Appendix
SERVICE MANUAL
TANDBERG TAPE RECORDER
MODEL 3 STEREO, MODEL 3B, MODEL 3BF

TANDBERG TAPE RECORDER

MODEL 5

Service Manual

Tandberg

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MODEL 5

1. TECHNICAL DATA MODEL 5 STEREO QUADRUPLE

Line Voltage:	110 — 125 — 145 — 200 — 220 — 245 volts, 50 c/s (60 c/s).
Power Input:	75 watts.
Tubes:	2 EF804, 2 ECC83, 2 EL84, EM71 and Selenium Rectifier 100 mA, 250 volts. 2 low voltage Selenium Rectifiers.
Recording Tape:	Red oxide tape. Maximum reel diameter is 7″.
Tape Speeds:	7 ½″, 3 ¾″ and 1 ⅞″ per sec. The recording amplifier as well as both playback amplifiers are individually equalized, so that for all 3 speeds the amplifier corrections will conform to the NARTB standard. (The Recorder may also be supplied with amplifier corrections up to the CCIR standard). This allows the Recorder to play back stereophonic tapes recorded on 3 ¾″ and 1 ⅞″ per sec. Speed toleranse: ± 1% for all speeds at correct line frequency and voltage 50 c/s 220 V (60 c/s 110 V).
Heads:	Quadruple erase head. Record-playback head: Special made in line stereo quadruple. Head gap: .00016 inch. The Recorder will play back four track and two track stereo and monaural tapes as well as tapes recorded according to the former European Standard. The co-linear alignment of the heads is so good that when playing fulltrack tape, one may use both head halves. The Recorder can record four track and two track monaural, and also two track according to the former European Standard. In combination with the Stereo Record Amplifier for Model 5 the Recorder can record two track and four track stereo.
Playing Time:	Four track recording on 1200 ft. of tape gives the following playing times: Tape speed of 7 ½ ips: 2 x 32 min. stereophonic 4 x 32 min. monaur. Tape speed of 3 ¾ ips: 2 x 64 min. « 4 x 64 min. « Tape speed of 1 ⅞ ips: 2 x 128 min. « 4 x 128 min. «
Path of Tape:	The tape moves from left to right. The heads are positioned with the gaps towards the front. Recording takes place on track 1 or/and track 3.
Fast Forward- and Rewinding:	Takes about 2 min. in either direction, without wearing the heads.
Controls:	Combination playback and record-level control. Double potentiometer with a double knob with mutual friction and dial which makes it possible to regulate the two amplifiers simultaneously or individually. Speed Change Switch 7 ½″, 3 ¾″, 1 ⅞″. Monitor Speaker Switch. Bass Switch equalizes both amplifiers simultaneously in playback position only. Mode Switch for recording, playback and pub. addr.

Lever Control for start, stop, forward and rewind.
As an extra equipment recorders for 110 V 60 c/s are equipped with a Cathode Follower-Power Output-Switch which makes it possible to bypass the power output stage when using external power amplifiers. Stereo Monaural Switch (located under the level control knob) giving the following possibilities:

1. Mode Switch in pos. RECORD.

   a) Pos. STEREO: The upper track amplifier operates as a normal recording amplifier. The lower track amplifier is disconnected. The erase head gets erase current on both head halves and will erase track 1 and 3 (or 4 and 2) simultaneously. This combination of switch positions must therefore only be used when recording stereo.
   Stereo recording is only possible when plugging in the Stereo Record Amplifier. In this set-up the lower part of the record-playback head will get bias current through contacts in the plug, signal current from the Stereo Record Amplifier and the Recorder will record 4 track stereo. The program on track 1 (or 4) comes from the inputs on the Recorder itself and is controlled by the potentiometer connected to the large knob on the gain control. The program on track 3 (or 2) comes from the input on the Stereo Record Amplifier and is controlled by the gain control at the Stereo Record Amplifier.
   The magic eye on the Recorder acts as a recording level indicator for track 1 (or 4), the magic eye at the Stereo Record Amplifier acts as a record level indicator for track 3 (or 2). When recording stereo, please remember that according to the standard the left hand program shall be recorded on the upper track. Also check that the speed selectors on the Stereo Record Amplifier and the Recorder are placed in the same position. The Recorder in combination with the Stereo Record Amplifier is capable of recording 4 track stereo at 7 ½ ips, 3 ¾ ips and 1 ⅞ ips with the same quality as described for monaural recordings.

   b) Pos. MONAUR.: The upper track amplifier operates as a normal recording amplifier for track 1 (or 4). The gain is controlled by the potentiometer connected to the large knob. The lower track amplifier is connected as a power amplifier for the recorded program. The gain in the extra amplifier is controlled by the potentiometer connected to the small knob.

   c) Pos. EXTRA: The upper track amplifier operates as a normal recording amplifier for track 3 (or 2). The gain is controlled by the potentiometer connected to the large knob. The lower track amplifier is connected as a power amplifier for the recorded program. The gain in the extra amplifier is controlled by the potentiometer connected to the small knob.

2. Mode Switch in pos. PLAYBACK:

   a) Pos. STEREO: Each amplifier is connected to the individual two headhalves, ready for playing back stereo tape, two tracks or quadruple. The level control simultaneously or individually controls both amplifiers.
   The double-potentiometer is adjusted so that the amplification in the two amplifiers never deviate more than 2 dB from each other. Differences in tape, external amplifiers or loudspeakers can be compensated by turning the large knob relative to the small knob.

   b) Pos. MONAUR.: Both amplifiers coupled to track 1 (or 4) and the gain of the two amplifiers may be controlled individually or simultaneously.

c) Pos. EXTRA: Both amplifiers coupled to track 3 (or 2) and the gain of the two amplifiers may be controlled individually or simultaneously.

3. Mode switch in pos. PUB.ADDR.:

a) Pos. STEREO: The two amplifiers are connected to the stereo pick-up inputs. The sensitivity across the stereo input is approx. 15 mV for 3.5 watts across the output transformer. The frequency response flat.

b and c). Pos. MONAUR. and EXTRA: Both amplifiers connected to the ordinary inputs and the gain of the amplifiers may be controlled individually or simultaneously.

Frequency Response at Record-Playback: Flat within ± 2 dB from 30 to 16 000 c/s, from 40 to 10 000 c/s and from 70 to 5 000 c/s for the 7 ½ ips, 3 ¾ ips and 1 ⅞ ips speed respectively.

Distortion and Noise Level: The tape recorded to the maximum level by a 400 c/s signal will give less than 5 % distortion when played back. A recording level 10 dB below the maximum level results in less than 1% distortion of the 400 c/s signal when played back. The noise level is 55 dB below the signal level when the tape is driven to the maximum level.

Wow: Better than 0.15 % at 7 ½ ips tape speed.
Better than 0.2 % at 3 ¾ ips tape speed.
Better than 0.3 % at 1 ⅞ ips tape speed.

Wow is defined as the r.m.s. value of frequency deviation to one side in percent of the signal frequency, when a constant signal is recorded and played back. The peak to peak value is 2.8 times greater.

Input: Microphone 5 Megohms.
Because of the high impedance input, the loss due to the input impedance is below 3 dB at 20 cycles when using the Tandberg TM2 microphone. Sensitivity of mike input — 1.5 millivolt, for maximum recording level at 1000 cycles.

Phono or radio input (.5 Megohm) with provision for simultaneous use of both inputs for mixing.

Phono or radio sensitivity — 75 millivolts.

Input for stereo pick-up. Sensitivity when used as stereo disc amplifier 15 mV for full power output (2 x 3.5 watts).

Microphone: Crystal mike shock-insulated for rugged use. Response — 20 to 13 000 cycles ± 3 dB.

Erase and Bias Frequency: 66 ⅔ kc/s.
Even harmonic distortion in high frequency bias current is below 0.5 %.

Record Amplifier: Recording Level Indicator: Distortion at maximum recording level — below 1 %. The electronic magic eye maintains its sensitivity corresponding to recording current to 10 000 cycles (with selenium rectifier and damped backward movement). Electronic eye tube range is 26 dB, plus overload.

Playback Amplifiers, Frequency Response: Two identical playback amplifiers, matched to the heads give a frequency response when playing back a NARTB standard tape to within ± 2 db at all recorded frequencies.

Playback Amplifier Gain:

The double potentiometer and the gain of the amplifiers are matched to give a maximum difference in output voltage when playing bask full track tape of 2 dB in the range from 0 to 25 dB.

