

# QUAD 405

## POWER AMPLIFIER

### Service Data

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Keith Snook modifications	<a href="#">Click here</a>

## CIRCUIT DESCRIPTION

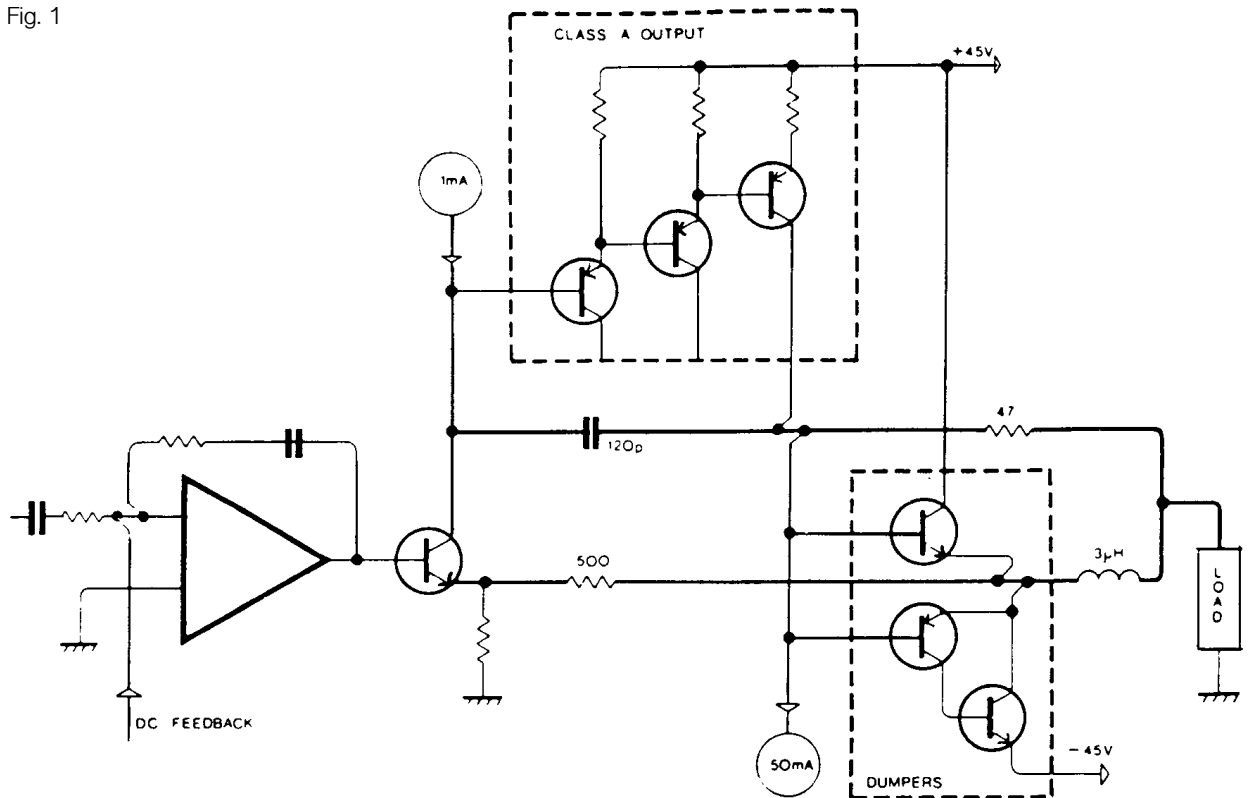
The QUAD 405 is a two channel power amplifier primarily intended for use in high quality sound reproducing systems. The amplifier is usually used with QUAD control units though other signal sources can readily be accommodated.

The amplifier uses a current dumping output circuit, a QUAD invention which eliminates many of the problems associated with transistor amplifiers, and covered by patents in several countries.

In a current dumping amplifier there is in effect both a low powered very high quality amplifier and a high powered heavy duty amplifier. The low power amplifier controls the loudspeakers at all times, calling upon the high power section to provide most of the muscle. The small amplifier is so arranged - it carries an error signal - that provided the larger power transistors (the dumpers) get within the target area of the required output current it will fill in the remainder accurately and completely. The reproduced quality is solely dependent on the small amplifier which because of its low power can be made very good indeed.

Problems of crossover, crossover distortion, quiescent current adjustment, thermal tracking, transistor matching, all disappear. There are no internal adjustments or alignments and the choice of power transistor types is less restrictive.

Fig. 1



Simplified Schematic of QUAD 405 Amplifier showing Class A, Dumpers and Bridge Components.

## TEST EQUIPMENT

Sound Technology Distortion Analyser 1700A (ST 1700A)

Dual Beam Oscilloscope

4Ω and 8Ω load of 100W dissipation

1Ω load of 25W dissipation

2.5 kHz Square Wave Generator

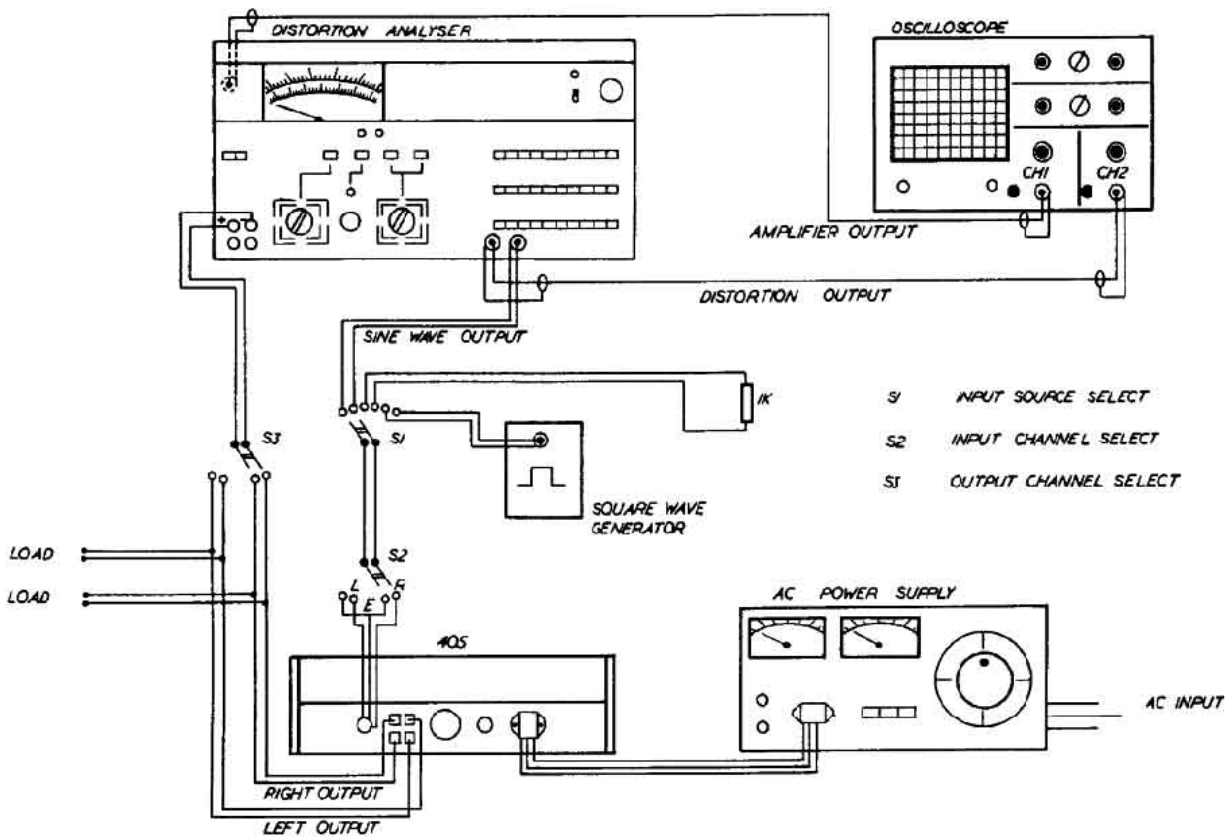
Input Sensitivity Indicator (0 to 1V RMS)

AVOMeter (or similar multimeter)

0 to 12V d.c. power supply

Variac a.c. power supply

Fig. 2 illustrates a simple switching circuit which may assist if much testing is anticipated.



SUGGESTED SWITCHING ARRANGEMENT FOR TESTING QUAD 405

Fig. 2

Before testing, the cover of the 405 should be removed.

### DISCONNECTING CLAMP CIRCUITS

When servicing a 405 fitted with a clamp circuit, it may be necessary to bypass this circuit.

For 405s fitted with amplifier boards M12368, this may be done by removing the push-on connectors carrying the brown wires from the amplifier boards, and connecting the loads between the black output terminals and the output terminals on the amplifier boards.

For 405s fitted with amplifier boards type M12565, it will be necessary to remove the side panels to gain access to the printed copper side of the amplifier boards. the three screws securing each side panel should be removed, the panel may then be slid outwards from the amplifier. If the solder is removed from the link pad shown in Fig. 18 (A), the clamp circuit will become disconnected.

Care should be taken to ensure that when testing is completed, the link pad is re-soldered.

## AMPLIFIER CIRCUIT TESTING M 12368 - M 12565

the following test procedure is with reference to a 240V amplifier with no voltage limiters.

Select:

<b>Controls</b>	Y1 - 0.5V/cm d.c. coupled Y2 - 0.1V/cm d.c. coupled Timebase 0.2 ms/cm
<b>ST 1700A-</b>	Volts/power 100W RMS Distortion Ratio 0.01% 80kHz and 400kHz filters both in Frequency 1kHz Low Distortion Osc. level minimum
<b>Connections</b>	Load 8Ω SI Sine Wave (ST1700A) S2 Left Input S3 Left Output

If the Amplifier fails any of the following tests, refer to the appropriate part of the fault finding section, page 6.

1. Check inside the amplifier for obvious faults such as burnt components, blown internal fuses etc.  
Each of the following checks should be repeated on the other channel.
2. Apply the **a.c. Supply Volts** whilst observing the current consumption which should not exceed 0.12A.
3. Increase the **oscillator level** to 0.5V RMS  $\pm 0.5$ dB. the output should be 100W with no sign of clipping.
4. Select **set level** and adjust meter deflection for zero. Select **distortion** which should be less than 0.01%  
Select **volts/power**, decrease the **applied frequency** to 100Hz, remove **400Hz** filter and adjust **oscilloscope timebase** to 2ms/cm. Set level, select distortion which should be less than 0.01%. Select **volts/power**, increase the **applied frequency** to 3kHz, select **400Hz** filter and adjust **timebase** to 50μs/cm. Select **distortion** which should again be less than 0.01%.
5. Select **volts/power**, increase **applied frequency** to 10kHz and adjust **timebase** to 20μs/cm. Adjust **oscillator level** so that output is 100W. Set level then select **distortion** which should be less than 0.05%.
6. Select **volts/power**, increase **applied frequency** to 20kHz and adjust the **timebase** to 10μs/cm. Reduce **output level** to 80W. Set level and measure **distortion** which should be less than 0.1%.
7. Select **volts/power** and decrease frequency to 1kHz. Adjust **oscillator level** so that output is 100W and adjust **timebase** to 0.2ms/cm. The following checks are to monitor the low frequency roll off of the 405. Select **30Hz** and the output level should fall by approximately 0.3dB. Select **20Hz** and the output level should fall by approximately 1dB. Select **10Hz** and the output level should fall by 7dB  $\pm 1.5$ dB.
8. Increase **frequency** to 1kHz. For 405s with amplifier boards type M 12368 insert 1.8kΩ voltage limiting resistors into the mini sockets on each amplifier board. For 405s with amplifier boards type M 12565-3 insert a link into these sockets. The output waveform should indicate clipping. Reduce the oscillator level until the clipping just disappears at which point the output level should be 20V RMS  $\pm 1$ V. Remove voltage voltage limiters, and adjust **oscillator level** for 100W output.
9. Select **volts/power** and **square wave** input, (S1). Adjust **timebase** to 0.1ms/cm. Remove **load** and note the difference in the waveform with load and no load. there should be a slight difference in gain (10mV) but no overshoot. Reconnect the 8Ω load.
10. The following checks should be carried out with no input signal and the input to the amplifier board loaded by a 1kΩ resistor, (S1). Remove **400Hz** filter and select **noise** which should be better than -93dB unweighted.
11. Select **volts/power**, **400Hz** filter and **sine wave** input at a **frequency** of 1kHz and adjust **oscillator level** for 100W output. Select **1Ω load**. the output should clip equally on both halves of the waveform as shown in Fig. 11.
12. Select **4Ω load**, output level should be 70W just prior to clipping.
13. **CLAMP CIRCUIT TESTING**

In order to test the clamp circuit, the circuit should first be disconnected from its amplifier board, as described on page 4.

