

# Service manual

## HILIPS



### RECORDERS N4450

00/15/19/43



584A

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CS32933



Subject to modification



4822 726 10863

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## TECHNICAL SPECIFICATION

|                                  |                                                                                                                                                                  |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mains voltages                   | : 110-127-220-240 V                                                                                                                                              |
| Mains frequency                  | : 50 - 60 Hz (timer must be adapted only)                                                                                                                        |
| Power consumption                | : min. 29 W<br>max. 120 W                                                                                                                                        |
| Number of tracks                 | : 4                                                                                                                                                              |
| Tape speeds                      | : 4.75 cm/sec - 1 7/8 ips (+ 2 %)<br>9.5 cm/sec - 3 3/4 ips (+ 1 %)<br>19 cm/sec - 7 1/2 ips (+ 1 %)                                                             |
| Max. reel diameter               | : 26.5 cm (10 1/2")                                                                                                                                              |
| Number of heads                  | : 6 (2 recording, 2 playback, 2 erase heads)                                                                                                                     |
| Number of motors                 | : 4 (one Hall motor - collectorless d.c. motor - for driving the capstans, two d.c. motors for driving the reel discs, one synchronous motor for tape transport) |
| Wow and flutter                  | : 4.75 cm/sec ≤ 0.35 %<br>9.5 cm/sec ≤ 0.2 %<br>19 cm/sec ≤ 0.15 %                                                                                               |
| Winding time                     |                                                                                                                                                                  |
| 26 cm reel with LP tape (1080 m) | : ≤ 250 secs                                                                                                                                                     |
| 18 cm reel with LP tape ( 540 m) | : ≤ 150 secs                                                                                                                                                     |
| Input sensitivities:             |                                                                                                                                                                  |
| Micro                            | : 0.15 mV/ > 2 kΩ                                                                                                                                                |
| Tape                             | : 2 mV/ 20 kΩ (1, 4)<br>100 mV/ 1 MΩ (3, 5)                                                                                                                      |
| Tuner                            | : 100 mV/100 kΩ                                                                                                                                                  |
| Phono                            | : 1.5 mV/ 47 kΩ (MD/ceramic HiFi)<br>100 mV (X-tal)                                                                                                              |
| Aux                              | : 2 mV/ 20 kΩ (1, 4)<br>100 mV/ 1 MΩ (3, 5)                                                                                                                      |
| Output voltages:                 |                                                                                                                                                                  |
| Tape                             | : 1 V/ > 50 kΩ                                                                                                                                                   |
| Monitor                          | : 1 V/ > 50 kΩ                                                                                                                                                   |
| Headph                           | : 3 V/400-600 Ω                                                                                                                                                  |
| Output power                     | : 2 x 20 W (d < 1 % - 8 Ω)                                                                                                                                       |
| Frequency range (within 6 dB)    | : 4.75 cm/sec 60 - 8,000 Hz<br>9.5 cm/sec 40 - 15,000 Hz<br>19 cm/sec 40 - 20,000 Hz<br>40 - 16,000 Hz (with stereofilter)                                       |
| Rumble filter                    | : -10 dB at 30 Hz                                                                                                                                                |
| Scratch filter                   | : -15 dB at 15 kHz                                                                                                                                               |
| Physiological tone control       | : +14 dB at 50 Hz,<br>+ 6 dB at 10 kHz                                                                                                                           |
| Erase frequency                  | : 100 kHz (+ 10 %)                                                                                                                                               |
| Dimensions (including lid)       | : 520 x 500 x 210 mm (20 1/2" x 19 5/8" x 8 3/8")                                                                                                                |
| Weight                           | : approx. 20 kg (44 lbs)                                                                                                                                         |

## INPUTS AND OUTPUTS

| Marking                              | For connection of                                                                                                                                                                                                                           | Sensitivity           | Impedance                                        | Kind of socket    | Connection                                                                                                                                          | Place         |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--------------------------------------------------|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| MICRO L + ST<br>BU8                  | a microphone with either 3-pole, 180°, DIN plug for recording any channel in position 1-4, 3-2 and for recording left-hand channel in position ST, or with 5-pole, 180°, DIN plug for stereo recording                                      | 0.15 mV *)            | >2 k $\Omega$                                    | 5p, 180°, DIN<br> | 1 - left<br>4 - right<br>2 -<br>5 -<br>3 -                                                                                                          | front         |
| MICRO R<br>BU9                       | a microphone with either 3 or 5-pole, 180°, DIN plug for recording the right-hand channel in position ST                                                                                                                                    | 0.15 mV *)            | >2 k $\Omega$                                    | 5p, 180°, DIN<br> | 1/4 - right<br>2 -<br>5 -<br>3 -                                                                                                                    | front         |
| TAPE IN/OUT<br>BU2<br>BU10           | a second tape recorder or any apparatus provided with a 5-pole 180° DIN in/output socket:<br>input : pins 1 and 4<br>pins 3 and 5<br>output : pins 3 and 5                                                                                  | 2 mV<br>100 mV<br>1 V | 20 k $\Omega$<br>1 M $\Omega$<br>>50 k $\Omega$  | 5p, 180°, DIN<br> | 1 - left<br>4 - right<br>2 -<br>5 - left<br>3 - right                                                                                               | rear<br>front |
| HEADPH.<br>BU11                      | a stereo headphone, provided with a 5-pole, symmetrical DIN plug                                                                                                                                                                            | 3 V                   | 400-600 $\Omega$                                 | 5p, sym. DIN<br>  | 1 -<br>2 -<br>3 -<br>4 - left<br>5 - right                                                                                                          | front         |
| TUNER<br>BU1                         | a tuner                                                                                                                                                                                                                                     | 100 mV                | 100 k $\Omega$                                   | 5p, 180°, DIN<br> | 1 -<br>4 -<br>2 -<br>5 - right<br>3 - left                                                                                                          | rear          |
| PHONO<br>BU4                         | a record player with either a crystal, a ceramic, or a dynamic P.U. element. The input sensitivity for crystal and ceramic HiFi/dynamic P.U. elements can be set by means of a switch underneath the socket to crystal ceramic HiFi/dynamic | 100 mV **)<br>1.5 mV  | -<br>47 k $\Omega$                               | 7p, DIN<br>       | 1 - right<br>4 -<br>2 -<br>5 - right<br>3 - left<br>6 - MP1<br>7 - MP101                                                                            | rear          |
| AUX.<br>BU3                          | any kind of electronic musical equipment, e.g. an electronic organ, or a tape recorder, a record player with a crystal P.U. element<br>input : pins 1 and 4<br>pins 3 and 5                                                                 | 2 mV<br>100 mV        | 20 k $\Omega$<br>1 M $\Omega$                    | 5p, 180°, DIN<br> | 1 - left<br>4 - right<br>2 -<br>5 - right<br>3 - left                                                                                               | rear          |
| MONITOR<br>BU5                       | a monitor amplifier                                                                                                                                                                                                                         | 1 V                   | >50 k $\Omega$                                   | 7p, DIN<br>       | 1 -<br>4 -<br>2 -<br>5 - right<br>3 - left<br>6 - MP2<br>7 - MP102                                                                                  | rear          |
| LOUDSP. L<br>LOUDSP. R<br>BU6<br>BU7 | a loudspeaker enclosure either 4 $\Omega$ or 8 $\Omega$                                                                                                                                                                                     | -                     | 4 $\Omega$ /8 $\Omega$<br>4 $\Omega$ /8 $\Omega$ | 2p, DIN<br>       | 1 - 4 $\Omega$ /8 $\Omega$<br>2 -                                                                                                                   | rear          |
| REMOTE<br>BU201                      | the remote control unit N6719 (optional)                                                                                                                                                                                                    | -                     | -                                                | 10p<br>           | 1 - recording<br>2 - stop<br>3 - fast wind left<br>4 - fast wind right<br>5 - pause<br>6 -<br>7 - left/right<br>8 - right<br>9 - -26 V<br>10 - left | rear          |

\*) In case only one mono microphone is connected, and the track selector is in position 1-4 or 3-2 (mono) the sensitivity is 0.2 mV at >2 k $\Omega$ .

\*\*) Measured with series capacity of 2,000 pF.

# REMOVING THE CABINET (see Fig. 1 and 2)

- Remove the five screws A at the rear to take off the rear panel.
  - The black ornamental plate at the front can be removed after loosening the five screws A and removing the switch knob between the two turntables.
  - Also remove the head covers D; these can be slid forwards off the mounting pins.
  - In most cases it is recommendable to take the complete amplifier unit out of the cabinet for repairs to this unit. For this, remove the five screws B and screw C in the middle above the ornamental surround of the switches. The complete unit can now be carefully slid forwards out of the cabinet.
- The amplifier unit is connected to the rest of the circuitry with three wire forms, viz.:
- a. one thick wire form between the switch p.c. board and the amplifier board. This wire form is connected to the amplifier board by means of connectors.
  - b. one three-fold wire form between the heads p.c. board and the amplifier board.
  - c. two wires between the mains switch and the timer.

## Attention

The wires mentioned under c. carry mains voltage. A warning plate is fitted near the place where the wires are plugged onto the connection tags at the rear left of the recorder.

When fitting the amplifier unit, check that the wire forms do not touch the flywheels. The flywheel bracket has been provided with a cable tie for fixing wire form b.

# Replacing the buttons 168 and the switch wipers

- Buttons 168 can be withdrawn from the switch wipers by pulling them forwards.
- Remove the two output amplifier units P8/P108.
- Push the spring slightly back and remove the pawl and spring.
- Remove the pin from the switch wiper; the wiper can now be pulled forwards out of the switch.
- When refitting the wiper, the stop spring should be slightly lifted so that it fits into the labyrinth.

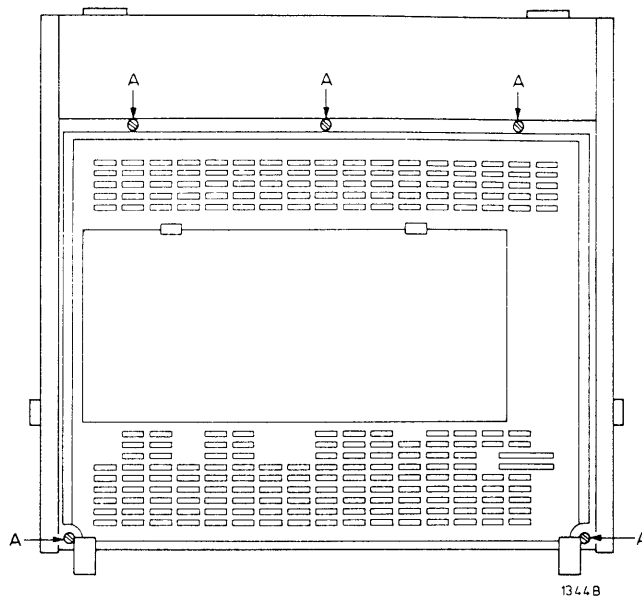


Fig. 1

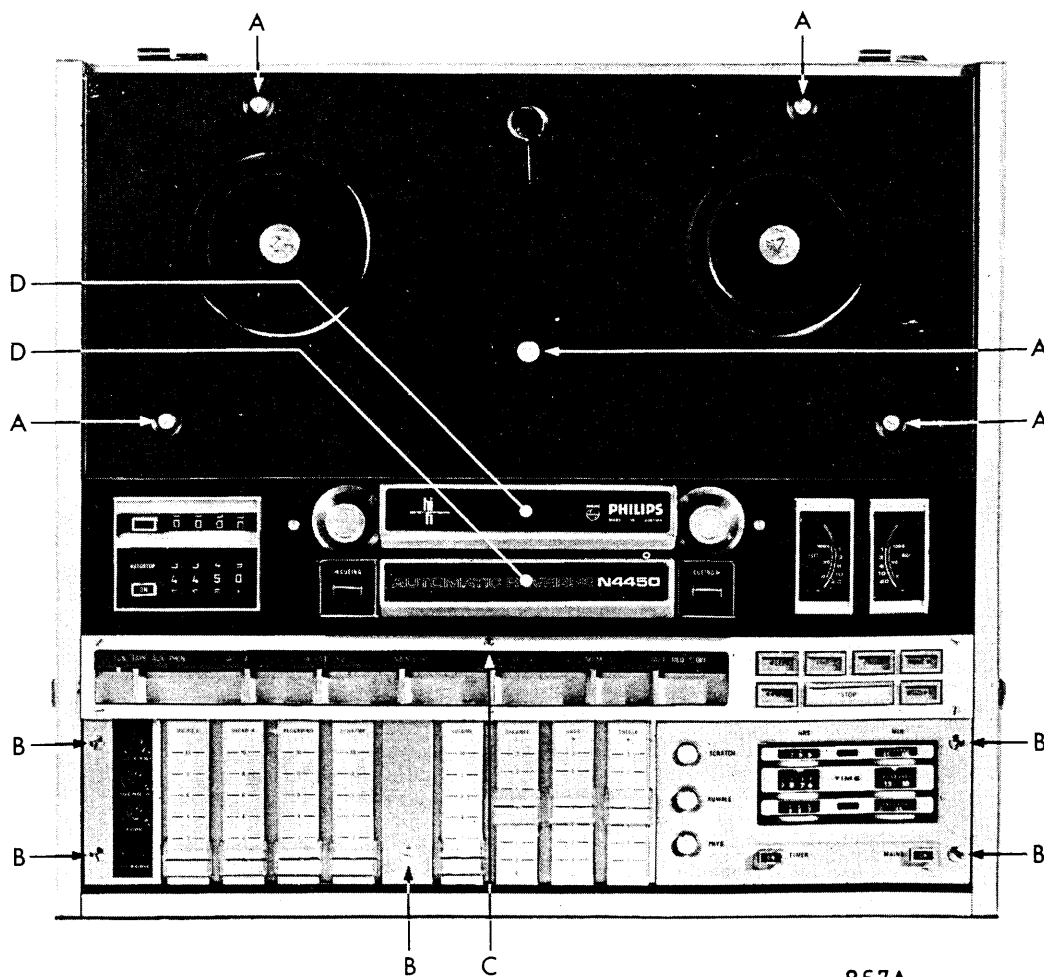


Fig. 2

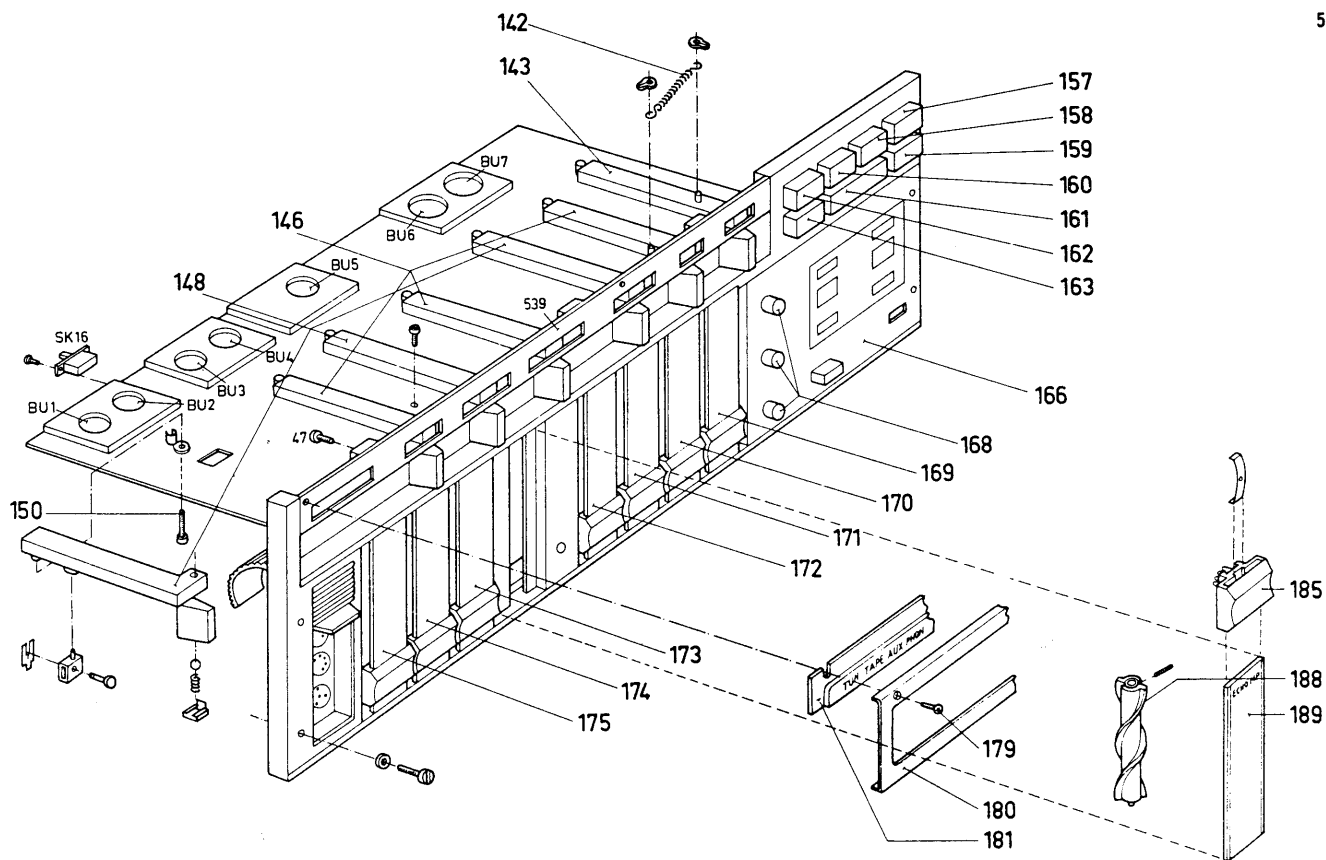


Fig. 3

#### REPAIR HINTS (see Fig. 3)

##### Amplifier unit

To remove this unit, see "Removing the cabinet".

##### Replacing the switch brackets 143/146/148

- Remove the ornamental surround 180 round the switches and buttons (9 Philips head screws), indication strip 181 and bracket 539.
- Remove the 3 screws 47 with which the stop bar of the switch brackets is secured and lift the bracket slightly.
- Loosen the screw on which the switch bracket to be replaced hinges (for "FAST-MED-SLOW" switch also detach spring 142).
- Replace the switch bracket, taking care that the switch wiper engages the relevant opening in the bracket.

##### Replacing the recorder control buttons 157...163

- Remove the ornamental surround 180 round the switches and buttons (9 Philips head screws), indication strip 181 and bracket 539.
- Bend the tags on the edge of ornamental plate 166 round the buttons, aside.
- Pull out the spindle on which the buttons are hinged.
- The button can now be replaced.
- Refit the spindle and bend the tags back.
- Refit the ornamental surround etc.

##### Replacing the slide controls 185 and panels 169...175, 189

- Remove the ornamental surround 180 round the switches and buttons (9 Philips head screws), indication strip 181 and bracket 539.
- Insert a screwdriver at the top between the panel of the slide control and the front panel (see Fig. 4).
- Prize off the glued panel with the screwdriver.
- When refitting, check that the control 185 just fits over wormwheel 188 of the potentiometer.
- To fit the panel, apply some glue.

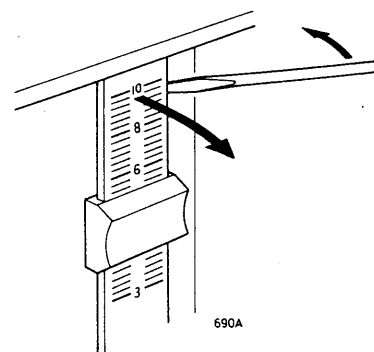


Fig. 4

## ELECTRICAL CHECKS AND ADJUSTMENTS

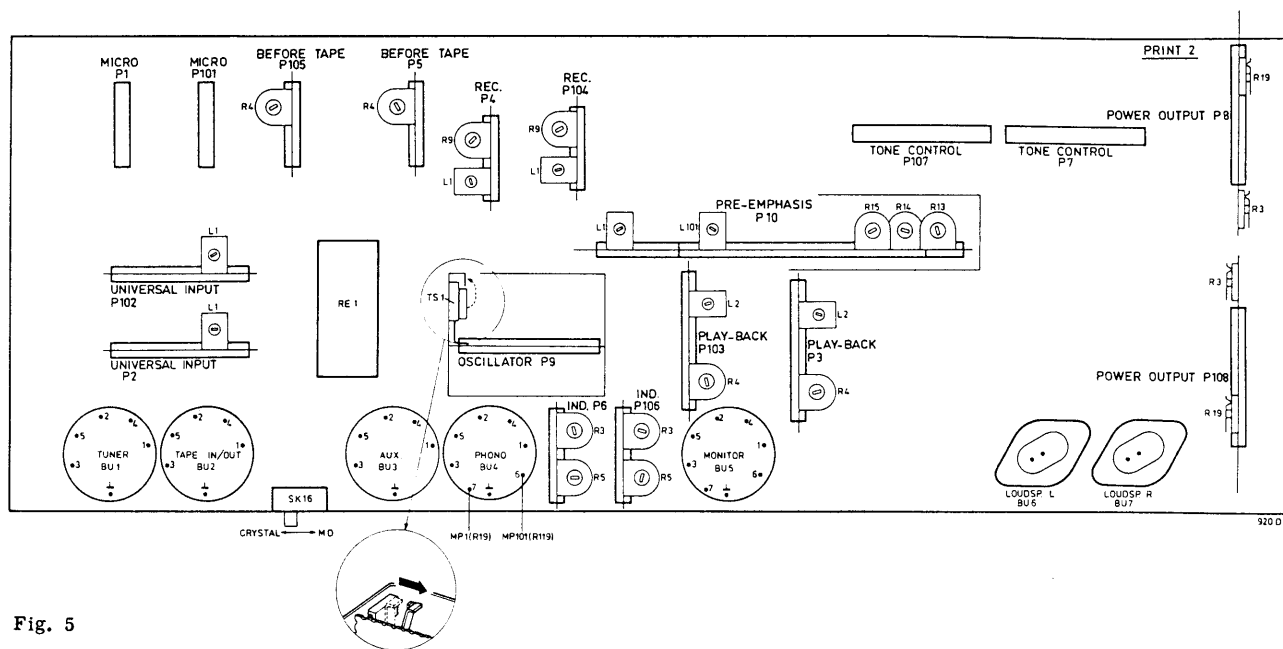


Fig. 5

## Required test equipment

|                              |                                        |
|------------------------------|----------------------------------------|
| Multi-meter 40 k $\Omega$ /V | P 81700 or PM 2411                     |
| RF millivoltmeter            | GM 6012 or PM 2454                     |
| AF signal generator          | GM 2317 or PM 5105                     |
| Reference tape               | 8222 305 1138 (according to DIN 45513) |

## I. FUNCTIONAL UNITS

## P1/P101

## MICRO INPUT UNIT

This unit requires no adjustments.

## P2/P102

## UNIVERSAL INPUT UNIT

Recorder set

to position : recording-"TUN"- "B"- "ST"- "NOR"- "19"  
potentiometer "RECORDING" to maximum;  
other potentiometers to minimum

## Rejection 19 kHz signal

Input : BU1 TUNER 3/5 19 kHz - 1 V  
Output : BU5 MONITOR 3/5 Adjust for min.  
voltage with L1

The unit supplied for service purposes has already been  
adjusted for max. rejection of the 19 kHz signal by the  
manufacturer.

## P3/P103

## PLAYBACK UNIT

Recorder set

to position : playback-"ST"- "9.5"  
Input : BU5 MONITOR 6/7 333 Hz - 330 mV  
(MP2/102)  
Output : BU5 MONITOR 3/5 Adjust for output  
voltage of 1 V with R4

## Check:

Input:  
BU5 MONITOR 6/7

9.5 cm/sec 40 Hz - 100 mV  
10 kHz - 1000 mV  
19 cm/sec 333 Hz - 100 mV  
40 Hz - 100 mV  
10 kHz - 1000 mV

4.75 cm/sec 333 Hz - 100 mV  
40 Hz - 100 mV  
10 kHz - 1000 mV

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Output:  
BU5 MONITOR 3/5

0.6 - 1 V  
0.57 - 0.69 V  
0.27 - 0.33 V  
0.45 - 0.7 V  
0.32 - 0.38 V  
0.28 - 0.34 V  
0.6 - 1 V  
0.9 - 1 V

## Rejection of radiated erase oscillator signal (100 kHz)

Recorder set

to position : recording-"TAPE"- "A"- "ST"- "NOR"- "9.5"  
potentiometer "RECORDING" to maximum;  
other potentiometers to minimum; no tape on  
the set

Output : BU5 MONITOR 3/5 Adjust for minimum  
RF voltage with L2

The unit supplied for service purposes has already been  
adjusted for max. rejection of the erase oscillator signal by  
the manufacturer.

## P4/P104

## RECORDING UNIT

Recorder set

to position : recording-"TAPE"- "B"- "ST"- "9.5"  
Input : BU2 TAPE IN/OUT 3/5 333 Hz - 1 V  
Output : BU5 MONITOR 5 Adjust for 1 V with  
potentiometer  
"RECORDING"  
R721/751  
BU5 MONITOR 3 Value to be measured  
1 V + x V (x = max.  
0.8 V)  
Halve the difference  
with 1 V with R4 on P;  
BU4 PHONO 6 (MP1) Adjust for 1.5 mV  
with R9 on P4 \*)  
BU5 MONITOR 5 Value to be measured  
1 V + y V (y = max.  
0.8 V)  
Halve the difference  
with 1 V with R4 on  
P105  
If thereupon  $\frac{x}{2} \neq \frac{y}{2}$ ,  
halve the difference  
voltage once more in  
respect of 1 V  
BU4 PHONO 7 (MP101) Adjust for 1.5 mV  
with R9 on P104 \*)

\*) To make sure that the bias current is measured as well,  
remove oscillator unit P9 from the apparatus (see Fig. 5).

Rejection 38 kHz signal

Recorder set  
to position : recording-"TUN"- "B"- "ST"- "NOR"- "9.5"  
potentiometer "RECORDING" to maximum;  
other potentiometers to minimum

Input : BU1 TUNER 3/5 38 kHz - 0.1 V  
Output : point 2 of unit P4/104 Adjust for min.  
amplitude of this  
38 kHz signal with  
L1 (< 600 mV)

The unit supplied for service purposes has already been adjusted for max. rejection of the 38 kHz signal by the manufacturer.

## P5/P105

## BEFORE TAPE UNIT

Recorder set  
to position : recording-"TAPE"- "B"- "ST"- "NOR"- "9.5"  
potentiometer "RECORDING" to maximum;  
other potentiometers to minimum.

Input : BU2 TAPE IN/OUT 3/5 333 Hz - 100 mV  
Output : BU5 MONITOR 3/5 Adjust for 1 V with  
R4

For further adjustments, see "RECORDING UNIT" (P4/104).

## P6/P106

## INDICATOR UNIT

Recorder set  
to position : "STOP"

Adjust R3 on P6 so that the left indicator gives a just noticeable deflection with respect to zero.  
The same applies to R3 on P106.

Recorder set  
to position : recording-"TAPE"- "B"- "ST"- "NOR"- "9.5"  
Input : BU2 TAPE IN/OUT 3/5 333 Hz - 1 V  
Output : BU5 MONITOR 3/5 Adjust for 1 V with  
potentiometer  
"RECORDING".

Adjust R5 on P6 so that the pointer of the left-hand indicator indicates 100 % (0 dB).  
The same applies to R5 on P106.

## P7/P107

## TONE CONTROL UNIT

This unit requires no adjustments.

## P8/P108

## POWER OUTPUT UNIT

Recorder set  
to position : "AMP"  
all potentiometers to minimum

No input signal, if desired, short-circuit the input of the amplifier section (points 13 and 14).  
Immediately after switching on, adjust the direct voltage on the output (points 4, 5) to +100 mV with R3.  
Owing to the temperature rise, this value decreases to approx. +30 mV after a few minutes; if desired readjust with R3.

Adjusting the quiescent current

The quiescent current through TS7/TS8 must be adjusted to 50 mA with R19. Check value after 1 min. and if necessary readjust.  
The quiescent current can be checked by measuring the voltage across R28//R30 (approx. 25 mV).  
As the quiescent current through TS5/TS6 is negligible compared with that through TS7/TS8, it is also allowed to measure the current by connecting the measuring instrument instead of the fuse.

## P9

## OSCILLATOR UNIT

The unit requires no adjustments.  
Oscillator frequency : 100 kHz  $\pm$  10 %  
Voltage measured across erase head  
K3/K6 : 36 - 40 V

## P10

## PRE-EMPHASIS/SPEED SELECTOR UNIT

Recorder set  
to position : recording-"TAPE"- "B"- "ST"- "NOR"- "4.75"  
potentiometer "RECORDING" -20 dB (approx. 6);  
other potentiometers to minimum

Input : BU2 TAPE IN/OUT 3/5 10 kHz - 100 mV  
Output : BU4 PHONO 6/7 1.0 mV, to be  
adjusted with  
L1/L101

For adjustment of the tape speed, see under "Mechanical adjustments" Speed adjustment.

Adjusting the bias current

For this adjustment, use a new, non-modulated tape of good quality. Make sure that the magnetic heads are clean.

Recorder set  
to position : recording-"TAPE"- "B"- "ST"- "NOR"- "19"  
Input : BU2 TAPE IN/OUT 3/5 1 kHz - 1 V  
Output : BU5 MONITOR 3/5 Adjust for 1 V with  
potentiometer  
"RECORDING". The  
indicators should  
deflect as far as 100 %.

Remove the core from the coil to be adjusted completely. Now adjust the core until the output voltage does not decrease any more. Secure the cores with wax. To check this adjustment, the distortion and the frequency response of a recording can be measured. The after-tape distortion should be  $\leq$  3 % at 1 kHz (100 % modulation).  
For the correct values of the frequency response see the appropriate measurement.

## P203/P204

## TAPE TENSION UNIT

For adjustment of the motor current, see under "Mechanical adjustments" Adjusting the tape tension.

## P201

## RESET/AUTOMATIC REVERSE UNIT

## P202

## MOTOR STOP UNIT

## P205/P206

## FLIP-FLOP UNIT

## P207

## SPEED CONTROL UNIT

These units require no adjustments.

## II. INPUT SENSITIVITIES

Recorder set  
to position : "AMP"  
potentiometers not mentioned set to minimum

| Input:                                                                      |                  | Output:         |
|-----------------------------------------------------------------------------|------------------|-----------------|
| "TUN"; potentiometer "RECORDING" maximum                                    |                  | BU5 MONITOR 3/5 |
| BU1 TUNER 3/5                                                               | 333 Hz - 100 mV  | 0.75 - 1.25 V   |
| "AUX"                                                                       |                  |                 |
| BU3 AUX 3/5                                                                 | 333 Hz - 100 mV  | 0.75 - 1.25 V   |
| "PHON"- "DYN" (SK16); potentiometer "RECORDING" -20 dB (6)                  |                  |                 |
| BU4 PHONO 3/5                                                               | 40 Hz - 1.2 mV   | 0.56 - 1.32 V   |
|                                                                             | 333 Hz - 12 mV   | 1.5 - 2.5 V     |
|                                                                             | 10 kHz - 12 mV   | 0.14 - 0.34 V   |
| "CRYST" (SK16); potentiometer "RECORDING" maximum; apply signal via 2000 pF |                  |                 |
| BU4 PHONO 3/5                                                               | 40 Hz - 1 V      | 0.32 - 0.76 V   |
|                                                                             | 333 Hz - 1 V     | 0.6 - 1.4 V     |
|                                                                             | 10 kHz - 100 mV  | 0.2 - 0.5 V     |
| Potentiometers "MICRO L" and "MICRO R" maximum                              |                  |                 |
| BU8/BU9 MICRO 1/4                                                           | 333 Hz - 0.15 mV | 0.75 - 1.25 V   |

### III. FREQUENCY RESPONSE

Recorder set

to position : recording-"TAPE"- "A"- "ST"- "NOR"- "19"  
all potentiometers to minimum

Input : BU2 TAPE IN/OUT 3/5 1 kHz - 1 V

Output : BU5 MONITOR 3/5 Adjust for 1 V with potentiometer "RECORDING". The indicators should deflect as far as 100 %

Now decrease the input voltage to 0.1 V (= -20 dB).  
Make a recording of the following frequencies: 40 Hz - 60 Hz - 1 kHz - 8 kHz - 20 kHz. (The input voltage must remain the same.) The play-back frequency response which is now measured relative to 1 kHz, must be in accordance with the curve given in Fig. 6.

It is also possible to measure this curve at a speed of 9.5 cm/sec.

The highest frequency must now be 15 kHz (see Fig. 7).  
In position "TUNER" and "AUX" a rejection filter for the stereo pilot signal is included.

This results in frequencies above 16 kHz being considerably attenuated, as can be seen in Fig. 8.

At the speed 4.75 cm/sec the frequency response in the range 60 ... 8000 Hz is within 6 dB.

For the complete frequency curve see Fig. 9.

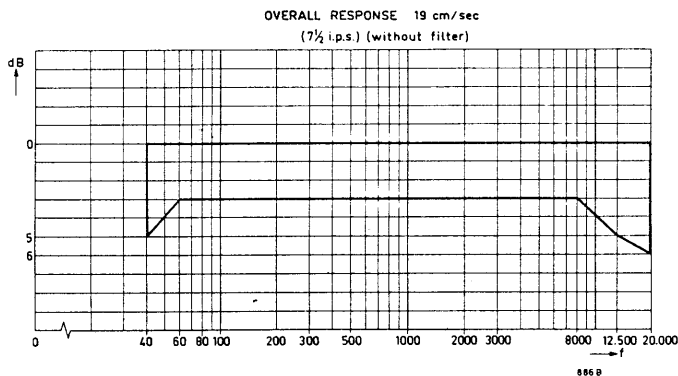


Fig. 6

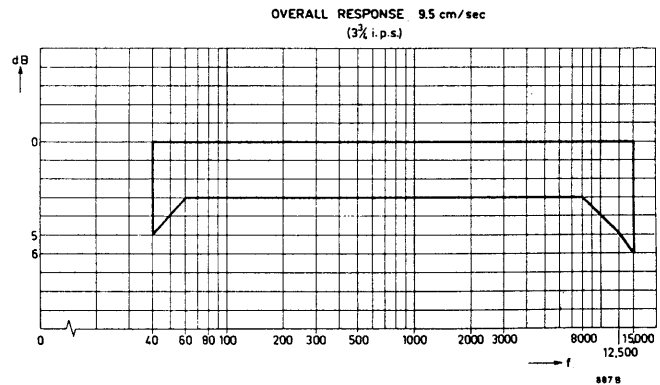


Fig. 7

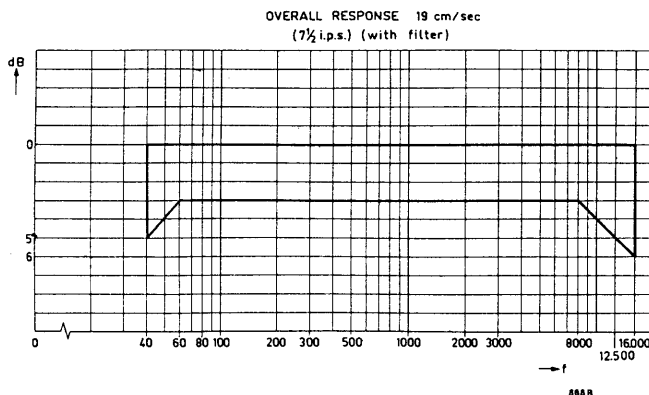


Fig. 8

### IV. CHECKING THE CROSS-TALK

Recorder set

to position : recording-"TAPE"- "B"- "ST"- "NOR"  
potentiometer "RECORDING" to maximum;  
other potentiometers to minimum

Input:

BU2 TAPE IN/OUT 3

10 kHz - 100 mV

BU2 TAPE IN/OUT 5

10 kHz - 100 mV

Output:

BU5 MONITOR 5 < 50 mV

BU5 MONITOR 3 < 50 mV

#### Cross-talk between inputs not used:

Input : BU2 TAPE IN/OUT 3/5 10 kHz - 2 V  
BU3 AUX 3/5 10 kHz - 2 V  
BU4 PHONO 3/5 10 kHz - 50 mV  
(SK16 DYN)  
BU8/BU9 MICRO 1/4 10 kHz - 0.15 mV

Output : BU5 MONITOR 3/5

The voltage on points 3/5 of the monitor socket caused by cross-talk of the signal to the non-used sockets must not exceed 30 mV.

#### Cross-talk in position "1-4" - "3-2"

##### Tracks 1-4

Input : BU5 MONITOR 6 15 kHz - 1 V  
Output : Point 2 P104 < 20 mV

##### Tracks 3-2

Input : BU5 MONITOR 7 15 kHz - 1 V  
Output : Point 2 P4 < 20 mV

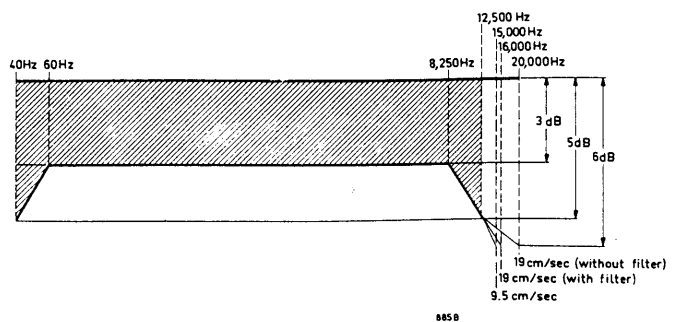


Fig. 9

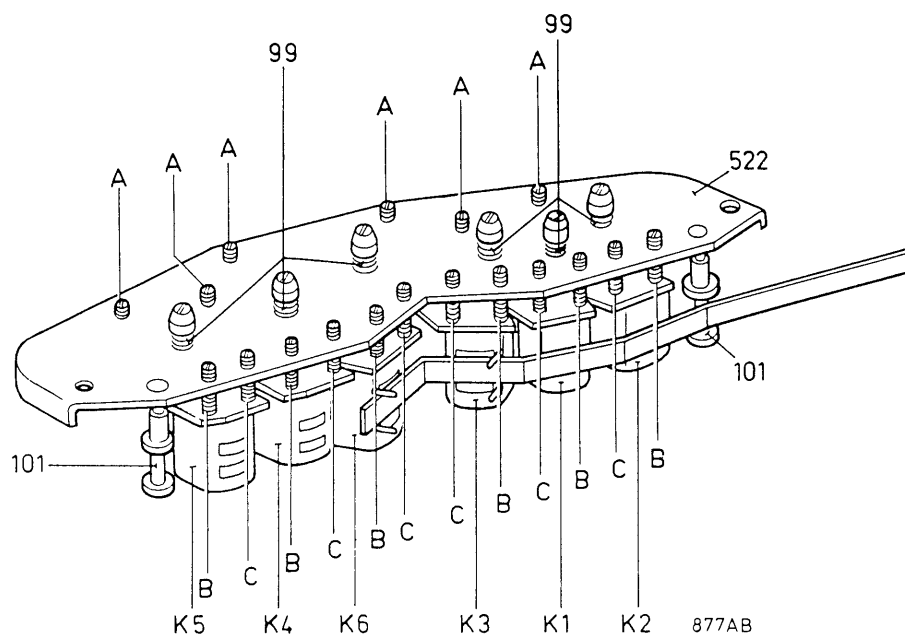


Fig. 10

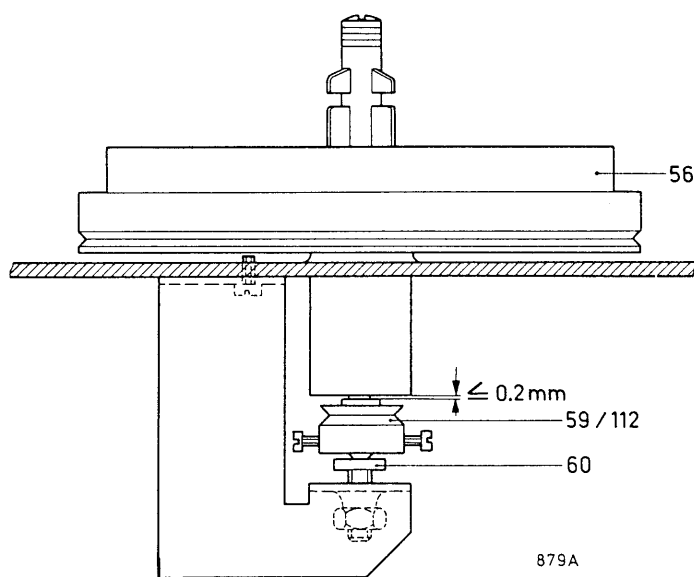


Fig. 11

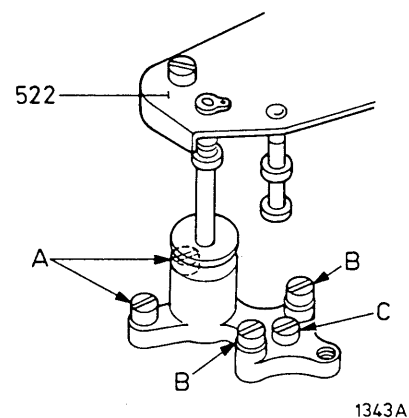


Fig. 12

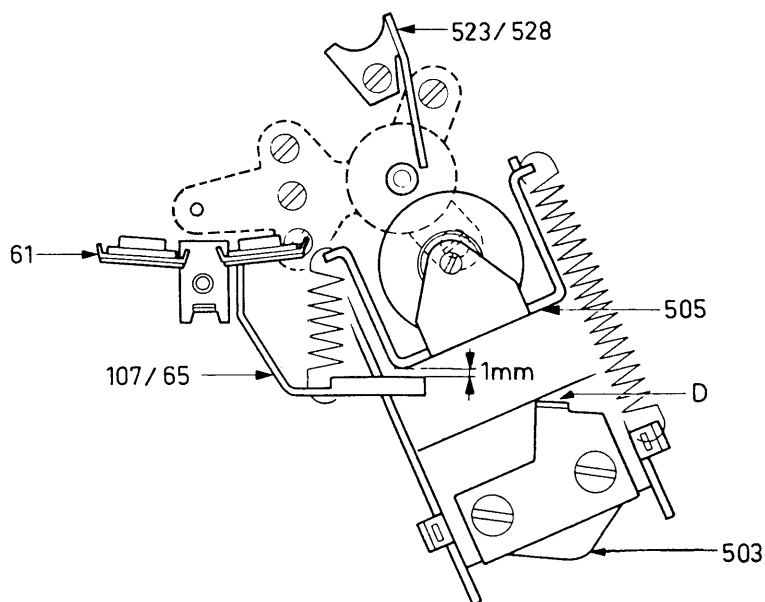


Fig. 13

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### 3. Solenoids

Remove head covers 120 and 121, button 137 and cover plate 134.

#### Pressure-roller solenoids (see Fig. 14)

- When the solenoid is energised, the force at the top of the pressure-roller bearing-bracket 505 must be approx. 1300 grammes. This force must occur at the moment that a perceptible clearance arises between the lower bolts on drawrod 73 and bushing 71 in the solenoid armature. The force can be adjusted with the upper bolts 15 on the drawrod.
- When the solenoid is energised, the clearance between bushing 71 and the lower bolts on the drawrod must be just perceptible (0.1 to 0.2 mm).
- End stops 531 must be adjusted so that the clearance between the bottom of the pressure-rollers and a tape which is tensioned around the guide rollers is approx. 1 mm when the solenoids are de-energised (see Fig. 15).
- The clearance between the control bracket for the head switching 74 and 75, and the ring 72 on the drawrod should be approx. 0.2 mm when the solenoid is energised.

#### Centre-pin solenoid

The first three procedures for adjusting the pressure-roller solenoid also apply to the centre-pin solenoid. The force at the top of the bracket 518 should be approx. 300 grammes.

#### Brake solenoid and brakes (see Fig. 17)

- When both brake shoes are applied, the two brake brackets 82 and 90 must be in parallel. Adjust by bending the brackets. Check that the brackets do not touch each other after they have been bent.
- When the two brake shoes are positioned against the turntables, cams A and B should be bent so that they are positioned in the middle of the recesses.
- When the solenoid is energised, the clearance between the brake shoes and the turntables must be 0.5 to 1 mm. This can be adjusted by means of the upper nut 15 on drawrod 86.
- When the solenoid is de-energised and the brake shoes have been reversed, end stop 531 must be positioned so that the clearance at the top of drawrod 86 in the recesses of the brake bracket is approx. 0.5 mm.
- Check the braking force of the left-hand and right-hand reel disc as stated in Fig. 16; this force must be about 1000 grammes (force  $\times$  radius of wound tape). Adjustment is possible by shortening or stretching the springs 80 in Fig. 17.

### 4. "Cueing" switches (see Fig. 18)

Remove head covers 120 and 121, button 137 and cover plate 134.

- Bend connecting rod 512 so that the clearance between the plastic brackets 511 and 513 and the solenoid armatures is the same.
- Adjust the clearance between the plastic brackets and the solenoid armatures to 1-2 mm with the aid of end stop 515.
- Bend the end stop for the cueing switch (D in Fig. 13) so that the clearance between the pressure-roller and capstan is approx. 2 mm when the cueing button is depressed.
- Move mounting bracket 524 of cueing switches SK703 and SK704 so that both pins touch the top of the plastic bracket 513 when the cueing buttons are depressed.
- Bend bracket 524 so that switches SK703 and SK704 are operated when the cueing buttons are depressed.

### 5. Adjusting the tape tension (see Fig. 19)

Remove head covers 120 and 121, button 137, cover plate 134 and rear panel 115.

- The clearance between the contact points of SK706 and SK707 must be approx. 0.5 mm.
- The clearance between the cam of the tape tension comparator and the centre contact of the switch must be 0.1 to 0.2 mm in the rest position. Adjust by bending bracket 516.
- The force on the pin of the tape tension comparator must be approx. 20 grammes when the contacts just open. Adjust by hooking the tension spring into another hole (higher: force increases; lower: force decreases).
- Adjust the motor current of the left as well as the right winding motor to 150 mA (= 75 mV across resistors R708//R709 and R706//R707 on the mounting strips on either side of the winding motors). For this, connect the meter to the resistors, depress button "◁LEFT" or "RIGHT▷" and block the relevant reel disc by hand.

When the meter indication is stable, the motor current may be corrected, if necessary, with potentiometer R9 on the tape tension units (lower unit for left winding motor; upper unit for right winding motor).

- Adjust the belt dampers so that they just touch the belts.

### 6. Capstan motor

Remove rear panel 115 and remove the bracket with capstan motor 533.

- Adjust the height of pulley 111 so that the core of head K7 and the magnet ring on the pulley are flush.
- The clearance between the magnet ring and head must be approx. 0.1 mm. This can be adjusted by loosening the fixing screws of the head and moving the head.

### 7. Capstans (see Fig. 20)

Remove head covers 120 and 121 and rear panel 115.

- Adjust lower pivot bearing 60 so that drive belt 93 runs in parallel with the mounting plate. When the recorder is in the vertical position, the flywheels must be clear of the bearing bushes.
- The upper pivot bearings 105 must spring against the capstans. When the recorder is in the vertical position, there must be no play between the bearing and capstan.
- The play between the bearing bush and the oil seal must be approx. 1 mm.

### 8. Speed adjustment (see Fig. 21)

- Remove the amplifier unit from the recorder.
- Insert a test tape with a frequency of 3150 Hz, recorded at 4.75, 9.5 or 19 cm/sec, depending on the speed to be adjusted.
- Connect the wow and flutter meter to BU2 TAPE IN/OUT 3/5.
- Adjust the speed with one of the preset potentiometers on unit P10. The potentiometers can be adjusted with an alignment tool through one of the openings in the heatsink of the output amplifier.

