Comark®

Service Manual — Section A

Electronic Thermometers (Group 1)

TYPE 1601	NiCr/NiAl Thermocouples
TYPE 1621	Cu/Con Thermocouples
TYPE 1641	Fe/Con Thermocouples

SECTION A of this manual relates to the maintenance of Electronic Thermometers in Group 1, as listed above. It contains specific information only and must be read in conjunction with SECTION D which describes the sub-assemblies common to this and other groups of thermometers.

LIST OF CONTENTS

Contents Cont....

Comark ELECTRONICS LTD.

Brookside Avenue · Rustington · Sussex · England · Tel: Rustington 3147/8

ELECTRONIC THERMOMETERS (GROUP 1)

Types 1601, 1621, 1641

GENERAL DESCRIPTION

The Electronic Thermometers of Group 1 each have four ranges - one for temperatures below zero and three for temperatures above zero. The positive ranges start from zero and are de-sensitised to give increased coverage; the negative range uses a simple backing off circuit.

A number of custom-built instruments are similar to Group 1 thermometers; the differences are listed on a special manual sheet, specific to the instrument type concerned.

Each instrument has three units:

UNIT 1 (Front) — This unit determines the type of instrument. It contains the following sub-assemblies:

D.C. Power Stabiliser	1600/1B
D.C. Amplifier Board	1600/2B
Switch Assembly	
Meter	

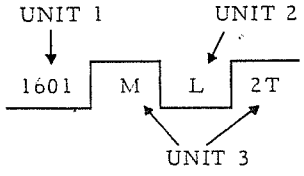
UNIT 2 (Case) — The case and fittings are structural parts and no servicing should be required.

UNIT 3 (Rear) — A number of different rear units are available; the one fitted will depend upon the facilities requested when the instrument was ordered.

This manual describes the recalibration of Unit 1 and servicing of Units 1 and 3. The units fitted are denoted by the type reference. The four figure number refers to Unit 1 and indicates the type of instrument supplied.

The second letter refers to Unit 2 and denotes the case style fitted.

The remainder of the reference refers to Unit 3 and designates the facilities available from the instrument.



NiCr/NiAl thermometer in laboratory case, a.c. powered and fitted with two trips.

Typical Type Number

SPECIFICATIONS

NOTE: Each instrument is fitted with ALL the ranges listed under its type number

Thermocouple Material	Instrument Type	Ranges	Accuracy at 23°C	Cold Junction Deviation with Amb. Temp.	Resolution per Division
NiCr/NiAl to BS 1827	1601	−87°C to +25°C 0 to +100°C 0 to +300°C 0 to +1000°C	±2% FSD	±2°C 0 to +40°C	2°C 1°C 5°C 10°C
Cu/Con to BS 1828	1621	−60°C to +10°C 0 to +60°C 0 to +180°C 0 to +400°C	±2% FSD	±2°C 0 to +40°C	1°C 1°C 2°C 10°C
Fe/Con to BS 1829	1641	−65°C to +20°C 0 to +78°C 0 to +240°C 0 to +730°C	±2% FSD	±2°C 0 to +40°C	2°C 1°C 5°C 10°C

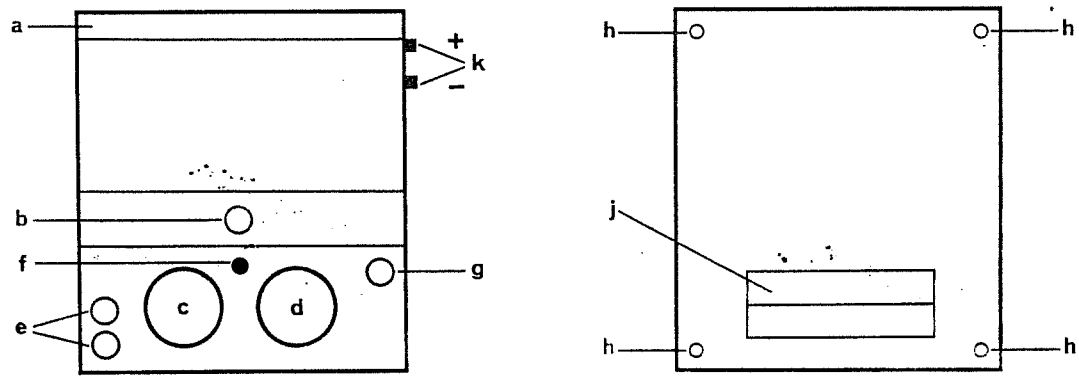
General

4,7" (120mm) scale meters on all instruments.

Input Terminals:	Single Input : 4mm socket; 0,75" (19mm) pitch Selector: Terminal Strip
Lead Resistance:	1000Ω causes 1°C error
DC Output:	+1V for FSD, 2mA maximum current. Output impedance 500Ω
Power Supplies:	Battery: 8 off, SP11 (R14 size C) 600 hours battery life AC Powered: 110V or 240V, 40-60Hz

OPERATING INSTRUCTIONS

1. Connect the thermocouple to input (e). Verify the correct polarity.
2. Switch (d) to 'bat min' and check that the meter pointer is above 'min'. Switch to °C.
3. Switch (c) to positions 'A', 'B', 'C' or 'D', to obtain the largest on-scale pointer deflection. Read temperature on the appropriate meter scale.
4. Output + 1 Volt d.c. at full scale deflection, 2mA maximum from sockets (k). The output must be isolated from the thermocouple. Output resistance 500Ω.



Front View Rear View

Fig. 1. Control Positions

Precautions

1. Use the correct thermocouple type - see (a) on diagram above.
2. Before switching on, check that the meter pointer is at the '0' mark. Adjust (b) if necessary.
3. Do not operate the instrument in a draught.
4. Extend thermocouple leads with compensating leads only.

Note: When out of use for long periods, remove the batteries.

Access

1. Batteries - Remove screws (h) on rear cover. Use leak-proof cells of the correct type only. Verify polarity.
2. AC Powered Models - To change line voltage, remove screws (h) on rear cover. Solder red covered link to pin corresponding to line voltage required (110V/230V) accessible through rectangular cut-out in back panel.