Playback Amplifiers Output & Distortion:

At 1000 cycles:

1.6 watts (2.5 volts)	Distortion below 1%
2.5 watts (3.15 volts)	Distortion below 5%

At 50 cycles:

1 watt (2 volts)	Distortion below 1%
1.5 watts (2.5 volts)	Distortion below 5%

Effective source impedance of playback amplifiers is less than 1 ohm, negative feedback about 15 dB. (Matched load impedance — 4 ohms).

Because of the low output impedance and high degree of negative feedback with corresponding low distortion, the output can be fed into any Hi-Fi amplifier, regardless of input impedance, with no loss in frequency response or quality.

Frequency response when used as PA amplifier — $\pm$ 2 dB, 40 to 20 000 cycles.

Monitor Speaker:

Goodman, 5 in. x 7 in.

The monitor speaker may be switched to the upper track amplifier, the lower track amplifier or neither.

Clock-Counter:

(Similar to an ordinary clock dial). Each hour (by hour-hand) shows 150 revolutions of tape spool, each minute (by minute-hand) shows 2 ½ revolutions. Location and length of recording is designated as time on a clock (e.g. 2:12 to 3:15).

Automatic Stop:

Possible on tape which has the necessary metal coating at beginning and end of the reel.

Stereo Recording:

Equipped with connectors for «Stereo Record Amplifier for Model 5».

Dimensions:

Fine grain mahogany cabinet, 15″ long 11 ⅞″ wide, 6 ⅞″ high.

Weight:

Instrument alone 27 lbs., with carrying case 32 lbs.

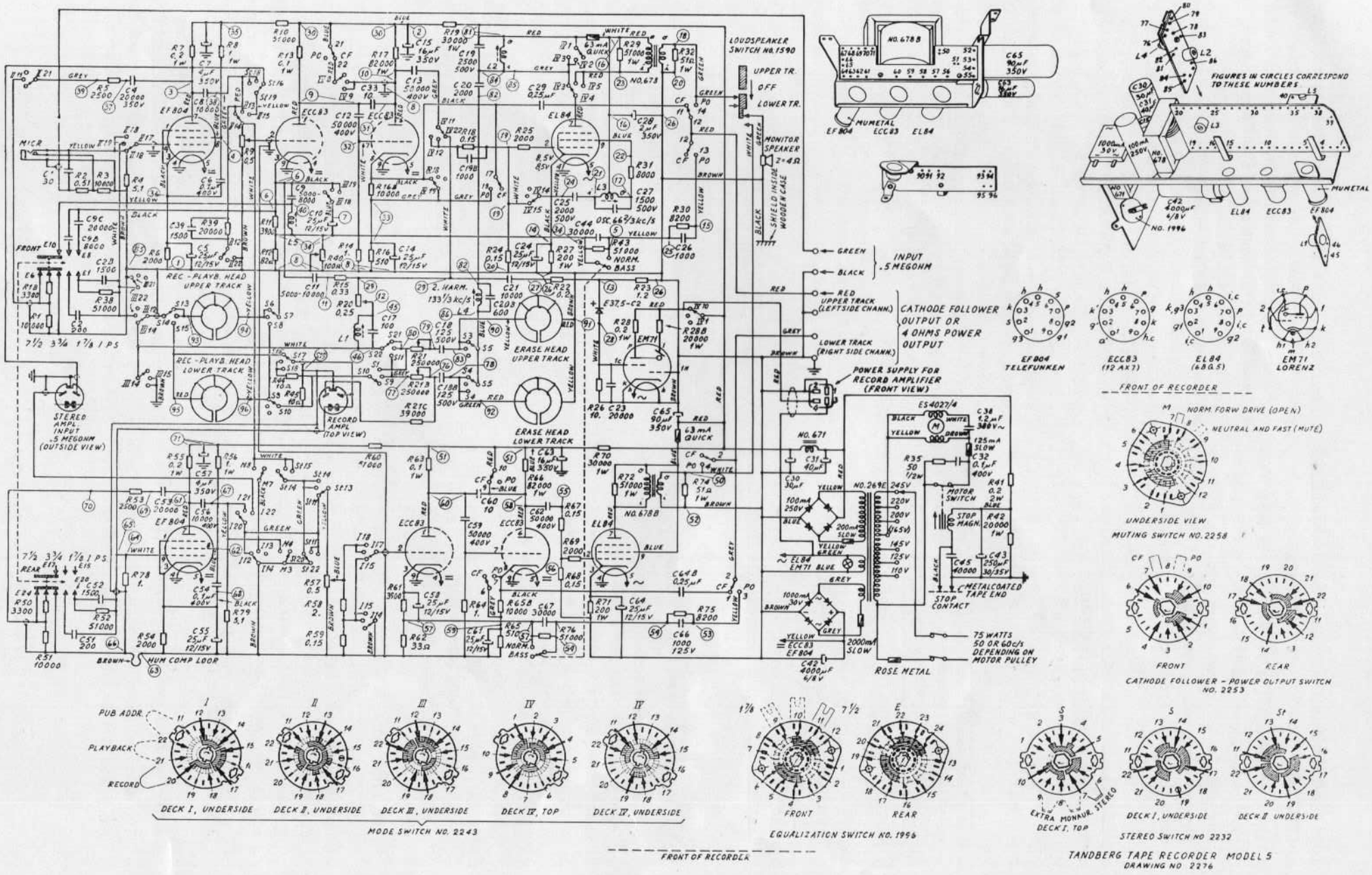


Fig. 1.

Up to serial no. 282 700 — also see page 22.

2. ALTERATIONS COMPARED WITH MODEL 3 STEREO

The tape transport is exactly like the tape transport in the Model 3 Stereo. The alterations therefore are limited to the heads and the electrical circuitry. This description is based on the Service Manual, Model 3 Stereo, and references to this are abbreviated to S.M.

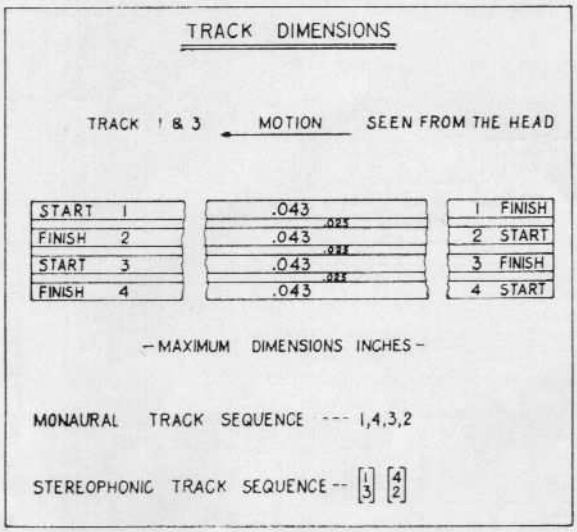


Fig. 2.

2.1 The Quadruple Track Standard.

Fig. 2 shows the quadruple track standard, seen from the head. The double track head makes contact with tracks 1 and 3. By turning the reels over, the tracks 4 and 2 will come in contact with the head. By means of the SRTEEO — MONAUR. — EXTRA — switch the desired track (or tracks) is selected. The record-playback head gaps are .00016" and in line. The width of the record playback head corresponds to the track width, and the inductance of each head half is approx. .6—1 Hy.

The erase head is also a double head and the STEREO — MONAUR. — EXTRA — switch also recouples the erase heads so in all positions of the switch the correct track (or tracks) is erased. The width of the erase head halves is .060". The gaps .02" and in line. Inductance approx. 25—35 mHy.

2.2 Alterations in the Electrical Circuitry.

2.2.1 The Bias and Erase Current Circuits.

The introduction of the quadruple standard with the possibilities for four track monaural and stereo recording has made no changes in the oscillator circuit. The EL84 in the upper track amplifier is an electron-coupled oscillator with the tank circuit L3—C27 and the plate circuit L2—C9 tuned to 66 ⅔ kc/s. See S.M. sec. 4.2.1.

The bias and erase circuitry is, however, completely changed. From the plate circuit the H.F. current is fed to contact S5 in the stereo switch via condenser C20—.002 μF and the second harmonic suppressor circuit L4—C25. From contact S5 in the stereo switch the H.F. voltage is fed to the two erase heads via contacts S3 and S4 dependent on the position of the stereo switch. Because of the switching between, the upper and lower erase heads it is not possible to obtain the bandfilter coupling used in the former models. The erase heads have a resonant frequency slightly above the erase frequency. In stereo position the two heads are coupled in parallel directly across the plate circuit (C20 is large) and the combination of the two erase heads and plate circuit is tuned to resonance by the core in L2. Disconnecting one head will slightly detune the circuit, but at the same time the load will decrease, the result being approx. the same voltage across the erase head. This voltage should be 160—210 volts.