#### Attention

- The speed can also be adjusted with the aid of a stroboscope.
- Place the stroboscope next to the recorder and feed the tape around the roller.
- Set the speed selector to 9.5 cm/sec.
- Adjust the correct speed with potentiometer R14.

After adjusting the speed, wow and flutter must be

- $\leq 0.35\%$  at 4.75 cm/sec
- $\leq 0.2\%$  at 9.5 cm/sec
- $\leq 0.15\%$  at 19 cm/sec

## MAINTENANCE

It is recommended to clean and lubricate the recorder at regular intervals. The following parts may be cleaned with e.g. alcohol:

- tape guides
- erase, recording and playback heads
- drive belts
- capstans
- pressure rollers
- grooves in pulleys, flywheels and reel discs
- brake shoes.

The pressure felts for the heads may be cleaned with a brush.

## LUBRICATING INSTRUCTIONS

### Shell Clavus 17 - 4822 390 10048

Bearings of flywheels 95, turntables 56, guide rollers 51 and pressure rollers 63.

The part of the capstan which protrudes above the seal must be thoroughly cleaned after lubrication.

### Shell Alvania 2 - 4822 389 10001

The various pivots such as those of the pressure felt bracket 65/107, centre pin 78, pressure-roller bracket 506, brake brackets 82/90 etc., the pivot bearings of the reel discs and flywheels 60, the various contact faces such as those between drawrod 83/73 and pressure-roller brackets 506.

## MECHANICAL ADJUSTMENTS

### Required tools and test equipment:

- set of feeler gauges 0.1 ... 2 mm
- spring-pressure gauge, 30 g
- spring-pressure gauge, 1500 g
- head alignment jig, code number 4822 403 50686
- test tape 13 kHz - 1 kHz, code number 4822 397 30014
- test tape
  - 3150 Hz, 4.75 cm/sec., code number 8222 305 11170
  - 3150 Hz, 9.5 cm/sec., code number 8222 305 11190
  - 3150 Hz, 19 cm/sec., code number 8222 305 11150
- stroboscope, 50 Hz, 4822 395 90001
- 60 Hz, 4822 395 90002
- "wow and flutter" meter, e.g. Bruno Woelke, type ME104

### 1. Adjusting the recording, playback and erase head

Remove head covers 120 and 121.

#### Coarse adjustment (see Fig. 10)

- Remove head assembly 522.
- With the aid of the gauge and screws A, B and C adjust the heads so that:
  - the top of the upper cores of the right-hand recording and playback heads (K1 and K2) are flush with the top of the gauge.
  - the underside of the lower cores of the left-hand recording and playback heads (K4 and K5) is flush with the underside of the gauge.
  - the gauge can move freely between the guide pins of the erase heads (K3 and K6) and tape guides 101.
  - the front of the heads is perpendicular to the mounting plate.

#### Fine adjustment (with test tape 13 kHz - 1 kHz)

- Set the speed selector to position "19" and the track selector to position "1-4".
- Adjust the height of the right-hand playback head (K2) by turning screw B until the 1 kHz signal is just audible above the noise.
- Set the speed selector to position "9.5".
- Adjust the azimuth of the right-hand playback head (K2) by turning screw C until the reproduction of the 13 kHz signal is optimum. If desired, this adjustment can be checked with an oscilloscope connected to BU5 MONITOR 3/5.
- The left playback head (K5) is adjusted in the same way. Do not forget to reverse the test tape and to set the recorder to tape transport to the left!

#### Phase adjustment

First of all, the playback head should be adjusted so that the upper and lower core gaps are in line. Subsequently, the adjustment of the recording head should be adapted to this.

#### Adjusting the playback head (with test tape 13 kHz - 1 kHz)

- Set the speed selector to "9.5" and the track selector to position "ST"; tape transport to the right.
- Connect a double beam oscilloscope to BU5 MONITOR (e.g. output left channel (3) to Ya input and output right channel (5) to the Yb input).
- Adjust the right-hand playback head (K2) by turning screw C until both signals are in phase and have max. amplitude.
- Adjust the left playback head (K5) in the same way. Do not forget to reverse the test tape and to change the tape transport direction to the left!

#### Attention

It may occur that the amplitude of the two signals is not the same. This is caused by dirt on the heads or head wear, poor solder joints etc.

#### Adjusting the recording head

- Insert a normal tape (preferably a high-output tape) and apply a signal of e.g. 10 kHz to the inputs of both channels (e.g. to socket BU2 TAPE IN/OUT 3/5).
- Set the recorder to position recording, the speed selector to "19" and the track selector to "A".
- Connect a double beam oscilloscope to BU5 MONITOR (e.g. output left channel (3) to Y<sub>A</sub> input and output right channel (5) to the Y<sub>B</sub> input).
- Adjust the right-hand recording head (K1) by turning screw C until both signals are in phase.
- Adjust the left recording head (K4) in the same way. The tape should now run to the left.

#### Attention

- Coarse adjustment of the heads is also possible with a normal tape. However, this should be done only if both tape guides 101 are perpendicular.
- To replace one head, unscrew it from the base plate; this will not affect the adjustment.
- During all adjustments check that springs 99 are not fully compressed.
- After the complete adjustment procedure, set screws A, B and C should be lock-painted.
- Erase heads K3 and K6 are supplied in one version only. By fitting the fixing nut either in the upper or lower recess at the back of the erase head, it can be rendered suitable for mounting to the left or right of the centre pin.

### 2. Tape path

Remove head covers 120 and 121, button 137, cover plate 134 and rear panel 115.

#### Pulley of winding motors

- The height of the pulley 55 on the shaft must be adjusted so that the groove is at the same height as the groove of the reel disc.

#### Reel discs (see Fig. 11)

- The height of the reel disc must be adjusted so that the tape runs in the middle of the reel. Adjust with pivot bearing 60.
- The axial play must be adjusted to  $\leq 0.2$  mm by moving pulley 59 and ring 112 respectively.

#### Guide rollers

- The axial play of the guide rollers 51 must be adjusted to  $\leq 0.2$  mm with the aid of the circlip.

#### Attention

The height of the guide rollers have been factory-adjusted with the aid of shims. When replacing the roller, the height must be checked with the aid of the head alignment jig.

#### Capstan bearings (see Fig. 12)

- Block the relay of the centre pin, so that this relay cannot be energised.
- Remove the head assy 522.
- Thread a normal tape.
- Loosen the screws A, B and C half a turn.
- Adjust screws B so that the tape runs straight between the capstan and pressure-roller.
- Tighten screw C, so that the adjustment is not disturbed.
- Tighten the screws A and B.

#### Pressure-rollers (see Fig. 13)

- Position the bearing bracket of pressure-roller 503 so that the roller presses flatly against the capstan without any clearance at the top or bottom.

#### Centre pin

- Bend the stop cam on bracket 527 so that the centre pin is perpendicular to the mounting plate when the relay is energised.

#### Spacer brackets (see Fig. 13)

- Bend brackets 523 or 528 so that the clearance to the capstan is approx. 1 mm.

#### Pressure felts (see Fig. 13)

- The pressure felts must seat accurately against the heads.
- The clearance between the bearing bracket of pressure roller 505 and the cam of pressure-felt bracket 107 or 65 must be approx. 1 mm when the relay is energised.

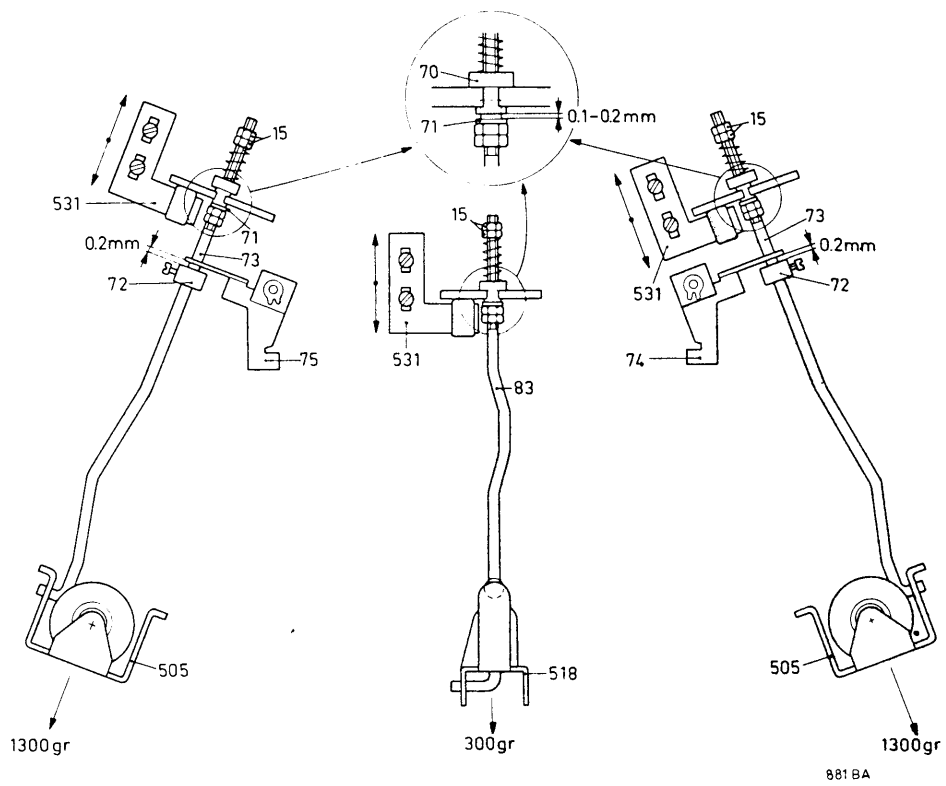


Fig. 14

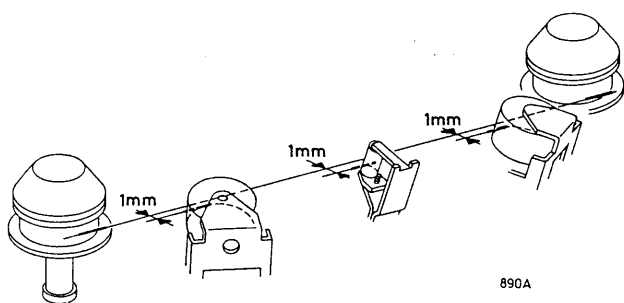


Fig. 15

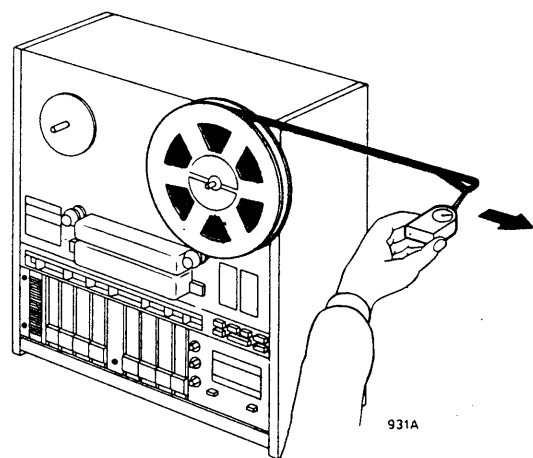


Fig. 16

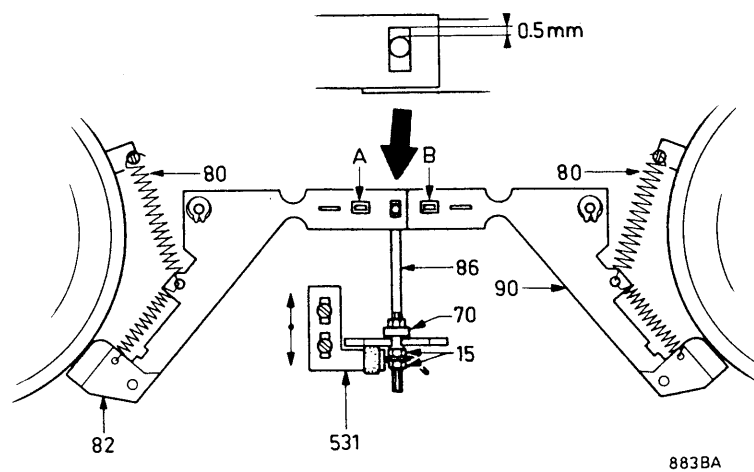


Fig. 17

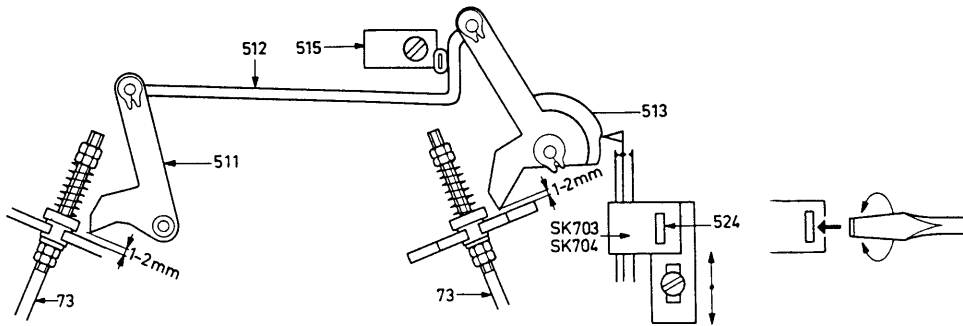


Fig. 18

882B

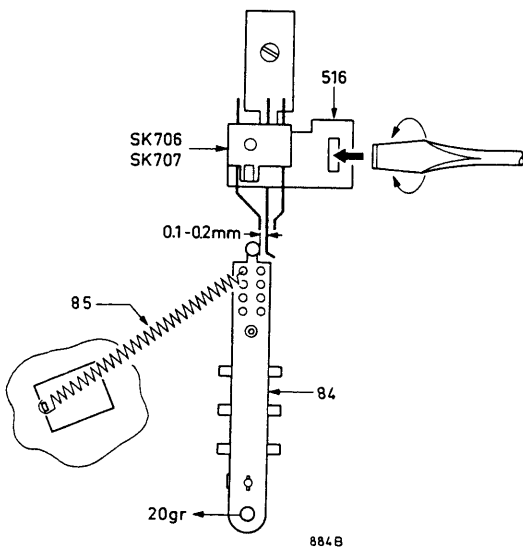


Fig. 19

884B

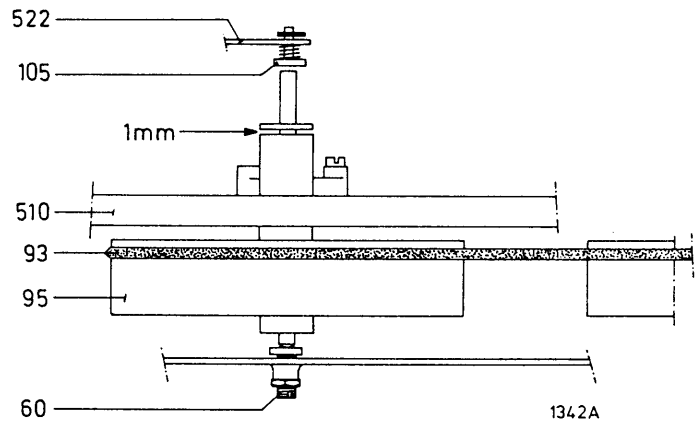


Fig. 20

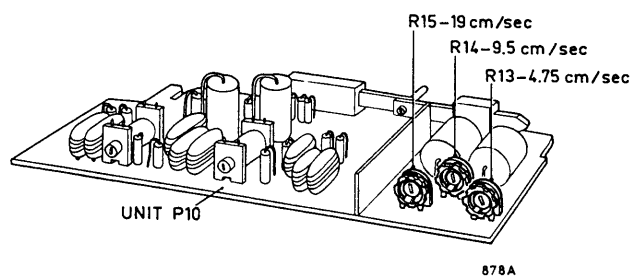


Fig. 21

878A

## LIST OF MECHANICAL PARTS

## I. Tape transport

|    |                          |                |     |                      |                |
|----|--------------------------|----------------|-----|----------------------|----------------|
| 1  | Screw M2x5               | 4822 502 10679 | 94  | Belt damper          | 4822 479 30051 |
| 2  | Screw M3x4               | 4822 502 11189 | 95  | Flywheel             | 4822 528 60069 |
| 3  | Washer                   | 4822 532 50725 | 96  | Grub screw M3x10     | 4822 535 80528 |
| 4  | Screw M3x8               | 4822 502 11053 | 97  | Screw                | 4822 502 11217 |
| 5  | Nut M5                   | 4822 505 10327 | 98  | Nut                  | 4822 505 10408 |
| 6  | Screw M4x6               | 4822 502 11065 | 99  | Compression spring   | 4822 492 50924 |
| 7  | Retaining ring 3 dia.    | 4822 530 70115 | 100 | Washer               | 4822 532 10657 |
| 8  | Washer 7 x 3.2 x 0.3     | 4822 532 50298 | 101 | Bush                 | 4822 532 20433 |
| 9  | Washer 4.3 Ø             | 4822 532 10333 | 102 | Washer               | 4822 528 70246 |
| 10 | Washer                   | 4822 532 50268 | 103 | Hexagon nut M1.6     | 4822 505 10514 |
| 11 | Screw M3x6               | 4822 502 11064 | 104 | Bearing              | 4822 535 70468 |
| 12 | Screw M4x12              | 4822 502 10694 | 105 | Compression spring   | 4822 492 50925 |
| 13 | Screw M3x10              | 4822 502 10689 | 106 | Screw                | 4822 502 11216 |
| 14 | Washer 3 dia.            | 4822 530 80082 | 107 | Splicing device      | 4822 403 50639 |
| 15 | Nut M3                   | 4822 505 10325 | 108 | Pressure felt assy   | 4822 403 50614 |
| 16 | Screw M2.5x4             | 4822 502 10812 | 109 | Bearing bracket assy | 4822 403 50612 |
| 18 | Selftap screw 4.2 x 25   | 4822 502 30101 | 110 | Grommet              | 4822 325 60029 |
| 19 | Lock washer              | 4822 530 80083 | 111 | Pulley               | 4822 528 80476 |
| 20 | Screw M4x10              | 4822 502 11066 | 112 | Ring                 | 4822 532 30253 |
| 22 | Screw M2, 5x10           | 4822 502 10814 |     |                      |                |
| 23 | Screw M2x3               | 4822 502 10908 |     |                      |                |
| 24 | Washer 4 dia.            | 4822 530 70116 |     |                      |                |
| 25 | Washer 3.2 dia.          | 4822 532 10332 |     |                      |                |
| 27 | Curved washer            | 4822 530 80069 |     |                      |                |
| 28 | Screw M3x15              | 4822 502 10691 |     |                      |                |
| 30 | Screw M2x4               | 4822 502 11059 |     |                      |                |
| 31 | Washer                   | 4822 492 61711 |     |                      |                |
| 32 | Screw M3x20              | 4822 502 11004 |     |                      |                |
| 33 | Distant bush 3.1x16      | 4822 532 20607 |     |                      |                |
| 34 | Screw M2x6               | 4822 502 10745 |     |                      |                |
| 36 | Screw M2.5x6             | 4822 502 10813 |     |                      |                |
| 37 | Washer                   | 4822 532 50928 |     |                      |                |
| 38 | Spring washer            | 4822 530 80144 |     |                      |                |
| 51 | Guide roller             | 4822 528 70232 |     |                      |                |
| 52 | Screw of reel disc       | 4822 502 11218 |     |                      |                |
| 53 | Catch piece of reel disc | 4822 532 20578 |     |                      |                |
| 54 | Compression spring       | 4822 492 50923 |     |                      |                |
| 55 | Pulley                   | 4822 528 80477 |     |                      |                |
| 56 | Reel disc assy           | 4822 528 10251 |     |                      |                |
| 57 | Drive belt               | 4822 358 30127 |     |                      |                |
| 58 | Belt damper              | 4822 479 30049 |     |                      |                |
| 59 | Pulley                   | 4822 528 80478 |     |                      |                |
| 60 | Hexagon nut              | 4822 502 10765 |     |                      |                |
| 61 | Pressure felt assy       | 4822 403 50638 |     |                      |                |
| 62 | Set screw                | 4822 502 10522 |     |                      |                |
| 63 | Pressure roller          | 4822 528 70018 |     |                      |                |
| 64 | Tension spring           | 4822 492 30934 |     |                      |                |
| 65 | Pressure felt assy       | 4822 403 50615 |     |                      |                |
| 66 | Bearing bracket assy     | 4822 403 50613 |     |                      |                |
| 67 | Tension spring           | 4822 492 30681 |     |                      |                |
| 68 | Tension spring           | 4822 492 30933 |     |                      |                |
| 69 | Compression spring       | 4822 492 50923 |     |                      |                |
| 70 | Bush                     | 4822 532 30256 |     |                      |                |
| 71 | Tubular rivet            | 4822 532 20618 |     |                      |                |
| 72 | Washer                   | 4822 532 30255 |     |                      |                |
| 73 | Rod                      | 4822 535 80491 |     |                      |                |
| 74 | Bracket                  | 4822 403 50627 |     |                      |                |
| 75 | Bracket                  | 4822 403 50628 |     |                      |                |
| 76 | Centre pin               | 4822 535 80529 |     |                      |                |
| 77 | Counter switch unit assy | 4822 349 50058 |     |                      |                |
| 78 | Bracket                  | 4822 403 40042 |     |                      |                |
| 79 | Driving belt             | 4822 358 30045 |     |                      |                |
| 81 | Tension spring           | 4822 492 30935 |     |                      |                |
| 82 | Brake bracket left       | 4822 403 10119 |     |                      |                |
| 83 | Rod                      | 4822 535 80492 |     |                      |                |
| 84 | Tape tension comparator  | 4822 403 50629 |     |                      |                |
| 85 | Tension spring           | 4822 492 30936 |     |                      |                |
| 86 | Rod                      | 4822 535 80493 |     |                      |                |
| 87 | Washer                   | 4822 532 50716 |     |                      |                |
| 88 | Capstan bearing          | 4822 520 10311 |     |                      |                |
| 89 | Compression spring       | 4822 492 50152 |     |                      |                |
| 90 | Brake bracket right      | 4822 403 10121 |     |                      |                |
| 91 | Tension spring           | 4822 492 30678 |     |                      |                |
| 92 | Bearing bracket assy     | 4822 403 50611 |     |                      |                |
| 93 | Drive belt               | 4822 358 30163 |     |                      |                |

## II. Cabinet and amplifier unit

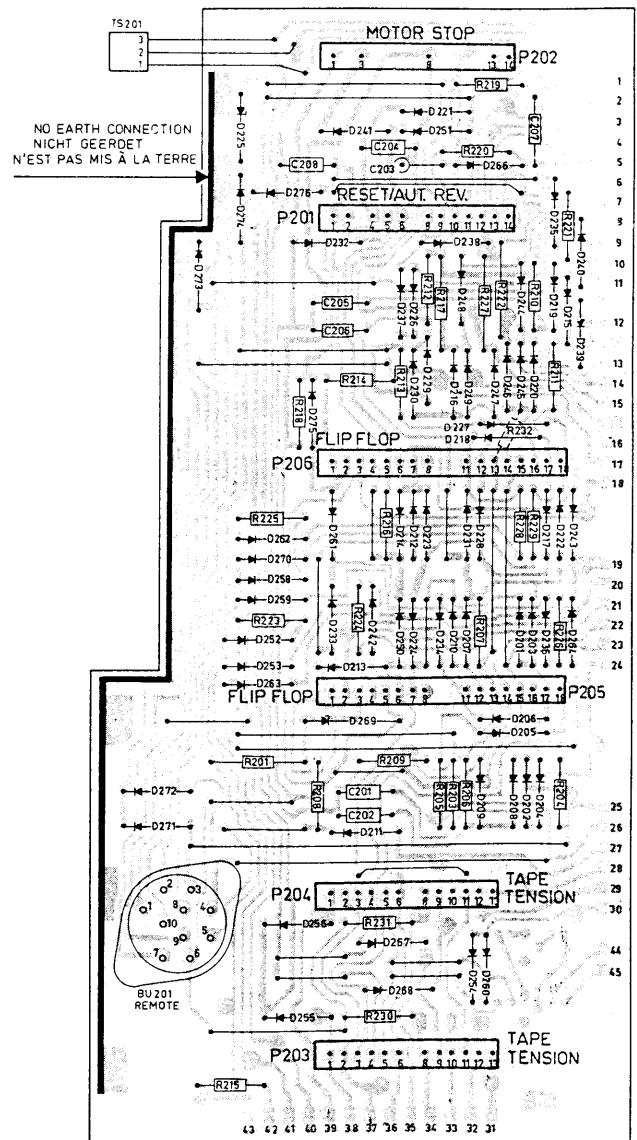
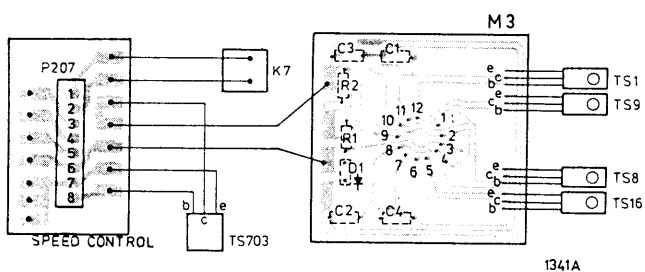
|     |                              |                |     |                               |                |
|-----|------------------------------|----------------|-----|-------------------------------|----------------|
| 7   | Retaining ring 3 dia.        | 4822 530 70115 | 173 | Ornamental plate (PHONO)      | 4822 454 20204 |
| 9   | Washer 4.3 dia.              | 4822 532 10333 | 174 | Ornamental plate (MICRO       |                |
| 16  | Screw M2.5x4                 | 4822 502 10812 |     | RIGHT)                        | 4822 454 20203 |
| 39  | Screw                        | 4822 502 10053 | 175 | Ornamental plate (MICRO LEFT) | 4822 454 20202 |
| 40  | Selftap screw                | 4822 502 30048 | 176 | Cover                         | 4822 443 60369 |
| 41  | Wood screw 2.2x15            | 4822 528 70246 | 177 | Socket plate assy             | 4822 267 20131 |
| 42  | Nut M4                       | 4822 505 10262 | 178 | Screw                         | 4822 502 10856 |
| 43  | Screw M4x22                  | 4822 502 11161 | 179 | Screw M3x8                    | 4822 502 11074 |
| 44  | Selftap screw                | 4822 502 30091 | 180 | Cover                         | 4822 460 20067 |
| 46  | Screw M1.7x4                 | 4822 502 10948 | 181 | Plate                         | 4822 454 20212 |
| 47  | Screw M4x8                   | 4822 502 10693 | 182 | Isolator                      | 4822 325 10057 |
| 48  | Selftap screw                | 4822 502 30081 | 183 | Spring                        | 4822 492 61712 |
| 49  | Washer                       | 4822 532 10479 | 184 | Leaf spring                   | 4822 492 61709 |
| 113 | Lid                          | 4822 443 60368 | 185 | Slider                        | 4822 278 30091 |
| 114 | Bolt                         | 4822 500 10181 | 187 | Screw M3x4                    | 4822 502 10663 |
| 115 | Rear panel                   | 4822 443 50193 | 188 | Worm                          | 4822 522 31099 |
| 116 | Foot                         | 4822 462 40017 | 189 | Ornamental plate (ECHO)       | 4822 454 20205 |
| 117 | Tubular rivet                | 4822 535 90914 |     |                               |                |
| 118 | Support                      | 4822 532 20063 |     |                               |                |
| 119 | Handle assy                  | 4822 498 40314 |     |                               |                |
| 120 | Head cover                   | 4822 443 60366 |     |                               |                |
| 121 | Head cover                   | 4822 443 60367 |     |                               |                |
| 122 | Button assy                  | 4822 410 30061 |     |                               |                |
| 123 | Button assy                  | 4822 276 10447 |     |                               |                |
| 124 | Plate                        | 4822 459 80053 |     |                               |                |
| 125 | Plate (foot)                 | 4822 443 60365 |     |                               |                |
| 126 | Catch piece                  | 4822 403 50683 |     |                               |                |
| 127 | Strip                        | 4822 403 50624 |     |                               |                |
| 129 | Slider                       | 4822 403 50625 |     |                               |                |
| 130 | Ornamental cap               | 4822 462 50178 |     |                               |                |
| 131 | Hinge                        | 4822 417 10295 |     |                               |                |
| 132 | Spring                       | 4822 492 40502 |     |                               |                |
| 133 | Housing assy                 | 4822 443 40069 |     |                               |                |
| 134 | Cover plate assy             | 4822 443 30214 |     |                               |                |
| 135 | Washer                       | 4822 532 50924 |     |                               |                |
| 136 | Cover                        | 4822 443 20071 |     |                               |                |
| 137 | Knob                         | 4822 411 50268 |     |                               |                |
| 138 | Ornamental screw             | 4822 502 11215 |     |                               |                |
| 139 | Meter right                  | 4822 347 10071 |     |                               |                |
| 141 | Meter left                   | 4822 347 10069 |     |                               |                |
| 142 | Tension spring               | 4822 492 30937 |     |                               |                |
| 143 | Bracket                      | 4822 403 50626 |     |                               |                |
| 144 | Button                       | 4822 410 21244 |     |                               |                |
| 145 | Cover                        | 4822 459 40261 |     |                               |                |
| 146 | Bracket assy (light channel) | 4822 403 50616 |     |                               |                |
| 147 | Cover                        | 4822 459 80038 |     |                               |                |
| 148 | Bracket assy (light channel) | 4822 403 50617 |     |                               |                |
| 149 | Cover                        | 4822 459 80037 |     |                               |                |
| 150 | Full dog point screw         | 4822 502 11259 |     |                               |                |
| 151 | Ball 5/32"                   | 4822 520 40024 |     |                               |                |
| 152 | Leaf spring                  | 4822 492 61812 |     |                               |                |
| 153 | Catch                        | 4822 535 70419 |     |                               |                |
| 154 | Bolt                         | 4822 535 90912 |     |                               |                |
| 155 | Compression spring           | 4822 492 50927 |     |                               |                |
| 156 | Bracket                      | 4822 403 50682 |     |                               |                |
| 157 | "RIGHT▷" button assy         | 4822 410 21174 |     |                               |                |
| 158 | "PAUSE" button assy          | 4822 410 21173 |     |                               |                |
| 159 | "WIND▷▷" button assy         | 4822 410 21176 |     |                               |                |
| 160 | "REC" button assy            | 4822 410 21172 |     |                               |                |
| 161 | "STOP" button assy           | 4822 410 21169 |     |                               |                |
| 162 | "◁LEFT" button assy          | 4822 410 21171 |     |                               |                |
| 163 | "◁◁WIND" button assy         | 4822 410 21175 |     |                               |                |
| 164 | Cover (clock)                | 4822 459 80037 |     |                               |                |
| 165 | Clock assy                   | 4822 282 10096 |     |                               |                |
| 166 | Ornamental plate             | 4822 454 20211 |     |                               |                |
| 168 | Button                       | 4822 410 21243 |     |                               |                |
| 169 | Ornamental plate (TREBLE)    | 4822 454 20208 |     |                               |                |
| 170 | Ornamental plate (BASS)      | 4822 454 20209 |     |                               |                |
| 171 | Ornamental plate (BALANCE)   | 4822 454 20207 |     |                               |                |
| 172 | Ornamental plate (VOLUME)    | 4822 454 20206 |     |                               |                |

## LIST OF ELECTRICAL PARTS

## I. Control part

|                   |                                  |                |
|-------------------|----------------------------------|----------------|
| P201              | Reset/automatic reverse unit     | 4822 218 30063 |
| P202              | Motor stop unit                  | 4822 218 30069 |
| P203, 204         | Tape tension unit                | 4822 218 30067 |
| P205, 206         | Flip-flop unit                   | 4822 218 30068 |
| P207              | Speed control unit               | 4822 218 30062 |
| P10               | Speed selector/pre-emphasis unit | 4822 218 30064 |
| SK6               | Slide switch (MP-NOR-ECH-AMP)    | 4822 277 30497 |
| SK8               | Slide switch (NOR-REV)           | 4822 277 30498 |
| SK9               | Slide switch (FAST-MED-SLOW)     | 4822 277 30499 |
| SK30              | Slide switch (head switch)       | 4822 277 60118 |
| SK701             | Push button switch (AUTOSTOP)    | 4822 276 10448 |
|                   | Button for SK701                 | 4822 276 10447 |
| SK705             | Switch (reel-size selector)      | 4822 273 40283 |
| SK706, 707        | Switch (tape tension)            | 4822 278 90035 |
| SK712             | Push button switch (TIMER)       | 4822 276 10448 |
|                   | Button for SK712                 | 4822 276 10447 |
| all diodes except | BA217                            | 4822 130 30703 |
| D225              | Zener diode BZX79/C16            | 4822 130 30438 |
| D242 t/m          |                                  |                |
| D245, D248        |                                  |                |
| D249, D263        |                                  |                |
| D264              | Diode OF223                      | 4822 130 30791 |
| D255, 256         | Diode BAX16                      | 4822 130 30273 |
| D257              | Zener diode BZX79/C4V7           | 4822 130 30773 |
| D269              | Stabistor BZX75/C2V1             | 4822 130 30789 |
| D279, 280         | Zener diode BZX79/C30            | 4822 130 30701 |

|                      |                                 |                |
|----------------------|---------------------------------|----------------|
| BU201                | Socket 10p (REMOTE)             | 4822 267 50149 |
| RE1                  | Relay                           | 4822 280 60177 |
| RE201, 202, 203, 204 | Solenoid                        | 4822 280 70134 |
| TS201                | Transistor 2SC931               | 4822 130 40799 |
| TS701, 702           | Transistor 2N6107               | 4822 130 40903 |
| TS703                | Transistor BD135                | 4822 130 40645 |
| M1, 2                | Winding motor                   | 4822 361 20091 |
| M3                   | Capstan motor                   | 4822 361 20092 |
| K7                   | Pulse head                      | 4822 249 20025 |
| L701, 702, 703, 704  | Coil                            | 4822 158 10224 |
| LA501, 602           | Lamp 19 V - 50 mA               |                |
| 603, 604             | (button illumination)           | 4822 134 40078 |
| 605, 606             |                                 |                |
|                      | Socket for functional unit, 14p | 4822 267 50151 |
|                      | Socket for functional unit, 8p  | 4822 267 50156 |



552 C

Fig. 24

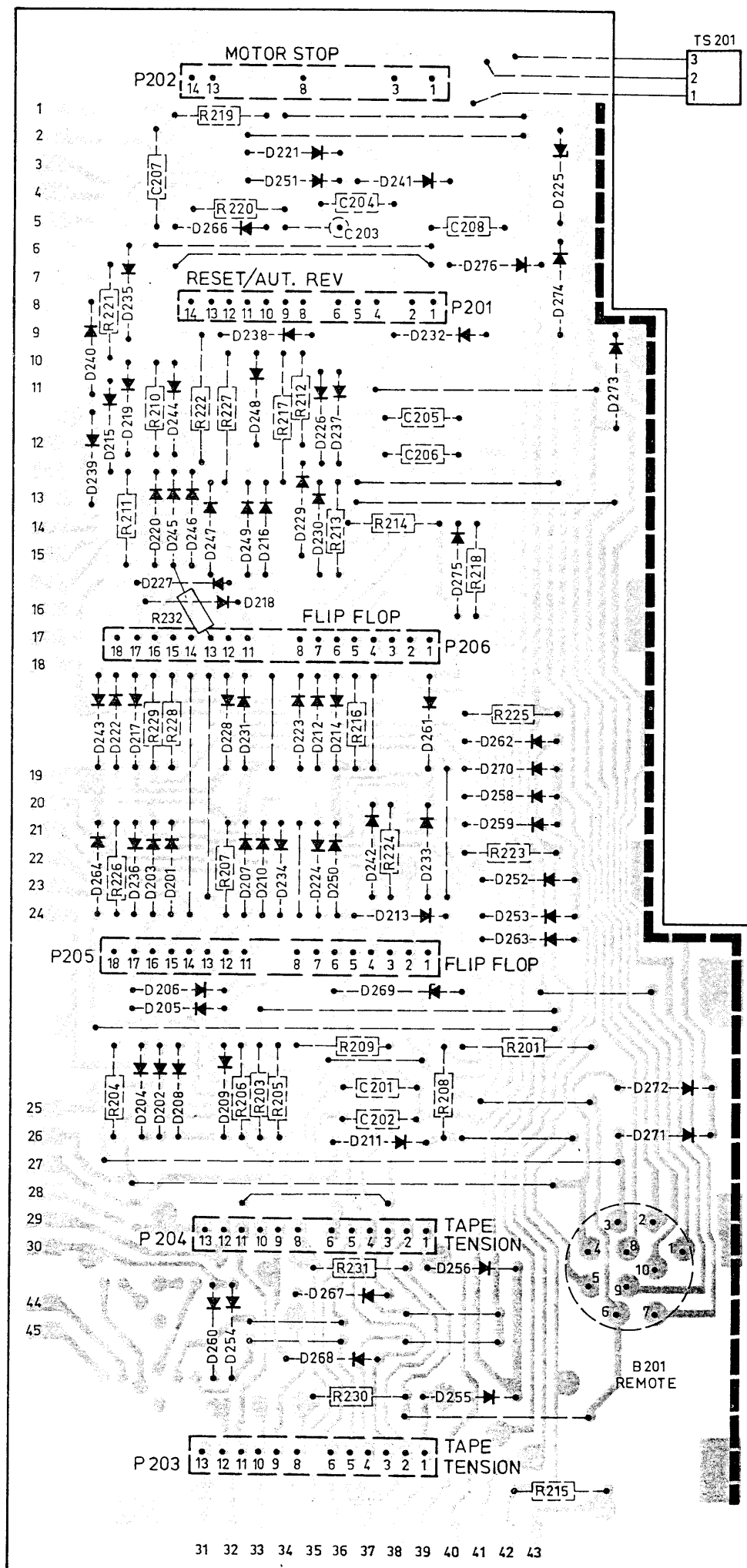


Fig. 29

1339C

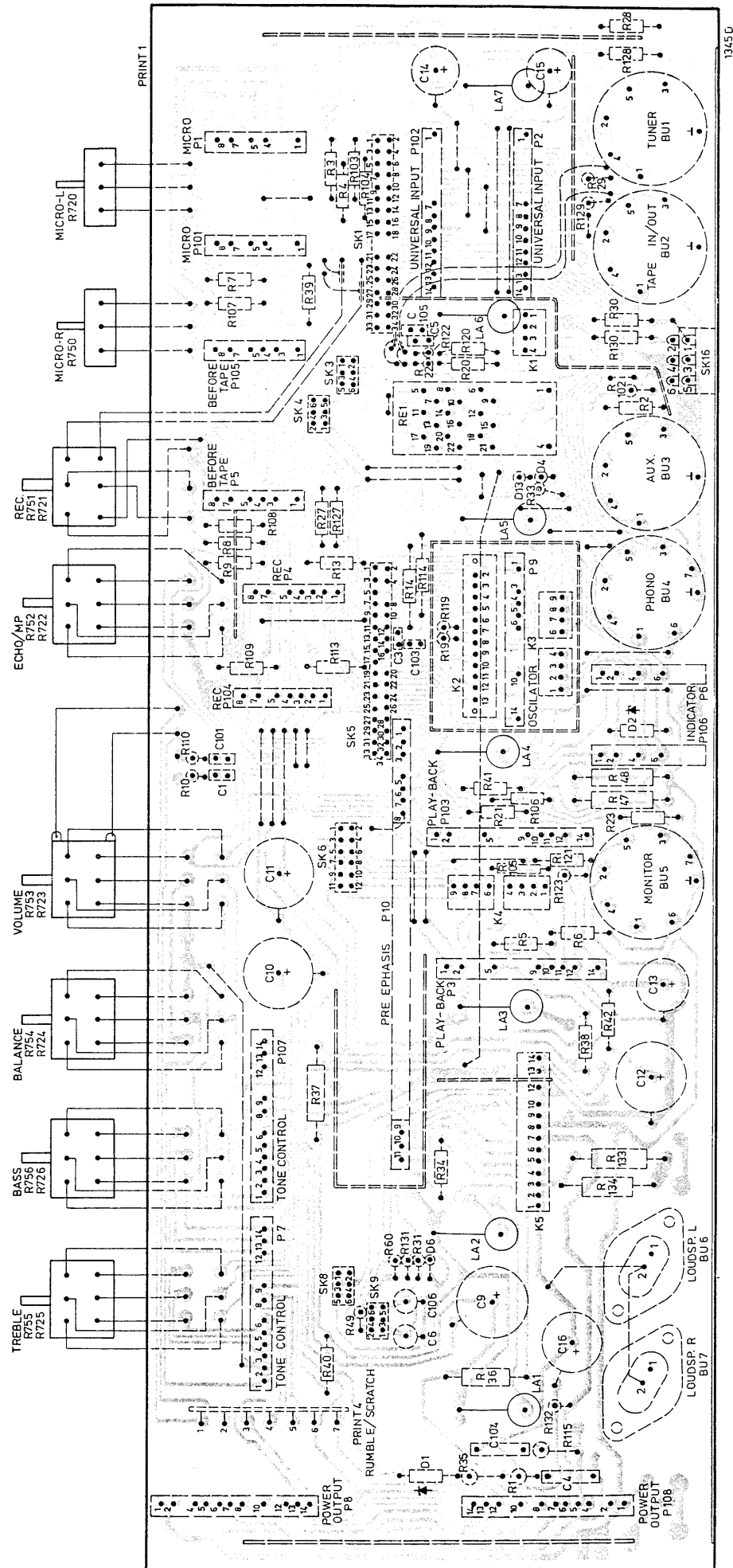


Fig. 30

## II. TAPE LOOPS DURING RECORDING/PLAYBACK

- . Check the tape transport functions of the apparatus.  
Check in particular that the tape is tantened if the set is switched on and if the centre pin and the pressure rollers are attracted.
  - . Check the motor current of the two winding motors (M1 and M2). See Mechanical adjustments "Adjusting the tape tension".
1. Motor currents are not correct → Adjust
- Motor current of M1 (left) cannot be adjusted exactly → Replace P203 or TS701 (readjust motor current)
  - Motor current M2 (right) cannot be adjusted exactly → Replace P204 or TS702 (readjust motor current)
  - The two motor currents can be adjusted properly →
2. Motor currents are correct → Replace P203 or P204 (Adjust motor current)
- . The tape is still looping → . Remove the tape  
Recorder in position "RIGHT ▷"
  - . Push the left-hand tape tension comparator (SK706) in the direction of the tape guide.  
Left-hand reel disc does not stop within about 2 seconds → Check SK706, D262 or R228.

- . Push the right-hand tape tension comparator (SK707) in the direction of the tape guide.  
Right-hand reel disc does not stop within about 5 seconds → Check SK707, D258 or R225
- . Recorder in position "◁ LEFT".
- . Push the right-hand tape tension comparator (SK707) in the direction of the tape guide.  
Right-hand reel disc does not stop within about 2 seconds → Check D270 or R229
- . Push the left-hand tape tension comparator (SK706) in the direction of the tape guide.  
Left-hand reel disc does not stop within about 5 seconds → Check D252 or R223

## TAPE LOOPS DURING FAST WINDING

- . Check the braking forces, see under "Mechanical Adjustments" Brake solenoid and brakes.
- . Check the brake solenoid for attracting and repelling properly (in particular zener diode D 257).
- . Recorder in position "WIND ▷▷"
- . Push the left-hand tape tension comparator (SK706) in the direction of the tape guide.  
Left-hand reel disc does not stop within about 2 seconds → Check D253 or R224
- . Recorder in position "◁◁ WIND"
- . Push the right-hand tape tension comparator (SK707) in the direction of the tape guide.  
Right-hand reel disc does not stop within about 2 seconds → Check D259 or R226

## III. SPECIAL FAULTS

- . Recorder does not start after a certain command when the tape contact is switched on →
  - ▷ → D274
  - ◁ → D273
  - ▷▷ → D272
  - ◁◁ → D271
  - ▷+◁+▷▷+◁◁ → P201 or D225
- . When two keys are depressed at the same time both commands are carried out →
  - ▷+◁◁ } → D203
  - ◁+▷▷ } → D207
  - ▷+▷▷ } → D231
  - ◁+◁◁ } → D222
- . Recorder stops after a certain key has been depressed repeatedly →
  - ▷ → D230
  - ◁ → D220
  - ▷▷ → D209
  - ◁◁ → D204
- . Automatic reverse does not operate → P201, SK8, D216, D235, R217, C208

## IV. CHECKING SEQUENCE FOR THE CONTROL SECTION

- The encircled figures in the last column correspond to those stated in the fault finding tree (A) of the control section.
- In order to find your way about in the repair method always begin with the first instruction in the table. After some practice this will take you only a few minutes.
- 10 → NOR
- 27 → NOR
- TIMER/AUTOSTOP → off



## REPAIR METHOD

### General remarks

Apart from fault finding tree **A** (to check the control section) and fault finding tree **B** (to check the amplifier), both present in an envelope at the back of this service manual, this repair method includes:

- I. an example
- II. tape loops during recording/play-back and fast winding
- III. special faults
- IV. checking sequence for the control section
- V. an explanation of the symbols used in this method

### Attention

- Check the control circuit without tape.  
Check the recording/playback printed panel with tape.
  - After P203, P204, TS701, TS702, M1 or M2 have been replaced, always readjust the motor current of M1 and M2 respectively.
  - All control keys, except for the stop key, are fitted with pilot lamps:
    - . if the lamp burns at full power, the function concerned has been adjusted.
    - . if lamp LA604 of key "◁ LEFT" or lamp LA605 of key "RIGHT ▷" burns at half power, the latest playing direction is indicated; burning at half power does not mean that the function has been switched on. Burning at half power is not mentioned in the repair method any more and is considered to be not burning.
  - The symbols or indications underlined mean that an operation has to be carried out with one of the operating controls.
- 
- If the repair method refers to a certain component or to a printed panel, not only the component but also connecting leads, print tracks, soldering connections and plug connections to the component/printed panel in question must be checked.
  - We suggest that the lower head cover is removed when you want to look at the pressure roller, centre pin etc.
  - The repair method does not deal with adjustments. See the adjusting instruction.

### I. EXAMPLE

Assume diode D205 has been short-circuited:

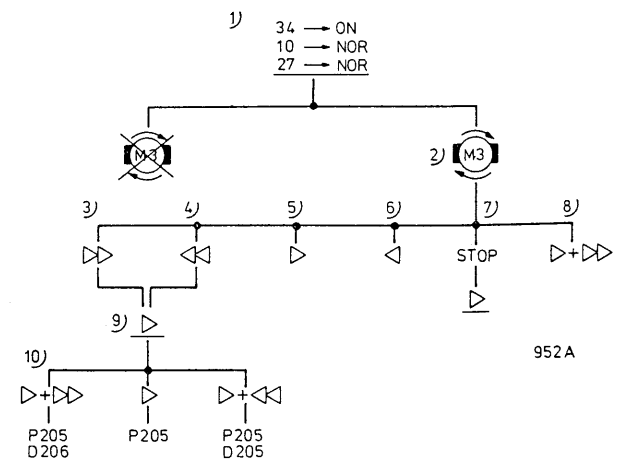
1. Remove the tape and set the knobs 34, 10 and 27 as indicated.
2. Check that M3 (capstan motor) runs.  
Result: M3 runs.  
There are now various possibilities when the recorder is being switched on.
3. ▷▷ → Fast winding right is switched on
4. ◁◁ → Fast winding left is switched on
5. ▷ → Playback right is switched on
6. ◁ → Playback left is switched on
7. Stop → This is the normal situation
8. ▷+▷▷ → Playback and fast winding right are switched on etc.

