UCTION MANUAL
HE PS SERIES OF
RATED CIRCUIT
VER SUPPLIES

NEW ZEALAND BROADCASTING CORPORATION

HEAD OFFICE ENGINEERING DIVISION
WELLINGTON

Instruction Manual for the PS Series of Integrated Circuit Regulated Power Supplies

VIDEO EQUIPMENT
DEVELOPMENT GROUP

NZBC Report F10660

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February 1971

A. K. Richardson
Chief Engineer

I N D E X

1. INTRODUCTION

The initial development of the NZBC range of I.C. regulated power supplies is described in report F10291 "The Development of an I.C. Regulated Power Supply" (July 1970). For convenience this report will be referred to as "ref. 1".

The power supplies use the type A4-10084/2 "Universal Voltage Regulator" PC board. Applications of this PC board are outlined in the "Application Manual for the Universal Voltage Regulator" (NZBC Report F10500, October 1970). This report will be referred to as "ref. 2".

The PC board configuration given in ref. 2 and in this manual supersedes that in ref. 1.

2. POWER SUPPLY CLASSIFICATION

NZBC I.C. regulated power supplies are distinguished by a model number such as "PS3A4" where "PS" stands for "power supply", 3A indicates that the d.c. current rating is 3 amps and "4" shows that the d.c. voltage is in the fourth voltage range. The voltage ranges are:-

1) 2 - 7 volts

2) 7 - 15 volts

3) 14 - 22 volts

4) 21 - 28 volts

The selection of voltage ranges was influenced by the need to have a division at 7 volts (section 3) and also the need to limit the thermal disipation of the regulating transistor (section 4).

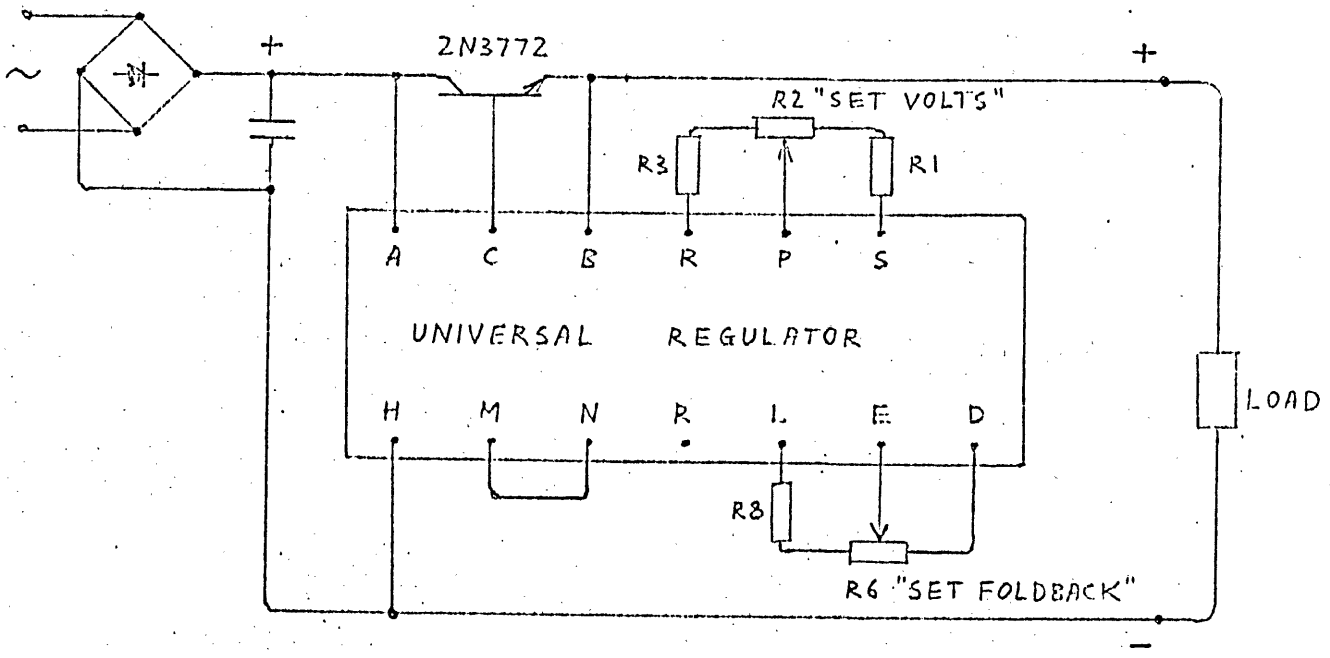
3. CIRCUIT DESCRIPTION AND OPERATING PRINCIPLES

A differential amplifier is used to compare the output voltage (or a fixed fraction of it) with a reference voltage (or a fixed fraction of it). Any difference between the two voltages is used to apply negative feedback to the series regulator thus tending to keep the two voltages equal (ref. 1, section 5.1). The reference voltage used is about 7 volts. For a power supply giving less than 7 volts it is necessary to take a fraction of the reference voltage using a simple voltage divider and to compare it with the output voltage. For a supply giving more than 7 volts it is necessary to take a fraction of the output voltage using a simple voltage divider and to compare it with the input voltage. This means that slightly different circuits must be used for supplies below and above 7 volts and there must be a division in voltage ranges at this point (section 2).

