note: During the following operations the setting of PLAYB VOLUME must on no account be touched.

5.11.2 Indicator (Indicating the Playback Output Level).

Connections and settings are the same as under para. 5.11.1. A-test.
Adjust potentiometer R325 until the meter indicates zero.

5.11.3 Adjustment of Playback Amplifier.

Connect a V.T.V.M. loaded with a 600 ohm resistor to LINE OUTPUT.
Play back Tandberg Test Tape no. 4, 400 Hz at tape speed $7^1/_2$ ips. Adjust R314 until the V.T.V.M. reads 1.45 V.

5.12 ADJUSTMENT OF RECORDING LEVEL

5.12.1 B-test.

Adjust the signal generator to 125 mV, 400 Hz and connect to HIGH INPUT. Connect a V.T.V.M. in parallel with a 600 ohm resistor to LINE OUTPUT. Use a new (erased) tape and start the tape recorder in record/playback mode (B-test). Adjust R241 until the V.T.V.M. indicates 1.55 V.

5.12.2 Indicator (Recording Level).

Adjust the potentiometer R255 until the recording level meter indicates zero.

5.12.3 Adjustment of Equalizing Coil L201

Adjust the signal generator connected to HIGH INPUT to 18 000 Hz, 12.5 mV. Set the tape recorder to B-test at tape speed $3^3/_4$ ips.
Start the tape recorder and adjust the core in L201 to maximum deflection on the indicator.

5.12.4 Adjustment of the Limiting Threshold.

Depress the LIMIT button while the PLAYB button is unoperated. Start the tape recorder in A-test. Adjust R238 until the V.T.V.M. indicates 1 dB below 1.55 V, i.e. 1.38 V.

5.12.5 Distortion.

Connect a distortion meter parallel to the V.T.
Use a new tape (erased) and start the tape reco
in record/playback mode (B-test).
Check that the V.T.V.M. indicates 1.55 V. Distor
should be less than 3 % when the recording l
indicator on the tape recorder reads zero.

5.13 LIMITER RELEASE TIME

Connect a signal generator to HIGH INPUT and
the input level to 125 mV, 400 Hz. Load the L
OUTPUT with a 600 ohm resistor and connect
oscilloscope and a V.T.V.M. in parallel to the out
Start the tape recorder in record mode. Adjust
INPUT LEVEL until the recording level indic
reads zero. Adjust PLAYB VOLUME to 1.55 V on
V.T.V.M. Depress the LIMIT push-button. Incre
the signal level from the generator by 20 dB. T
reduce the signal level.
Use the oscilloscope to determine the time for
output signal to return to normal level (4.38 V p
to peak). This is the release time which should
0.3–0.7 seconds.

5.14 OVERALL FREQUENCY RESPONSE

Set the external power supply to 14 V and conne
to the ACCESSORY socket, pins 2 and 3. Conr
the signal generator to HIGH INPUT and set
level to 12.5 mV, 15.000 Hz. Connect a V.T.V.M
parallel with a 600 ohm resistor to LINE OUTP
Turn the V.T.V.M. to the 100 mV range. Set the
corder in record/playback mode (B-test).

$7^1/_2$ ips.

Set the signal generator to 1.000 Hz and adjust
PLAYB VOLUME until the V.T.V.M. indicates appı
55 mV.
Increase the generator frequency continuously up
16.000 Hz at constant amplitude. Check that out
signal does not deviate more than ± 2 dB from
reference level at 1.000 Hz.
If the treble amplitudes are too high, adjust bias
means of C130. If treble amplitudes are lower tl
nominal, adjust C130 for maximum reading on
V.T.V.M. at 1500–2000 Hz. Recheck the overall
quency response.
Frequency response: ± 2 dB, 40–16.000 Hz.

$3^3/_4$ and $1^7/_8$ ips.

The setting and adjustment procedure is the sa
as for $7^1/_2$ ips.

Frequency response:
$3^3/_4$ ips: ± 2 dB, 50–10.000 Hz
$1^7/_8$ ips: ± 2 dB, 50–5.000 Hz

0 ADJUSTMENT OF PILOT EQUIPMENT SERIES 11-P

HEIGHT ADJUSTMENT OF PILOT HEAD

external amplifier is connected to pins 5 and 2 ound) on PILOT socket and a V.T.V.M. is connect- to the output of the external amplifier (fig. 6.0). y Tandberg test tape no. 18. Adjust the height ition of the pilot head with the two height adjust-

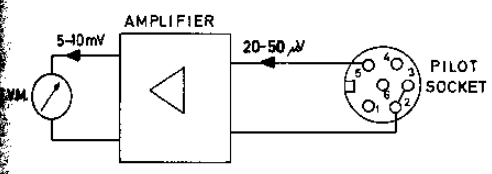


Fig. 6.0.

nt screws and the azimuth screw until maximum lection on the V.T.V.M. Check that the track is ered by the tape, ref. para. 5.1.1. Height alignment the heads, full track version. Check that the head- nt is parallel with the capstan and that the head is parallell to the tape edge. When maximum ding on the V.T.V.M. is obtained short-circuit per track and check that the reading is reduced a factor of two. Then short-circuit lower headhalf d check that also this deflection is reduced by a tor of two.

6.2. BALANCE ADJUSTMENT OF PILOT RECORDING

Connect a signal generator to pin 6 and pin 2 (ground) on the PILOT socket. Set the generator to 50 Hz, 0.8 V. Connect a V.T.V.M. to LINE OUTPUT. Start the tape recorder in record/playback mode (B-test) using a new (erased) tape. The 50 Hz, 0.8 V signal will then be recorded on the tape. Check that the pilot indicator operates (red). The two head halves are connected so that the signals recorded are of opposite phase. Adjust the potentiometer R354 to minimum deflection on the V.T.V.M.

6.3 CONTROL OF START MARKING VOLTAGE

Connect a V.T.V.M. to LINE OUTPUT and set to the 3 V range.
Feed a dc voltage, (+) 8 V to pin 6 on PILOT socket, pins 2 or 3 as ground. Start the tape recorder in record/playback mode (B-test).
The deflection on the V.T.V.M. should be 0.8–1.5 V.

6.4 CONTROL OF PLAYBACK LEVEL

Tandberg Synchronizer is needed for this operation. Set switch on Tandberg Synchronizer to PLAYBACK MSC. position. Play back the recording made during balance adjustment of pilot recording, ref. para. 6.2. Check that the pilot indicator on the Tandberg Synchronizer operates.

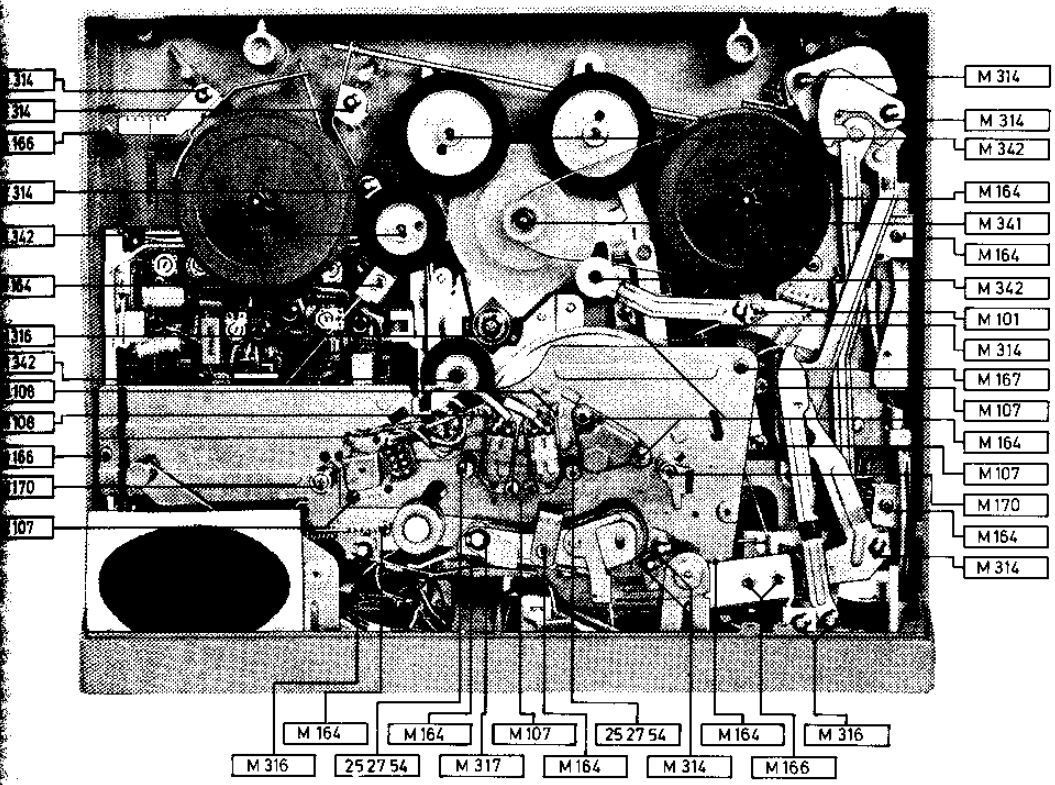


Fig. 6.1. Location of screws, washers and retaining rings.

7.0 SPARE PARTS LIST

7.1 ORDERING OF PARTS

As a result of continuous research in order to improve our products, a few modifications have been introduced to mechanical as well as electrical design of the series 11 Tape Recorders.
When ordering a mechanical component, it is essential that the appropriate part number being used as a reference in this manual, be specified.
For ordering of electrical parts, however, the position number (C131, R119 etc.) is used.

NOTE: In units deviating from the original design, one to three asterisks are added to the part number to be used, and need not be specified in the order.

* Parts introduced with transfer wheel motor — to — flywheel transmission.

** Parts introduced in units above serial number 2 305 225.

*** Parts omitted from units above serial number 2 305 225.

7.2 EXPLANATION OF PARTS IDENTIFICATION

1. The 6 digit part number specifies the part.
2. The designation 11C indicates that the part can be used in all models of series 11.
3. The designation 111 indicates a part unique for the full track model.
4. The designation 112 indicates a part unique for the half track model.

7.3 EXPLANATION OF VERSION IDENTIFICATION

1. The designation 31 indicates a recorder equipped with Cannon XL-3-31 microphone socket.
2. The designation 32 indicates a recorder equipped with Cannon XL-3-32 microphone socket.
3. The designation 31P indicates a Pilot Model equipped with Cannon XL-3-31 microphone socket.
4. The designation 32P indicates a Pilot Model equipped with Cannon XL-3-32 microphone socket.
5. The designation D indicates a recorder equipped with DIN microphone socket.
6. The designation DP indicates a Pilot Model equipped with DIN microphone socket.

7.4 TYPES OF MICROPHONE SOCKETS AND PLUGS APPLIED ON TANDBERG SERIES 11.

Model	Full track/Half track	Microphone socket	Microphone plug	Notes
11-1-DIN	Full track	DIN-socket	DIN-plug w/bayonet lock	
11-1-DIN-P	Full track	DIN-socket	DIN-plug w/bayonet lock	Pilot model
11-2-DIN	Half track	DIN-socket	DIN-plug w/bayonet lock	
11-1-C31	Full track	Cannon XL-3-31	Cannon XL-3-12	
11-1-C31-P	Full track	Cannon XL-3-31	Cannon XL-3-12	Pilot model
11-2-C31	Half track	Cannon XL-3-31	Cannon XL-3-12	
11-1-C32	Full track	Cannon XL-3-32	Cannon XL-3-11	
11-1-C32-P	Full track	Cannon XL-3-32	Cannon XL-3-11	Pilot model

When connecting external equipment such as radio, amplifier, line, headphones etc. to model 11, standard miniature plugs ($^1/_8$") have to be used.

7.5 MECHANICAL PARTS:

Ref. No.	Description	Fig. ref.	Notes
200895-11C	Rivet, fast winding lever		
201605-11C	Shaft, pinch roller		
205319A-11C	Screw, tape guide		
207906-11C	Ring, turntable	3.6, 3.10	
208222-11C	Transformer T201, microphone		
210757-11C	Rubber mounting	3.12	
210887-11C	Bushing, turntable bearing	3.6, 3.10	
211426-11C	Meter V303, indicator	5.5	
211620-11C	Cup, turntable bearing	3.6, 3.10	
212036-11C	Housing, operating lever ball	3.0	
212561-11C	Transformer T301, output		
218840-11C	Rubber mounting	3.11	
219925-11C	Rivet, battery compartment lid		
220025-11C	Emblem, "Tandberg"		
220040-11C	Clip, turntable bearing cup	3.6, 3.10, 5.2	
220406-11C	Arm, fast winding (right)		
220693-11C	Lever, braking system	3.1, 3.2, 3.5, 3.7	
220981-11C	Hinge, top cover	3.1	
223129-11C	Spring, loudspeaker cover		
223172-11C	Case, battery		
223193-11C	Lever, lower, braking system	3.1, 3.2, 3.5, 3.7	
223488-11C	Connector, 5-pin, printed circuit board		
224027-11-D	Connector, DIN, MICROPHONE		
224235-11C	Spring, battery contact		
225140-11C	Sleeve, reel lock	3.6, 3.10	
225801-11C	Lever, fast winding	3.1, 3.2, 3.5, 3.7	
226613-11C	Spring, battery compartment lid		
226749-11C	Clip, printed circuit board		
226778-11C	Hinge, printed circuit board		
227662-11C	Mounting, microswitches		
227741-11C	Connector, ACCESSORY		
227949-11C	Foot, rubber		
228286-11C	Mounting, plastic, styroflex capacitors		
229149-11C	Clip, axle, operating lever assembly	3.0, 5.2	
229515-11C	Arm, fast rewinding (left)		
229630-11C	Terminal, flat (for p.c. board)		
229802B-11C	Interlock arm, push button switch		
230097-11C	Spring, pinch roller	3.9	
230183-11C	Shield, pinch roller arm		
230204-11C	Arm, knee joint operating	3.1	
230212-11C	Washer, flutter filter	3.12	
230298-11C	Frame, printed circuit boards	3.1	
230363-11C	Spring, latch arm, momentary stop		
230535-11C	Disk, mumetal, motor	3.12, 3.13	
230765-11C	Spring, feeler arm	3.1, 3.2, 3.5, 3.7	
230801-111-31P	Plate, mounting, front		
230801-111-31	Plate, mounting, front		
230944-11C	Lever, momentary start/stop		
230973-11C	Can, outer shielding, coil L101		
231030-11C	Hinge, edge connector	3.1	
231031-11C	Cloth, loudspeaker grill		
231476-11C	Lever, forked, pinch roller arm	3.9	
231620-11C	Rod, brake connecting	3.1, 3.2, 3.5, 3.7	
231634-11C	Plate, angular, feeler arm link adjuster	3.1, 3.2, 3.5, 3.7	
231699-11C	Plate, motor mounting	3.13	
231706-11C	Stud, braking system arm		
231764-11C	Plate, cover, operating lever	5.5	
232180-11C	Knob, speed selector		
232237-11C	Bushing, threaded, adjustable, tape guide	3.1	
232403-11C	Spring plate, mech. flutter filter	3.9	
232482-11C	Washer, stepped pulley		
232798-11C	Spring, forked lever	3.1, 3.5	
233107-11C	Washer, nylon, transfer wheels	3.1	
233229-11C	Ball, steel, momentary stop		
233315-11C	Connector, edge, p.c. board, playback amplifier	3.1	
233365-11C	Connector, p.c. board, 3 pins		
233387-11C	Shaft, acetal levers	3.0	
233445-11C	Plate, top		
233538-11C	Can, motor shielding	3.12, 3.13, 5.2	
233581-11C	Lever, knee joint operation	3.1	
233646-11C	Spring, reel lock	3.6, 3.10	
233710-11C	Wheel, motor	3.13, 3.14	
233897-11C	Ring, reel lock	3.6, 3.10	
234012-11C	Shaft, momentary stop	3.1	