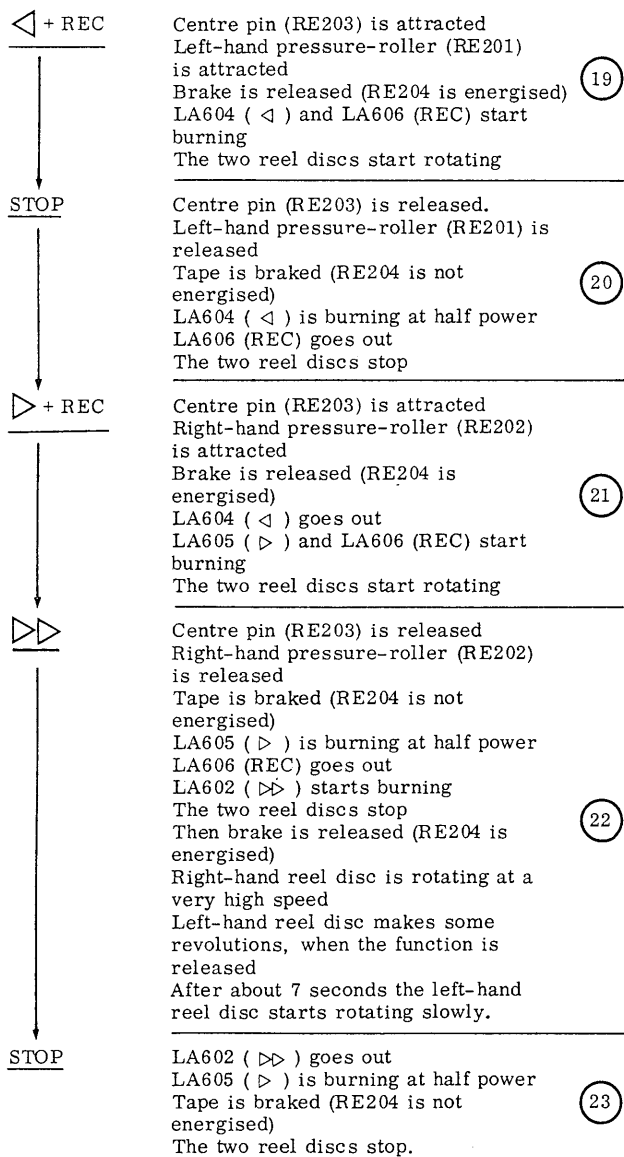
In case of this fault phenomenon 4) will reveal. This may have various causes (for example P205, D205 or D206). To distinguish between these parts, we continue with:

9. ▷ → Depress the key "RIGHT ▷"

The consequence may be:

10. ▷+▷▷ → Playback right + fast winding right
11. ▷ → Playback right
12. ▷+◁◁ → Playback right + fast winding left. This means that for example, D205 may be defective.





## V. EXPLANATION OF THE SYMBOLS

|  |                                                                      |
|--|----------------------------------------------------------------------|
|  | Motor M... runs                                                      |
|  | Motor M... does not run                                              |
|  | The two reel discs turn immediately after the command has been given |
|  | Reel discs do not rotate                                             |
|  | Left-hand reel disc does not rotate                                  |
|  | Right-hand reel disc does not rotate                                 |
|  | Relay is energised                                                   |
|  | Relay is not energised                                               |
|  | Lamp does not burn                                                   |
|  | Fit a short-circuit lead                                             |
|  | Remove the short-circuit load                                        |
|  | Recorder stops between two commands                                  |
|  | Recorder does not stop between two commands                          |
|  | No deviation                                                         |
|  | Deviation                                                            |
|  | Measure the voltage                                                  |
|  | Measure the resistance                                               |
|  | Playback is good                                                     |
|  | Playback is not good                                                 |
|  | Recording is good                                                    |
|  | Recording is not good                                                |
|  | Echo is not good                                                     |
|  | Multiplay is not good                                                |
|  | Sound                                                                |
|  | No Sound                                                             |
|  | Inject an LF signal                                                  |
|  | Check circuit between ... and ...                                    |
|  | Indicator functions                                                  |
|  | Indicator does not function                                          |

# Service Information



PHILIPS

18-9-1972

N4450 - N4418 - N4416 - N4414 - N4510

Bc 1301

Due to a printing error the code number of a test tape as stated in some of the abovementioned service manuals is incorrect.  
The correct code number of the test tape, 3150 Hz - 19 cm/sec is 8222 305 11550.

-----

Par suite d'une faute d'imprimerie, le no.de code de la bande d'essai dans quelques documentations techniques est erroné. Le no.de code correct de la bande d'essai 3150 Hz - 19 cm/sec est 8222 305 11550.

-----

Debido a un error de imprenta en algunos de las documentaciones arriba mencionadas es dado un número de código erróneo para un cinta de prueba.  
El número de código correcto debe ser:  
Cinta de prueba 3150 Hz - 19 cm/seg., número de código 8222 305 11550.

-----

Ten gevolge van een drukfout staat in een gedeelte van bovengenoemde dokumentaties het kodenummer van een testband verkeerd vermeld.

Het juiste kodenummer moet zijn:  
Testband 3150 Hz - 19 cm/sek, kodenummer 8222 305 11550.

-----

Infolge eines Druckfehlers ist die Code-Nummer für ein Testband in obengenannten Dokumentationen falsch angegeben. Die richtige Code-Nummer ist:  
Testband 3150 Hz - 19 cm/s, Code-Nummer 8222 305 11550.

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CS34759



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# Service Information



PHILIPS

1974-01-02

RECORDERS N4450

AR 73-12

## A. Modifications in recorders

### Version WR09

In recorders, marked from WR09/243 the following resistors in the amplifier have been replaced:

|                 | Original value | New value      |
|-----------------|----------------|----------------|
| R3/R103         | 5.1 k $\Omega$ | 6.8 k $\Omega$ |
| R4/R104         | 75 k $\Omega$  | 100 k $\Omega$ |
| R7/R8/R107/R108 | 22 k $\Omega$  | 7.5 k $\Omega$ |
| R9/R109         | 820 k $\Omega$ | 270 k $\Omega$ |

(all resistors 1/8 W  $\pm$  5 %)

This modification has been made to improve the dynamics of the recording amplifier.

- In recorders, marked from WR09/303, the tape tension comparators 84 have been provided with dampers. These dampers consist of two plastic discs between which there is a silicon liquid. For the code numbers of the new parts and the sequence of mounting, see Fig. 1.

Note:

The two plastic discs (with silicon liquid) have been pressed together in a special manner. Therefore, the discs must on no account be separated when they are mounted.

- In recorders, marked from WR09/304, resistor R202 (2.2 k $\Omega$  - 1/8 W  $\pm$  5 %) has been added on p.c. board 2 (see Fig. 2). Furthermore, the diodes D10 and D11 (BZX88/C3V3) on the RESET/AUTOMATIC REVERSE UNIT P201 have been replaced by BZX79/C4V7. This modification has been introduced because the recorder sometimes stopped at any moment when the remote control unit N6719 was used.
- In recorders, marked from WR09/304, the coils L701, L702, L703 and L704 and the capacitors C703 and C704 have been left out. In recorders, marked from WR09/309, the capacitors have been reintroduced, to avoid motor sparks.
- In recorders, marked from WR09/309, resistor R39 has been replaced; the value was 560  $\Omega$  and is now 1.5 k $\Omega$  (safety resistor; code number 4822 110 63112), and capacitor C14 (220  $\mu$ F - 25 V) has been replaced by a capacitor of 220  $\mu$ F - 16 V (code number 4822 124 20473). As a consequence, C14 becomes smaller, and therefore the roll shutter 176 cannot push against the capacitor anymore.
- In recorders, marked from WR09/309, the following modifications on p.c. board 1 have been made (see Fig. 3):
  - the connecting surfaces for soldering the socket contacts have been enlarged;
  - the lampholders have been left out because the connecting wires of the lamps are soldered direct to the p.c. board.
- In recorders, marked from WR09/311, a screening plate has been fitted between switch SK5 and unit P10 (PRE-EMPHASIS/SPEED SELECTOR UNIT). This modification has been introduced to prevent crosstalk between track 3 and track 1.
- In recorders, marked from WR09/323, the following modifications have been made on p.c. board 2 (see Fig. 2):
  - the print tracks have been modified;
  - the diodes D277, 278, 279, 280, 281, 282 and the resistors R232, 233, 234 are fitted to the component side.
- Version WR10
 

In recorders, marked from WR10/334, transistor TS201 (2SC931) has been replaced by BD437. The code number of this transistor is 4822 130 40982.

Note:

Under code number 4822 130 40899, transistor D330D8D will be supplied by Service for the time being. This transistor can also be used instead of 2SC931.
- In recorders, marked from WR10/334, the frequency range has been increased from 20,000 Hz to 25,000 Hz at 19 cm/s. Therefore, the PLAYBACK UNIT and the PRE-EMPHASIS/SPEED SELECTOR UNIT have been modified. The new units

have the following code numbers:

- PLAYBACK UNIT 4822 218 30152
- PRE-EMPHASIS/SPEED SELECTOR UNIT 4822 218 30153

### Version WR11

In recorders, marked from WR11/335, the reel discs, have been provided with a conducting rubber ring and an earthing spring to eliminate the static charge.

The new reel discs can be used instead of the old ones. The code number is 4822 528 10293.

## B. Addenda to the Service Manual

### Modified adjusting method for RECORDING UNIT P4/P104

Recorder in

position : Recording - "TAPE" - "B" - "ST" - "NOR" - "9.5" potentiometer "REC" at maximum; other controls at minimum

|         |                       |                                                                                                                                                                                                                                       |
|---------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Input:  | BU2 TAPE IN/OUT 3/2   | 333 Hz - 0.1 V                                                                                                                                                                                                                        |
| Output: | BU5 MONITOR 3/2       | to be adjusted to 1 V with R4 on P5                                                                                                                                                                                                   |
| Input:  | BU2 TAPE IN/OUT 5/2   | 333 Hz - 0.1 V                                                                                                                                                                                                                        |
| Output: | BU5 MONITOR 5/2       | to be adjusted to 1 V with R4 on P105                                                                                                                                                                                                 |
| Input:  | BU2 TAPE IN/OUT 5/2   | 333 Hz - 1 V                                                                                                                                                                                                                          |
| Output: | BU5 MONITOR 5/2       | to be adjusted to 1 V with recording control "REC"                                                                                                                                                                                    |
| Input:  | BU2 TAPE IN/OUT 3/2   | 333 Hz - 1 V                                                                                                                                                                                                                          |
| Output: | BU5 MONITOR 3/2       | value to be measured 1 V + x V (x = max. 0.8 $\bar{V}$ ). The difference with respect to 1 V to be halved with R4 on P5.                                                                                                              |
| Output: | BU4 PHONO 6/2 (MP1)   | to be adjusted to 1.5 mV with R9 on P4                                                                                                                                                                                                |
| Input:  | BU2 TAPE IN/OUT 5/2   | 333 Hz - 1 V                                                                                                                                                                                                                          |
| Output: | BU5 MONITOR 5/2       | value to be measured 1 V + y V (y = max. 0.8 $\bar{V}$ ). The difference with respect to 1 V to be halved with R4 on P105. If then $\frac{x}{2} \neq \frac{y}{2}$ , the difference voltage with respect to 1 V is to be halved again. |
| Output: | BU4 PHONO 7/2 (MP101) | to be adjusted to 1.5 mV with R9 on P104                                                                                                                                                                                              |

Note:

To avoid that the bias current is also measured, the oscillator unit P9 must be taken out of the recorder.

### Correction of the adjustment of the bias current.

With this adjustment, switch SK3 "B-A" must be in position "A".

- In some cases it may occur that the magnetic field of the ring on the pulley of capstan motor M3, decreases. This may be ascertained if the output voltage of pulse head K4 is measured.

The table below states these voltages for various tape speeds.

| Tape speed | Output voltage K4 |
|------------|-------------------|
| 4.75 cm/s  | 54 mV             |
| 9.5 cm/s   | 110 mV            |
| 19 cm/s    | 175 mV            |

- In part I of the Service Manual, the impression is created that this circuit is protected from short-circuit of the output. However, the output stage is protected only from failing owing to too strong input signals.

## A. Änderungen im Gerät

### Ausführung WR09

Bei Geräten ab Stempelung WR09/243 wurden folgende Widerstände im Verstärker geändert:

|                 |                                        |
|-----------------|----------------------------------------|
| R3/R103         | war 5,1 k $\Omega$ wird 6,8 k $\Omega$ |
| R4/R104         | war 75 k $\Omega$ wird 100 k $\Omega$  |
| R7/R8/R107/R108 | war 22 k $\Omega$ wird 7,5 k $\Omega$  |
| R9/R109         | war 820 k $\Omega$ wird 270 k $\Omega$ |

(alle Widerstände 1/8 W + 5 %)

Durch diese Änderung wird die Dynamik des Aufnahmeverstärkers verbessert.

Bei Geräten ab Stempelung WR09/303 haben die Bandspannungskomparatoren 84 Dämpfer erhalten. Diese Dämpfer bestehen aus zwei Kunststoffscheiben mit einer Zwischenlage aus Silikonöl. Für die Kodenummern der neuen Einzelteile und die Montage siehe Abb. 1.

#### Achtung:

Die beiden Kunststoffscheiben werden in der Fabrik mit Silikonöl bestrichen und nach einem bestimmten Verfahren zusammengepresst. Die Scheiben dürfen deshalb bei der Montage auf keinen Fall getrennt werden.

Bei Geräten ab Stempelung WR09/304 ist auf Leiterplatte 2 der Widerstand R202 (2,2 k $\Omega$  - 1/8 W + 5 %) hinzugefügt (siehe Abb. 2). Gleichzeitig mit dieser Änderung wurden auf der RESET/AUTOMATIC REVERSE UNIT P201 die Dioden D10 und D11 von BZX88/C3V3 in BZX79/C4V7 geändert. Diese Änderung wurde eingeführt, weil das Gerät bei Verwendung der Fernbedienungseinheit N6719 manchmal ohne Grund stoppte.

Bei Geräten ab Stempelung WR09/304 sind die Spulen L701, L702, L703 und L704 sowie die Kondensatoren C703 und C704 entfallen. Ab Stempelung WR09/309 wurden diese Kondensatoren wieder eingeführt, um Störungen durch den Motor zu unterdrücken.

Bei Geräten ab Stempelung WR09/309 ist Widerstand R39 von 560  $\Omega$  in 1,5 k $\Omega$  (Sicherheitswiderstand; Kodenummer 4822 110 63112) und Kondensator C14 von 220  $\mu$ F - 25 V in 220  $\mu$ F - 16 V (Kodenummer 4822 124 20473) geändert. Weil der neue Kondensator C14 kleiner ist, kann die Jalousie 176 nicht mehr an den Kondensator stossen.

Bei Geräten ab Stempelung WR09/309 wurden auf Leiterplatte 1 u.a. folgende Änderungen vorgenommen (siehe Abb. 3):

- die Anschlussflächen für das Lötten der Buchsenkontakte wurden vergrößert;
- die Lampenfassungen sind entfallen, weil die Anschlussdrähte der Lampen jetzt direkt auf die Leiterplatte gelötet werden.

Bei Geräten ab Stempelung WR09/311 wird zwischen Schalter SK5 und Einheit P10 (PRE-EMPHASIS/SPEED SELECTOR UNIT) eine Abschirmplatte montiert. Durch diese Änderung soll Übersprechen zwischen Spur 3 und Spur 1 vermieden werden.

Bei Geräten ab Stempelung WR09/323 wurden auf Leiterplatte 2 u.a. folgende Änderungen vorgenommen (siehe Abb. 2):

- Leiterbahnen geändert
- die Dioden D277, 278, 279, 280, 281 und 282 und die Widerstände R232, 233, 234 werden auf der Bauelementeseite der Leiterplatte montiert.

### Ausführung WR10

Bei Geräten ab Stempelung WR10/334 ist Transistor TS201 von 2SC931 in BD437 geändert. Kodenummer dieses Transistors: 4822 130 40982.

#### Anmerkung:

Unter der Kodenummer 4822 130 40899 liefert der Service vorläufig den Transistor D330D8D, der ebenfalls an Stelle des 2SC931 verwendet werden kann.

Bei Geräten ab Stempelung WR10/334 ist der Frequenzbereich bei 19 cm/s von 20.000 Hz auf 25.000 Hz erhöht. Hierzu wurden die PLAY-BACK UNIT und die PRE-EMPHASIS/SPEED SELECTOR UNIT geändert. Die neuen Einheiten sind unter folgenden Kodenummern lieferbar:

|                                    |                |
|------------------------------------|----------------|
| - PLAYBACK UNIT                    | 4822 218 30152 |
| - PRE-EMPHASIS/SPEED SELECTOR UNIT | 4822 218 30153 |

### Ausführung WR11

Bei Geräten ab Stempelung WR11/335 erhalten die Spulenteiler einen Ring aus leitendem Gummi und eine Erdungsfeder, um statische Ladung abzuleiten. Diese neuen Spulenteiler können an Stelle der alten montiert werden. Kodenummer: 4822 528 10293.

## B. Ergänzungen der Dokumentation

Geänderte Einstellmethode RECORDING UNIT P4/P104

### Tonbandgerät

in Stellung : Aufnahme - "TAPE" - "B" - "ST" - "NOR" - "9,5"  
Aufnahmeregler "REC" auf Maximum; andere Regler auf Minimum

|          |                     |                                  |
|----------|---------------------|----------------------------------|
| Eingang: | BU2 TAPE IN/OUT 3/2 | 333 Hz - 0,1 V                   |
| Ausgang: | BU5 MONITOR 3/2     | mit R4 auf P5 einstellen auf 1 V |

|          |                     |                                    |
|----------|---------------------|------------------------------------|
| Eingang: | BU2 TAPE IN/OUT 5/2 | 333 Hz - 0,1 V                     |
| Ausgang: | BU5 MONITOR 5/2     | mit R4 auf P105 einstellen auf 1 V |

|          |                     |                                             |
|----------|---------------------|---------------------------------------------|
| Eingang: | BU2 TAPE IN/OUT 5/2 | 333 Hz - 1 V                                |
| Ausgang: | BU5 MONITOR 5/2     | mit Aufnahmeregler "REC" einstellen auf 1 V |

|          |                     |                                                                                                                 |
|----------|---------------------|-----------------------------------------------------------------------------------------------------------------|
| Eingang: | BU2 TAPE IN/OUT 3/2 | 333 Hz - 1 V                                                                                                    |
| Ausgang: | BU5 MONITOR 3/2     | zu messender Wert $1 V + x V$ ( $x = \max. 0,8 \bar{V}$ ). Die Differenz gegenüber 1 V mit R4 auf P5 halbieren. |

|          |                     |                                     |
|----------|---------------------|-------------------------------------|
| Ausgang: | BU4 PHONO 6/2 (MP1) | mit R9 auf P4 einstellen auf 1,5 mV |
|----------|---------------------|-------------------------------------|

|          |                     |                                                                                                                   |
|----------|---------------------|-------------------------------------------------------------------------------------------------------------------|
| Eingang: | BU2 TAPE IN/OUT 5/2 | 333 Hz - 1 V                                                                                                      |
| Ausgang: | BU5 MONITOR 5/2     | zu messender Wert $1 V + y V$ ( $y = \max. 0,8 \bar{V}$ ). Die Differenz gegenüber 1 V mit R4 auf P105 halbieren. |

Wenn danach  $\frac{x}{2} \neq \frac{y}{2}$

erneut die Differenzspannung gegenüber 1 V halbieren.

|          |                       |                                        |
|----------|-----------------------|----------------------------------------|
| Ausgang: | BU4 PHONO 7/2 (MP101) | mit R9 auf P104 auf 1,5 mV einstellen. |
|----------|-----------------------|----------------------------------------|

#### Achtung:

Um zu verhindern, dass auch die Vormagnetisierungsspannung gemessen wird, die Oszillatoreinheit P9 aus dem Gerät nehmen.

Korrektur der Einstellung des Vormagnetisierungsstromes  
Bei dieser Einstellung muss Schalter SK3 "B-A" in Stellung "A" stehen.

In Einzelfällen kann es vorkommen, dass das Feld des magnetisierten Ringes auf der Stufenscheibe des Bandantriebsmotors M3 abnimmt. Dies kann man durch Messen der Ausgangsspannung des Impulskopfes K4 feststellen.

In untenstehender Tabelle sind diese Spannungen für die einzelnen Bandgeschwindigkeiten angegeben:

| Bandgeschwindigkeit | Ausgangsspannung K4 |
|---------------------|---------------------|
| 4,75 cm/s           | 54 mV               |
| 9,5 cm/s            | 110 mV              |
| 19 cm/s             | 175 mV              |

Bei der Beschreibung der Endstufe in Teil I der Dokumentation wird der Eindruck erweckt, dass der Ausgang der Schaltung kurzschlussfest ist. Das ist nicht der Fall. Die Endstufe ist nur vor Beschädigungen durch zu hohe Eingangsspannungen geschützt.

## A. Modificaciones en el aparato

### Versión WR09

En los aparatos a partir del estampillado WR09/243 han sido modificados las siguientes resistencias:

R3/R103 era 5,1 k $\Omega$  y es ahora 6,8 k $\Omega$   
 R4/R104 era 75 k $\Omega$  y es ahora 100 k $\Omega$   
 R7/R8/R107/R108 era 22 k $\Omega$  y es ahora 7,5 k $\Omega$   
 R9/R109 era 820 k $\Omega$  y es ahora 270 k $\Omega$

(todas las resistencias 1/8 W + 5 %)

Esta modificación es introducida a fin de mejorar la dinámica del amplificador de registro.

- En los aparatos a partir del estampillado WR09/303 los "tape tension comparators" 84 son provistos de amortiguadores. Estos amortiguadores son compuestos de dos discos de material sintético entre los cuales hay un liquido de silicon. Para los números de código de estos nuevos componentes y el orden de montaje véase a la figura 1.

Atención:

Los dos discos de material sintético son provistos por la fábrica de liquido silicona y comprimidos de una manera especial. Por ello estos discos no deben ser separados jamás durante el montaje.

- En aparatos a partir del estampillado WR09/304 es anadido la resistencia R202 (2,2 k $\Omega$  - 1/8 W  $\pm$  5 %) sobre la placa impresa 2 (véase la fig. 2). Al mismo tiempo son modificados los diodos D10 y D11 sobre la unidad RESET/AUTOMATIC REVERSE P201 de BZX88/C3V3 en BZX79/C4V7. Esta modificación es introducida debido a que el aparato se paraba a veces sin razón alguna al ser usado la unidad de mando a distancia N6719.

- En aparatos a partir del estampillado WR09/304 han sido suprimidos las bobinas L701, L702, L703 y L704 y los condensadores C703 y C704. A partir del estampillado WR09/309 los condensadores son nuevamente introducidos a fin de evitar chasquidos de motor.

- En aparatos a partir del estampillado WR09/309 es modificado la resistencia de 560  $\Omega$  en 1,5 k $\Omega$  (resistencia de seguridad; número de código 4822 110 63112) y el condensador C14 de 220  $\mu$ F - 25 V en 220  $\mu$ F - 16 V (número de código 4822 124 20473). Como que por ello C14 es más pequeño, la tapa corrediza no chocará más contra este.

- En aparatos a partir del estampillado WR09/309 son introducidos los siguientes modificaciones sobre la placa impresa 1 (véase la fig. 3)

- las superficies de conexión para soldar a los contactos del enchufe son agrandadas
- los portalamparillas han quedado suprimidos ya que las lamparillas son soldados directamente sobre la placa impresa.

- En aparatos a partir del estampillado WR09/311 es montado una plaquencia de blindaje entre el conmutador SK5 y la unidad P10 (PRE-EMPHASIS/SPEED SELECTOR UNIT). Esta modificación es introducida a fin de evitar la influencia mutua entre los pistas impresas 3 y 1.

- En aparatos a partir del estampillado WR09/323 son introducidos las siguientes modificaciones sobre la placa impresa 2 (véase la fig. 2):

- trazado impreso modificado
- los diodos D277, 278, 279, 280, 281, 282 y las resistencias R232, 233, 234 son montados sobre el lado de componentes de la placa impresa.

### Versión WR10

En aparatos a partir de WR10/334 es modificado el transistor TS201 de 2SC931 en BD437. El número de código de este transistor es 4822 130 40982.

Nota:

El Servicio suministra temporaneamente al transistor D330D8D bajo el número de código 4822 130 40899, cual puede ser aplicado también en lugar del 2SC931.

- En aparatos a partir del estampillado WR10/334 es aumentado el margen de frecuencia de 20 000 Hz hasta 25 000 Hz para 19 cm/seg.

Para esto son modificados la unidad de PLAYBACK y la unidad de PRE-EMPHASIS/SPEED SELECTOR. Las nuevas unidades son suministrados bajo los siguientes números de código:

- PLAYBACK UNIT 4822 218 30152  
 - PRE-EMPHASIS/SPEED SELECTOR UNIT 4822 218 30153

### Versión WR11

En aparatos a partir del estampillado WR11/335 los platos de bobina son provistos de un aro de caucho conductor y un resorte lámina de masa a fin de hacer afluir la carga electrostática.

Los platos de bobina no modificados pueden ser sustituidos sin más por estos nuevas.

El número de código es 4822 528 10293.

## B. Suplemento a la documentación

Método de ajuste modificado para RECORDING UNIT P4/P104.

Magnétopono

en posición : Resistro - "TAPE" - "B" - "ST" - "NOR" - "9.5"  
 Control de registro "REC" al máximo; todos los demás controles al mínimo.

|          |                       |                                                                                                                                                                                                                 |
|----------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Entrada: | BU2 TAPE IN/OUT 3/2   | 333 Hz - 0,1 V                                                                                                                                                                                                  |
| Salida:  | BU5 MONITOR 3/2       | ajústese con R4 sobre P5 a 1 V                                                                                                                                                                                  |
| Entrada: | BU2 TAPE IN/OUT 5/2   | 333 Hz - 0,1 V                                                                                                                                                                                                  |
| Salida:  | BU5 MONITOR 5/2       | ajústese con R4 sobre P105 a 1 V                                                                                                                                                                                |
| Entrada: | BU2 TAPE IN/OUT 5/2   | 333 Hz - 1 V                                                                                                                                                                                                    |
| Salida:  | BU5 MONITOR 5/2       | ajústese con el control de registro "REC" a 1 V                                                                                                                                                                 |
| Entrada: | BU2 TAPE IN/OUT 3/2   | 333 Hz - 1 V                                                                                                                                                                                                    |
| Salida:  | BU5 MONITOR 3/2       | valor a medirse 1 V + x V (x = 0,5 V max). Mediar la diferencia con respecto a 1 V mediante R4 sobre P5.                                                                                                        |
| Salida:  | BU4 PHONO 6/2 (MP1)   | ajústese mediante R9 sobre P4 a 1,5 mV                                                                                                                                                                          |
| Entrada: | BU2 TAPE IN/OUT 5/2   | 333 Hz - 1 V                                                                                                                                                                                                    |
| Salida:  | BU5 MONITOR 5/2       | valor a medirse 1 V + y V (y = 0,5 V max). Mediar la diferencia con respecto a 1 V mediante R4 sobre P105. Si luego $\frac{x}{2} \neq \frac{y}{2}$ entonces mediar nuevamente la diferencia con respecto a 1 V. |
| Salida:  | BU4 PHONO 7/2 (MP101) | ajústese mediante R9 sobre P104 a 1,5 mV                                                                                                                                                                        |

Atención:

Afin de evitar de que se nude a la vez a la tensión de premagnetización hay que quitar del aparato a la unidad osciladora P9.

- Rectificación del ajuste de la corriente de premagnetización  
 Para este ajuste el conmutador SK3 "B-A" debe hallarse en la posición "A".

- En algunos casos puede suceder que el campo magnético del aro magnetizado, cual se encuentra sobre la patea del motor de cabrestante M3, disminuye. Esto puede ser constatado nudiéndose a la tensión de salida de la cabeza de impulsos K4. En la tabla a continuación son dados estas tensiones para los diversos velocidades de cinta.

| Velocidad de cinta | Tension de salida K4 |
|--------------------|----------------------|
| 4,75 cm/seg.       | 54 mV                |
| 9,5 cm/seg.        | 110 mV               |
| 19 cm/seg.         | 175 mV               |

- En la parte I de la documentación es dado la impresión en la descripción de la etapa final de que este circuito es asegurado contra el cortocircuitado de la salida. Esto no es así. La etapa final es solamente asegurado contra el defectuarse debido a senales de entrada demasiados grandes.



# Service Information



PHILIPS

1973-09-28

FUNCTIONAL UNITS  
N4414, N4416, N4418, N4450, N4510

AR 73-24

This information summarises the modifications to all Functional Units of the above-mentioned recorders.

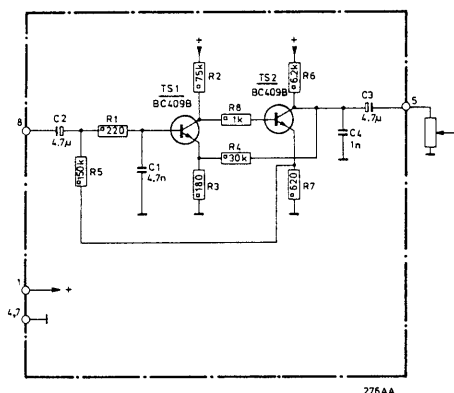
## General remark



- The form of the unit has been modified. Thus, it will not occur that, when a unit is drawn out of the recorder, one of its corners breaks off.

## MICRO INPUT UNIT

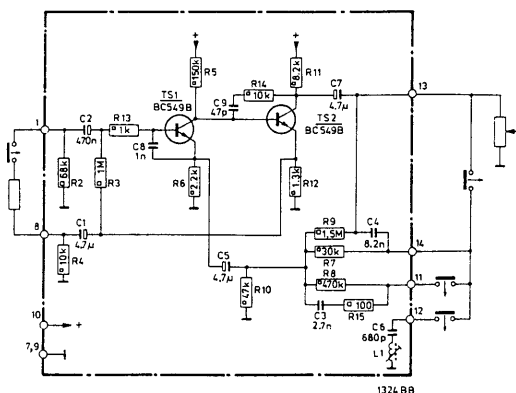
N4450



- TS1,2 - BC149B have been replaced with BC409B. Thus, the roller shutters in front of the input sockets will not slide against the transistors.

## UNIVERSAL INPUT UNIT

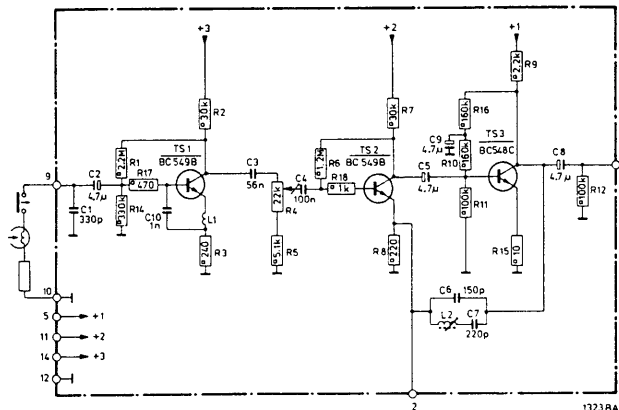
N4418, N4450, N4510



- R9 - 620 k $\Omega$  has been replaced with a resistor of 1.5 M $\Omega$ . Thus, the frequency range for "Phono" has been improved. This modification has been made in recorders N4450 marked from WR07/150.  
Note: The N4418 and the N4510 have been featuring this modification from the start of production.
- TS1,2 - BC149B have been replaced with BC549B. Thus, fitting the transistors has been facilitated.

## PLAYBACK UNIT

N4418, N4450, N4510

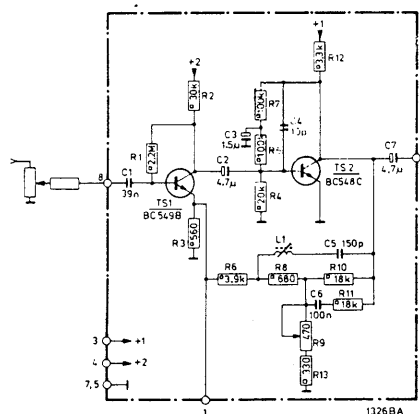


- C1 - 680 pF has been replaced with a capacitor of 330 pF. Thus, the frequency characteristic has been improved up to 25 kHz at  $v = 19$  cm/s. This modification has been made in recorders marked from WR07/327 (N4418), WR10/334 (N4450) or WR02/327 (N4510).
  - Three transistors have been replaced.
- | Original types | Replacement types |
|----------------|-------------------|
| TS1,2 - BC149B | BC549B            |
| TS3 - BC148C   | BC548C            |
- Thus, fitting the transistor has been facilitated.

Note: The units containing the modifications to obtain an improved frequency characteristic are supplied under code number 4822 218 30152.

## RECORDING UNIT

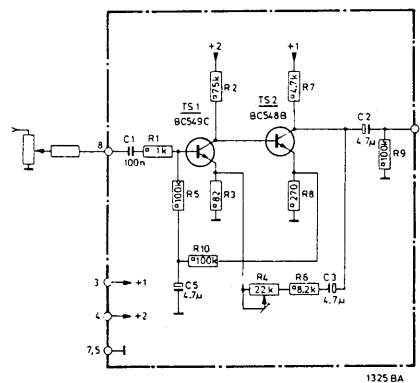
N4418, N4450, N4510



- The correct value of R13 is 330  $\Omega$ .
- TS1 - BC149C has been replaced with BC549C, and TS2 - BC148B with BC548B. Thus, fitting these transistors has been facilitated.

## BEFORE TAPE UNIT

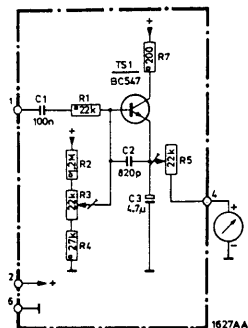
N4418, N4450, N4510



- TS1 - BC149C has been replaced with BC549C, and TS2 - BC148B with BC548B. Thus, fitting these transistors has been facilitated.

## INDICATOR UNIT

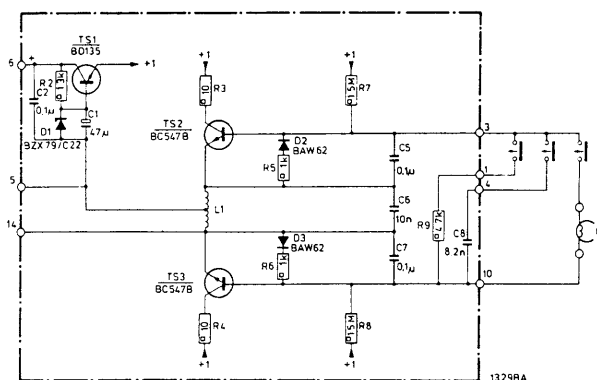
N4416, N4418, N4450, N4510



- Two resistors have replaced:
- | Original type       | Value of replacement type |
|---------------------|---------------------------|
| R2 - 1.5 M $\Omega$ | 1.2 M $\Omega$            |
| R4 - 12 k $\Omega$  | 27 k $\Omega$             |
- Thus, the quiescent current can be better adjusted. The recorders have been featuring this modification from the start of production.
- TS2 - BC147 has been replaced with BC547. Thus, fitting this transistor has been facilitated.

## OSCILLATOR UNIT

N4418, N4450, N4510



- The erase frequency has been reduced from 114 kHz to 100 kHz. Thus, MW reception has been improved. Owing to this modification, C3, C4, C9 and C10 are no longer used. Besides, some capacitors have been replaced.

| Replaced capacitors | Value of replacement type |
|---------------------|---------------------------|
| C5 and C7 - 56 pF   | 0.1 $\mu$ F               |
| C6 - 8.2 nF         | 10 nF                     |
| C8 - 6.2 nF         | 8.2 nF                    |

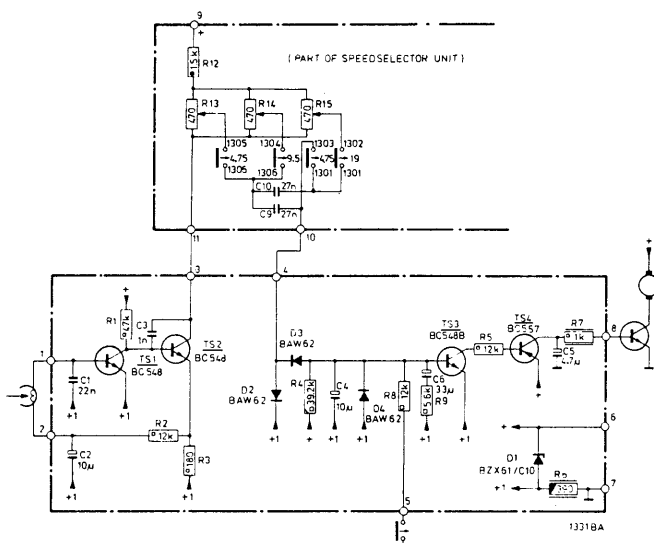
D1 - BZX79/C20 has been replaced with BZX79/C22; besides, R5 and R6 (10 k $\Omega$  each) have been replaced with resistors of 1 k $\Omega$ ; they are now in series with D2 and D3 respectively. Thus, the erasing capacity has been improved. These modifications have been made in recorders marked from WR06/148 (N4450).

The N4418 and N4510 have been featuring these modifications from the start of production.

- D2,3 - BA216 have been replaced with BAW62. Thus, the reliability has been improved. This modification has been made in: N4418 marked from WR07/322, N4450 marked from WR09/322, N4510 marked WR02/322.
- TS2,3 - BC147B have been replaced with BC547B. Thus, fitting the transistors has been facilitated.

## SPEED CONTROL UNIT

N4418, N4450, N4510



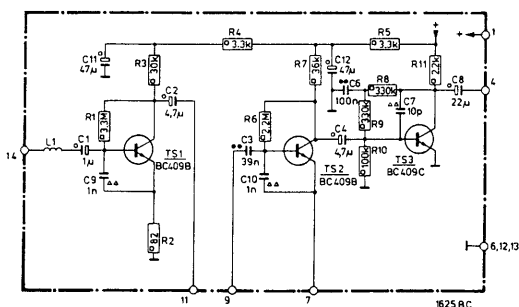
- D1 - BZX79/C10 has been replaced with BZX61/C10. Thus, the reliability has been improved. This modification has been made in recorders marked from WR07/317 (N4418), from WR09/316 (N4450), or from WR02/317 (N4510).

- D2,3 - BA217 have been replaced with BAW62; D4 - BA216 has been replaced with BAW62. Thus, the reliability has been improved. These modifications have been made in recorders marked from: WR07/304 (N4418), WR09/304 (N4450), WR02/304 (N4510).

- Some transistors have been replaced.
- | Original type | Replacement type |
|---------------|------------------|
| TS1,2 - BC148 | BC548            |
| TS3 - BC148   | BC548B           |
| TS4 - BC157   | BC557            |
- Thus, fitting these transistors has been facilitated.

## REC/PLAYBACK UNIT

N4414, N4416



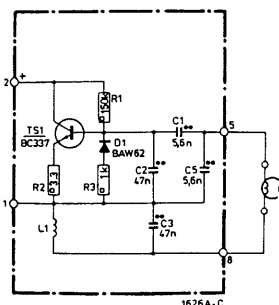
- The circuit has been modified as a consequence of standardisation. The unit can now also be used in the N2407, N2408 and N2509.

The modified unit can also be used in recorders of an earlier production.

In recorders produced after this modification was made, the new unit (marked 11.2 on the track side) must be used. This modification has been made in recorders marked from WR02/304 (N4414) or WR04/302 (N4416).

## OSCILLATOR UNIT

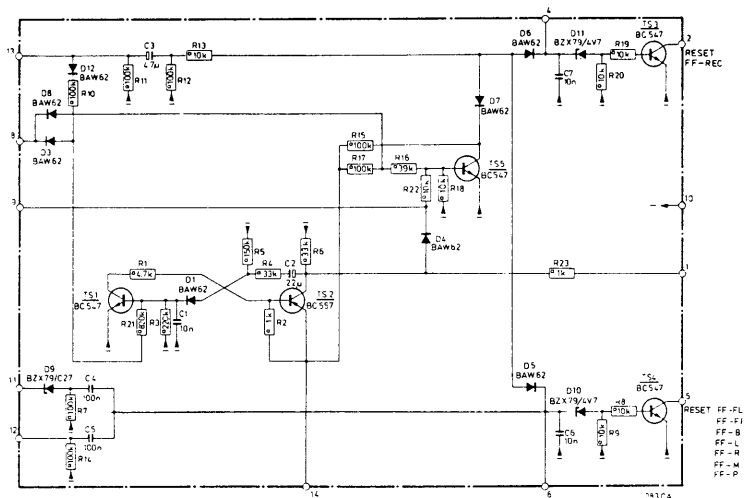
N4414, N4416



- D1 - BA217 has been replaced with BAW62. Thus, the reliability has been increased. This modification has been made in recorders marked from WR02/304 (N4414) or WR04/304 (N4416).

## RESET-AUTOMATIC REVERSE UNIT

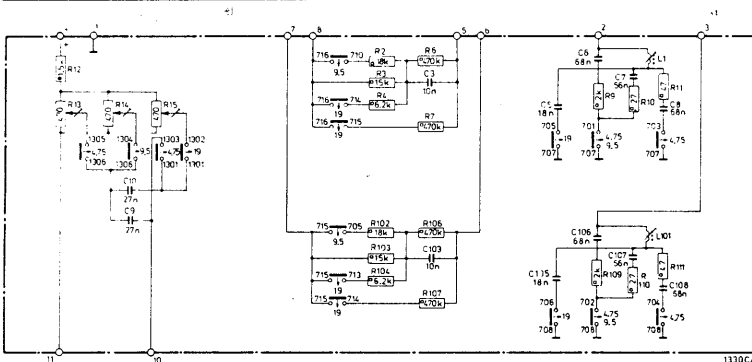
N4450



- D10, 11 - BZX88/C3V3 have been replaced with BZX79/C4V7. Thus, it has been avoided that the recorder suddenly stops when remote control N6719 is being used. This modification has been made in a limited number of recorders marked from WR09/240 and in all recorders marked from WR09/304.
- D9 - BZX79/C30 has been replaced with BZX79/C27. Thus, the switch clock will again function properly at too low a mains voltage. This modification has been made in recorders marked from WR09/333.
- D1, 3, 4, 5, 6, 7, 8, 12 - BA217 have been replaced with BAW62. Thus, the reliability has been increased. This modification has been made in WR09/304.
- TS1, 3, 4 and 5 - BC147 have been replaced with BC547; TS2 - BC157 has been replaced with BC557.

## PRE-EMPHASIS/SPEED SELECTOR UNIT

N4418, N4450, N4510

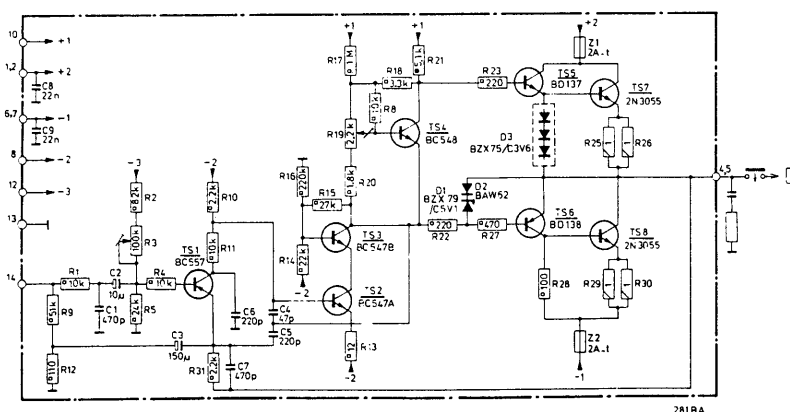


- R8, 108 are no longer used and C5, 105 - 27 nF have been replaced with capacitors of 8 nF. Thus, the frequency characteristic has been improved up to 25 kHz at  $v = 19$  cm/s. This modification has been made in recorders marked from:  
WR07/327 (N4418)  
WR10/334 (N4450)  
WR02/327 (N4510)

Note: The units containing the modifications to obtain an improved frequency characteristic are supplied under code number 4822 218 30153.

## POWER OUTPUT UNIT

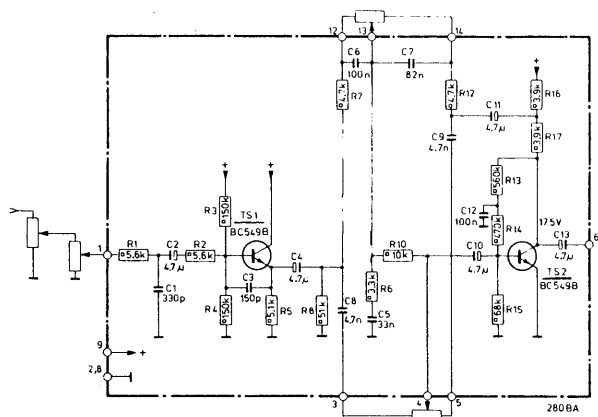
N4450



- TS5, 6 - 2N2219A, 2N2905A have been replaced with transistor pair BD137/138. This modification has been made in recorders marked from WR09/306. R24 has been replaced with stabistor D3 - BZX75/C3V6. Thus, the fuses cannot fail. This modification has been made in recorders marked from WR09/329.
  - D2 - BAX13 has been replaced with BAW62 because of a new supply programme. The following transistors have been replaced.
- | Original type | Replacement type |
|---------------|------------------|
| TS1 - BC157   | BC557            |
| TS2 - BC147A  | BC547A           |
| TS3 - BC147B  | BC547B           |
| TS4 - BC148   | BC548            |
- Thus, fitting these transistors has been facilitated.

## TONE CONTROL UNIT

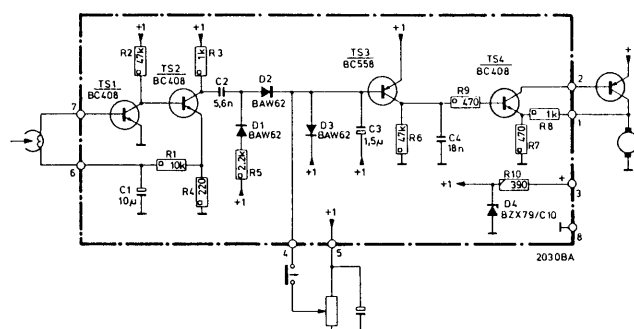
N4450



- TS1,2 - BC149B have been replaced with BC549B. Thus, fitting these transistors has been facilitated.

## SPEED CONTROL UNIT

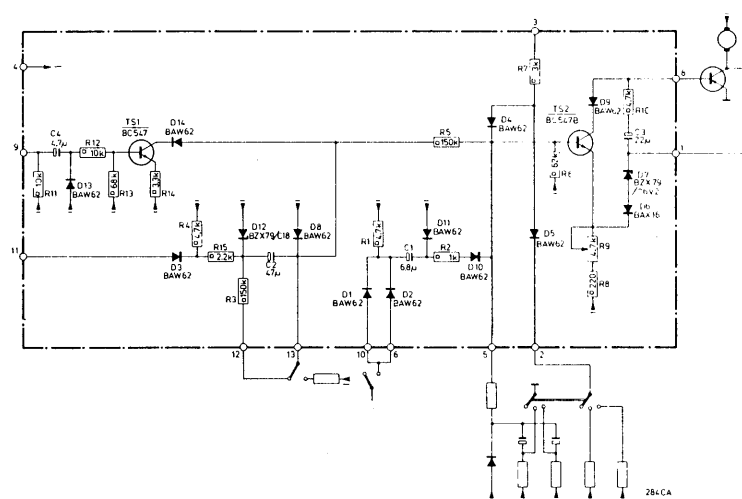
N4414, N4416



- D4 - BZX79/C10 has been replaced with BZX61/C10. Thus, the reliability has been improved. This modification has been made in recorders marked from WR02/317 (N4414) or from WR04/317 (N4416).
- D1,2,3 - BA217 have been replaced with BAW62 because the range of diodes has been changed.
- TS3 - BC158 has been replaced with BC558. Thus, fitting this transistor has been facilitated.