For 405s fitted with amplifier boards M 12368 apply **6V d.c.** across the output terminals of the relevant channel with an ammeter in circuit.

For 405s fitted with amplifier boards M 12565 a wire should be soldered across the back of the amplifier board as shown in Fig. 18(B). 6V d.c. should be applied between this wire and the black output terminal of the relevant channel, with an ammeter in circuit.

In both cases the current should not exceed 0.5mA. Reverse the polarity of the supply and repeat the test.

The test should then be carried out on the other channel.

The complete test should then be repeated using a 12V d.c. supply with a 10Ω resistor in series, when the current should be approximately 1A.

## FAULT FINDING

The following information may assist in locating faults occurring on the amplifier boards of a 405. In each case only the faulty channel of the 405 is driven, as in the test procedure. The input should be a sine wave of 0.5V RMS and the output should be applied to an 8Ω load unless otherwise stated. The numbers refer to the relevant test check.

\*Board type M12368 only \*\*Board type M12565 only.

Effect	Cause
1. R33 Burnt R37 Burnt R41 Burnt R39 Burnt R38 Burnt	Collector-Base Tr10 o/c L1 o/c (solder joints) L3 o/c (solder joints) R20 or R21 o/c D5 or D6 o/c
2. High Current □ *□ **□ Draws high current which drops to 0.1A□ after approx 2 seconds□	Tr2 o/c, Tr3 o/c, Tr7 o/c Tr9 s/c Tr10 s/c, R7 o/c C8 s/c C3 s/c D2 o/c R8 o/c  R14 o/c
3. No increase in a.c. supply current for increase in signal□ Signal is unstable and clips□ 100W output for 0.3V input□ Waveform trace as in Fig. 3□ Waveform trace as in Fig. 4□ Approximately 4W output□	R3 o/c, C1 o/c, R31 o/c R6 o/c R20 or R21 o/c Tr8 o/c, Tr6 s/c, R36 o/c, R30 o/c, C10 s/c L2 o/c (solder joints) R16 o/c
4. Second Harmonic Distortion□ Second Harmonic Distortion especially at 100Hz□ and on o/c load Third Harmonic Distortion especially at 100Hz□ Third Harmonic Distortion□ Hum and Noise□ Hum*□ Waveform trace as in Fig. 5*□ Waveform trace as in Fig. 6*□ Waveform trace as in Fig. 7□ Waveform trace as in Fig. 8*□ Waveform trace as in Fig. 9□	IC1, Tr1, Tr2, Tr3, Tr4, R5, R6, R17, R18, R22, C1 C2, C7, C8  R5 L2, R3, R6, R16, R20, R21, C3 C5 o/c R37 o/c Tr3 s/c R23 o/c, R5 o/c□ □ □ R33 s/c R8 o/c C5 s/c, R15 o/c, Tr1 o/c
6. Distortion at 20kHz□	D5 or D6 s/c,
8. Limiting resistor R11 has no effect□	R10 s/c
9. Square Wave trace as in Fig. 10□	C6 o/c
10. Noise especially at 100Hz□ Noise with large spikes□ Noise□	R5 Tr1 R12, R3, R4, Tr2, IC1 (change to topology!)
11. Current limiting check with 1Ω load Waveform trace as in Fig. 12□ Waveform trace as in Fig. 13□ Waveform trace as in Fig. 14□ Waveform trace as in Fig. 8□	R29 o/c, R28 s/c, R25 o/c D3 s/c, R27 o/c, R24 o/c, R26 s/c Tr6 o/c C11 s/c Tr5 o/c
13. Draws high current with 6V d.c. supply□	T2 s/c

