6W audio amplifier with preamplifier — TDA1010A

The TDA1010A is a monolithic integrated class-B audio amplifier circuit in a 9-lead single in-line (SIL) plastic package. The device is primarily developed as a 6 W car radio amplifier for use with 4 Ω and 2 Ω load impedances. The wide supply voltage range and the flexibility of the IC make it an attractive proposition for record players and tape recorders with output powers up to 10 W.

Special features are:

- single in-line (SIL) construction for easy mounting
- separated preamplifier and power amplifier
- high output power
- low-cost external components
- good ripple rejection
- thermal protection

QUICK REFERENCE DATA

Supply voltage range	V_P		6 to 24 V
Repetitive peak output current	I_{ORM}	max.	3 A
Output power at pin 2; d_{tot} = 10%			
V_P = 14,4 V; R_L = 2 Ω	P_o	typ.	6,4 W
V_P = 14,4 V; R_L = 4 Ω	P_o	typ.	6,2 W
V_P = 14,4 V; R_L = 8 Ω	P_o	typ.	3,4 W
V_P = 14,4 V; R_L = 2 Ω; with additional bootstrap resistor of 220 Ω between pins 3 and 4	P_o	typ.	9 W
Total harmonic distortion at P_o = 1 W; R_L = 4 Ω	d_{tot}	typ.	0,2 %
Input impedance			
preamplifier (pin 8)	$\lvert Z_i \rvert$	typ.	30 kΩ
power amplifier (pin 6)	$\lvert Z_i \rvert$	typ.	20 kΩ
Total quiescent current at V_P = 14,4 V	I_{tot}	typ.	31 mA
Sensitivity for P_o = 5,8 W; R_L = 4 Ω	V_i	typ.	10 mV
Operating ambient temperature	T_{amb}		−25 to + 150 °C
Storage temperature	T_{stg}		−55 to + 150 °C

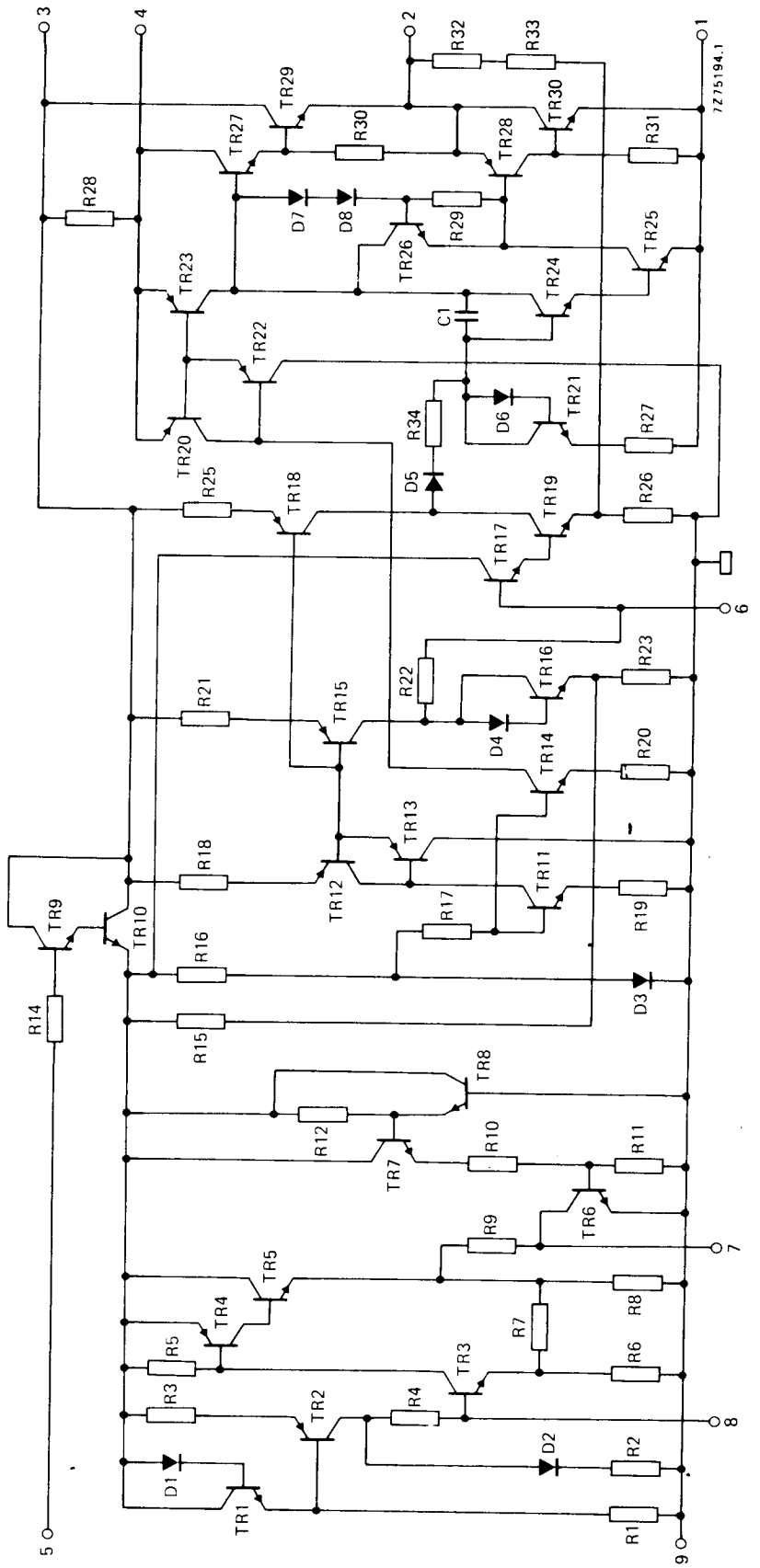

Fig. 1 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Supply voltage	V_P	max.	24 V
Peak output current	I_{OM}	max.	5 A
Repetitive peak output current	I_{ORM}	max.	3 A
Total power dissipation	see derating curve Fig. 2		
Storage temperature	T_{stg}	−55 to + 150	°C
Operating ambient temperature	T_{amb}	−25 to + 150	°C
A.C. short-circuit duration of load during sine-wave drive; without heatsink at V_P = 14,4 V	t_{sc}	max.	100 hours

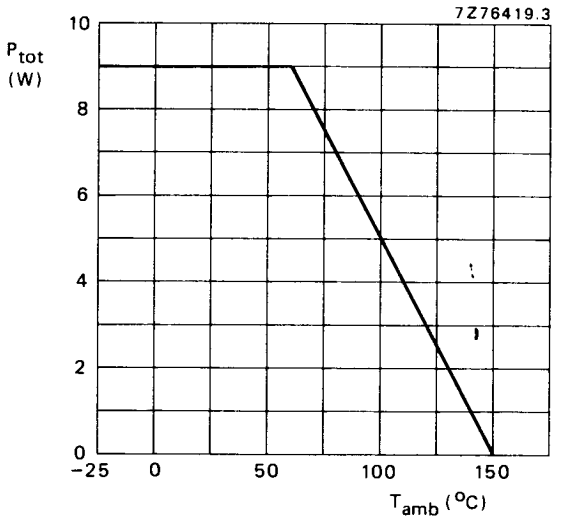

Fig. 2 Power derating curve.

HEATSINK DESIGN

Assume V_P = 14,4 V; R_L = 2 Ω; T_{amb} = 60 °C maximum; thermal shut-down starts at T_j = 150 °C. The maximum sine-wave dissipation in a 2 Ω load is about 5,2 W. The maximum dissipation for music drive will be about 75% of the worst-case sine-wave dissipation, so this will be 3,9 W. Consequently, the total resistance from junction to ambient

$$R_{th\ j\text{-}a} = R_{th\ j\text{-}tab} + R_{th\ tab\text{-}h} + R_{th\ h\text{-}a} = \frac{150 - 60}{3,9} = 23\ K/W.$$

Since $R_{th\ j\text{-}tab}$ = 10 K/W and $R_{th\ tab\text{-}h}$ = 1 K/W,

$R_{th\ h\text{-}a}$ = 23 − (10 + 1) = 12 K/W.

D.C. CHARACTERISTICS

Supply voltage range	V_P	6 to 24	V
Repetitive peak output current	I_{ORM}	< 3	A
Total quiescent current at V_P = 14,4 V	I_{tot}	typ. 31	mA

A.C. CHARACTERISTICS

T_{amb} = 25 °C; V_P = 14,4 V; R_L = 4 Ω; f = 1 kHz unless otherwise specified; see also Fig. 3.