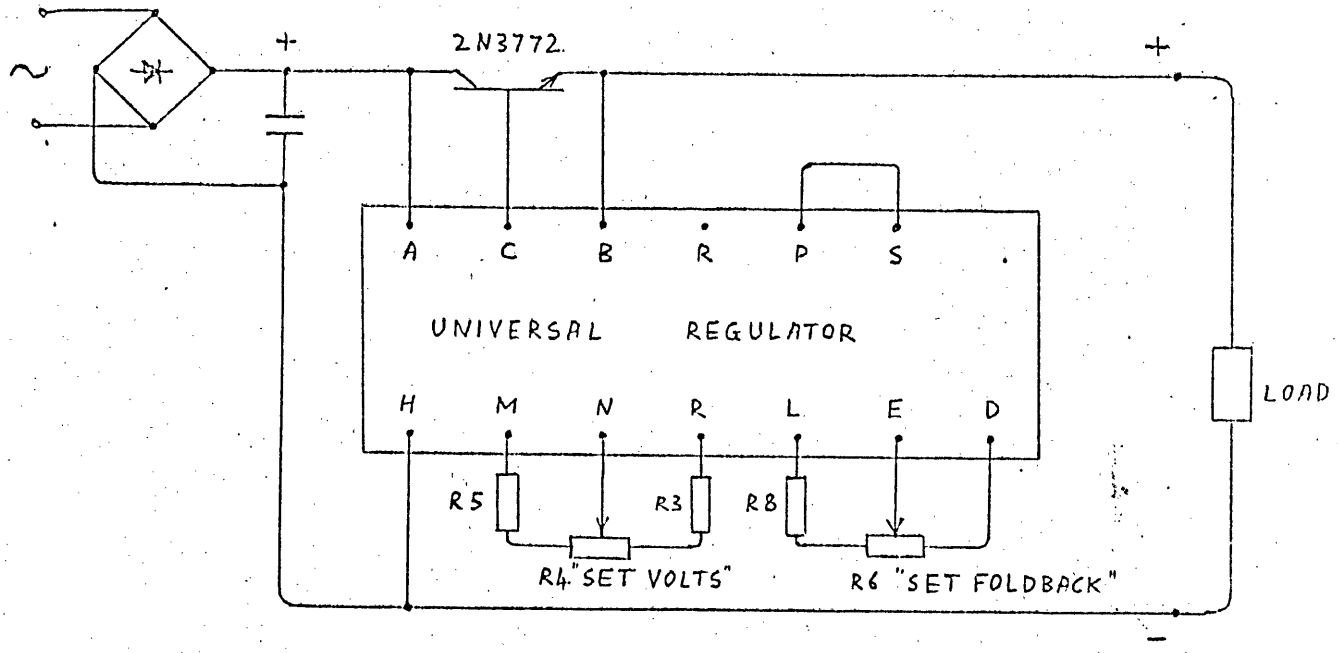
For a detailed explanation of power supply operation refer to refs. 1 and 2.

The following diagrams show the relationship between the Universal Regulator and the modular supply both above and below 7 volts. The corresponding circuit diagrams 10,279/1 & 2 complete the section.

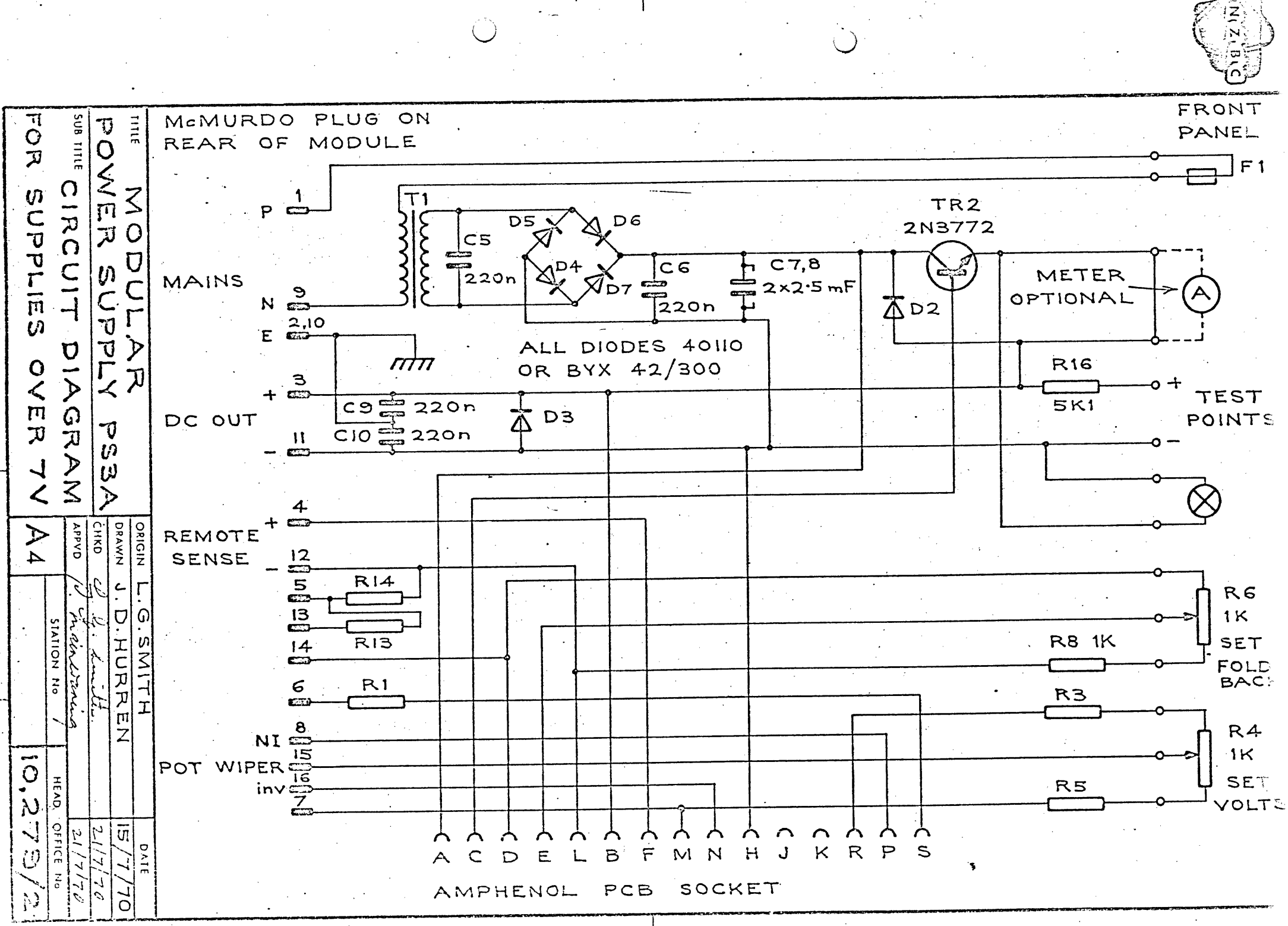
3.1 Below 7 Volts



3.2 Above 7 Volts



TITLE	MODULAR POWER SUPPLY PS3A	ORIGIN L.G.SMITH	DATE
		DRAWN J.D.HURREN	14/7/70
		CHKD L. G. Smith	21/7/70
SUB TITLE	CIRCUIT DIAGRAM FOR SUPPLIES UNDER 7V	APPVD P. Trainworring	21/7/70
	A4	STATION No	HEAD OFFICE No 10,279/1