The fact that it is not possible to maintain the bandfilter coupling in this model will increase the second harmonic distortion in the erase and bias voltage. To avoid this, a second harmonic supressor circuit is inserted, which brings the second harmonic distortion well below 1 % in all combinations of erase heads connections. To adjust this, it is necessary to have a tuned voltmeter set to the second harmonic (132 ⅔ kc/s) and tune the circuit to max. second harmonic voltage.

The H.F. recording bias for each track is taken from the corresponding erase head via C18 and C18B. The routing for the bias and signal currents is as follows:

1. Upper head in position MONAURAL and STEREO.

   From the upper erase head through C18—.000125 μF and R21 to contact S21 in the stereo switch. R21 is a semivariable potentiometer and should be adjusted to give .4 to .45 mA bias current (.4 to .45 volt across 1000 ohms in series with the upper head). With the stereo switch in position STEREO and MONAURAL contact S21 makes contact with S22 and at this point the signal current from the recording amplifier in the

tape recorder is injected. The bias and the signal are then fed to the upper head via contacts III_{14} III_{12} in the mode switch and contacts S14 —S13in the stereo switch. In position EXTRA the bias route to the upper head is broken at several points, and the contact S21 is grounded via S1—S10 and R45. This is done to avoid leakage of bias current to the upper head in this position.

2. Lower head in position EXTRA.

From the lower erase head the bias current goes through C18B—.000125 μF and R21B to contact S11 in the stereo switch. R21B is a semivariable potentiometer and should be adjusted to give .4 to .45 mA bias current (.4 to .45 volt across 1000 ohms in series with the lower head). With stereo switch in position EXTRA S11 makes contact with S22 and at this point the signal current from the built in record amplifier is injected. The bias and the signal current is then fed to the lower head via contacts III_{14}—III_{12} in the mode switch and S14—S15 in the stereo switch. In position MONAURAL the bias route for the lower head is broken at different points and the contact S11 is grounded via S9—S10 and R45 for the same reason as explained above.

3. Lower head in position STEREO.

From the lower erase head the bias current goes through C18B (.000125 μF) and R21C (20—100 Kohms) to contact 2 in socket in the rear trim cover. R21C is a fixed resistor and adjusted to give .4 to .5 mA bias current through lower head. The adjustment of the bias current for the lower head had to be done seperately in STEREO position because the capacitance of the .leads differs considerably from the lead capacitance in position EXTRA. When the plug from the external record amplifier is inserted in the socket, the contacts 1—2 are shorted, and simultaneously the signal current from the external record amplifier is injected. From contact 2 in the socket the bias current together with the signal current is fed to the lower head via contacts S17—S15 in stereo switch.

2.2.2 The Recoupling of the Record Playback Heads.

The switching of the record playback head in RECORD position is explained in the above sec.

In playback the mode switch is in its mid position and the connections between head and tubes are again determined by the stereo switch.

a) STEREO position: The upper head is connected to the EF804 in the upper track amplifier via contacts S13—S14 in the stereo switch, and contact III_{12}—III_{22} and II_{17}—II_{19} in the mode switch. At contact III_{22} the equalization switch is connected. This switch couples condensers across each head to give a resonant peak which compensates for the playback losses at 1 7/8 ips and 3 3/4 ips. There is no condenser at 7 1/2 ips because the resonant frequency of the head and the wiring capacity gives the proper compensation at 7 1/2 ips. Contact III_{14} is grounded to reduce crosstalk and to increase the stability of the amplifiers. The lower head is connected to the EF804 in the lower track amplifier via contacts S15—S17 in the stereo switch, and contacts 3—4 in the socket at the rear trim cover. These socket contacts are shorted when the plug from the external record ampilfier is not inserted. At the grid of EF804 the equalization switch is connected and works in the same manner as described for the upper head.

b) Position MONAURAL. The upper head is connected to the EF804 in the same way as in position STEREO. The connection between the lower head and the EF804 in the lower track amplifier is broken by S17—S15 and the grid of EF804 is grounded by S17—S18 via R44—R45 (each 10 ohms).

c) Position EXTRA. The upper head is disconnected from the EF804 in the upper track amplifier because S13—S14 is opened. The lower head is connected to the EF804 in the upper track amplifier via contacts S15—S14 in the stereo switch and contacts III_{12}—III_{22} and II_{17}—II_{19} in the mode switch. The lower head takes then the place of the upper head and uses the equalization circuits of the upper track amplifier.

The interconnections between the two amplifiers in PLAYBACK — RECORD and PUB.ADDR. work in the same manner as in the Model 3 Stereo: In PLAYBACK both amplifiers are connected to the same track in MONAURAL and EXTRA.
When recording in MONAURAL and EXTRA positions, the lower track amplifier works as a monitor amplifier for the recorded program.
In PUB.ADDR. both amplifiers are connected to

the inputs in MONAURAL and EXTRA. In PUB.-ADDR. and STEREO see sec. 2.2.5 Stereo Amplifier Input.

The switching between the two amplifiers is done after the two potentiometers. It is therefore possible to regulate the output of the two amplifiers individually in all combinations. This coupling loads the the plate of EF804 in the upper track amplifier with two .5 Mohm potentiometers in parallel in both RECORD and PLAYBACK position in MONAURAL and EXTRA, while in STEREO it is loaded with only one potentiometer. This means that the frequency response in record-playback differs approx. 4 dB at 50 c/s for STEREO to MONAURAL — EXTRA. The equalization is therefore adjusted to give approx. +2 dB at 50 c/s in STEREO position.

2.2.3 Equalization Curves.

The decrease in gap width has made it possible to change to 100 μS playback equalization curve at 3¾ ips and 250 μS at 1⅞ ips and yet increase the frequency response. The redesigning of the head together with the two potentiometers R21 and R21B has reduced the Q value of the head and decreased the resonance peak both in playback and recording. The decrease i Q value is wanted in playback because the reduced gap reduces the playback losses. To obtain correct preemphasis in recording position, a resonant circuit has been introduced in the feed back loop in recording position. This resonant circuit (L5—C9) is placed in the cathode of the first triode of ECC83 and is tuned to approx. 18 000 c/s at 7½ ips. By means of C9B and C9C this peak is changed to approx. 12 000 c/s and 8 600 c/s at 3¾ ips and 1⅞ ips respectively. By means of the core in L5 minor corrections at the high frequency response can be made. Fig. 3 and 4 shows the frequency response of the record and playback amplifiers at different speeds. Fig. 5 shows the total frequency response of the Recorder.

2.2.4 Muting Switch.

In NEUTRAL and in both FAST WINDING positions the amplifiers are muted by grounding the tops of the potentiometers. These groundings are made by the muting switch situated underneath the upper mounting plate. The muting takes place in the following manner. The plate of the EF804 tube in the lower track amplifier is grounded after C56 via contacts M3—M4 in muting switch and mutes the amplifier in the STEREO position. This plate is already muted via contacts I_{21}—I_{20} in the mode switch and contacts St22—St21 in the stereo switch in positions MONAURAL and EXTRA to avoid crosstalk. The muting of the upper track amplifier in position STEREO and both amplifiers in positions MONAURAL and EXTRA is done by contacts M8—M7 in the muting switch and contacts I_{13}—I_{14} in the mode switch. In positions RECORD and PUB.ADDR. the muting switch has no effect whatsoever.

On the first series the muting of the upper track amplifier was done directly on the head via contacts III_{12}—III_{22} in the mode switch and contacts M8—M7 in the muting switch. On those recorders the upper track amplifiers are more noisy when muted, because noise generated in the first tubes, is present. Those recorders may not be changed because the muting of the plate of EF804 in the upper track amplifier requires changing of the mode switch.

2.2.5 Stereo Amplifier Input.

To permit playback of stereo discs through the two amplifiers or to use the recorder as a stereo power amplifier for other program sources, a stereo amplifier input is introduced. With the mode switch in position PUB.ADDR. and the stereo switch in position STEREO the potentiometer in the upper track amplifier is connected to the socket marked Stereo Amplifier Input via contacts St16—St19 in the stereo switch and contacts II_{14}—II_{15} in the mode switch. The potentiometer in the lower track amplifier is connected to the socket via contacts I_{22}—I_{20} in the mode switch and contacts St11—St13 in the stereo switch. The potentiometer in the lower track amplifier is connected to the grid of the ECC83 tube in the lower track amplifier via contacts I_{18}—I_{17} in the mode switch. The gain of the two amplifiers from the top of the potentiometers is approx. 250 times or 48 dB. For full amplifier output (2 x 3 watts) it is necessary to have 15 mV at the Stereo Amplifier input socket.