A.F. output power (see Fig. 4) at d_{tot} = 10%; measured at pin 2; with bootstrap			
V_P = 14,4 V; R_L = 2 Ω (note 1)	P_o	typ. 6,4	W
V_P = 14,4 V; R_L = 4 Ω (note 1 and 2)	P_o	> 5,9 typ. 6,2	W W
V_P = 14,4 V; R_L = 8 Ω (note 1)	P_o	typ. 3,4	W
V_P = 14,4 V; R_L = 4 Ω; without bootstrap	P_o	typ. 5,7	W
V_P = 14,4 V; R_L = 2 Ω; with additional bootstrap resistor of 220 Ω between pins 3 and 4	P_o	typ. 9	W
Voltage gain			
preamplifier (note 3)	G_{v1}	typ. 24 21 to 27	dB dB
power amplifier	G_{v2}	typ. 30 27 to 33	dB dB
total amplifier	$G_{v\,tot}$	typ. 54 51 to 57	dB dB
Total harmonic distortion at P_o = 1 W	d_{tot}	typ. 0,2	%
Efficiency at P_o = 6 W	η	typ. 75	%
Frequency response (−3 dB)	B	80 Hz to 15	kHz
Input impedance			
preamplifier (note 4)	$\lvert Z_i \rvert$	typ. 30 20 to 40	kΩ kΩ
power amplifier (note 5)	$\lvert Z_i \rvert$	typ. 20 14 to 26	kΩ kΩ
Output impedance of preamplifier; pin 7 (note 5)	$\lvert Z_o \rvert$	typ. 20 14 to 26	kΩ kΩ
Output voltage preamplifier (r.m.s. value) d_{tot} < 1% (pin 7) (note 3)	$V_{o(rms)}$	> 0,7	V
Noise output voltage (r.m.s. value; note 6)			
R_S = 0 Ω	$V_{n(rms)}$	typ. 0,3	mV
R_S = 8,2 kΩ	$V_{n(rms)}$	typ. 0,7 < 1,4	mV mV
Ripple rejection at f = 1 kHz to 10 kHz (note 7)	RR	> 42	dB
at f = 100 Hz; C2 = 1 μF	RR	> 37	dB
Sensitivity for P_o = 5,8 W	V_i	typ. 10	mV
Bootstrap current at onset of clipping; pin 4 (r.m.s. value)	$I_{4(rms)}$	typ. 30	mA

Notes

1. Measured with an ideal coupling capacitor to the speaker load.
2. Up to $P_o \leqslant 3$ W : $d_{tot} \leqslant 1\%$.
3. Measured with a load impedance of 20 kΩ.
4. Independent of load impedance of preamplifier.
5. Output impedance of preamplifier ($|Z_o|$) is correlated (within 10%) with the input impedance ($|Z_i|$) of the power amplifier.
6. Unweighted r.m.s. noise voltage measured at a bandwidth of 60 Hz to 15 kHz (12 dB/octave).
7. Ripple rejection measured with a source impedance between 0 and 2 kΩ (maximum ripple amplitude: 2 V).
8. The tab must be electrically floating or connected to the substrate (pin 9).

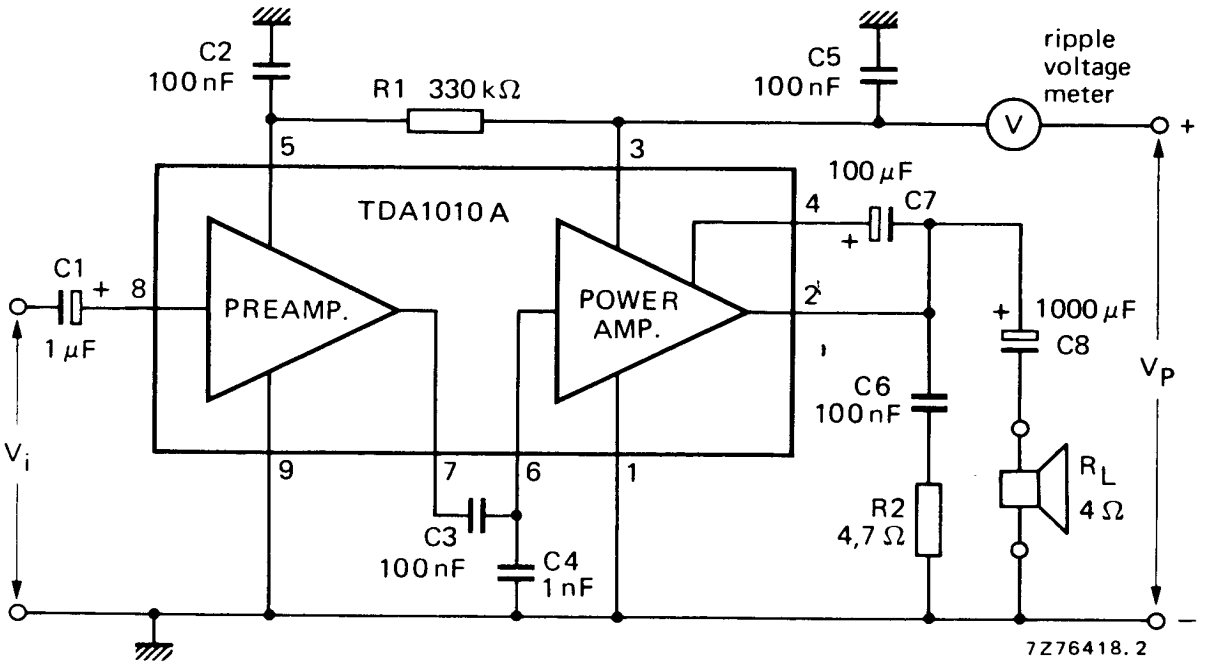

Fig. 3 Test circuit.

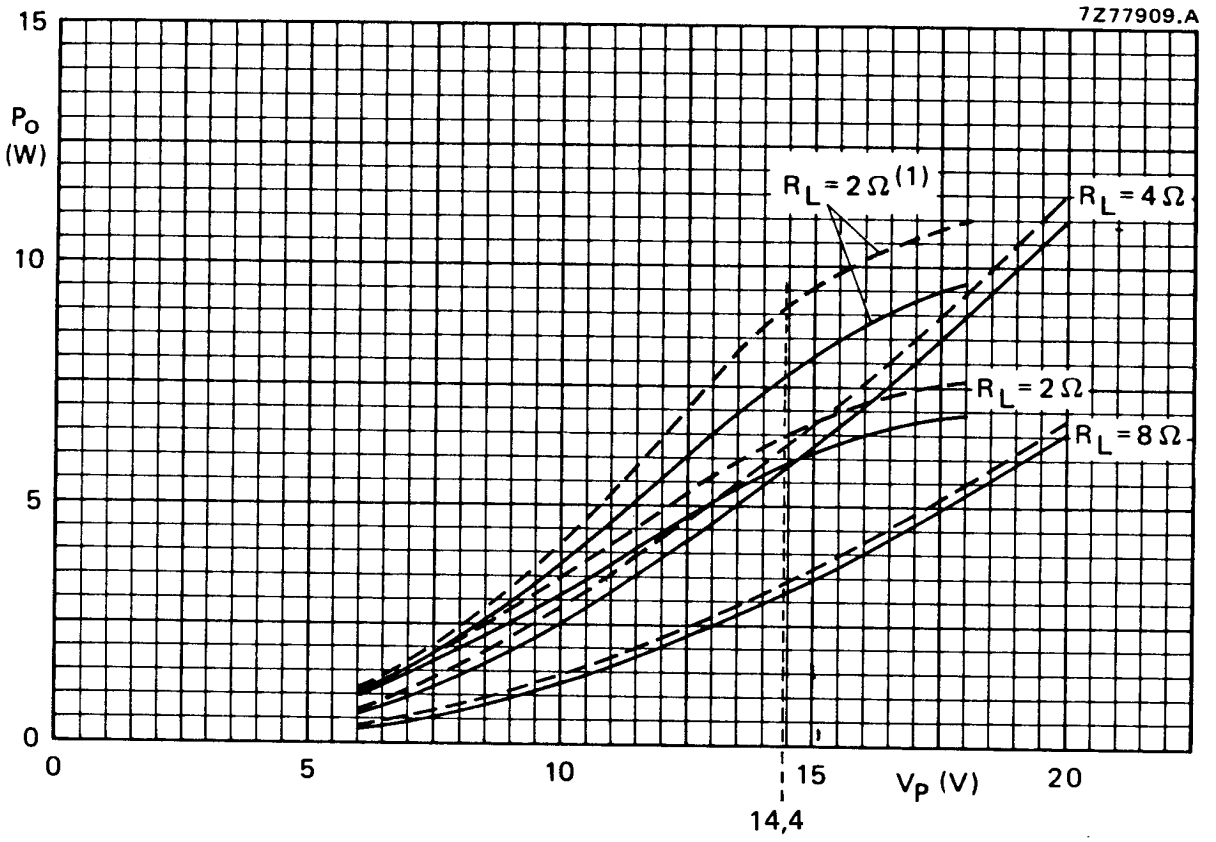

Fig. 4 Output power of the circuit of Fig. 3 as a function of the supply voltage with the load impedance as a parameter; typical values. Solid lines indicate the power across the load, dashed lines that available at pin 2 of the TDA1010. $R_L = 2\ \Omega$ (1) has been measured with an additional 220 Ω bootstrap resistor between pins 3 and 4. Measurements were made at f = 1 kHz, d_{tot} = 10%, T_{amb} = 25 °C.