McMURDO PLUG ON
REAR OF MODULE
FRONT
PANEL
F1
MAINS
P
N
E
1
9
2,10
T1
C5
220n
D5
D6
D4
D7
C6
220n
C7,8
2x2·5 mF
TR2
2N3772
D2
METER
OPTIONAL
A
ALL DIODES 40110
OR BYX 42/300
DC OUT
+
−
3
11
C9
220n
C10
220n
D3
R16
5K1
TEST
POINTS
REMOTE
SENSE
4
12
5
13
14
6
R14
R13
R1
R6
1K
SET
FOLD
BACK
R8 1K
R3
R4
1K
SET
VOLTS
R5
NI
POT WIPER
inv
8
15
16
7
A C D E L B F M N H J K R P S
AMPHENOL PCB SOCKET
TITLE
MODULAR
POWER SUPPLY PS3A
SUB TITLE
CIRCUIT DIAGRAM
FOR SUPPLIES OVER 7V
A4
ORIGIN L.G.SMITH
DRAWN J.D.HURREN
CHKD
APPVD
DATE
15/7/70
21/7/70
STATION No 7
HEAD OFFICE No
10,279/2

4. MECHANICAL CONSIDERATIONS

The power supplies conform to the NZBC 8943 modular system. All power supply modules utilise the maximum module depth of 11⅜ inches and are 5¼ inches high (3 modular height units). The width of the modules is a function of current rating but is 5½ inches (8 modular width units or ⅓ of a rack width) for the 3 amp power supplies.

The size of the power supply module is largely determined by two factors; the size of the transformer and the size of the heatsink. The size of the transformer is a function of the product of current and of output voltage. The size of the heatsink is a function of the product of current and of the voltage drop in the series regulator.

The heatsink is located at the back of the module and a metal heatshield is used to ensure that the flow of hot air avoids the equipment immediately above the module.

The plug on the rear of the module is the McMurdo Red Range 16 pin RP16SM. The corresponding rack socket is the McMurdo RS16SM. The wiring of this socket is discussed in the next section.

In order to reduce the possibility of plugging a module into the wrong socket the plugs and sockets are mounted in different manners for different voltage ranges:

Nominal Voltage	Plug and Socket Orientation	Plug and Socket Location (viewed from the front)
0 - 7	Terminals 1 & 9 at top	Right
7 - 14	Terminals 1 & 9 at bottom	Right
14 - 21	Terminals 1 & 9 at bottom	Left
21 - 28	Terminals 1 & 9 at top	Left

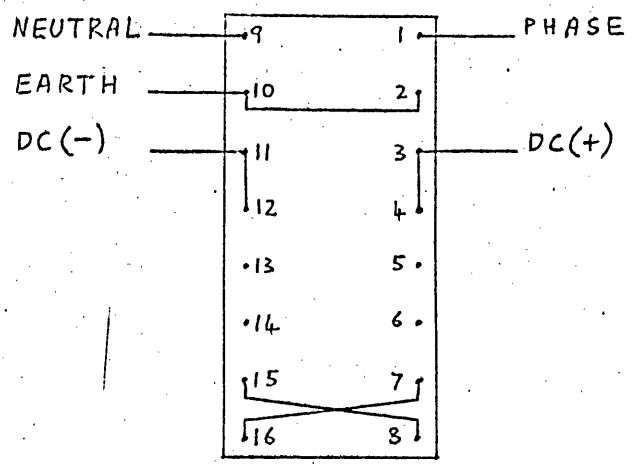
In order to indicate the presence of mains voltage a polarising pin is used next to the bottom of the left hand socket position (viewed from the front).

5. EXTERNAL WIRING

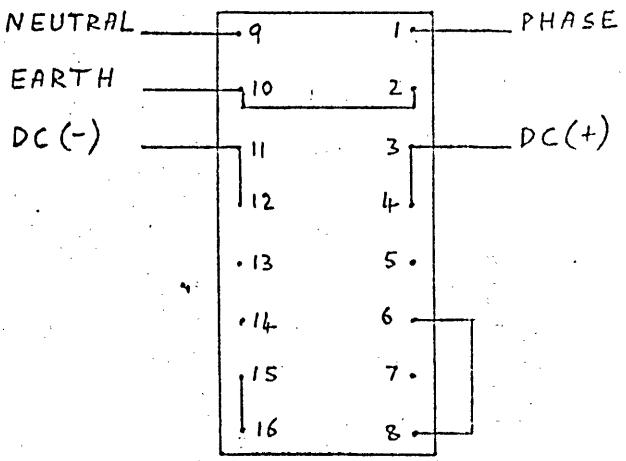
External wiring is made to a McMurdo Red Range 16 pin RS16SM socket. The socket is mounted as is described in the previous section.

The wiring of the socket is as follows:-

SUPPLIES UNDER 7V.



SUPPLIES OVER 7V



It should be noted that the power supply will be floating unless either DC(+) or DC(-) is earthed.

The wiring of the socket for special applications is considered in sections 8, 9, 10, 11 and 12.

6. INSTALLATION AND ADJUSTMENT

The McMurdo socket should be mounted and wired as described in the previous two sections.

Before plugging the power supply into the socket or making any adjustments the mains should be switched off, the d.c. terminals should be open circuited and the "set foldback" control on the front panel should be turned fully clockwise.