## TAPE TENSION UNIT

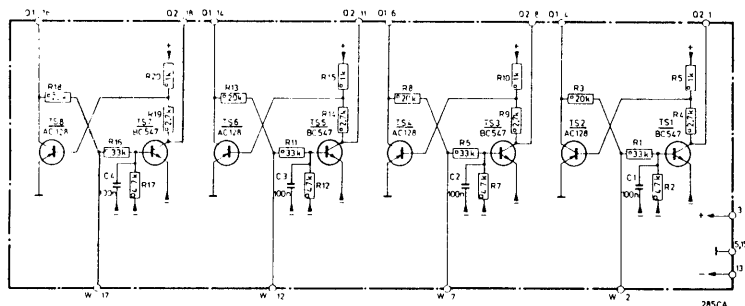
N4450



- D1,2,3,4,5,9,10,11,13,14 - BA217 have been replaced with BAW62 because of the changed range of diodes.
- TS1 - BC147 and TS2 - BC147B have been replaced with BC547 and BC547B respectively. Thus, fitting these transistors has been facilitated.

## FLIP FLOP UNIT

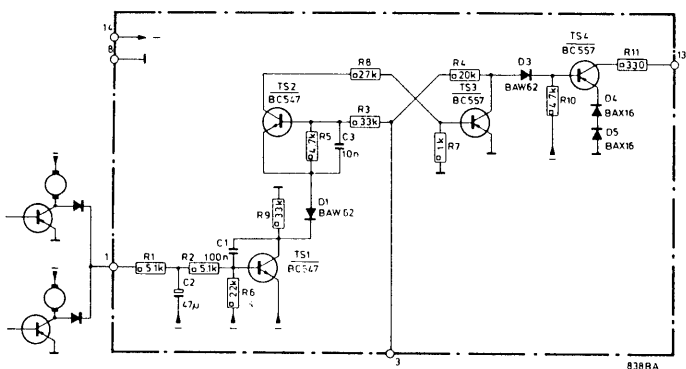
N4450



- TS1,3,5,7 - BC147 have been replaced with BC147. Thus, fitting these transistors has been facilitated.

## MOTOR STOP UNIT

N4450



- D1,3 - BA217 have been replaced with BAW62 because of the new range of diodes.

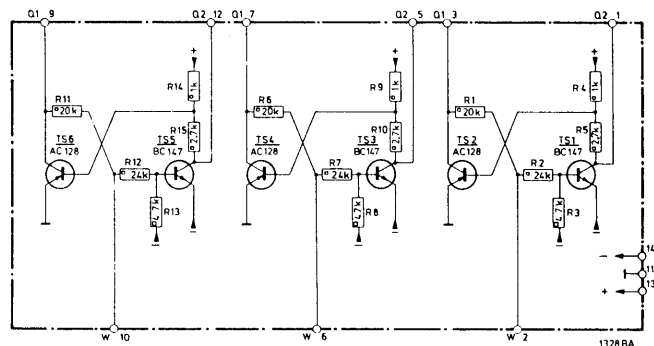
- Replaced transistors

| Original type | Replacement type |
|---------------|------------------|
| TS1,2 - BC147 | BC547            |
| TS3,4 - BC157 | BC557            |

Thus, fitting these transistors has been facilitated.

## FLIP FLOP UNIT

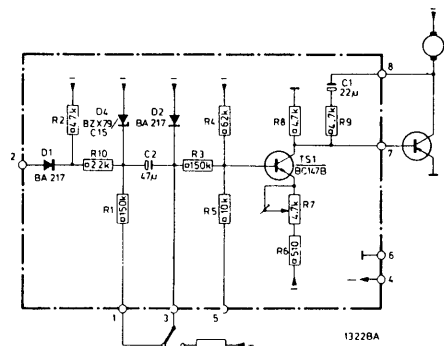
N4418, N4510



- R2,7,12 - 33 kΩ have been replaced with resistors of 24 kΩ. Thus, the brake and coil magnets are prevented from not being actuated at lower mains voltages. This modification has been made in recorders marked from WR06/244 (N4418) or from WR01/244 (N4510).

## TAPE TENSION UNIT

N4418, N4510



- R7 - 2.2 kΩ has been replaced with a resistor of 4.7 kΩ. Thus, the adjustment of the quiescent current has been facilitated.

This modification has been made in recorders marked from WR04/202 (N4418) and in recorders N4510 from the start of production.

- R5 - 27 kΩ has been replaced with a resistor of 10 kΩ. Thus, the winding torque during forward winding has been increased.

This modification has been made in recorders marked from WR06/236 (N4418) or WR01/236 (N4510).

# Service Information



**PHILIPS**

1974-08-19

RECORDERS N4414-N4416-N4418-  
N4510-N4450

AR74-6

To obtain an optimal sound reproduction and minimal head wear, the record and playback heads must be adjusted correctly. The tape transport can vary for each recorder; the heads are also made with certain tolerances. Therefore replaced heads must be re adjusted.

The height of the head and the azimuth can be adjusted with one single test tape. On this test tape a 10-kHz signal has been recorded over the full width. About 1.2 mm from the upperside of the tape there is a 1-mm wide track on which a signal of 1-kHz has been recorded.

When the height of the head has been adjusted correctly, the 1-kHz track is just under the uppermost core. The 1-kHz signal should then be just audible above the noise. When the azimuth alignment is correct, the core gaps are perpendicular to the running direction of the tape. Then there is a maximum reproduction of the 10-kHz signal.

## N4414-N4416

Required tools and measuring instruments:

- Head adjusting jig 4822 403 50718
- Test tape 1 kHz-10 kHz 4822 397 30014
- Spring pressure gauge 3-55 g 4822 395 80029
- mV-meter GM6012 or PM2454B
- Dual-beam oscilloscope PM3230 or PM3130

## Adjusting the head inclination (Fig. 1)

Carefully check whether the front of the head is perpendicular to the mounting plate. Adjust with nut C.

## Adjusting the height of the head

- With the adjusting jig
  - Place the jig in the recorder (Fig. 2)
  - The upperside of the uppermost core must be situated just below the upperside of the adjusting jig. Adjust with nuts B and C and screw A.
- With test tape
  - Insert the test tape into the recorder
  - Recorder in position "1-4" - "9.5" - "PLAY"
  - Adjust, with nuts B and C and screw A, the height of the head so that the 1 kHz signal is still just audible above the noise.

Attention:

The nuts B and C and screw A must be equally turned when the height of the head is being adjusted. Otherwise the adjustment of the head inclination would be changed.

## Adjusting the azimuth

- Insert the test tape into the recorder
- Recorder in position "1-4" - "9.5" - "PLAY"
- Adjust with screw A the azimuth of the head so that the reproduction of the 10-kHz signal is maximal. Consequently, the reproduction of the 1-kHz signal may become stronger. Then the height of the head must be readjusted.

## Adjusting the head mirror

- Connect a mV-meter so socket TAPE IN/OUT (point 5)
- Insert the test tape into the recorder
- Recorder in position "1-4" - "9.5" - "PLAY"

- Pull off the pressure felt pad in front of the head. The meter reading may decrease by 1 dB at most. If the deviation should be larger, loosen screw E and turn the head so that the deviation is  $\leq 1$  dB.
- Check the azimuth adjustment of the head

Attention:

When fitting a new head, push it forwards as much as possible.

## Erase head

Check whether the surface of the core next to the core gap is smooth. If this surface should be rough, the erase head must be replaced; otherwise the tape might be damaged.

A new erase head need not be readjusted. The tape guides of the erase head are a fixed point for the tape transport.

It is therefore suggested to check the tape transport after the erase head has been replaced. If necessary, correct the adjustment of the other tape guides as well. Use an adjusting jig for checking and adjusting.

## Pressure felt pads

Check the condition of the pressure felt pads. If they should have become hard, they must be replaced. Check the pressure force. The force of the felt pad in front of the erase head must be 5...10 g, and is measured at the upperside of bracket 72. To adjust the force, shorten or stretch spring 92. The force of the felt pad in front of the record/playback head must be 20...40 g, and is measured at the upperside of bracket 106. When rings (dia 2.2 mm) are added under spring 109, the force can be increased; by shortening the spring, the force is reduced. The clearance between the pressure roller bearing bracket and the nuts on pull rod 108 must be about 1.5 mm (pressure roller magnet attracted). Be sure that the pull rod can move freely!

## Capstan

Check the adjustment of the capstan (see Service Manual). A slanting capstan causes a heavy wear of the tape. A slanting position of the capstan can be recognised by the stepwise wear of the pressure roller.

## Cleaning

After the heads have been adjusted or replaced, all tape guides, tape tension comparators, the capstan, the pressure roller etc. must be carefully cleaned with alcohol or methylated spirit.

## N4418-N4510

Required tools and measuring instruments:

- Head adjusting jig 4822 403 50718
- Test tape 1 kHz-10 kHz 4822 397 30014
- Spring pressure gauge 3-55 g 4822 395 80029
- mV-meter GM6012 or PM2454B
- Dual-beam oscilloscope PM3230 or PM3130
- LF generator PM5105



CS31379

### Adjusting the head inclination of the record and playback head (Fig. 3)

Carefully check whether the front of the head is perpendicular to the mounting plate.  
Adjust with nut C.

### Adjusting the height of the playback head

- With adjusting jig
  - Place the jig in the recorder (Fig. 4)
  - The upperside of the uppermost core must be situated exactly under the upperside of the adjusting jig. Adjust with nuts B and C and screw A.
- With test tape
  - Insert the test tape into the recorder
  - Recorder in position: "1-4" - "9.5" - "PLAY"
  - Adjust with nuts B and C and screw A, the height of the head so that the 1-kHz signal is still just audible above the noise.

#### Attention:

The nuts B and C and screw A must be equally turned. Otherwise the head inclination would be changed.

### Adjusting the azimuth of the playback head

- Insert the test tape into the recorder
- Recorder in position "1-4" - "NOR" - "9.5" - "PLAY"
- Adjust with screw A the azimuth of the head so that the reproduction of the 10-kHz signal is maximal. Consequently, the reproduction of the 1-kHz signal may become stronger again. Then the height of the head must be readjusted again.

### Adjusting the head mirror of the playback head

- Connect a mV-meter to socket MONITOR (point 5)
- Insert the test tape in the recorder
- Recorder in position "1-4" - "NOR" - "9.5" - "PLAY"
- Pull off the pressure felt pad in front of the head. The meter reading may decrease by 1 dB at most. If the deviation should be larger, loosen screw E and turn the head so that the deviation is  $\leq 1$  dB.
- Check the azimuth adjustment of the head.

#### Attention:

When fitting a new head, push it forwards as much as possible.

### Adjusting the head height, the azimuth and the head mirror of the record head

- Unsolder the wiring from the playback head and resolder it to the record head.
- Connect a mV-meter to socket MONITOR (point 5).
- Insert the test tape into the recorder.
- Recorder in position "1-4" - "NOR" - "9.5" - "PLAY"
- Adjust with nuts B and C and screw D, the height of the head so that the 1-kHz signal is still just audible above the noise.

#### Attention:

The nuts B and C and screw D must be equally turned when the height of the head is being adjusted. Otherwise the head inclination would be changed.

- Adjust with screw D the azimuth of the head so that the reproduction of the 10-kHz signal is maximal. Consequently, the reproduction of the 1-kHz signal may become stronger again. The height of the head must then be readjusted.
- Pull off the pressure felt pad in front of the head. The meter reading may decrease by 1 dB at most. If the deviation should be larger, loosen screw F and turn the head so that the deviation is  $\leq 1$  dB.
- Check the azimuth adjustment.
- Restore the wiring

### Adjusting the phase difference of the record/playback head

This adjustment must be carried out only if the other head adjustments have already been checked.

- Connect an LF generator to socket TAPE IN/OUT (points 3/2 and 5/2) and supply a 1-kHz signal.
- Connect a dual beam oscilloscope to socket MONITOR (for example, the output of the right-hand channel (point 5) to the Ya input and the output of the left-hand channel (point 3) to the Yb output).
- Recorder in position: "TAPE" - "A" - "ST" - "19" - "REC" - "PLAY".
- Adjust with screw D the record head so that the two signals are in phase.
- Check the phase difference also at higher frequencies and readjust the record head, if necessary.

### Erase head

Check whether the surface next to the core gap is smooth. If this surface should have become rough, the erase head must be replaced. Otherwise the tape might be damaged.

A new erase head need not be readjusted. The tape guides of the erase head are a fixed point for the tape transport. Therefore, it is suggested that, after the erase head has been replaced, the tape transport is checked and that, if necessary, the other tape guides are readjusted. Use an adjusting jig for both purposes.

### Pressure felt pads

Check the condition of the pressure felt pads. If they should have become hard, they must be replaced. Check the pressure force. The force of the felt pad in front of the erase head must be 5...10 g, and is measured at the upper side of bracket 88. When spring 55 is shortened or stretched, the force can be adjusted. The force of the felt pads for the record and playback head must be 20...40 g, and is measured at the upperside of bracket 106. When rings (dia. 2.2 mm) are added under spring 109, the force can be increased; shortening the spring results in an decrease in force. The clearance between the pressure roller bearing bracket and the nuts on pull rod 108 must be about 1.5 mm (pressure roller magnet attracted). Check whether the pull rod can move freely!

### Capstan

Check the adjustment of the capstan (see Service Manual). A slanting capstan causes a heavy wear of the tape. A slanting position of the capstan is recognised by the stepwise wear of the pressure roller.

### Cleaning

After the heads have been adjusted or replaced, all tape guides, tape tension comparators, the capstan, the pressure roller, etc. must be carefully cleaned with alcohol or methylated spirit.

### N4450

#### Required tools and measuring instruments:

- |                               |                   |
|-------------------------------|-------------------|
| - Head adjusting jig          | 4822 403 50686    |
| - Test tape 1 kHz - 10 kHz    | 4822 397 30014    |
| - Pressure spring gauge 3-5 g | 4822 395 80029    |
| - mV-meter                    | GM6012 or PM2454B |
| - Dual beam oscilloscope      | PM3230 or PM3130  |
| - LF generator                | PM5105            |

The record and playback heads of the N4450 can be adjusted in the same way as with the N4418-N4510. However, the record and playback head for left transport and the record and playback head for right transport must be adjusted separately.

## A. Modifications apportées aux appareils

### . Version WR09

Sur les appareils portant la marque WR09/243 et les suivants, les résistances suivantes ont été changées:

|                 |                         |
|-----------------|-------------------------|
| R3/R103         | passé de 5,1 à 6,8 kΩ   |
| R4/R104         | passé de 75 kΩ à 100 kΩ |
| R7/R8/R107/R108 | passé de 22 à 7,5 kΩ    |
| R9/R109         | passé de 820 à 270 kΩ   |

(toutes résistances 1/8 W + 5 %)  
Ces modifications ont été apportées afin d'améliorer la dynamique de l'amplificateur d'enregistrement.

Sur les appareils portant la marque WR09/303 et les suivants, les comparateurs de tension de bande 84 sont pourvus d'amortisseurs. Ceux-ci se composent de deux disques en plastique entre lesquels il a été inséré du liquide silicone. Pour ce qui est des numéros de code des nouvelles pièces et de l'ordre de succession du montage, voir fig. 1.

Attention:

Les deux disques en plastique sont pourvus de ce liquide silicone à l'usine et sont pressés de façon spéciale.

Ces disques ne doivent absolument pas être séparés pendant le montage.

Sur les appareils portant la marque WR09/304 et les suivants, la résistance R202 (2,2 kΩ - 1/8 W + 5 %) a été insérée (voir fig. 2). Cette transformation est allée de pair avec le remplacement des diodes D10 et D11 de type BZX88/C3V3 de l'unité RESET/AUTOMATIC REVERSE P201, par des diodes BZX79/C4V7. Cette transformation a été apportée parce que l'appareil s'arrêtait brusquement et sans raison apparente à l'usage de la télécommande N6719.

Sur les appareils portant la marque WR09/304 et les suivants, les bobines L701, L702, L703 et L704 et les condensateurs C704 et C703 sont supprimés. Sur les appareils marqués WR09/309 et les suivants, les condensateurs sont à nouveau montés afin d'éviter les crachements de moteur.

Sur les appareils portant la marque WR09/309 et les suivants, la résistance R39 est passée de 560 Ω à 1,5 kΩ (résistance de sécurité - 4822 110 63112) et le condensateur C14, de 220 μF à 220 μF - 16 V (4822 124 20473). Du fait que C14 en est réduit, la paroi 176 ne cogne plus le condensateur.

Sur les appareils portant la marque WR09/309 et les suivants, les modifications suivantes ont été apportées sur la platine 1 (voir fig. 3):

- les surfaces de connexion pour le soudage des douilles de contact ont été agrandies;
- les supports de lampes sont supprimés parce que les fils des lampes sont soudés directement sur la platine.

Sur les appareils portant la marque WR09/311 et les suivants, il a été monté une paroi d'isolation entre le commutateur SK5 et l'unité P10 (PRE-EMPHASIS/SPEED SELECTOR UNIT). Cette modification a été apportée afin d'éviter la diaphonie des pistes 3 et 1.

Sur les appareils portant la marque WR09/323 et les suivants, les modifications suivantes ont été faites sur la platine 2 (voir fig. 2):

- trace imprimée
- les diodes D277, 278, 279, 280, 281, 282 et les résistances R232, 233, 234 seront montées côté composants de la platine.

### . Version WR10

Sur les appareils portant la marque WR10/334 et les suivants, le transistor TS201 - 2SC931 - est remplacé par un BD437. Numéro de code: 4822 130 40982.

N.B.:

Le Service fournit momentanément sous le numéro

4822 130 40899 le transistor D330D8D, qui peut aussi être utilisé à la place du 2SC931.

Sur les appareils portant la marque WR10/334 et les suivants, la gamme de fréquence est passée de 20.000 Hz à 25.000 Hz à 19 cm/sec. A cet effet, les unités PLAY-BACK et PRE-EMPHASIS/SPEED SELECTOR ont été adaptées. Les nouvelles unités sont livrables sous les numéros suivants:

- PLAY-BACK UNIT: 4822 218 30152
- PRE-EMPHASIS/SPEED SELECTOR UNIT 4822 218 30153

### . Version WR11

Sur les appareils portant la marque WR11/335 et les suivants, les plateaux à bobine sont pourvus d'un anneau-guide en caoutchouc et d'un ressort de terre afin de dévier la charge statique. Les nouveaux plateaux à bobine peuvent être montés au lieu des anciens. Numéro de code: 4822 528 10293.

## B. Complément à la Notice Technique

. Méthode de réglage de l'unité RECORDING P4/P104 modifiée:

Magnétophone

en position : enregistrement-"TAPE"- "B"- "ST"- "NOR"- "9,5"  
commande d'enregistrement "REC" au maximum  
autres commandes au minimum

|         |                       |                                                                                                                                                                                                                                                |
|---------|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Entrée: | BU2 TAPE IN/OUT 3/2   | 333 Hz - 0,1 V                                                                                                                                                                                                                                 |
| Sortie: | BU5 MONITOR 3/2       | régler sur 1 V avec R4 sur P5                                                                                                                                                                                                                  |
| Entrée: | BU2 TAPE IN/OUT 5/2   | 333 Hz - 0,1 V                                                                                                                                                                                                                                 |
| Sortie: | BU5 MONITOR 5/2       | régler sur 1 V avec R4 sur P105                                                                                                                                                                                                                |
| Entrée: | BU2 TAPE IN/OUT 5/2   | 333 Hz - 1 V                                                                                                                                                                                                                                   |
| Sortie: | BU5 MONITOR 5/2       | régler avec la commande d'enregistrement "REC" sur 1 V                                                                                                                                                                                         |
| Entrée: | BU2 TAPE IN/OUT 3/2   | 333 Hz - 1 V                                                                                                                                                                                                                                   |
| Sortie: | BU5 MONITOR 3/2       | valeur à mesurer 1 V + x V (x = max. 0,8 V). Diviser en deux la différence par rapport à 1 V avec R4 sur P5. régler sur 1,5 mV avec R9 sur P4                                                                                                  |
| Sortie: | BU4 PHONO 6/2 (MP1)   | 333 Hz - 1 V                                                                                                                                                                                                                                   |
| Entrée: | BU2 TAPE IN/OUT 5/2   | valeur à mesurer 1 V + y V (y = max. 0,8 V). Diviser en deux la différence par rapport à 1 V avec R4 sur P105. Si par la suite on obtient $\frac{x}{2} \neq \frac{y}{2}$ diviser de nouveau en deux la tension de différence par rapport à 1 V |
| Sortie: | BU4 PHONO 7/2 (MP101) | Régler sur 1,5 mV avec R9 sur P104                                                                                                                                                                                                             |

Attention:

Afin d'éviter que la tension de prémagnétisation ne soit aussi mesurée, enlever l'unité d'oscillateur P9.

. Correction du réglage du courant de prémagnétisation

Le commutateur SK3 "B-A" doit se trouver en position "A" pour ce réglage.

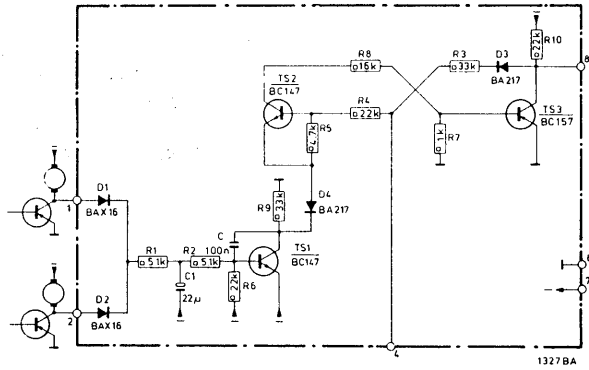
. Dans certains cas, il peut arriver que le champ de l'anneau aimanté monté sur la poulie du moteur de cabestan M3, se réduise. Ceci pourra être constaté en mesurant la tension de sortie de la tête K4. On trouvera ci-dessous une table donnant ces tensions aux différentes vitesses.

| Vitesse     | Tension de sortie K4 |
|-------------|----------------------|
| 4,75 cm/sec | 54 mV                |
| 9,5 cm/sec  | 110 mV               |
| 19 cm/sec   | 175 mV               |

. Dans la partie I de la Notice Technique, il est donné l'impression dans la description de l'étage de sortie, que ce circuit est protégé contre les court-circuits de la sortie. L'étage de sortie n'est en fait protégé que contre la panne résultant de signaux d'entrée trop élevés.

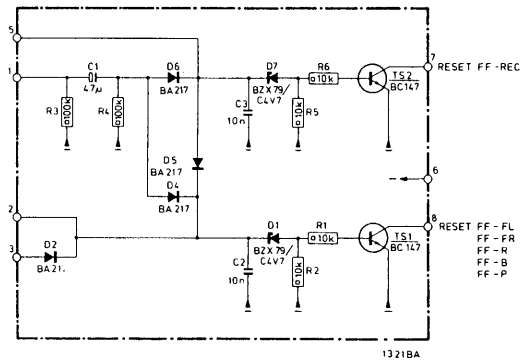
## MOTOR STOP UNIT

N4418, N4510



## RECORDER STOP UNIT

N4418, N4510



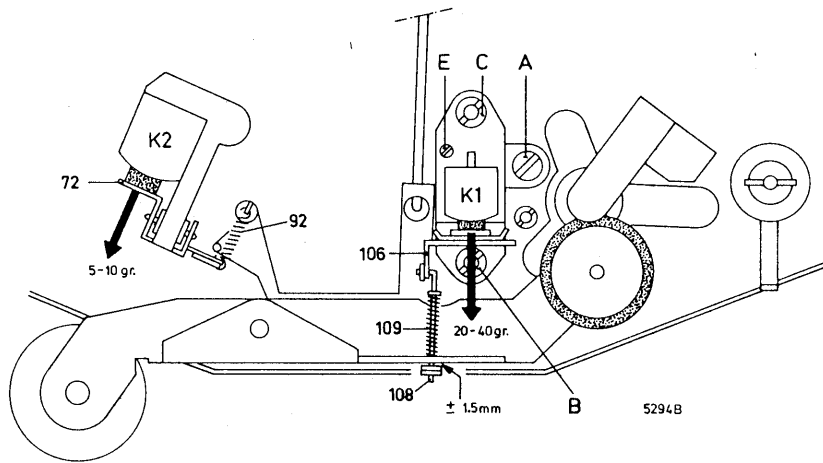


Fig. 1

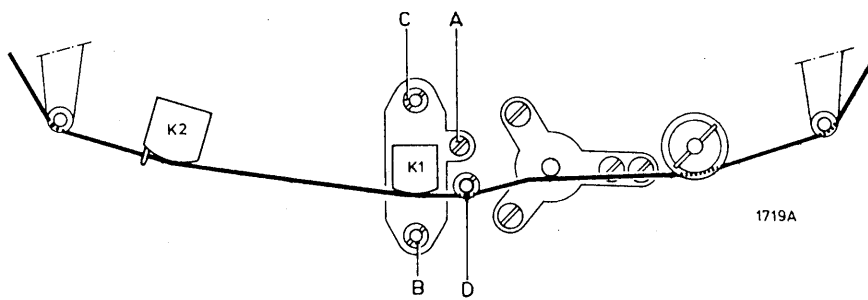


Fig. 2

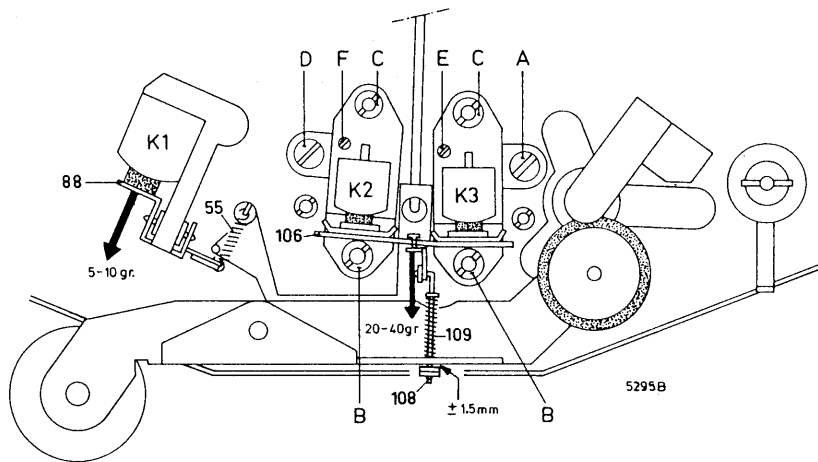


Fig. 3

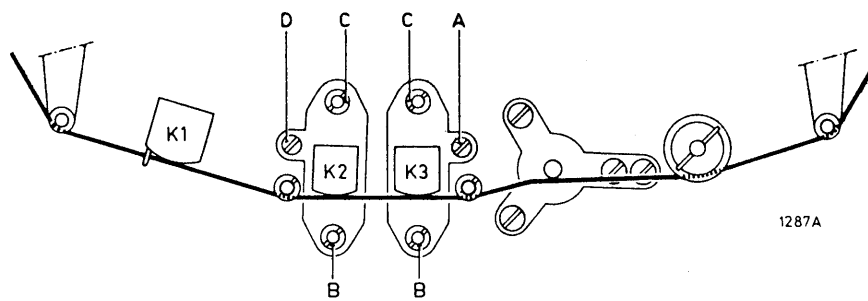


Fig. 4

# Service Information

1975-10-23

REEL - to REEL RECORDERS

AR 75-13

## Concerning: Replacing the heads.

The heads 4822 249 10057 and 4822 249 20032 may be replaced by the heads 4822 249 10085 and 4822 249 20037 respectively, which are of the long-life type.

However, when the replacement types are used, the bias current adjustment is more critical. The approximate value of the bias current, when long-life heads are used, is 4 dB lower than when mu-metal heads are employed. Anyhow, a compromise between the frequency response and distortion must be found:

- If there are too few treble tones and if distortion is too great, the bias current must be reduced.
- If there are too many treble tones and if distortion should be too great, the bias current must be increased.

Distortion must not exceed 3 %.

## Betreft: Vervangen van koppen.

De koppen 4822 249 10057 en 4822 249 20032 kunnen worden vervangen door de koppen 4822 249 10085 resp. 4822 249 20037. Deze laatste zijn van het "long-life" type.

Bij vervangen is het instellen van de voormagnetisatiestroom kritischer. De richtwaarde van de voormagnetisatiestroom bij "long-life" koppen is 4 dB lager dan bij "mu-metalen" koppen.

In alle gevallen geldt een kompromis tussen de frekwentie-karakteristiek en de vervorming:

- Bij te weinig hoge tonen en te grote vervorming moet de voormagnetisatiestroom verlaagd worden.
- Bij te veel lage tonen en te grote vervorming moet de voormagnetisatiestroom verhoogd worden.

De vervorming moet kleiner dan 3 % zijn.

## Concernant: Remplacement de têtes.

Les têtes 4822 249 10057 et 4822 249 20032 peuvent être remplacées par, respectivement, les têtes 4822 249 10085 ou 4822 249 20037; ces dernières étant de type "long-life".

Lors du remplacement le réglage du courant de pré-magnétisation est plus critique. La valeur d'orientation pour le courant de pré-magnétisation avec des têtes de type "long-life" est inférieure de 4 dB à celle avec têtes au  $\mu$ -métal. Dans les deux cas, un compromis entre la courbe de fréquence et la distortion doit être trouvé:

- En présence d'un manque de tous aigus et de trop de distortion, le courant de pré-magnétisation doit être réduit
- En présence de trop d'aigus et d'une trop forte distortion, le courant de pré-magnétisation devra être baissé.

La distortion doit être inférieure à 3 %.

## Betrifft: Ersetzen der Köpfe.

Die Köpfe 4822 249 10057 und 4822 249 20032 darf man durch die Köpfe 4822 249 10085 bzw. 4822 249 20037 ersetzen. Die Ersatz-Köpfe sind vom "long-life" Typ.

Beim Ersetzen ist zu berücksichtigen, dass das Einstellen des Vormagnetisierungs-stromes kritischer ist. Der Dichtwert des Vormagnetisierungs-stromes ist bei "long-life" Köpfen um ca 4 dB niedriger als bei Mu-Metall-Köpfen. Es ist jedenfalls ein Kompromiss zwischen dem Frequenzgang und der Verformung anzustreben:

- Bei zu wenig hohen Tönen und zu grosser Verformung ist der Vormagnetisierungs-strom zu erniedrigen.
- Bei zu viel hohen Tönen und zu grosser Verformung ist die Vormagnetisierungs-strom zu erhöhen.

Die Verformung soll geringer als 3 % sein.

ES LIMITEDAMENDMENTS AND ADDITIONS TO N4450 SERVICE MANUALREVISED CIRCUIT DIAGRAM, CABINET AND MECHANICAL EXPLODED VIEWS

During production several changes have been made to the N4450 tape recorder, details of which are given in the following paragraphs.

Models bearing Factory Code WRO4-144 and onwards

Pulleys 55 are secured by means of 2 Allen screws 3mm x 8mm (Item 4). For code number see spare parts list.

Models bearing Factory Code WRO5-147 and onwards

In order to extend the life of the lamps, safety resistors R43, R44, R45, R46 180 $\Omega$  have been added in series with lamps LA1, LA2, LA3, LA4 respectively.

In addition the values of safety resistors R47 and R48 have been changed from 22 $\Omega$  to 120 $\Omega$ .

For code numbers of safety resistors see spare parts list.

Models bearing Factory Code WRO6-147 and onwards

An 80mA fuse was added in series with timer motor M4, and this fuse continued in use until version WRO8-206 appeared, at which time the fuse was changed to 250mA-T. For code number see spare parts list.

Model bearing Factory Code WRO7 and onwards

In recorders marked -149 serial number 4600 and onwards transistors type 16-175 (2N6107) were introduced to control the winding motors. For code number see spare parts list.

Models marked -150 and onward had a recess made to the right of bracket 540 in order that bracket 550 might be adjustable. The adjustment was necessary in cases when switch SK9 (Fast-Med-Slow) failed to operate.

Models bearing Factory Code WRO8 and onwards

Recorders marked -203 and onward incorporate the following changes.

- (a) The screws (11) securing the capstan motor 173 to bracket 531 have been sealed with locking paint.
- (b) Ornamental frame 180 is fitted with 10 retaining screws rather than six. The code number of the 10 hole frame 180 remains the same i.e. 460.20067.
- (c) To prevent a grinding sound when the recorder is tilted forward, a washer (200) was fitted between each flywheel 95 and capstan bearing 88. Washer code number 532.50301.
- (d) The lower part of ornamental cover 136 can be fixed in position when opened.

Cover 136 complete with closing bracket 140 continues with the same code number i.e. 443.20071.

Closing bracket 140 code number 403.50738.

/Cont'd....

- (e) In this model fuse Z701 in series with motor M4 changed from 80mA to 250mA-T. (See models bearing Factory Code WRO6-147).

Models bearing Factory Code WRO9 and onwards

In versions coded -210 onwards head adjusting screws 96 have finer threads to facilitate precise adjustments of the heads.

In versions coded -227 onwards thermal conduction between TS701/702 and their mounting plate has been improved by means of silicone paste.

In versions coded -238 (serial number 6001) onwards on extra bracket 542 has been fitted to prevent movement of oil seals 87.

MULTI-WAY CONNECTORS

The various functional units are connected to printed circuit boards 1 and 2 via multi-way connectors with provision for a total of 3, 8 or 14 contacts. As the circuits of the units vary, different combinations of pin arrangements are required on many connectors.

For servicing purposes, only 3 types of connector will be supplied, 3, 8, and 14 pole versions each complete with a full set of connecting pins.

Un-necessary contacts should be removed before fitting.

SPARE PARTS LIST

(Additions and Amendments only)

MECHANICAL PARTS

Item

|    |                        |           |
|----|------------------------|-----------|
| 2  | Screw 3mm x 4mm        | 502.11069 |
| 4  | Screw 3mm x 8mm        | 502.10174 |
| 5  | Nut 5mm                | 505.10513 |
| 8  | Washer 3.2 x 7 x 0.3mm | 532.50298 |
| 9  | Washer 4.2 x 8 x 0.5mm | 532.10333 |
| 14 | Washer 3.2 x 6 x 0.4mm | 530.80082 |
| 17 | Washer 3.2 x 9 x 0.8mm | 532.10582 |
| 24 | Circlip                | 530.70116 |
| 25 | Washer 3.2 x 7 x 0.5mm | 532.10332 |
| 26 | Screw 3 x 4mm          | 502.11189 |
| 27 | Washer                 | 532.10332 |
| 29 | Washer 3.2 x 4.5 x 0.3 | 532.50938 |
| 32 | Screw 3 x 20mm         | 502.11096 |
| 33 | Spacer 3.1 x 16 x 5mm  | 532.20607 |
| 35 | Screw 2 x 8mm          | 502.10681 |
| 47 | Screw 4 x 8mm          | 502.10693 |
| 49 | Washer 4.2 x 8 x 0.1mm | 532.10479 |

/Cont'd....

Item

|     |                        |           |
|-----|------------------------|-----------|
| 50  | Washer 3.2 x 8 x 0.2mm | 532.50298 |
| 57  | Belt                   | 358.30145 |
| 60  | Bearing                | 502.10765 |
| 71  | Washer                 | 532.30266 |
| 79  | Belt                   | 358.30045 |
| 96  | Screw                  | 502.10665 |
| 97  | Screw 3mm              | 502.11217 |
| 98  | Nut 3mm                | 505.10408 |
| 104 | Pressure spring        | 492.50925 |
| 105 | Bearing                | 535.70468 |
| 110 | Grommet                | 528.80545 |
| 200 | Washer 5.2 x 9 x 0.5mm | 532.50301 |
| 201 | Screw 3 x 8mm          | 502.11053 |
| 202 | Washer 3.6 x 12 x 1mm  | 532.10489 |
| 203 | Washer                 | 532.50786 |
| 204 | Tension spring         | 492.30355 |
| 205 | Belt damper            | 479.30045 |

CABINET AND AMPLIFIER

Item

|     |                                   |           |
|-----|-----------------------------------|-----------|
| 3   | Washer                            | 532.50725 |
| 15  | Nut 3mm                           | 505.10325 |
| 39  | Screw 4 x 30mm                    | 502.10053 |
| 40  | Screw 3mm                         | 502.11287 |
| 41  | Screw 3.9 x 9.13mm                | 502.30006 |
| 43  | Screw 4 x 22mm                    | 502.10051 |
| 44  | Screw (self-tapping) 2.9 x 15mm   | 502.30048 |
| 45  | Screw (self-tapping) 2.9 x 4.37mm | 502.30065 |
| 118 | Support                           | 325.20063 |
| 131 | Hinge                             | 417.10516 |
| 139 | Meter ME101                       | 347.10069 |
| 140 | Bracket                           | 403.50738 |
| 141 | Meter ME1                         | 347.10071 |
| 149 | Socket cover plate                | 459.80039 |
| 151 | Ball 5/32"                        | 520.40012 |
| 154 | Pin                               | 535.90912 |
|     | Ball for switch SK5               | 535.90913 |
| 155 | Pressure spring                   | 492.50927 |
|     | Pressure spring for switch        |           |
|     | Fast-Med-Slow                     | 492.51037 |
| 187 | Screw 3 x 4mm                     | 502.10663 |
| 190 | Lens                              | 381.10401 |
| 191 | Lamp holder                       | 256.90135 |

ELECTRICAL MISCELLANEOUS

(a) Control section

|                                    |           |
|------------------------------------|-----------|
| Switch SK8 (NOR-REV)               | 277.30378 |
| Switch 702 (Counter)               | 278.90231 |
| Plug for BU201                     | 264.50043 |
| TS201 Transistor 2SC931            | 130.40899 |
| TS701 ) Transistor 16-175 (2N6107) | 130.40903 |
| TS702 )                            |           |
| Lamp holder for LA601 - LA606      | 401.10561 |

(b) Supply

|                              |           |
|------------------------------|-----------|
| Switch SK105 Voltage adaptor | 272.10202 |
| Lamp LA8/9 19V-50mA (timer)  | 134.40078 |
| Lamp-holder for LA1 - LA4    | 256.90135 |
| Lamp-holder for LA701, 702   | 401.10561 |
| Holder for fuses Z501,502    | 492.60063 |
| Holder for fuse Z701         | 256.30128 |
| Fuse Z701 250mA-T            | 253.30013 |

Safety Resistors

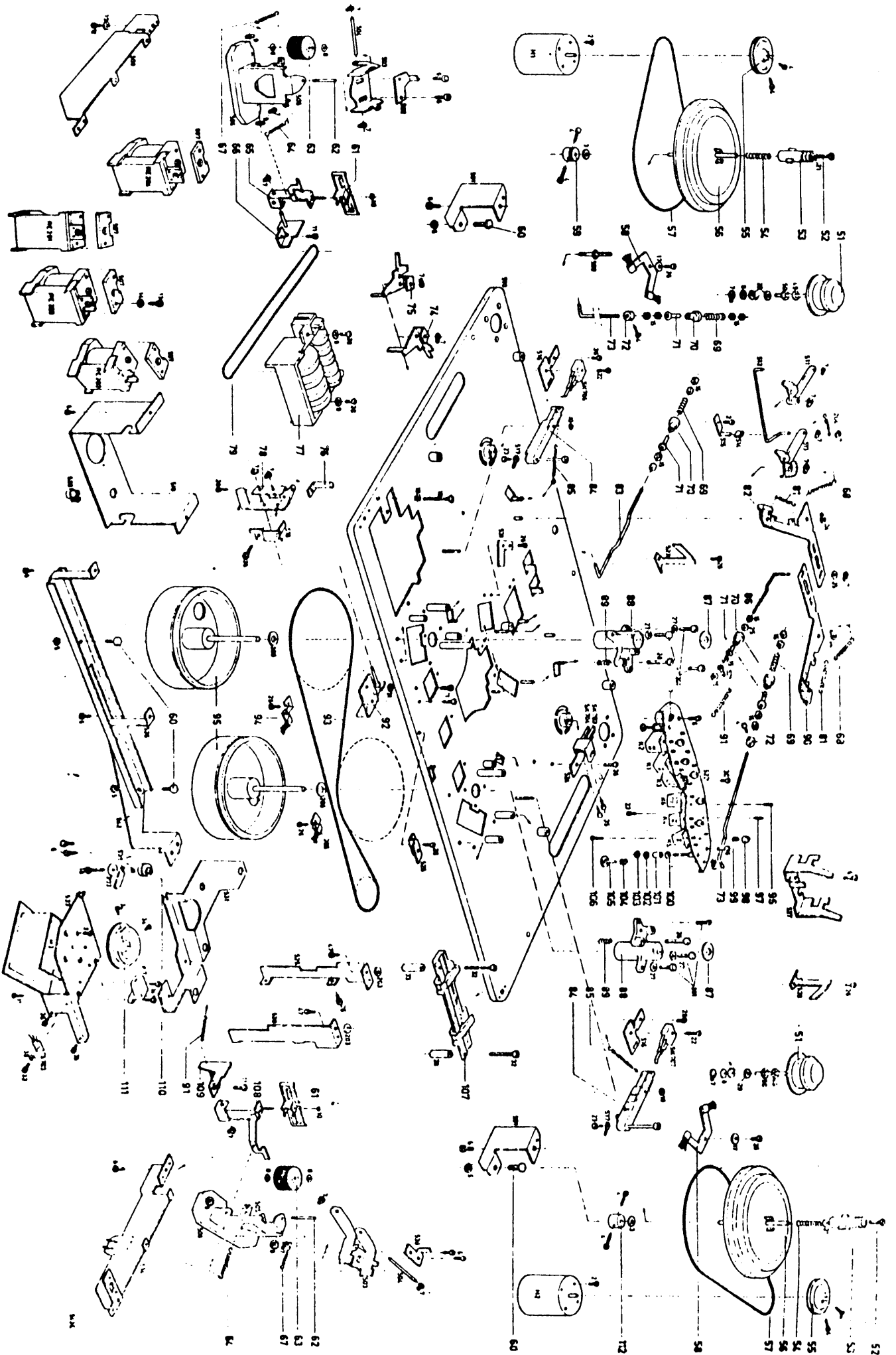
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|---------------|--------------|-----------|
| R35           | 10k $\Omega$ | 110.53134 |
| R36,R132      | 68 $\Omega$  | 110.53076 |
| R37           | 330 $\Omega$ | 110.43094 |
| R38           | 820 $\Omega$ | 111.30424 |
| R39           | 560 $\Omega$ | 111.30374 |
| R40           | 1k $\Omega$  | 111.30404 |
| R41           | 3k3 $\Omega$ | 111.30413 |
| R42           | 3k $\Omega$  | 111.30442 |
| R47,R48       | 120 $\Omega$ | 111.50135 |
| R43,R44,R45   |              |           |
| R46,R133,R134 | 180 $\Omega$ | 110.43087 |
| R502          | 33 $\Omega$  | 111.30418 |

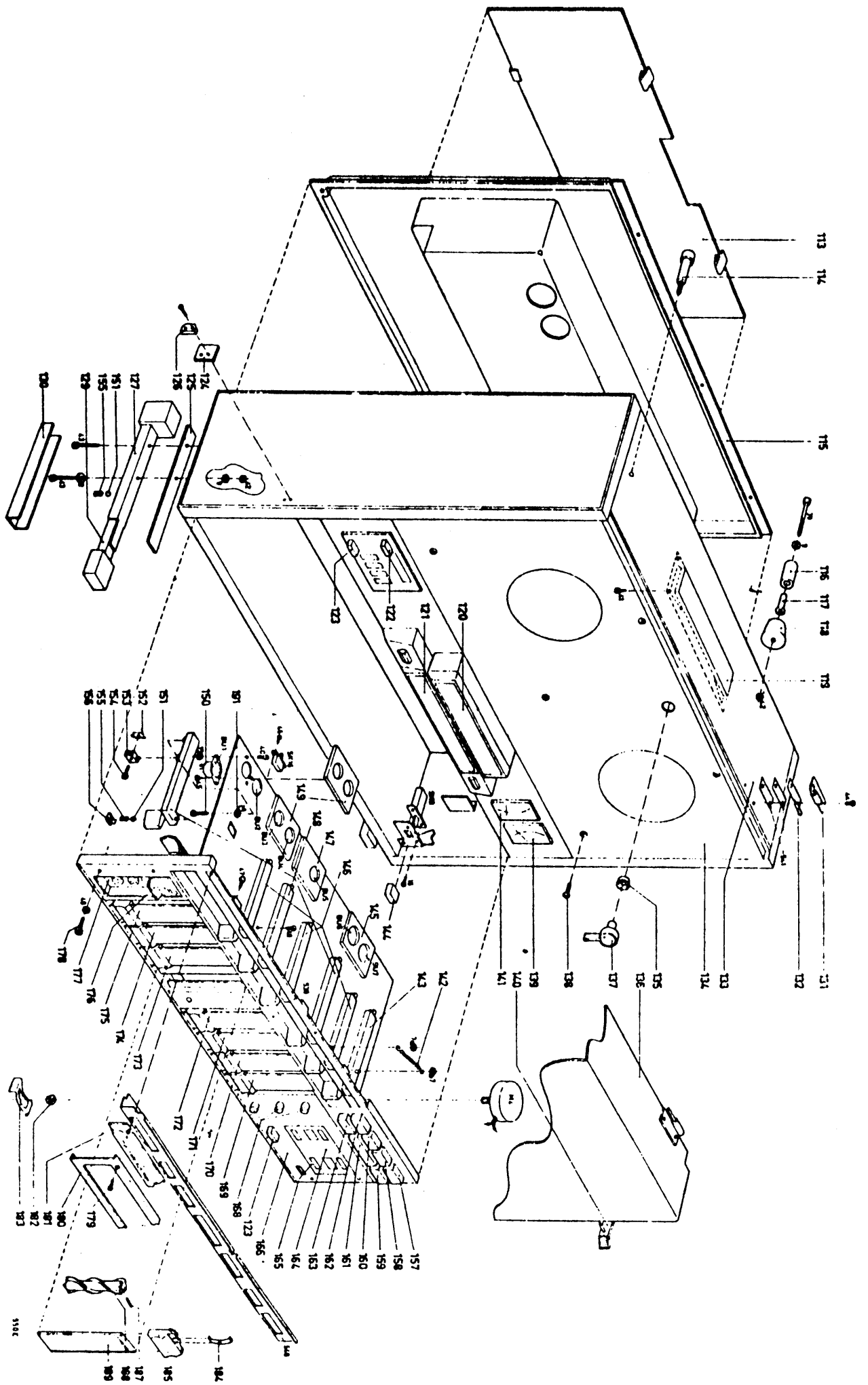
(c) Amplifier

|                                        |              |           |
|----------------------------------------|--------------|-----------|
| Switches SK703,704                     | 278.90232    |           |
| Contact spring for BU8 - BU10 (signal) | 268.20032    |           |
| Contact spring for BU8 - BU10 (earth)  | 492.61313    |           |
| Plug for BU1 - BU5, and BU8 - BU10     | 264.40023    |           |
| Plug for BU6, BU7                      | 264.30041    |           |
| Plug for BU11                          | 264.40092    |           |
| Adjusting core for L301 - L304         | 526.10014    |           |
| Plug on multiple cable 14 pole         | 264.50079    |           |
| C13                                    | 150uF - 25V  | 124.20388 |
| C508                                   | 330uF - 63V  | 124.20404 |
| C705                                   | 1000uF - 63V | 124.70215 |