2.2.6 Power Output — Cathode Follower Switch.

On special request some of the Model 5 have been equipped with a Power Output — Cathode Follower Switch. This switch makes it possible to bypass the two EL84s and the output transformers, when external power amplifiers are used. The lever for the switch is situated at the rear left of the recorder in

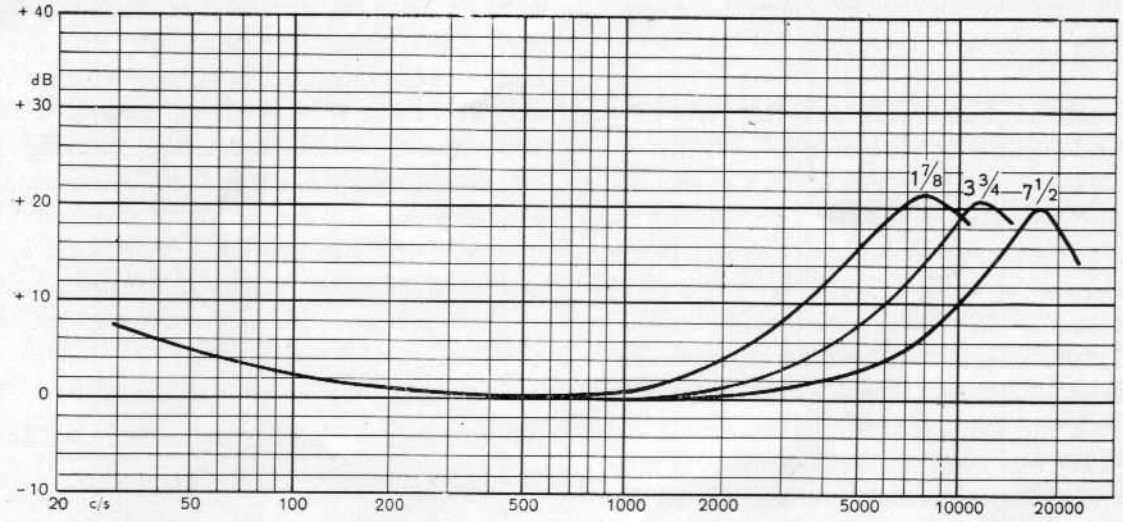


Fig. 3.
Recording Amplifier Response Curves

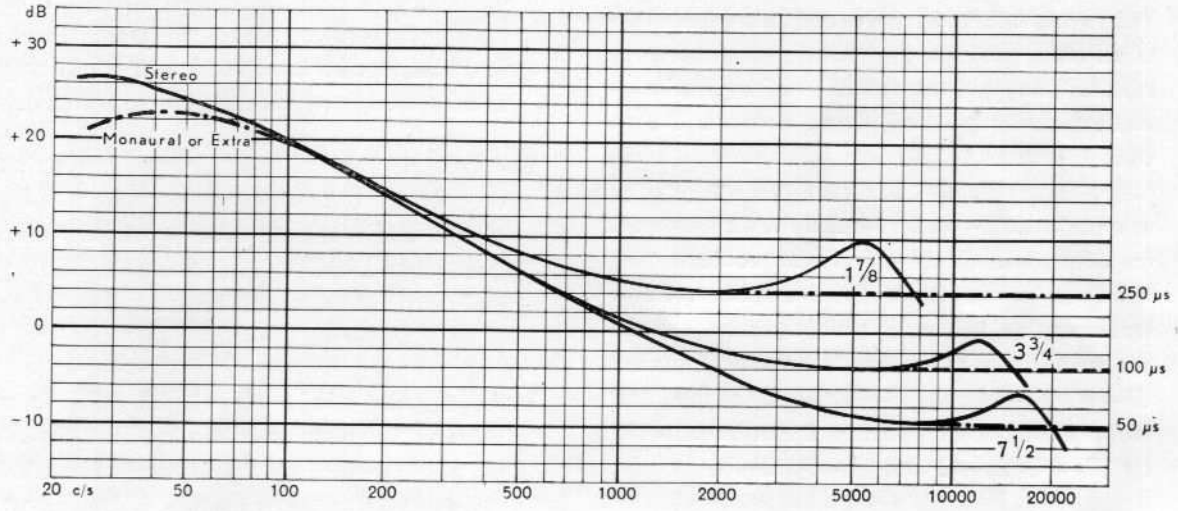


Fig. 4.
Playback Amplifier Response Curves

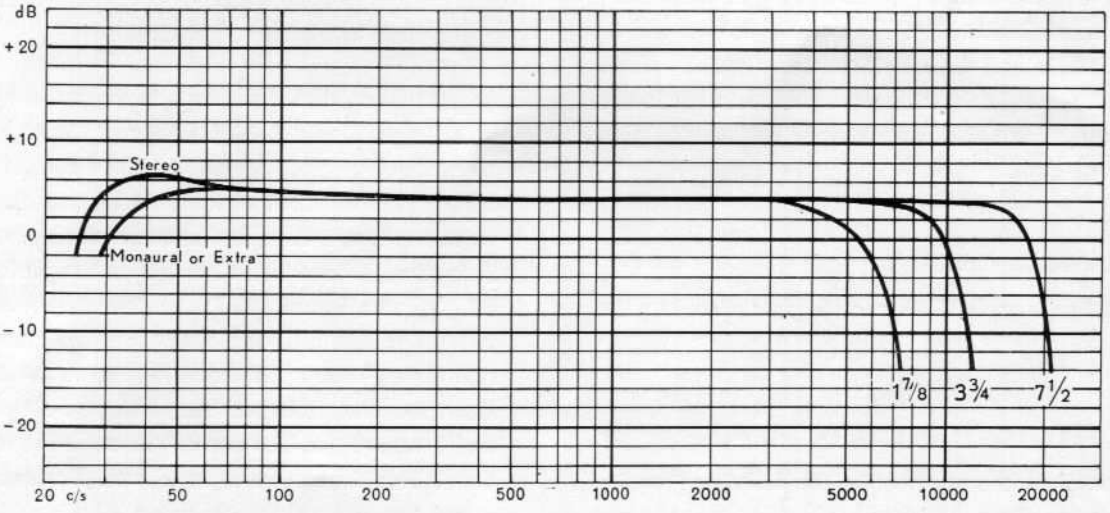


Fig. 5.
Total Frequency Response by Record-Playback

the slit between the top plate and the wooden case. It functions as follows:

1. In position Power Output the two amplifiers function as described in S. M.

2. In position Cathode Follower the shorting of R16B and R65 B in the cathodes of the second triodes of the ECC83 tubes is opened at contacts PO—CF 17—18 and contacts PO—CF 6—7. Simultaneously, R17 and R66 are shorted by contacts CF—PO 22—21 and 9—10. The opening of R16B and shorting of R17 in the upper track amplifier are, when the mode switch is in position RECORD, prevented by contacts IV_{18}—IV_{19} and IV_8—IV_9 in the mode switch, and the operation of the PO—CF switch will not affect the recording function of the upper track amplifier. The switch will, however, recouple the amplifiers in all other positions of the stereo and the mode switch. When placing the PO—CF switch in cathode follower position, the cathodes of the second triodes of ECC83 will be connected to the output terminals for each track, via C29—.25 μF and contacts CF—PO, 11—12 for the upper track amplifier, and C64B—.25 μF and contacts CF—PO 1—2 for the lower track amplifier. Simultaneously the two output transformers are disconnected from the output terminals by contacts CF—PO 12—14 and CF—PO 2—4. The feed back loops in the two amplifiers are also disconnected by CF—PO 12—13 and CF—PO 2—3.

2.2.7 Miscellaneous Improvements.

To improve the hum level d.c. heating is introduced on the two ECC83 tubes. The rectifier is changed to B30—C1000, and C42 is increased to 4000 μF. A loop is inserted in the cathode of EF804 in the lower track amplifier. This loop should be bent to give minimum hum.

3. MECHANICAL CHECK UP

The instructions in S.M. sec. 5 goes also for the Model 5.

4. INSTRUCTIONS FOR ELECTRICAL CHECK UP

For complete measurements, the following equipment is needed: Universal voltage and current instrument, audio signal generator, vacuum tube voltmeter with a frequency range from 50 c/s to 100 kc/s and a voltage range from 70 mV to 200 volts, a.c. electromagnet, output meter, distortion meter, wow meter and a standard alignment tape. (Ampex Standard Alignment Tape for 7½ ips). Wow is defined as the effective value of frequency deviation from a signal of constant frequency recorded and played back taken as a percentage of the signal frequency. The electric check up falls into two parts, introductory and final checking.