Fig. 5 See next page.
Total harmonic distortion in the circuit of Fig. 3 as a function of the output power with the load impedance as a parameter; typical values. Solid lines indicate the power across the load, dashed lines that available at pin 2 of the TDA1010. $R_L = 2\ \Omega$ (1) has been measured with an additional 220 Ω bootstrap resistor between pins 3 and 4. Measurements were made at f = 1 kHz, V_P = 14,4 V.

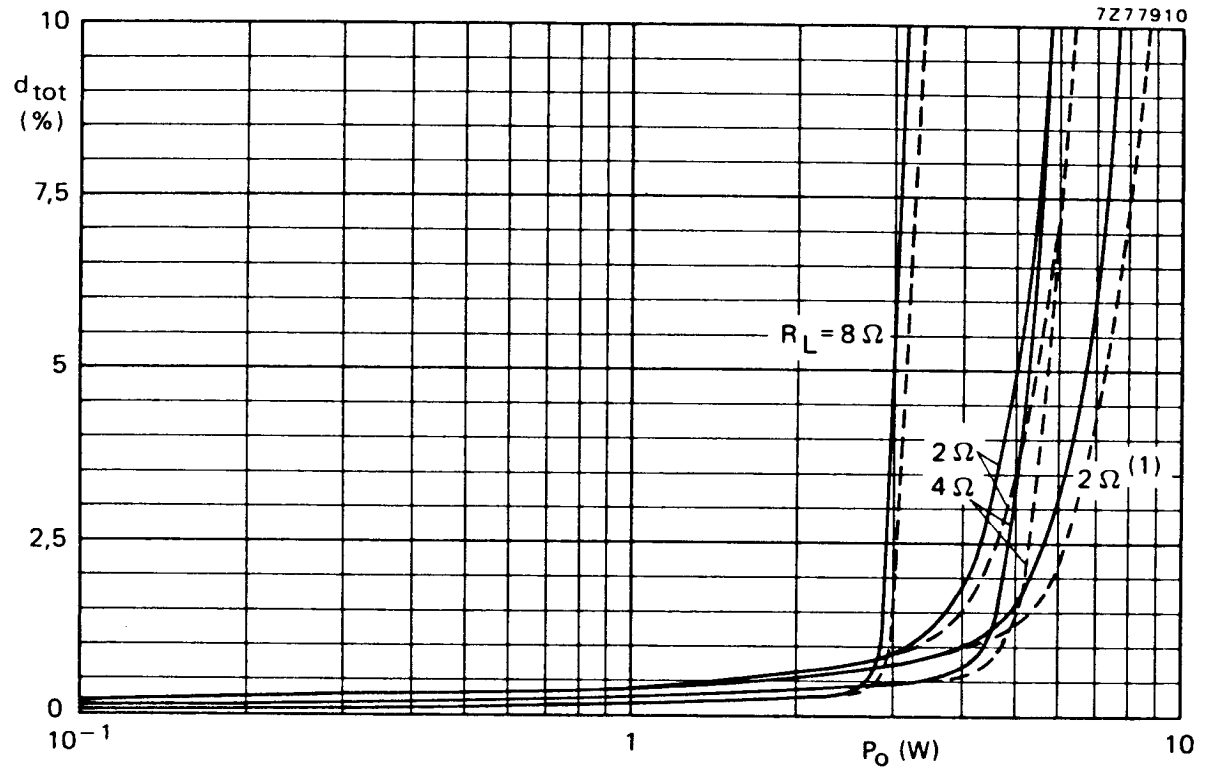

Fig. 5 For caption see preceding page.

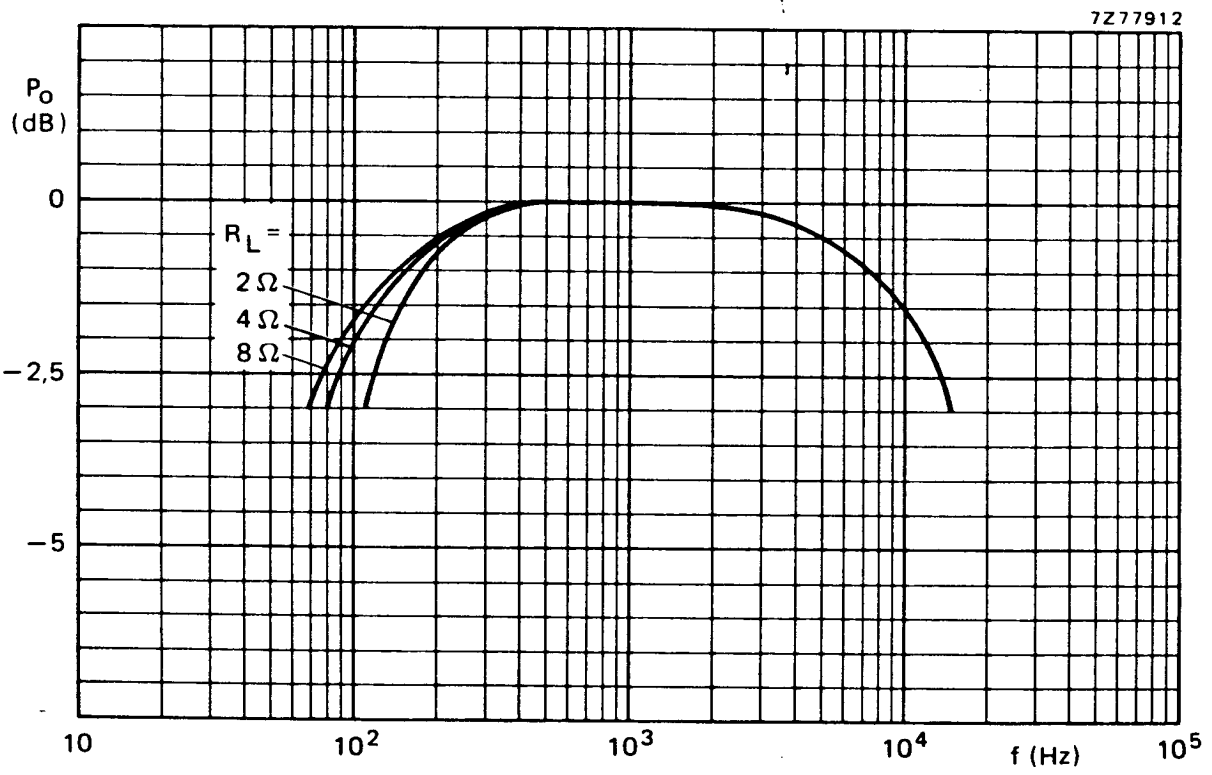

Fig. 6 Frequency characteristics of the circuit of Fig. 3 for three values of load impedance; typical values. P_O relative to 0 dB = 1 W; V_P = 14,4 V.