6.1 To Set The Output Voltage

After carrying out the instructions in the previous paragraph:

1) Plug the power supply into its socket.

2) Connect a d.c. voltmeter to the "Check Volts" terminals on the front panel.

3) Switch the mains on. The "D.C. Volts" lamp should glow.

4) Set the output voltage using the "Set Volts" control on the front panel. (A clockwise rotation increases the voltage and also the brightness of the "D.C. Volts" lamp.

6.2 To Set The Foldback Current

1) Attach a load resistance to the d.c. output terminals of the power supply. The load must be one which will not draw more than the rated current as specified on the front panel.

2) Adjust the load until the power supply is delivering the required current (if the power supply has no ammeter on the front panel it will be necessary to insert one into the d.c. load line).

3) Turn the "set foldback" control on the front panel anti-clockwise until there is a very slight reduction in the d.c. output voltage.

4) Turn the "set foldback" control slightly clockwise until the output voltage has just increased to its former value.

7. CURRENT FOLDBACK

The "current-foldback" facility is intended to prevent excessive heat dissipation under short circuit conditions (ref. 1, section 10.2). As the load resistance is reduced the current in the load will increase until it equals the preset foldback current level, it will then commence to decrease. The short circuit current will be about one third of the preset foldback current.

The method used to set the foldback current is outlined in section 6.

When a power supply has "folded back" the "D.C. Volts" lamp will extinguish and the ammeter will register only about one third of the normal operating current.

There are at least two conditions which may make the use of current foldback unsuitable.

1) When units are operated in "auto-series" (section 9) an unstable foldback may occur. This could lead to a reverse voltage being placed on one of the units and a possible failure to recover when the short circuit is removed.

2) When used with lamp loads a permanent foldback could occur owing to the short-circuit presented by cold lamp filaments.

It should be remembered that one of the advantages of the current foldback circuit is that it is self-resetting when the cause of the foldback is removed.

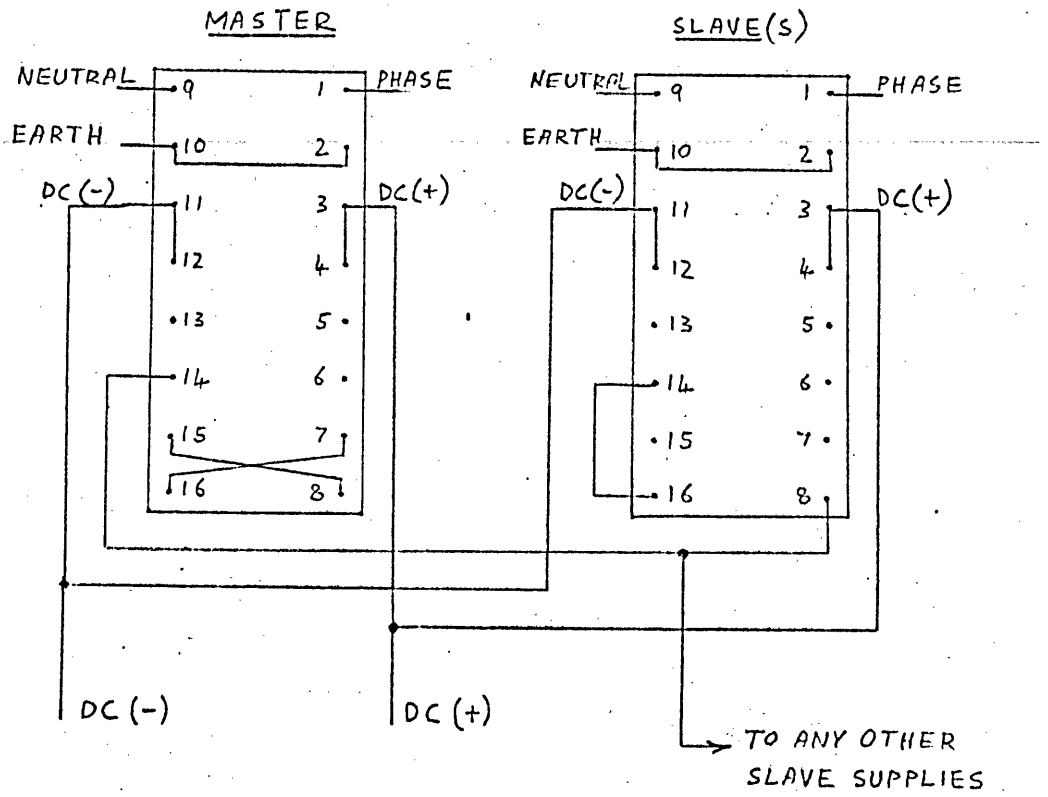
8. AUTO PARALLEL OPERATION

An introduction to auto-parallel operation is given in ref. 1, section 7.1.