4.1 Introductory Check Up of the Oscillator.

1. Adjust the oscillator frequency. A radio receiver tuned to 200 kc/s is used as an indicator. The antenna input terminals must be supplied with a signal of 200 kc/s (Droitwich or a crystal oscillator) and the oscillator coil L3 (22.1) of the tape recorder, see circuit diagram Fig. 4 and foto S.M. Fig. 21, is adjusted so its third harmonic of 66⅔ kc/s beats with the 200 kc/s signal.

2. Adjust the oscillator frequency rejector circuit L1 (27.1). See photographs S.M. Fig. 17 and 18 and schematic S.M. Fig. 5. The V.T.V.M. is attached to point P in schematic S.M. Fig. 20 and should indicate about 5 volts when the circuit is adjusted for minimum.

3. Adjust the plate circuit L2 (28.2) to maximum with the stereo switch in STEREO position, see photograph S.M. Fig. 21 and schematic S.M. Fig. 6. As an indicator use a V.T.V.M. across one of the erase heads. It should be 160—200 volts across the erase head. Check that the erase voltage is approx. the same regardless of whether one or two heads are connected.

4. Adjust the bias current through the upper head in position MONAURAL and through the lower head in position EXTRA to .4 mA (.4 volt across 1000 ohms in series with the head). The adjustments are done by the semivariable potentiometers R21 and R21B located on the plate circuit bakelite board (28.3). Set the stereo switch in position STEREO and check that the bias current through the upper head is approx. the same, insert the plug from the Stereo Record Amplifier and measure the bias current through the lower head. This should be .4 to .5 mA. If necessary, adjust this current by changing R21C, which is also located on the plate circuit bakelite board.

5. Tune the second harmonic rejector circuit L4 located on the plate circuit bakelite board to min. second harmonic (133 ⅔ kc/s) in the bias current. To do this it is necessary to have a frequency selective V.T.V.M. The second harmonic in the bias current should be well below .5 %.

4.2 Introductory Adjustment of the Amplifiers in Recording Position.

This test is performed without the tube EL84 in the upper track amplifier. The mode switch (39.2) and the operating lever (50.14) are put in position for recording. The input terminals are supplied with a voltage from the audiosignal generator. The V.T.V.M. is attached to measure the voltage over 1000 ohms in series with the upper track record head.

1. Sensitivity of the indicator.
   The audio signal generator should supply a signal enough to drive the tape to its maximum recording level, indicated by the magic eye. The recording current through the head should then be between 90—110 microamperes or a voltage of 90—110 mV across the series resistor. If the current does not check with the value given, the semivariable potentiometer R20 should be adjusted.

2. The frequency response curve of the recording amplifier. In the position for recording, the frequency response of the upper track amplifier is changed by changing the speed. Drive the amplifier with a voltage corresponding to 20 dB below maximum recording level. The response curves should be as shown in Fig. 3, curves 7 ½, 3 ¾ and 1 ⅞. The response is checked at all three speeds. The sensitivity at 1000 c/s should be between 100 and 200 mV across the input terminals in back of the recorder, when the voltage across 1000 ohms in series with the head is 90 to 110 mV and the volume is set to max.

3. The lower track amplifier during recording. Check that the lower track amplifier is connected to the recorded program in both position MONAURAL and EXTRA of the stereo switch and that the output may be regulated by the little knob. The frequency response measured across the output terminals of the amplifier is shown in S.M. Fig. 24.
   It should be noted that the interconnection between the two amplifiers is broken on position STEREO. The cross talk in this position shall be better than — 55 dB.

4.3 Introductory Check Up of the Amplifiers in Playback Positions.

1. Put the tube EL84 in its socket in the upper track amplifier. Connect generator to 1000 ohms in series with the head for the lower track and the Vacuum Tube Voltmeter to the output terminals of the lower track amplifier. Adjust the generator to 250 c/s and set the volume control of the tape recorder to max. The generator voltage is adjusted to give 2—3 volts across the output terminals of the lower track amplifier. (This corresponds to a generator voltage of approx. .6—.9 mV. If necessary, use a voltage divider on the generator terminals to avoid hum). The volume control for the lower track amplifier is regulated down 4 dB. Check that the output of the lower track amplifier is cut out when the stereo-monaur. lever (59.8) is set in position MONAUR. but is present in position STEREO and EXTRA. Also check that the built in loudspeaker is connected to the lower track amplifier when the loudspeaker switch (30.7) is set in the right position and is disconnected in middle and left position. Check that the upper track amplifier is connected to the lower head in position EXTRA. Connect the generator to 1000 ohms in series with the upper track head without changing either volume control on the tape recorder or the generator voltage. By means of the semivariable potentiometer R40 (see S.M. Fig. 17) the gain of the upper track amplifier is adjusted similarly to that outlined above for the lower track amplifier. (The final adjustment is done when playing the alignment tape see sec. 4.4 point 4). The loudspeaker switch (30.7) has to be set in the middle position during the gain adjustment. (Both amplifiers unloaded). Check that the loudspeaker switch (30.7) connects the built in loudspeaker to the upper track amplifier in the left position and disconnects the loudspeaker in the two other positions. Further check that with the stereo switch in position MONAUR. the lower track amplifier is connected, and disconnected i position STEREO and that both amplifiers are connected in position EXTRA.

2. The frequency response of the two amplifiers is checked at all three speeds. The response should correspond to the curves in Fig. 4. During these measurements the generator is connected across 1000 ohms in series with the heads and the V.T.V.M. across the corresponding output terminals. The generator voltage is regulated so that the output voltage does not exceed 3 volts at frequencies with max. gain (30—60 c/s). The stereo-monaur. switch is set to STEREO position and the loudspeaker switch (30.7) in the middle position. The gain at 1000 c/s with the volume control at max. is approx. 67.5 dB (2400 times) at 7 ½ ips, approx. 70 dB (3150 times) at 3 ¾ ips and approx. 73.5 dB (4750 times) at 1 ⅞ ips, measured from the head to the output terminals. Also check that the output voltage increases 10—12 dB at 100 c/s when the bass switch is set in position BASS in both amplifiers and at all speeds.

4.4 Final Check Up.

1. Demagnetization. The heads, tape guides, pressure wheel assembly and the adjustable tape guide must be demagnetized by means of a powerful a.c. magnet.

2. The procedure in S.M. sec. 3.9 point 1 to 4 has to be followed.

3. Adjustment of the tape height. This adjustment is made by sight and the gain of the amplifiers needs no adjustment. By means of the adjustable tape guide the tape path is adjusted so that the upper edge of the tape runs exactly even with the upper edge of the record-playback head. Then check that the tape runs equidistant from the flanges of the adjustable tape guide. If not, the height of the fixed tape guides should be adjusted by means of washers to allow this. If a rather large adjustment of the tape path is necessary, the azimuth alignment of the head gaps should be rechecked.

4. After the correction of the tape path has been done, the stereo switch is set in position STEREO. Both potentiometers are set to max., and the large knob is fastened by means of the fastening screw in such a position that the mutual dial between the two knobs is in mid position. Play back a 250 c/s steady note recorded at full track and regulate the potentiometers until the lower amplifier gain is approx. 4 dB below maximum. In this position the gain of the upper track amplifier is adjusted by means of the semivariable potentiometer R40 to give exactly the same output as the lower track amplifier.

5. The height of the erase head. The height of the erase head is rather critical with respect to unwanted erasing. Adjust the height of the erase head by changing the little rod underneath the head mounting plate in such a way that the upper edge of the tape runs 0.25 mm (0.1″) below the edge of the erase head. Then record a steady 400 c/s note on track 1 and 3 on the same portion of the tape. Turn the reels and erase in position EXTRA (track 2) intermittent 10 sec. erasing and 10 sec. no erasing. Be sure that the erasures take place at the same portion where the tape has been recorded. Turn the reels again and play back in position STEREO with output meters across the terminals of the two amplifiers. It should not be possible to measure any erasing effect whatsoever on the tracks 1 and 3 on the portions of the tape where track 2 has been erased.
   If so, the height of the erase head has to be adjusted. Any erasing of the upper track (track 1) indicates that the erase head stands too low, and erasing on the lower track (track 3) that the erase head stands too high. Adjust the head if necessary several times until the correct height of the erase head is secured. As a final and most critical check one should record in position EXTRA (track 3) and turn the reels and erase the tape in position STEREO (track 2 and 4), turn the reels once more and measure the erasing of track 3. This should be below .3 dB. If the erasing effect is more than .3 dB, minor corrections of the height of the erase head should be done.