Variants

1. Selector Unit - Connect the inputs to terminal strip (j) on the rear; each channel is fully isolated. Select the required input with switch (d). Input (e) may only be used when there are no thermocouples connected to (j).
2. Temperature Trip - Select the required temperature range with switch (c). Set switch (d) to 'Set Trip' and adjust (f) until the pointer indicates the required trip temperature. The relay contacts are accessible on a terminal strip on the rear of the instrument. 'Hi' contacts close at trip temperature. Contacts fail safe to 'Hi' for power failure or open circuit thermocouple. The trip circuit does not affect the normal operation of the instrument.
3. Dual Temperature Trip - Set the first trip temperature as in (2). Set switch (d) to 'Set Trip B' and adjust (g) until the pointer indicates the required trip temperature.

RECALIBRATION

Group 1 instruments should be recalibrated after repair work has been carried out and it is advisable to check calibration every six months to compensate for aging of components. The procedure given will bring the instrument within specification on all ranges. By modifying the calibration routine it is possible to obtain better accuracy on any one range, but other ranges may then be out of specification.

Equipment Required

Precision d.c. voltage source and potentiometer (to give outputs from 0 to 50mV resolved to 1μV)

Backing-off supply (0-3mV)

Recalibration tables (see Table 1)

Access to Calibration Controls

The calibration controls are mounted behind the front panel and may be reached without removing the case, by the following procedure:

Pull the top edge of the meter forward until the meter mounting panel is clear of the top frame.

Slide the meter and panel towards the top of the instrument to reveal the calibration controls in the gap between the meter panel and the front panel.

To adjust RV4, refer to page 1600-2

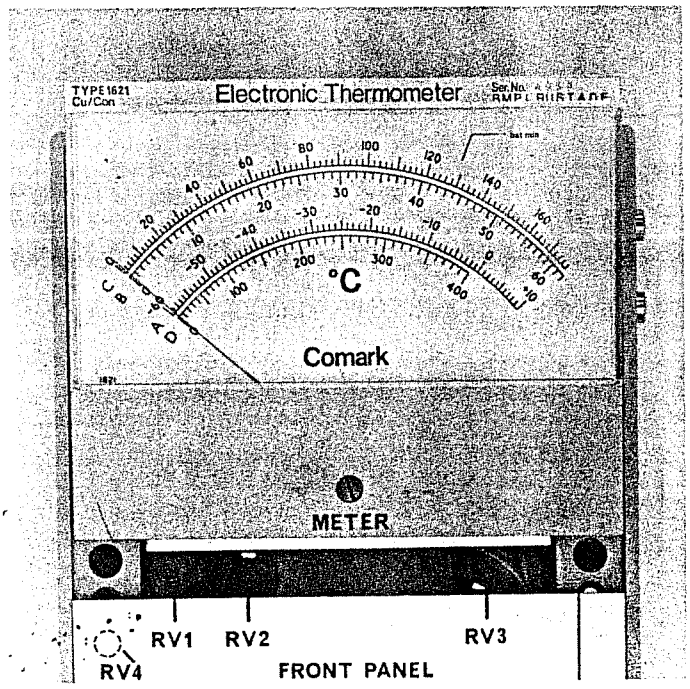


Fig. 2. Location of Calibration Controls

Recalibration Procedure

1. Connect up the equipment as shown in the block diagram.

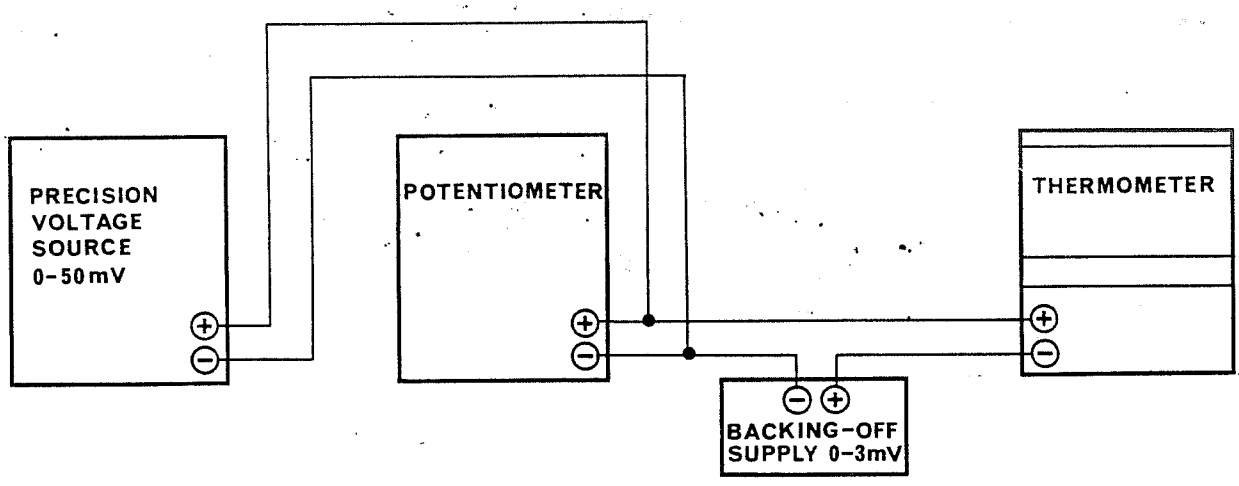


Fig. 3. Block Diagram - Recalibration Equipment

2. Set the precision d.c. voltage source to zero (but not open circuit) and switch the electronic thermometer to temperature range (B). Adjust the backing-off supply until the thermometer reads 0°C. The precision d.c. voltage source now represents a thermocouple with the cold junction reference at 0°C.

3. Set the thermometer to each of the three positive ranges (B, C, D) in turn and set the precision d.c. voltage source to deliver the appropriate output voltage (see Calibration Tables, Table 1, for various thermocouple materials, extracted from British Standards). Adjust RV3 to obtain the optimum overall accuracy, i.e., minimum error on the three ranges.

4. Switch the thermometer to the lowest temperature range (A) and set the precision voltage source to zero. Adjust RV1 until the meter reads 0°C again. Check range (A) at minimum temperature, reversing the polarity of the precision voltage source.

5. Disconnect the test equipment from the thermometer and replace with a thermocouple of the correct material, immersed in melting ice (distilled water ice). Set the thermometer to the lowest temperature range (A) and adjust RV2 until the meter reading is 0°C.