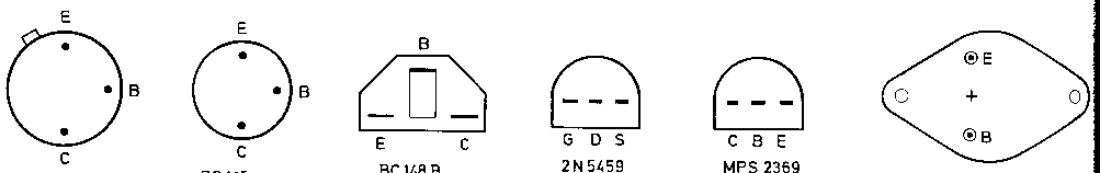
Ref. No.	Description	Fig. ref.	Notes
234077A-11C	Spring, braking system	3.1	
234306-11C	Plate, plastics front mounting		
234479-11C	Spring, transfer wheel	3.2, 3.5, 3.7	
234486-11C	Arm, tape guide		
234515-111-DP	Plate, mounting, front		
234515-11-D	Plate, mounting, front		
234658-11C	Link, momentary stop/braking system		
234708-11C	Switch, push button	3.1	
234744-11C	Spring, head cover		
234917-11C	Clip, shielding can, coil L101		
235068-11C	Rivet, momentary stop		
235363-11C	Screw, carrying strap attachement	3.1	
235420-11C	Shaft, forked lever	3.9	
235679-11C	Spring, brake lever	3.1, 3.2, 3.5, 3.7	
235894-11C	Knob, volume controls		
236045-11C	Plate, pinch roller spring	3.9	
236153-11C	Spring, knee joint		
236303A-11C	Motor	3.9, 3.12, 3.13	
236368-11C	Can, inner shielding, coil L101		
236383-11C	Clip, head terminal		
236389-11C	Switch, battery test	5.5	
236433-11C	Arm, knee joint, steel	3.9	
236634-11-32	Connector XL-3-32, MICROPHONE		
236871-11C	Adjuster, feeler arm spring tension	3.2, 3.5, 3.7	
236943-11C	Bush, distance, turntable bearing	3.6, 3.10	
237029-11C	Connector, edge, p.c. board, rec. amplifier	3.1	
237094-11C	Post, motor wheel bearing plate	3.13	
237159-11C	Plate, cover, momentary stop		
237252-11C	Post, tape, guide	3.1, 3.5	
237360-11C	Spring, take-up belt tensioner	3.1	
237417-11C	Support, rubber, motor	3.12, 3.13	
237482-11C	Spring, head adjustment screw		
237575-11C	Knob, momentary stop		
237611-11C	Stud, hinge, printed circuit board	3.1	
237719-11C	Link, additional friction	3.1, 3.2, 3.5, 3.7	
237725-11C	Lever I, operating lever assembly	3.0, 3.2, 3.5, 3.7, 3.14	
237726-11C	Spring, index, fast winding	3.1, 3.2, 3.5, 3.7	
237877-11C	Rivet, pressure roller arm		
238027-11C	Bar, momentary stop	3.1	
238121-11C	Gasket, foam plastics, loudspeaker		
238193-11C	Link, feeler arm	3.1, 3.2, 3.5, 3.7	
238631-11C	Mounting, coil L101		
238782-11C	Link, take-up belt tensioner	3.1	
239041-11C	Spring, recording switch interlock lever		
239206-11C	Plate, mounting, motor wheel bearing	3.13	
239472-11C	Spring, additional friction	3.1, 3.2, 3.5, 3.7	
239608-11C	Knob, operating lever		
239672-11C	Disk, thrust bearing, turntable shaft	3.6, 3.10	
239708-11C	Stud, cover plate, operating lever		
239909-11C	Lever II, operating lever assembly	3.0, 3.2, 3.5, 3.7, 3.13	
239910-111-32P	Plate, mounting front		
239910-11-32	Plate, mounting front		
239981-11-31	Connector XL-3-31, MICROPHONE		
240097-112-31	Sign		
240291-11C	Plate, right tape guide	3.1, 5.5	
240406-11C	Spring, head adjustment screw		
240449-111-31	Sign		
240801-111-31P	Sign		
241130-11C	Connector, pilot equipment		
241245-111-31P	Plate, front cover		
241597-111-31	Plate, front cover		
241972-11C	Guide, tape, right	5.5	
242130-111-32	Sign		
242482-111-32P	Sign		
242926-111-32P	Plate, front cover		
243278-11-32	Plate, front cover		
243459-112-D	Sign		
243630-112-D	Plate, front cover		
243653-11C	Spacer, right tape guide	5.5	
243717C-11C	Plate mounting	3.14	
243811-111-D	Sign		
243890-11C	Strap, plastics		
244163-111-DP	Sign		
244959-111-DP	Plate, front cover		
245262-11C	Belt, take-up	3.1	
245937-11C	Bushing, feeler arm shaft		
247395-11C	Strap, wires		

Ref. No.	Description	Fig. ref.	Notes
990050-11C	Pinch roller	3.9	
990051-112	Printed circuit board, motor control, complete		
990052-11C*	Brake spring w/pad, flywheel	3.1	
990053-11C*	Flywheel		
990054-11C**	Flywheel w/cogs	3.1, 3.2, 3.5, 3.7	
990055-11C*	Transfer wheel	3.1, 3.2, 3.5, 3.7, 3.12	
990056-11C*	Shaft, transfer wheel		
990057-11C*	Bracket, motor mounting	3.12	
990058-11C	Lever w/shaft, transfer wheel, left	3.2, 3.5, 3.7	
990059-11C	Lever w/shaft, transfer wheel, right	3.1, 3.2, 3.5, 3.7	
990060-11C**	Bracket, motor mounting		
990061-11C**	Printed circuit board, motor control	5.2	
990062-11C	Lever, momentary stop, riveted	3.1, 5.5	
990063-11C**	Microswitch w/mounting plate, start/stop	3.1	
990064-11C*	Terminal strip, head connection	5.5	
990065-11-P	Pilot indicator	5.5	

7.6 SCREWS, WASHERS AND RETAINING RINGS

M101	screw	3 x 4 mm	c.h. DIN 84–40
M104	»	3 x 6 mm	c.h.
M107	»	3 x 8 mm	c.h.
M108	»	3 x 15 mm	c.h.
M140	»	3 x 3 mm	c.h.
M149	»	1/2" No. 4	p.h. selftapping
M152	»	1/4" No. 6	f.h. selftapping
M154	»	3/8" No. 4	p.h. selftapping
M163	»	1/4" No. 2	f.h. selftapping
M164	»	1/4" No. 4	p.h. selftapping
M165	»	5/16" No. 4	f.h. selftapping
M166	»	1/2" No. 4	p.h. selftapping
M167	»	1/2" No. 4	l.h. selftapping
M168	»	1/2" No. 6	p.h. selftapping
M169	»	5/8" No. 4	p.h. selftapping
M170	»	1" No. 4	l.h. selftapping
M171	»	3 x 5 mm	DIN 438–53
M181	»	3 x 12 mm	c.h.
M302	Turbax washer	7.5 x 4.2 x 0.3 mm	
M314	Retaining ring DIN 471	3 mm	
M316	Retaining ring DIN 471	4 mm	
M317	Retaining ring DIN 471	5 mm	
M338	Steel washer	7 x 3.2 x 0.5 mm	
M341	Retaining ring DIN 6799	1.9 mm	
M342	Retaining ring DIN 6799	1.5 mm	
M358	Retaining ring DIN 6799	5 mm	
M359	Retaining ring DIN 6799	2.3 mm	

Abbreviations:
c.h. – cylinder head
f.h. – flange head
l.h. – lens head
p.h. – pan head



U 2850/1
BC 140-10
BC 109

BC 115
BC 125/BC126
BC153/U3963/1

BC 148 B
BC149 B-C

2N 5459

MPS 2369
MPS 6531
MPS 3640

AD 150

Fig. 7.0. Transistors seen from underneath.

7.7 ELECTRICAL COMPONENTS:

Ref. No.	Description	Notes
Transistors:		
Q101-11C***	Transistor BC 149B	
Q102-11C***	Transistor BC 148B	
Q103-11C***	Transistor BC 115	
Q104-11C***	Transistor BC 115	
Q105-11C***	Transistor BC 148B	
Q106-11C***	Transistor BC 148B	
Q107-11C***	Transistor BC 148B	
Q108-11C***	Transistor BC 148B	
Q109-11C***	Transistor BC 148B	
Q110-11C***	Transistor BC 148B	
Q111-11C***	Transistor BC 148B	
Q112-11C***	Transistor BC 148B	
Q113-11C***	Transistor BC 115	
Q114-11C***	Transistor U2850/1	
Q115-11C	Transistor BC 107B	
Q115-11C*	Transistor BC 115	
Q116-11C	Transistor BC 107B	
Q116-11C*	Transistor BC 115	
Q201-11C	Transistor BC 149B	
Q202-11C	Transistor BC 149B	
Q203-11C	Transistor BC 149B	
Q204-11C	Transistor BC 149B	
Q205-11C	Transistor BC 149B	
Q206-11C	Transistor 2N5459	
Q207-11C	Transistor BC 149B	
Q208-11C	Transistor BC 148B	
Q209-11C	Transistor BC 153	
Q210-11C	Transistor BC 148B	
Q211-11C	Transistor BC 148B/U3963/1	
Q212-11C	Transistor BC 148B	
Q213-11C	Transistor BC 115	
Q214-11C	Transistor BC 148B	
Q215-11C	Transistor BC 148B	
Q301-11C	Transistor BC 149B	
Q302-11C	Transistor BC 149C	
Q303-11C	Transistor BC 149B	
Q304-11C	Transistor BC 148B	
Q305-11C	Transistor BC 148-10	
Q306-307-11C	Transistor BC 125/BC 126	
Q308-11C	Transistor BC 148B	
Q309-11C	Transistor BC 115	
Q310-11C	Transistor AD 150	
Q350-11P	Transistor BC 115	
Q501-11C**	Transistor BC 149C	
Q502-11C**	Transistor MPS 2369	
Q503-11C**	Transistor MPS 3640	
Q504-11C**	Transistor MPS 2369	
Q505-11C**	Transistor MPS 2369	
Q506-11C**	Transistor MPS 2369	
Q507-11C**	Transistor BC 148B	
Q508-11C**	Transistor BC 154	
Q509-11C**	Transistor BC 154	
Q510-11C**	Transistor MPS 6531	
Q511-11C**	Transistor 2N 5087	
Q512-11C**	Transistor BC 148C	
Q513-11C**	Transistor BC 148C	
Q514-11C**	Transistor BC 153	
Q515-11C**	Transistor BC 148B	
Q516-11C**	Transistor BC 148B	
Q517-11C**	Transistor BC 148B	
Q518-11C**	Transistor BC 148B	
Q519-11C**	Transistor BC 148B	
Q520-11C**	Transistor BC 153	
Q521-11C**	Transistor BC 115	
Q522-11C**	Transistor U 2850/1	
Q601-11-P	Transistor BC 148B	
Q602-11-P	Transistor BC 148B	
Q603-11-P	Transistor BC 148B	
Diodes:		
D101-11C***	Diode BA 170	
D102-11C***	Diode BA 170	

7.7 ELECTRICAL COMPONENTS:

Ref. No.	Description	Notes
Transistors:		
Q101-11C***	Transistor BC 149B	
Q102-11C***	Transistor BC 148B	
Q103-11C***	Transistor BC 115	
Q104-11C***	Transistor BC 115	
Q105-11C***	Transistor BC 148B	
Q106-11C***	Transistor BC 148B	
Q107-11C***	Transistor BC 148B	
Q108-11C***	Transistor BC 148B	
Q109-11C***	Transistor BC 148B	
Q110-11C***	Transistor BC 148B	
Q111-11C***	Transistor BC 148B	
Q112-11C***	Transistor BC 148B	
Q113-11C***	Transistor BC 115	
Q114-11C***	Transistor U2850/1	
Q115-11C	Transistor BC 107B	
Q115-11C*	Transistor BC 115	
Q116-11C	Transistor BC 107B	
Q116-11C*	Transistor BC 115	
Q201-11C	Transistor BC 149B	
Q202-11C	Transistor BC 149B	
Q203-11C	Transistor BC 149B	
Q204-11C	Transistor BC 149B	
Q205-11C	Transistor BC 149B	
Q206-11C	Transistor 2N5459	
Q207-11C	Transistor BC 149B	
Q208-11C	Transistor BC 148B	
Q209-11C	Transistor BC 153	
Q210-11C	Transistor BC 148B	
Q211-11C	Transistor BC 148B/U3963/1	
Q212-11C	Transistor BC 148B	
Q213-11C	Transistor BC 115	
Q214-11C	Transistor BC 148B	
Q215-11C	Transistor BC 148B	
Q301-11C	Transistor BC 149B	
Q302-11C	Transistor BC 149C	
Q303-11C	Transistor BC 149B	
Q304-11C	Transistor BC 148B	
Q305-11C	Transistor BC 148-10	
Q306-307-11C	Transistor BC 125/BC 126	
Q308-11C	Transistor BC 148B	
Q309-11C	Transistor BC 115	
Q310-11C	Transistor AD 150	
Q350-11P	Transistor BC 115	
Q501-11C**	Transistor BC 149C	
Q502-11C**	Transistor MPS 2369	
Q503-11C**	Transistor MPS 3640	
Q504-11C**	Transistor MPS 2369	
Q505-11C**	Transistor MPS 2369	
Q506-11C**	Transistor MPS 2369	
Q507-11C**	Transistor BC 148B	
Q508-11C**	Transistor BC 154	
Q509-11C**	Transistor BC 154	
Q510-11C**	Transistor MPS 6531	
Q511-11C**	Transistor 2N 5087	
Q512-11C**	Transistor BC 148C	
Q513-11C**	Transistor BC 148C	
Q514-11C**	Transistor BC 153	
Q515-11C**	Transistor BC 148B	
Q516-11C**	Transistor BC 148B	
Q517-11C**	Transistor BC 148B	
Q518-11C**	Transistor BC 148B	
Q519-11C**	Transistor BC 148B	
Q520-11C**	Transistor BC 153	
Q521-11C**	Transistor BC 115	
Q522-11C**	Transistor U 2850/1	
Q601-11-P	Transistor BC 148B	
Q602-11-P	Transistor BC 148B	
Q603-11-P	Transistor BC 148B	
Diodes:		
D101-11C***	Diode BA 170	
D102-11C***	Diode BA 170	