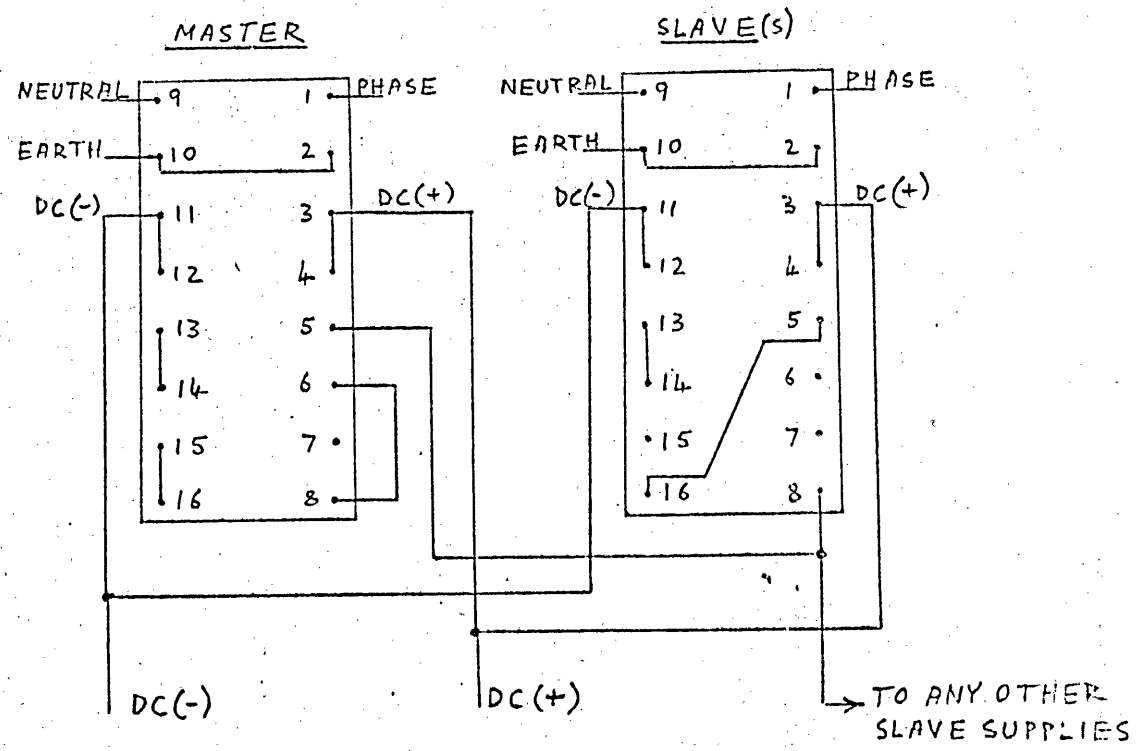
Auto-parallel or automatic-parallel operation of power supplies permits equal current sharing by such supplies under all load conditions and allows complete control of the d.c. output voltage of the auto-parallel ensemble using only the voltage control of the Master supply. The voltage controls of the Slave supplies become inoperative. It is unnecessary to alter the internal circuitry of the power supplies for use in auto-parallel, but the McMurdo sockets must be rewired. When the sockets have been correctly wired the Master and Slave supplies will be interchangeable.

The McMurdo sockets are wired as follows:-

8.1 Supplies Under 7 Volts



8.2 Supplies Over 7 Volts



9. AUTO SERIES OPERATION

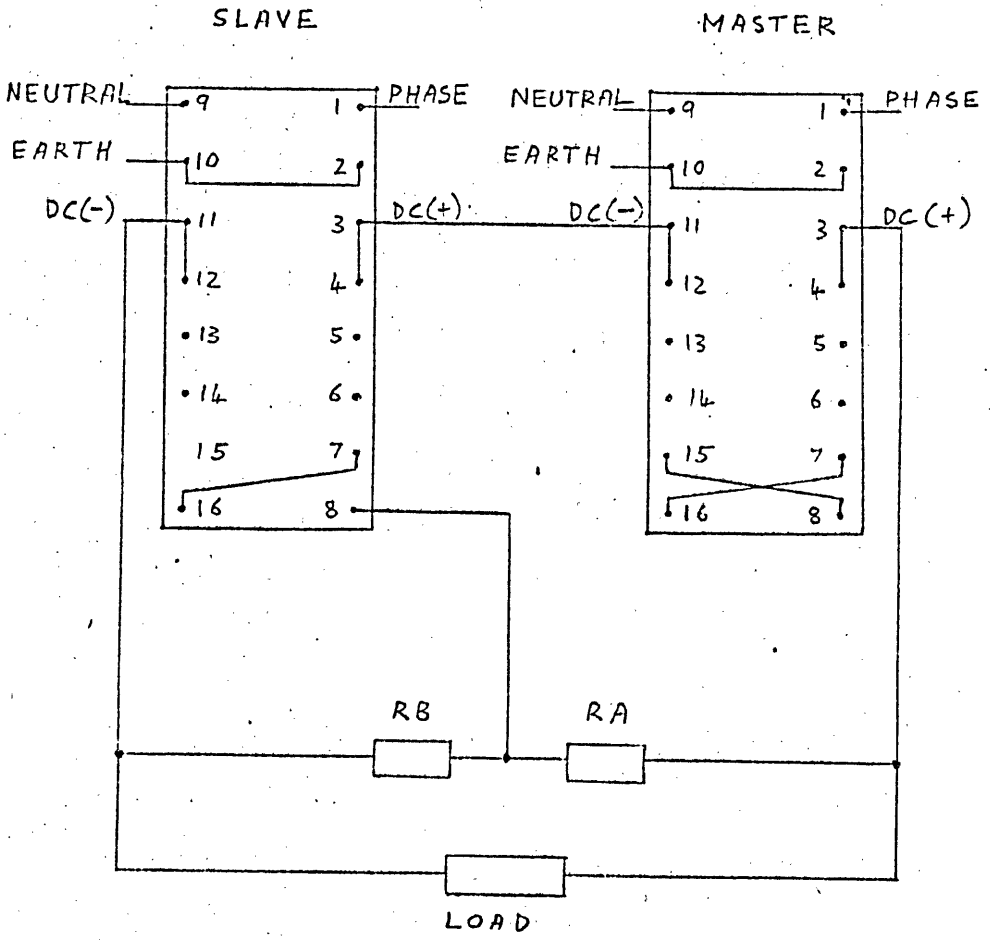
An introduction to auto-series operation is given in ref. 1, section 7.2.

Automatic-series operation of power supplies permits equal or proportional voltage sharing by such supplies under all load conditions with complete control of the d.c. output voltage of the auto-parallel ensemble using only the voltage control of the Master supply.

It is unnecessary to alter the internal circuitry of the power supplies for use in auto-series but the McMurdo sockets must be rewired. When the sockets have been correctly wired the Master and Slave supplies will be interchangeable.