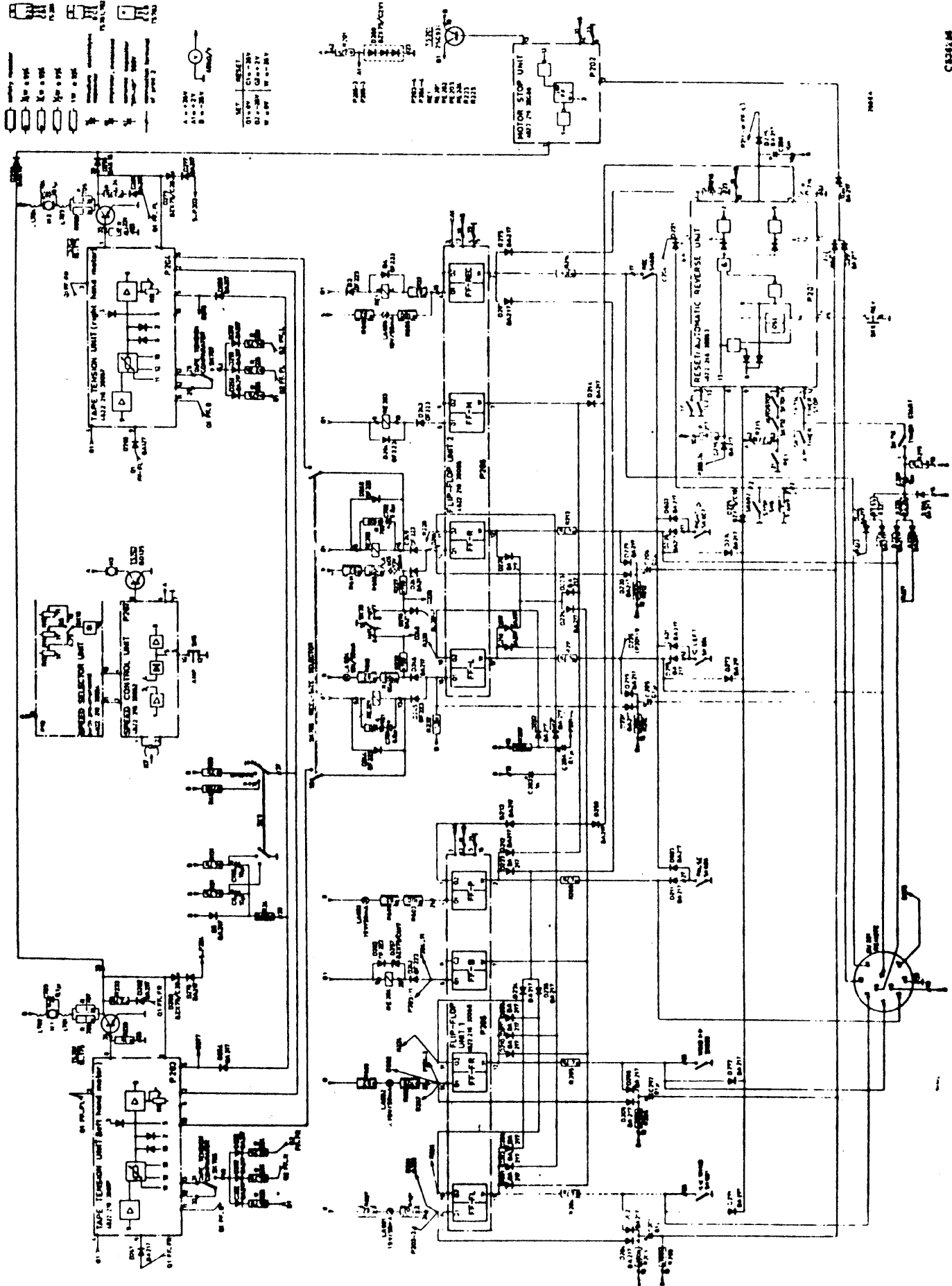
Safety Resistors

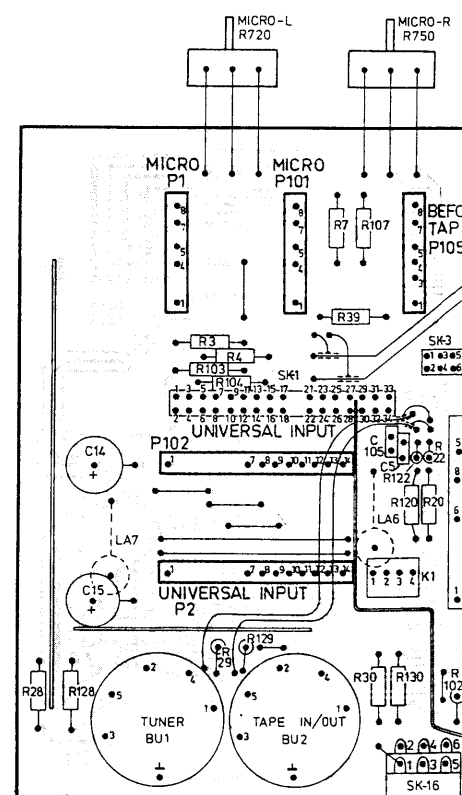
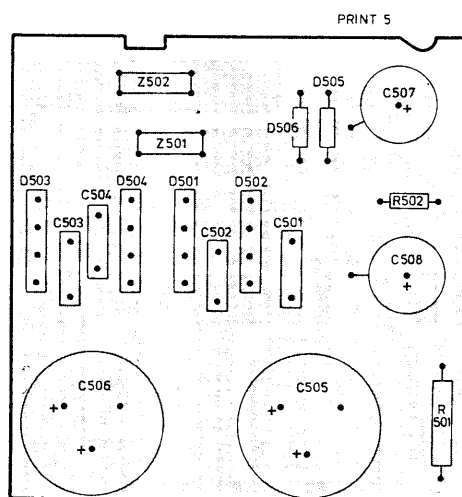
|           |             |           |
|-----------|-------------|-----------|
| R15, R115 | 20 $\Omega$ | 111.50372 |
|-----------|-------------|-----------|

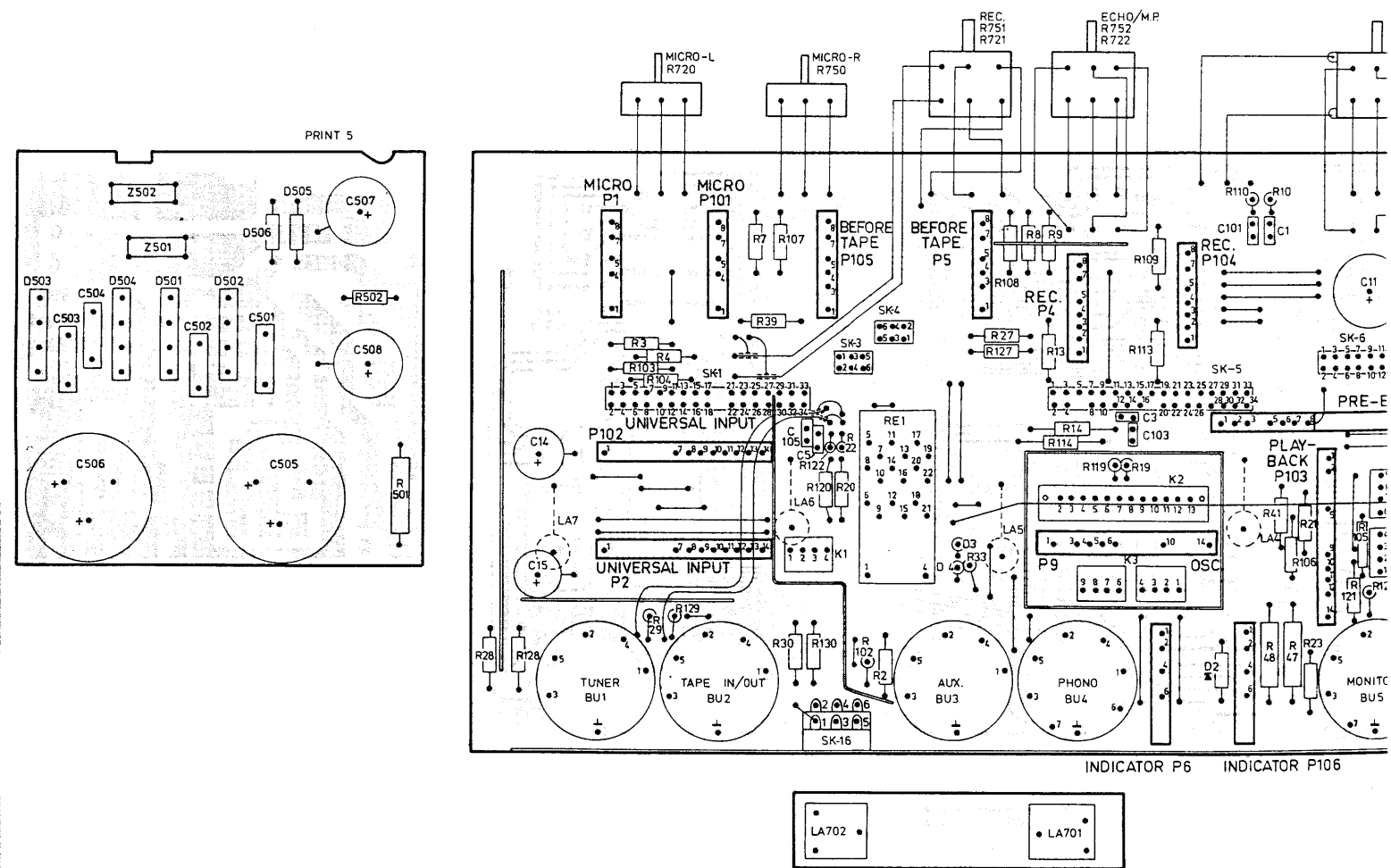
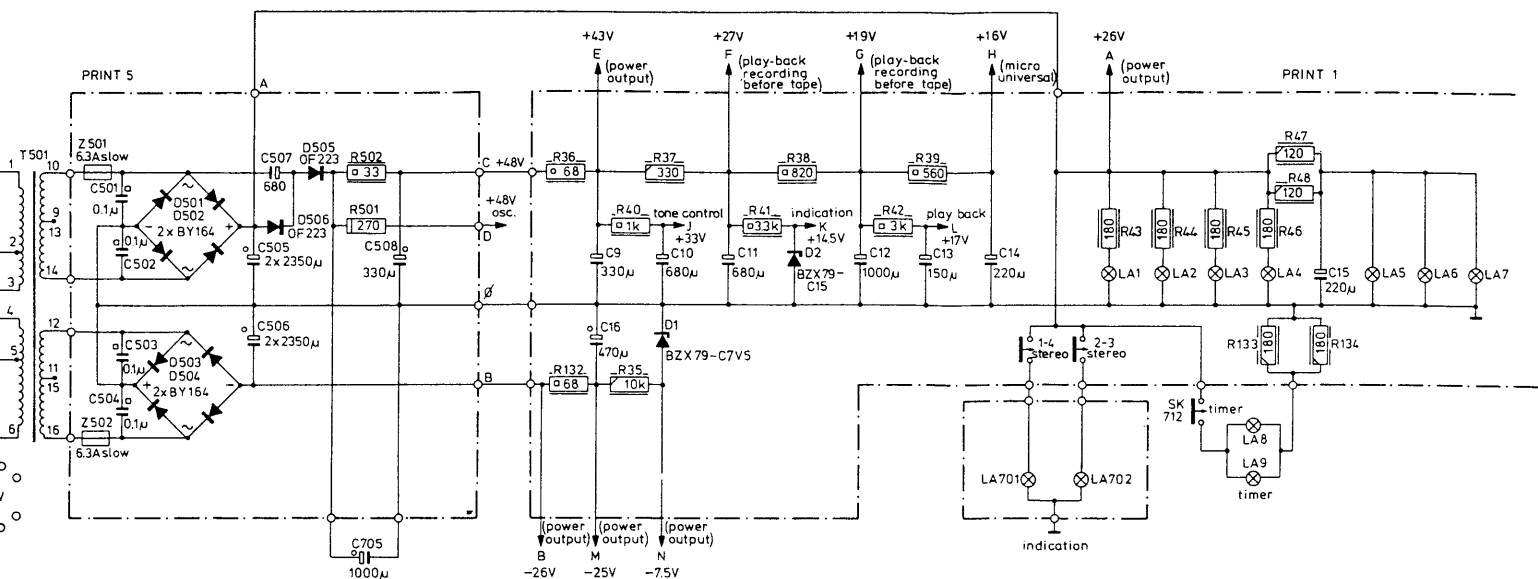


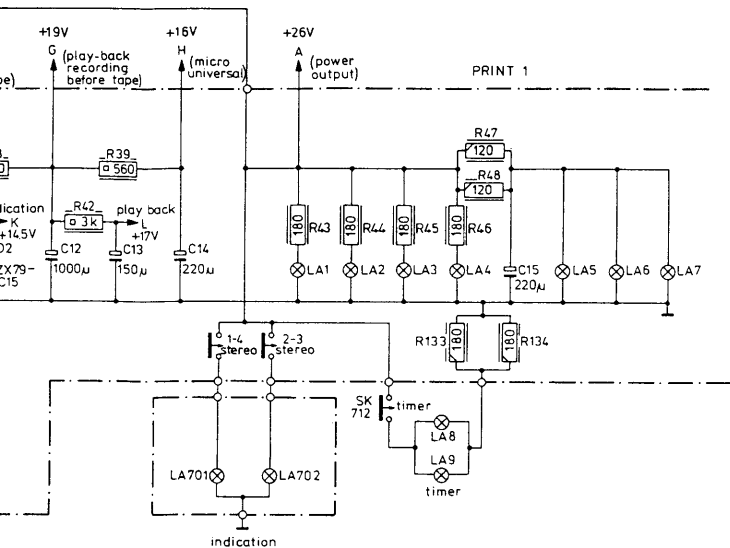


| WIRE NO. | TO   | FROM | WIRE NO. | TO   | FROM | WIRE NO. | TO   | FROM | WIRE NO. | TO   | FROM |
|----------|------|------|----------|------|------|----------|------|------|----------|------|------|
| 1        | 2    | 3    | 4        | 5    | 6    | 7        | 8    | 9    | 10       | 11   | 12   |
| 13       | 14   | 15   | 16       | 17   | 18   | 19       | 20   | 21   | 22       | 23   | 24   |
| 25       | 26   | 27   | 28       | 29   | 30   | 31       | 32   | 33   | 34       | 35   | 36   |
| 37       | 38   | 39   | 40       | 41   | 42   | 43       | 44   | 45   | 46       | 47   | 48   |
| 49       | 50   | 51   | 52       | 53   | 54   | 55       | 56   | 57   | 58       | 59   | 60   |
| 61       | 62   | 63   | 64       | 65   | 66   | 67       | 68   | 69   | 70       | 71   | 72   |
| 73       | 74   | 75   | 76       | 77   | 78   | 79       | 80   | 81   | 82       | 83   | 84   |
| 85       | 86   | 87   | 88       | 89   | 90   | 91       | 92   | 93   | 94       | 95   | 96   |
| 97       | 98   | 99   | 100      | 101  | 102  | 103      | 104  | 105  | 106      | 107  | 108  |
| 109      | 110  | 111  | 112      | 113  | 114  | 115      | 116  | 117  | 118      | 119  | 120  |
| 121      | 122  | 123  | 124      | 125  | 126  | 127      | 128  | 129  | 130      | 131  | 132  |
| 133      | 134  | 135  | 136      | 137  | 138  | 139      | 140  | 141  | 142      | 143  | 144  |
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| 253      | 254  | 255  | 256      | 257  | 258  | 259      | 260  | 261  | 262      | 263  | 264  |
| 265      | 266  | 267  | 268      | 269  | 270  | 271      | 272  | 273  | 274      | 275  | 276  |
| 277      | 278  | 279  | 280      | 281  | 282  | 283      | 284  | 285  | 286      | 287  | 288  |
| 289      | 290  | 291  | 292      | 293  | 294  | 295      | 296  | 297  | 298      | 299  | 300  |
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| 541      | 542  | 543  | 544      | 545  | 546  | 547      | 548  | 549  | 550      | 551  | 552  |
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| 697      | 698  | 699  | 700      | 701  | 702  | 703      | 704  | 705  | 706      | 707  | 708  |
| 709      | 710  | 711  | 712      | 713  | 714  | 715      | 716  | 717  | 718      | 719  | 720  |
| 721      | 722  | 723  | 724      | 725  | 726  | 727      | 728  | 729  | 730      | 731  | 732  |
| 733      | 734  | 735  | 736      | 737  | 738  | 739      | 740  | 741  | 742      | 743  | 744  |
| 745      | 746  | 747  | 748      | 749  | 750  | 751      | 752  | 753  | 754      | 755  | 756  |
| 757      | 758  | 759  | 760      | 761  | 762  | 763      | 764  | 765  | 766      | 767  | 768  |
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| 805      | 806  | 807  | 808      | 809  | 810  | 811      | 812  | 813  | 814      | 815  | 816  |
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| 841      | 842  | 843  | 844      | 845  | 846  | 847      | 848  | 849  | 850      | 851  | 852  |
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| 889      | 890  | 891  | 892      | 893  | 894  | 895      | 896  | 897  | 898      | 899  | 900  |
| 901      | 902  | 903  | 904      | 905  | 906  | 907      | 908  | 909  | 910      | 911  | 912  |
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| 925      | 926  | 927  | 928      | 929  | 930  | 931      | 932  | 933  | 934      | 935  | 936  |
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| 997      | 998  | 999  | 1000     | 1001 | 1002 | 1003     | 1004 | 1005 | 1006     | 1007 | 1008 |
| 1009     | 1010 | 1011 | 1012     | 1013 | 1014 | 1015     | 1016 | 1017 | 1018     | 1019 | 1020 |
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| 1117     | 1118 | 1119 | 1120     | 1121 | 1122 | 1123     | 1124 | 1125 | 1126     | 1127 | 1128 |
| 1129     | 1130 | 1131 | 1132     | 1133 | 1134 | 1135     | 1136 | 1137 | 1138     | 1139 | 1140 |
| 1141     | 1142 | 1143 | 1144     | 1145 | 1146 | 1147     | 1148 | 1149 | 1150     | 1151 | 1152 |
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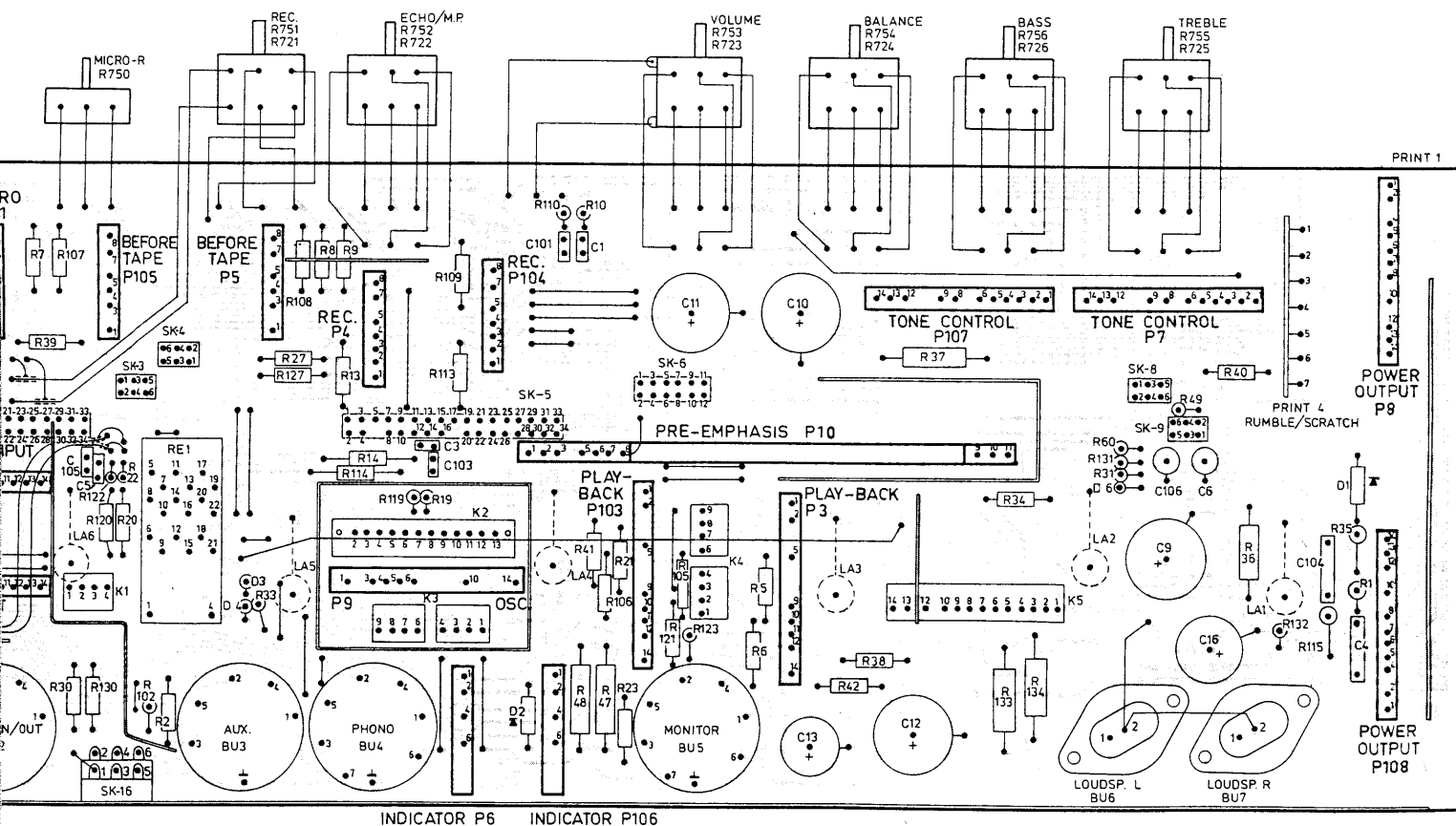






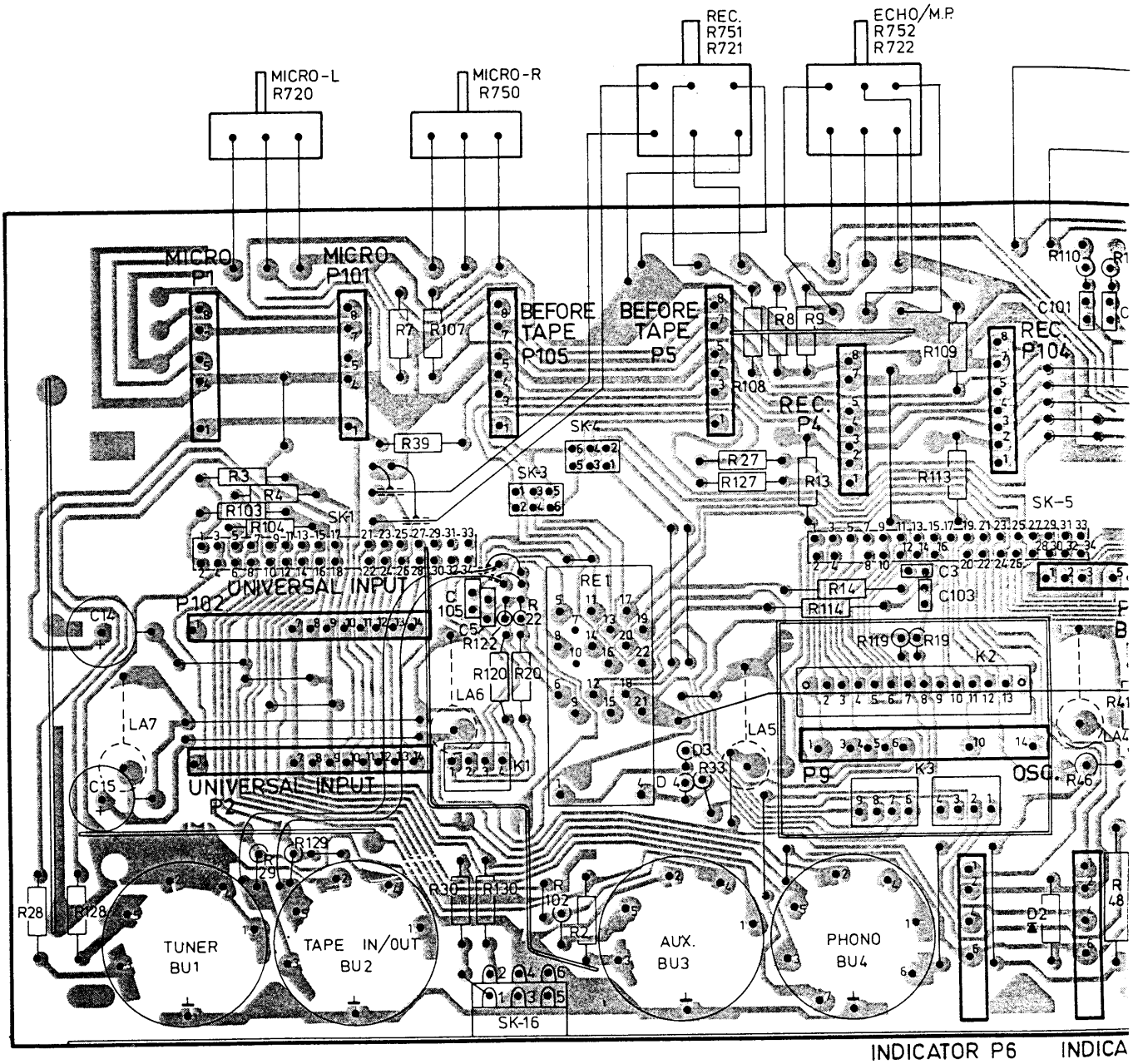
40kΩ/V  
 A = +26V  
 B = -26V  
 C = +48V  
 D = +50V  
 E = +43V  
 F = +27V  
 G = +19V  
 H = +16V  
 J = +33V  
 K = +14.5V  
 L = +17V  
 M = -25V  
 N = -7.5V

safety resistor  
 1/8W ± 5%  
 1/4W ± 5%  
 1/2W ± 5%  
 5.5W ± 5%  
 POLYESTER CAPACITOR 250 V  
 MINIATURE ELECTROLYTIC CAPACITOR  
 LAMP 28V/40mA



585FA

CS36288



INDICATOR P6 INDICA

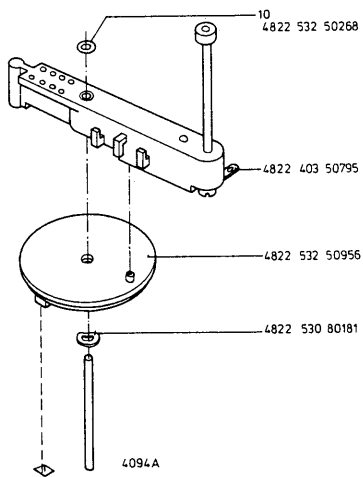


Fig. 1

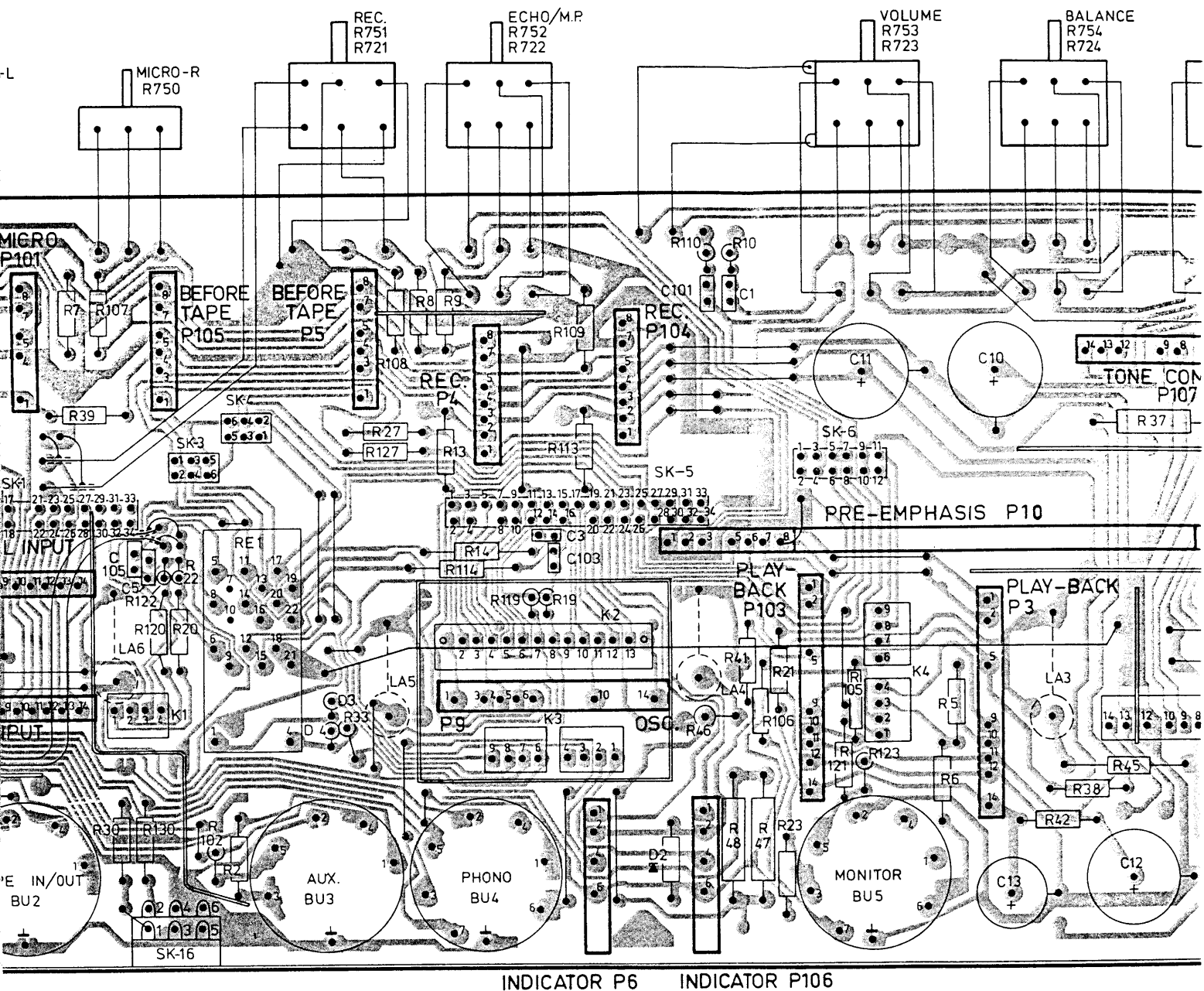


Fig. 3

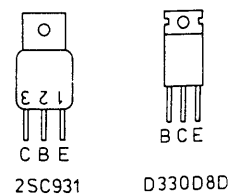
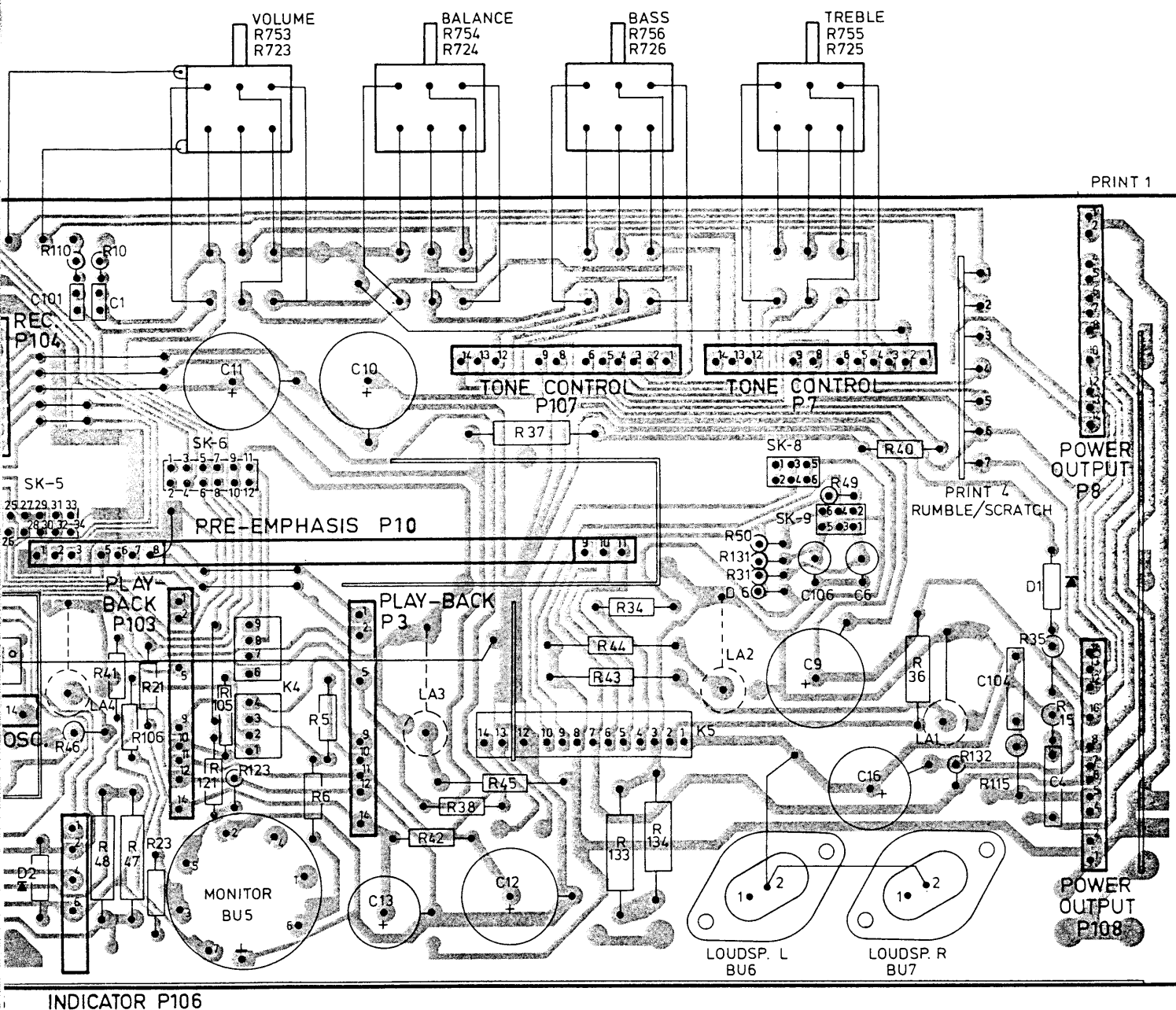


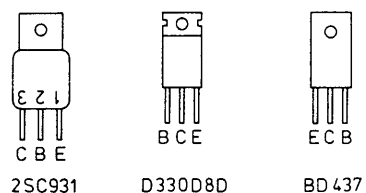
Fig. 4



INDICATOR P106

585FB

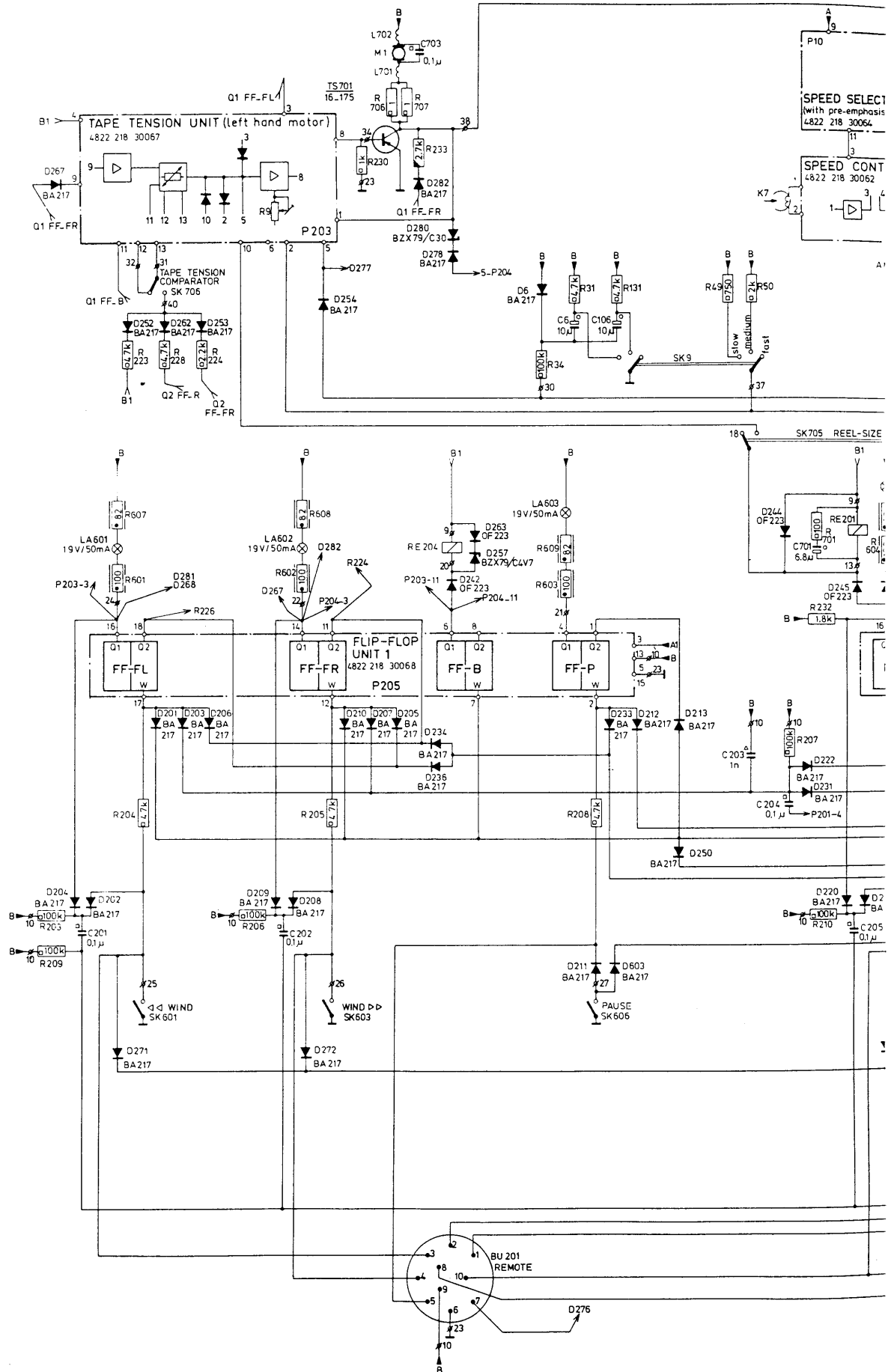
Fig. 3

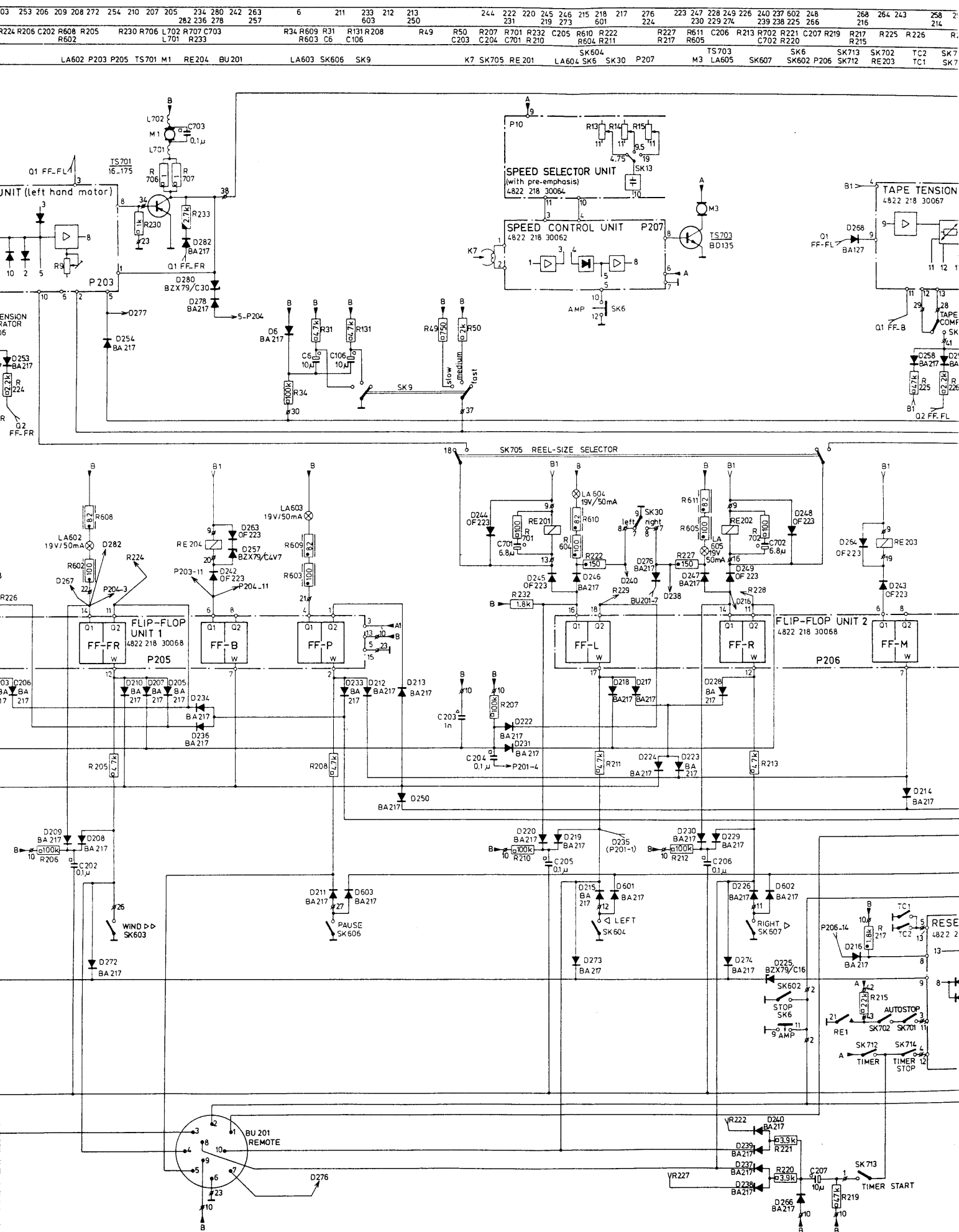


4174 A

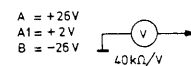
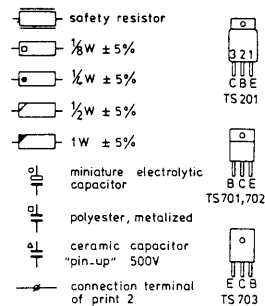
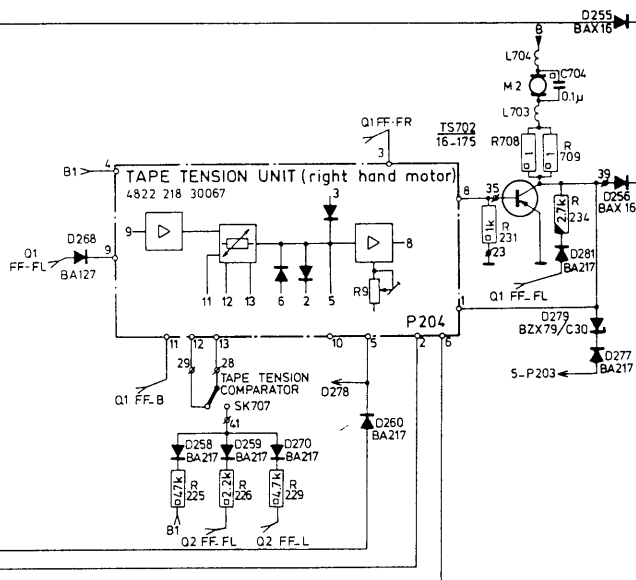
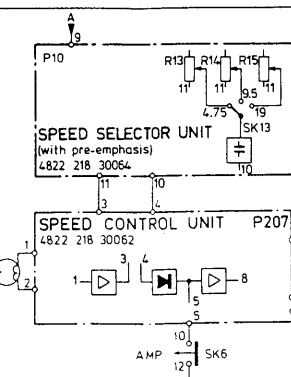
Fig. 4

|        |       |       |       |       |      |      |       |      |       |       |       |       |      |      |       |       |      |     |      |      |     |     |      |      |      |      |      |      |     |
|--------|-------|-------|-------|-------|------|------|-------|------|-------|-------|-------|-------|------|------|-------|-------|------|-----|------|------|-----|-----|------|------|------|------|------|------|-----|
| D.     | 267   | 204   | 252   | 262   | 203  | 253  | 206   | 209  | 208   | 272   | 254   | 210   | 207  | 205  | 234   | 280   | 242  | 263 | 6    | 211  | 233 | 212 | 213  | 250  | 244  | 222  | 220  | 245  | 246 |
| R.C.L. | R203  | R607  | R223  | R204  | R228 | R224 | R206  | C202 | R608  | R205  | R230  | R706  | L702 | R707 | C703  | R34   | R609 | R31 | R131 | R208 | R49 | R50 | C203 | R207 | R701 | R232 | C205 | R219 | 273 |
| MISC.  | LA601 | SK601 | SK706 | LA602 | P203 | P205 | TS701 | M1   | RE204 | BU201 | LA603 | SK606 | SK9  | K7   | SK705 | RE201 | LA60 |     |      |      |     |     |      |      |      |      |      |      |     |