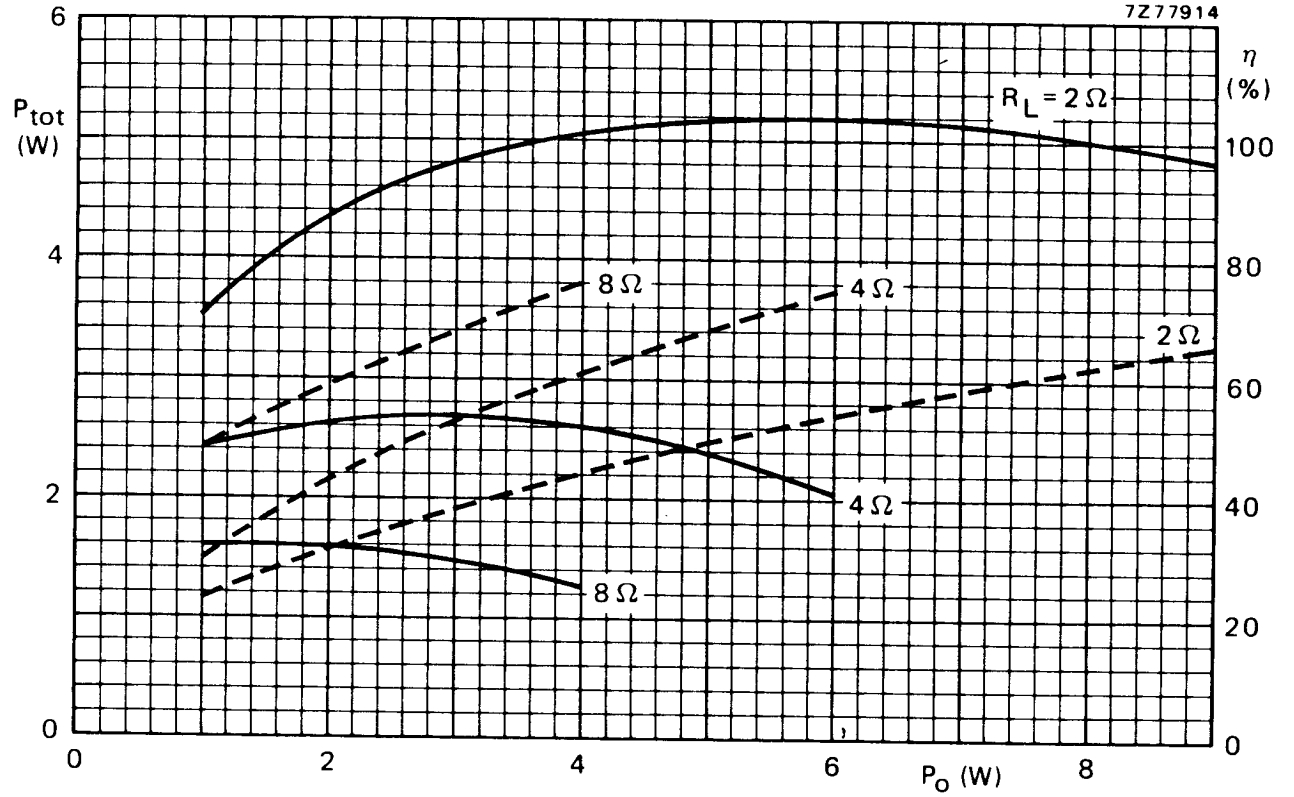

Fig. 7 Total power dissipation (solid lines) and the efficiency (dashed lines) of the circuit of Fig. 3 as a function of the output power with the load impedance as a parameter (for $R_L = 2\,\Omega$ an external bootstrap resistor of 220 Ω has been used); typical values. $V_P = 14{,}4$ V; f = 1 kHz.

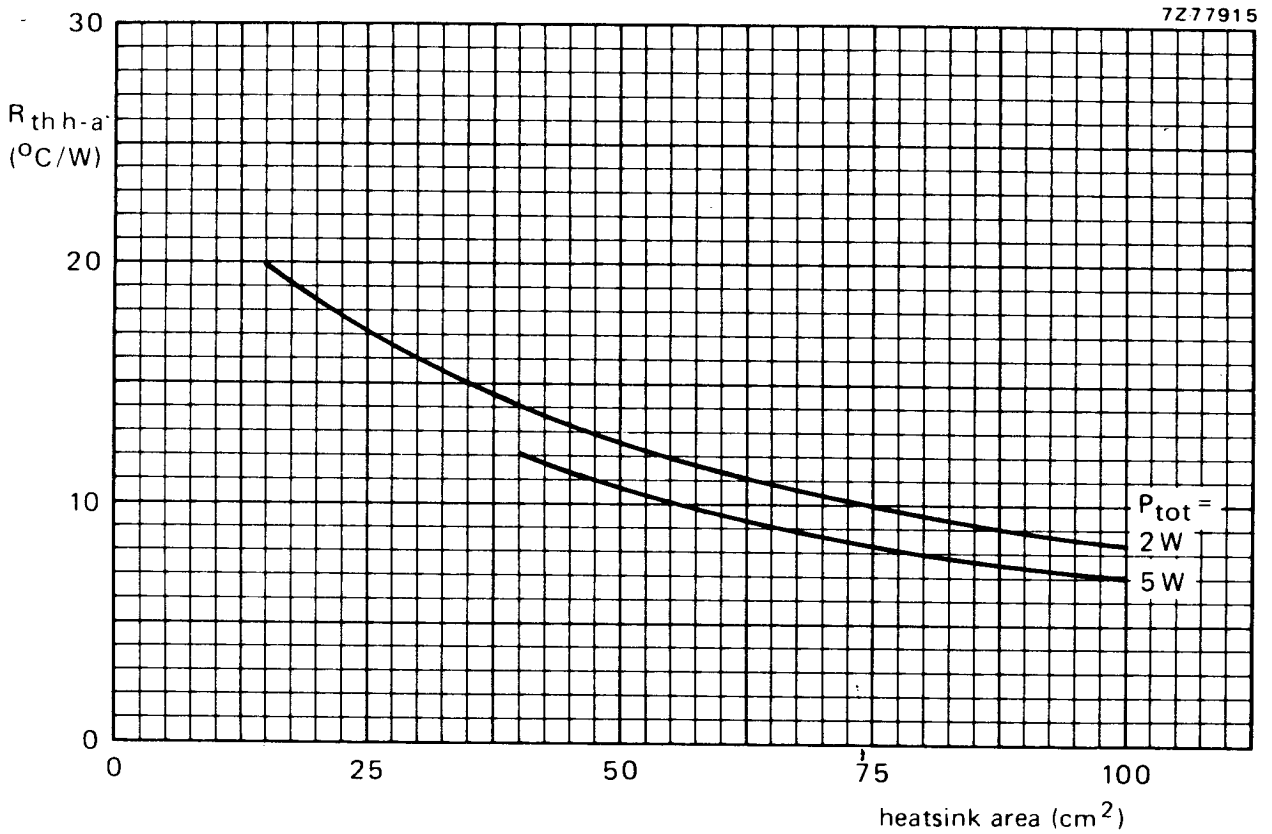

Fig. 8 Thermal resistance from heatsink to ambient of a 1,5 mm thick bright aluminium heatsink as a function of the single-sided area of the heatsink with the total power dissipation as a parameter.

APPLICATION INFORMATION

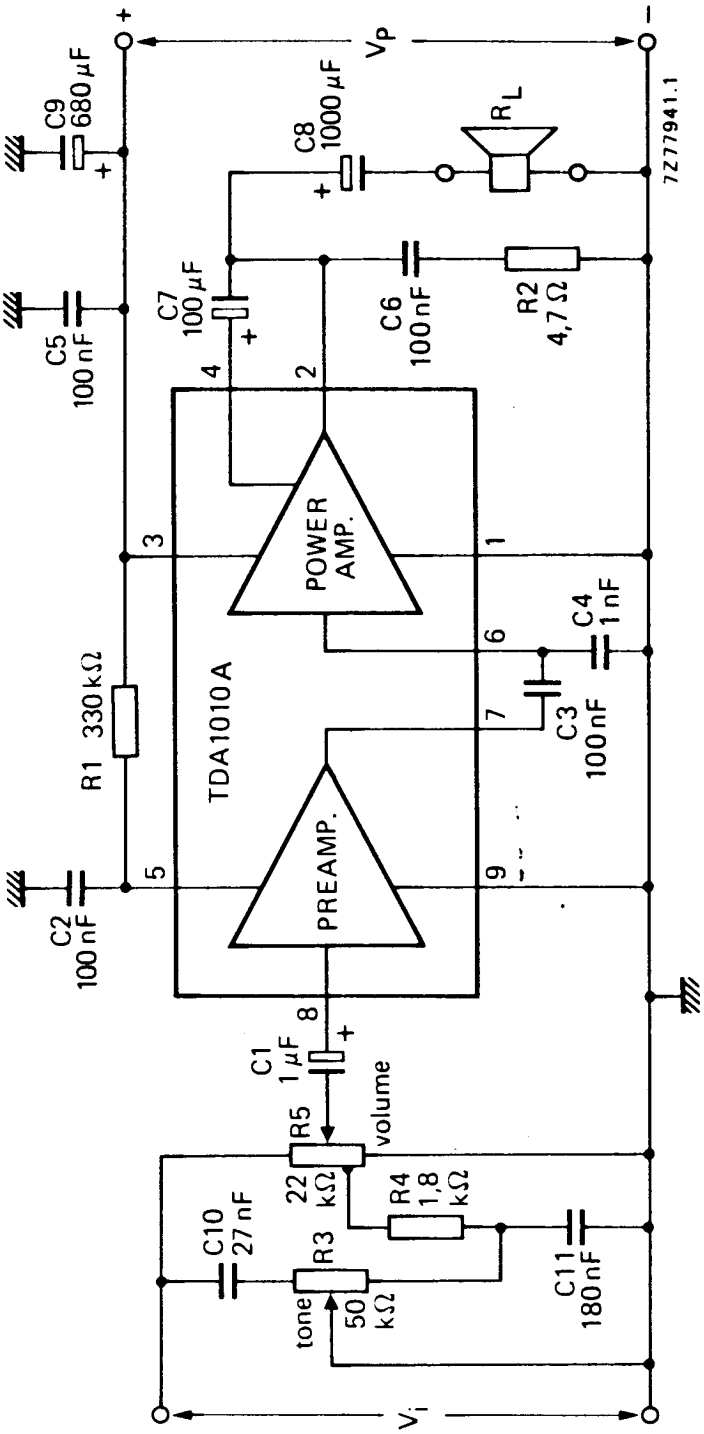

Fig. 9 Complete mono audio amplifier of a car radio.