6. This completes the recalibration procedure. Replace the meter.

TABLE 1

Extract from British Standard Specifications

	BS 1827:1952		BS 1828:1961		BS 1829:1962	
RANGE	1601 (NiCr/NiAl)		1621 (Cu/Con)		1641 (Fe/Con)	
	Temp.	mV	Temp.	mV	Temp.	mV
A	−87°C	−3,09	−60°C	−2,13	−65°C	−3,12
A	+25°C	+1,00	+10°C	+0,39	+20°C	+1,02
B	+100°C	+4,10	+60°C	+2,45	+78°C	+4,08
C	+300°C	+12,21	+180°C	+8,14	+240°C	+13,01
D	+1000°C	+41,31	+400°C	+20,59	+730°C	+41,05

CIRCUIT DESCRIPTION

General

The Group 1 Electronic Thermometers employ a chopper amplifier as a high input resistance millivoltmeter. The values of the feedback components R3 and R4 are selected to give direct readings in °C when measuring the output from a thermocouple of the correct materials. The thermocouple e.m.f. is fed to the inverting input of the amplifier and the gain is set to obtain an output of 1V at FSD. A temperature sensitive voltage is connected to the non-inverting input of the amplifier by Th, R1 and R2 and its magnitude is set to compensate for changes in thermocouple e.m.f. as the ambient (cold junction) temperature varies.

A d.c. power stabiliser which operates from batteries or a.c. supply establishes a reference potential for the cold junction correction supply. It also provides a set zero voltage through R5 for the negative temperature range.

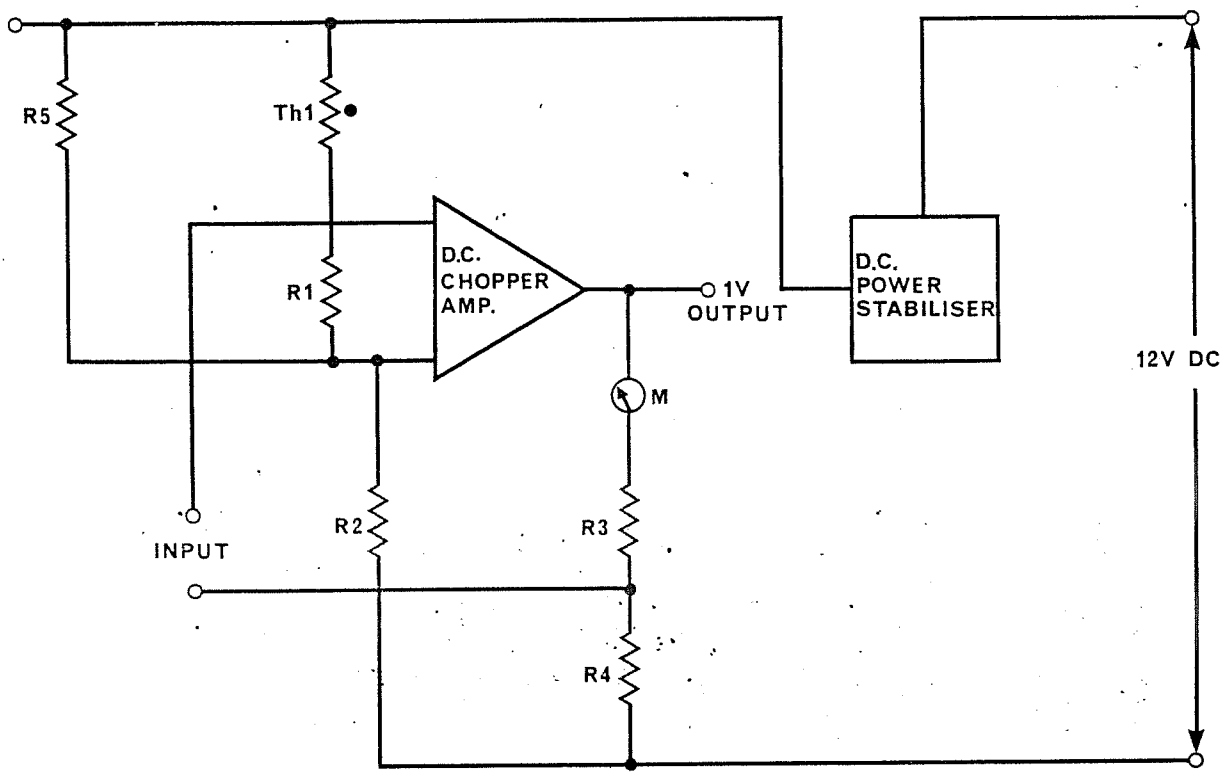


Fig. 4. Schematic Diagram - Group 1 Electronic Thermometers

a) Switch Sub-Assembly
(Circuit part of Fig. 10)

The switch sub-assembly consists of a plate on which the range switch is mounted. The resistors which control feedback and backing-off are wired to this assembly, together with P.C.B. 1600/5B which provides terminations for the cableform and the variable resistors.

The meter is scaled to suit the type of instrument in use; the correct scale is defined by the part number.