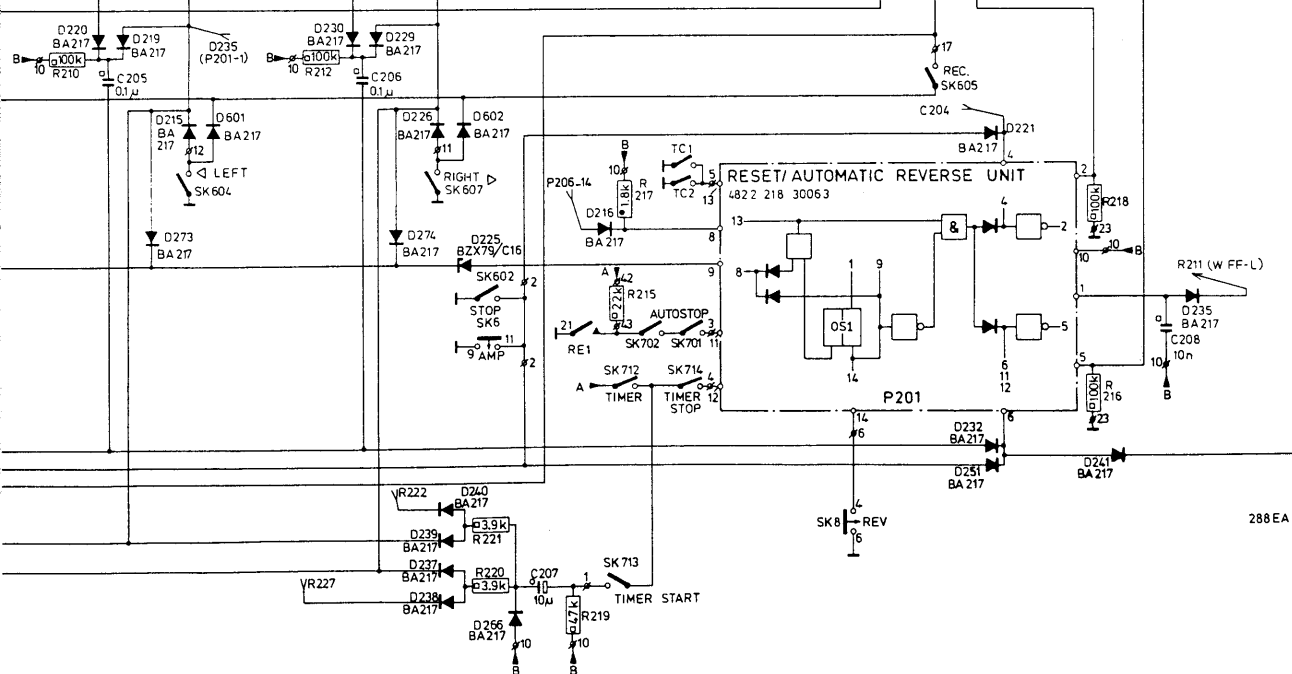
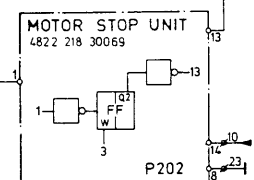
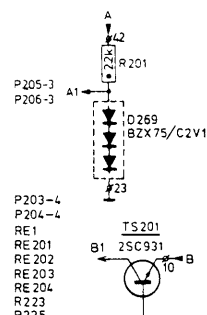
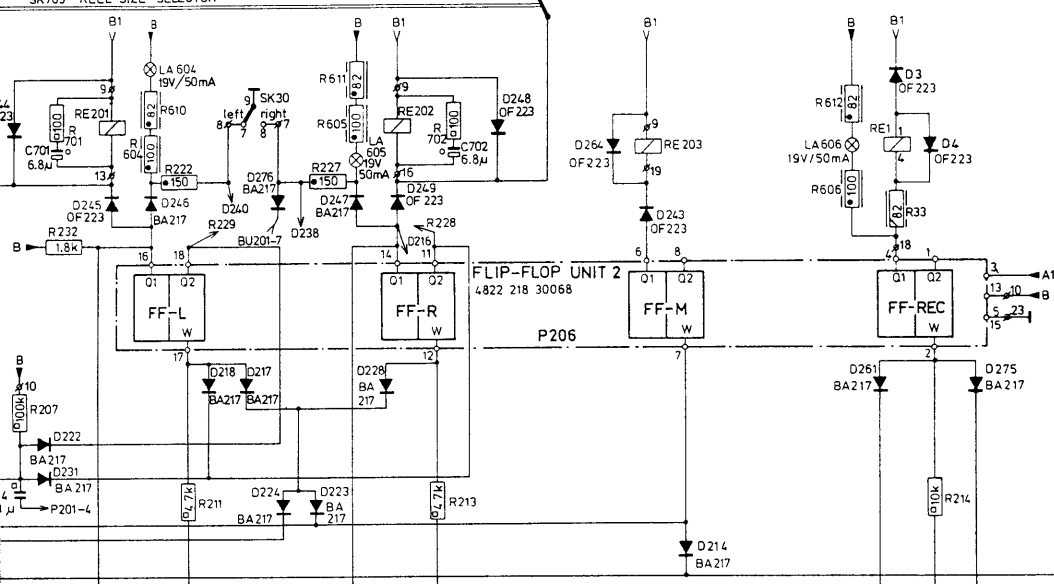


|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|------|-------|------|------|-------|------|-------|------|------|------|------|------|-------|-------|-------|------|-------|-------|------|-------|------|------|-----|------|-------|------|------|------|------|------|------|------|-----|-----|
| 44   | 222   | 220  | 245  | 246   | 215  | 218   | 217  | 276  | 223  | 247  | 228  | 249   | 226   | 240   | 237  | 602   | 248   | 268  | 264   | 243  | 258  | 259 | 270  | 260   | 3    | 4    | 275  | 232  | 279  | 241  | 255  | 235 | 269 |
|      | R701  | R232 | C205 | R610  | R222 | R604  | R211 | R227 | R217 | R611 | C206 | R213  | R702  | R221  | C207 | R219  | R217  | R225 | R226  | R229 | R612 | R33 | R214 | R231  | R708 | L704 | R709 | C704 | R218 | C208 | R201 |     |     |
| 207  | R701  | R232 | C205 | R610  | R222 | R604  | R211 | R227 | R217 | R611 | C206 | R213  | R702  | R221  | C207 | R219  | R217  | R225 | R226  | R229 | R612 | R33 | R214 | R231  | R708 | L704 | R709 | C704 | R218 | C208 | R201 |     |     |
| 204  | C701  | R210 |      | SK604 |      | LA604 | SK6  | SK30 | P207 |      | M3   | LA605 | SK607 | SK602 | P206 | SK712 | RE203 | TC1  | SK714 | SK8  | P201 |     | P204 | TS702 | M2   |      |      |      |      |      |      |     |     |
| K705 | RE201 |      |      | SK604 |      | LA604 | SK6  | SK30 | P207 |      | M3   | LA605 | SK607 | SK602 | P206 | SK712 | RE203 | TC1  | SK714 | SK8  | P201 |     | P204 | TS702 | M2   |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      |       |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |
|      | </    |      |      |       |      |       |      |      |      |      |      |       |       |       |      |       |       |      |       |      |      |     |      |       |      |      |      |      |      |      |      |     |     |

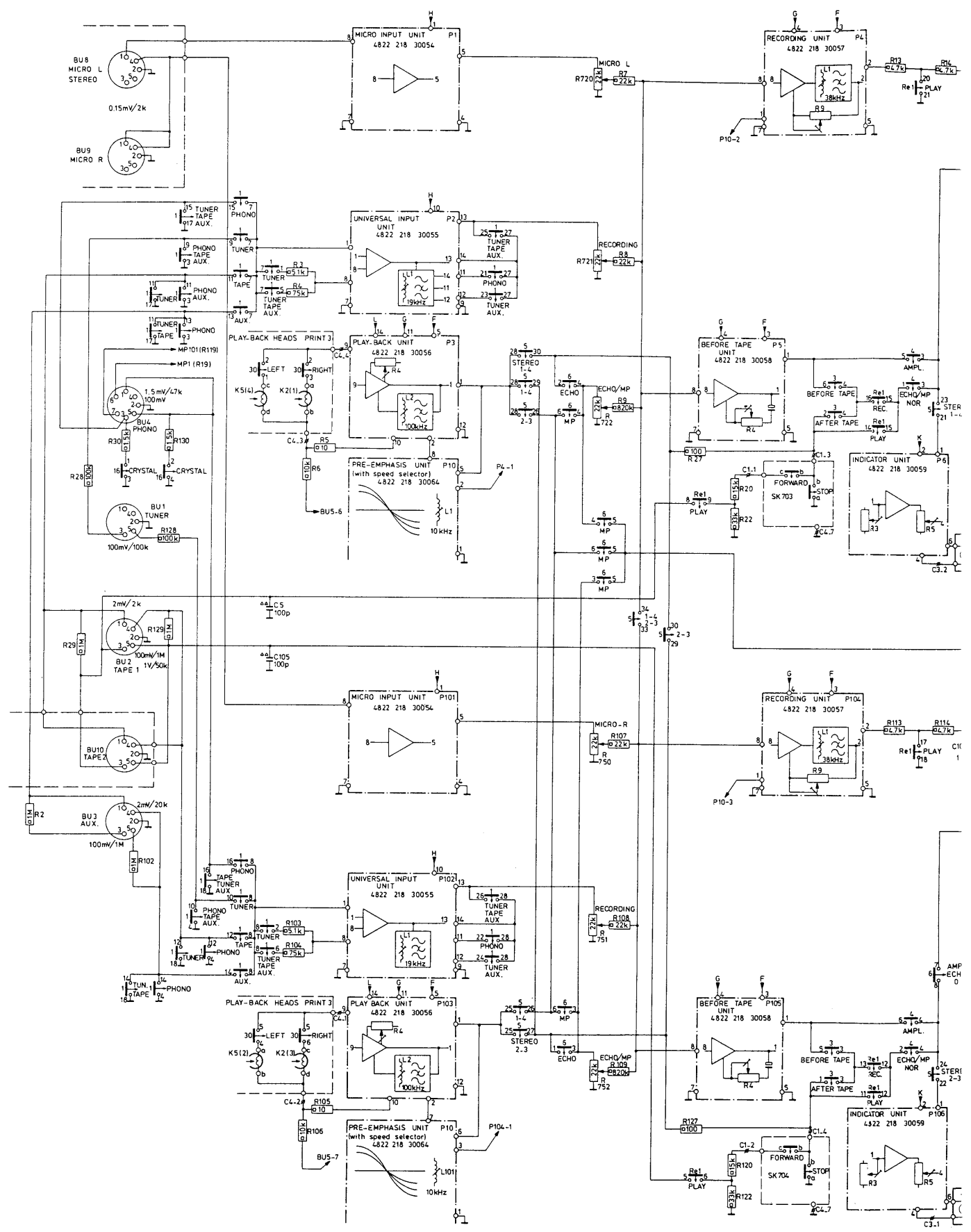


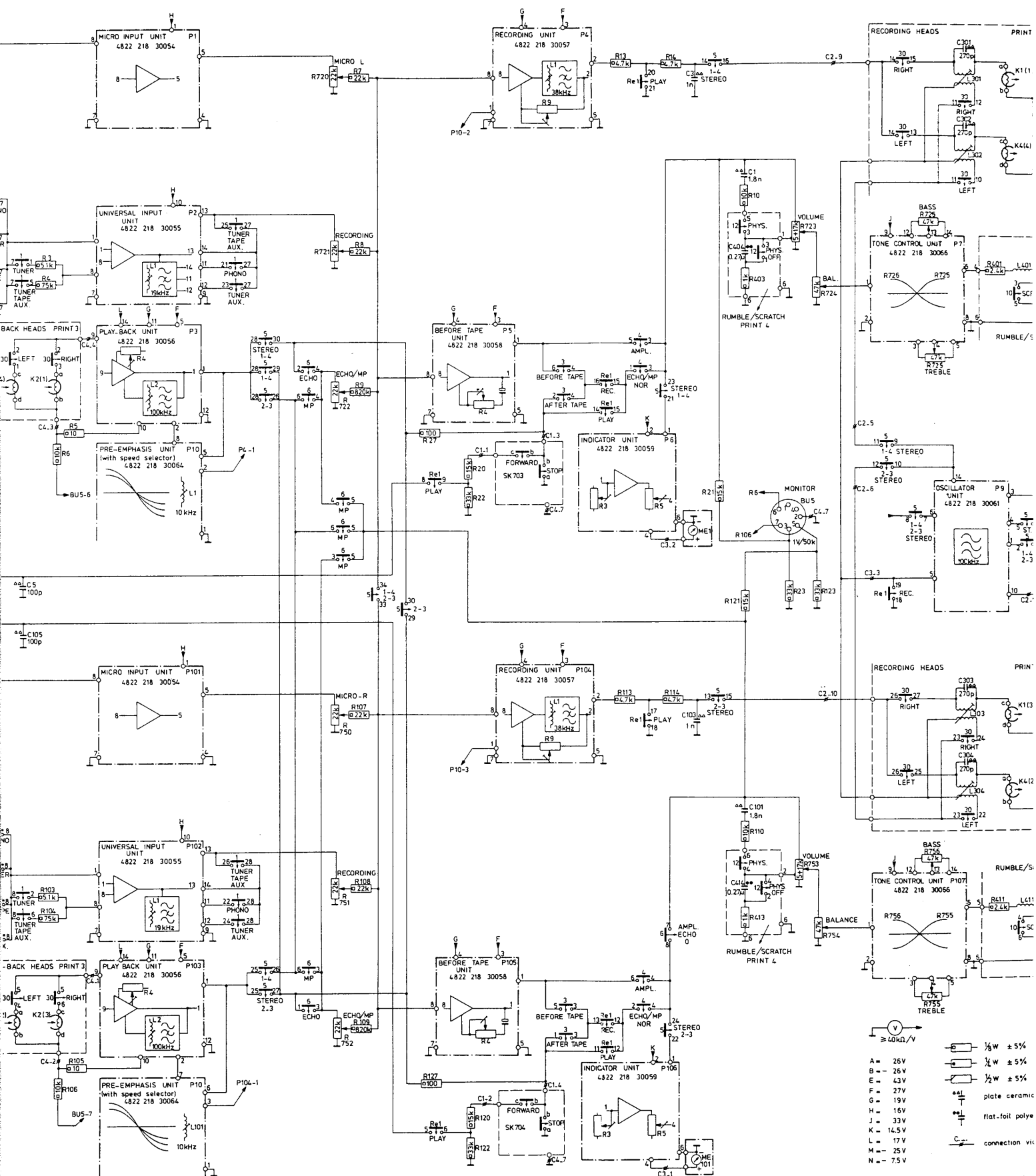
| SET       | RESET     |
|-----------|-----------|
| Q1 = 0V   | Q1 = -26V |
| Q2 = -26V | Q2 = +2V  |
| W = 0V    | W = -26V  |

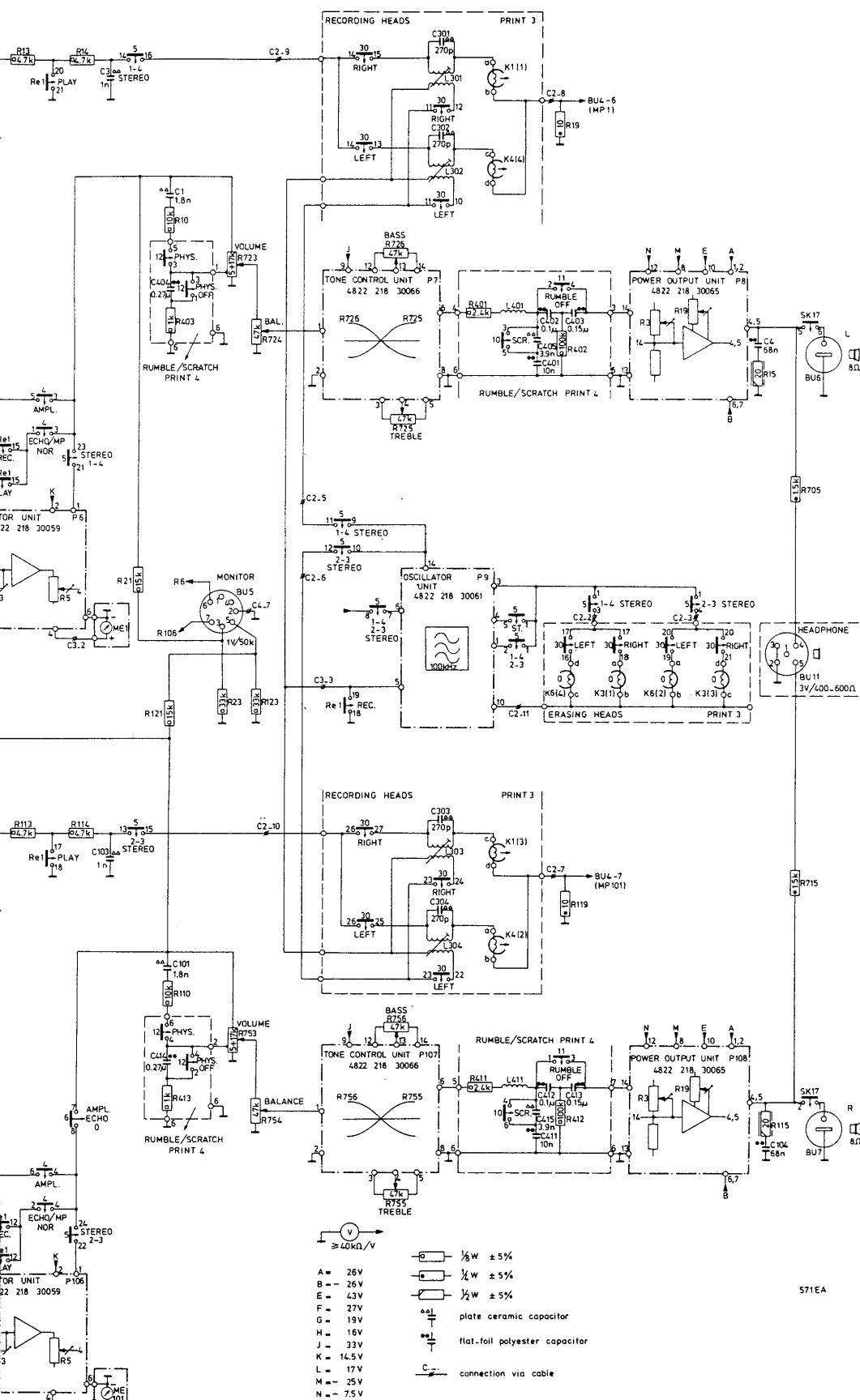
#### SK705 REEL-SIZE SELECTOR



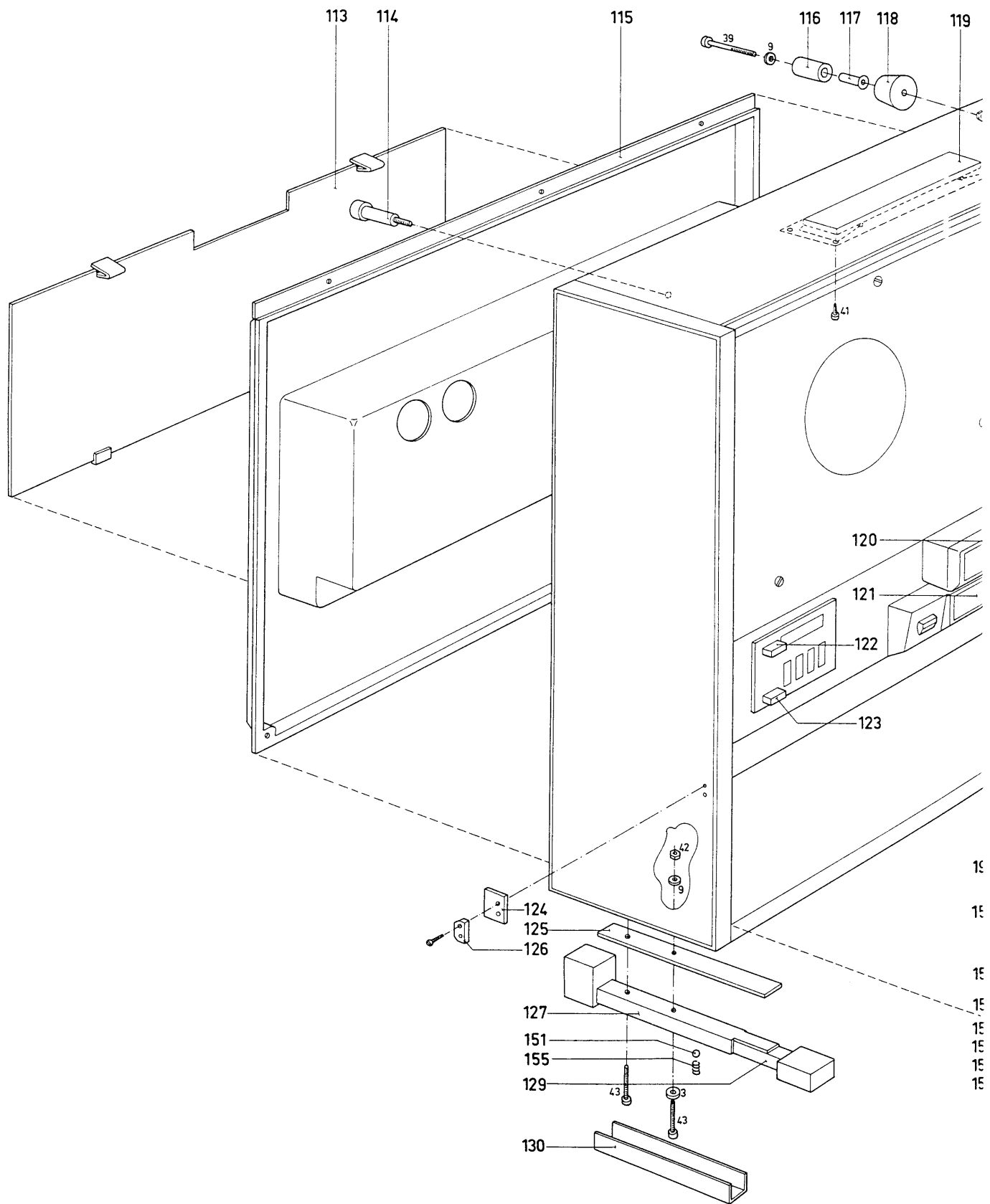
| MISC.          | C                        | R   |
|----------------|--------------------------|-----|
| P1<br>P4       |                          |     |
| BU8            | 7                        | 720 |
| BU9            |                          |     |
| P2             | 8<br>721<br>3            | 4   |
| P3<br>P5       |                          |     |
| K5(1)<br>K2(1) | 9                        |     |
| BU4            | 722                      |     |
| P10            | 27                       |     |
| SK703          | 20                       |     |
| BU1            | 22                       | 128 |
|                | 5                        |     |
| BU2            | 129                      |     |
| P101<br>P104   | 29                       |     |
| BU10           | 107                      | 750 |
| BU3            | 2                        |     |
| P102           | 102                      |     |
| P103<br>P105   | 108<br>103<br>751<br>104 |     |
| K5(2)<br>K2(3) | 109                      |     |
| P10            | 752<br>105<br>127<br>106 |     |
| SK704          | 120                      |     |
|                | 122                      |     |

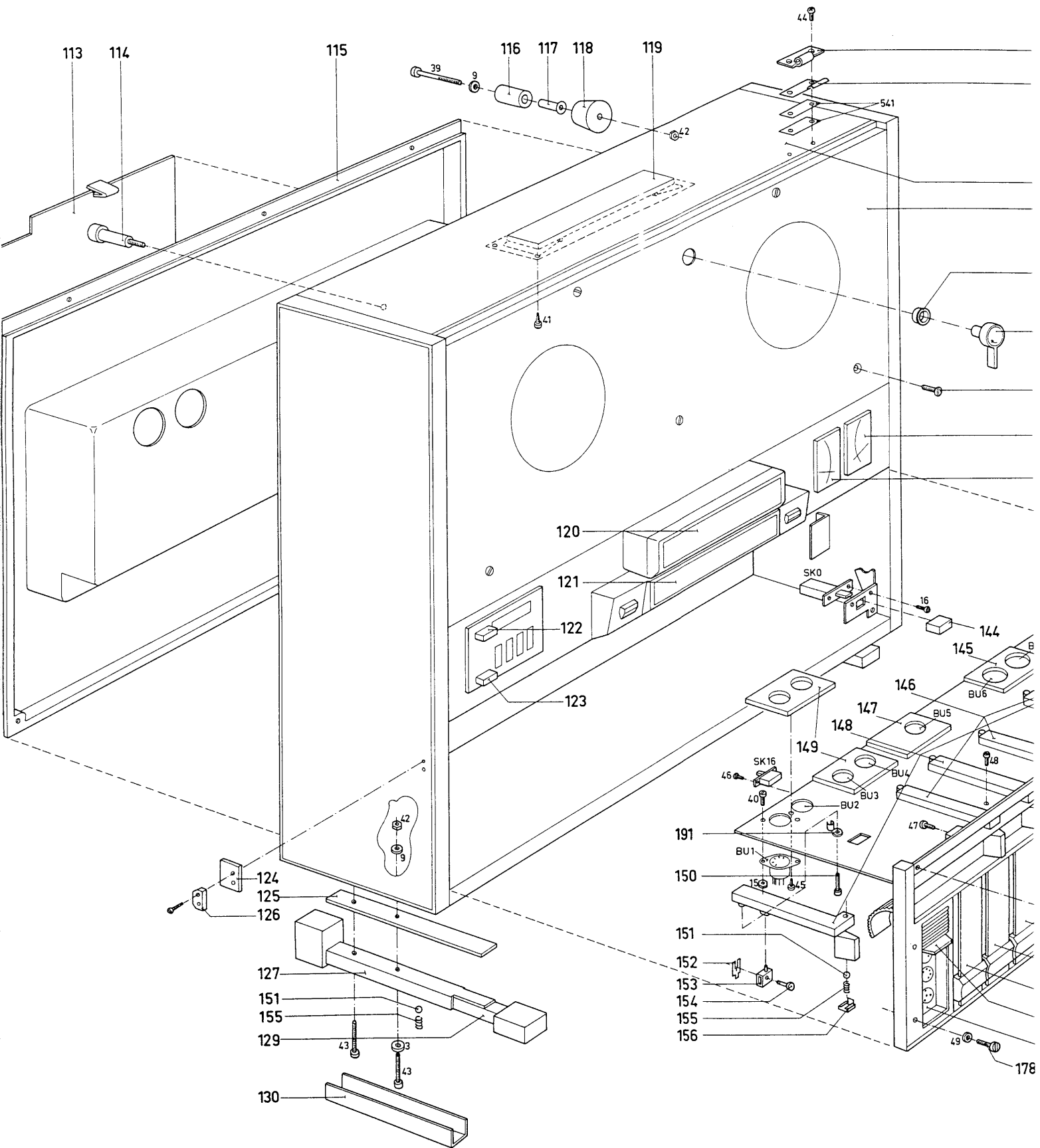


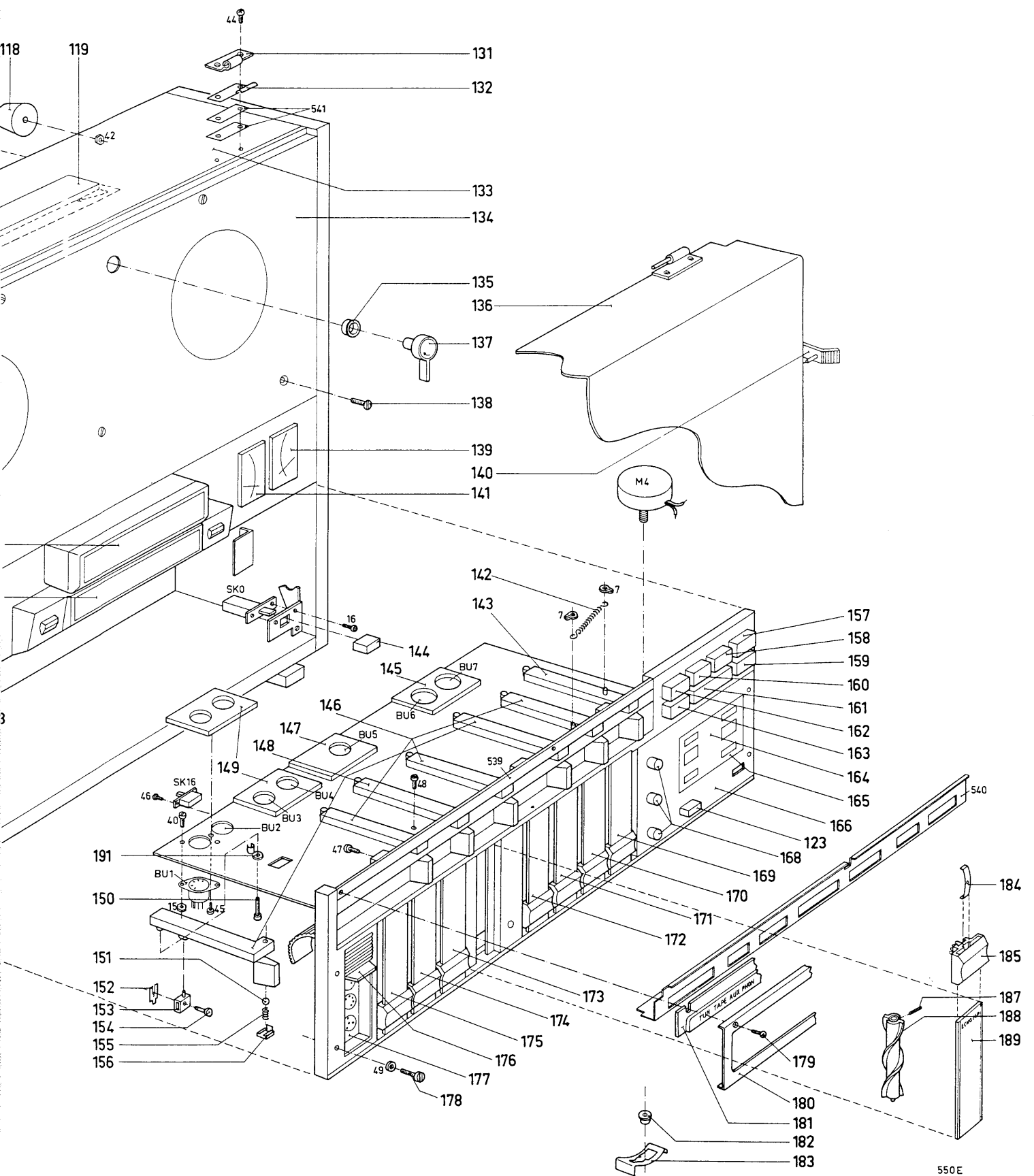




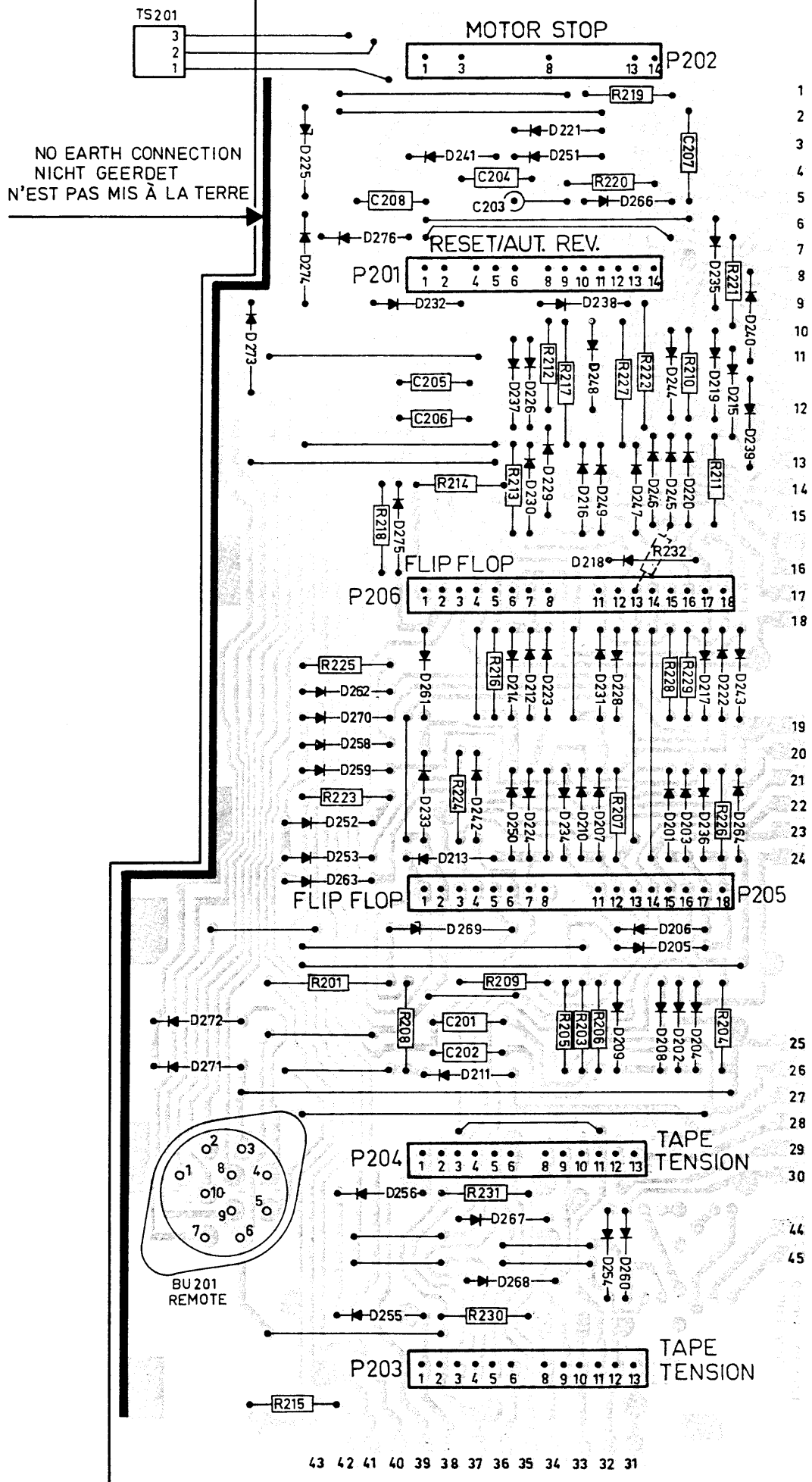
| R   | C   | MISC. |
|-----|-----|-------|
| 13  | 301 |       |
| 14  | 3   | K1(1) |
|     |     | L301  |
| 19  | 302 |       |
|     |     | K4(4) |
|     |     | L302  |
| 10  |     |       |
| 726 |     |       |
| 723 |     |       |
|     |     | P7    |
|     |     | P8    |
| 401 |     | L401  |
| 403 |     | L403  |
| 724 |     | L405  |
| 402 |     | L401  |
| 15  |     | BU6   |
| 725 |     |       |
|     |     | P6    |
| 21  |     | P9    |
|     |     | BU5   |
|     |     | ME1   |
|     |     | BU11  |
|     |     | K6(4) |
|     |     | K3(1) |
| 23  |     | K6(2) |
| 123 |     | K3(3) |
| 121 |     |       |
| 113 | 303 |       |
| 114 |     |       |
| 103 |     | K1(3) |
|     |     | L303  |
| 715 |     |       |
| 119 | 304 |       |
|     |     | K4(2) |
|     |     | L304  |
| 101 |     |       |
| 110 |     |       |
| 756 |     |       |
| 753 |     |       |
|     |     | P107  |
| 414 |     | P108  |
| 411 |     | L411  |
| 413 |     | SK17  |
| 412 |     |       |
| 754 |     |       |
| 415 |     |       |
| 111 |     |       |
| 104 |     | BU7   |
| 755 |     |       |
|     |     | P106  |
|     |     | ME101 |

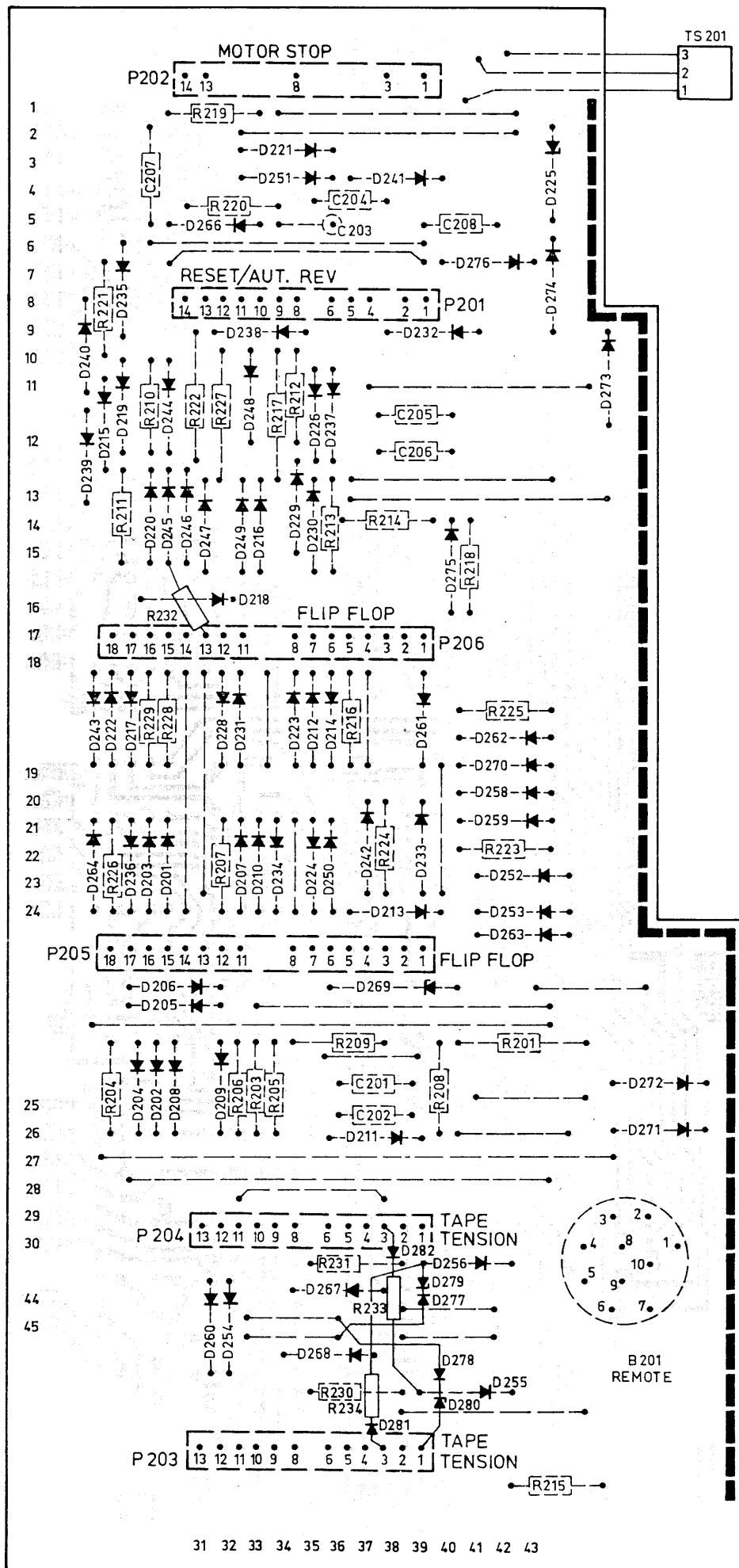






550E





# Service Information



PHILIPS

28-12-1972

RECORDERS N 4450

Bc 1329

## I. SEVERAL MODIFICATIONS

### A. Version WR04

- In sets, marked from 144, the pulleys 55 are secured with two Allen screws M3x8 (item 4).  
The code number of these screws is 4822 502 11069.
- The glue of the tape on the anchor plate of the electromagnets RE201...RE204 had not hardened enough. Consequently, the anchor was sticking in some cases.  
In sets WR04/05, from serial number 3100, the glue has better hardened.

### B. Version WR05

- In sets, marked from 147, safety resistors R43...R46 of 180  $\Omega$  have been added in series with lamps LA1...LA4. This has been done to extend the lifes of these lamps. Besides, the values of R47 and R48 have been changed from 22  $\Omega$  into 120  $\Omega$ .  
For code numbers, see the List of Electrical Parts, B Supply.

### C. Version WR06

- In sets, marked from 147, a 80-mA fuse has been added in series with timer motor M4. In sets WR08, marked from 206, the value of this fuse has been changed into 250 mA-T.
- In sets, marked from 148 - serial number 3350, diode D227 (connected to W/FF-R) has been left out.  
In position "REV", the pulse from the tape contact is applied, via the reset/automatic reverse unit P201, to flip-flop FF-L. Owing to tolerances of the components used in the flip-flops, it may happen that FF-L is preferred to FF-R. Under these circumstances, FF-R cannot be switched on any more. Now that D227 is no longer used, FF-R is preferred to FF-L.

### D. Version WR07

- In sets, marked from 149 - serial number 4600, the transistors TS701, 702 (controlling the winding motors) have been replaced by type 16-175 (=2N6107).  
The code number of TS701, 702 is 4822 130 40903.
- In sets, marked from 150, a recess has been made to the right of bracket 540. Via this recess, bracket 550 is adjustable. This was necessary because, in a few cases, switch SK9 (FAST-MED-SLOW) did not operate.

### E. Version WR08

- In sets, marked from 203, the screws securing the capstan motor M3 (11 in bracket 536) have been lockpainted.
- In sets, marked from 203, ornamental frame 180 has been secured with 10 instead of with 6 screws.  
The code number of ornamental frame 180 with 10 screw holes remains unchanged: 4822 460 20067.
- In sets, marked from 203, a ring has been added between flywheels 95 and capstan bearings 88. This has been done because the sets produced a scouring noise when being tilted forwards.  
The code number of ring 200 is: 4822 532 50301.
- In sets, marked from 203, the lower part of ornamental cover 136 can be fixed when it is opened.  
The code number of ornamental cover 136 with closing bracket 140 remains unchanged: 4822 443 20071.  
The code number of bracket 140 is: 4822 403 50738.
- In sets, marked from 206, the value of fuse Z701 (in series with timer motor M4) has been changed from 80 mA into 250 mA-T.  
The code number of the fuse is: 4822 253 30013.

### F. Version WR09

- In sets, marked from 210, the screws 96 (for adjusting the heads) have finer threads so that it is possible to adjust the heads more precisely.  
The code number of screw 96 is: 4822 502 10665.
- In sets, marked from 227, silicone paste has been applied between the mounting plate and transistors TS701, TS702 with a view to a better thermal conduction.
- In sets, marked from 238, serial number 6001, an additional bracket 542 has been fitted to prevent the oil seals 87 from shifting.

## II. MULTIWAY CONNECTORS

The functional units are secured to p.c. boards 1 and 2 with multiway connectors for three, eight or fourteen contacts. Whether or not these contacts are available, depends upon the circuit on the units; consequently, there is a great number of versions. For servicing purposes, only three versions are supplied, namely: the 3-pole, the 8-pole and the 14-pole versions with all contacts. Non-functional contacts can be easily removed with tweezers.

## III. MODIFICATIONS AND ADDITIONS TO LIST OF MECHANICAL PARTS.

### A. Tape deck

|     |                      |                |
|-----|----------------------|----------------|
| 2   | Screw M3x4           | 4822 502 11069 |
| 4   | Screw M3x8           | 4822 502 10174 |
| 5   | Nut M5               | 4822 505 10513 |
| 8   | Ring 3.2 x 7 x 0.3   | 4822 532 50298 |
| 9   | Ring 4.2 x 8 x 0.5   | 4822 532 10333 |
| 14  | Ring 3.2 x 6 x 0.4   | 4822 530 80082 |
| 17  | Ring 3.2 x 9 x 0.8   | 4822 532 10582 |
| 20  | Ring                 | 4822 532 20619 |
| 24  | Clamping ring 4 dia  | 4822 530 70116 |
| 25  | Ring 3.2 x 7 x 0.5   | 4822 532 10332 |
| 26  | Screw M3x4           | 4822 502 11189 |
| 27  | Ring                 | 4822 532 10332 |
| 29  | Ring 3.2 x 4.5 x 0.3 | 4822 532 50938 |
| 32  | Screw M3x20          | 4822 502 11096 |
| 33  | Spacer 3.1 x 16 x 5  | 4822 532 20607 |
| 35  | Screw M2x8           | 4822 502 10681 |
| 47  | Screw M4x8           | 4822 502 10693 |
| 49  | Ring 4.2 x 8 x 0.1   | 4822 532 10479 |
| 50  | Ring 3.2 x 8 x 0.2   | 4822 532 50298 |
| 57  | Cord                 | 4822 358 30145 |
| 60  | Bearing              | 4822 502 10765 |
| 71  | Ring                 | 4822 532 30266 |
| 79  | Cord                 | 5322 358 30045 |
| 96  | Screw                | 4822 502 10665 |
| 97  | Screw M3             | 4822 502 11217 |
| 98  | Nut M3               | 4822 505 10408 |
| 104 | Pressure spring      | 4822 492 50925 |
| 105 | Bearing              | 4822 535 70468 |
| 110 | Grommet              | 4822 528 80545 |
| 200 | Ring 5.2 x 9 x 0.5   | 4822 532 50301 |
| 201 | Screw M3x8           | 4822 502 11053 |
| 202 | Ring 3.6 x 12 x 1    | 4822 532 10489 |
| 203 | Ring                 | 4822 532 50786 |
| 204 | Tension spring       | 4822 492 30355 |
| 205 | Cord damper          | 4822 479 30045 |

## B. Cabinet and amplifier

|     |                                                               |                |
|-----|---------------------------------------------------------------|----------------|
| 3   | Ring                                                          | 4822 532 50725 |
| 15  | Nut M3                                                        | 4822 505 10325 |
| 39  | Screw M4x30                                                   | 4822 502 10053 |
| 40  | Screw M3                                                      | 4822 502 11287 |
| 41  | Screw 3.9x9.13                                                | 4822 502 30006 |
| 43  | Screw M4x22                                                   | 4822 502 10051 |
| 44  | Self-tapping screw 2.9x15                                     | 4822 502 30048 |
| 45  | Self-tapping screw 2.9x4.37                                   | 4822 502 30065 |
| 118 | Support                                                       | 4822 325 20063 |
| 131 | Hinge                                                         | 4822 417 10516 |
| 139 | Meter on the right (ME101)                                    | 4822 347 10069 |
| 140 | Bracket                                                       | 4822 403 50738 |
| 141 | Meter on the left (ME1)                                       | 4822 347 10071 |
| 149 | Socket-cover plate                                            | 4822 459 80039 |
| 151 | Ball 5/32"                                                    | 5322 520 40012 |
| 154 | Pin                                                           | 4822 535 90912 |
|     | Ball for SK5                                                  | 4822 535 90913 |
| 155 | Pressure spring                                               | 4822 492 50927 |
|     | Pressure spring (light conductor<br>for switch FAST-MED-SLOW) | 4822 492 51037 |
| 187 | Screw M3x4                                                    | 4822 502 10663 |
| 190 | Lense                                                         | 4822 381 10401 |
| 191 | Lamp holder                                                   | 4822 256 90135 |

## IV. MODIFICATIONS AND ADDITIONS TO LIST OF ELECTRICAL PARTS

## A. Control section

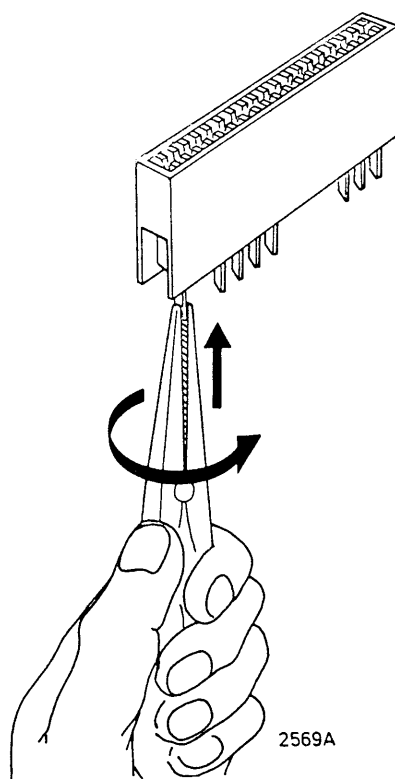
|            |                              |                |
|------------|------------------------------|----------------|
| SK8        | Slide switch (NOR-REV)       | 4822 277 30378 |
| SK702      | Switch (counter)             | 4822 278 90231 |
|            | Plug for BU201               | 5322 264 50043 |
| TS201      | Transistor 2 SC931           | 4822 130 40899 |
| TS701, 702 | Transistor 16-175 (=N1607)   | 4822 130 40903 |
|            | Lampholder for LA601...LA606 | 4822 401 10561 |