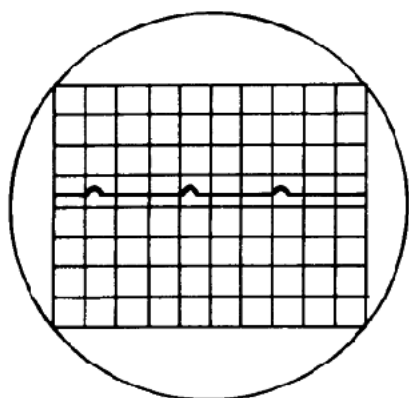


Fig. 3

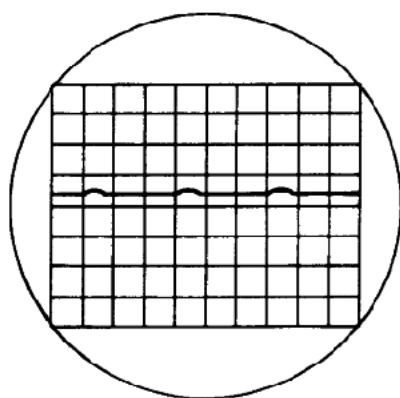


Fig. 4

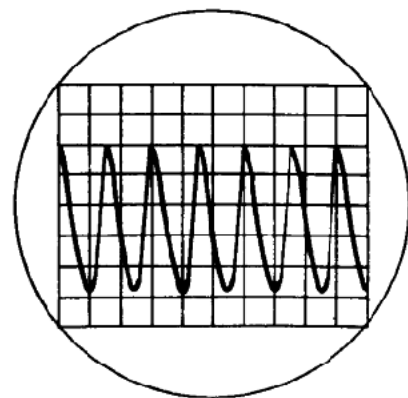


Fig. 5

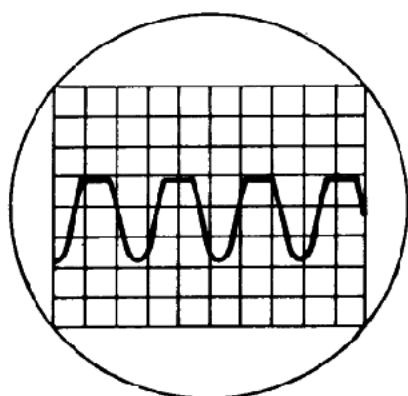


Fig. 6

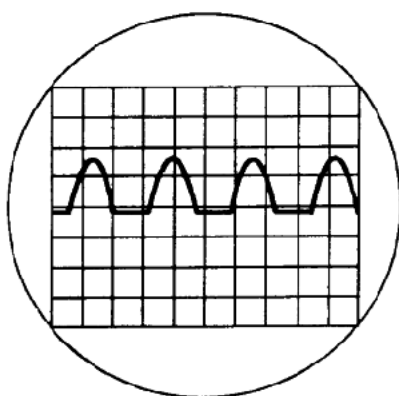


Fig. 7

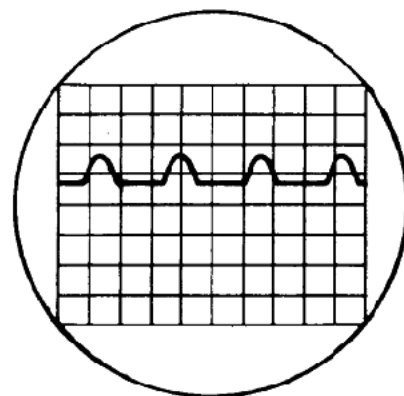


Fig. 8

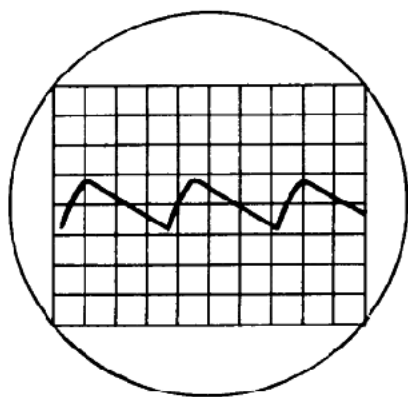


Fig. 9

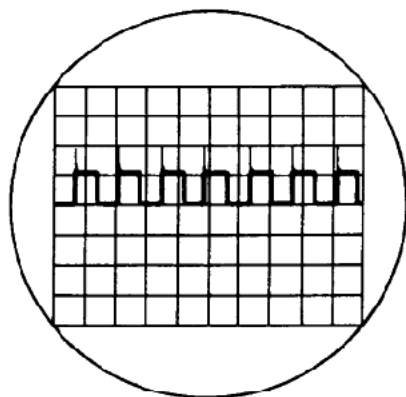


Fig. 10

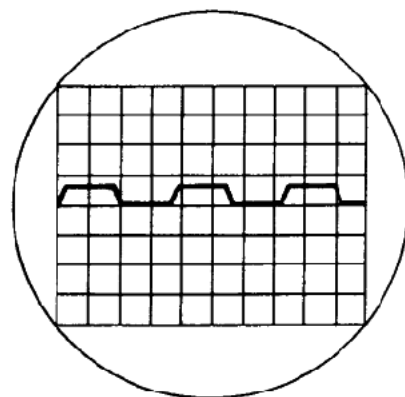


Fig. 11

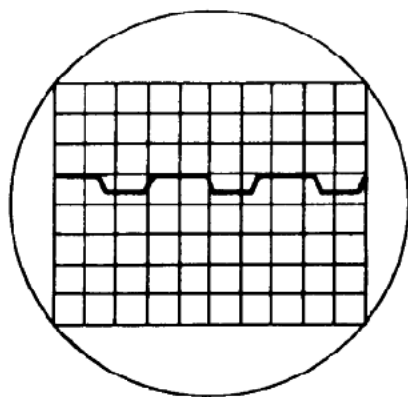


Fig. 12

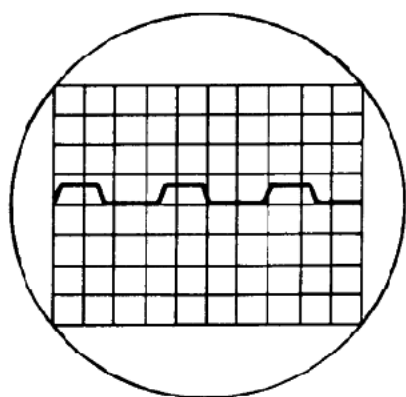


Fig. 13

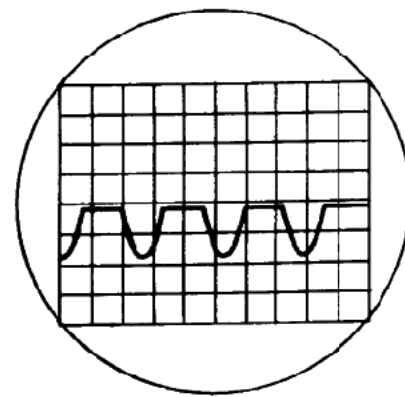


Fig. 14

## MODIFICATIONS TO PRINTED CIRCUIT BOARDS.

- **Amplifier Board M 12368 iss.5** originally fitted. □ □ □ □ Circuit diagram iss. 2.
- 1.□ **Amplifier board M 12368 iss.6**  
□ Copper track layout modified - component layout unchanged.
- 2.□ **Amplifier board M 12368 iss.7** □ □ □ □ □ □ Circuit diagram iss. 3.  
□ R4 changed from 10k to 22k  
□ R5 changed from 10k to 4k7  
□ R9 changed from 180Ω to 220Ω  
□ R19 (3k3) removed (combined with R23)  
□ R23 changed from 3k3 to 1k2  
□ C9 (330pF) removed (would be in parallel with C11)  
□ C18 47nF fitted to -ve supply after FS2 - see circuit diagram  
□ FS1 and FS2 effectively changed places  
□ R2 changed from 2.2Ω to 10Ω  
□ Copper track width reduced□
- 3.(a)□ **Amplifier board M 12368 iss.9** introduced at serial number 9000.□ □ Circuit diagram iss. 4.  
□ R41 22Ω added  
□ L3 6.9μH added  
□ C15 0.1μF added  
□ C16 0.1μF added  
□ C18 (47nF) removed  
□ C19 1nF fitted between base and collector of Tr10 ([not recommended if stable without](#))  
□ Copper track width reduced  
□ Also at s/n 9000 a clamp circuit, on PCB M12400, was mounted on the output terminal (Fig. 15).  
□ This detects excessive d.c. offset at the output and short circuits, blowing the internal 4A fuses  
□ FS1 and/or FS2 to protect the loudspeaker.
- 3.(b)□ The following component changes were made at serial number 29000.□ □ Circuit diagram iss. 5.  
□ R10 changed from 1k to 1k8  
□ R27 changed from 8k2 to 15k  
□ R29 changed from 8k2 to 15k  
□ R35 changed from 0.08Ω to 0.091Ω  
□ R36 changed from 0.08Ω to 0.091Ω  
□ D1 changed from LR120C to LR150C (op-amp voltage increased from 12V to 15V)  
□ D2 changed from LR120C to LR150C (op-amp voltage increased from 12V to 15V)
- 4.□ **Amplifier board M 12368 iss.10**  
□ Identical to M12368 iss. 9 except copper pads for power transistors modified for production.
- 5.□ **Amplifier board M 12565 iss.3** Introduced at serial number 59001.□ □ Circuit diagram iss. 6.  
□ Other QUAD 405s with this PCB fitted were serial numbers 57301 to 57600 inc.  
□ This board incorporates the clamp circuit and the ESL voltage limiter is now a link
- 6.□ **Amplifier board M 12565 iss.5** (QUAD 405-2 PCB). □ □ □ Circuit diagram iss. 7.  
□ Was fitted at serial number 62500 but with a 405 name plate until serial number 65000.  
□ See page 12 for 405-2 PCB changes.

## Alternatives

Transistors - on PCB M12368 iss. 5, 6 & 7 BDY77 or BDY74 may have been used for Tr9 and Tr10. BDY77 is a suitable replacement for both but beware - **faster transistors may cause instability**.  
On M12368 iss. 9 & 10 and M12565 iss. 3 Transistors Tr9 and Tr10 may be 2SD424, 17556 or 2SD676 and are interchangeable.  
Tr2 - BC682, ZTX304, BCX32 and BC546B are interchangeable.  
Tr3, Tr4 - E5458, ZTX504 and BC556B are interchangeable.  
Tr7, Tr8 - 40872 or 2SA740 are interchangeable.

LED - LP1 - HP5082-4850, Exciton XC5053, Toshiba TLR114A (or any modern LED with R40 adjusted).



## CLAMP CIRCUIT

Introduced co-incident with amplifier PCB M 12368 iss. 9 at serial number 9001. All 405s with serial numbers 9000 and under being returned for service, should be fitted with a clamp board as shown below. At serial number 59001 the clamp circuit was fitted as an integral part of the amplifier board M 12565 iss. 3. The function of this circuit is to monitor the d.c. component of the output. In the event of a component failure which causes excessive d.c. voltage, the circuit will short circuit the amplifier output and thus protect the speakers.

## REPLACING THE CLAMP BOARD

If it is necessary to replace a clamp board the following instructions should be followed:

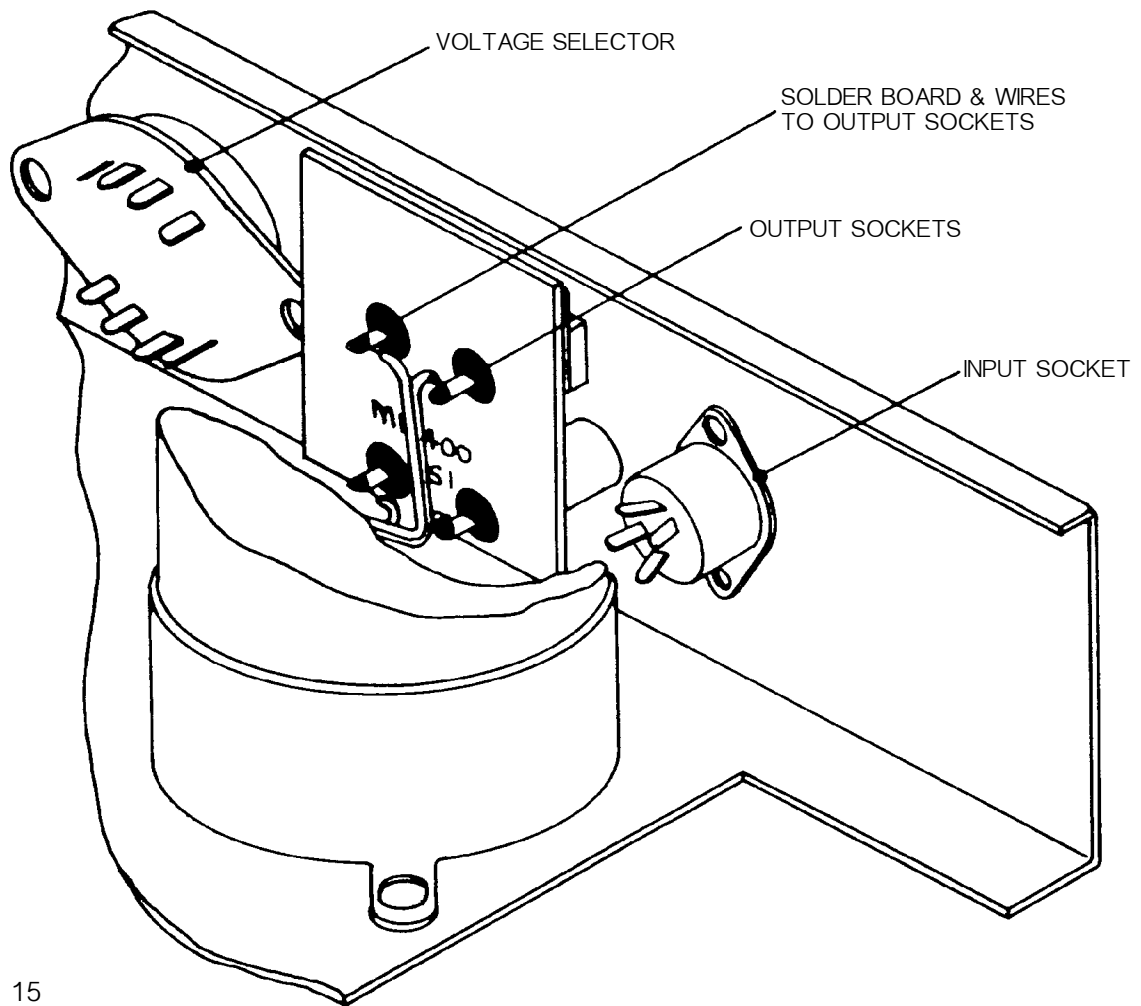


Fig. 15

1. Disconnect the wiring to the right channel circuit board and fold it back onto the transformer. Loosen the clamp holding the electrolytic capacitor next to the output terminals, and lift the capacitor out of the way.
2. Disconnect the leads to the output sockets, place the clamp board over the output connectors and re-solder. It is advisable to tin the output connector tags before positioning the clamp board. This makes soldering easier.
- Replace the capacitor and reconnect the tags to the right channel amplifier board.

## CLAMP CIRCUIT ALTERNATIVES

T1 - 2N4992 or BS08A-03

T2 - Sc141B or TIC226B or RCA T2800

## CONVERSION OF 405 TO A MONO 180W AMPLIFIER

To carry out the conversion, the modification kit Q410MOD should first be obtained.

- 1.□ Remove the 405 cover and base plate.
- 2.□ Unplug the AMP connectors from the right-hand channel PCB (right-hand side when viewed from front).
- 3.□ Release the clip securing the rear 10,000 $\mu$ F capacitor (C 14) and lay the capacitor over the right-hand PCB.  
□
- 4.□ Unsolder the 4 leads from the output terminals.  
□ For 405s fitted with PCBs M 12368 (serial numbers below 59000) remove the clamp board M 14200.  
□ To disconnect the clamp circuit on 405s fitted with PCBs M 12565 (serial numbers above 59000) remove both of the side panels. The solder should then be removed from the link pads shown as "A" in fig. 18.  
□
- 5.□ Remove the output terminals and replace those for the right-hand channel with the sockets provided, Red at the top. Fit the blanking grommets provided in the vacant holes.  
□
- 6.□ Fit the new printed circuit clamp board to the output sockets and reconnect the output leads. Brown/Red to the pin marked R, Brown/White to the pin marked L and both Green leads to the pin next to L.  
□
- 7.□ Remove the 4 pin DIN socket and unsolder the leads from it.
- 8.□ Connect these leads to the new input board, White to L and Red to R and the screens to the two E tags.
- 9.□ Fit the new input socket and board.
- 10.□ Refit C 14 and the AMP connector to the right-hand PCB.
- 11.□ Remove the output leads Brown/White from left-hand PCB and Brown/Red from right-hand PCB.
- 12.□ Connect a 4-8 $\Omega$  speaker between the output tags of these two PCBs.
- 13.□ Switch on the 405, inject a signal of approximately 100mV at 1kHz at the input socket (left and right pins are now common). Remove the blanking grommet adjacent to the input socket and adjust the pre-set potentiometer through this hole for a null in the signal from the speaker, increase the input signal level as required for final setting.  
□
- 14.□ Switch off remove signal input, disconnect the loudspeaker, reconnect the output leads, refit blanking grommet and all covers.  
□

## REMOVING THE AMPLIFIER MODULES

1. Note the colour coding for reconnection and remove the push-on AMP connectors A.
2. Undo the four fixing screws B, for each module.
3. Remove the heatsink grease from the face of the aluminium T-section and retain for use when re-fitting.  
(not recommended after years of service - use new heat sink compound or sheet material)