Ref. No.	Description	Notes
D103-11C***	Diode OA 81	
D104-11C***	Diode OA 81	
D105-11C***	Diode BA 170	
D201/202-11C	Diode 2-AA 119	
D203-11C	Diode ZF 6.2 (Zener)	
D301-11C	Diode BA 170	
D302-11C**	Diode BA 164	
D303-11C**	Diode BA 164	
D304-11C	Diode ZF 8.2 (Zener)	
D501-11C**	Diode BA 170	
D502-11C**	Diode BA 170	
D503-11C**	Diode BA 170	
D504-11C**	Diode BA 170	
D505-11C**	Diode BA 170	
D506-11C**	Diode BA 170	
D507-11C**	Diode BA 170	
D508-11C**	Diode BA 170	
D509-11C**	Diode BA 170	
D510-11C**	Diode BA 170	
D511-11C**	Diode BA 170	
D512-11C**	Diode BA 170	
Potentiometers:		
R1/R2-11C	Potentiometer 10+100 kohm	
R3/R4-11C	Potentiometer 2 x 10 kohm	
R5-11C	Potentiometer 10 kohm	
R155-11C	Potentiometer, trimming 0.1 Mohm	
R238-11C	Potentiometer, trimming 10 kohm	
R241-11C	Potentiometer, trimming 10 kohm	
R255-11C	Potentiometer, trimming 1 kohm	
R314-11C	Potentiometer, trimming 10 kohm	
R319-11C	Potentiometer, trimming 0.5 Mohm	
R321-11C	Potentiometer, trimming 250 ohm	
R325-11C	Potentiometer, trimming 10 kohm	
R352-11C**	Potentiometer, trimming 47 kohm	
R354-11-P	Potentiometer, trimming 500 ohm	
R526-11C**	Potentiometer 1 kohm wire wound	
R533-11C**	Potentiometer, trimming 250 ohm	
R534-11C**	Potentiometer, trimming 500 ohm	
Trimming capacitors:		
C107-11C***	Capacitor, trimming 10-60 pF	
C109-11C***	Capacitor, trimming 10-60 pF	
C130-111	Capacitor, trimming 105-750 pF	
C130-112	Capacitor, trimming 20-250 pF	
Coils:		
L1-L2-11C	Motor noise suppressor, complete	
L101-11C***	Coil L101, detector	
L102-11C	Coil L102, oscillator	
L103-11-P	Coil L103, pilot	
L201-11C	Coil L201, equalization	
L202-11C	Coil L202, 85.5 kHz trap	
Heads:		
49H-112	Erase head, half track	
50H-112	Record head, half track	
51H-112	Playback head , half track	
62H-11-P	Pilot head	
63H-11C	Tachometer head	
64H-111	Erase head, full track	
65H-111	Record head, full track	
66H-111	Playback head, full track	
Transformers:		
T201-11C	Transformer T201	
T301-11C	Transformer T301	

7.8 RESISTORS

Ref. No.	Description			Notes
R1/R2-11C	10/100 kohm, potentiometer			
R3/R4-11C	2 x 10 kohm, potentiometer			
R5-11C	10 kohm, potentiometer			
R6-111	6,8 kohm			
R7-111	6,8 kohm			
R10-11C	200 kohm	1/4 W	5 %	
R11-11C	1 Mohm	1/4 W wirewound	5 %	
R101-11C***	4,7 kohm	1/3 W	5 %	
R102-11C***	1 Mohm	1/2 W	5 %	
R103-11C***	4,7 kohm	1/4 W	5 %	
R104-11C***	15 kohm	1/3 W	5 %	
R105-11C***	680 kohm	1/2 W	5 %	
R106-11C***	68 kohm	1/4 W	5 %	
R107-11C***	10 kohm	1/3 W	5 %	
R108-11C***	51 kohm	1/4 W	5 %	
R109-11C***	10 kohm	1/3 W	5 %	
R110-11C***	1 kohm	1/2 W	5 %	
R111-11C***	3,3 kohm	1/2 W	5 %	
R112-11C***	68 ohm	1/2 W	5 %	
R113-11C***	1 kohm	1/4 W	5 %	
R114-11C***	1 Mohm	1/4 W	5 %	
R115-11C***	270 kohm	1/4 W	5 %	
R116-11C***	100 kohm	1/4 W	5 %	
R118-11C***	33 ohm	1/3 W	5 %	
R119-11C***	100 kohm	1/2 W	5 %	
R120-11C***	100 kohm	1/2 W	5 %	
R121-11C***	1 Mohm	1/3 W	5 %	
R122-11C***	33 kohm	1/3 W	5 %	
R123-11C***	68 kohm	1/3 W	5 %	
R124-11C***	100 kohm	1/4 W	5 %	
R125-11C***	2 kohm	1/3 W	5 %	
R126-11C***	33 ohm	1/3 W	5 %	
R127-11C***	10 kohm	1/3 W	5 %	
R128-11C***	6,8 kohm	1/2 W	5 %	
R129-11C***	39 kohm	1/4 W	5 %	
R130-11C***	3,3 kohm	1/4 W	5 %	
R131-11C***	39 kohm	1/4 W	5 %	
R132-11C***	3,3 kohm	1/4 W	5 %	
R133-11C***	39 kohm	1/4 W	5 %	
R134-11C***	4,7 kohm	1/4 W	5 %	
R135-11C***	15 kohm	1/3 W	5 %	
R136-11C***	1 kohm	1/2 W	5 %	
R137-11C***	220 kohm	1/2 W	5 %	
R138-11C***	100 kohm	1/3 W	5 %	
R139-11C***	10 kohm	1/2 W	5 %	
R140-11C***	1 kohm	1/2 W	5 %	
R141-11C***	10 kohm	1/3 W	5 %	
R143-11C***	10 kohm	1/3 W	5 %	
R144-11C***	100 kohm	1/2 W	5 %	
R145-11C***	1 Mohm	1/3 W	5 %	
R146-11C***	100 kohm	1/3 W	5 %	
R147-11C***	10 kohm	1/3 W	5 %	
R148-11C***	2,4 ohm	2 W wirewound	10 %	
R150-11C	20 ohm	1/2 W	10 %	
R151-11C	10 kohm	1/4 W	5 %	
R152-11C	20 kohm	1/4 W	5 %	
R153-11P	10 ohm	1/2 W	10 %	
R155-11C	100 kohm	potentiometer		
R204-11C	10 kohm	1/4 W	5 %	
R205-11C	30 kohm	1/4 W	1 %	
R206-11C	15 kohm	1/4 W	5 %	
R207-11C	1 kohm	1/3 W	5 %	
R208-11C	180 ohm	1/4 W	5 %	
R209-11C	3,6 kohm	1/2 W	5 %	
R210-11C	3,3 kohm	1/4 W	5 %	
R211-11C	750 ohm	1/3 W	5 %	
R212-11C	39 kohm	1/4 W	5 %	
R213-11C	470 ohm	1/3 W	5 %	
R214-11C	30 kohm	1/2 W	5 %	
R215-11C	680 ohm	1/4 W	5 %	
R216-11C	47 kohm	1/2 W	5 %	
R217-11C	6,8 kohm	1/2 W	5 %	
R218-11C	1,5 kohm	1/4 W	5 %	
R219-11C	680 ohm	1/4 W	5 %	
R220-11C	39 kohm	1/4 W	5 %	
R221-11C	150 ohm	1/3 W	5 %	
R222-11C	180 kohm	1/4 W	5 %	
R223-11C	47 kohm	1/2 W	5 %	

Ref. No.	Description			Notes
R224-11C	220 ohm	1/2 W	5 %	
R225-11C	100 kohm	1/2 W	5 %	
R226-11C	1,8 kohm	1/3 W	5 %	
R227-11C	470 ohm	1/4 W	5 %	
R228-11C	6,2 kohm	1/3 W	5 %	
R229-11C	10 kohm	1/3 W	5 %	
R230-11C	470 ohm	1/3 W	5 %	
R231-11C	10 kohm	1/3 W	5 %	
R232-11C	10 kohm	1/2 W	5 %	
R233-11C	2,2 kohm	1/2 W	5 %	
R234-11C	470 ohm	1/3 W	5 %	
R235-11C	330 kohm	1/2 W	5 %	
R237-11C	150 ohm	1/3 W	5 %	
R238-11C	10 kohm potentiometer			
R239-11C	20 kohm	1/4 W	5 %	
R241-11C	10 kohm potentiometer			
R242-11C	680 kohm	1/4 W	5 %	
R243-11C	10 kohm	1/4 W	5 %	
R244-11C	1,5 kohm	1/3 W	5 %	
R245-11C	100 ohm	1/4 W	5 %	
R247-11C	130 ohm	1/4 W	5 %	
R248-112	8,2 kohm	1/4 W	5 %	
R248-111	4,7 kohm	1/4 W	5 %	
R249-11C	4,7 kohm	1/3 W	5 %	
R250-11C	10 kohm	1/3 W	5 %	
R251-11C	22 ohm	1/3 W	5 %	
R252-11C	510 ohm	1/3 W	5 %	
R253-11C	22 ohm	1/3 W	5 %	
R254-11C	2 kohm	1/2 W	10 %	
R255-11C	1 kohm potentiometer			
R256-11C	1 kohm	1/4 W	5 %	
R257-112	510 ohm	1/2 W	5 %	
R257-111	270 ohm	1/2 W	5 %	
R258-112	510 ohm	1/2 W	5 %	
R258-111	270 ohm	1/2 W	5 %	
R259-11C	10 ohm	1/3 W	5 %	
R260-11C	1 Mohm	1/4 W	5 %	
R261-11C	4,7 kohm	1/4 W	5 %	
R263-11C	470 ohm	1/3 W	5 %	
R264-11C	150 kohm	1/4 W	5 %	
R265-11C	3,3 Mohm	1/4 W	5 %	
R266-11C	220 kohm	1/4 W	5 %	
R267-11C	6,8 kohm	1/4 W	5 %	
R270-11C	10 kohm	1/4 W	5 %	
R271-111	100 kohm	1/4 W	5 %	
R272-111	47 kohm	1/4 W	5 %	
R273-111	47 kohm	1/4 W	5 %	
R274-111	22 kohm	1/4 W	5 %	
R275-111	10 kohm	1/4 W	5 %	
R300-11C	390 kohm	1/4 W	5 %	
R301-11C	22 ohm	1/3 W	5 %	
R302-11C	220 kohm	1/4 W	1 %	
R303-111	150 ohm	1/4 W	5 %	
R303-112	220 ohm	1/2 W	5 %	
R304-11C	1,5 kohm	1/2 W	5 %	
R305-11C	15 kohm	1/3 W	5 %	
R306-11C	8,2 kohm	1/2 W	5 %	
R307-11C	3,3 kohm	1/4 W	5 %	
R308-11C	150 kohm	1/2 W	5 %	
R309-11C	390 kohm	1/2 W	5 %	
R310-11C	3,3 kohm	1/2 W	5 %	
R311-11C	1,8 kohm	1/2 W	5 %	
R312-11C	2,7 kohm	1/4 W	5 %	
R313-11C	820 ohm	1/2 W	10 %	
R314-11C	10 kohm potentiometer			
R315-11C	680 kohm	1/2 W	5 %	
R316-11C	510 ohm	1/3 W	5 %	
R317-11C	10 kohm	1/3 W	5 %	
R318-11C	68 ohm	1/2 W	5 %	
R319-11C	500 kohm potentiometer			
R320-11C	100 ohm	1/4 W	5 %	
R322-11C	130 ohm NTC	1/3 W	5 %	
R323-11C	510 ohm	1/3 W	5 %	
R324-11C	3,3 kohm	1/3 W	5 %	
R325-11C	10 kohm potentiometer			
R326-11C	20 ohm	1/2 W	10 %	
R327-11C	4,7 kohm	1/2 W	10 %	
R330-11C	10 kohm	1/3 W	5 %	

Ref. No.	Description			Notes
R332-11C	180 ohm	1/3 W	5 %	
R333-11C	2,7 kohm	1/3 W	5 %	
R334-11C	1 kohm	1/3 W	5 %	
R335-11C	510 ohm	1/3 W	5 %	
R336-11C	51 ohm	1/3 W	5 %	
R337-11C	10 kohm	1/3 W	5 %	
R338-11C	2 kohm	1/2 W	10 %	
R351-11P	1 kohm	1/2 W	5 %	
R352-11P**	4,7 kohm	1/2 W	5 %	
R353-11P	330 ohm	1/2 W	5 %	
R355-11P	330 ohm	1/2 W	5 %	
R501-11C**	4,7 kohm	1/3 W	10 %	
R502-11C**	82 kohm	1/3 W	10 %	
R503-11C**	47 kohm	1/3 W	10 %	
R504-11C**	2,7 kohm	1/3 W	10 %	
R505-11C**	2,7 kohm	1/3 W	10 %	
R506-11C**	4,7 kohm	1/3 W	10 %	
R507-11C**	82 kohm	1/3 W	10 %	
R508-11C**	47 kohm	1/3 W	10 %	
R509-11C**	2,7 kohm	1/3 W	10 %	
R510-11C**	2,7 kohm	1/3 W	10 %	
R511-11C**	2,2 kohm	1/3 W	10 %	
R512-11C**	2,7 kohm	1/3 W	10 %	
R513-11C**	390 ohm	1/3 W	10 %	
R514-11C**	10 kohm	1/3 W	10 %	
R515-11C**	10 kohm	1/3 W	10 %	
R516-11C**	56 kohm	1/3 W	10 %	
R517-11C**	56 kohm	1/3 W	10 %	
R518-11C**	68 kohm	1/3 W	10 %	
R519-11C**	10 kohm	1/3 W	10 %	
R520-11C**	22 kohm	1/3 W	10 %	
R521-11C**	10 kohm	1/3 W	10 %	
R522-11C**	4,7 kohm	1/3 W	10 %	
R523-11C**	33 ohm	1/3 W	10 %	
R524-11C**	560 ohm	1/3 W	10 %	
R525-11C**	1,2 kohm	1/8 W	1 %	
R526-11C**	1 kohm potentiometer, wirewound			
R527-11C**	1 kohm	1/8 W	1 %	
R528-11C**	560 ohm	1/3 W	10 %	
R529-11C**	100 ohm	1/3 W	10 %	
R530-11C**	1,2 kohm	1/8 W	1 %	
R531-11C**	2,4 kohm	1/8 W	1 %	
R532-11C**	5,1 kohm	1/8 W	1 %	
R533-11C**	250 ohm potentiometer			
R534-11C**	500 ohm potentiometer			
R535-11C**	22 kohm	1/3 W	10 %	
R536-11C**	22 kohm	1/3 W	10 %	
R537-11C**	22 kohm	1/3 W	10 %	
R538-11C**	3,9 kohm	1/3 W	10 %	
R539-11C**	100 ohm	1/3 W	10 %	
R540-11C**	820 ohm	1/3 W	10 %	
R541-11C**	470 ohm	1/3 W	10 %	
R542-11C**	1,2 kohm	1/8 W	1 %	
R543-11C**	330 ohm	1/8 W	1 %	
R544-11C**	1 kohm	1/3 W	10 %	
R545-11C**	18 kohm	1/3 W	10 %	
R548-11C**	47 kohm	1/3 W	10 %	
R549-11C**	4,7 kohm	1/3 W	10 %	
R550-11C**	22 kohm	1/3 W	10 %	
R551-11C**	4,7 kohm	1/3 W	10 %	
R552-11C**	68 kohm	1/3 W	10 %	
R553-11C**	68 kohm	1/3 W	10 %	
R554-11C**	4,7 kohm	1/3 W	10 %	
R555-11C**	3,9 kohm	1/3 W	10 %	
R556-11C**	820 ohm	1/3 W	10 %	
R557-11C**	3,3 kohm	1/3 W	10 %	
R558-11C**	10 kohm	1/3 W	10 %	
R559-11C**	680 kohm	1/3 W	10 %	
R560-11C**	10 kohm	1/3 W	10 %	
R561-11C**	68 kohm	1/3 W	10 %	
R562-11C**	33 kohm	1/3 W	10 %	
R563-11C**	3,3 kohm	1/3 W	10 %	
R564-11C**	100 kohm	1/3 W	10 %	
R565-11C**	4,7 kohm	1/3 W	10 %	
R566-11C**	10 kohm	1/3 W	10 %	
R567-11C**	390 ohm	1/3 W	10 %	
R568-11C**	2,4 ohm	wirewound 1/3 W	10 %	
R601-11P	6,8 kohm	1/4 W	5 %	