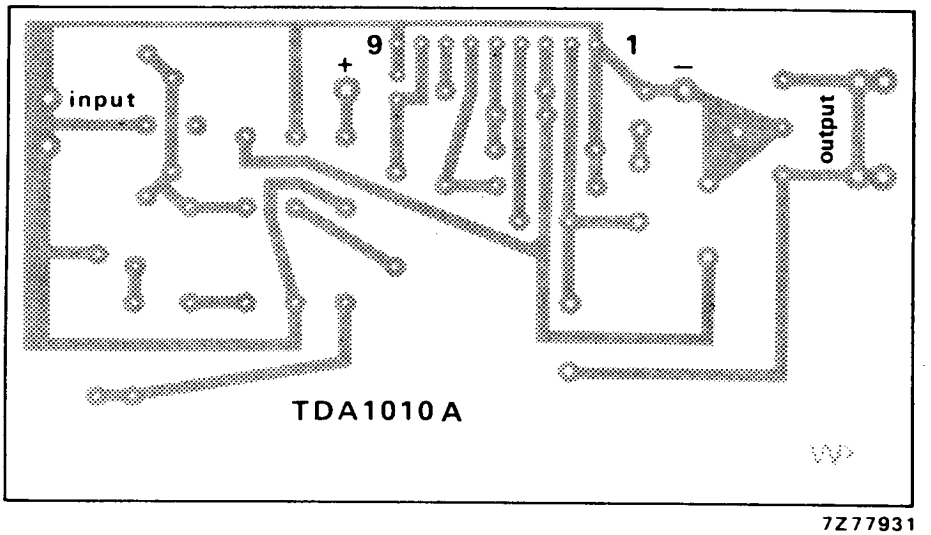

Fig. 10 Track side of printed-circuit board used for the circuit of Fig. 9; p.c. board dimensions 92 mm x 52 mm.

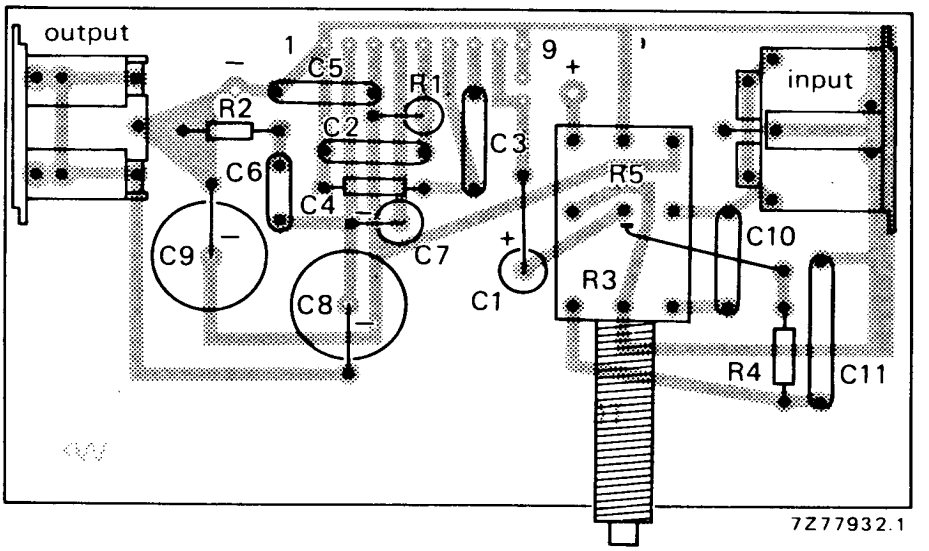

Fig. 11 Component side of printed-circuit board showing component layout used for the circuit of Fig. 9.

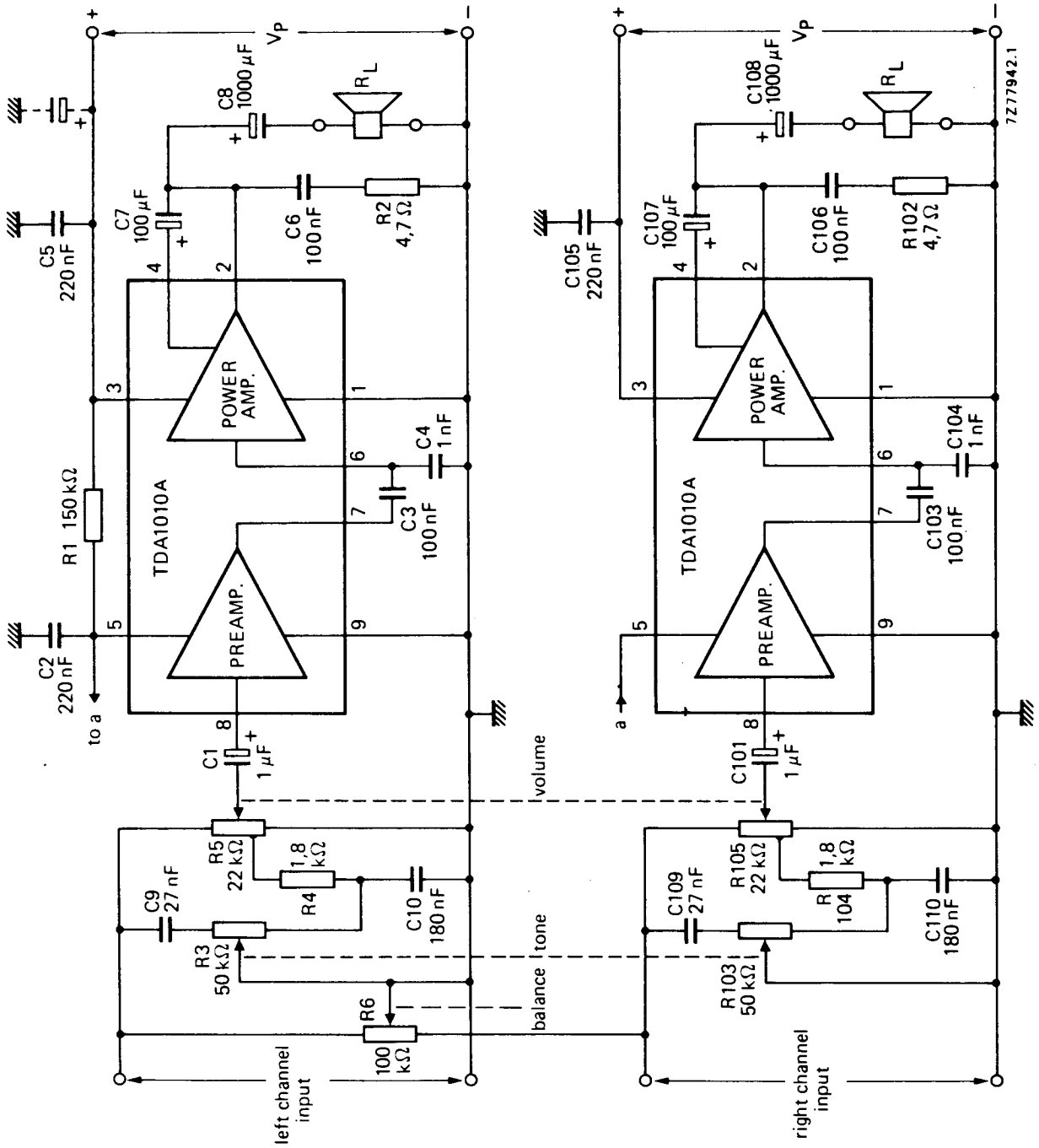

Fig. 12 Complete stereo car radio amplifier.