The McMurdo rack sockets are wired as follows:-

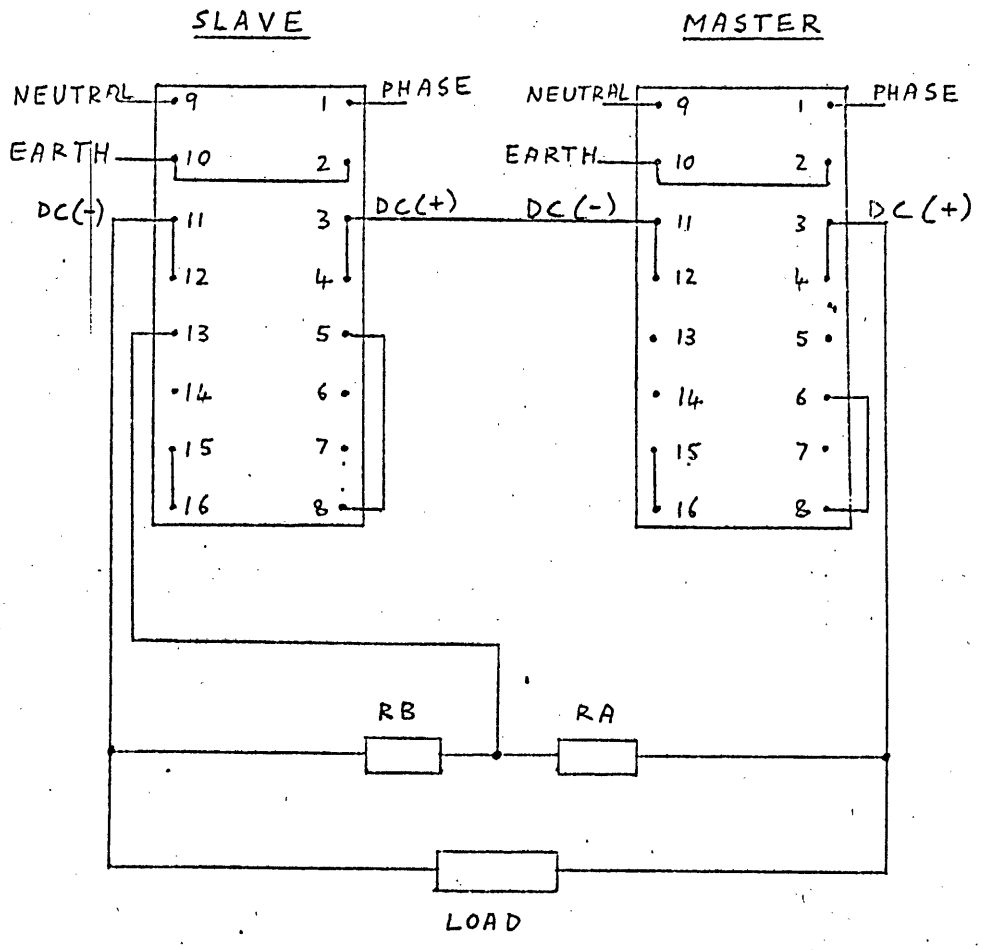
9.1 Supplies Under 7 Volts



Under no circumstances should the voltage between terminals 11 and 8 on a Slave supply exceed 7 volts.

The voltage contributed by the Master supply is set by using the voltage control on the Master supply. The ratio between voltages contributed by the two supplies is approximately equal to RA:RB. Resistors RA and RB should have a power rating at least 10 times their actual dissipation and should be selected so that the current through them is in the order of 5 mA. Resistors RA and RB may be replaced by a suitable potentiometer.

9.2 Supplies Over 7 Volts

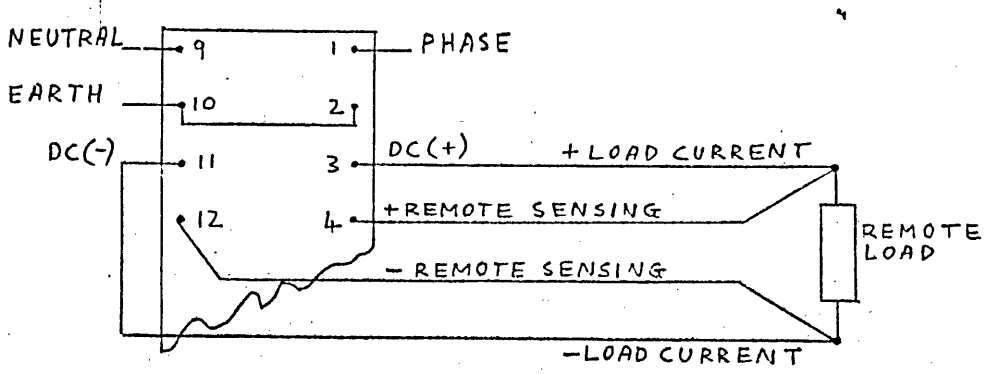


10. REMOTE SENSING

Normally a power supply achieves its optimum load and line regulation, its lowest output impedance, drift, ripple and noise and its fastest transient recovering performance at the power supply output terminals. If the load is separated from the output terminals by any lead length, some of these performance characteristics will be degraded at the load terminals to a degree which depends apon the impedance of the load leads compared to with the output impedance of the power supply.

With remote error sensing it is possible to connect the feedback amplifier directly to the load terminals wherever they are, thus giving optimum performance at the load. (ref. 1, section 7.3).