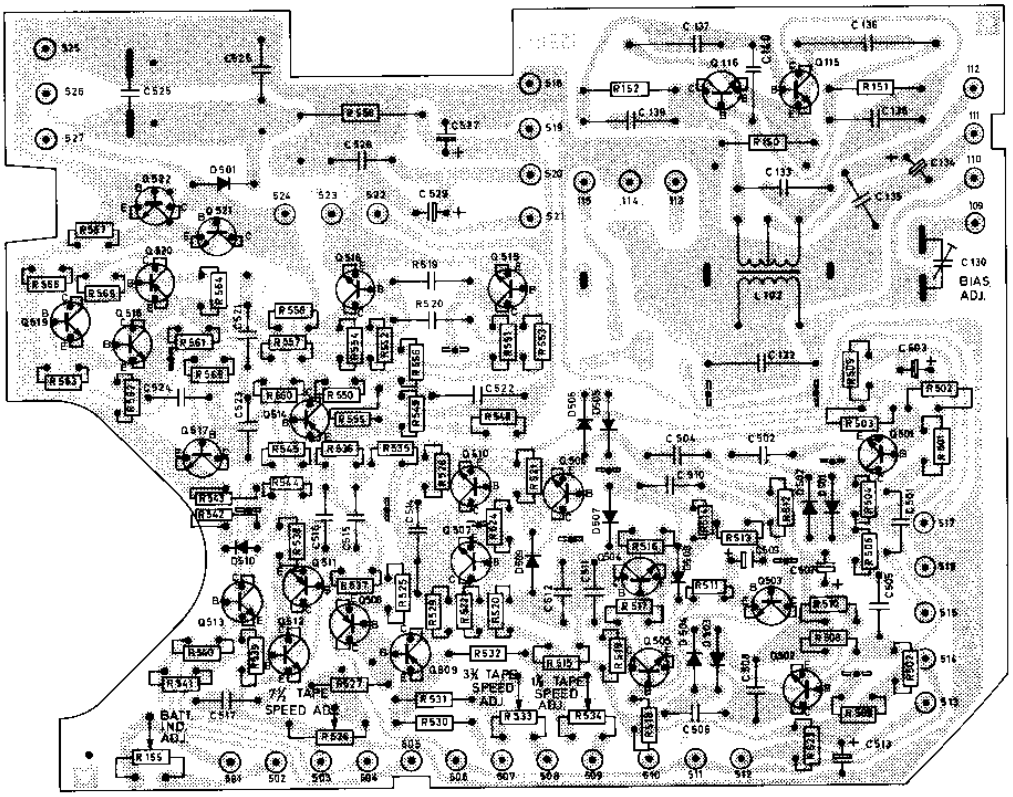
Ref. No.	Description			Notes
R602-11P	47 kohm	1/4 W	5 %	
R603-11P	47 kohm	1/4 W	5 %	
R604-11P	6,8 kohm	1/4 W	5 %	
R605-11P	27 kohm	1/4 W	5 %	
R606-11P	4,7 kohm	1/4 W	5 %	
R607-11P	4,7 kohm	1/4 W	5 %	

7.9 CAPACITORS

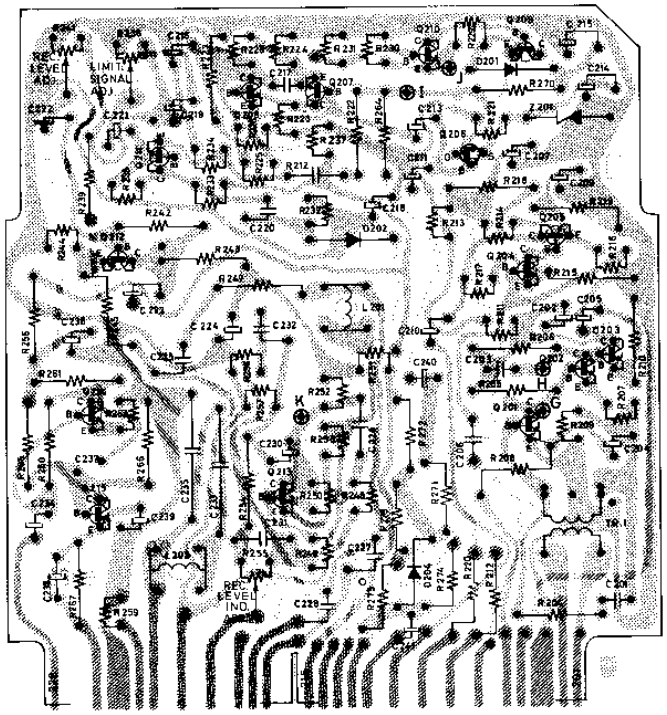
Ref. No.	Description			Type	Notes
C10-11C	1 μF	100 V	10 %	Polyester	
C101-11C***	0,1 μF	160 V	10 %	Polyester	
C102-11C***	0,1 μF	160 V	10 %	Polyester	
C103-11C***	0,1 μF	160 V	10 %	Polyester	
C104-11C***	10 μF	15 V		Electrolytic	
C105-11C***	100 μF	12 V		Electrolytic	
C106-11C***	100 μF	12 V		Electrolytic	
C107-11C***	10—60 pF			Ceramic, trimming capacitor	
C108-11C***	220 pF	160 V		Styroflex	
C109-11C***	10—60 pF			Ceramic, trimming capacitor	
C110-11C***	500 pF	160 V	2,5 %	Styroflex	
C110B-11C***	350 pF	160 V	2,5 %	Styroflex	
C110C-11C***	180 pF	63 V	2,5 %	Styroflex	
C111-11C***	2200 pF	63 V	2,5 %	Styroflex	
C117-11C***	0,15 μF	160 V	5 %	Polyester	
C119-11C***	100 μF	12 V		Electrolytic	
C120-11C***	1000 pF	500 V	20 %	Ceramic	
C121-11C***	1000 pF	500 V	20 %	Ceramic	
C122-11C***	1500 pF	630 V	20 %	Metalized paper	
C123-11C***	0,1 μF	160 V	10 %	Polyester	
C124-11C***	120 pF	500 V	10 %	Ceramic	
C125-11C***	100 μF	40 V		Electrolytic	
C126-11C***	1000 μF	35 V		Electrolytic	
C127-11C***	0,33 μF	200 V	20 %	Metalized paper	
C128-11C***	0,68 μF	100 V	10 %	Polyester	
C129-11C***	100 μF	12 V		Electrolytic	
C130-111	150—750 pF			Mica, trimming capacitor	
C130-112	20—250 pF			Mica, trimming capacitor	
C132-11C	3300 pF	63 V	2,5 %	Styroflex	
C133-11C	1000 pF	63 V	2,5 %	Styroflex	
C134-11C	100 μF	12 V		Electrolytic	
C135-11C	0,1 μF	250 V	20 %	Polyester	
C136-11C	2200 pF	63 V	2,5 %	Styroflex	
C137-11C	2200 pF	63 V	2,5 %	Styroflex	
C138-11C	1000 pF	63 V	2,5 %	Styroflex	
C139-11C	1000 pF	63 V	2,5 %	Styroflex	
C140-11C	2200 pF	63 V	2,5 %	Styroflex	
C150-111	150 pF	160 V	2,5 %	Styroflex	
C201-11C	470 pF	500 V	20 %	Ceramic	
C202-11C	100 μF	12 V		Electrolytic	
C203-11C	330 pF	500 V	10 %	Ceramic	
C204-11C	100 μF	12 V		Electrolytic	
C205-11C	2 μF	50 V		Electrolytic	
C206-11C	0,15 μF	160 V	5 %	Polyester	
C207-11C	100 μF	12 V		Electrolytic	
C209-11C	100 μF	12 V		Electrolytic	
C210-11C	2 μF	50 V		Electrolytic	
C211-11C	2 μF	50 V		Electrolytic	
C212-11C	0,1 μF	250 V	20 %	Polyester	
C213-11C	10 μF	15 V		Electrolytic	
C214-11C	2 μF	50 V		Electrolytic	
C215-11C	2 μF	50 V		Electrolytic	
C216-11C	100 μF	12 V		Electrolytic	
C217-11C	470 pF	500 V	20 %	Ceramic	
C218-11C	100 μF	12 V		Electrolytic	

Ref. No.	Description			Type	Notes
C219-11C	100 µF	12 V		Electrolytic	
C220-11C	100 µF	12 V		Electrolytic	
C221-11C	2 µF	50 V		Electrolytic	
C222-11C	2 µF	50 V		Electrolytic	
C223-11C	2 µF	50 V		Electrolytic	
C224-11C	100 µF	12 V		Electrolytic	
C225-11C	0,015 µF	100 V	5 %	Polyester	
C226-11C	0,22 µF	100 V	10 %	Polyester	
C227-11C	0,033 µF	160 V	5 %	Polyester	
C228-11C	0,022 µF	400 V	5 %	Polyester	
C230-11C	32 µF	10 V		Electrolytic	
C231-11C	4700 pF	630 V	20 %	Metallic paper	
C232-111	0,022 µF	400 V	5 %	Polyester	
C232-112	0,01 µF	400 V	5 %	Polyester	
C233-11C	2200 pF	63 V	2,5 %	Styroflex	
C234-11C	2 µF	50 V		Electrolytic	
C235-11C	2200 pF	63 V	2,5 %	Styroflex	
C236-11C	100 µF	12 V		Electrolytic	
C237-11C	2 µF	50 V		Electrolytic	
C238-11C	10 µF	16 V		Electrolytic Tantal	
C238-11C	15 µF	10 V		Electrolytic Tantal	
C238-11C	22 µF	6,3 V		Electrolytic Tantal	
C238-11C	33 µF	10 V		Electrolytic Tantal	
C239-11C	32 µF	10 V		Electrolytic	
C240-111	2,2 µF	100 V		Electrolytic	
C241-111	2,2 µF	100 V		Electrolytic	
C301-11C	100 µF	16 V		Electrolytic	
C302-11C	32 µF	10 V		Electrolytic	
C303-11C	500 µF	6,4 V		Electrolytic	
C304-11C	0,033 µF	160 V	5 %	Electrolytic	
C305-11C	0,68 µF	100 V	10 %	Polyester	
C306-11C	2 µF	50 V		Electrolytic	
C307-11C	100 µF	16 V	−10/100 %	Electrolytic	
C308-11C	10 µF	15 V		Electrolytic	
C309-11C	470 pF	500 V	20 %	Ceramic	
C310-11C	320 µF	10 V		Electrolytic	
C312-11C	10 µF	15 V		Electrolytic	
C315-11C	320 µF	10 V		Electrolytic	
C316-11C	0,1 µF	200 V	20 %	Metalized paper	
C317-11C	100 µF	40 V		Electrolytic	
C318-11C	25 µF			Electrolytic	
C320-11C	330 pF	500 V	10 %	Ceramic	
C321-11C	39 pF	500 V	10 %	Ceramic	
C350-11P	100 µF	16 V		Electrolytic	
C351-11P	0,1 µF	250 V	20 %	Polyester	
C352-11P	0,1 µF	250 V	20 %	Polyester	
C501-11C**	0,1 µF	100 V	20 %	Polyester	
C502-11C**	0,22 µF	100 V	10 %	Polyester	
C503-11C**	5 µF	70 V		Electrolytic	
C504-11C**	0,022 µF	400 V	10 %	Metalized paper	
C505-11C**	0,1 µF	100 V	20 %	Polyester	
C506-11C**	0,1 µF	100 V	20 %	Polyester	
C507-11C**	5 µF	70 V		Electrolytic	
C508-11C**	0,01 µF	400 V	10 %	Metalized paper	
C509-11C**	5 µF	70 V		Electrolytic	
C510-11C**	4700 pF	630 V	20 %	Metalized paper	
C511-11C**	2200 pF	63 V	2,5 %	Styroflex	
C512-11C**	560 pF	160 V	5 %	Styroflex	
C513-11C**	100 µF	35 V		Electrolytic	
C514-11C**	0,15 µF	100 V	5 %	Polycarbonat	
C515-11C**	0,047 µF	200 V	10 %	Metalized paper	
C516-11C**	0,047 µF	200 V	10 %	Metalized paper	
C517-11C**	0,015 µF	400 V	10 %	Metalized paper	
C521-11C**	0,1 µF	100 V	20 %	Polyester	
C522-11C**	1 µF	100 V	20 %	Polycarbonat	
C523-11C**	2200 pF	63 V	2,5 %	Styroflex	
C524-11C**	0,22 µF	100 V	10 %	Polyester	
C525-11C**	1000 µF	35 V		Electrolytic	
C526-11C**	0,33 µF	100 V	5 %	Polyester	
C527-11C**	100 µF	35 V		Electrolytic	
C528-11C**	0,68 µF	100 V	10 %	Polyester	
C529-11C**	100 µF	35 V		Electrolytic	
C601-11P	0,01 µF	250 V	20 %	Polyester	
C602-11P	0,01 µF	250 V	20 %	Polyester	
C603-11P	2,5 µF	64 V		Electrolytic	
C604-11P	5000 pF	150 V	10 %	Metalized paper	