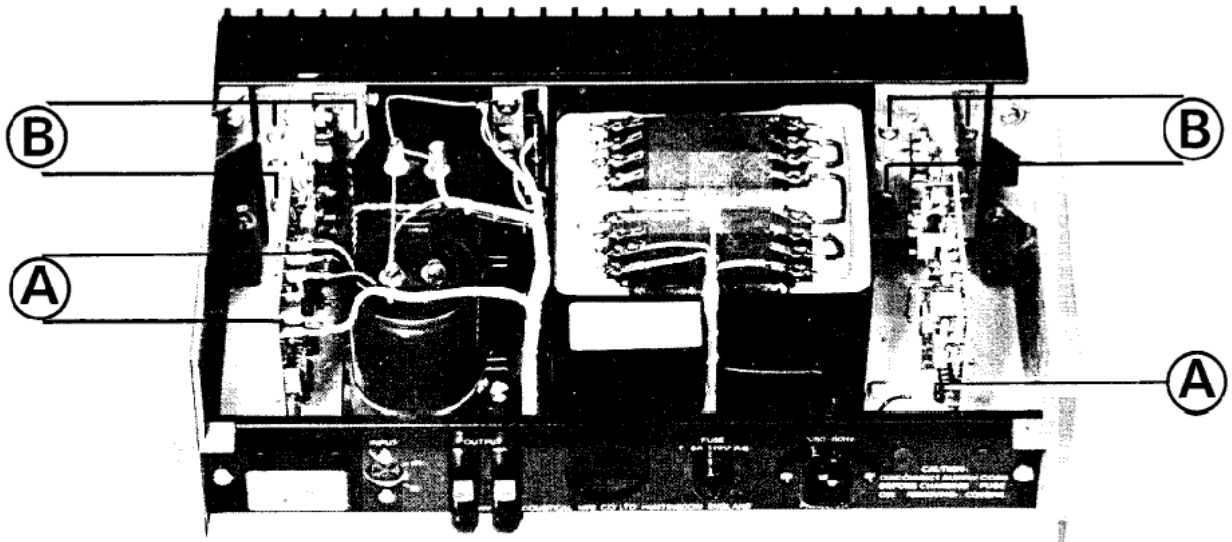


Fig. 16

## REPLACING THE QUAD 405 TRANSFORMER

1. Disconnect the a.c. supply and remove top cover (2 M4 screws) and bottom plate (4 M4 screws).
2. Note the connections and then unsolder the external wiring to the a.c. supply transformer.
3. Remove the two retaining screws through the large centre holes of each T-section heat-sink then release the amplifier boards by removing the other 4 screws on each. These 12 screws fasten into tapped strips located in slots in the rear of the finned heat-sink sections, which now become free of the front plate.
4. Release the transformer by undoing 4 screws through the front plate and 2 through the bottom plate.
5. Reverse the procedure with the new transformer.

Note: It should not be necessary to remove the push-on AMP connectors from the amplifier PCBs.

**QUAD 405-2**

The original 405 provided 100 Watts per channel into load impedances between 4.5Ω and 8 Ω. To meet the need of 4Ω and 8Ω loudspeakers whose impedance falls below 4.5Ω, the 405-2 was introduced in January 1983 at serial number 65000, but the 405 modules had already been fitted from serial number 62500 onwards. Many earlier amplifiers have also since been converted to 405-2 by owners and dealers replacing the modules.

The 405-2 has a more sophisticated current limiter circuit based on a thick-film assembly N1/N2 permitting full output into loads between 3Ω and 10Ω, and upto 50W into 1.5Ω loads, provided the output transistors will not be hazarded by doing so. (see Fig. 17). As with earlier 405 models after serial number 59001, the output stage clamp circuit is incorporated in the main module boards and a shorting link used for the voltage limiter.

The first 405-2 circuit diagram was 12333 iss. 7 and the PCB reference M12565 iss. 5.

Subsequent modifications were:

Date	Serial Number	PCB 12565 issue	Circuit Diagram 12333 iss.	Changes
May 83	66700	6	8	C20 (4n7) added to avoid mild instability when switching off. D13 added in series with D5 to correct response at 20kHz. R44 added to maintain unconditional stability.
July 83	67950	6	8	Output terminals replaced by 4mm sockets.
Aug 84	72501	7	9	Tr4 changed to BC556B and R18 omitted replacing both Tr3 and Tr4.
Dec 85	83000	7	-	Voltage selector omitted.
Feb 86	85000	7	10	New mains input connector incorporating fuse-holder DIN input replaced by phono sockets. Signal earth isolated from chasis by R2 to avoid hum loop when using mains earth.

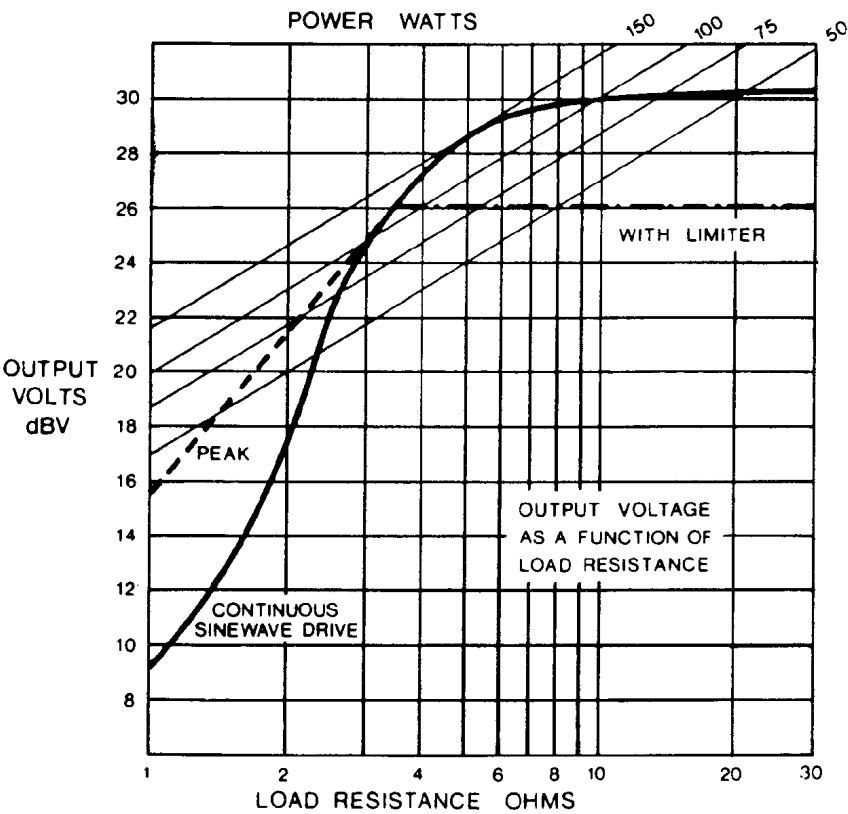


Fig. 17

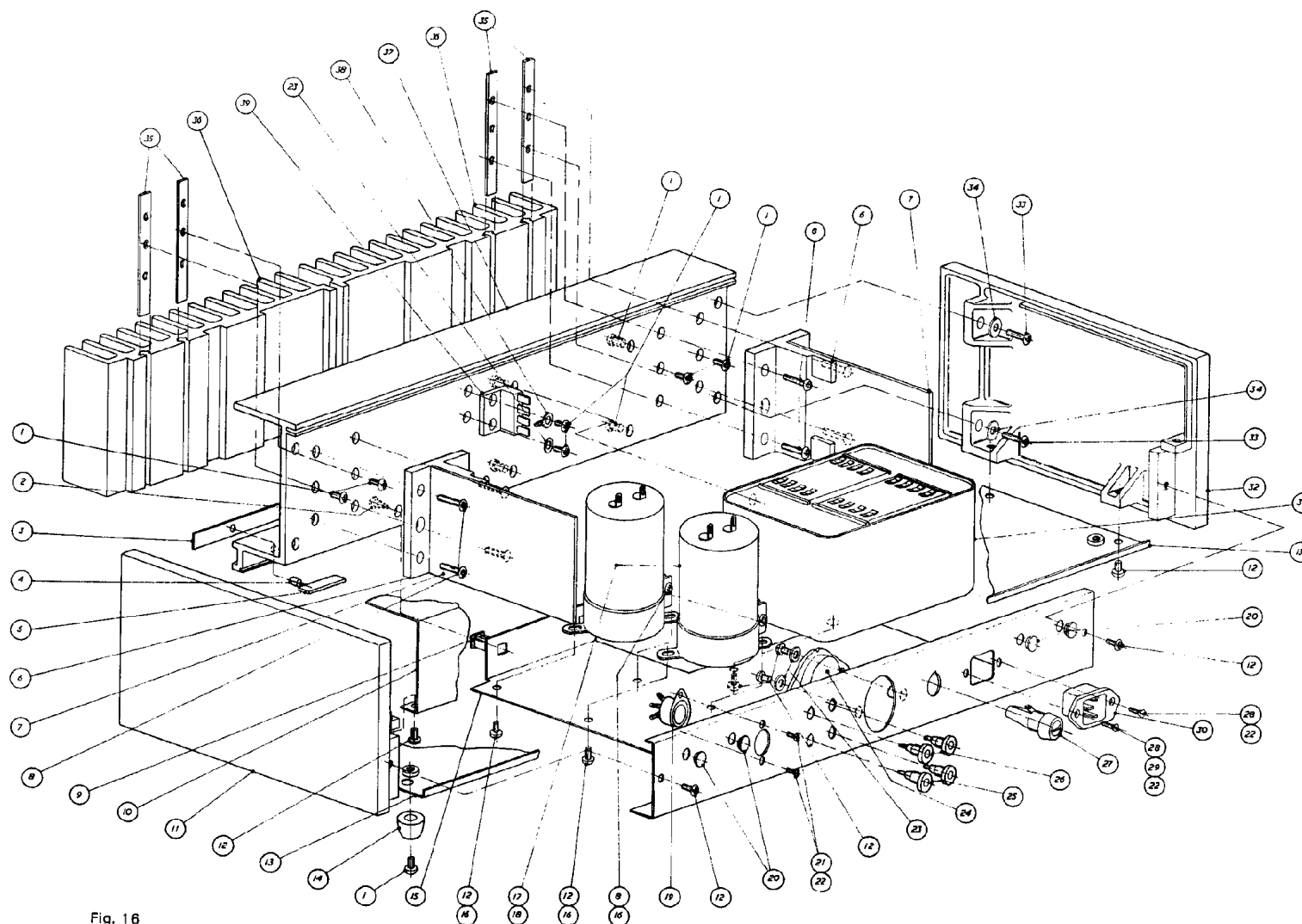


Fig. 16

Assembly Diagram.