When using remote sensing it is unnecessary to alter the power supply. The McMurdo socket should be wired as in previous sections of this Manual except for terminals 3, 4, 11 and 12 which should be wired as follows:-



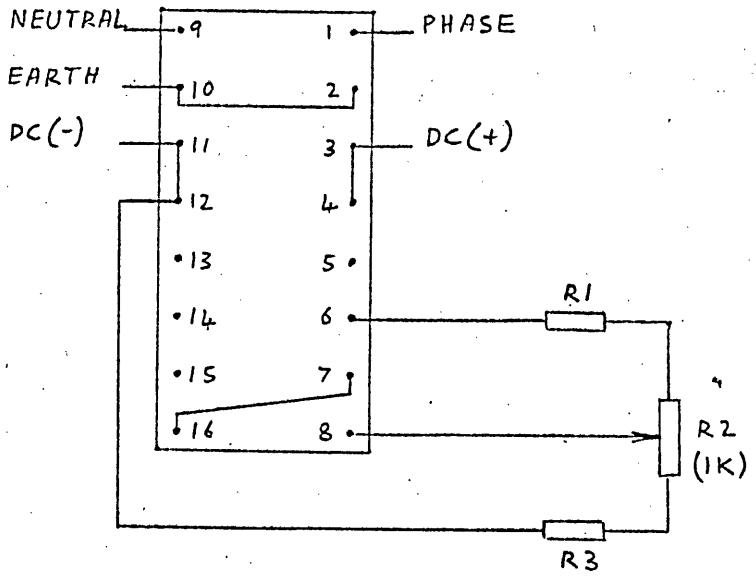
When the Remote Sensing facilities are not being used it is necessary to link 11 to 12 and 3 to 4.

The Remote Sensing leads carry a very small current and will sense the load voltage accurately as they will suffer no significant voltage drop; this means that the voltage drops in the long load current leads will not impair the performance of the power supply.

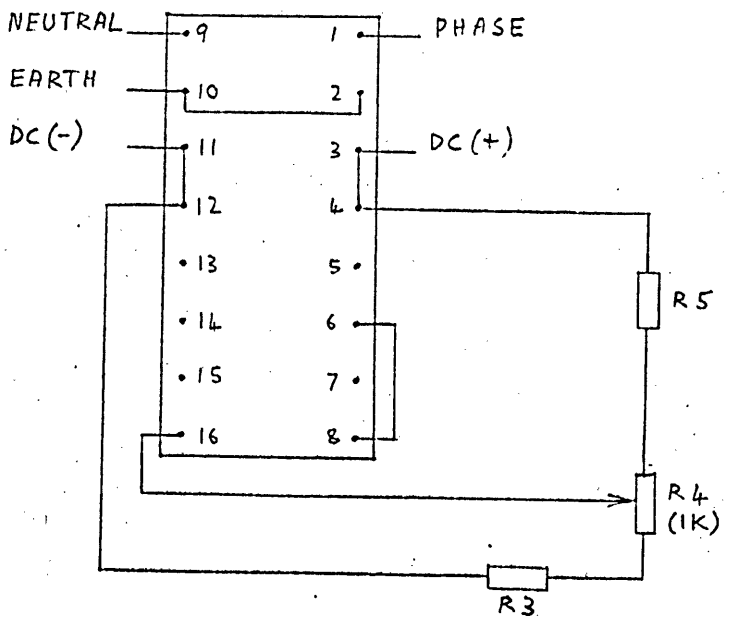
11. REMOTE PROGRAMMING WITH RESISTANCE CONTROL

This permits the output voltage to be controlled using an external potentiometer (ref. 1, section 7.4). The voltage control on the front panel becomes inoperative. No external reference voltage is needed and it is not necessary to alter the power supply. The socket is wired as follows:-

11.1 Supplies Under 7 Volts



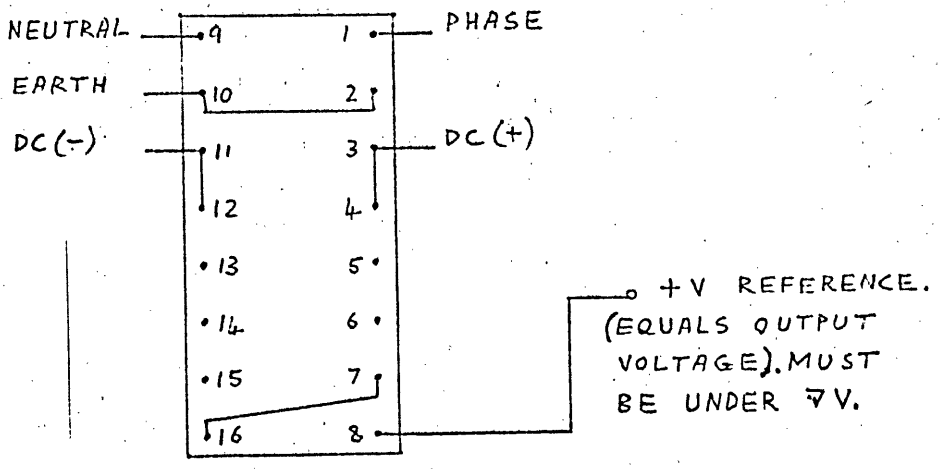
11.2 Supplies Over 7 Volts



12. REMOTE PROGRAMMING WITH VOLTAGE CONTROL

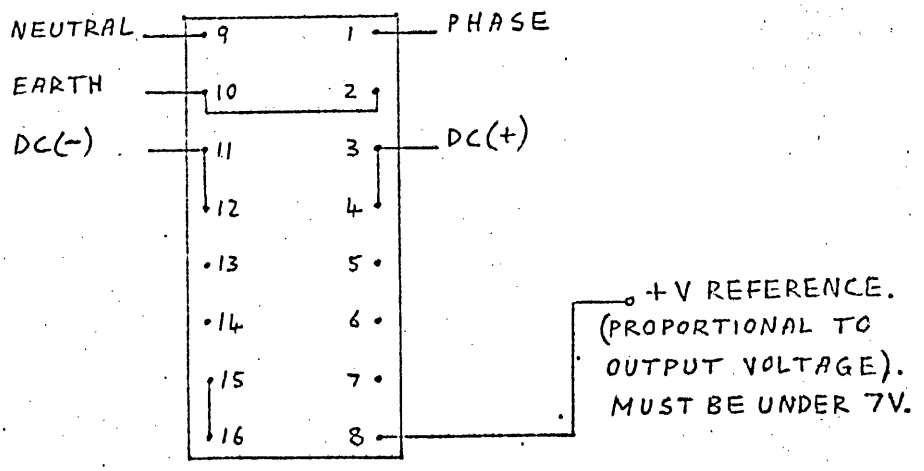
This permits the output voltage to be made equal or proportional to an external voltage (ref. 1, section 7.4). It is not necessary to alter the internal wiring of the power supply but the rack socket must be wired as follows:-

12.1 Supplies Under 7 Volts



The voltage control on the front panel becomes inoperative.