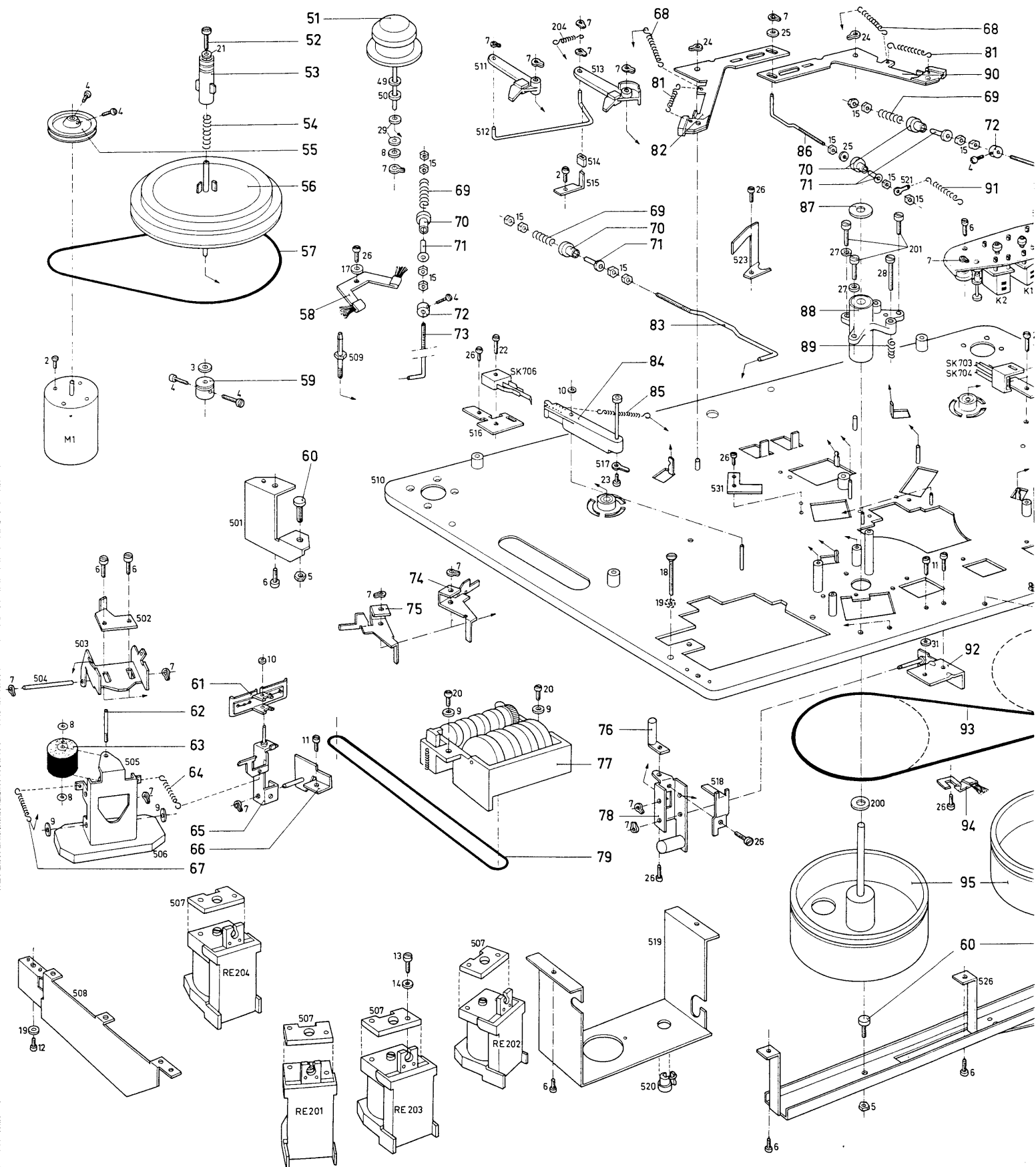
## B. Supply

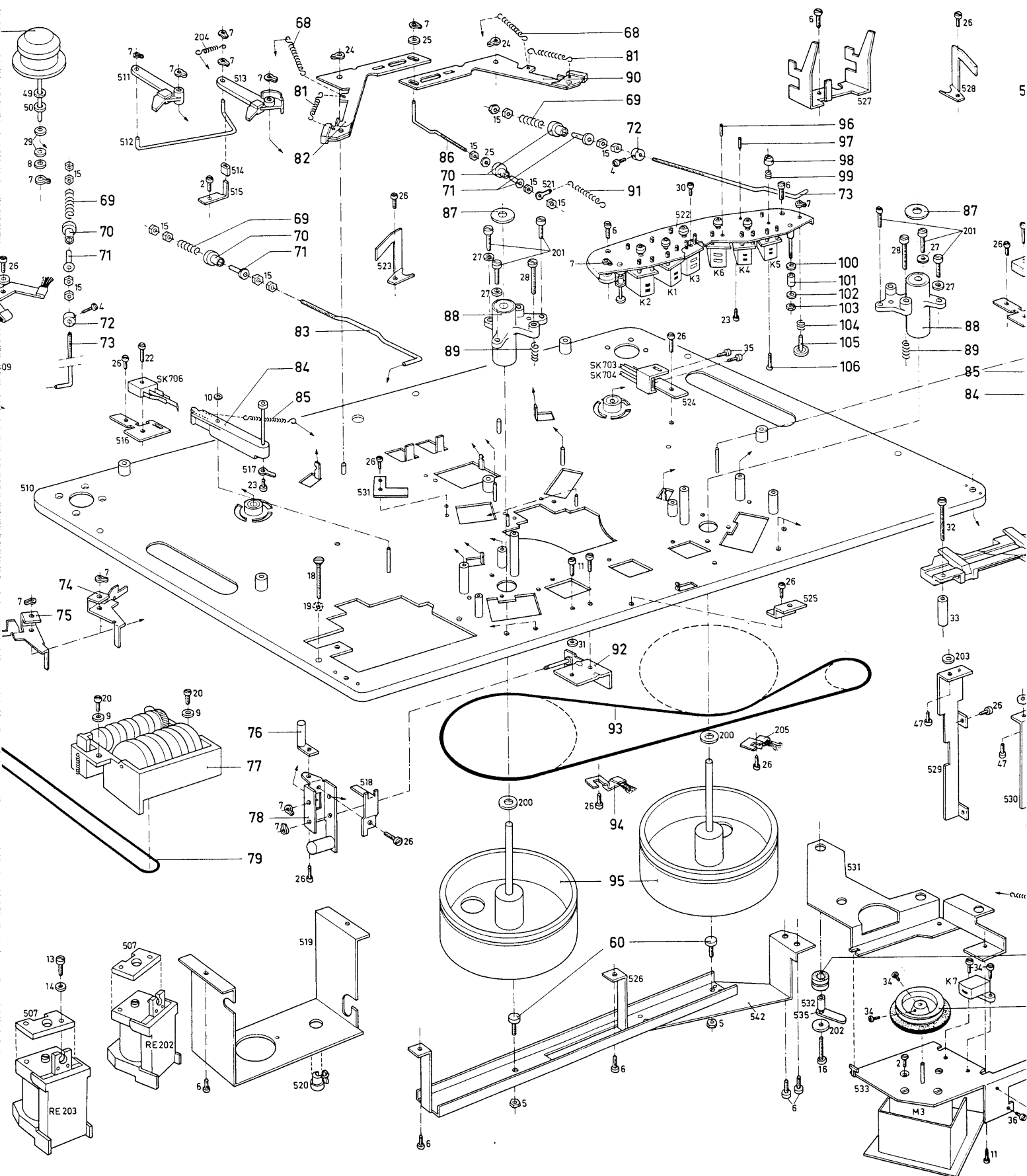
|               |                               |                |
|---------------|-------------------------------|----------------|
| SK105         | Voltage adapter               | 4822 272 10202 |
| LA8, 9        | Lamp 19 V-50 mA (timer)       | 4822 134 40078 |
|               | Lampholder for LA1...LA4      | 4822 256 90135 |
|               | Lampholder for LA701, 702     | 4822 401 10561 |
| Z701          | Fuse holder for Z501, 502     | 4822 492 60063 |
|               | Fuse 250 mA-T                 | 4822 253 30013 |
|               | Fuse holder for Z701          | 4822 256 30128 |
| R35           | Safety resistor 10 k $\Omega$ | 4822 110 53134 |
| R36, 132      | Safety resistor 68 $\Omega$   | 4822 110 53076 |
| R37           | Safety resistor 330 $\Omega$  | 4822 110 43094 |
| R38           | Safety resistor 820 $\Omega$  | 4822 111 30424 |
| R39           | Safety resistor 560 $\Omega$  | 4822 111 30374 |
| R40           | Safety resistor 1 k $\Omega$  | 4822 111 30404 |
| R41           | Safety resistor 3k3           | 4822 111 30413 |
| R42           | Safety resistor 3 k $\Omega$  | 4822 111 30442 |
| R47, 48       | Safety resistor 120 $\Omega$  | 4822 111 50135 |
| R133, 134, 43 |                               |                |
| 44, 45, 46    | Safety resistor 180 $\Omega$  | 4822 110 43087 |
| R502          | Safety resistor 33 $\Omega$   | 4822 111 30418 |

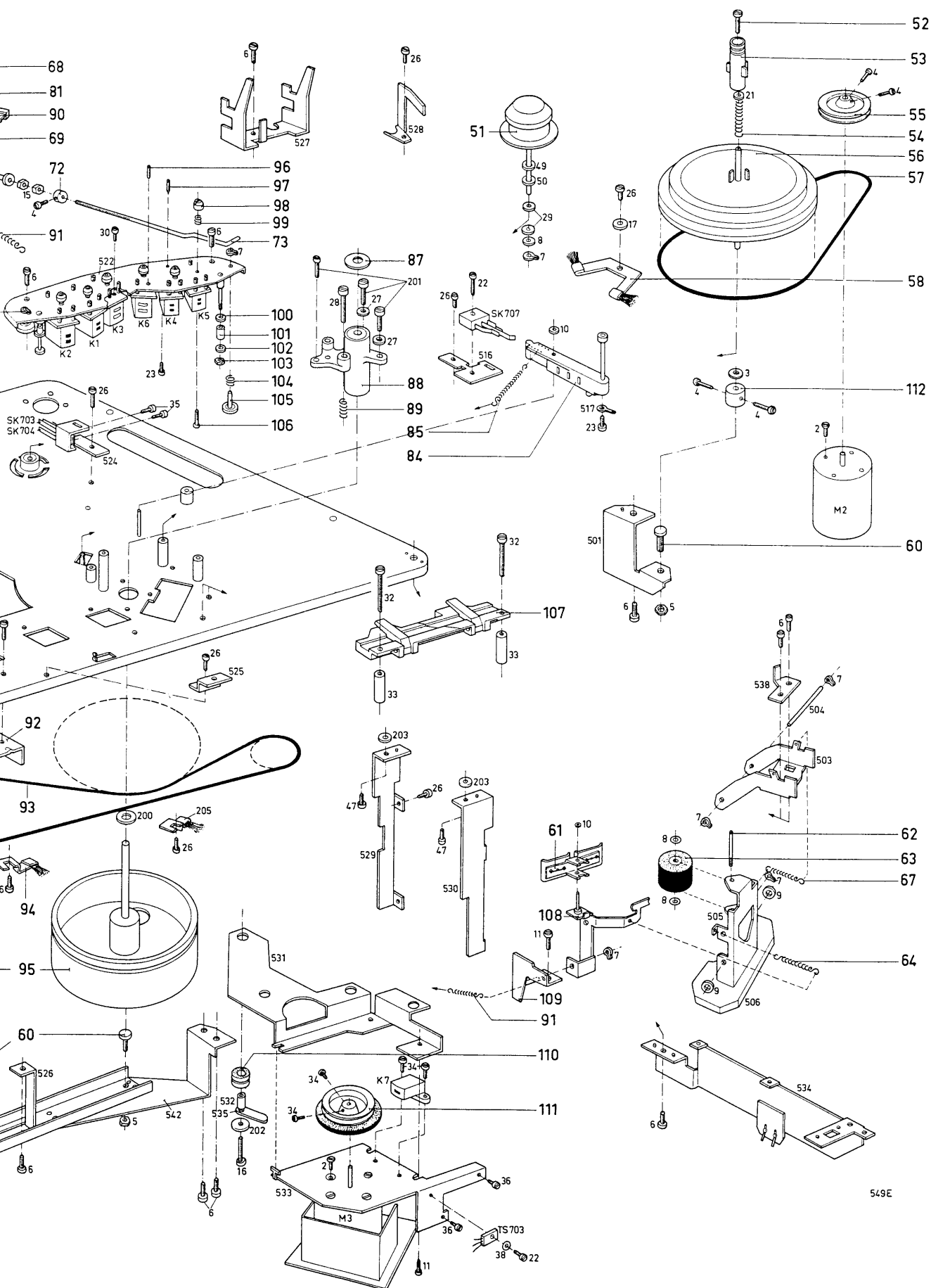
## C. Amplifier

|            |                                        |                |
|------------|----------------------------------------|----------------|
| SK703, 704 |                                        | 4822 278 90232 |
|            | Contact spring for BU8...BU10 (signal) | 4822 268 20032 |
|            | Contact spring for BU8...BU10 (earth)  | 4822 492 61313 |
|            | Plug for BU1...BU5 and BU8...BU10      | 4822 264 40023 |
|            | Plug for BU6, 7                        | 4822 264 30041 |
|            | Plug for BU11                          | 4822 264 40092 |
|            | Adjusting core for L301...L304         | 4822 526 10014 |
| ME1        | Meter, left                            | 4822 347 10071 |
| ME101      | Meter, right                           | 4822 347 10069 |
|            | Plug on cable tree, 14 poles           | 4822 264 50079 |
| C13        | 150 $\mu$ F-25 V                       | 4822 124 20388 |
| C508       | 330 $\mu$ F-63 V                       | 4822 124 20404 |
| C705       | 1000 $\mu$ F-63 V                      | 4822 124 70215 |
| R15, 115   | Safety resistor 20 $\Omega$            | 4822 111 50372 |









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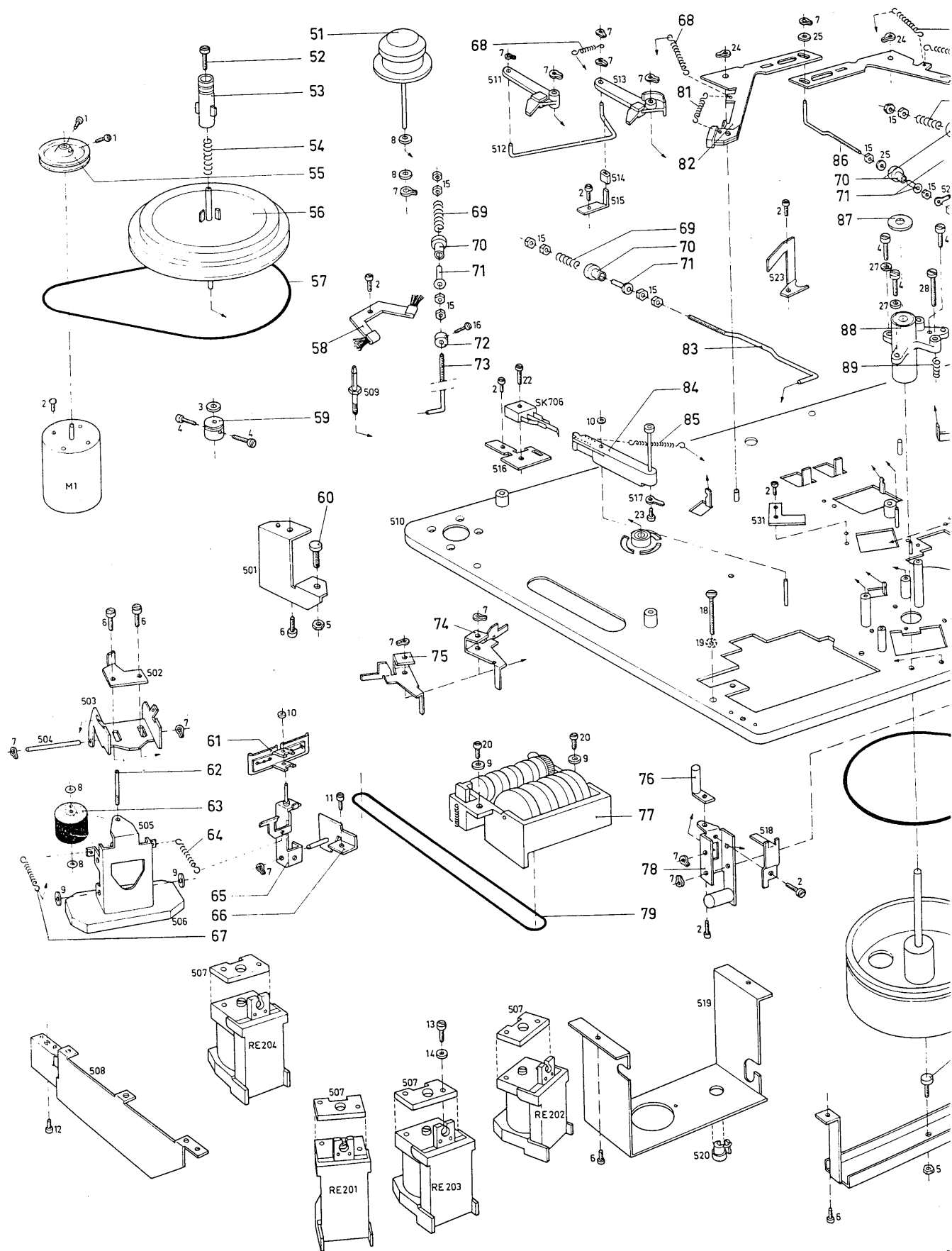


Fig. 2

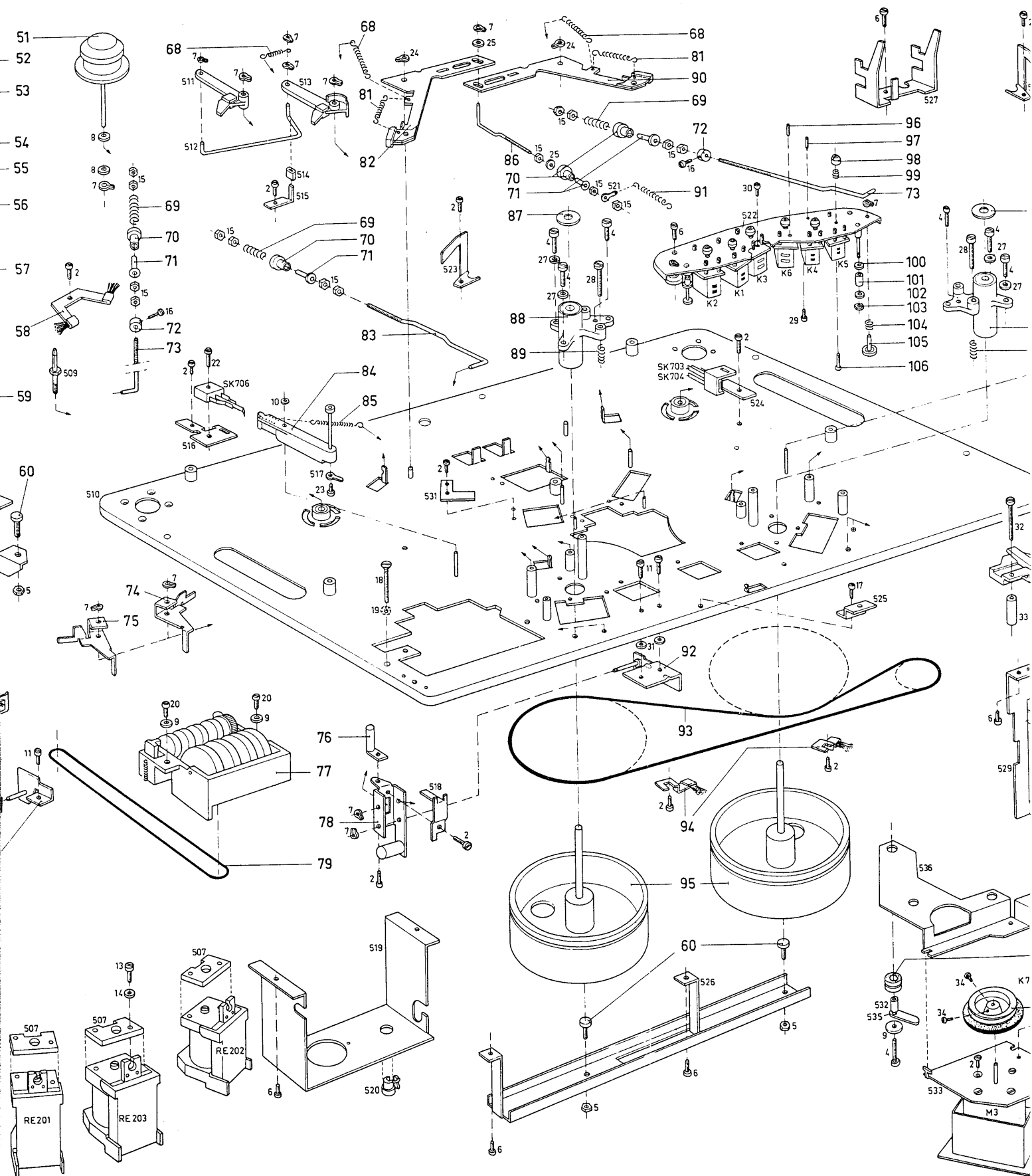
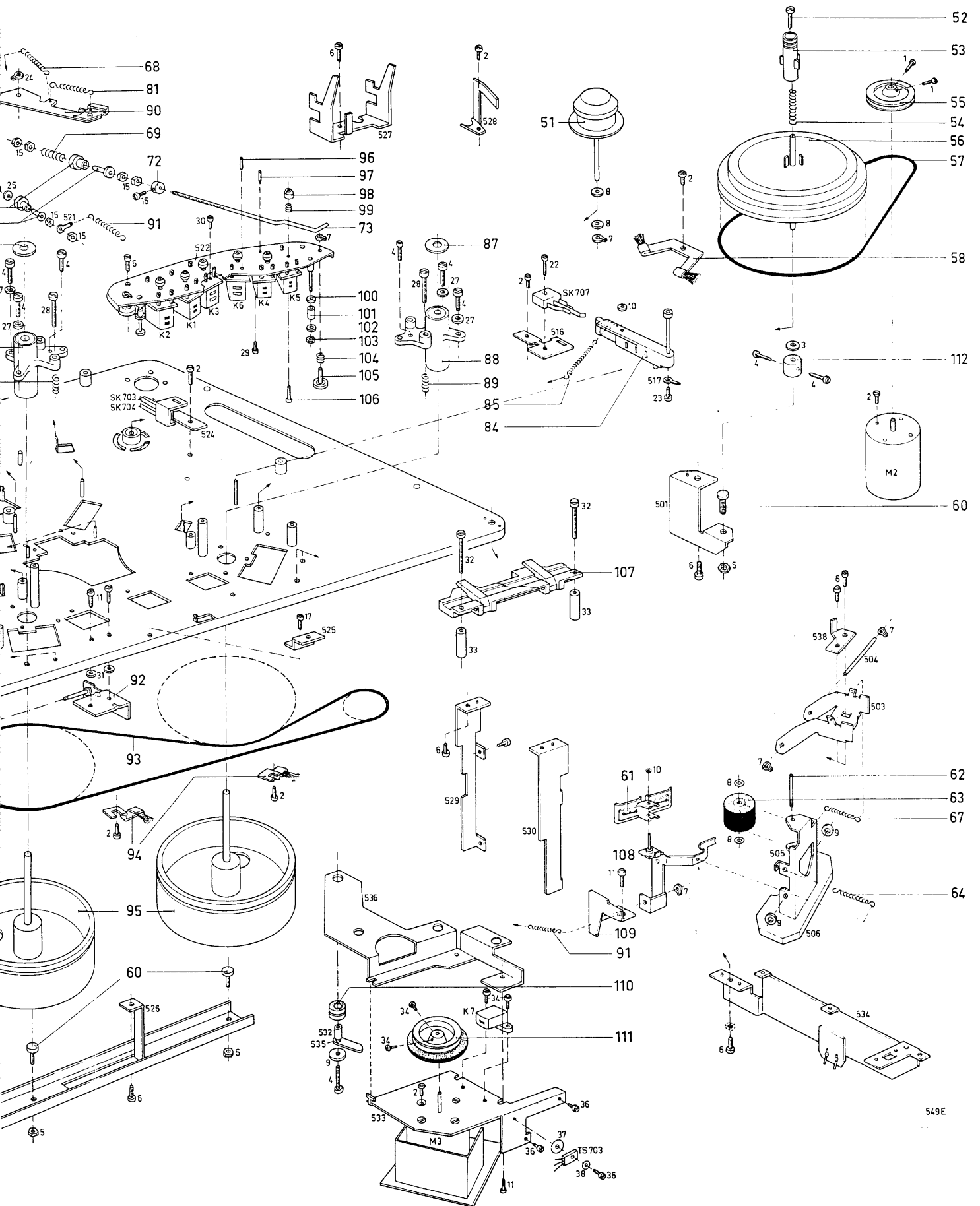


Fig. 22



549E

Fig. 22

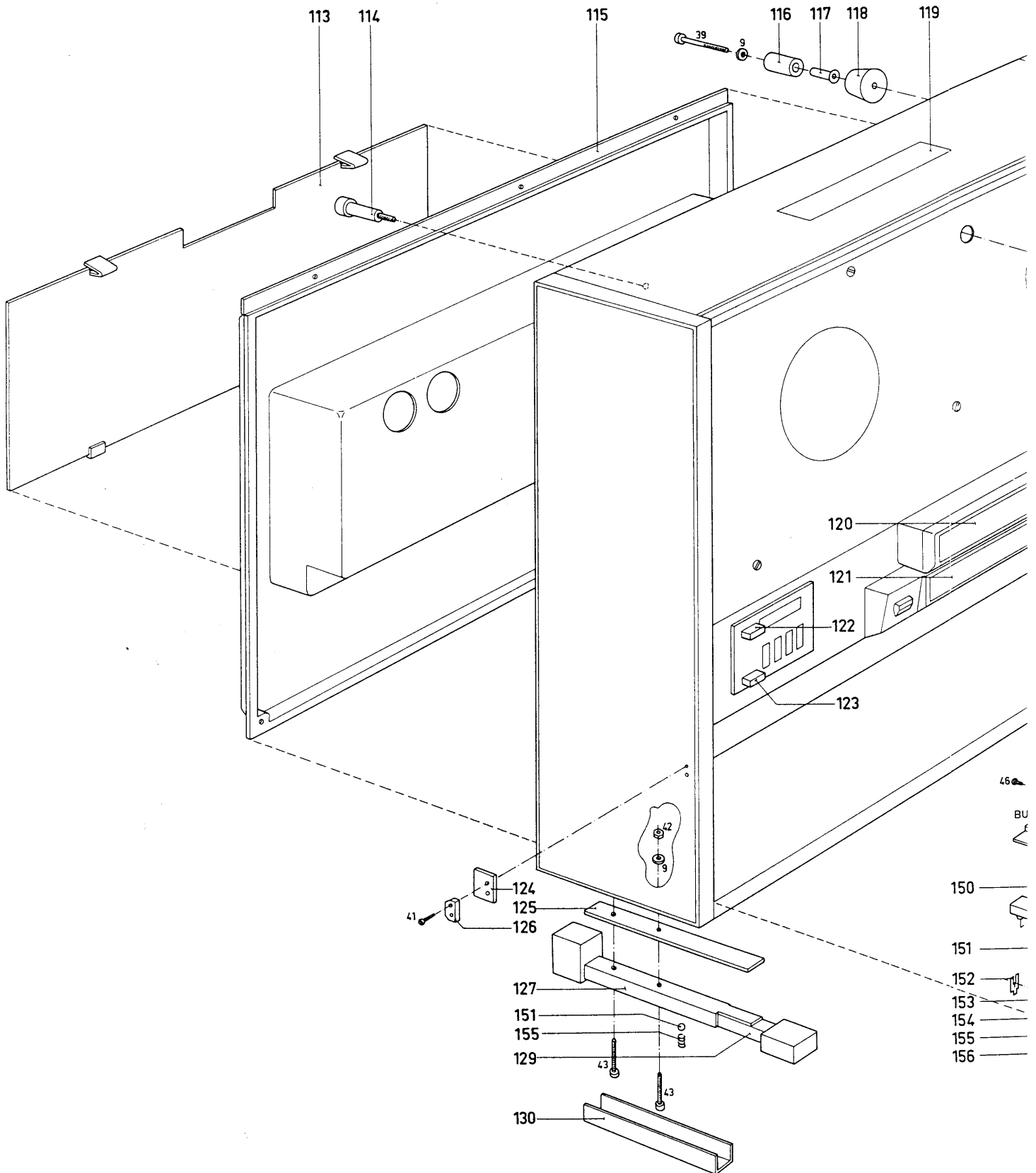


Fig. 23

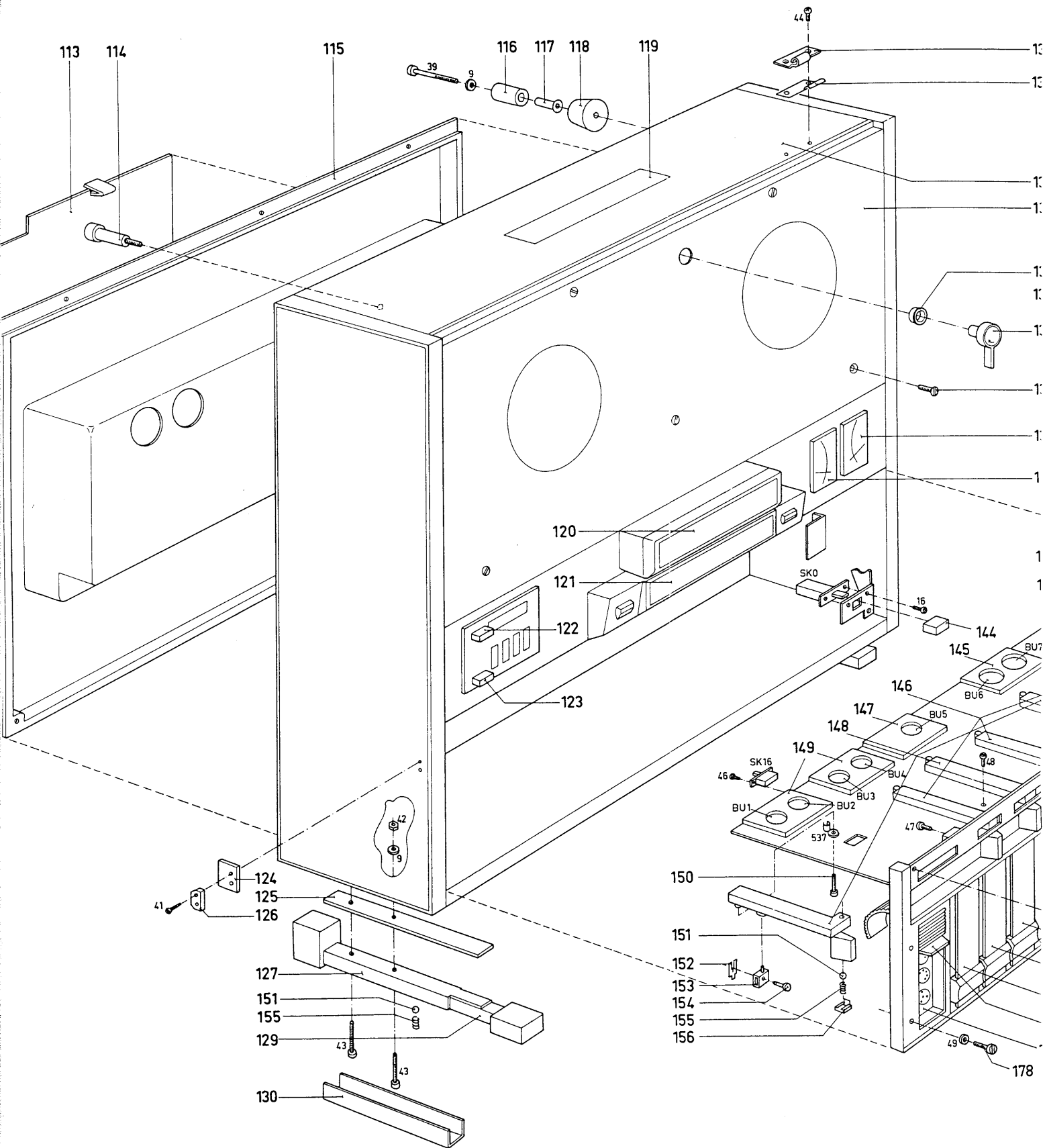
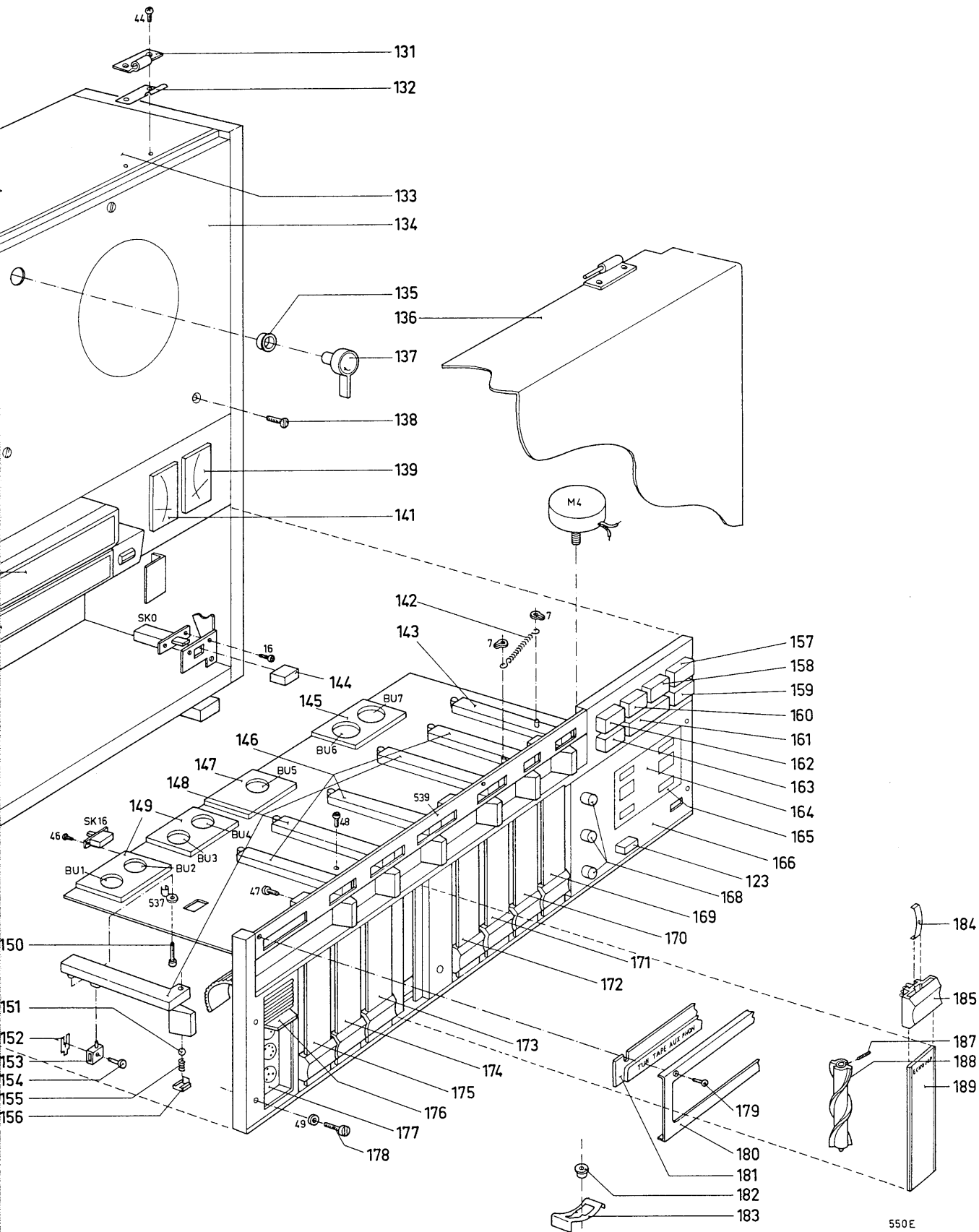
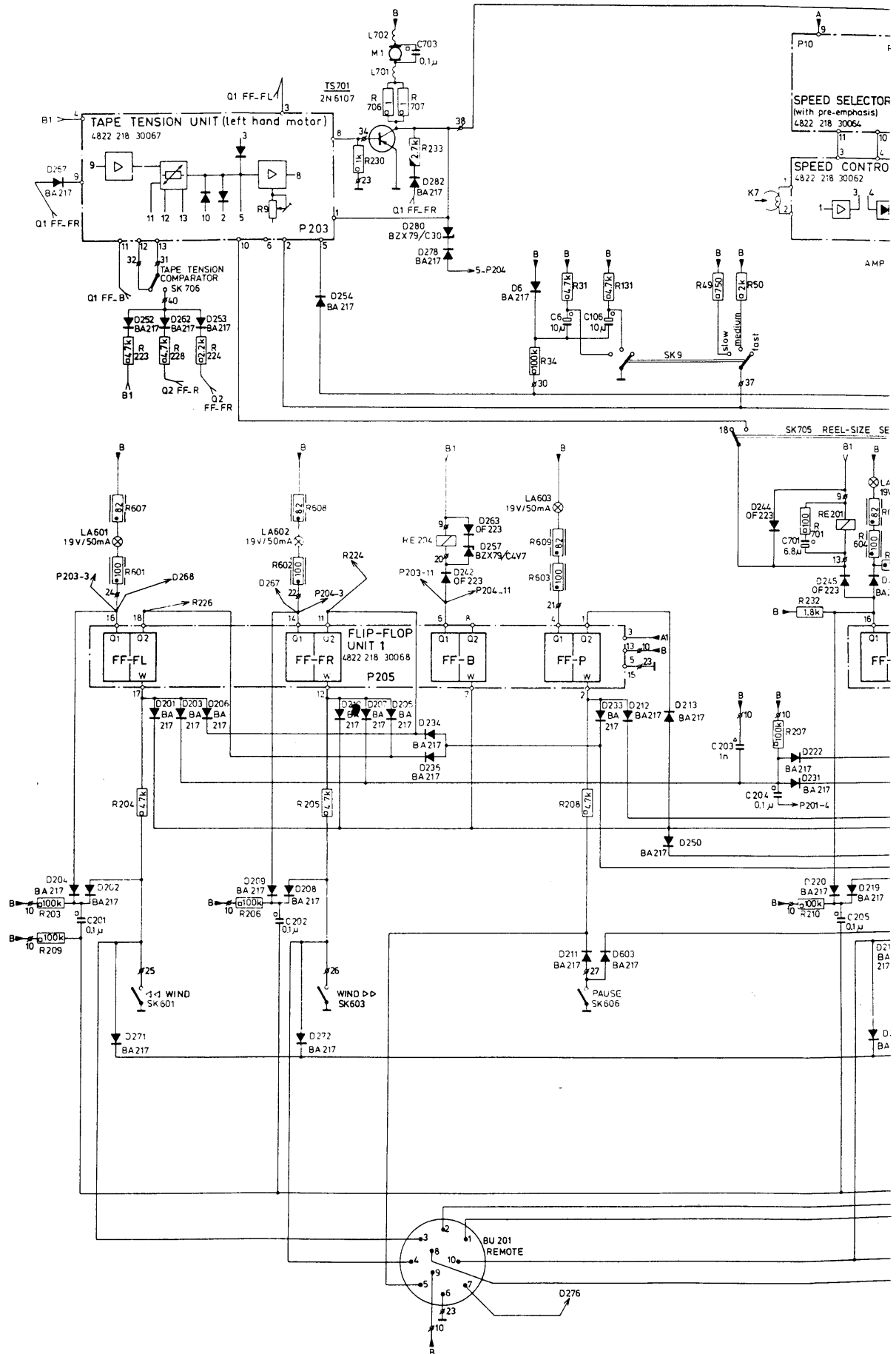


Fig. 23



|        |                            |              |              |      |      |      |      |      |                          |      |      |      |              |              |                 |     |                |           |                |                 |                                    |             |              |              |              |                |            |                                        |  |  |  |  |
|--------|----------------------------|--------------|--------------|------|------|------|------|------|--------------------------|------|------|------|--------------|--------------|-----------------|-----|----------------|-----------|----------------|-----------------|------------------------------------|-------------|--------------|--------------|--------------|----------------|------------|----------------------------------------|--|--|--|--|
| D.     | 252<br>267 204 202 271 201 |              |              |      |      |      |      |      |                          |      |      |      |              |              |                 |     | 262 203<br>201 | 253 206   | 209 208 272    | 254 210 207 205 | 234 280 242 263<br>282 236 278 257 |             |              | 6            | 211          | 233 212<br>603 | 213<br>250 | 244 222 220 245 246 215<br>231 219 273 |  |  |  |  |
| R.C.L. | R203<br>R204               | R607<br>R601 | R223<br>C201 | R204 | R228 | R224 | R206 | C202 | R608<br>R602             | R205 | R230 | R706 | L702<br>L701 | R707<br>R233 | C703            | R34 | R609<br>R603   | R31<br>C6 | R131<br>C106   | R208            | R49                                | R50<br>C203 | R207<br>C204 | R701<br>C701 | R232<br>R210 | C205           | R61<br>R6  |                                        |  |  |  |  |
| MISC.  | LA601 SK601 SK706          |              |              |      |      |      |      |      | LA602 P203 P205 TS701 M1 |      |      |      | RE204 BU201  |              | LA603 SK606 SK9 |     |                |           | K7 SK705 RE201 |                 |                                    |             | LA604 SK     |              |              |                |            |                                        |  |  |  |  |