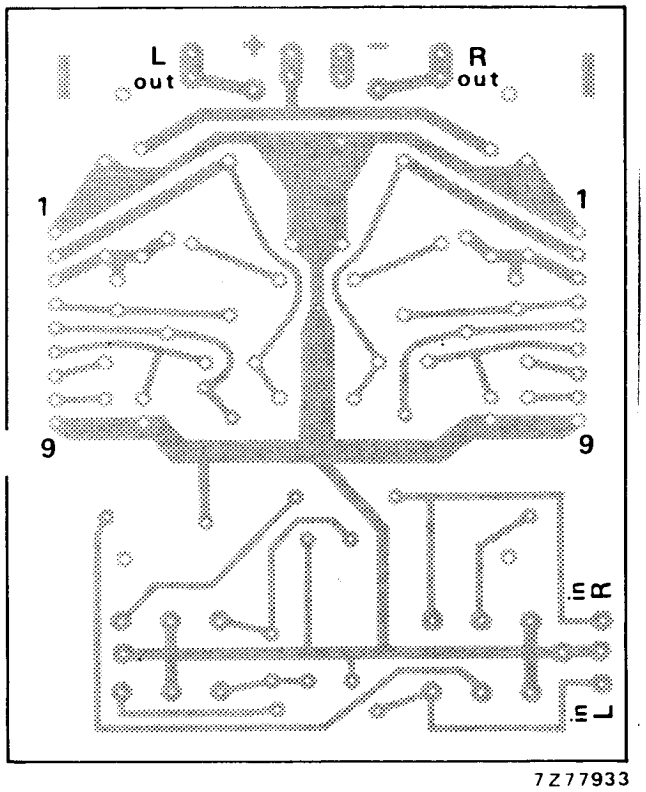

Fig. 13 Track side of printed-circuit board used for the circuit of Fig. 12; p.c. board dimensions 83 mm x 65 mm.

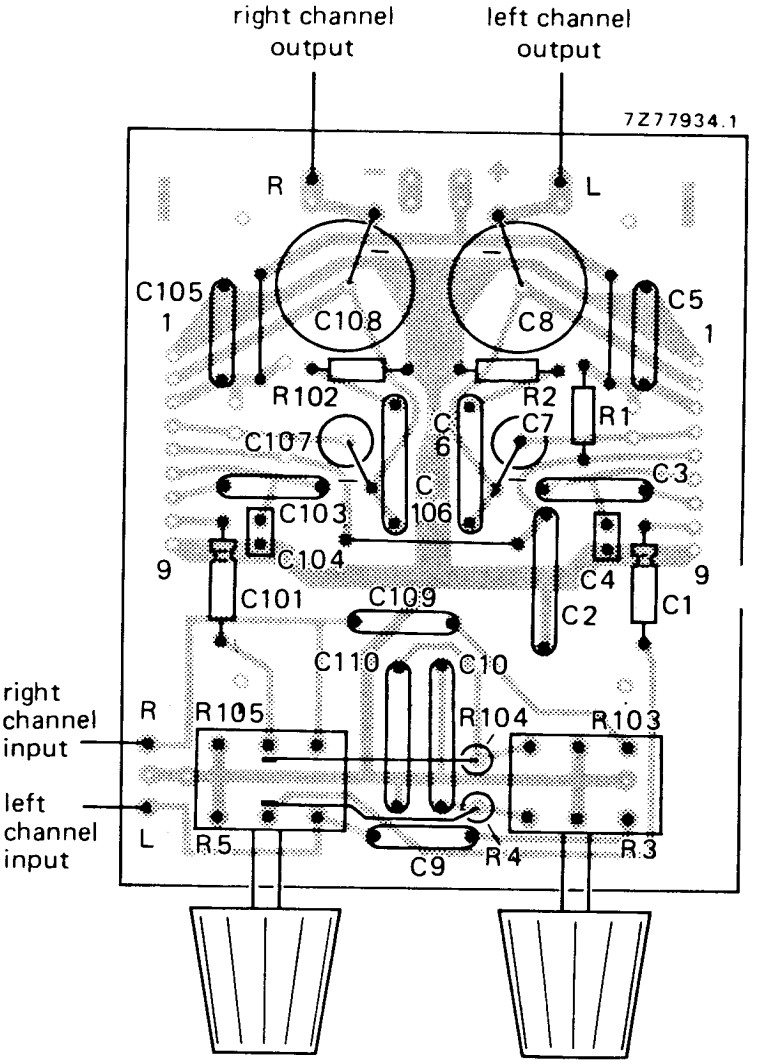

Fig. 14 Component side of printed-circuit board showing component layout used for the circuit of Fig. 12. Balance control is not on the p.c. board.

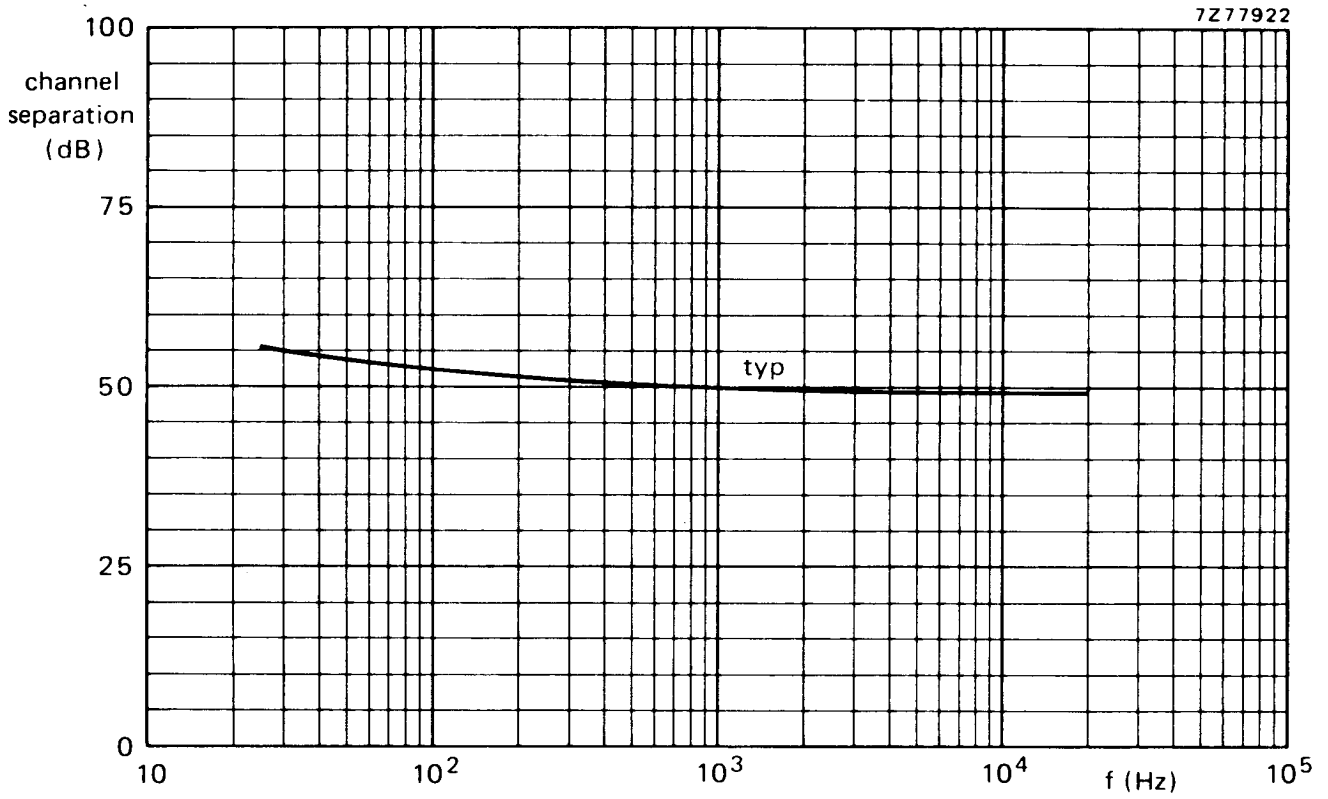

Fig. 15 Channel separation of the circuit of Fig. 12 as a function of the frequency.