6. Frequency response during play-back. The standard alignment tape with full track recording is played back at 7 ½ ips. The stereo switch in position STEREO and the bass switch in position NORM. The frequency response of the playback should be within ± 2 dB both amplifiers, and the deviation between the two outputs should not extend 3 dB at any frequency during this measurement. The volume controls should be adjusted to the same output at 250 c/s. If necessary, small corrections in frequency response can be done by varying R5 and R53.

7. Frequency response curves, distortion and noise level. The procedure is the same for all tape speeds. The numbers in paranthesis refer to the lower speeds.
In position MONAUR. record a 1000 c/s signal of about 0.5 volt across the input terminals and adjust the volume control for about 20 dB below closing of the magic eye. At this input and volume control position one records: 40 c/s, 100c/s, 1000 c/s, 5 000 c/s (3 000 c/s, 2 000 c/s), 10 000 c/s (6 000 c/s, 3 000 c/s), 15 000 c/s (8 000 c/s, 4 000 c/s) and 16 000 c/s (10 000 c/s, 5 000 c/s). Then record a 400 c/s signal at max. recording level. Pull out the generator leads. Put them back in place after a while and record 400 c/s at half of maximum recording level. (10 dB down).
Rewind tape and play back. The 1 000 c/s signal frequencies recorded should give signal outputs within ± 2 dB relative to the zero level.
Next play back the piece of tape containing the 400 c/s signal at max. recording level and measure distortion at 2.5 volts output. There must be less than 5 % distortion. Where nothing is recorded, read off the noise level. Leave the volume control unchanged. With a straight line voltmeter the noise voltage should be less than 8 mV or about 55 dB below maximum signal level.
The last thing to be checked is the distortion at — 10 dB signal level. At an output voltage of 1 volt the distortion should be less than 1.3 %.
Next check for wow. Wow should be less than 0.15 % at 7 ½ ips, 0.2 % at 3 ¾, 0.3 % at 1 ⅞ RMS.
If a wow meter is not avaible, a program recorded on a tape recorder having little wow can be played back through the unit, and the judgement done by ear. A program of piano music with some long notes will easily detect wow if this error is present.
All points with exception of the wow is then measured in position EXTRA and STEREO, with the signal fed through the built in amplifier.
If a stereo record amplifier is used, the procedure is repeated in stereo on lower track through stereo record amplifier. Be avare of the difference at the bass end between the frequency response in MONAUR. and STEREO.

8. Cross talk. With the volume control set to zero a part of the tape is erased. The two tape reels are turned upside and changed from left to right turntable and vice versa. A 1 000 c/s signal is recorded at maximum recording level on track 1. (Eye just closed). Rewind the tape and play back the 1 000 c/s signal (signal on upper track), set the stereo switch in position MONAUR. and regulate the volume control to give 3 volts across the output terminals of the lower track amplifier, with the built in loudspeaker connected. Set the stereo switch in position STEREO, and check that the signal is hardly heard in the loudspeaker (approx. 60 dB cross talk damping). Record in position EXTRA and measure the cross talk heard through the upper track amplifier in position STEREO. The tape is turned upside down again (signal on track 2), connect the loudspeaker to the upper track amplifier. With the same volume control setting (3 volts across the terminals of the lower track) and the stereo switch in position MONAUR. and then in position EXTRA, the signal should hardly be heard. The cross talk in these positions should also be approx. — 60 dB.
If correct measurement of the cross talk is wanted, it is necessary to use a wave analyzer because the cross talk signal will be masked by the noise when using a straight voltmeter.

9. Erasing. Record a 1 000 c/s note at maximum recording level in MONAUR. and EXTRA and erase in STEREO, MONAUR. and EXTRA. The erasing should be better than 60 dB in STEREO and better than 70 dB in MONAUR. and EXTRA.

10. Seal all adjusting screws with lacquer.

5. COMMENTS ON THE QUADRUPLE SYSTEM

The quality of a tape recorder is of course mainly dependent on the make and design. In this section the Model 5 will be compared with our former Model 3 Stereo. The advantage of the Model 5 is mainly twice as long playing time. In stereo this doubling of playing time is especially wanted because it offers the possibility of recording at «both sides« as former in monaural, thus playing stereo without rewind the tape. In addition the air gap of the playback head is reduced from approx. 6μ to 4μ (.00025 approx. .00016). This will reduce the playback losses due to air gap effect from approx. 8—10 dB to 3—4 dB at 10 000 c/s and 3 ¾ ips and 5 000 c/s and 1 ⅞ ips.
This reduction has made it possible to use a 100 μs playback equalization curve instead of 200 μs at 3 ¾ ips and still extend the frequency response beyond 10 000 c/s. At the same time the playback equali-

zation at 1 7/8 is 250 μs instead of 400 μs and the frequency response is extended beyond 5 000 c/s. These changes in playback equalization will of course reduce the high frequency components in tape and playback amplifier noise, at 3 3/4 and 1 7/8 ips.
To obtain the longer playing time and better frequency response one must sacrifice some of the signal to noise ratio in particular cases, see S.M. sec. 4.7. In order to understand the reasons for the loss let us look at the different noise factors separately.

1. Tape noise. The track width of the Model 5 is almost ½ of the track width of the Model 3 Stereo. The virgin tape noise as well as the noise arising from erase and bias current is mainly dependent on the grain size and structure of the magnetic layer of the tape and will be uncorrelated, i.e. the phase of the noise components will vary along the track width. The noise effect of an uncorrelated tape noise will be proportional to the track width. The signal on the tape will however be correlated (in phase along the whole track width) and the signal voltage will be proportional to the track width. By reducing the track width by one half, the noise will be reduced 3 dB and the signal by 6 dB, resulting a 3 dB poorer signal to noise ratio. This relative increase in noise will be inherent on the tape and it is therefore impossible to restore the signal to noise ratio by improved design of tape or amplifiers. The overall tape noise can, of course, be improved by better tape and perhaps by better erase methods, but the relation between the two track widths will be the same. Fortunately, other and often more important noise factors will not vary in the same manner.

2. Program source and recording amplifier noise. All noise generated in the system before the recording head will be recorded at the tape and therefore be correlated. The noise voltage will therefore vary in accordance to the signal voltage and the track width will have no effect whatsoever on the signal to noise factor referring to this special noise. This fact is especially important when playing prerecorded tape, where the recorded noise generally is much higher than the tape noise because of the numbers of copying processes from the original, see S.M. sec. 4.7. Consequently there will be no audible difference when playing back prerecorded tape on either 2 tracks or quadruple heads.

3. Noise in playback amplifier.
The noise in the playback amplifier consists mainly of tube and resistor noise. At a given amplifier gain this noise will be constant and the signal to noise ratio will be dependent on the signal at the input i.e. the signal voltage from the head. With the same numbers of turn and the same iron construction, the head sensitivity will decrease both with decreasing track width and gap width.
It has however been possible to design the quadruple head with approx. the same sensitivity as the former Model 3 Stereo head. The main difference in design being that the additional air gap in the rear is reduced. This will increase the danger of accidential d.c. magnetizing of the head. but experience has shown that this danger in the Model 5 is almost eliminated. The loss in signal to noise ratio in the playback amplifier is therefore not more than 1—2 dB and will generally not be detected because the tape noise and recorded noise will be dominating.

4. Hum.
The hum level is determinated by the hum induced in the head and the hum generated in the playback amplifier. The hum induced in the head is the difference of the induced hum voltage in the two windings in the head and will generally not be affected by alteration in the front and rear gap. The hum from the head will however be dependent on the physical size of the head and will normally decrease with decreasing size. The sensitivity of the head is approx. the same in the Model 3 Stereo as in the Model 5, whereas the hum from the head is lower in the Model 5 and there will be an improvement in hum level from the head in the Model 5 compared to the Model 3 Stereo. At the same time d.c. heating has been introduced on the two ECC83s in the Model 5 which reduces hum generated in the playback amplifier .The Model 5 has therefore a lower hum level than the Model 3 Stereo. In both models, different hum compensating devices are used and the hum may therefore differ from recorder to recorder, but the overall hum level will be 3—6 dB lower in the Model 5. The conclusions of the comparison in noise level between the Model 3 Stereo and the Model 5 are:

1. When recording programs where the noise from the program source is small compared

with the tape noise there will be a loss of 3 dB in signal to tape noise ratio.

2. When playing back prerecorded tape there will be no audible difference.

3. The hum level has been reduced in the Model 5 with the result that it has been possible to obtain the same measured overall signal to noise ratio (noise and hum) in the Model 5 as in the Model 3 Stereo, even when recording programs from sources with negligible noise.