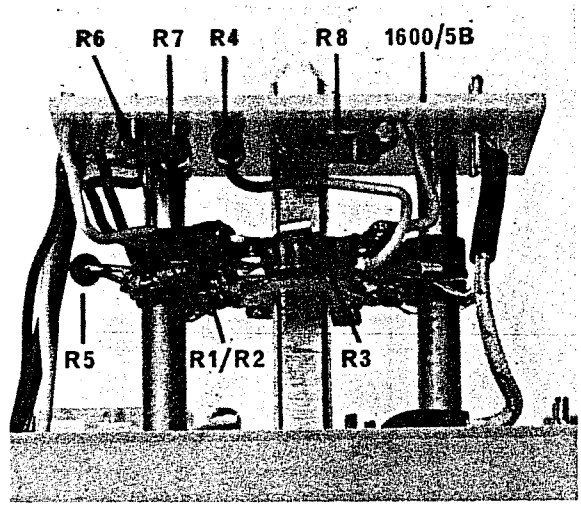
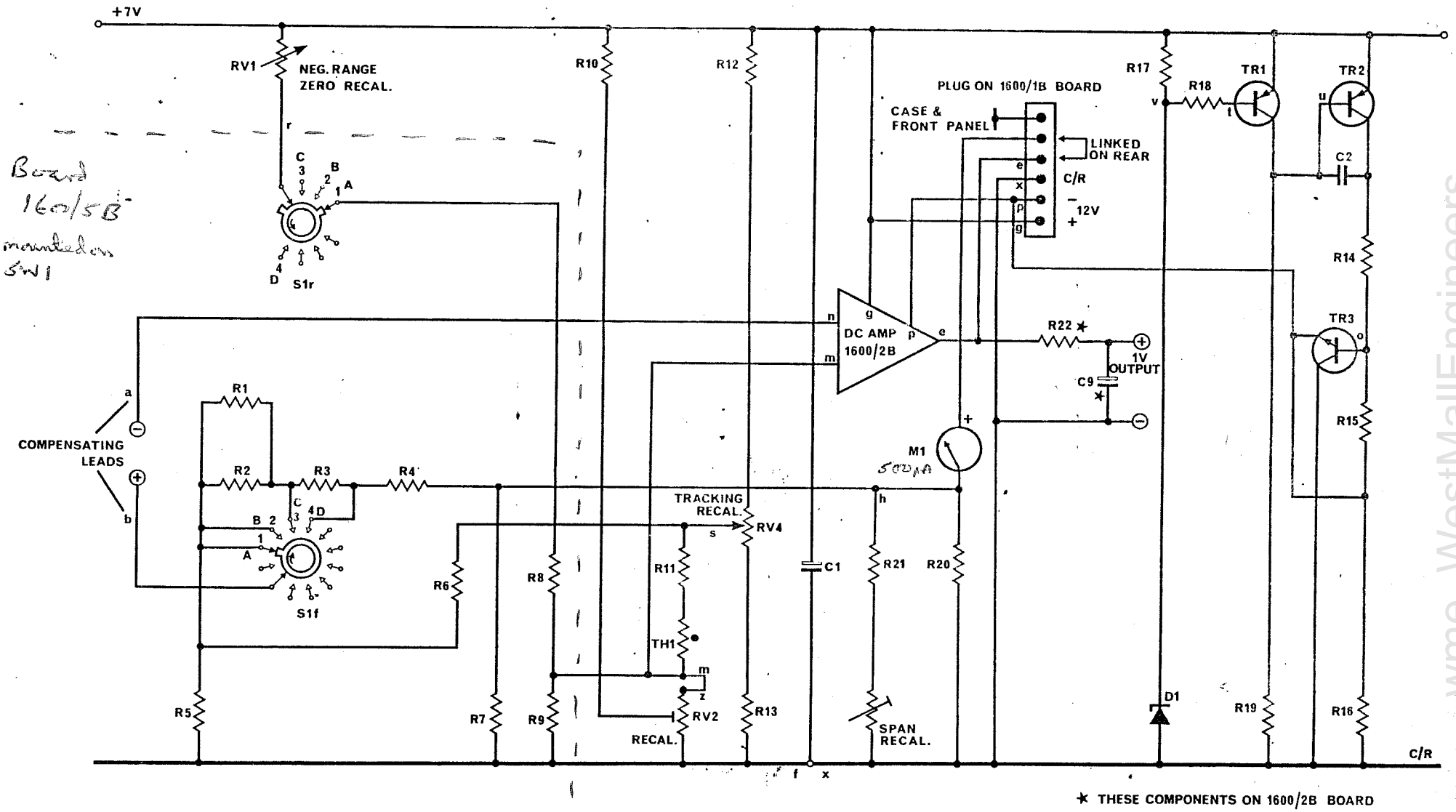


Fig. 5. Component Location -Range Switch & 1600/5B



Board 1601/5B mounted on SW1

Fig. 6. Circuit Diagram - Front Unit 1601

PARTS LIST Main Circuit

Circuit Ref.	Description	Value	Rating	Tol.	Type No.
Resistors (Ohms)					
R1	Metal oxide	220	1/8W	1%	C5
R2 (1601)	Carbon	24k	1/8W	5%	CR25
R2 (1621/1641)	Not Fitted				
R3	Metal oxide	680	1/8W	1%	C5
R4 (1601/1641)	Metal oxide	24k	1/8W	2%	TR5
R4 (1621)	Metal oxide	39k	1/8W	2%	TR5
R5	Metal oxide	100	1/8W	1%	C5
R6	Metal oxide	82k	1/8W	2%	TR5
R7 (1601/1641)	Metal oxide	18k	1/8W	2%	TR5
R7 (1621)	Metal oxide	15k	1/8W	2%	TR5
R8 (1601)	Metal oxide	24k	1/8W	2%	TR5
R8 (1621)	Metal oxide	39k	1/8W	2%	TR5
R8 (1641)	Metal oxide	30k	1/8W	2%	TR5
R9 (1601/1621)	Metal oxide	15	1/8W	2%	TR5
R9 (1641)	Metal oxide	18	1/8W	2%	TR5
R10	Metal oxide	68k	1/8W	2%	TR5
R11	Metal oxide	9,1k	1/8W	1%	C5
R12	Metal oxide	3,3k	1/8W	2%	TR5
R13	Metal oxide	2k	1/8W	2%	TR5
R14	Carbon	1k	1/8W	5%	CR25
R15	Carbon	6,8k	1/8W	5%	CR25
R16	Carbon	22k	1/8W	5%	CR25
R17	Metal oxide	330	1/8W	2%	TR5
R18	Carbon	470	1/8W	5%	CR25
R19	Metal oxide	39k	1/8W	2%	TR5
R20	Metal oxide	4,7k	1/8W	2%	TR5
R21	Metal oxide	4,7k	1/8W	2%	TR5
R22	Carbon	470	1/8W	5%	CR25
RV1	Wire wound	5k			PCM2
RV2	Carbon	1k			MPD
RV3	Carbon	1k			MPD
RV4	Carbon	1k			MPD
Capacitors					
C1	Electrolytic	64µF	10V		
C2	Polyester	0,01µF	250V		
C9	Electrolytic	10µF	2,5V		
Transistors					
TR1					2N4058
TR2					2N4058
TR3					BC108 or BC183L
Diodes					
D1	Zener				2N2062A
Thermistor	glass bead.				
TH1	10,000Ω at 20°C, 150Ω at 175°C 2mW/°C				41TF1 (Gulton Ind.) G14 (STC)
Meter					
M1	Meter	500µA			(1601 Scale 1601) (1621 Scale 1621) (1641 Scale 1641)

FAULT FINDING

Access

The case is retained by a screw clamp between the front and rear units; it may be removed as follows:

1. Remove the large knob on the right of the front panel by loosening the grub screw and pulling off the knob.
2. Remove the back cover which is held in place by four screws.
3. Unscrew the four larger screws in the rear moulded frame by about 0,25" (6mm).
4. Carefully ease the front and rear units apart until the plastic mouldings are clear of the central case section.
5. The wrap-around case may then be carefully sprung open from the bottom and lifted off over the spacers.
6. Remove the earth connection to the case.