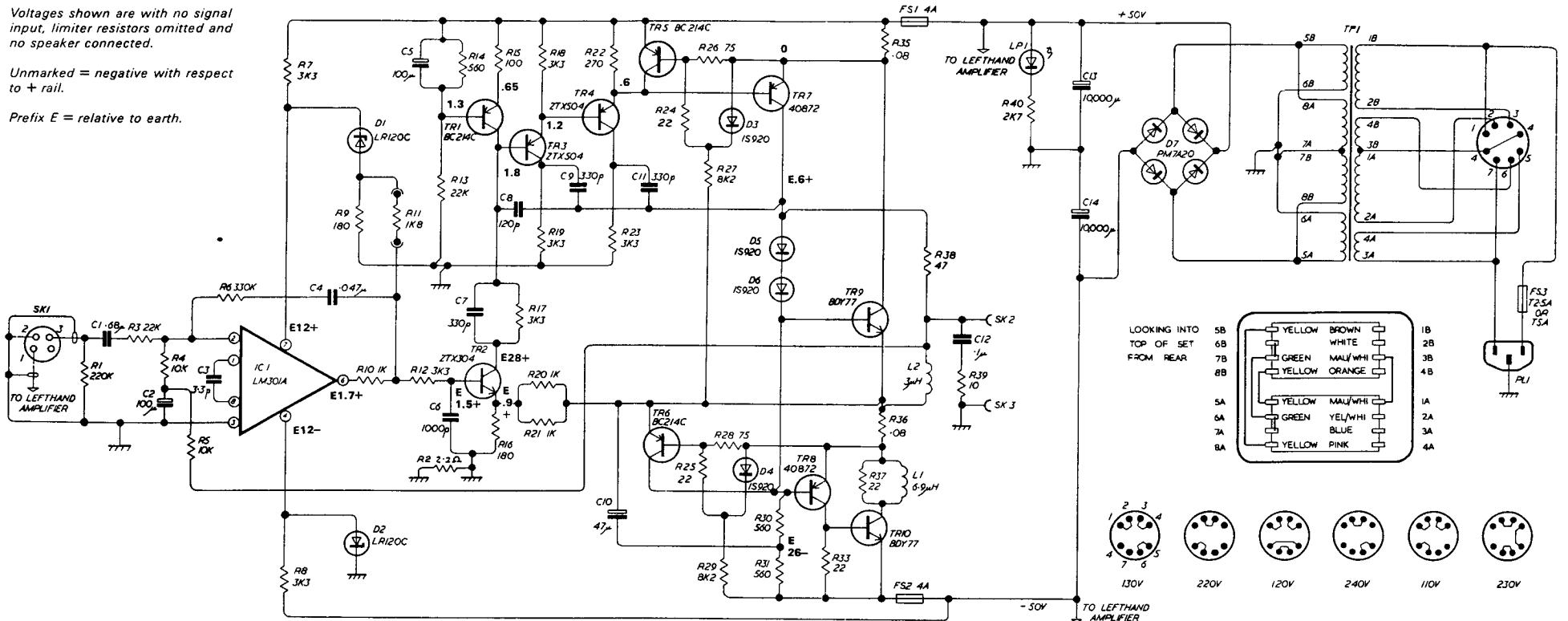
NO	DRAWING NO	DESCRIPTION	STOCK NO
1		SCREW M4 X 8 mm POSDRIV	
2		SCREW M4 X 5 mm POSDRIV	
3	A3/1234	POWER PLATE	
4		LED HEATLET PACKARD	
5	A4/1237	PRINTED WIRING BOARD	
6	A3/1234	AMPLIFIER MOUNTING BRACKET	
7	A3/1235	PRINTED WIRING BOARD	
8		SCREW M4 X 8 mm POSDRIV	
9		LOCKWIT M4 X 8 mm POSDRIV	
10	A4/1237	COVER	
11	A1/1238	RIGHT HAND END COVER	
12		SCREW M4 X 8 mm POSDRIV	
13	A4/1238	BASE PLATE	
14		FOOT CUP 5/16" DIA	
15	A1/1238	CHASSIS	
16		NUT M4 FULL HEX	
17		CAPACITOR 10000 63V ERIE	
18		EXPANSION CLIP 5/16" DIA	
19		SOCKET	AT-1
20		SOLD GARNISH M4 X 8 mm	
21		SCREW M4 X 8 mm POSDRIV	
22		NUT M4 FULL HEX	
23		WASHER M4	
24		VOLUME SELECTOR 7/1-001	
25		OUTPUT SOCKET BEL LINE BUCK 5/16"	
26		OUTPUT SOCKET BEL LINE BUCK 5/16"	
27		FILAMENT BUCKING 250/250	
28		SCREW M4 X 8 mm POSDRIV	
29		SOLDER TIE M4 TUCKER TIE	
30		MARKING PLUG OTTO HEL 4000-2	
31	A3/1238	TRANSFORMER	
32	A1/1238	LEFT HAND END COVER	
33		SCREW M4 X 8 mm POSDRIV	
34		WASHER M4 1/8" DIA	
35	A4/1238	HEAT SINK FIXING STRIP	
36	A4/1238	HEAT SINK	
37	A4/1238	FRONT PANEL	
38		SOLDER TIE M4 TUCKER TIE	
39		AMPLIFIER M41 PWTAB	
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# BOARD NUMBER M12368 ISS 5 AND 6

Voltages shown are with no signal input, limiter resistors omitted and no speaker connected.

Unmarked = negative with respect to + rail.

Prefix E = relative to earth.



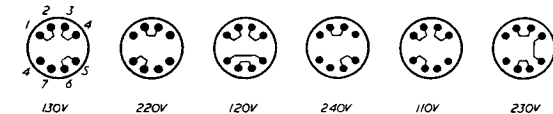
No.	Value	Tol	Reference	Stock No.
R1	220K	± 10%	Resistor	R220KJ1
R2	2.2	± 5%	Resistor	R2R200S
R3	22K	± 5%	Resistor	R22K0J1
R4	10K	± 10%	Resistor	R10K0J1
R5	10K	± 10%	Resistor	R10K0J1
R6	330K	± 5%	Resistor	R330KJ1
R7	3K3	± 10%	Resistor	R3K30J1
R8	3K3	± 10%	Resistor	R3K30J1
R9	180	± 5%	Resistor	R180RJ1
R10	1K	± 5%	Resistor	R1K00J1
R11	1K8	± 10%	Resistor	R1K80J1
R12	3K3	± 10%	Resistor	R3K30J1
R13	22K	± 5%	Resistor	R22K0J1
R14	580	± 10%	Resistor	R580RJ1
R15	100	± 10%	Resistor	R100RJ1
R16	180	± 5%	Resistor	R180RJ1
R17	3K3	± 10%	Resistor	R3K30J1
R18	3K3	± 10%	Resistor	R3K30J1
R19	3K3	± 10%	Resistor	R3K30J1
R20	1K	± 5%	Resistor	R1K00J1
R21	1K	± 5%	Resistor	R1K00J1
R22	270	± 10%	Resistor	R270RJ1
R23	3K3	± 10%	Resistor	R3K30J1
R24	22	± 10%	Resistor	R22RJ1
R25	22	± 10%	Resistor	R22RJ1
R26	75	± 5%	Resistor	R75RJ1

No.	Value	Tol	Reference	Stock No.
R27	8K2	± 5%	Resistor	R8K2RJ1
R28	75	± 5%	Resistor	R75RJ1
R29	8K2	± 5%	Resistor	R8K2RJ1
R30	580	± 10%	Resistor 2.5W	R580RJS
R31	580	± 10%	Resistor 2.5W	R580RJS
R33	22	± 10%	Resistor	R22RJ1
R35	0.08		Resistor Acoustical DRG A4/12383	RR091JY
R36	0.08		Resistor Acoustical DRG A4/12383	RR091JY
R37	22	± 10%	Resistor	R22RJ1
R38	47	± 5%	Resistor	R47RJ1
R39	10	± 10%	Resistor	R10RJ1
R40	2K7		Resistor 1.6W	R2K70JR
C1	0.68μ		Capacitor 100V	C680NKS
C2	100μ	± 10%	Capacitor 3V	C100UME
C3	3.3P	± 20%	Capacitor	C3P30KJ
C4	0.047μ		Capacitor 250V	C47N0JS
C5	100μ		Capacitor 6V	C100UZB
C6	1000P		Capacitor 400V	C1N00KK
C7	330P	± 20%	Capacitor	C330PKJ
C8	120P	± 5%	Capacitor	C120PJ1
C9	330P	± 20%	Capacitor	C330PKJ
C10	47μ		Capacitor 40V	C47U0ZB
C11	330P		Capacitor	C330PKJ

No.	Value	Tol	Reference	Stock No.
C12	0.1μ		Capacitor 250V	C100NKC
C13	10,000μ		Capacitor 63V	C10KUTA
C14	10,000μ		Capacitor 63V	C10KUTA
TR1			Transistor BC214C	DBC214C
TR2			Transistor BC882 or ZTX304 or BCX32	DZTX304
TR3			Transistor E5458 or ZTX504	DZTX504
TR4			Transistor E5458 or ZTX504	DZTX504
TR5			Transistor BC214C	DBC214C
TR6			Transistor BC214C	DBC214C
TR7			Transistor 40872 or 2SA740	D40872X
TR8			Transistor 40872 or 2SA740	D40872X
TR9			Transistor 80Y74 or 80Y77	D80Y77Q
TR10			Transistor 80Y74 or 80Y77	D80Y77Q
D1			Zener Diode LR120C	DZ12VAA
D2			Zener Diode LR120C	DZ12VAA
D3			Diode IS920	DIS920B
D4			Diode IS920	DIS920B
D5			Diode IS920	DIS920B
D6			Diode IS920	DIS920B
D7			Bridge Rectifier	DPM7A20
IC1			LM301A	DML301A
L1	6.9μH	± 20%	Inductor ANCO TC1/65	L12408A

No.	Value	Tol	Reference	Stock No.
L2	3μH	± 5%	Inductor ANCO 440/D	L12405A
FS1	4A			UM04AQA
FS2	4A			UM04AQA
FS3	T2.5A		220-240V	UM2A5DA
	T5A		110-130V	UM05ADA
LP1			Hewlett Packard 5082-4850 Red	BL5053R
TF1			Acoustical DRG A3/12362	L12362A





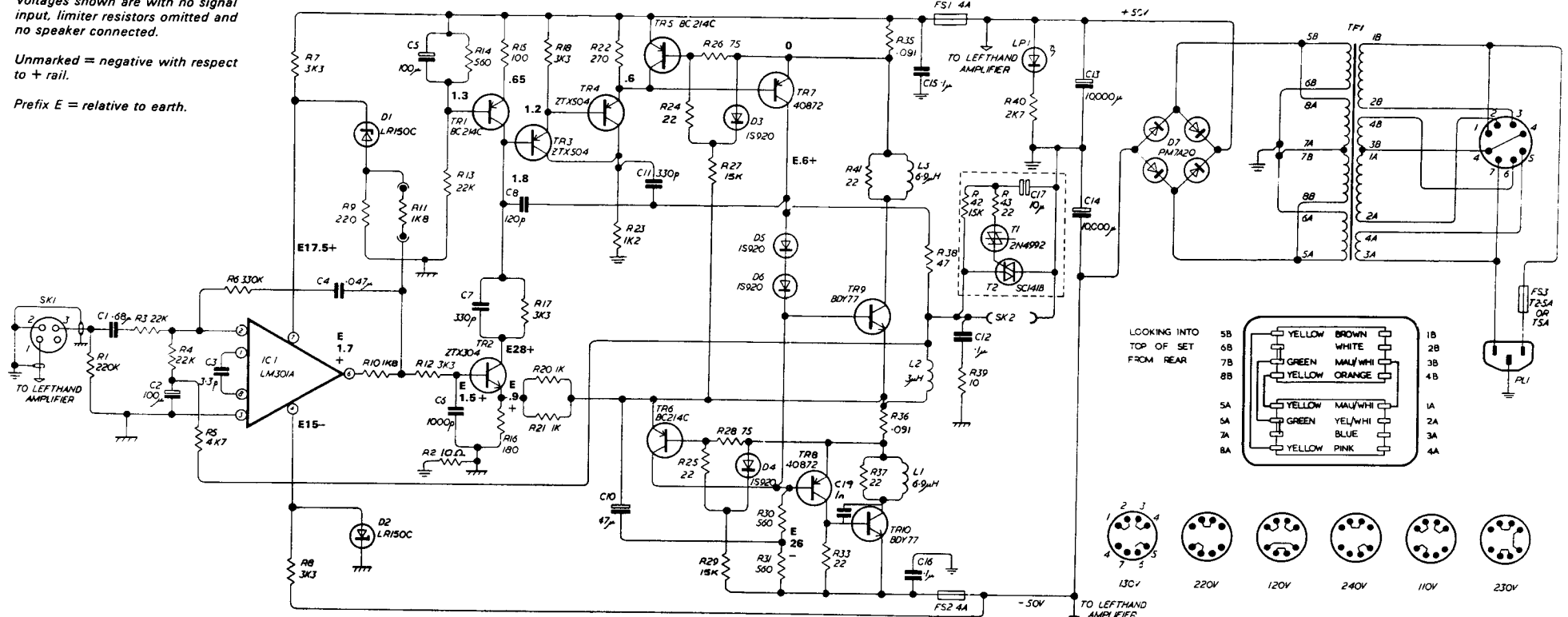
No.	Value	Tol	Reference	Stock No.
D1			Zener Diode LR120C	DZ12VAA
D2			Zener Diode LR120C	DZ12VAA
D3			Diode IS920	DIS920B
D4			Diode IS920	DIS920B
D5			Diode IS920	DIS920B
D6			Diode IS920	DIS920B
D7			Bridge Rectifier	DFM7A2Q
IC1			LM301A	DML301A
L1	6.9μH	± 20%	Inductor ANCO TC1/65	L12406A
L2	3μH	± 5%	Inductor ANCO 440/D	L12405A
L3	6.9μH	± 20%	Inductor ANCO TC1/65	L12406A
FS1	4A			UM04AQA
FS2	4A			UM04AQA
FS3	T2.5A		220-240V	UM2A60A
	T5A		110-130V	UM05ADA
LP1			Hewlett Packard 5062-4850 Red	BL5053P
TF1			Acoustical DRG A3/12362	L12362A



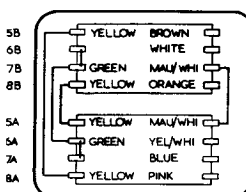
Voltages shown are with no signal input, limiter resistors omitted and no speaker connected.