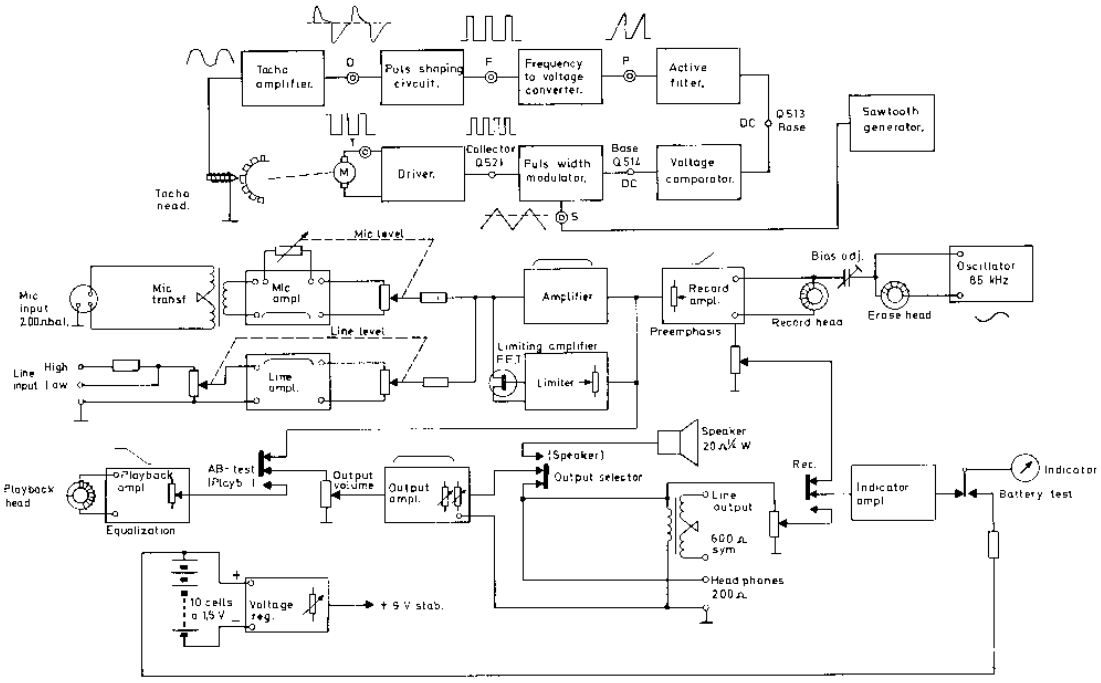
PRINTED CIRCUIT BOARDS, MODEL 11
APPLY ON MODELS ABOVE SERIAL NO. 2 305 225



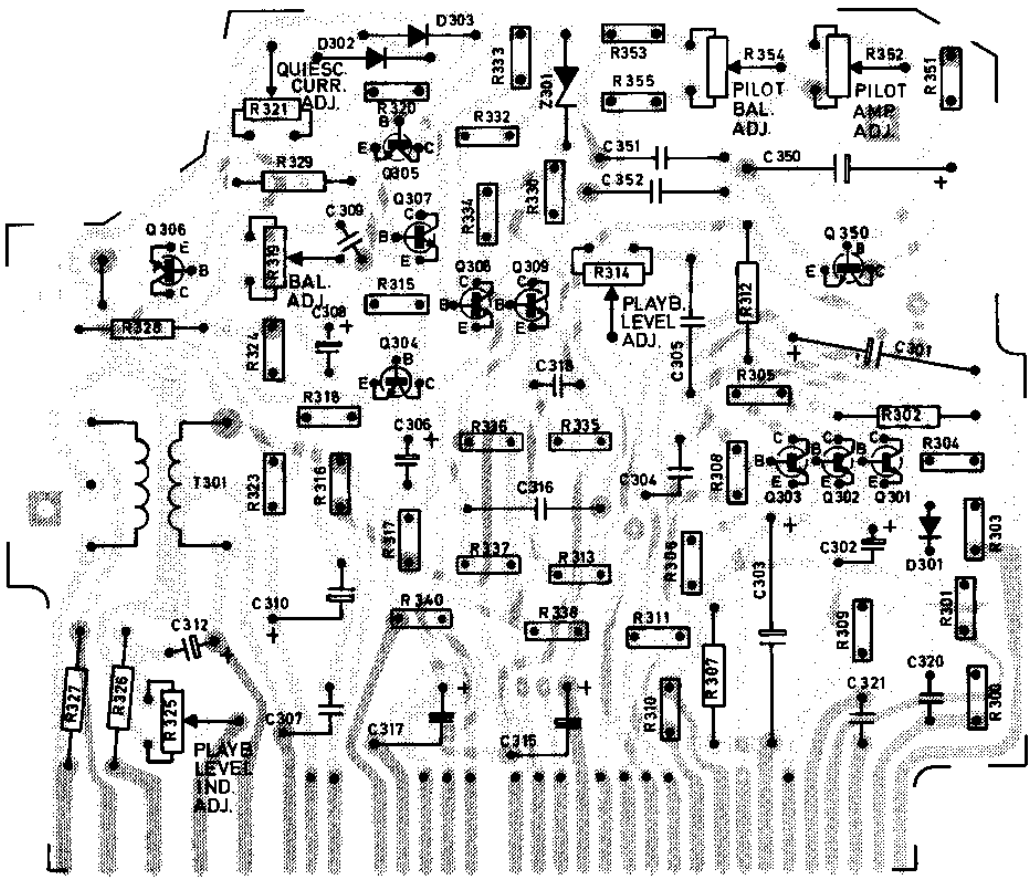
Motor control board, printed side.



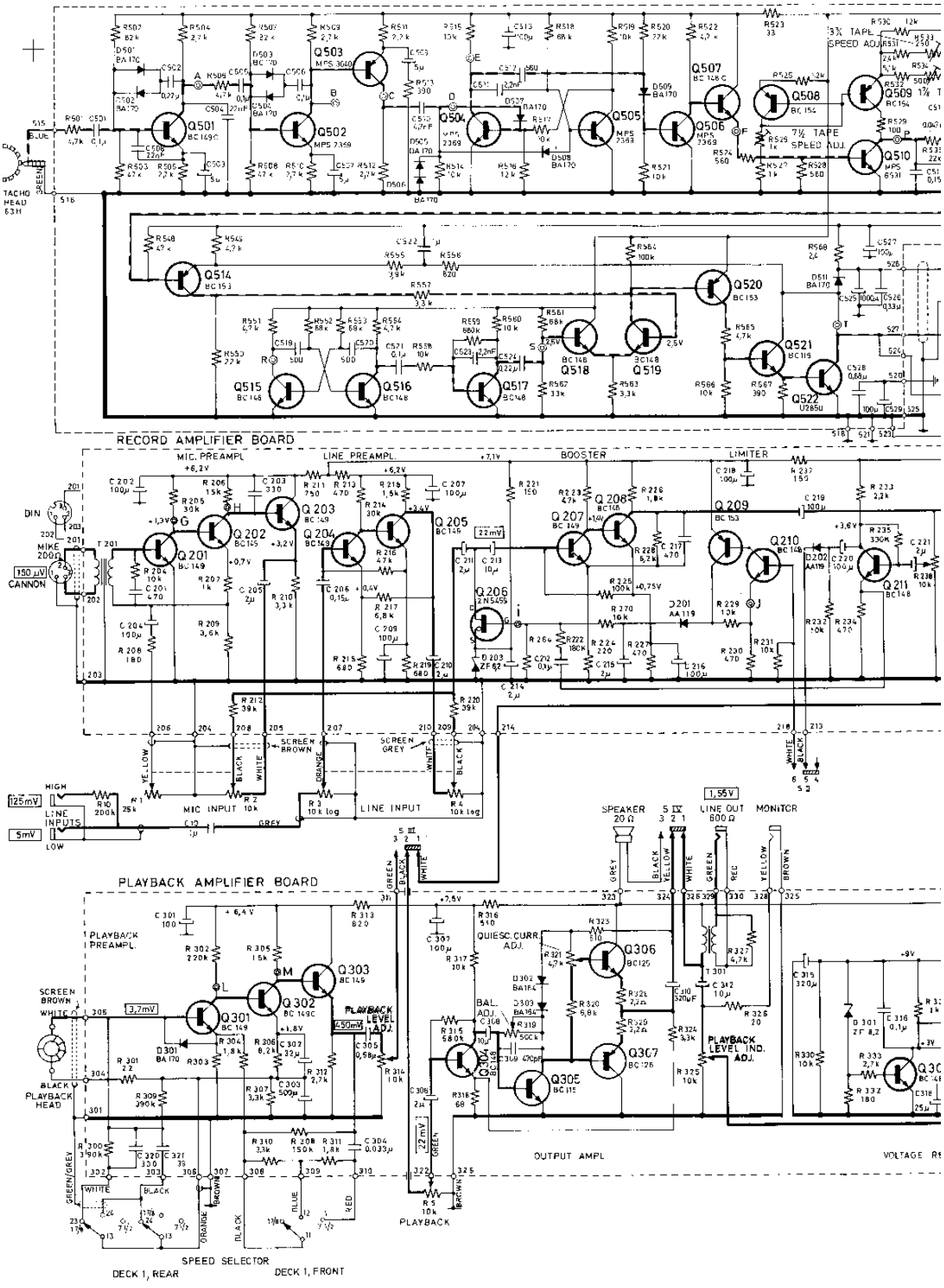
Record amplifier board, printed side.
Coloured printed wiring located on component side.

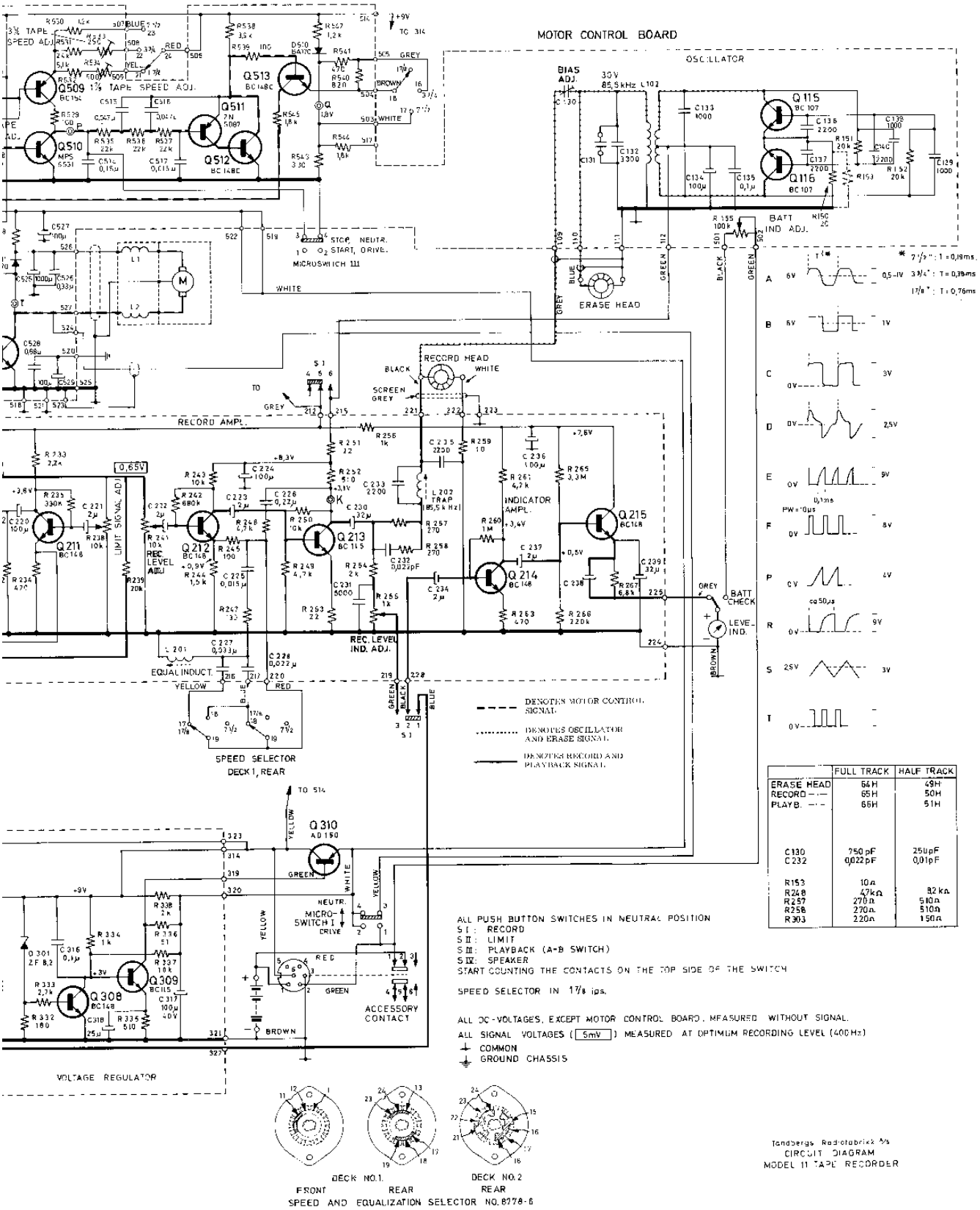


Block diagram model 11.
Apply on models above serial no. 2 305 225.



Playback amplifier board, printed side.
Coloured printed wiring located on component side.

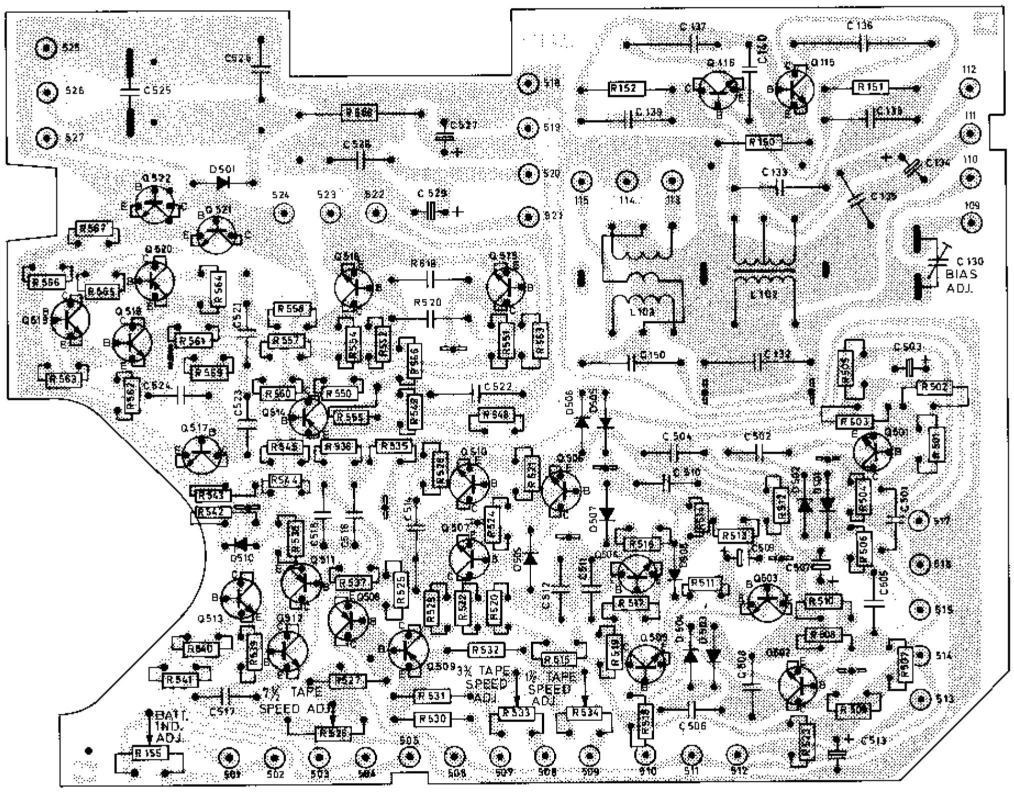

RECORD AMPLIFIER BOARD
MIC. PREAMPL.
LINE PREAMPL.
BOOSTER
LIMITER
PLAYBACK AMPLIFIER BOARD
PLAYBACK PREAMPL.
OUTPUT AMPL
SPEED SELECTOR
DECK 1, REAR
DECK 1, FRONT
TACHO HEAD 63H
DIN
MIKE 200Ω
150 µV CANNON
LINE INPUTS
125mV
5mV
MIC INPUT
LINE INPUT
SCREEN BROWN
SCREEN GREY
PLAYBACK HEAD
PLAYBACK
SPEAKER 20Ω
LINE OUT 600Ω
MONITOR
1,55V
7½ TAPE SPEED ADJ.
3¾ TAPE SPEED ADJ.
PLAYBACK LEVEL ADJ.
PLAYBACK LEVEL IND. ADJ.
BAL. ADJ.
QUIESC. CURR. ADJ.