With the case removed, circuits are available and tests can be made as given in the descriptions of the appropriate instrument types. To separate the front and rear units for replacement or better access:

7. Disconnect the plug and socket which connect front and rear units.
8. On instruments fitted with trip or selector units, disconnect the thermocouple compensating wires.
9. Completely remove the four large screws loosened at stage 3.
10. Separate the front and rear units.
11. To remove a printed circuit sub-assembly, undo the fixing nuts (see Figs 5 & 11). Lift off the printed circuit board and carefully unsolder leads as necessary.
12. To remove the meter, ease the spring clips off the plastic moulding; the meter and escutcheon may be withdrawn from the front of the instrument.

Component Replacement

The majority of the components used in Comark instruments have equivalents or are readily available from international sources. The main exceptions are:

1. Meters - There are Sangamo Weston agents in most countries who should be able to assist with repairs.
2. Wafer Switches - The mechanism should not give trouble and only two types of wafer are used in these instruments.

If faults on printed circuits cannot be readily located, complete replacement boards may be fitted. Overseas agents usually have serviceable replacement boards in stock to prevent delay in repair while a new board is ordered and supplied.

Spares Ordering

When ordering spares, always quote the instrument type number, serial number and circuit or assembly reference.

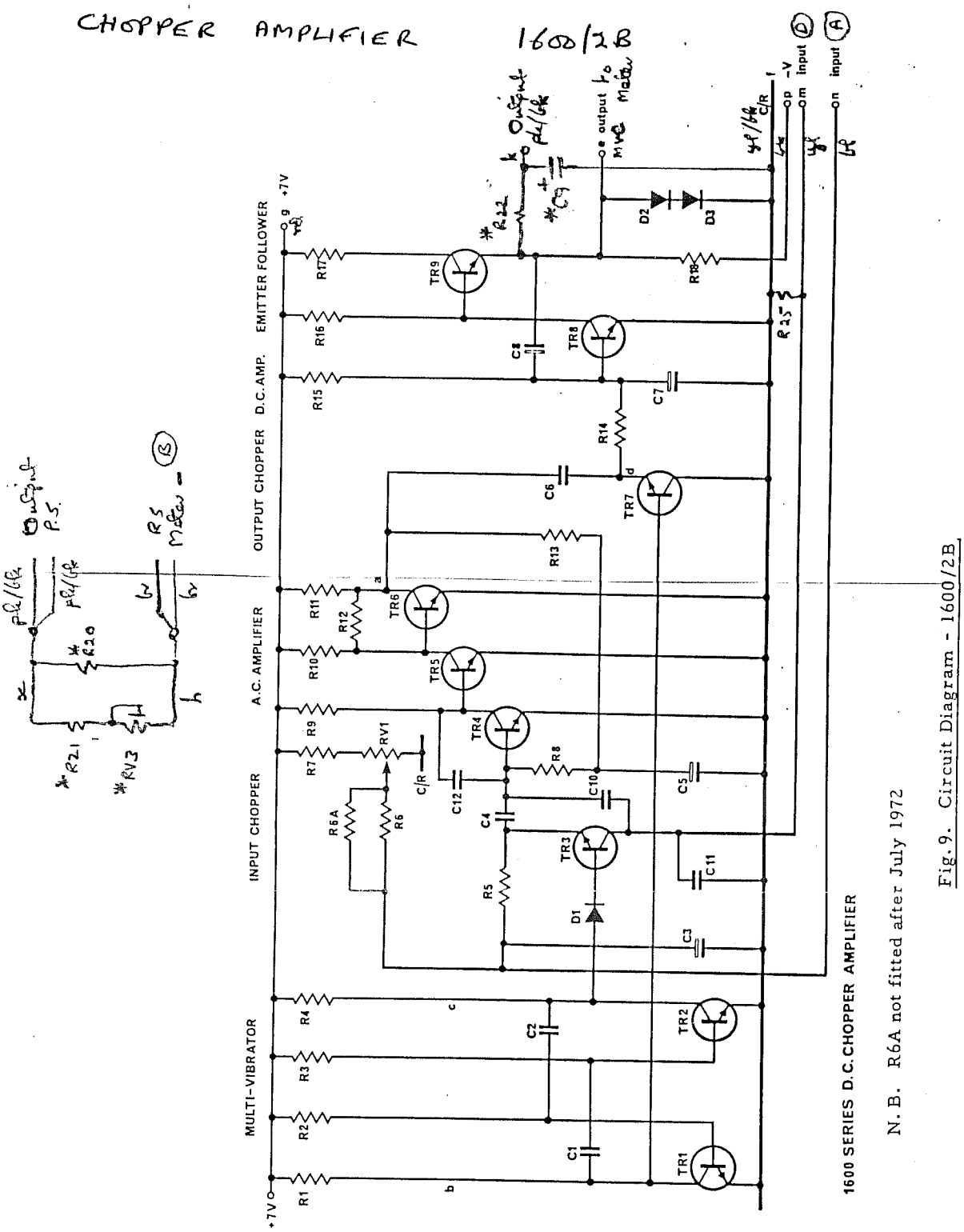


Fig. 9. Circuit Diagram - 1600/2B

N.B. R6A not fitted after July 1972

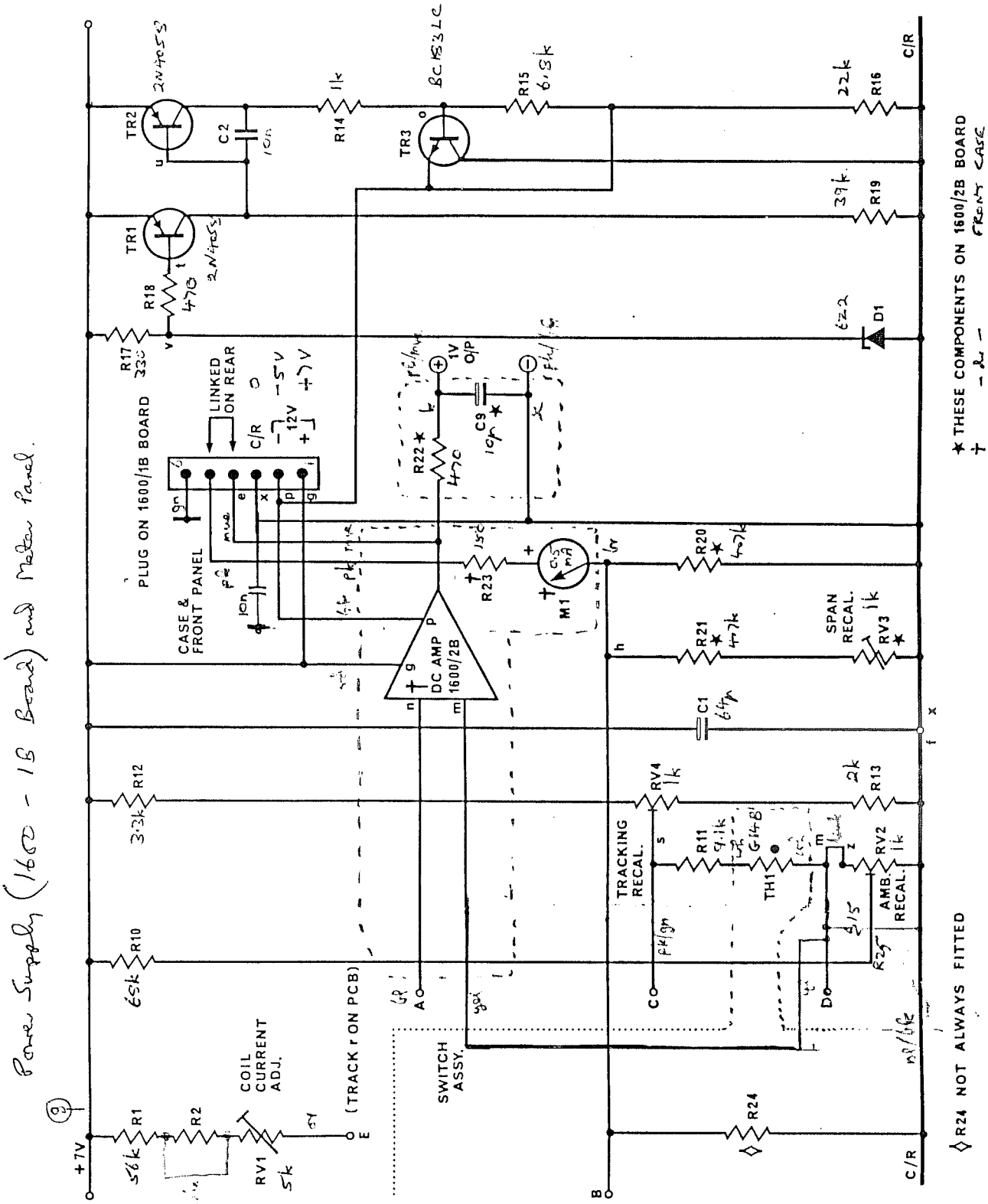
* These components are shown on Fig. 6 in the relevant instrument section.

Fig. 10. Component Location - 1600/2B

PARTS LIST Chopper Amplifier 1600/2B

Circuit Ref.	Description	Value	Rating	Tol.	Type No.
Resistors (Ohms)					