12.2 Supplies Over 7 Volts



The voltage control on the front panel may be used to adjust the ratio between the output voltage and the reference voltage.

13. MAINTENANCE

If the "D.C. Volts" lamp on the power supply front panel extinguishes it may be because:-

1) The fuse has blown

2) The unit is in foldback, in this case the current meter will indicate a small current (see section 7) and the fault will be outside the power supply.

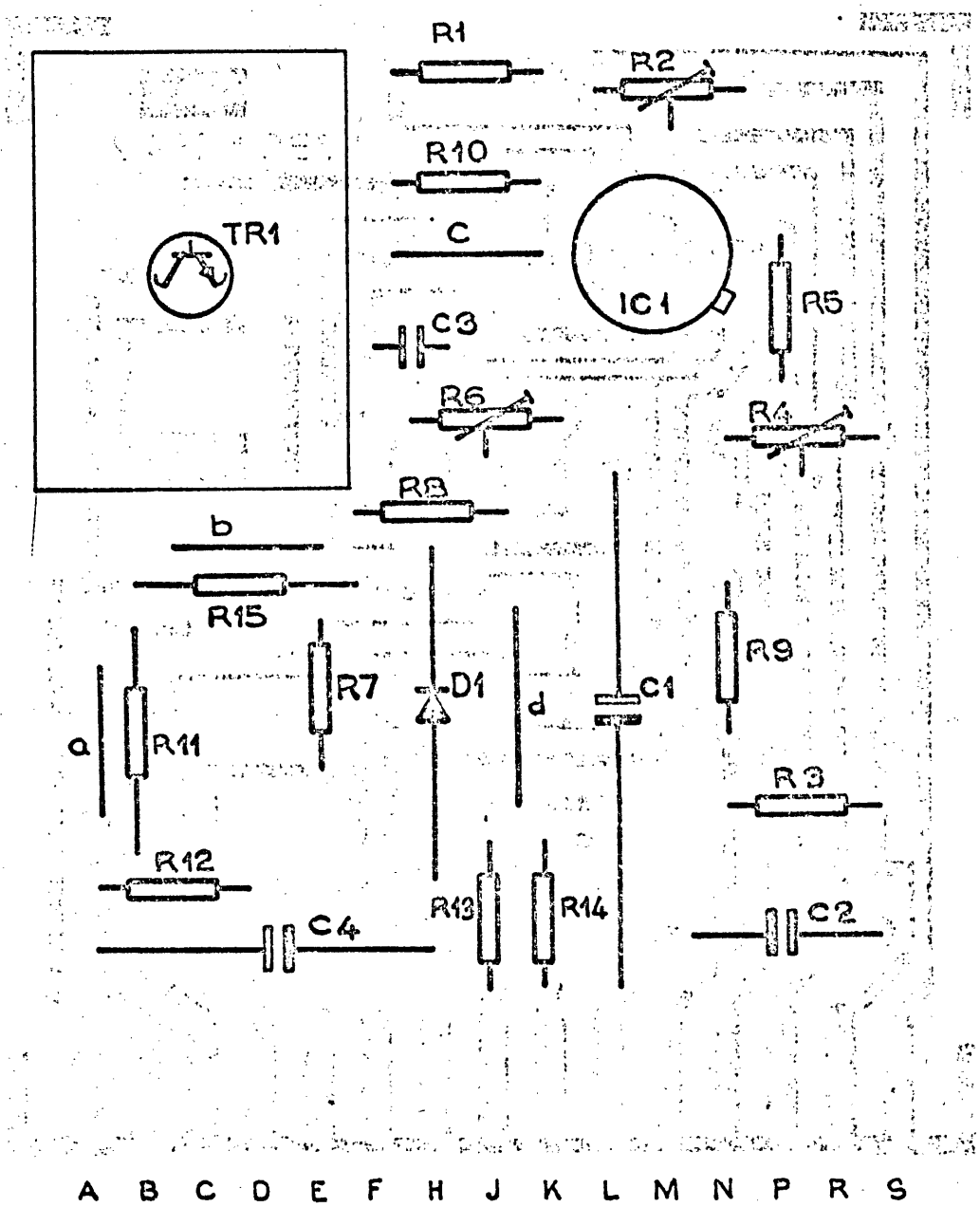
3) A component within the power supply has failed.

If possibilities 1 and 2 have been eliminated there will be two areas in which 3 may have occurred, viz, the power transistors (on the heatsink) and the PC board. If the power transistor is found to be satisfactory then the PC board should be replaced and the power supply installed and re-adjusted as in section 6.

The printed circuit board is known as the Universal Voltage Regulator (NZBC 10,084/2). The layout of components is shown in the attached drawing 10,084/3.

The components used are as follows:-

R 1	0 Ohms	C1	100µF 40 volts
R 2	Open	C2	16µF 10 volts
R 3	0 Ohms	C3	0.0047µF
R 4	Open	C4	16µF 40 volts
R 5	0 Ohms	a	Open
R 6	Open	b	0 Ohms
R 7	Open	c	Open
R 8	Open	d	0 Ohms
R 9	100 Ohms 0.25 watt		
R10	0 Ohms	TR1	RCA 40409
R11	62 Ohms 0.5 watt	D1	Philips BZY95-C39
R12	100 Ohms 0.25 watt	IC1	Fairchild FUA723C
R13	Open		
R14	Open		
R15	270 Ohms 0.5 watt		



TITLE: UNIVERSAL VOLTAGE REGULATOR	ORIGIN J.TULLETT	DATE
	DRAWN A.CRAWFORD	19-11-70
	CHKD J.TULLETT	26-11-70
SUB TITLE: P.C.B. Component Layout	APPD P. Swainstaring	30.11.70
	A4	DRAWING NUMBER 10084/3