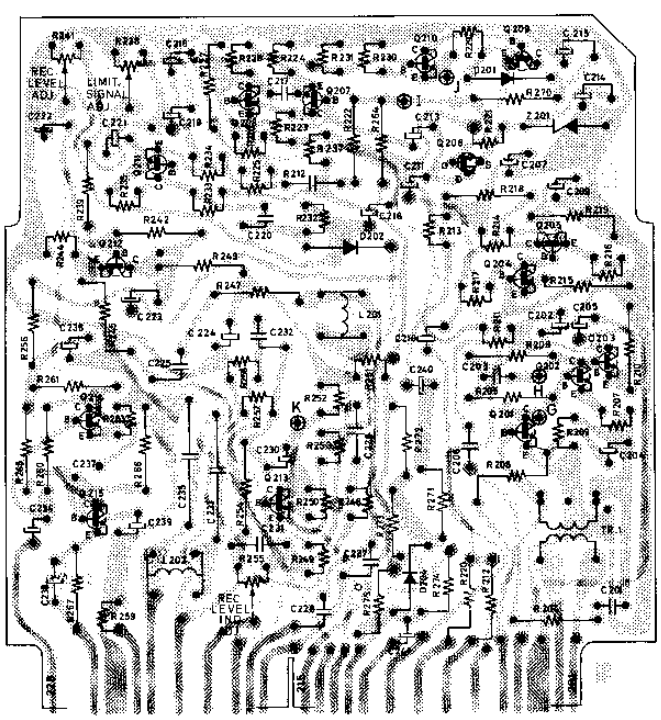
	FULL TRACK	HALF TRACK
ERASE HEAD	64 H	49 H
RECORD — —	65 H	50 H
PLAYB. — · —	66 H	51 H
C 130	750 pF	25 µpF
C 232	0,022 pF	0,01 pF
R 153	10 Ω	
R 248	47 kΩ	82 kΩ
R 257	270 Ω	510 Ω
R 258	270 Ω	510 Ω
R 303	220 Ω	150 Ω

Tandberg Radiofabrikk A/S
CIRCUIT DIAGRAM
MODEL 11 TAPE RECORDER

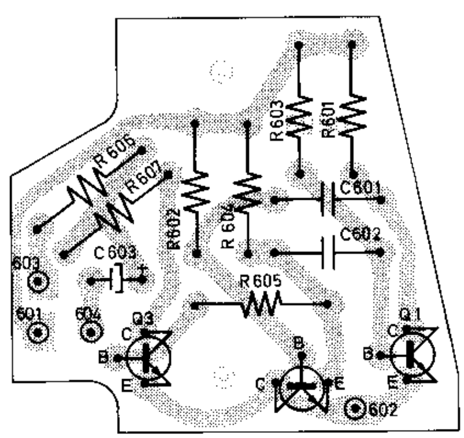
PRINTED CIRCUIT BOARDS, MODEL 11P
APPLY ON MODELS ABOVE SERIAL NO. 2 305 225



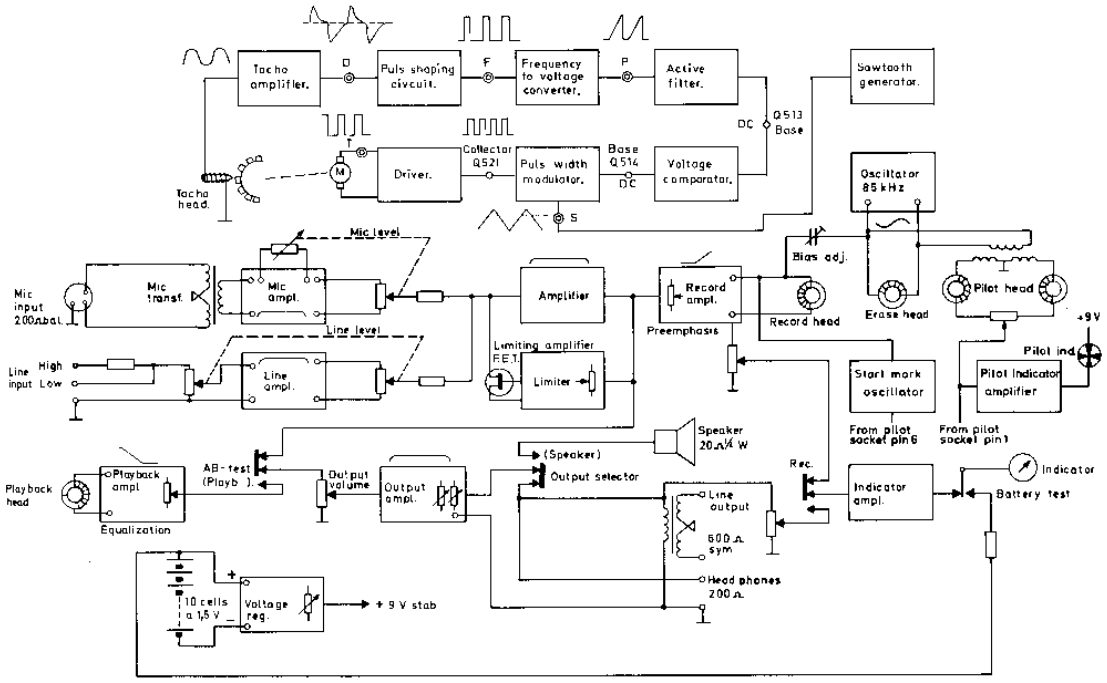
Motor control board, printed side.



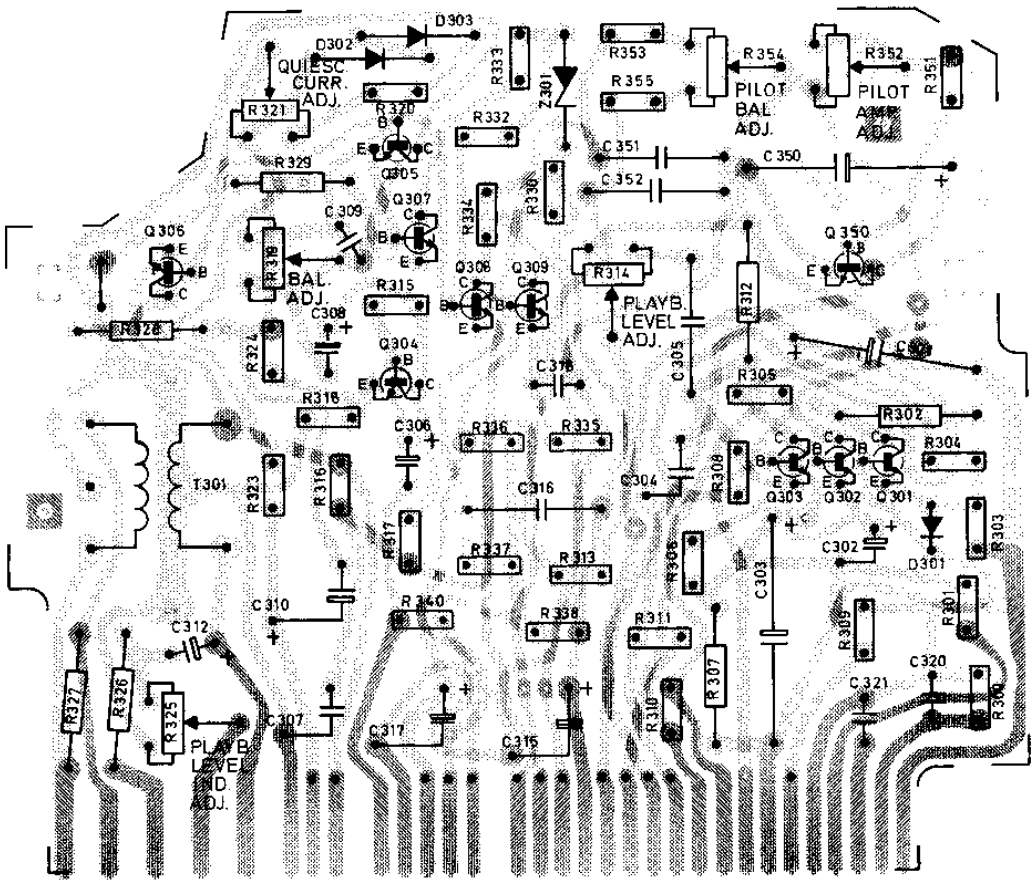
Record amplifier board, printed side.
Coloured printed wiring located on component side.



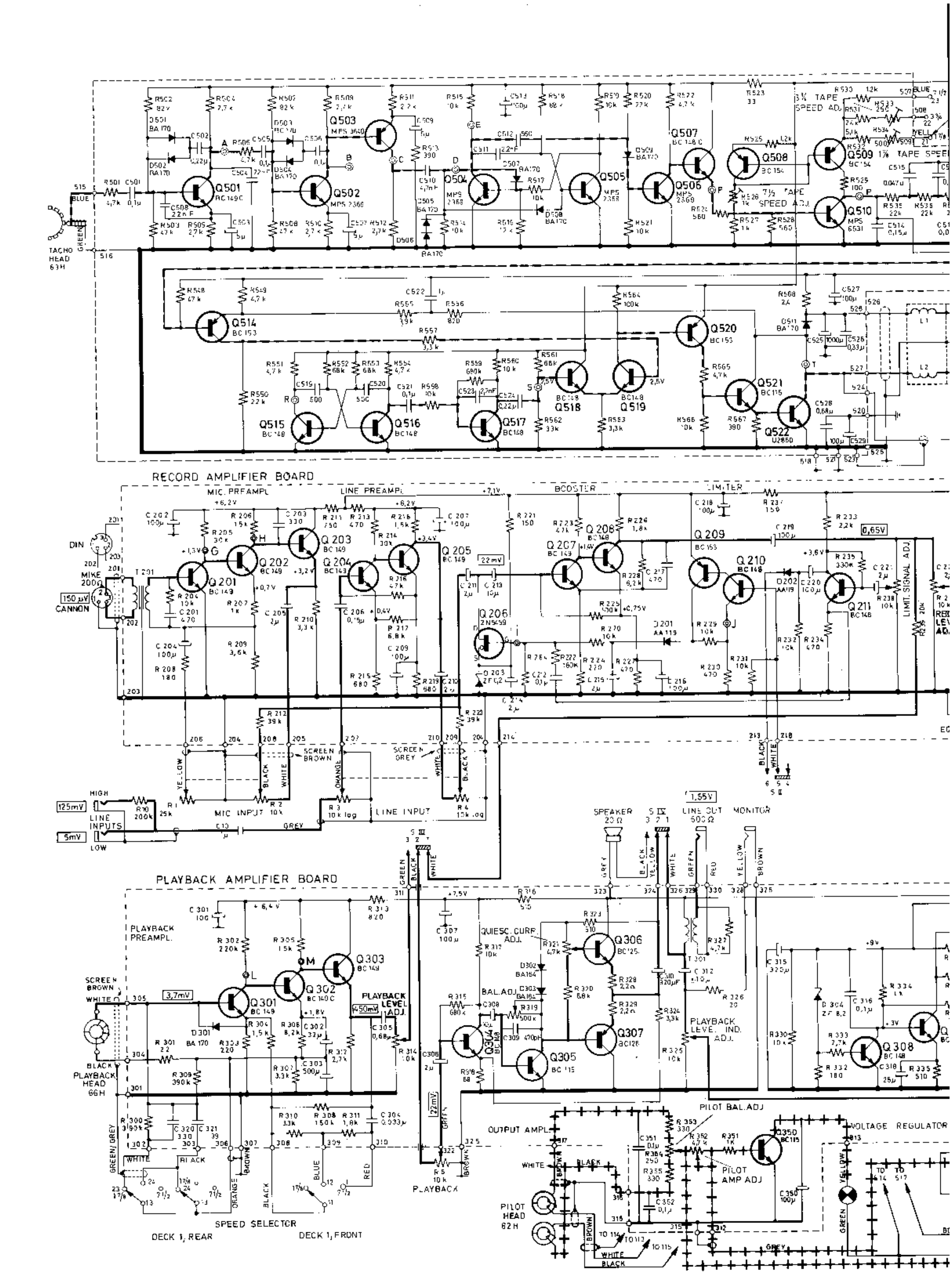
Automatic startmark board, printed side.



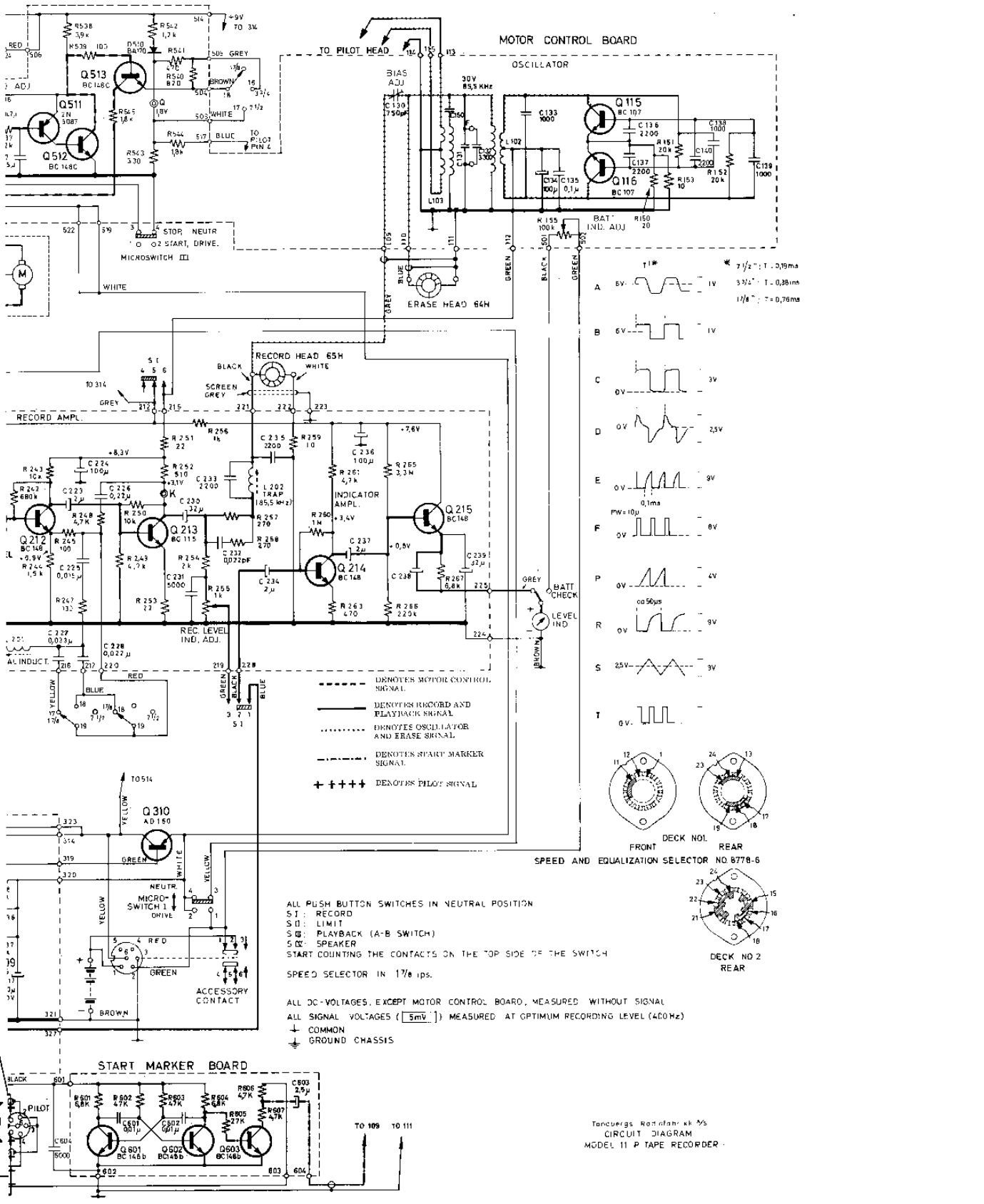
Block diagram model 11P.
Apply on models above serial no. 2 305 225.