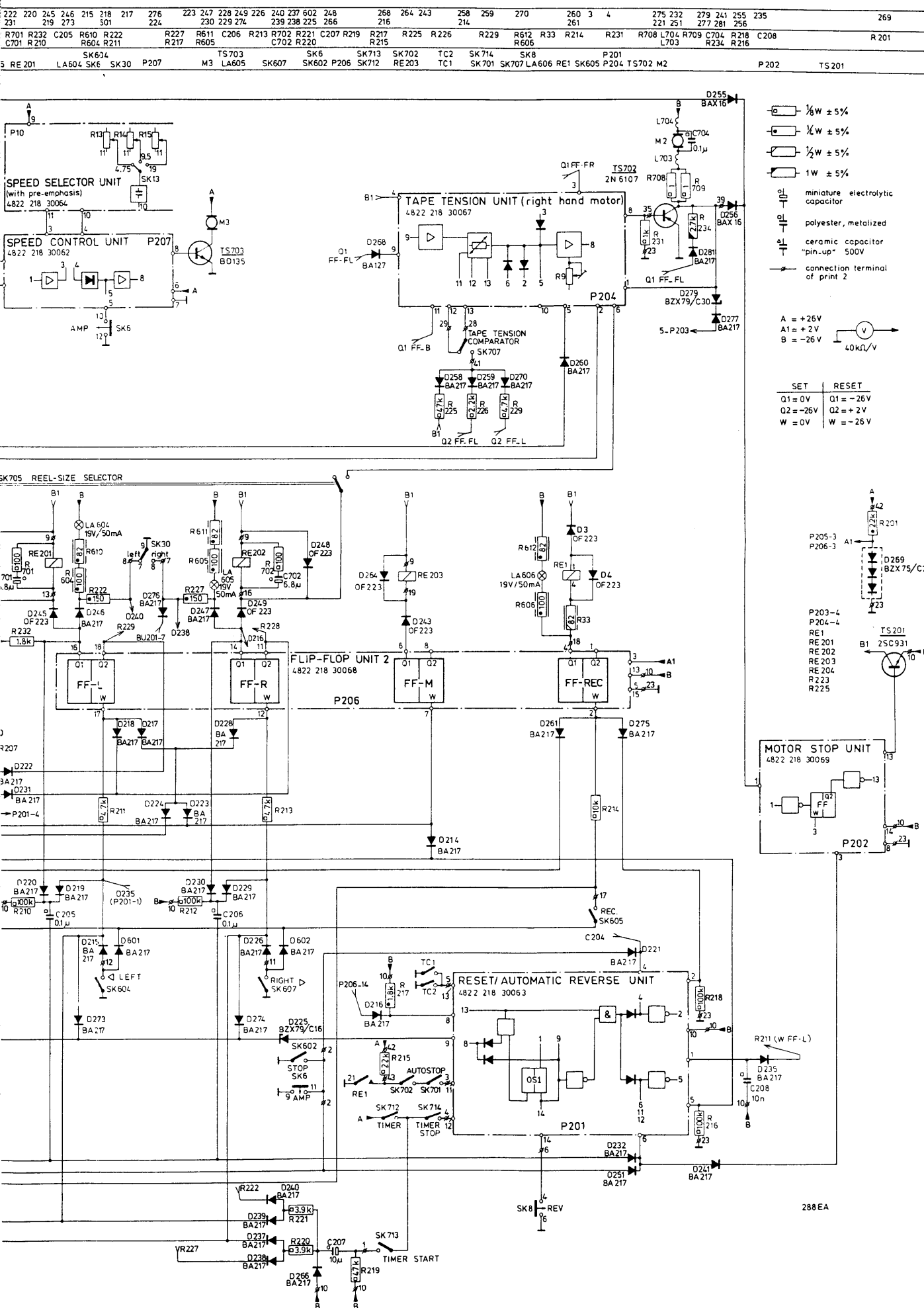


Fig. 25

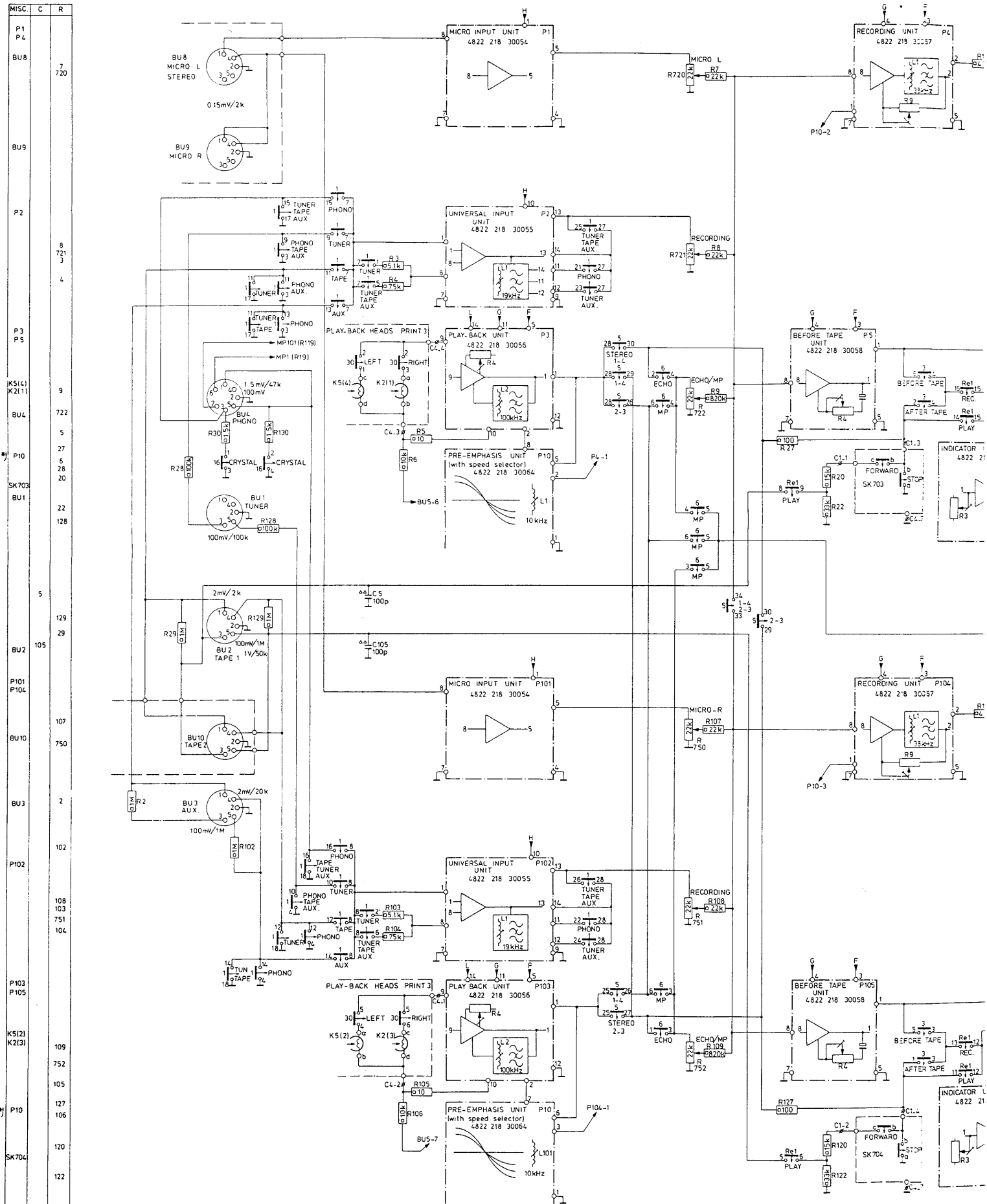


Fig. 26

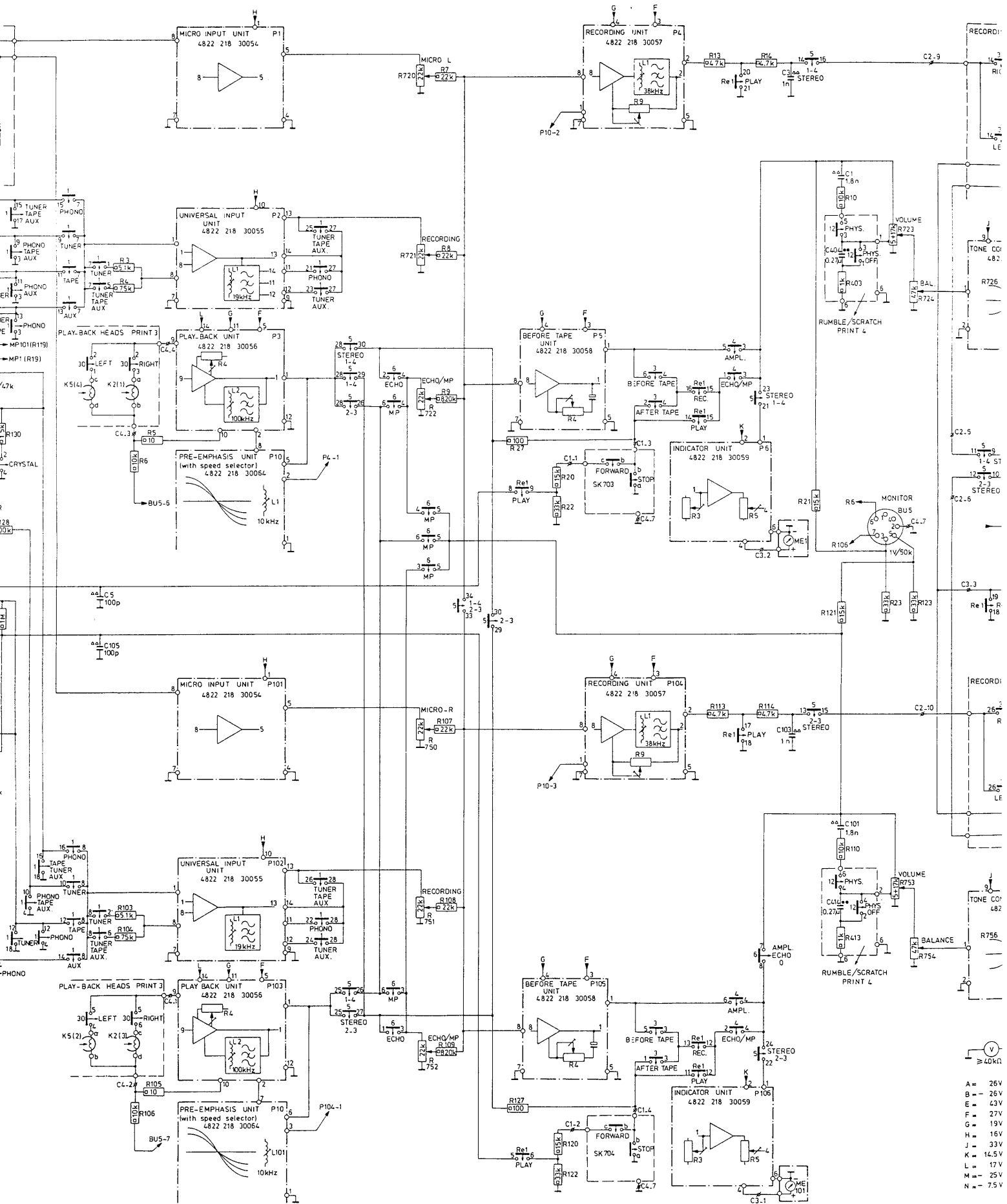


Fig. 26

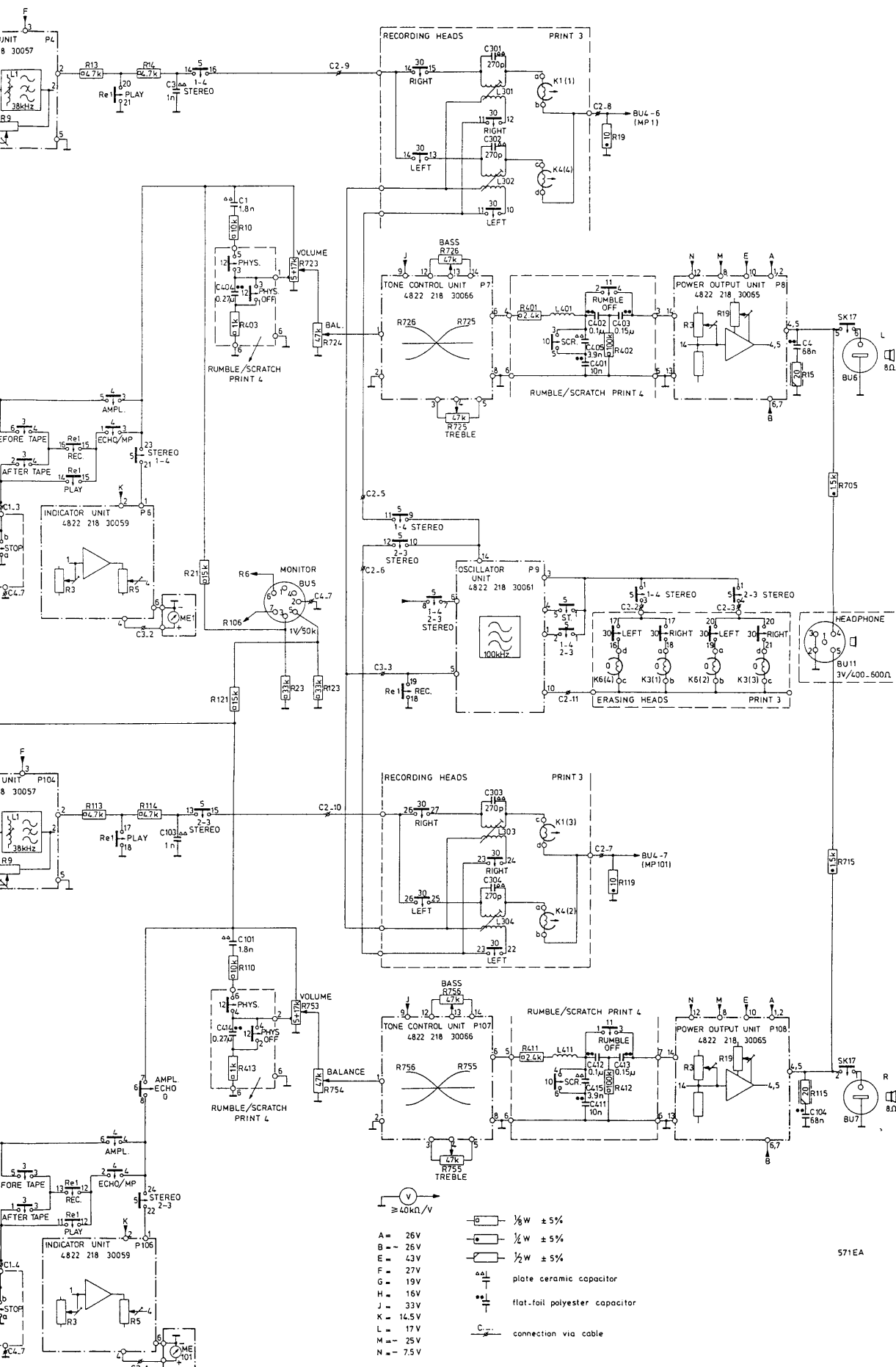


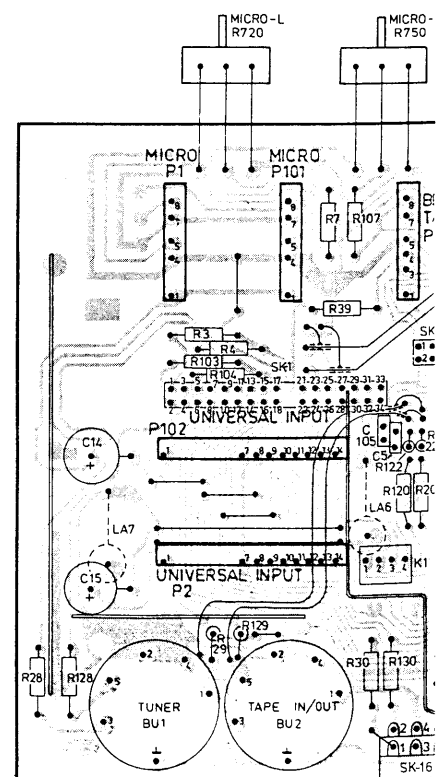
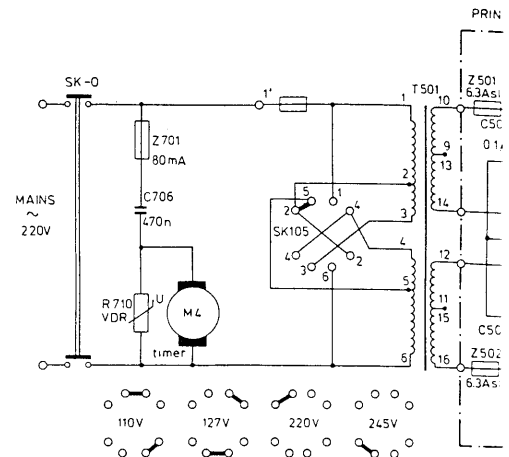
Fig. 26

## II. Supply

|                                            |                        |                |
|--------------------------------------------|------------------------|----------------|
| SK0                                        | Mains switch           | 4822 276 10483 |
| SK105                                      | Mains voltage selector | 4822 272 10102 |
| M4                                         | Timer motor            | 4822 361 60185 |
| L1, 2, 3, 4, 5,<br>6, 7, 8, 9,<br>701, 702 | Lamp 28 V - 40 mA      | 4822 134 40127 |
| R710                                       | VDR-resistor           | 4822 116 20103 |
| T501                                       | Mains transformer      | 4822 146 40197 |

## III. Amplifier part

|                     |                                                          |                |
|---------------------|----------------------------------------------------------|----------------|
| P1, 101             | Micro input unit                                         | 4822 218 30054 |
| P2, 102             | Universal input unit                                     | 4822 218 30055 |
| P3, 103             | Play-back unit                                           | 4822 218 30056 |
| P4, 104             | Recording unit                                           | 4822 218 30057 |
| P5, 105             | Before tape unit                                         | 4822 218 30058 |
| P6, 106             | Indicator unit                                           | 4822 218 30059 |
| P7, 107             | Tone control unit                                        | 4822 218 30066 |
| P8, 108             | Power output unit                                        | 4822 218 30065 |
| P9                  | Oscillator unit                                          | 4822 218 30061 |
| P10                 | Speed selector/pre-emphasis unit                         | 4822 218 30064 |
| SK1                 | Slide switch (TUN- TAPE-AUX-PHON)                        | 4822 277 30494 |
| SK3                 | Slide switch (AB)                                        | 4822 277 30378 |
| SK4                 | Slide switch (MP-NOR-ECH-AMP)                            | 4822 277 30495 |
| SK5                 | Slide switch (1-4 ST 3-2)                                | 4822 277 30496 |
| SK6                 | Slide switch (MP-NOR-ECH-AMP)                            | 4822 277 30497 |
| SK10, 11, 12        | Push button switch assy (SCRATCH-RUMBLE-PHYS)            | 4822 276 30201 |
| SK16                | Switch (CRYST-DYN)                                       | 4822 277 60119 |
| SK30                | Slide switch (head switch)                               | 4822 277 60118 |
| BU1, 2, 3           | Socket, 5p (TUNER, TAPE IN/OUT, AUX)                     | 4822 267 40174 |
| BU4, 5              | Socket, 7p (PHONO, MONITOR)                              | 4822 267 50148 |
| BU6, 7              | Socket, 2p (LOUDSP L, R)                                 | 4822 267 30233 |
| BU8, 9, 10          | see list of mechanical parts, cabinet and amplifier unit |                |
| BU11                | Socket, 5p (HEADPH)                                      | 4822 267 40175 |
| K1, 4               | Recording head                                           | 4822 249 20032 |
| K2, 5               | Play-back head                                           | 4822 249 30032 |
| K3, 6               | Erase head                                               | 4822 249 40058 |
| L301, 302, 303, 304 | Coil p.c. board 3                                        | 4822 156 40557 |
| L401, 411           | Coil p.c. board 4                                        | 4822 156 20594 |
| R720, 750           | Potentiometer (MICRO) 22 k $\Omega$ , log                | 4822 101 30266 |
| R721/751, 722/752   | Potentiometer (PHONO, ECHO) 22 k $\Omega$ , log          | 4822 102 30178 |
| R723/753            | Potentiometer (VOLUME) 5+17 k $\Omega$ , log             | 4822 102 30179 |
| R724/754            | Potentiometer (BALANCE) 47 k $\Omega$                    | 4822 102 30168 |
| R725/755, 726/756   | Potentiometer (TREBLE, BASS) 47 k $\Omega$ linear        | 4822 102 30177 |
| ME1                 | Meter, left                                              | 4822 347 10069 |
| ME101               | Meter, right                                             | 4822 347 10071 |
|                     | Socket for functional unit, 14p                          | 4822 267 50151 |
|                     | Socket for functional unit, 8p                           | 4822 267 50156 |
|                     | Socket for functional unit, 3p                           | 4822 267 50161 |
|                     | Connector for wire form, 14p                             | 4822 267 50163 |
|                     | Connector for wire form, 4p                              | 4822 267 40179 |
| Z501, 502           | Fuse 6, 3 A-T                                            | 4822 253 30031 |
| Z701                | Fuse 80 mA                                               | 4822 253 20005 |
| D1                  | Zenerdiode BZX79/C7V5                                    | 4822 130 30666 |
| D2                  | Zenerdiode BZX79/C15                                     | 4822 130 30781 |
| D501, 502, 503, 504 | Diode BY164                                              | 4822 130 30414 |
| D505, 506           | Diode OF223                                              | 4822 130 30791 |
| C9                  | 330 $\mu$ F - 63 V                                       | 4822 124 20404 |
| C10, 11             | 680 $\mu$ F - 40 V                                       | 4822 124 20413 |
| C12                 | 1000 $\mu$ F - 25 V                                      | 4822 124 20419 |
| C13                 | 150 $\mu$ F - 25 V                                       | 4822 124 20394 |
| C14, 15             | 220 $\mu$ F - 25 V                                       | 4822 124 20398 |
| C16                 | 470 $\mu$ F - 40 V                                       | 4822 124 20407 |
| C505, 506           | 2 x 2350 $\mu$ F - 40 V                                  | 4822 124 70226 |
| C507                | 680 $\mu$ F - 40 V                                       | 4822 124 20413 |
| C706                | 470 nF - 630 V                                           | 4822 121 40331 |



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IP)

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N)  
switch)

/OUT, AUX)

R)

P L, R)

cal parts, cabinet and

PH)

CRO)

ONO, ECHO)

LUME)

LANCE)

47 kΩ linear

al unit, 14p  
al unit, 8p  
al unit, 3p  
e form, 14p  
e form, 4p

/C7V5  
/C15

- 4822 276 10483
- 4822 272 10102
- 4822 361 60185
- 4822 134 40127
- 4822 116 20103
- 4822 146 40197
- 4822 218 30054
- 4822 218 30055
- 4822 218 30056
- 4822 218 30057
- 4822 218 30058
- 4822 218 30059
- 4822 218 30066
- 4822 218 30065
- 4822 218 30061
- 4822 218 30064
- 4822 277 30494
- 4822 277 30378
- 4822 277 30495
- 4822 277 30496
- 4822 277 30497
- 4822 276 30201
- 4822 277 60119
- 4822 277 60118
- 4822 267 40174
- 4822 267 50148
- 4822 267 30233
- 4822 267 40175
- 4822 249 20032
- 4822 249 30032
- 4822 249 40058
- 4822 156 40557
- 4822 156 20594
- 4822 101 30266
- 4822 102 30178
- 4822 102 30179
- 4822 102 30168
- 4822 102 30177
- 4822 347 10069
- 4822 347 10071
- 4822 267 50151
- 4822 267 50156
- 4822 267 50161
- 4822 267 50163
- 4822 267 40179
- 4822 253 30031
- 4822 253 20005
- 4822 130 30666
- 4822 130 30781
- 4822 130 30414
- 4822 130 30791
- 4822 124 20404
- 4822 124 20413
- 4822 124 20419
- 4822 124 20394
- 4822 124 20398
- 4822 124 20407
- 4822 124 70226
- 4822 124 20413
- 4822 121 40331

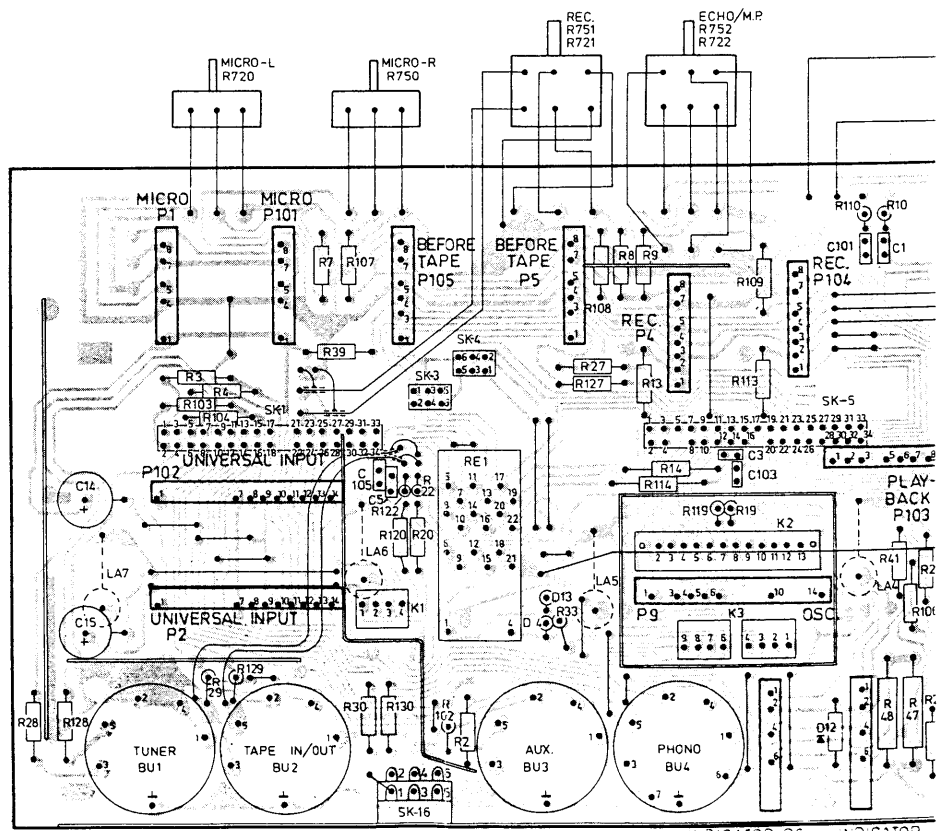
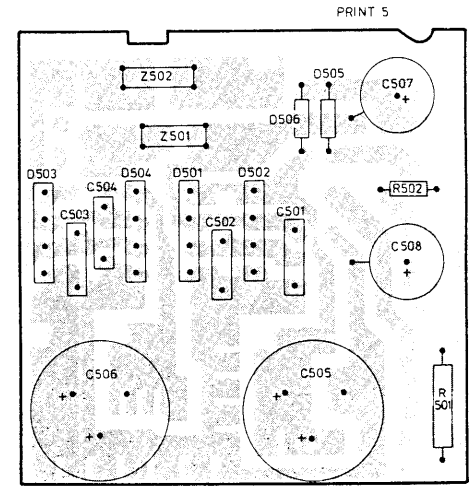
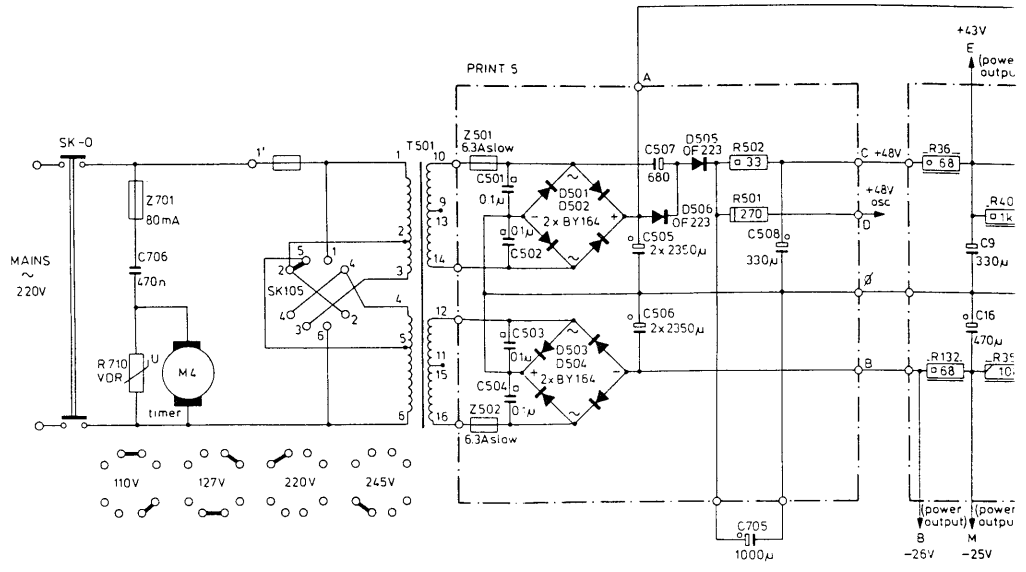
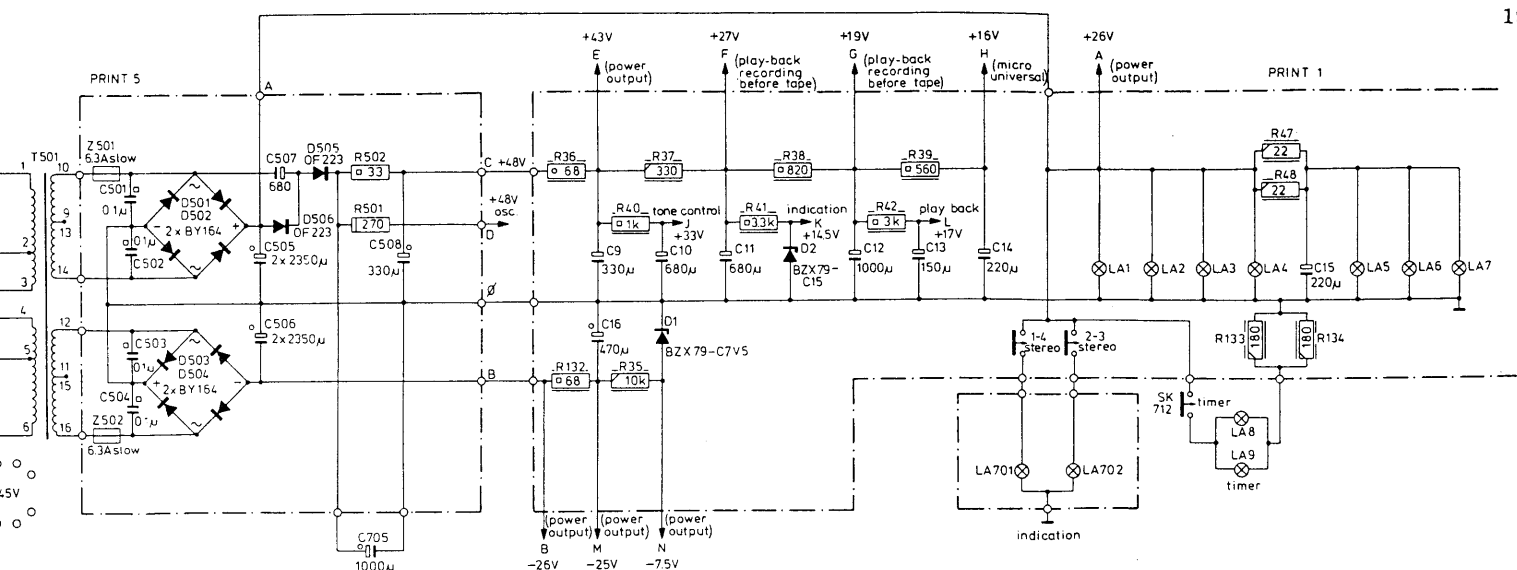
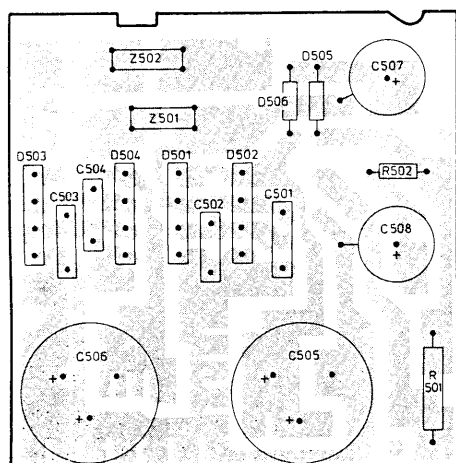


Fig. 27



PRINT 5



A = +26V

B = -26V

C = +48V

D = +50V

E = +43V

F = +27V

G = +19V

H = +16V

J = +33V

K = +14.5V

L = +17V

M = -25V

N = -7.5V

1/8W ± 5%

1/4W ± 5%

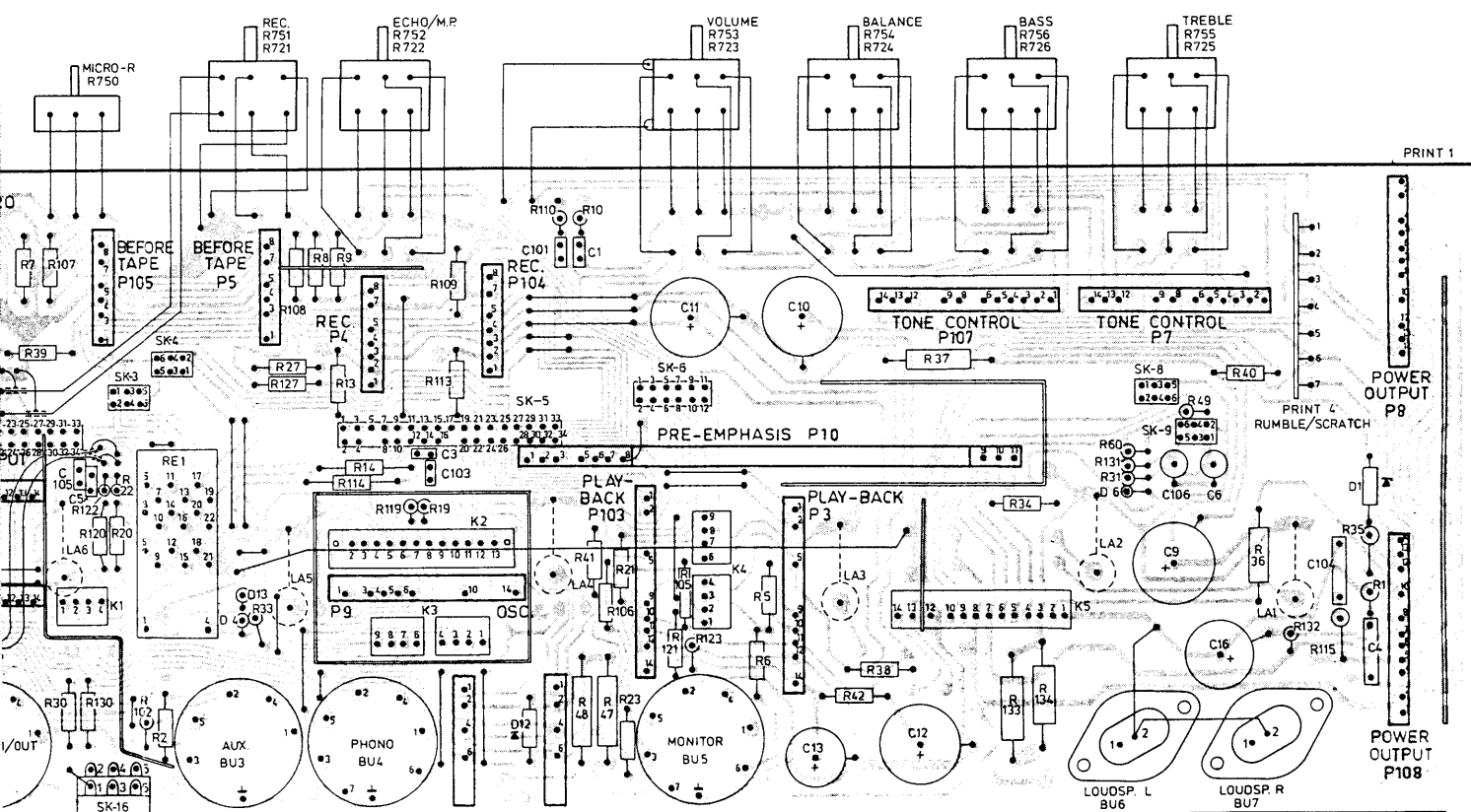
1/2W ± 5%

5.5W ± 5%

POLYESTER CAPACITOR 250 V

MINIATURE ELECTROLYTIC CAPACITOR

LAMP 28V/40mA



INDICATOR P5 INDICATOR P108

Fig. 27



|             |  |                 |  |           |  |            |  |                      |  |       |  |             |  |           |  |             |  |        |  |               |  |                  |  |
|-------------|--|-----------------|--|-----------|--|------------|--|----------------------|--|-------|--|-------------|--|-----------|--|-------------|--|--------|--|---------------|--|------------------|--|
| 709         |  | 708             |  | 502       |  | 401 + 403  |  | 411 + 413            |  | 701   |  | 702         |  |           |  |             |  |        |  |               |  |                  |  |
| 601 + 612   |  |                 |  | 501       |  |            |  |                      |  |       |  |             |  |           |  |             |  |        |  |               |  |                  |  |
| 704         |  | 705             |  | 501 + 508 |  | 401 + 405  |  | 411 + 415            |  | 701   |  | 702         |  |           |  |             |  |        |  |               |  |                  |  |
| D602        |  | SK 606          |  | L704      |  | D603       |  | D601                 |  | BK 2  |  | TS701 TS702 |  | Z502      |  | SK703 + 705 |  | RE 202 |  | RE 204 RE 203 |  | RE 201 SK706 BK1 |  |
| SK603 SK607 |  | M2 TS703 ME1 K7 |  | L703      |  | L601 + 606 |  | SK602 SK605 M3 SK601 |  | SK604 |  | D501 + 506  |  | SK10 + 12 |  | L411 L401   |  | T501   |  |               |  |                  |  |

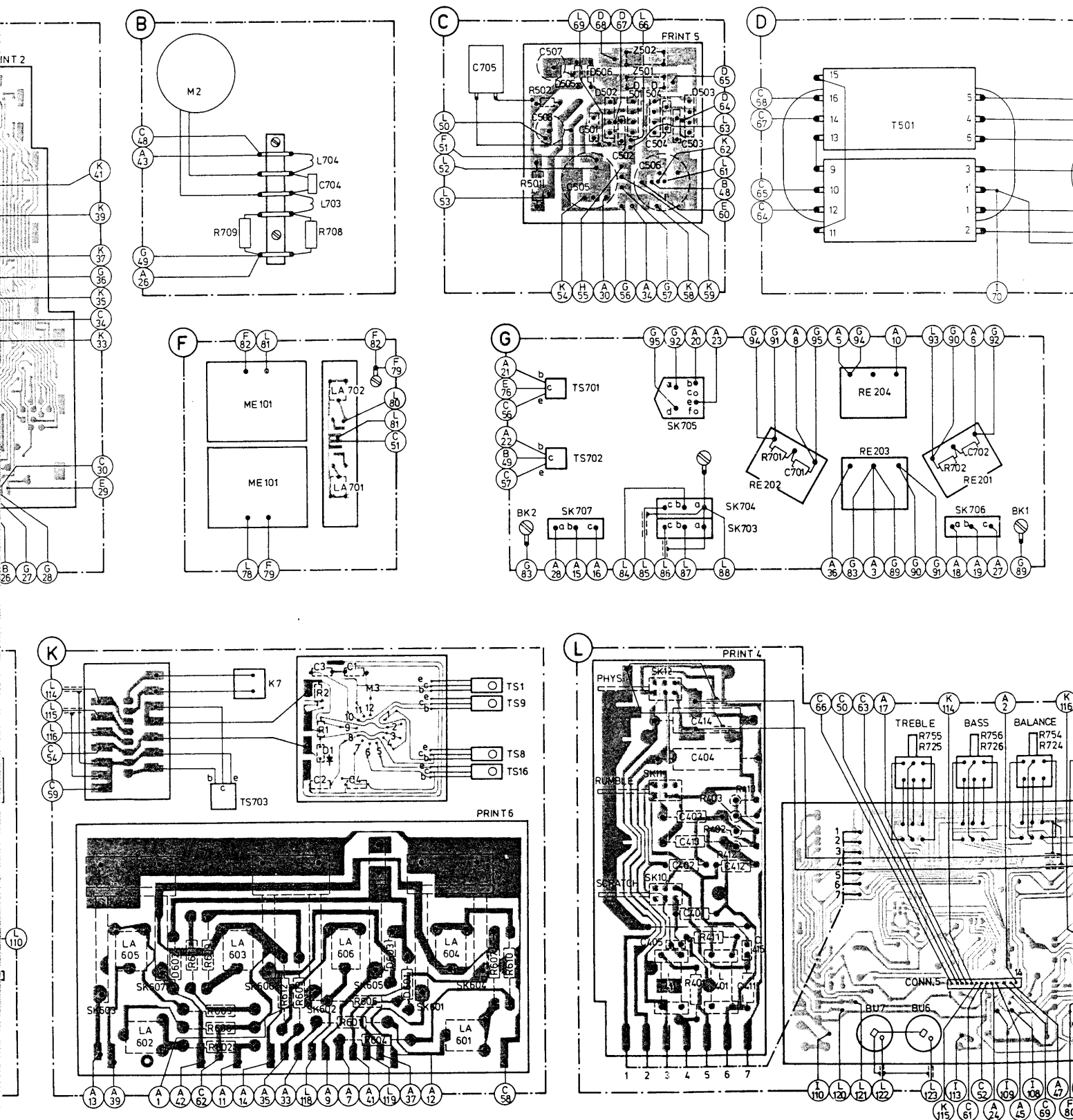


Fig. 28

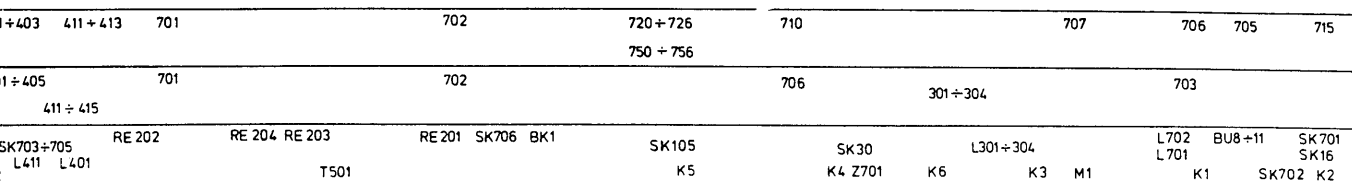
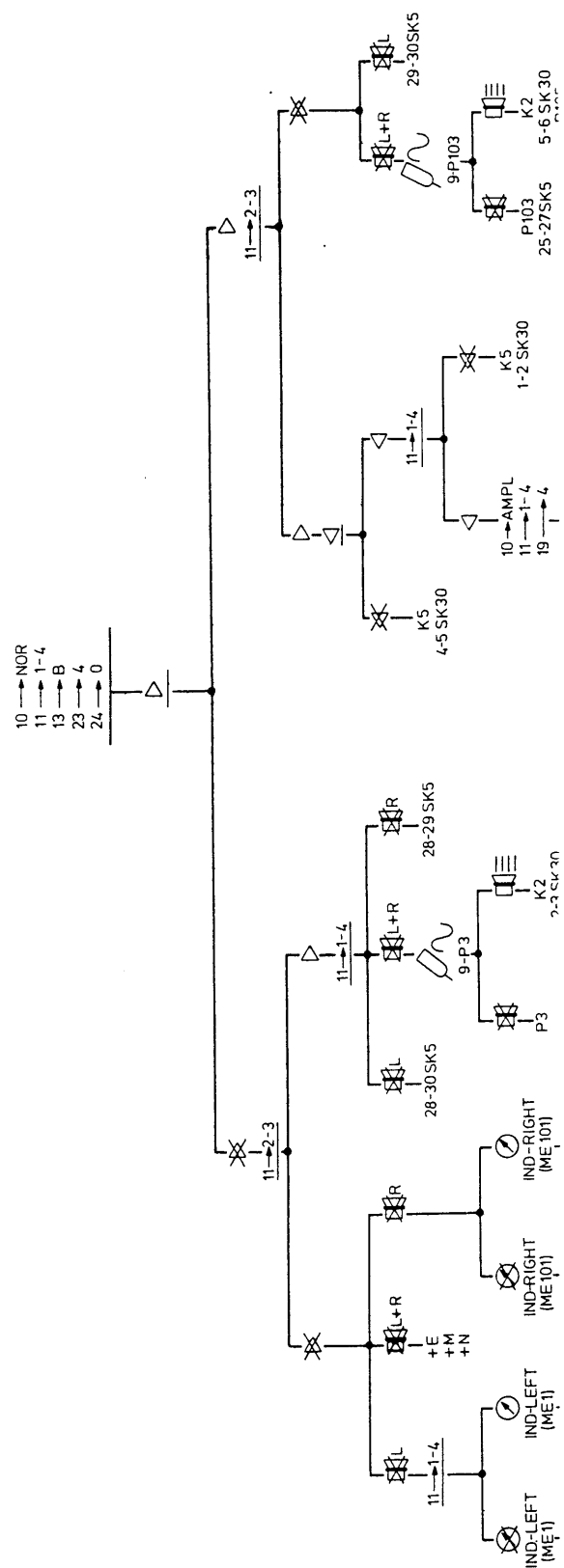
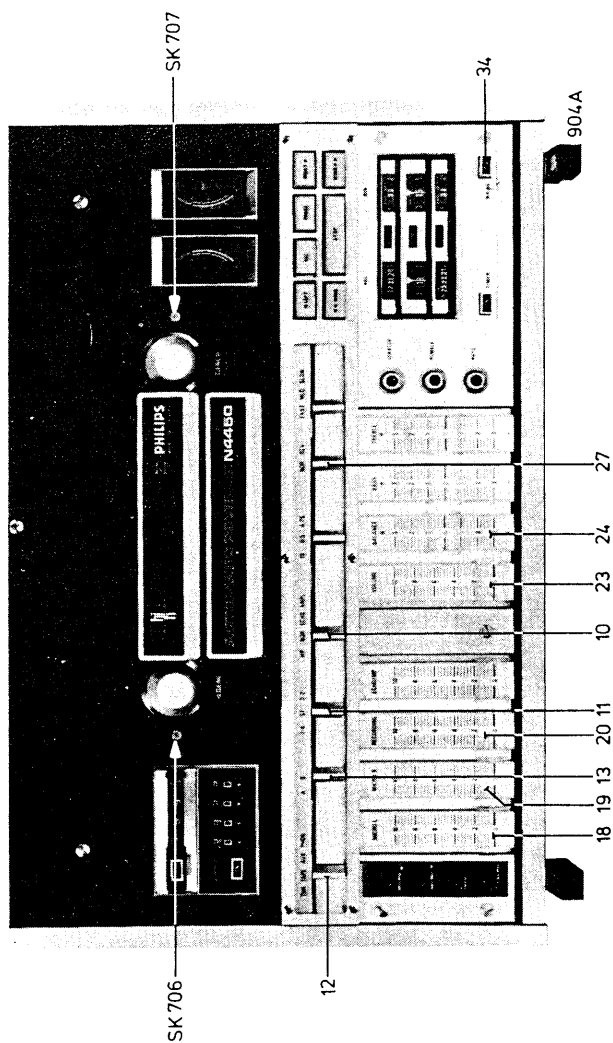
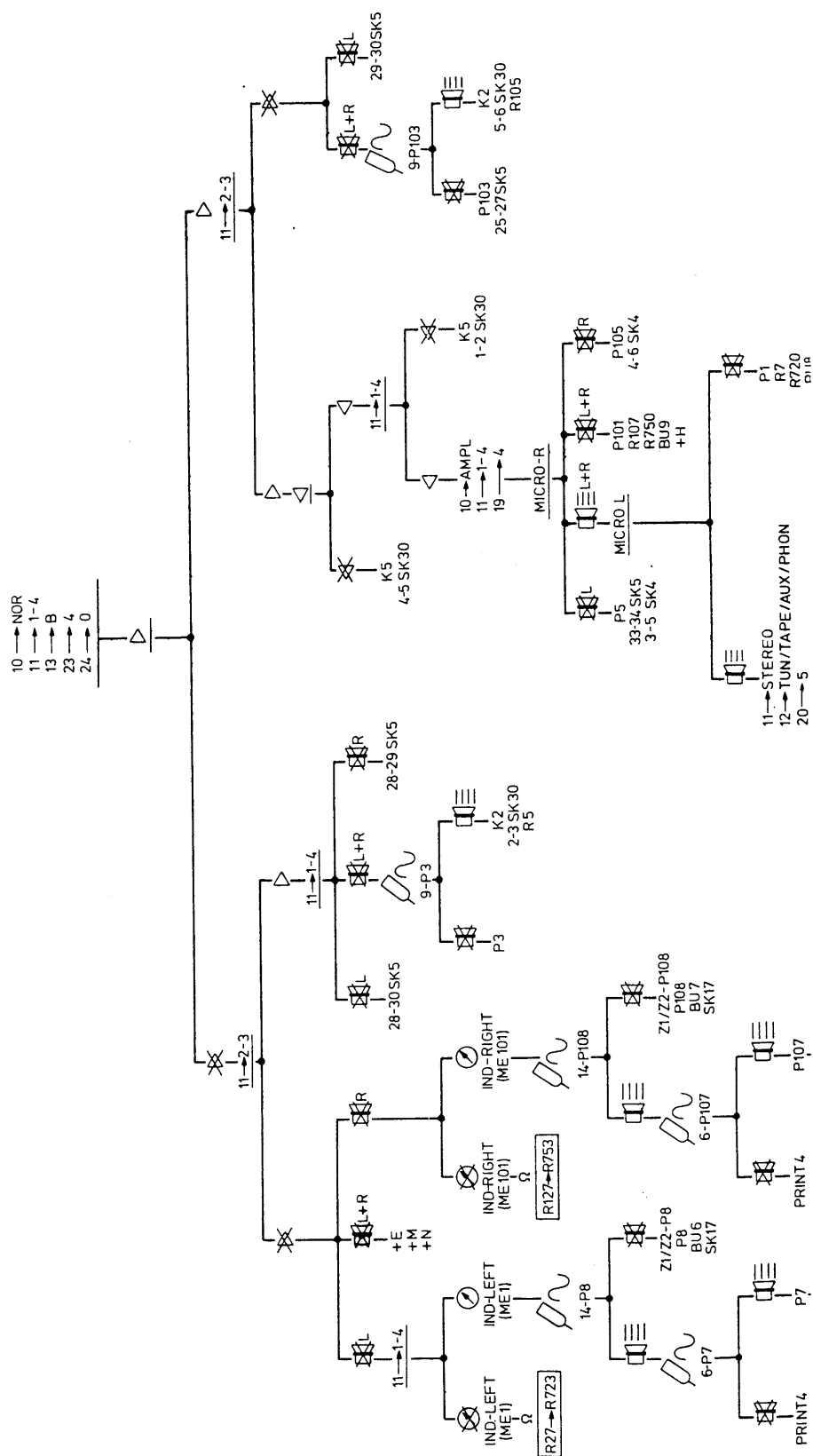


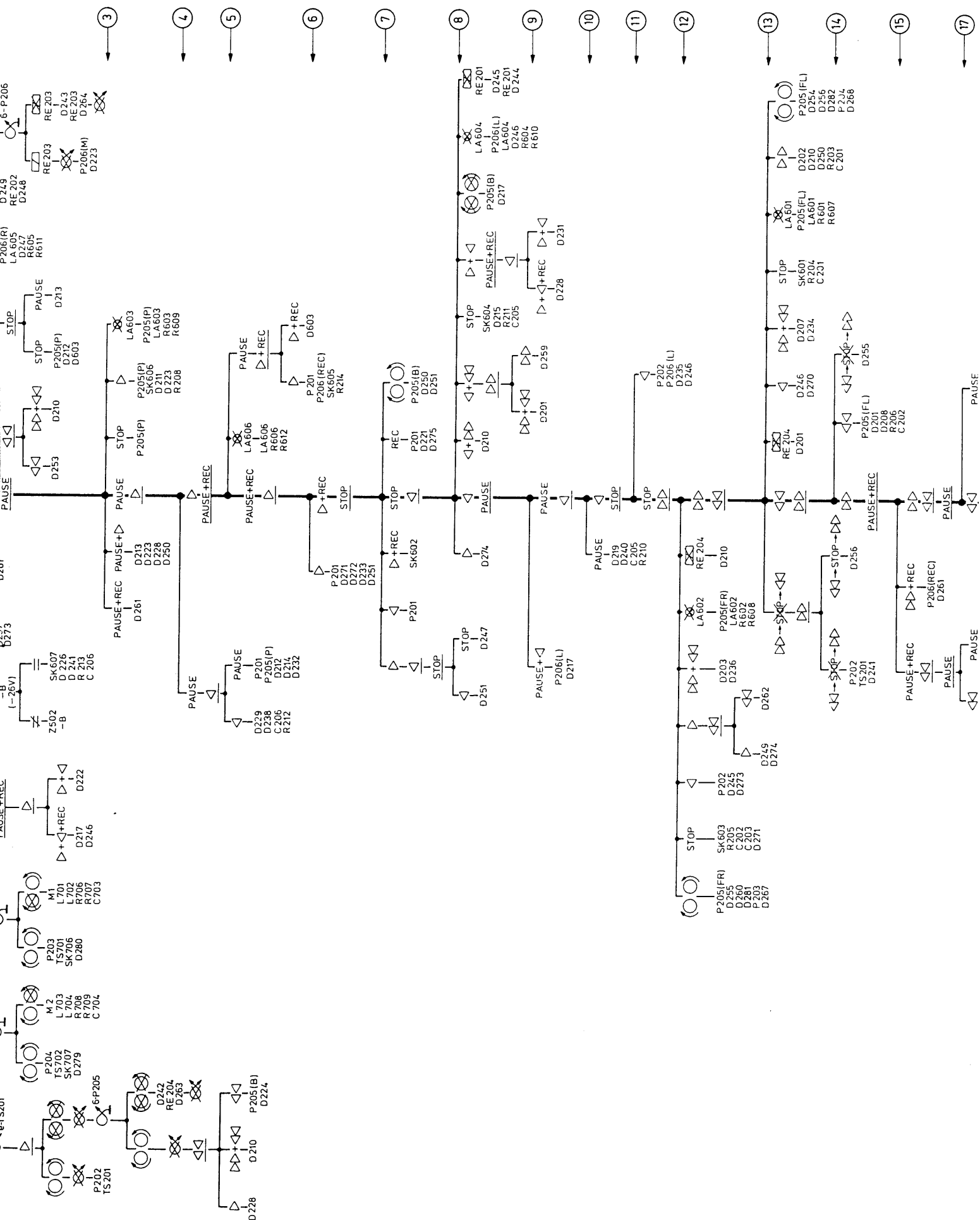
Fig. 28











## A