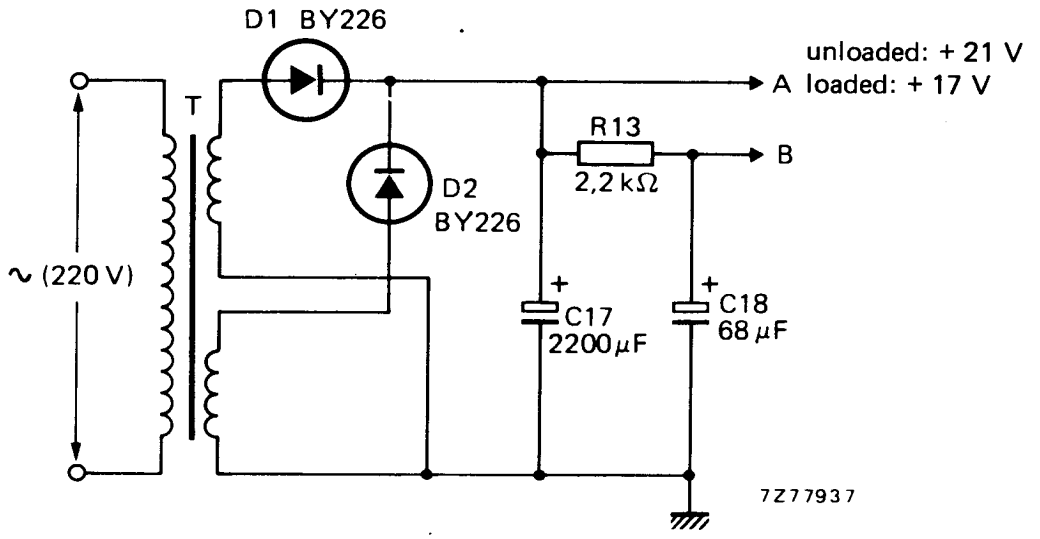

Fig. 16 Power supply of circuit of Fig. 17.

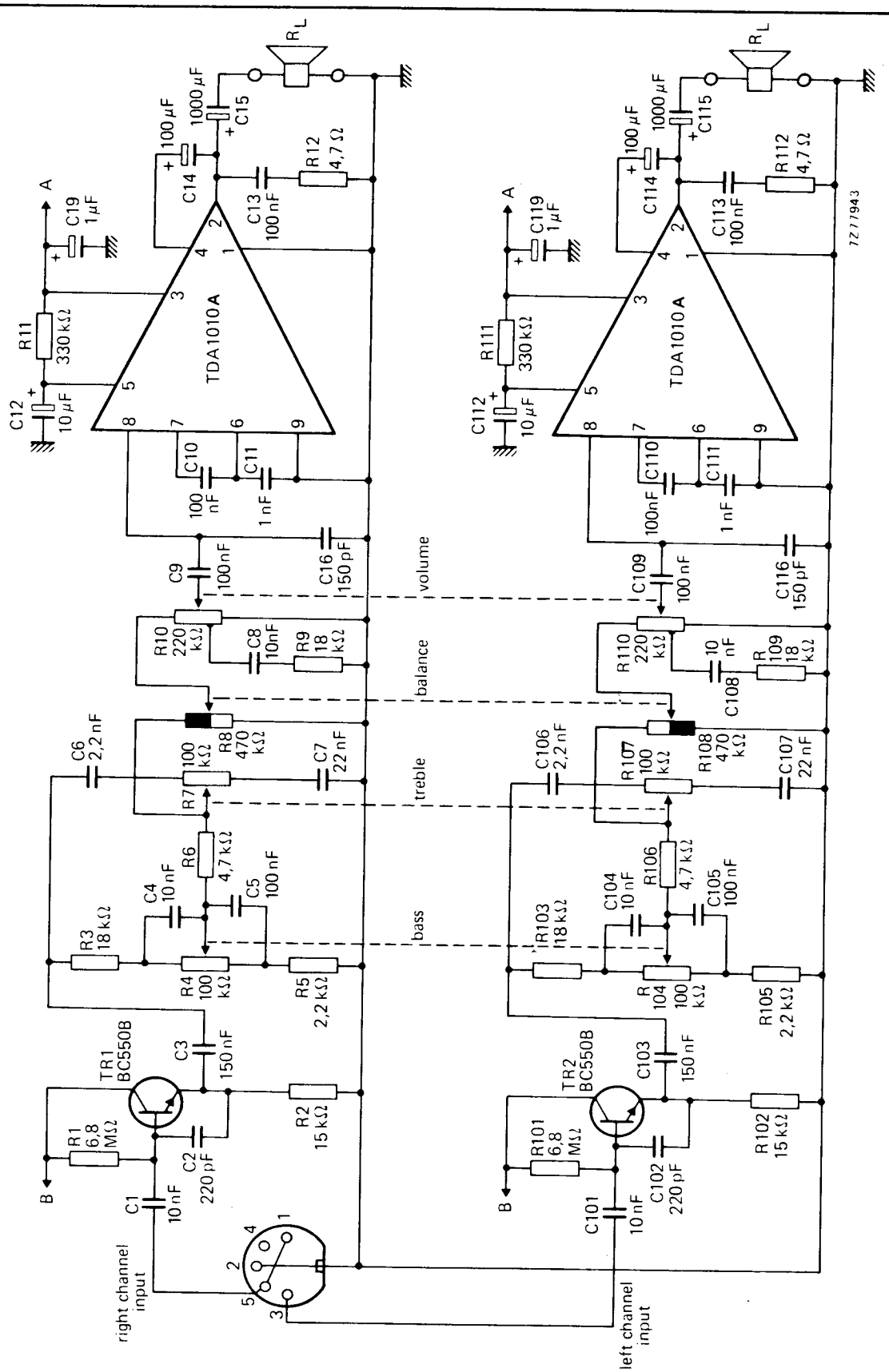

Fig. 17 Complete mains-fed ceramic stereo pick-up amplifier; for power supply see Fig. 16.

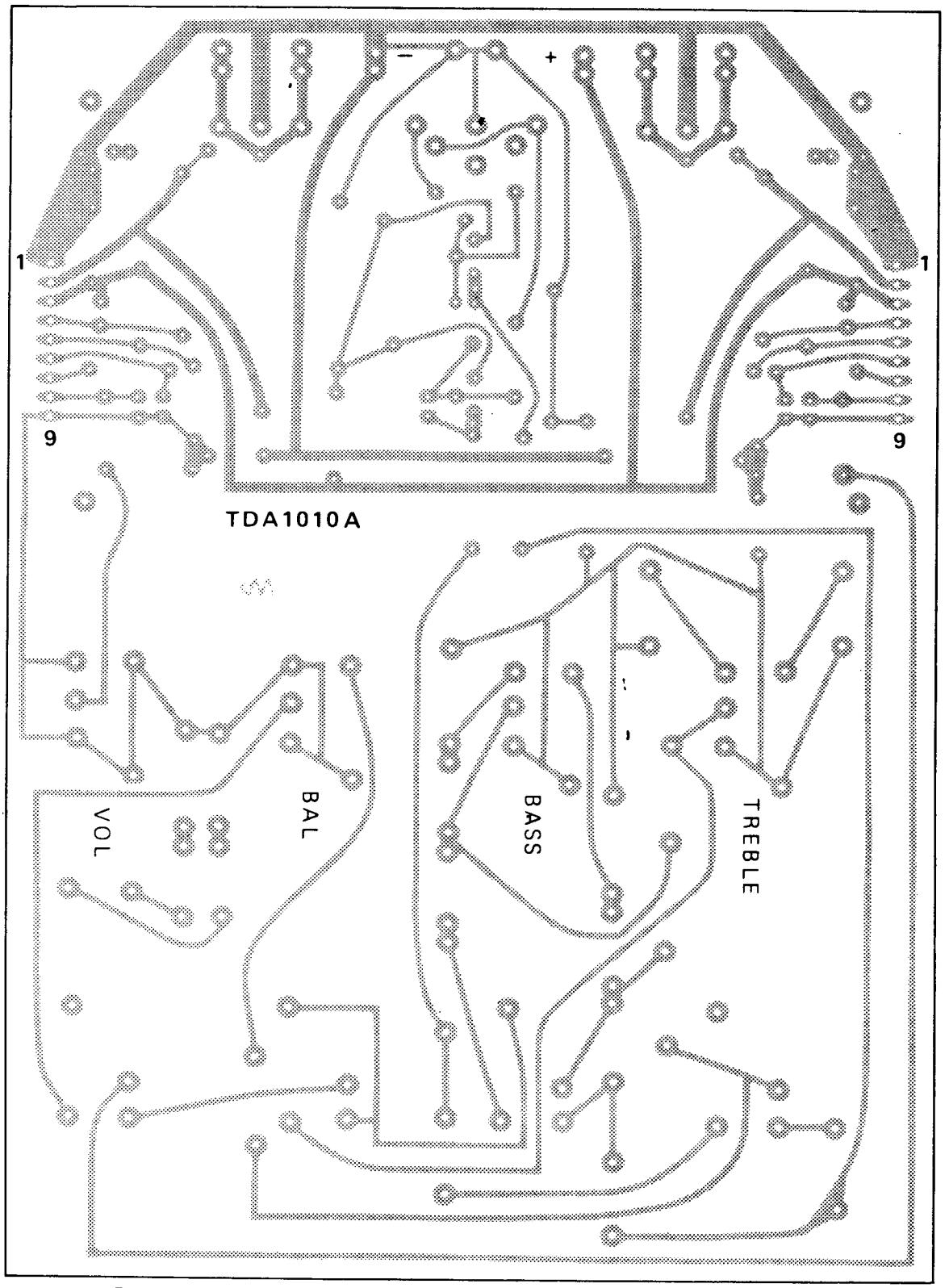

Fig. 18 Track side of printed-circuit board used for the circuit of Fig. 17 (Fig. 16 partly); p.c. board dimensions 169 mm x 118 mm.