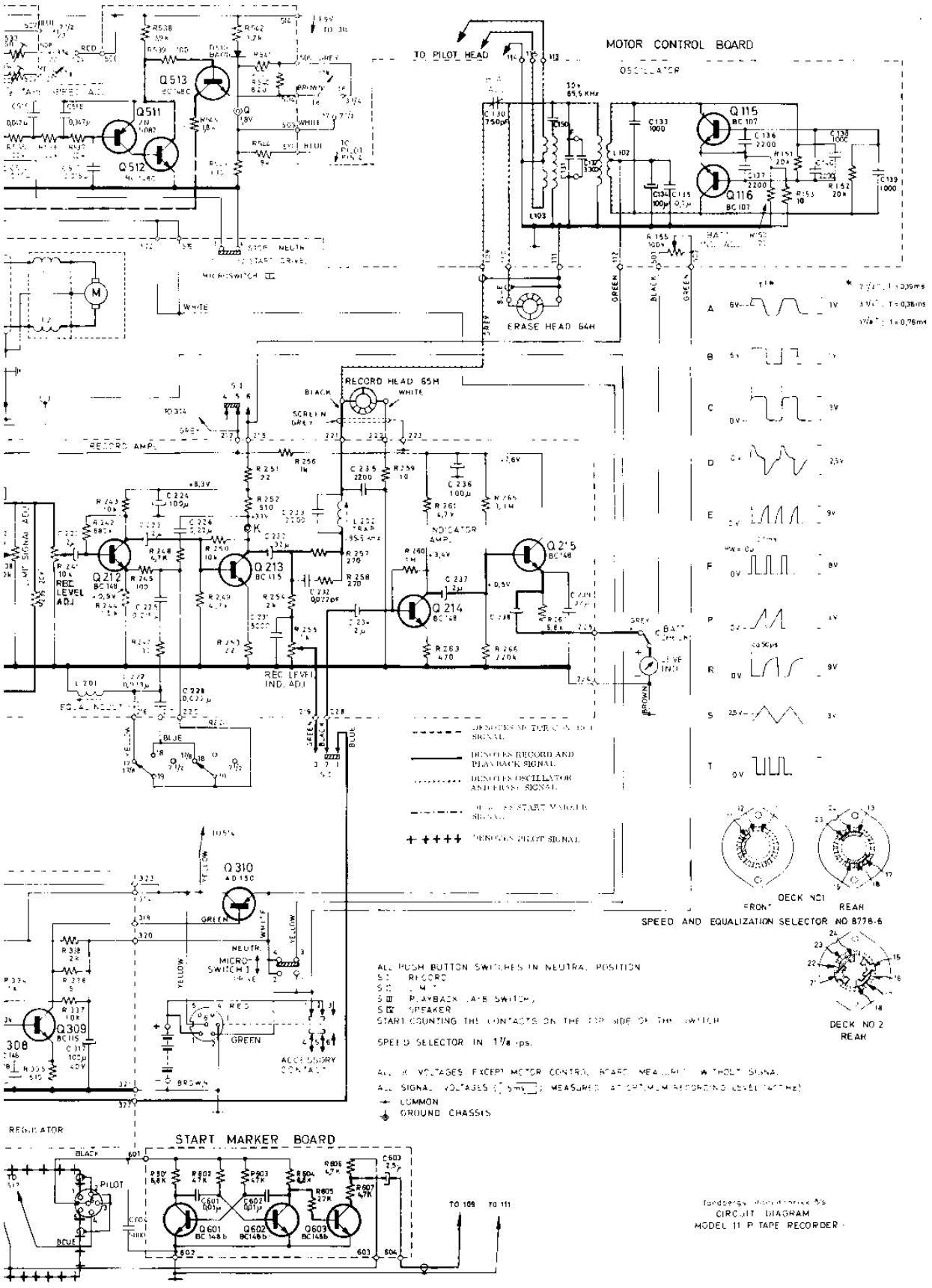


Playback amplifier board, printed side.
Coloured printed wiring located on component side.

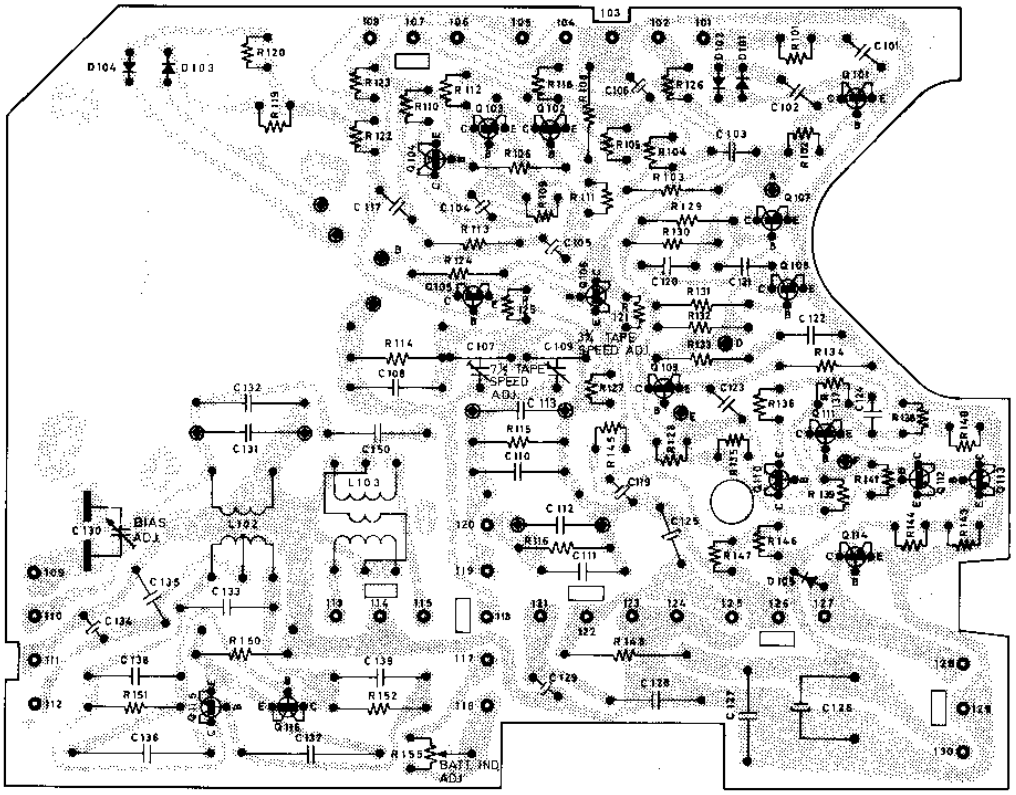


RECORD AMPLIFIER BOARD
MIC. PREAMPL.
LINE PREAMPL.
BOOSTER
LIMITER
LIMIT. SIGNAL ADJ.
PLAYBACK AMPLIFIER BOARD
PLAYBACK PREAMPL.
PLAYBACK LEVEL ADJ.
PLAYBACK LEVEL IND. ADJ.
QUIESC. CURR. ADJ.
BAL. ADJ.
OUTPUT AMPL.
PILOT BAL. ADJ.
PILOT AMP ADJ.
VOLTAGE REGULATOR
PILOT HEAD 62H
PLAYBACK HEAD 66H
TACHO HEAD 63H
SPEED SELECTOR
DECK 1, REAR
DECK 1, FRONT
MIC INPUT 10k
LINE INPUT
LINE INPUTS
HIGH
LOW
MIKE 200Ω
CANNON
DIN
SPEAKER 20Ω
LINE OUT 500Ω
MONITOR
3¾ TAPE SPEED ADJ.
7½ TAPE SPEED ADJ.
1⅞ TAPE SPEED ADJ.

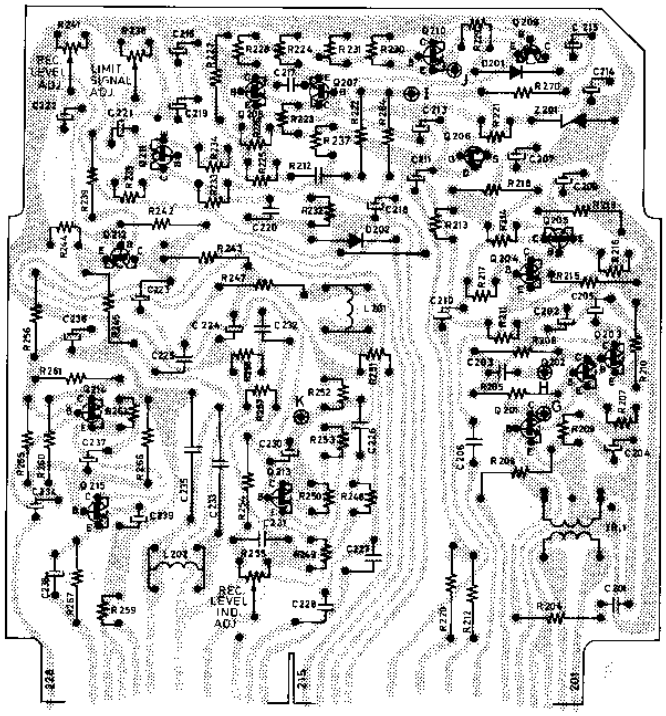

MOTOR CONTROL BOARD
TO PILOT HEAD
OSCILLATOR
BIAS ADJ
30V 85,5 KHz
Q 115 BC 107
Q 116 BC 107
Q 513 BC 148 C
Q 511 2N 3087
Q 512 BC 148 C
BATT. IND. ADJ
STOP NEUTR
START DRIVE
MICROSWITCH III
WHITE
ERASE HEAD 64H
RECORD HEAD 65H
RECORD AMPL.
INDICATOR AMPL.
Q 212 BC 148
Q 213 BC 115
Q 214 BC 148
Q 215 BC 148
REC. LEVEL IND. ADJ.
AL INDUCT.
BATT CHECK
LEVEL IND
DENOTES MOTOR CONTROL SIGNAL
DENOTES RECORD AND PLAYBACK SIGNAL
DENOTES OSCILLATOR AND ERASE SIGNAL
DENOTES START MARKER SIGNAL
DENOTES PILOT SIGNAL
Q 310 AD 150
MICRO-SWITCH 1 DRIVE
ACCESSORY CONTACT
START MARKER BOARD
Q 601 BC 148 b
Q 602 BC 148 b
Q 603 BC 148 b
TO 109
TO 111
FRONT
DECK NO1
REAR
SPEED AND EQUALIZATION SELECTOR NO. 8778-6
DECK NO 2
REAR
ALL PUSH BUTTON SWITCHES IN NEUTRAL POSITION
S I : RECORD
S II : LIMIT
S III : PLAYBACK (A-B SWITCH)
S IV : SPEAKER
START COUNTING THE CONTACTS ON THE TOP SIDE OF THE SWITCH
SPEED SELECTOR IN 1 7/8 ips.
ALL DC-VOLTAGES, EXCEPT MOTOR CONTROL BOARD, MEASURED WITHOUT SIGNAL
ALL SIGNAL VOLTAGES (5mV) MEASURED AT OPTIMUM RECORDING LEVEL (400 Hz)
COMMON
GROUND CHASSIS
CIRCUIT DIAGRAM
MODEL 11 P TAPE RECORDER


MOTOR CONTROL BOARD
TO PILOT HEAD
OSCILLATOR
Q 115
BC 107
Q 116
BC 107
Q 513
Q 511
Q 512
ERASE HEAD 64H
RECORD HEAD 65H
RECORD AMP.
INDICATOR AMP.
Q 212
BC 148
Q 213
BC 115
Q 214
BC 148
Q 215
BC 148
REC. LEVEL ADJ.
REC LEVEL IND. ADJ.
EQUAL. ADJUST
Q 310
AD 150
Q 309
BC 115
Q 308
MICRO-SWITCH 1
MICRO-SWITCH 2
ACCESSORY CONTACT
REGULATOR
START MARKER BOARD
Q 601
BC 148 b
Q 602
BC 146 b
Q 603
BC 146 b
TO 109
TO 111
DECK NO1
FRONT
REAR
SPEED AND EQUALIZATION SELECTOR NO 8778-6
DECK NO 2
REAR
ALL PUSH BUTTON SWITCHES IN NEUTRAL POSITION
S1 RECORD
S2 PLAYBACK (A-B SWITCH)
S3 SPEAKER
START COUNTING THE CONTACTS ON THE TOP SIDE OF THE SWITCH
SPEED SELECTOR IN 1 7/8 ips.
COMMON
GROUND CHASSIS
CIRCUIT DIAGRAM
MODEL 11 P TAPE RECORDER

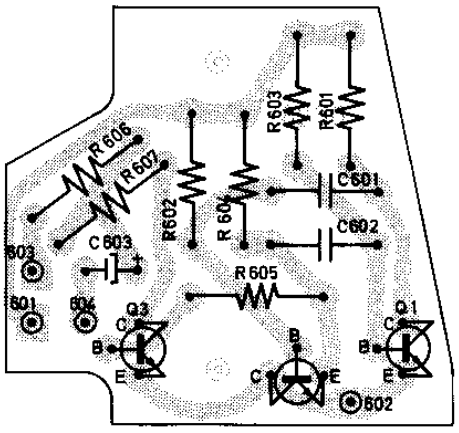
PRINTED CIRCUIT BOARDS, MODEL 11P
APPLY ON MODELS BELOW SERIAL NO. 2 305 225



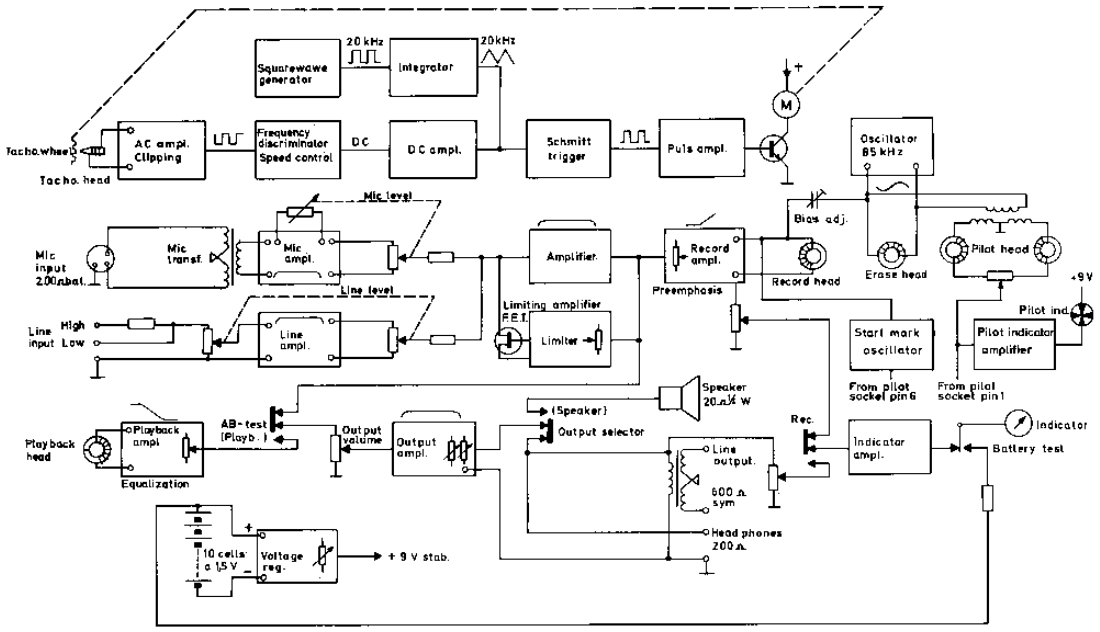
Motor control board, printed side.