The above comparisions apply to the 7½ ips speed since the equalization curves at this speed are unchanged. At 3¾ ips and 1⅞ ips a much greater improvement in noise level is obtained by changing the playback equalization curves. As will be seen from Fig. 3 this improvement has to a certain extent increased the risk of overloading the tape at the higher frequencies. One disadvantage with the Model 5 compared with the Model 3 Stereo is that the Model 5 requires a better adjustment of the tape path, and therefore faults may be caused by improper tape transport. Another difficulty is the erasing in STEREO position. There is a rather critical balance between sufficient erasure and unwanted erasure of the track inbetween. To avoid unwanted erasure it has been necessary to feed the two head halves in opposite phase. This will reduce the erasing effect in STEREO because the field from one head will counteract the other. This reduction limits the erasure to approx. 60—65 dB in STEREO position, while in MONAURAL and EXTRA the erasure is better than 70 dB.

A point which was taken into consideration by changing to the quadruple track standard, was the compatibility between the new standard and the former two track standard. All monaural recorded tape may be played at a quadruple recorder with the same quality. Prerecorded stereo tape has a track width of .1" whereas the upper edge of the lower head in quadruple standard is .11 inches above the lower edge of the tape. When playing prerecorded two track stereo tapes on a Model 5 .01" of the lower head will extend above the track, the result being a drop in output voltage of approx. 2 dB. This unbalance may however easily be restored by adjusting the potentiometers. The result being when playing prerecorded two track tapes, a loss of approx. 2 dB in playback amplifier gain, and a slightly increased noise level on the lower track.

6. ELECTRICAL TROUBLE — CAUSE AND REMEDY

Any amplifier not operating	Metal shield between wafers in mode switch or stereo switch is grounding rivets for contacts clips. Any blown fuse. Muting switch not open in the playback mode. Adjust switch arm for proper operation.
The upper track amplifier oscillating in playback mode.	Too high resistance in 63 mA fuse on power transformer. Occuring only in the first series of Model 5—50 c/s. Replace fuse or reroute wiring B plus supply for EL84 corresponding to the schematic diagram No 2276.
Hum, caused by false grounding.	Shielded wires from the amplifiers to the record/playback heads crimped underneath the top cover. Metal shield in wafer switch touching contact clip or rivet. Note the two 10 ohms resistors in front of the stereo switch.
Hum compensation in the upper track amplifier.	Locate mumetal shield in front of the playback head for minimum hum level.
Hum compensation in the lower track amplifier.	Stereo Switch in position STEREO. Bend brown wire loop at the front end of the lower track amplifier to obtain the lowest hum level.

Insufficient erasure.	Adjust to max. voltage across the erase heads in the stereo mode by tuning the plate circuit L2. See sec. 4.1.3. Incorrect height of the erase head, see sec. 4.4.5 for the adjustment procedure.
No recording on lower track in STEREO position.	Butt contacts in connector for the Stereo Record Amplifier (on top of the rear trim cover) does not open when the plug is inserted. Adjust contact springs. Defective Stereo Record Amplifier.

7. ADDITIONAL PARTS LIST FOR MODEL 5

A number of parts have been changed in the Model 5 from the Model 3 Stereo, from example Mode Switch, Stereo Switch, Double Potentiometer and many others. For these parts which are substitutes for parts existing in the Model 3 Stereo, one uses, when ordering, the same part numbers as the equivalent the Model 3 Stereo but state model, line voltage and frequency.
The following parts have no equivalent in the Model 3 Stereo.

7.1 Mechanical Parts.

Part no.:	Name:
06.1	Female plug for power connection Stereo Record Amplifier, wired
19.6	Socket for head connection Stereo Record Amplifier for Model 5, mounted with head terminal strip
30.33	P.O. — C.F. Switch
30.34	Muting Switch
30.35	Bracket for Muting Switch
30.36	Actuator for Muting Switch
30.37	Shaft for Muting Switch
30.38	Socket head connection from Stereo Record Amplifier (and Stereo Amplifier input)
30.39	Female plug (for power connection Stereo Record Amplifier)
33.15	Socket for Stereo Amplifier input, with turbax plate
39.3	P.O. — C.F. Switch, wired
39.4	Muting Switch, wired

7.2 Electrical Parts.

There may be some minor alterations in the value or type of electrical components. Simultaneously there are some new components.

When ordering electrical spare parts for the Model 5, please state component number, value and Model 5.

STEREO RECORD AMPLIFIER FOR MODEL 5

8. TECHNICAL DESCRIPTION FOR STEREO RECORD AMPLIFIER FOR MODEL 5

The Stereo Record Amplifier for Model 5 works as a normal record amplifier see S.M. sec. 4.2.1 and 4.2.2. Fig. 6 shows the wiring diagram for Stereo Record Amplifier for Model 5. To obtain a correct recording equalization, a resonance circuit is inserted in the feedback loop in the first cathode of ECC83 as described in sec. 2.2.3.
The frequency response of the Record Amplifier for Model 5 is shown in Fig. 3 for the different speeds.

The power supply for the Amplifier is taken from the Recorder. The check up corresponds to the procedure in sec. 4.2. One has to connect the Stereo Record Amplifier for Model 5 to the Recorder and set the Stereo Switch on the Recorder in position STEREO and the Mode Switch in position RECORD. All head measurements are then done at the lower head on the Recorder.

9. TECHNICAL DATA FOR STEREO RECORD AMPLIFIER FOR MODEL 5

Tubes:	EF804, ECC83, EM71, one low voltage selenium rectifier.
Power Consumption:	7 watts.
Controls:	Record level control.
Equalization Switch:	Changes the recording equalization to 7 ½, 3 ¾ and 1 ⅞ ips curves.
Frequency Response:	Gives flat response within ± 2 dB from 30—16 000, 40 to 10 000 and 70 to 5 000 when used in connection with the Model 5.
Distortion:	Less than 1 % at max. recording current.
Input:	Microphone 5 Mohms, sensitivity 1.5 mV for max. recording current. Phono- and radio input .5 Mohm, sensitivity — 75 mV.
Recording Level Indicator:	Magic eye with selenium rectifier and damped backward movement.
Connections:	Plug with leads for connections to lower head on the Model 5.
Dimensions:	All metal case 2 ¼" wide, 8 ¾" deep and 5" high (5.7 x 22 x 12.5 cm) without leads and knobs.
Weight:	2.2 lbs (1 kg).

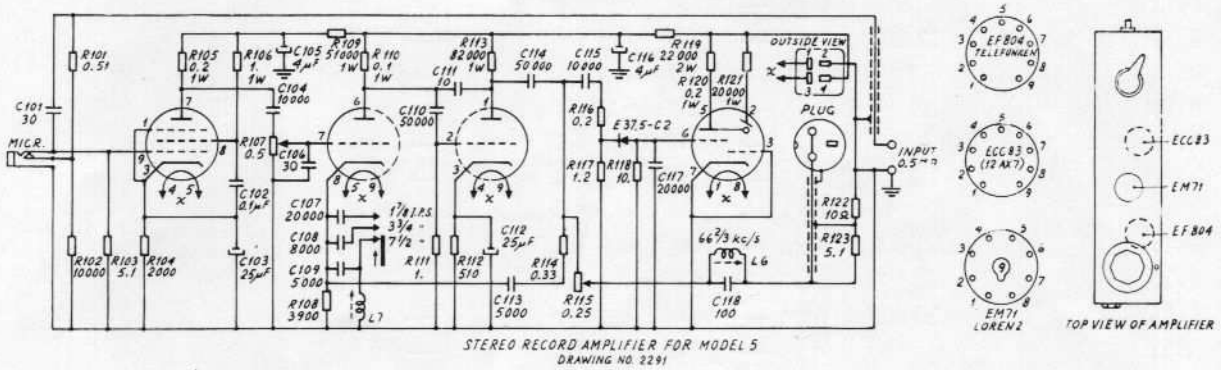


Fig. 6.