Unmarked = negative with respect to + rail.

Prefix E = relative to earth.



LOOKING INTO  
TOP OF SET  
FROM REAR



No.	Value	Tol	Reference	Stock No.
R1	220K	± 10%	Resistor	R220KJ1
R2	10	± 5%	Resistor	R10R0J1
R3	22K	± 2%	Resistor	R22K0J1
R4	22K	± 2%	Resistor	R22K0J1
R5	4.7K	± 10%	Resistor	R4K70J1
R6	330K	± 2%	Resistor	R330KJ1
R7	3K3	± 10%	Resistor	R3K30J1
R8	3K3	± 10%	Resistor	R3K30J1
R9	220	± 5%	Resistor	R220R0J1
R10	1K8	± 10%	Resistor	R1K80J1
R11	1K8	± 10%	Resistor	R1K80J1
R12	3K3	± 10%	Resistor	R3K30J1
R13	22K	± 2%	Resistor	R22K0J1
R14	560	± 10%	Resistor	R560R0J1
R15	100	± 10%	Resistor	R100R0J1
R16	180	± 2%	Resistor	R180R0J1
R17	3K3	± 10%	Resistor	R3K30J1
R18	3K3	± 10%	Resistor	R3K30J1
R19				
R20	1K	± 2%	Resistor	R1K00J1
R21	1K	± 2%	Resistor	R1K00J1
R22	270	± 10%	Resistor	R270R0J1
R23	1K2	± 10%	Resistor 1.6W	R1K20JR
R24	22	± 10%	Resistor	R22R0J1
R25	22	± 10%	Resistor	R22R0J1
R26	75	± 5%	Resistor	R75R0J1

No.	Value	Tol	Reference	Stock No.
R27	15K	± 5%	Resistor	R15K0J1
R28	75	± 5%	Resistor	R75R0J1
R29	15K	± 5%	Resistor	R15K0J1
R30	560	± 10%	Resistor 2.5W	R560RJS
R31	560	± 10%	Resistor 2.5W	R560RJS
R33	22	± 10%	Resistor	R22R0J1
R35	0.091		Resistor	RR091JY
R36	0.091		Resistor	RR091JY
R37	22	± 10%	Resistor	R22R0J1
R38	47	± 5%	Resistor	R47R0J1
R39	10	± 10%	Resistor	R10R0J1
R40	2K7		Resistor 1.6W	R2K70JR
R41	22	± 10%	Resistor	R22R0J1
R42	15K	± 10%	Resistor	R15K0J1
R43	22	± 10%	Resistor	R22R0J1
C1	0.68μ		Capacitor 100V	C680NKS
C2	100μ	± 10%	Capacitor 3V	C100UME
C3	3.3P	± 20%	Capacitor	C3P30KJ
C4	0.047μ		Capacitor 250V	C47N0JS
C5	100μ		Capacitor 6V	C100UZ8
C6	1000P		Capacitor 400V	C1N00KK
C7	330P	± 20%	Capacitor	C330PKJ
C8	120P	± 5%	Capacitor	C120PJ1

No.	Value	Tol	Reference	Stock No.
C9				
C10	47μ		Capacitor 40V	C47L0ZB
C11	330P		Capacitor	C330PKJ
C12	0.1μ		Capacitor 250V	C100NKC
C13	10,000μ		Capacitor 63V	C10KUTA
C14	10,000μ		Capacitor 63V	C10KUTA
C15	0.1μ		Capacitor 100V	C100NKS
C16	0.1μ		Capacitor 100V	C100NKS
C17	10μ		Capacitor 40V	C10U0ZR
C19	1000P		Capacitor	C1N00SA
TR1			Transistor BC214C	DBC214C
TR2			Transistor BC682 or ZTX304 or BCX32	DZTX304
TR3			Transistor E5458 or ZTX504	DZTX504
TR4			Transistor E5458 or ZTX504	DZTX504
TR5			Transistor BC214C	DBC214C
TR6			Transistor BC214C	DBC214C
TR7			Transistor 40872 or 2SA740	D40872X
TR8			Transistor 40872 or 2SA740	D40872X
TR9			Transistor 2SD424 or 2SD676 or 17556	D17556X
TR10			Transistor 2SD424 or 2SD676 or 17556	D17556X
T1			DIAC 2N4992 or 8508A-03	D8508AA
T2			TRIAC SC1418 or T1C2268 or T2800	DT2800B

No.	Value	Tol	Reference	Stock No.
D1			Zener Diode LR150C	DZ15VAA
D2			Zener Diode LR150C	DZ15VAA
D3			Diode IS920	DIS920B
D4			Diode IS920	DIS920B
D5			Diode IS920	DIS920B
D6			Diode IS920	DIS920B
D7			Bridge Rectifier	DDPM7A2Q
IC1			LM301A	DML301A
L1	6.9μH	± 20%	Inductor ANCO TC1/65	L12406A
L2	3μH	± 5%	Inductor ANCO 440/D	L12405A
L3	6.9μH	± 20%	Inductor ANCO TC1/65	L12406A
FS1	4A			UM04AQA
FS2	4A			UM04AQA
FS3	T2.5A		220-240V	UM2A5DA
	T8A		110-130V	UM05ADA
LP1			Hewlett Packard 5082-4850 Red	BL5053R
TF1			Acoustical DRG A3/1236Z	L12362A

BOARD NUMBER M12368 ISS 9 AND 10

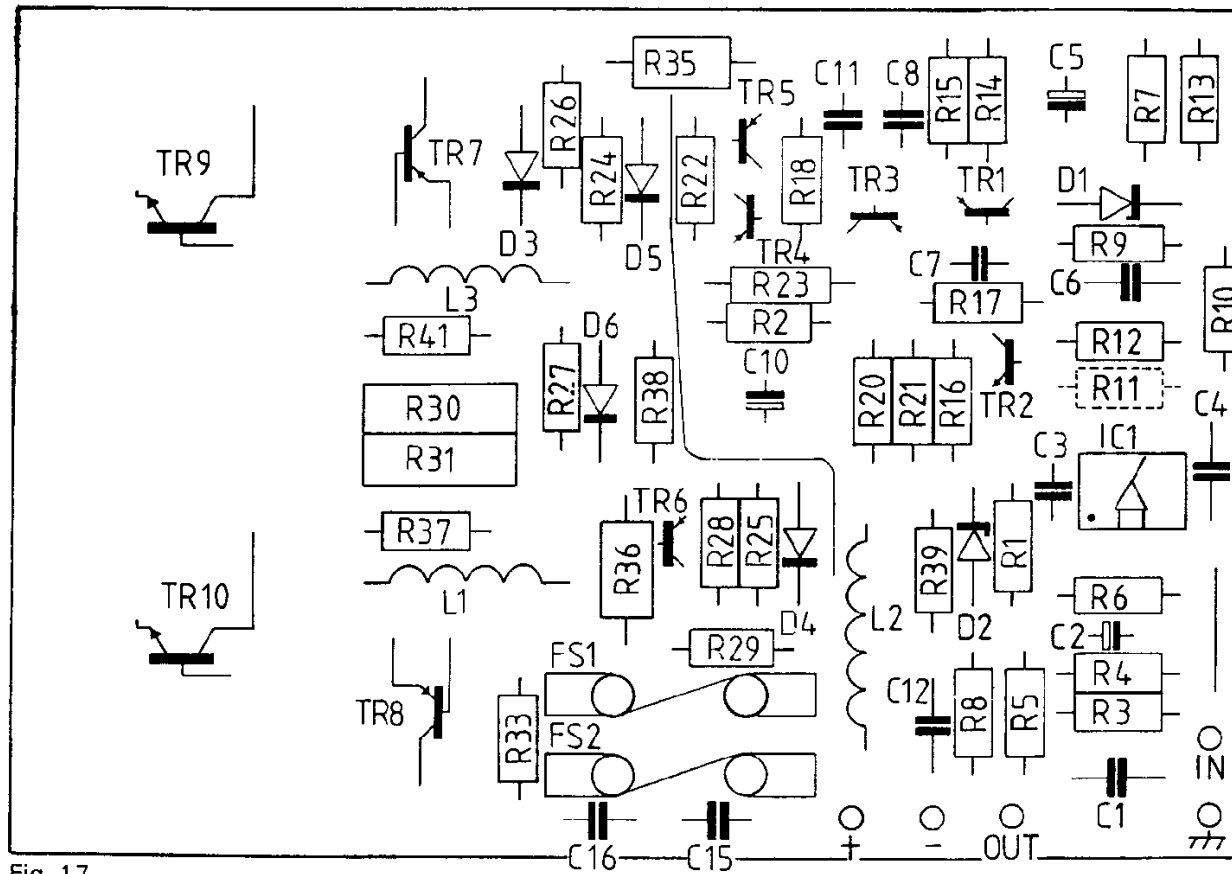
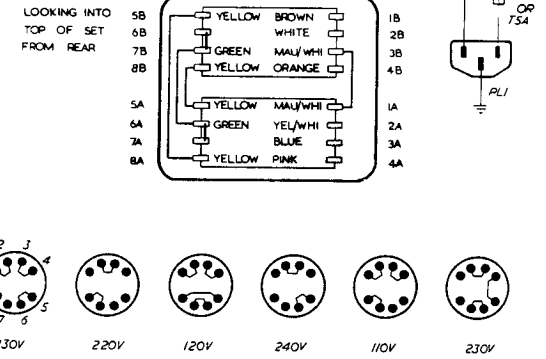
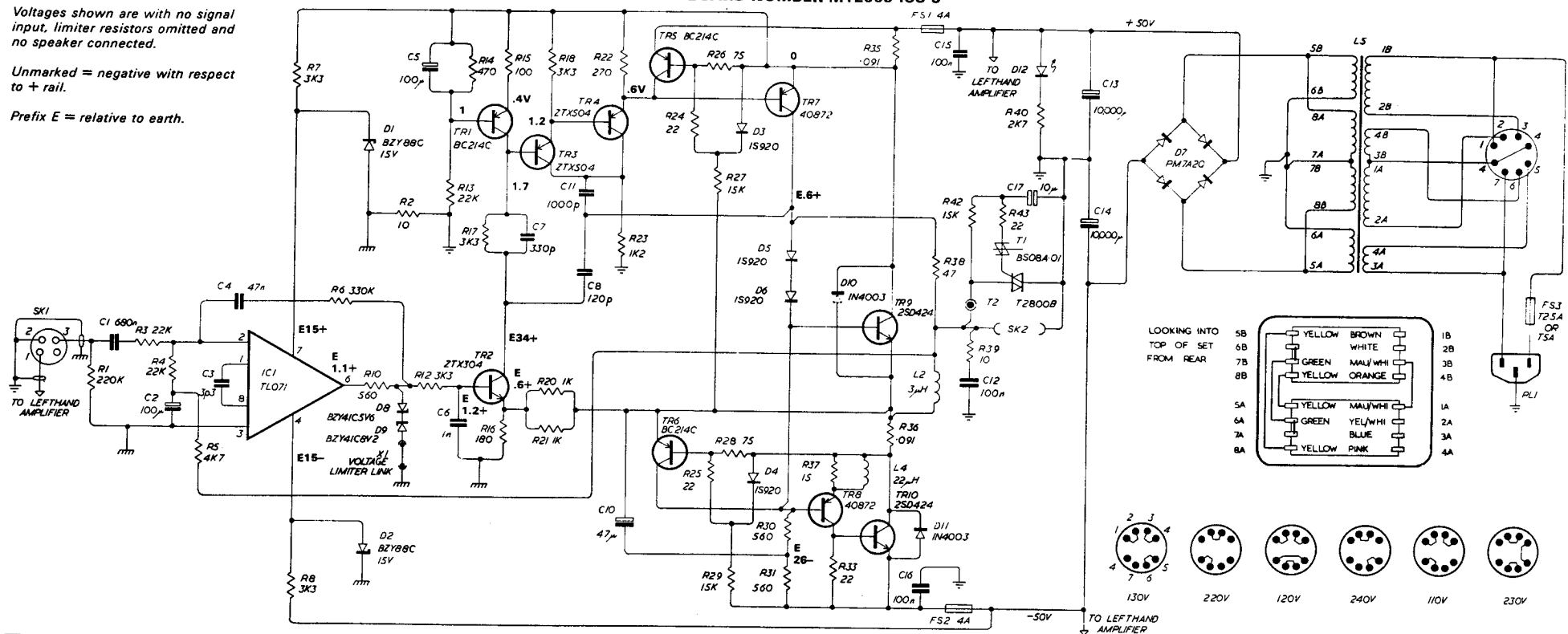