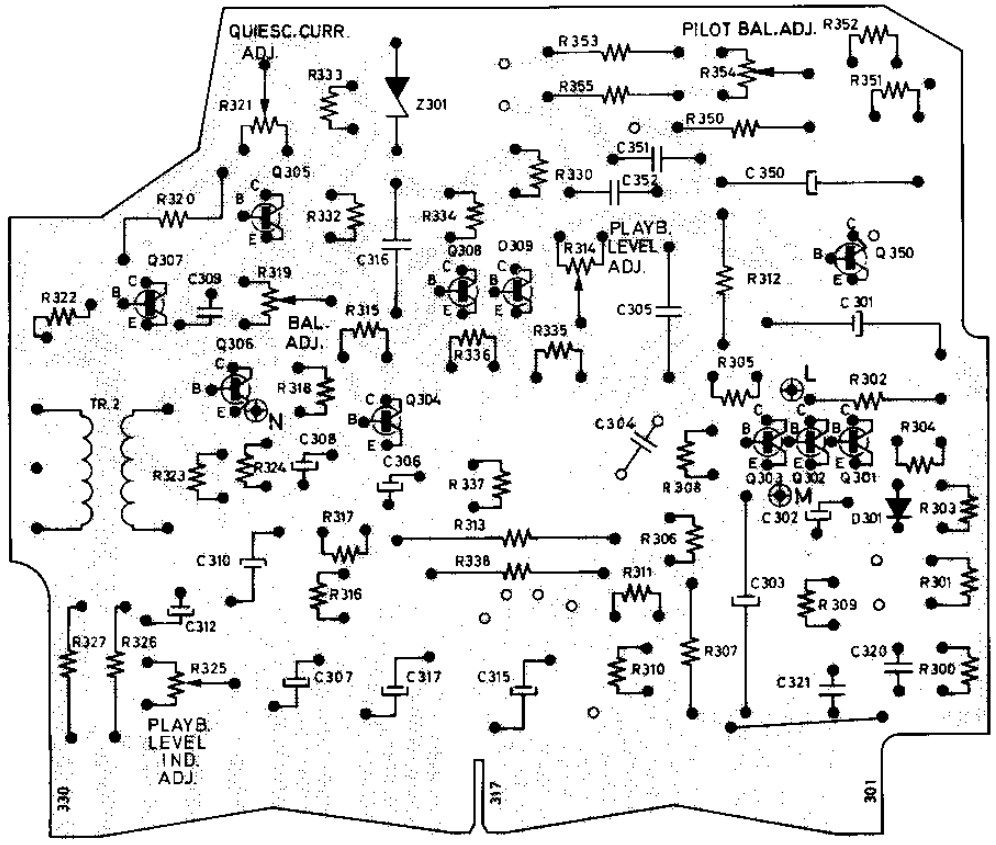
Record amplifier board, printed side.



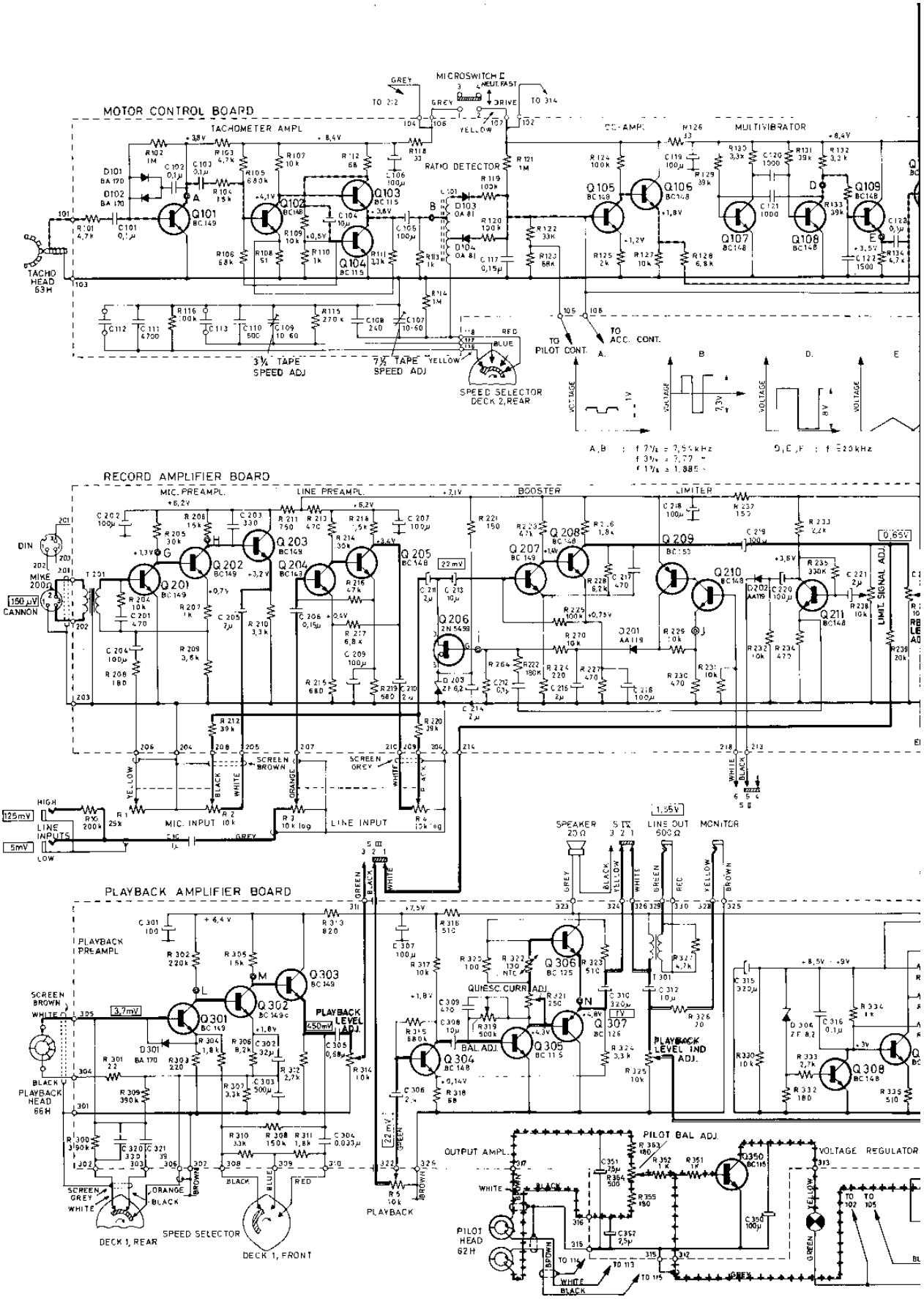
Automatic start marker board, printed side.

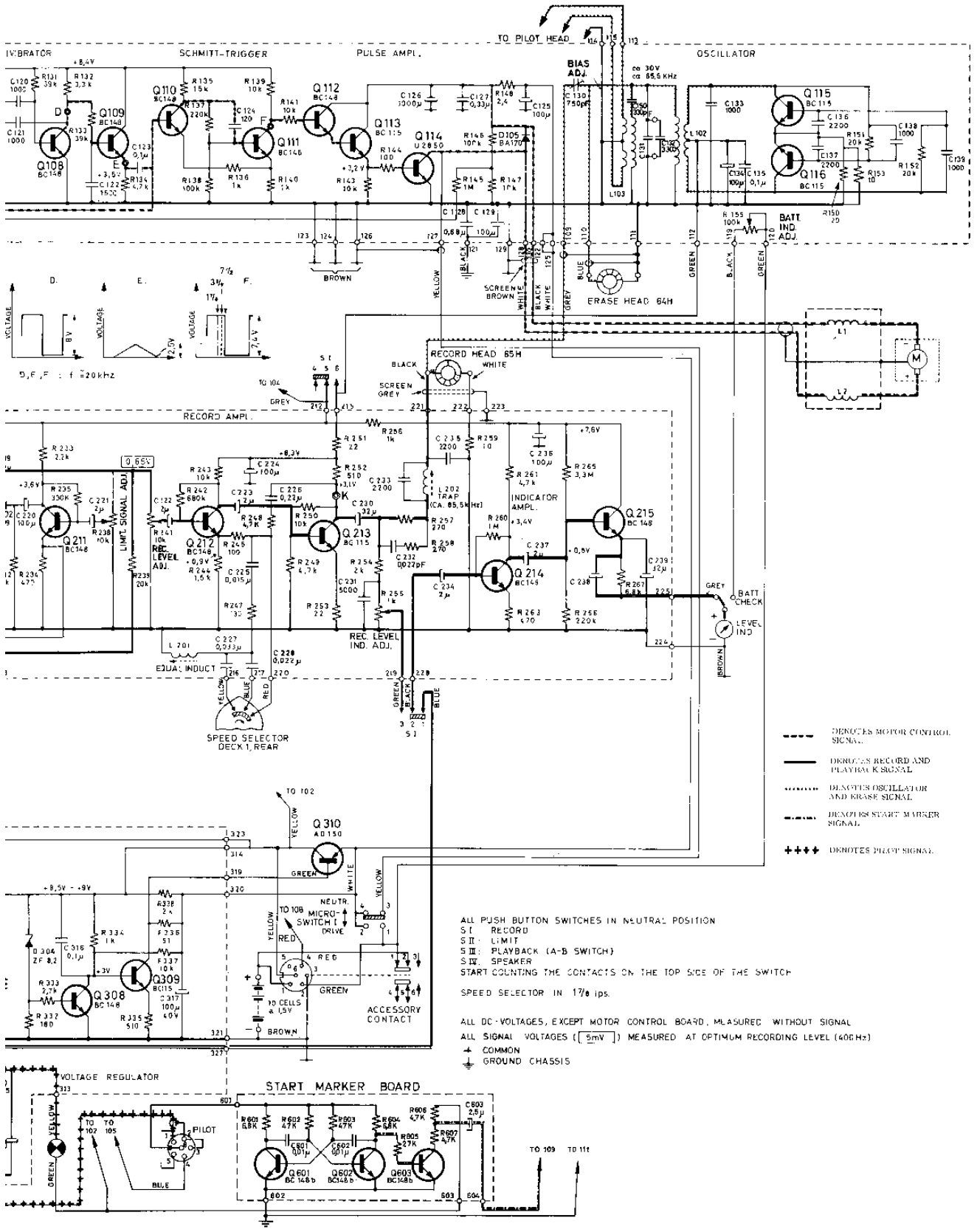


Block diagram model 11P. Apply on models below serial no. 2 305 225.



Playback amplifier board, printed side.


MOTOR CONTROL BOARD
TACHOMETER AMPL
RATIO DETECTOR
DC-AMPL
MULTIVIBRATOR
MICROSWITCH E
TACHO HEAD 69H
3¾ TAPE SPEED ADJ
7½ TAPE SPEED ADJ
SPEED SELECTOR DECK 2, REAR
TO PILOT CONT.
TO ACC. CONT.
RECORD AMPLIFIER BOARD
MIC. PREAMPL.
LINE PREAMPL.
BOOSTER
LIMITER
DIN
MIKE 200Ω
150 µV CANNON
LINE INPUTS
MIC. INPUT 10k
LINE INPUT
LIMIT SIGNAL ADJ.
SPEAKER 25Ω
LINE OUT 600Ω
MONITOR
PLAYBACK AMPLIFIER BOARD
PLAYBACK PREAMPL
PLAYBACK LEVEL ADJ.
QUIESC. CURR. ADJ.
BAL. ADJ.
PLAYBACK LEVEL IND ADJ.
PLAYBACK HEAD 66H
SPEED SELECTOR
DECK 1, REAR
DECK 1, FRONT
PLAYBACK
OUTPUT AMPL.
PILOT BAL ADJ.
VOLTAGE REGULATOR
PILOT HEAD 62H


TO PILOT HEAD
SCHMITT-TRIGGER
PULSE AMPL.
OSCILLATOR
BIAS ADJ.
ca 30V
ca 85,5 kHz
Q108 BC148
Q109 BC148
Q110 BC148
Q111 BC146
Q112 BC148
Q113 BC115
Q114 U 2650
Q115 BC115
Q116 BC115
D105 BA170
BATT. IND. ADJ.
BROWN
YELLOW
SCREEN BROWN
WHITE
BLACK
GREY
BLUE
GREEN
ERASE HEAD 64H
RECORD HEAD 65H
SCREEN GREY
TO 104
RECORD AMPL.
LIMIT SIGNAL ADJ.
REC. LEVEL ADJ.
EQUAL INDUCT
L 202 TRAP (CA. 85,5 kHz)
INDICATOR AMPL.
Q 211 BC148
Q 212 BC148
Q 213 BC 115
Q 214 BC148
Q 215 BC 148
REC. LEVEL IND. ADJ.
BATT CHECK
LEVEL IND
SPEED SELECTOR DECK 1, REAR
S 1
TO 102
Q 310 AD 150
TO 108
MICRO-SWITCH I DRIVE
NEUTR.
RED
10 CELLS a 1,5V
ACCESSORY CONTACT
Q 308 BC 148
Q 309 BC115
VOLTAGE REGULATOR
START MARKER BOARD
TO 102
TO 105
PILOT
Q 601 BC 148 b
Q 602 BC148 b
Q 603 BC148 b
TO 109
TO 111
D, E, F : f ≈ 20 kHz
DENOTES MOTOR CONTROL SIGNAL
DENOTES RECORD AND PLAYBACK SIGNAL
DENOTES OSCILLATOR AND ERASE SIGNAL
DENOTES START MARKER SIGNAL
DENOTES PILOT SIGNAL
ALL PUSH BUTTON SWITCHES IN NEUTRAL POSITION
S I : RECORD
S II : LIMIT
S III : PLAYBACK (A-B SWITCH)
S IV : SPEAKER
START COUNTING THE CONTACTS ON THE TOP SIDE OF THE SWITCH
SPEED SELECTOR IN 1 7/8 ips.
ALL DC-VOLTAGES, EXCEPT MOTOR CONTROL BOARD, MEASURED WITHOUT SIGNAL
ALL SIGNAL VOLTAGES (5mV) MEASURED AT OPTIMUM RECORDING LEVEL (400 Hz)
COMMON
GROUND CHASSIS