R1	Carbon	68k	1/8W	5%	CR25
R2	Carbon	1M	1/8W	5%	CR25
R3	Carbon	2M2	1/8W	5%	CR25
R4	Metal oxide	68k	1/8W	1%	C5
R5	Carbon	680	1/8W	5%	CR25
R6 *	Carbon	180k	1/8W	5%	CR25
R7	Carbon	680k	1/8W	5%	CR25
R8	Carbon	100k	1/8W	5%	CR25
R9	Carbon	100k	1/8W	5%	CR25
R10	Carbon	100k	1/8W	5%	CR25
R11	Carbon	33k	1/8W	5%	CR25
R12	Carbon	100k	1/8W	5%	CR25
R13	Carbon	100k	1/8W	5%	CR25
R14	Carbon	4k7	1/8W	5%	CR25
R15	Carbon	82k	1/8W	5%	CR25
R16	Carbon	56k	1/8W	5%	CR25
R17	Carbon	1k5	1/8W	5%	CR25
R18	Carbon	56k	1/8W	5%	CR25
RV1	Carbon	10k			PN11B
Capacitors					
C1	Polystyrene	1000pF	20V		
C2	Polystyrene	1000pF	20V		
C3	Electrolytic	500µF	2·5V		
C4	Polyester	0·1µF	250V		
C5	Electrolytic	10µF	6·4V		
C6	Polyester	0·1µF	250V		
C7	Electrolytic	10µF	6·4V		
C8	Electrolytic	10µF	16V		
C10	Ceramic	4700pF	30V		
C11	Ceramic	4700pF	30V		
C12	Polystyrene	10,000pF	20V		
Transistors					
TR1					BC183
TR2					BC183
TR3					BC183L
TR4					BC183
TR5					BC183
TR6					BC183
TR7					BC183L
TR8					BC183
TR9					BC183
Diodes					
D1					1S920
D2					1S920
D3					1S920

* Note: Prior to July 1972, R6 was 1MΩ and had R6A (220kΩ) in parallel.



Refer to Figs. 6A to 6E (according to type of instrument)

Fig. 6. Circuit Diagram - Front Unit

a) D.C. Power Stabilising Sub-Assembly 1600/1B (see Fig. 6 in relevant instrument section)

This sub-assembly (see Fig. 8) is used in all Comark electronic thermometers to stabilise the d.c. power from battery or a.c./d.c. power sources. It consists of a stabilising circuit, together with special networks which provide cold junction correction, recalibration and offset voltages. The letters indicating test points in Table 2 correspond with the letters on the circuit diagram. All voltages were measured with respect to common rail using a Comark Electronic Multimeter Type 1231.

NOTE: After replacing 1600/1B or zener diode D1, RV4 should be adjusted until the slider (s) is at +2,54V with respect to common rail. Front plate will have to be removed.