Fig. 17

Voltages shown are with no signal input, limiter resistors omitted and no speaker connected.

Unmarked = negative with respect to + rail.

Prefix E = relative to earth.



No.	Value	Tol	Reference	Stock No.
R1	220K		Resistor	R220KJ1
R2	10		Resistor	R10RJ1
R3	22K	± 2%	Resistor	R22KOG1
R4	22K	± 2%	Resistor	R22KOG1
R5	4K7		Resistor	R4K7OJ1
R6	330K	± 2%	Resistor	R330KG1
R7	3K3		Resistor	R3K3OJ1
R8	3K3		Resistor	R3K3OJ1
R10	560		Resistor	R560RJ1
R12	3K3		Resistor	R3K3OJ1
R13	22K	± 2%	Resistor	R22KOG1
R14	470		Resistor	R470RJ1
R15	100		Resistor	R100RJ1
R16	180	± 2%	Resistor	R180RG1
R17	3K3		Resistor	R3K3OJ1
R18	3K3		Resistor	R3K3OJ1
R20	1K	± 2%	Resistor	R1K0OG1
R21	1K	± 2%	Resistor	R1K0OG1
R22	270		Resistor	R270RJ1
R23	1K2		Resistor	R1K2OJR
R24	22		Resistor	R22ROJ1
R25	22		Resistor	R22ROJ1
R26	75		Resistor	R75RJ1

No.	Value	Tol	Reference	Stock No.
R27	15K		Resistor	R15K0J1
R28	75		Resistor	R75RJ1
R29	15K		Resistor	R15K0J1
R30	560		Resistor	R560RJ1
R31	560		Resistor	R560RJ1
R33	22		Resistor	R22ROJ1
R35	.091		Resistor	RR091JY
R36	.091		Resistor	RR091JY
R37	15		Resistor	R15RJ1
R38	47		Resistor	R47RJ1
R39	10		Resistor	R10RJ1
R40	2K7		Resistor	R2K7OJR
R42	15K		Resistor	R15K0J1
R43	22		Resistor	R22ROJ1
All Resistors ± 5% except where shown				
C1	880n		Capacitor	C880NKS
C2	100μ		Capacitor	C100UKT
C3	3p3		Capacitor	C3P3OC1
C4	47n		Capacitor	C47N0J1
C5	100μ		Capacitor	C100U2B
C6	1n		Capacitor	C1N00KK
C7	330p		Capacitor	C330PKJ

No.	Value	Tol	Reference	Stock No.
C8	120p		Capacitor	C120PJ1
C10	47μ		Capacitor	C47U02B
C11	1000p		Capacitor	C1K0PKJ
C12	100n		Capacitor	C100NJS
C13	10,000μ		Capacitor	C10KUTA
C14	10,000μ		Capacitor	C10KUTA
C15	100n		Capacitor	C100NKS
C16	100n		Capacitor	C100NKS
C17	10μ		Capacitor	C10U02R
TR1			Transistor BC 214C	DBC214C
TR2			Transistor 2TX304	D2TX304
TR3			Transistor 2TX504	D2TX504
TR4			Transistor 2TX504	D2TX504
TR5			Transistor BC214C	DBC214C
TR6			Transistor BC214C	DBC214C
TR7			Transistor 40872	D40872X
TR8			Transistor 40872	D40872X
TR9			Transistor 17556 or 2SD424	D17556X
TR10			Transistor 17556 or 2SD424	D17556X
T1			DIAC 8508A-01 or 2N4992	D8508AA
T2			TRIAC T2800B	DT2800B
D1			Zener Diode BZY88C 15V	DZ15VAA

No.	Value	Tol	Reference	Stock No.
D2			Zener Diode BZY88C 15V	DZ15VAA
D3			Diode 1S920T8	D1S920B
D4			Diode 1S920T8	D1S920B
D5			Diode 1S920T8	D1S920B
D6			Diode 1S920T8	D1S920B
D7			Bridge Rectifier PM7A2Q	DPM7A2Q
D8			Zener Diode BZV41C8V2	DZ8V2AA
D9			Zener Diode BZV41C5V6	DZ5V6AA
D10			Diode 1N4003	D1N4003
D11			Diode 1N4003	D1N4003
D12			LED XC5053R	BL5053R
IC1			Int. Circuit TL071, ME5534, LM351, LM301	DO71CPX
L2	3μH	± 5%	Choke	LT2405A
L4	22μH		Choke	LSC1022
L5			Transformer	LT2362A
FS1	4A		Fuse	UM04AQJ
FS2	4A		Fuse	UM04AQJ
FS3	T2A5		Fuse 220-240V	UM2A5DA
	T5A		Fuse 110-130V	UM05ADA
X1			Link	PP37712