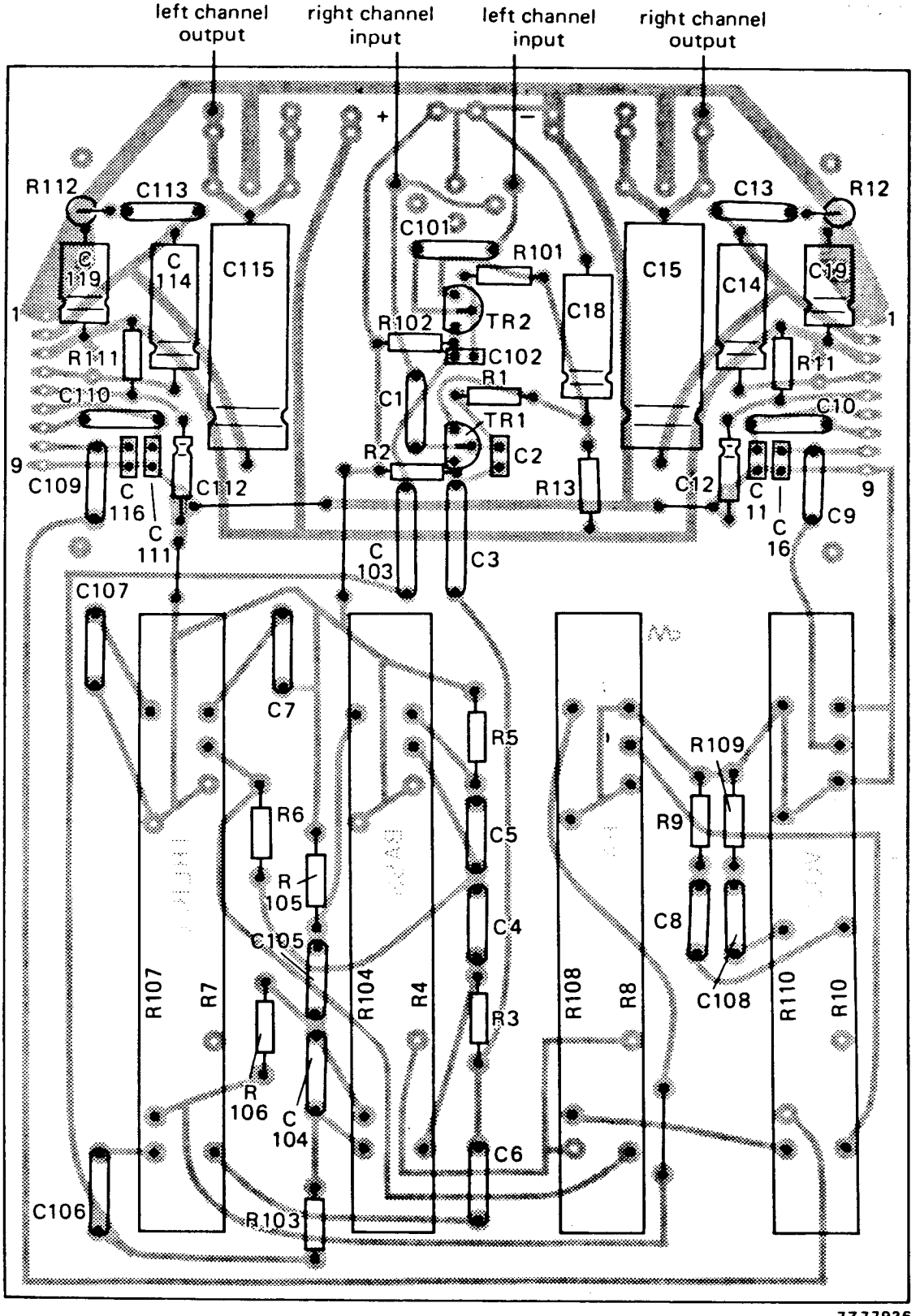

Fig. 19 Component side of printed-circuit board showing component layout used for the circuit of Fig. 17 (Fig. 16 partly).

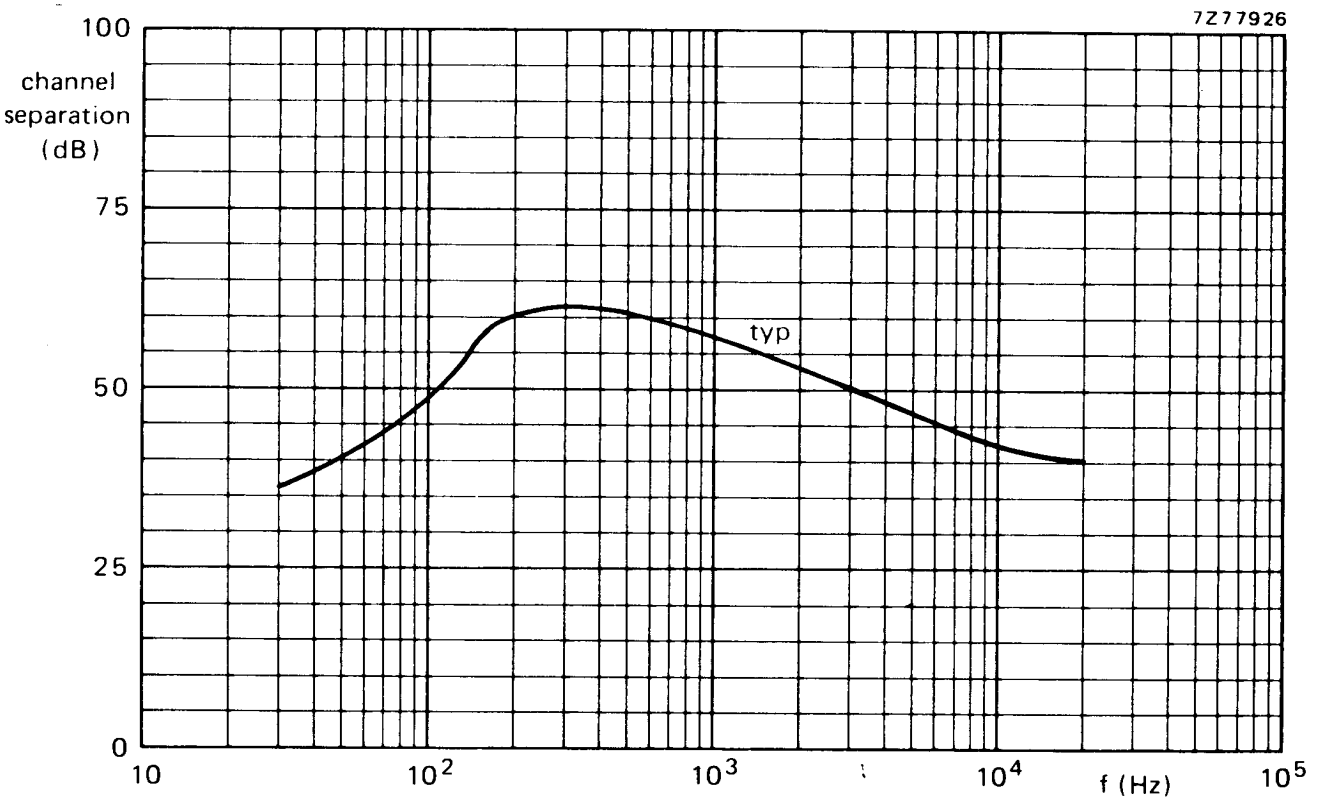

Fig. 20 Channel separation of the circuit of Fig. 17 as a function of frequency.