TABLE 2

Test Voltages - 1600/1B

Test Point	Voltage
f	C/R
g	+6V to +7V
m	2mV
o	−0,6V less than p
p	−2V to −5V (dependent on battery condition)
s	+2,54V nominal
t	+5,4V to +6,4V
u.	+5,4V to +6,4V
v	+5,4V to +6,4V
x	C/R

Power Unit location of adjustments

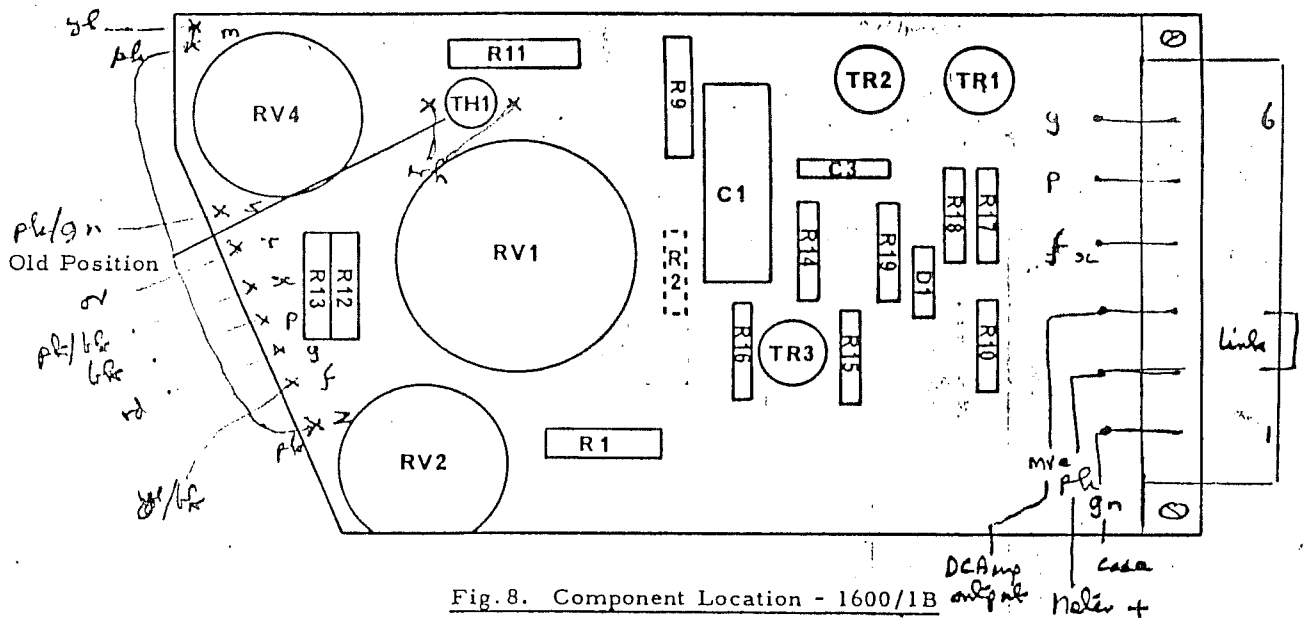
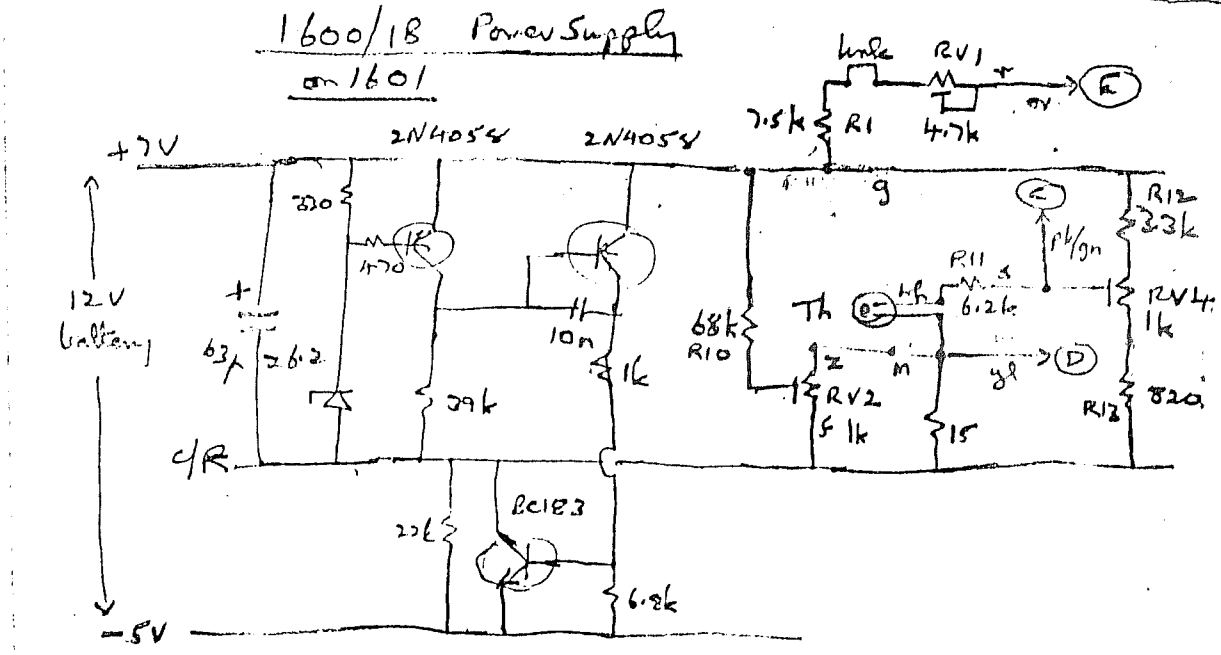
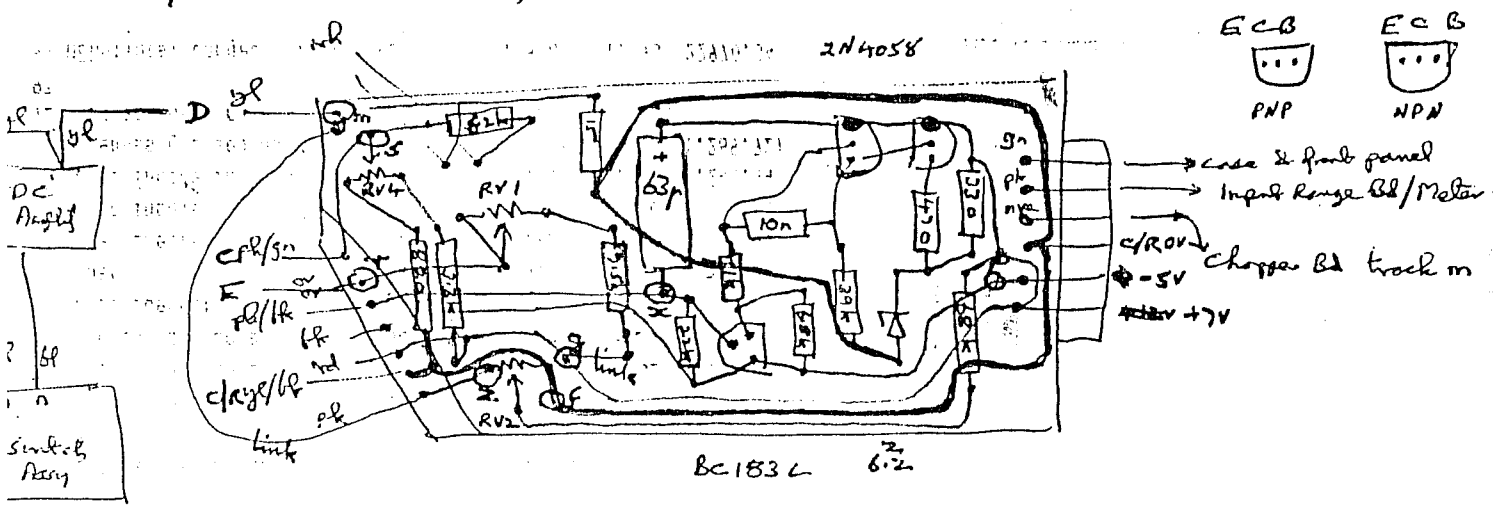