BOARD NUMBER M12565 ISS 3

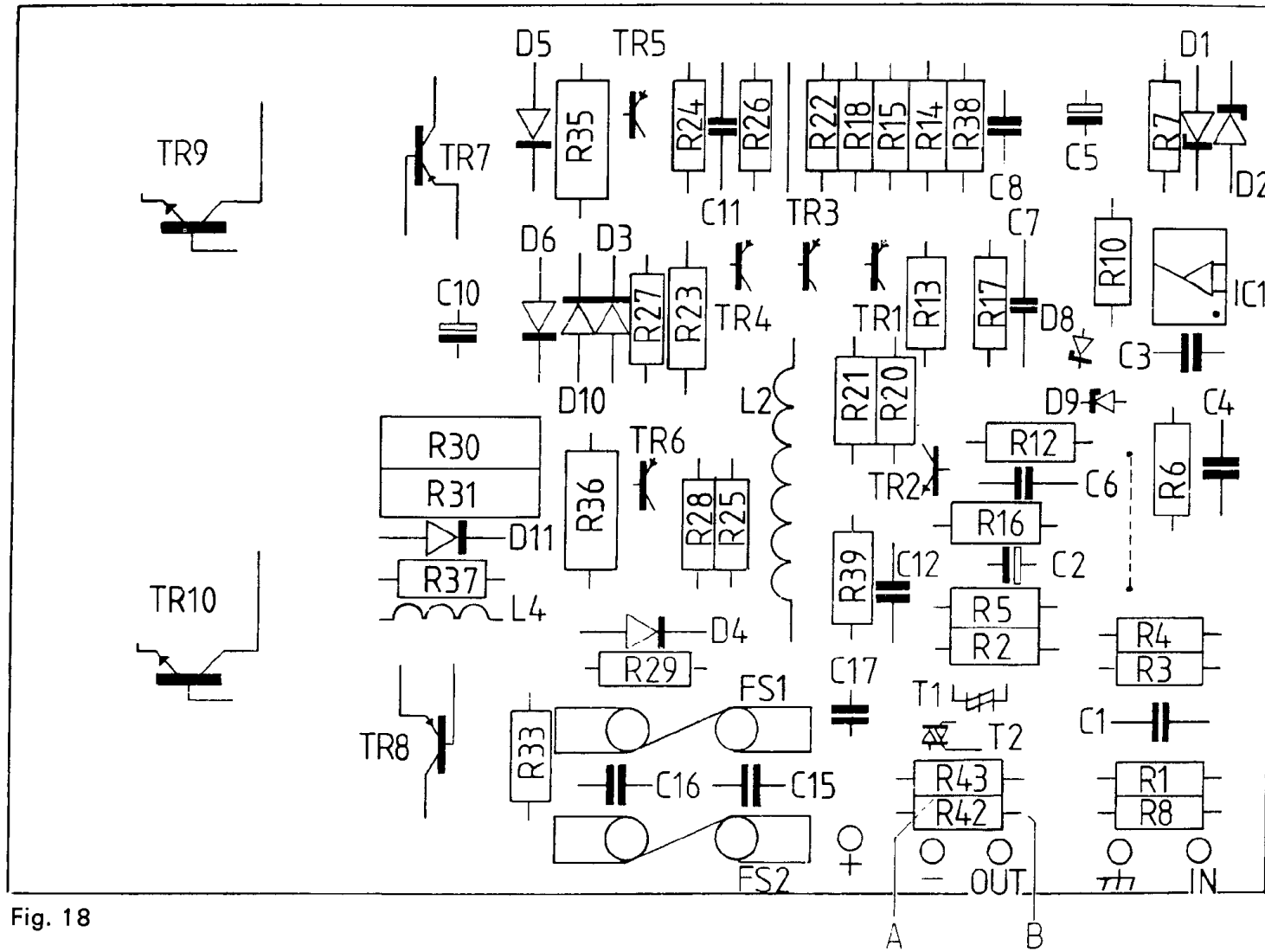
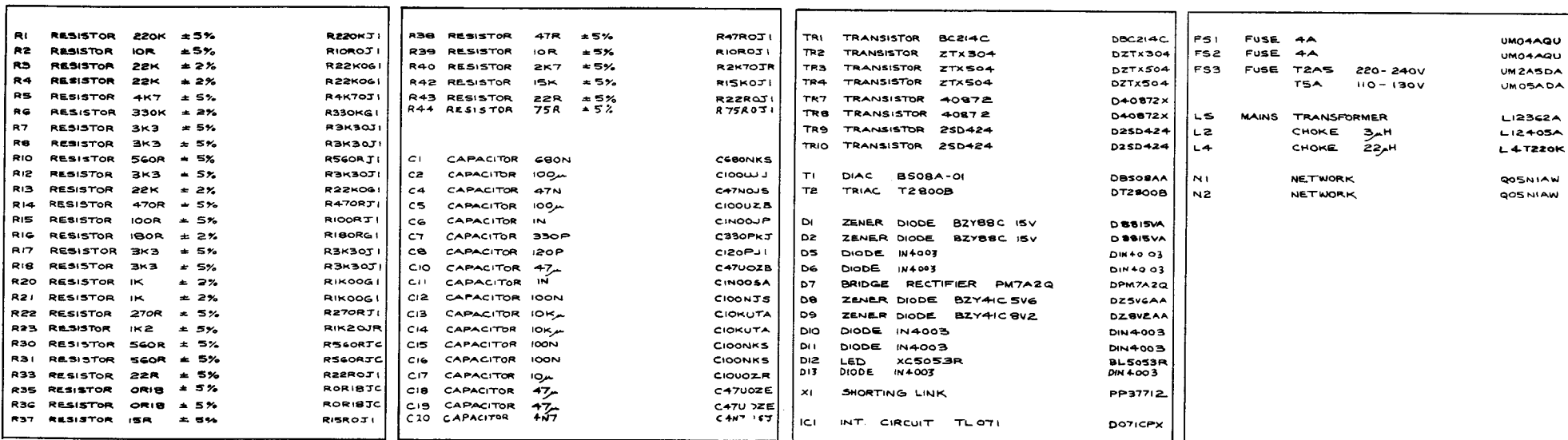
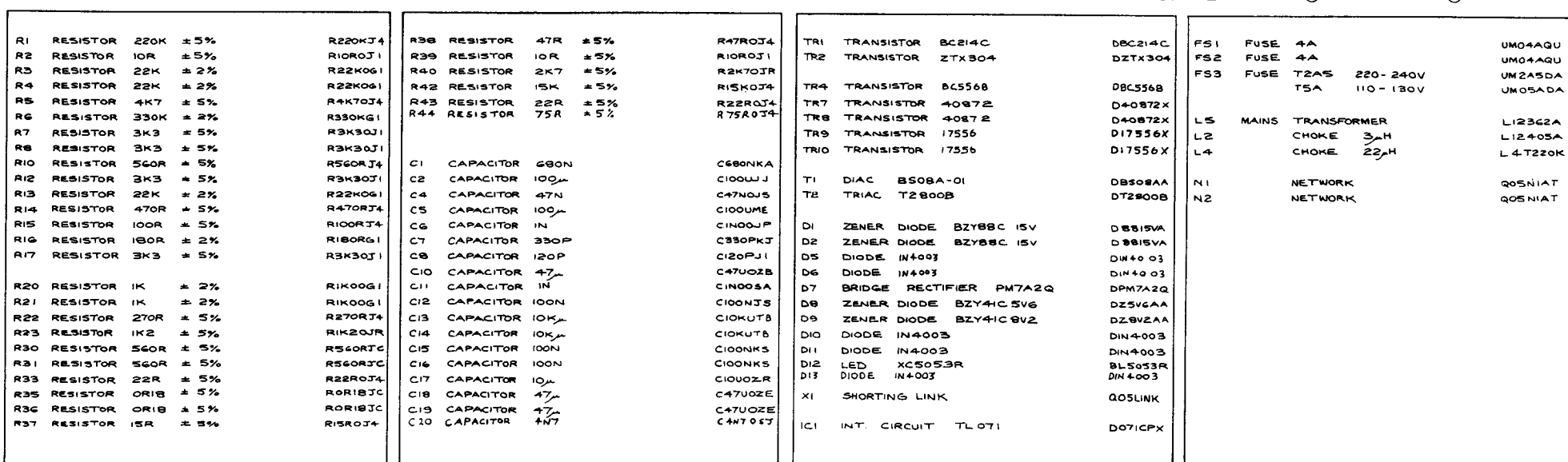
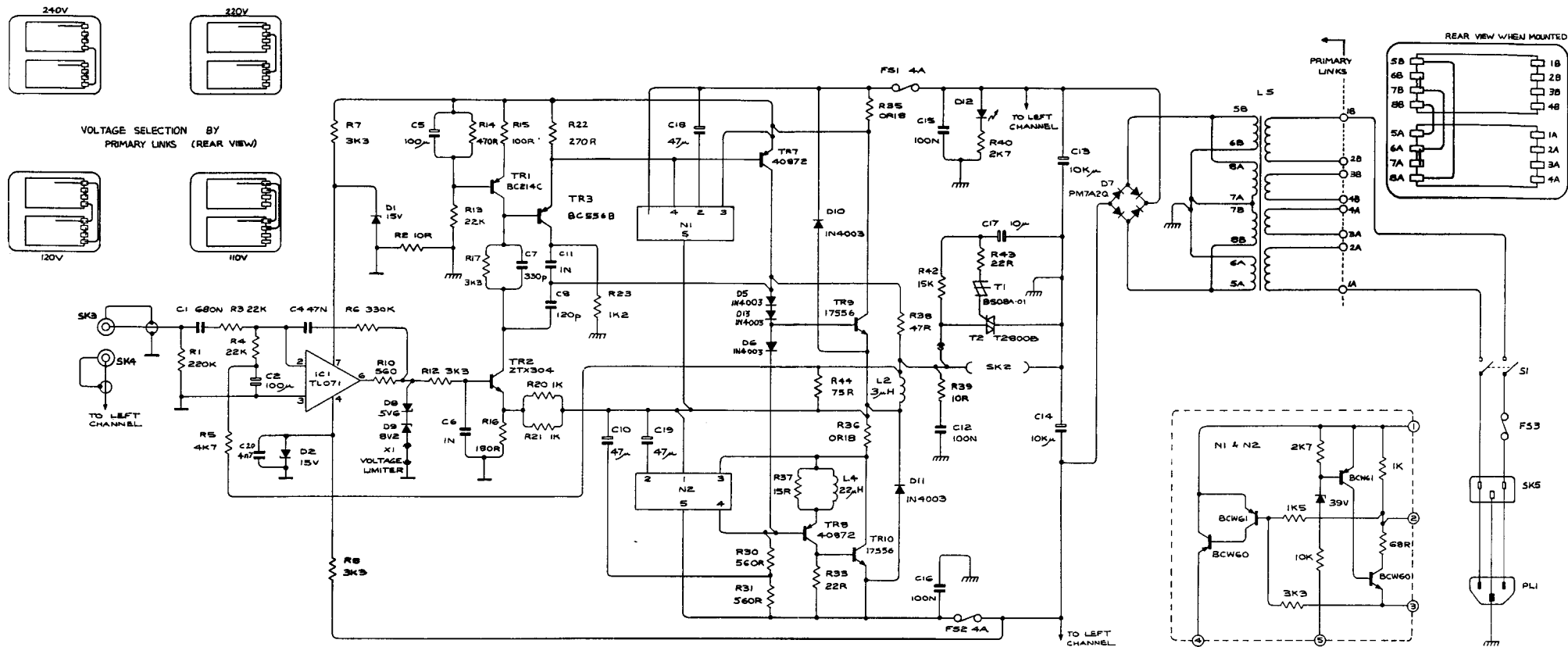


Fig. 18









R1 RESISTOR 220K ± 5%	R220KJ4	R39 RESISTOR 47R ± 5%	R47R0J4	TR1 TRANSISTOR BC214C	DBC214C	FS1 FUSE 4A	UM04AGU
R2 RESISTOR 10R ± 5%	R10R0J1	R39 RESISTOR 10R ± 5%	R10R0J1	TR2 TRANSISTOR 2TX304	DBC214C	FS2 FUSE 4A	UM04AGU
R3 RESISTOR 22K ± 2%	R22K061	R40 RESISTOR 2K7 ± 5%	R2K70J4	TR3 TRANSISTOR BC556B	DBC556B	FS3 FUSE T2A5 220-240V	UM2A5DA
R4 RESISTOR 22K ± 2%	R22K061	R42 RESISTOR 15K ± 5%	R15K0J4	TR7 TRANSISTOR 40972	D40972X	T5A 110-130V	UM05ADA
R5 RESISTOR 4K7 ± 5%	R4K70J4	R43 RESISTOR 22R ± 5%	R22R0J4	TR8 TRANSISTOR 40972	D40972X		
R6 RESISTOR 330K ± 5%	R330KQ1	R44 RESISTOR 75R ± 5%	R75R0J4	TR9 TRANSISTOR 17556	D17556X		
R7 RESISTOR 3K3 ± 5%	R3K3QJ1			TR10 TRANSISTOR 17556	D17556X		
R8 RESISTOR 3K3 ± 5%	R3K3QJ1						
R9 RESISTOR 560R ± 5%	R560RJ4						
R10 RESISTOR 3K3 ± 5%	R3K3QJ1						
R11 RESISTOR 3K3 ± 5%	R3K3QJ1						
R12 RESISTOR 3K3 ± 5%	R3K3QJ1						
R13 RESISTOR 22K ± 2%	R22K061						
R14 RESISTOR 470R ± 5%	R470RJ4						
R15 RESISTOR 100R ± 5%	R100RJ4						
R16 RESISTOR 100R ± 2%	R100RJ4						
R17 RESISTOR 3K3 ± 5%	R3K3QJ1						
R20 RESISTOR 1K ± 2%	R1K00G1						
R21 RESISTOR 1K ± 2%	R1K00G1						
R22 RESISTOR 270R ± 5%	R270RJ4						
R23 RESISTOR 1K2 ± 5%	R1K20J4						
R30 RESISTOR 560R ± 5%	R560RJ4						
R31 RESISTOR 560R ± 5%	R560RJ4						
R33 RESISTOR 22R ± 5%	R22R0J4						
R35 RESISTOR 0R1B ± 5%	R0R1BJ4						
R36 RESISTOR 0R1B ± 5%	R0R1BJ4						
R37 RESISTOR 15R ± 5%	R15R0J4						
C1 CAPACITOR 680N	C680NKA						
C2 CAPACITOR 100µ	C100µJ						
C4 CAPACITOR 47N	C47N0J5						
C5 CAPACITOR 100µ	C100µME						
C6 CAPACITOR 1N	C1000µP						
C7 CAPACITOR 330P	C330PKJ						
C8 CAPACITOR 120P	C120PJ1						
C10 CAPACITOR 47µ	C47µ0J2B						
C11 CAPACITOR 1N	C1000µA						
C12 CAPACITOR 100N	C100NJS						
C13 CAPACITOR 10K	C10KUTB						
C14 CAPACITOR 10K	C10KUTB						
C15 CAPACITOR 100N	C100NKS						
C16 CAPACITOR 100N	C100NKS						
C17 CAPACITOR 10µ	C10µ0ZL						
C18 CAPACITOR 47µ	C47µ0ZE						
C19 CAPACITOR 47µ	C47µ0ZE						
C20 CAPACITOR 47N	C47N0J7						
D1 ZENER DIODE BZY88C 15V	D88B15VA						
D2 ZENER DIODE BZY88C 15V	D88B15VA						
D5 DIODE 1N4003	D1N4003						
D6 DIODE 1N4003	D1N4003						
D7 BRIDGE RECTIFIER PM7A2Q	DPM7A2Q						
D8 ZENER DIODE BZY44C 5V6	D25V6AA						
D9 ZENER DIODE BZY44C 5V2	D25V2AA						
D10 DIODE 1N4003	D1N4003						
D11 DIODE 1N4003	D1N4003						
D12 LED XC5053R	DL5053R						
D13 DIODE 1N4003	D1N4003						
X1 SHORTING LINK	Q05LINK						
IC1 INT. CIRCUIT TL071	DO71CPX						
L5 MAINS TRANSFORMER	L12362A						
L2 CHOKE 3µH	L12405A						
L4 CHOKE 22µH	L4T220K						
N1 NETWORK	Q05NIAT						
N2 NETWORK	Q05NIAT						
PL1 AC. POWER IN/FUSEHOLDER	PPM12AA						
S1 SWITCH	S405OFF						
SK2 OUTPUT SOCKETS	RED P5R514C BLACK P5B514C						
SK3 INPUT RIGHT	P5PHON2						
SK4 INPUT LEFT	P5PHON9						
SK5 AC. POWER OUTLET SOCKET	P5P695S						