10. PARTS LIST FOR STEREO RECORD AMPLIFIER FOR MODEL 5

10.1 Mechanical Parts.

Part no.:	Name:
02.2	Coaxialcabel with plug
17.2	Bakelite strip
18.1	Equalization coil
18.6	Main bakelite board
18.7	Main bakelite board wired
27.1	Supressor coil
27.2	Board for supressor circuit
27.3	Supressor circuit mounted
30.9	Pot.meter 0.5 Megohm
30.40	Equalization switch
30.41	Four prongs contact, male
31.1	Socket for EM71 wired
45.1	Microphone jack, wired
47.9	Front cover
70.55	Rear cover
70.56	Polyethylen washer
70.57	Spacer for four prongs contact
70.58	Rubber mounting

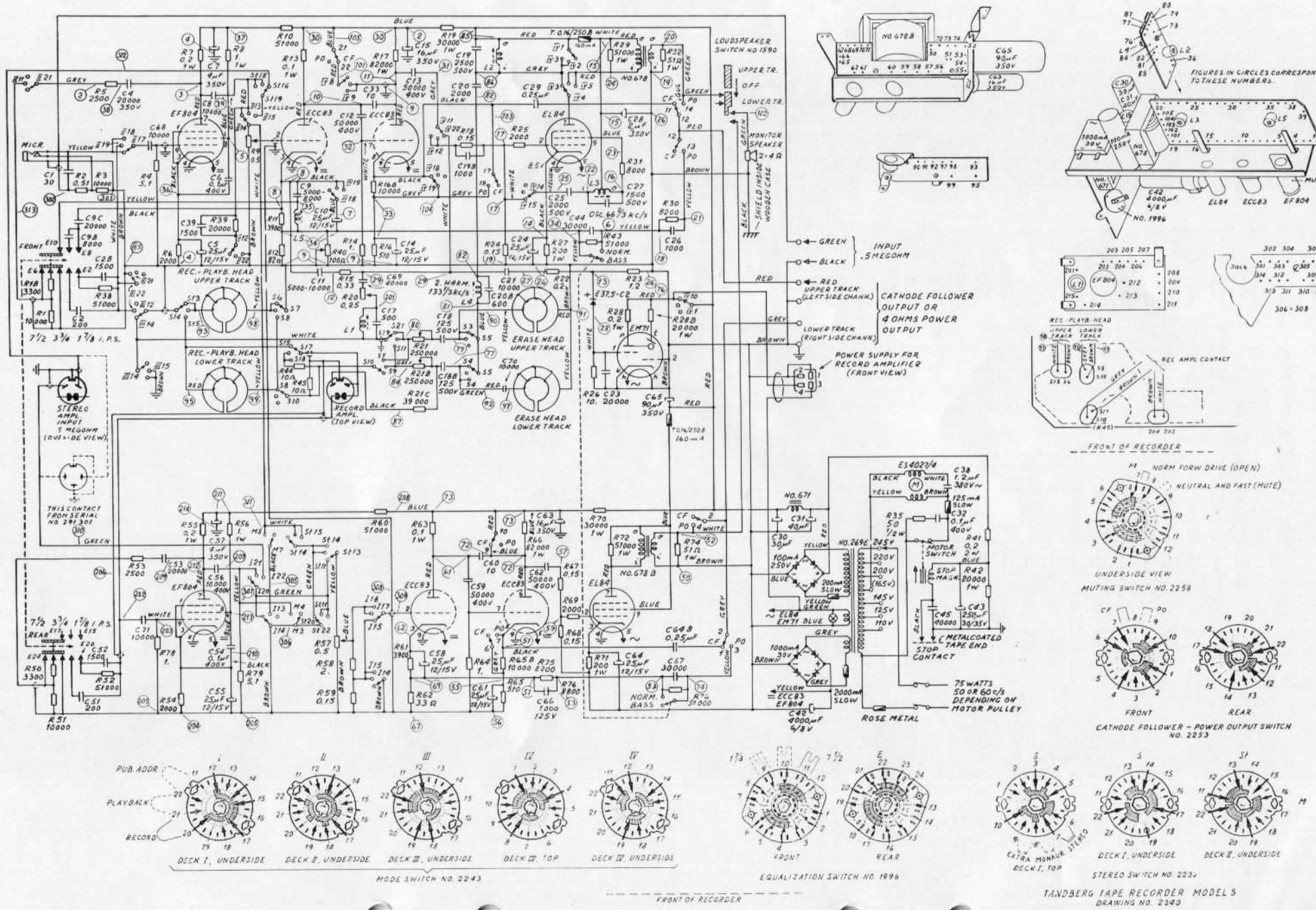
10.2 Electrical Parts.

10.2.1 Resistors.

Part no.:	Name:	Remarks:
R101	.51 M.ohm — ½ W Type SBT — 10 %	
R102	10 000 ohm — ½ W « « — 10 %	
R103	5.1 M.ohm — ½ W « « — 10 %	
R104	2 000 ohm — ½ W « SCD1 — 5 %	
R105	.2 M.ohm — 1 W « « — 10 %	
R106	1 « — 1 W « « — 10 %	
R107	.5 « — Pot. T. 1588B Elap	Log.
R108	3 900 ohm — ½ W — 10 %	
R109	51 000 « — 1 W Type ABT — 10 %	
R110	.1 M.ohm — 1 W « « — 10 %	
R111	1 « — ½ W « SBT — 10 %	
R112	510 ohm — ½ W « « — 5 %	
R113	82 000 « — 1 W « ABT — 10 %	
R114	.33 M.ohm — ½ W « SBT — 10 %	
R115	.25 « — Pot. Type 57 Tr, Elap	Lin.
R116	.2 « — ½ W Type SBT — 10 %	
R117	1.2 « — ½ W « « — 10 %	
R118	10 « — ½ W « « — 10 %	
R119	22 000 ohm — 2 W « BBT — 10 %	
R120	.2 M.ohm — 1 W « ABT — 10 %	
R121	20 000 ohm — 1 W « « — 10 %	
R122	10 « — ½ W « SBT — 10 %	
R123	5.1 M.ohm — ½ W « « — 10 %	

10.2.2 Capacitors.

Part no.:	Name:				Remarks:
C101	30 µµF	— Styroflex	10 %	125 V	
C102	.1 µF	— Paper A51	20 %	400 V	
C103	25 «	— Electrolytic		12/15 V	
C104	10 000 µµF	— Paper W99	10 % (20)	400 V	
C105	4 µF	— Electrolytic		350/385 V	
C106	30 µµF	— Styroflex	10 %	125 V	
C107	20 000 «	— Paper W99	10 % (20)	150 V	
C108	8 000 «	— « W99	10 % (20)		
C109	5 000 «	— « W99	10 % (20)		
C110	50 000 «	— « A50	20 %	400 V	
C111	10 «	— Ceramic	5 %	500 V	
C112	25 µF	— Electrolytic		12/15 V	
C113	5 000 µµF	— Paper W99	10 % (20)	150 V	
C114	50 000 «	— « A50	20 %	400 V	
C115	10 000 «	— « W99	10 % (20)	150 V	
C116	4 µF	— Electrolytic		350/385	
C117	20 000 µµF	— Paper W99	10 % (20)	150 V	
C118	100 «	— Styroflex	10 %	500 V	


From serial no. 282 701
LOUDSPEAKER SWITCH NO 1590
UPPER TR.
OFF
LOWER TR.
MONITOR SPEAKER
2 - 4 Ω
SHIELD INSIDE WOODEN CASE
INPUT .5 MEGOHM
CATHODE FOLLOWER OUTPUT OR 4 OHMS POWER OUTPUT
POWER SUPPLY FOR RECORD AMPLIFIER (FRONT VIEW)
REC.-PLAYB. HEAD UPPER TRACK
REC.-PLAYB. HEAD LOWER TRACK
ERASE HEAD UPPER TRACK
ERASE HEAD LOWER TRACK
RECORD AMPL. (TOP VIEW)
STEREO AMPL. INPUT 5 MEGOHM (UNDERSIDE VIEW)
THIS CONTACT FROM SERIAL NO. 291 301
7½ 3¾ 1⅞ I.P.S.
NO. 678 B
NO. 671
NO. 269 E
NO. 678
NO. 1996
NO. 2071
EL84 ECC83 EF804
MUMETAL
FIGURES IN CIRCLES CORRESPOND TO THESE NUMBERS.
REC. AMPL. CONTACT
FRONT OF RECORDER
NORM FORW DRIVE (OPEN)
NEUTRAL AND FAST (MUTE)
UNDERSIDE VIEW
MUTING SWITCH NO. 2258
METALCOATED TAPE END
STOP CONTACT
75 WATTS 50 OR 60 c/s DEPENDING ON MOTOR PULLEY
ROSE METAL
FRONT
REAR
CATHODE FOLLOWER - POWER OUTPUT SWITCH NO. 2253
PUB. ADDR.
PLAYBACK
RECORD
DECK I, UNDERSIDE
DECK II, UNDERSIDE
DECK III, UNDERSIDE
DECK III, TOP
DECK IV, UNDERSIDE
MODE SWITCH NO. 2243
EQUALIZATION SWITCH NO. 1996
EXTRA MONAUR DECK I, TOP
STEREO
DECK I, UNDERSIDE
DECK II, UNDERSIDE
STEREO SWITCH NO. 2234
TANDBERG TAPE RECORDER MODEL 5
DRAWING NO. 2240

Printed in Norway.

5 - 60

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