Fig. 8. Component Location - 1600/1B

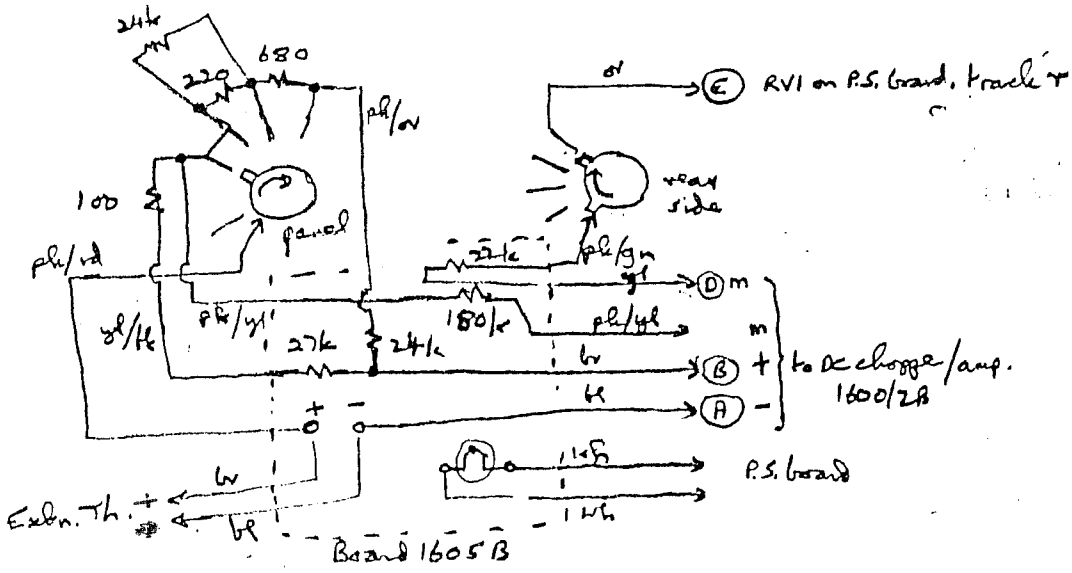
1600/1B Power Supply on 1601

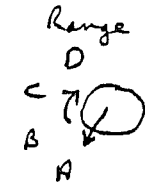


1600/1B Power Supply.



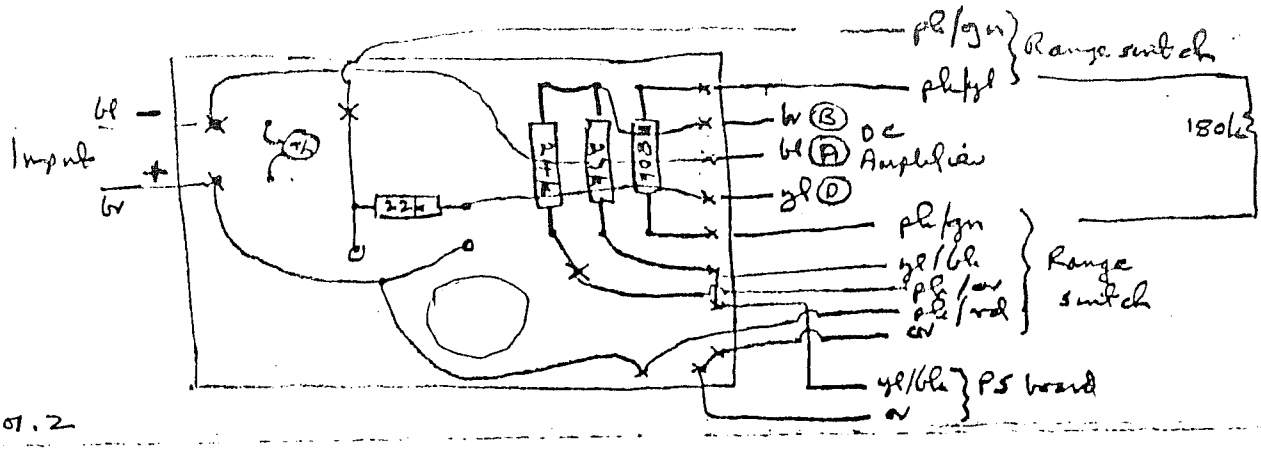
RANGE SWITCH 1601 Board 1605B.





K type thermocouple

A	−86 to +24°C
B	0 to 100
C	0 to 320
D	0 to 1000



1601.2