DEPARTMENT OF
MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

1975/141

MODIFICATION OF THE PRESS-EWING LONG-PERIOD SEISMOMETER TO COMPENSATE FOR THE EFFECTS OF TEMPERATURE CHANGES

by

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SUMMARY

A system has been designed for use with a Press-Ewing vertical long-period seismometer, which will compensate for the mechanical drift of the boom due to temperature changes of a few degrees Celsius. This record describes the mechanical modifications made to the seismometer and gives design details of the controlling servo-amplifier.

With this system the seismometer can be used, unattended, in most field conditions in Australia and PNG; without the system, use is limited to an observatory vault or similar environment.

The record gives instructions for the assembly, adjustment, and testing of the system.

1. INTRODUCTION

The Press-Ewing seismometer boom moves upward into the top mechanical stop when the temperature rises a few degrees Celsius and down into the bottom stop during a similar fall in temperature. When the boom is on or near a stop either the seismometer becomes completely inoperative or the records obtained are distorted because the boom bounces on the stop instead of oscillating freely.

These seismometers have been employed at unmanned remote sites where the diurnal temperature change is several degrees Celsius and consequently useful records were obtainable only during a small portion of each day. To extend this time to the whole day a servo-system has been developed which does not alter the seismometer response to oscillations with periods of less than 1000 seconds. The system keeps the boom close to its central position throughout temperature changes of $\pm$ 11°C, provided the rate of change of temperature is less than 1°C per hour, a requirement achieved by surrounding the seismometer with a styrene foam cover 10 cm thick.

Field use of the modified seismometer

Three seismometers have been modified and three compensator modules plus a spare set of circuit cards have been built. At time of writing, one seismometer is in use in the field at the Cooney observatory tunnel near Armidale, N.S.W. and is operating satisfactorily.

2. OUTLINE OF OVERALL SERVO-SYSTEM

Figure 1 is a block diagram of the system. A focused light beam is reflected from a small mirror, mounted on the end of the seismometer boom, onto a horizontally split photocell. The output of the photocell depends on the boom's position and varies between plus 25 milliamps and minus 25 milliamps. This current determines the input to an integrating operational amplifier which has the seismometer calibration coil as its output load. The calibration coil is located in the annular radial magnetic field between the poles of a permanent magnet and is mechanically attached to the seismometer boom.

When the boom moves from the central position the output current from the servo-amplifier slowly increases until the force between the calibration coil and the magnet is sufficient to recentralize the boom. The boom will then remain centred until the rate of change of temperature exceeds 1°C per hour when the deflection will still be small or until the amplifier reaches its maximum output voltage of $\pm$ 12 V. In the second case the amplifier must be switched off for a few minutes to allow the feedback capacitors to discharge; the boom is then recentred mechanically, and the amplifier switched on again.

3. DETAILED DESCRIPTION OF SYSTEM

The perspex window on the end of the seismometer pressure case was removed and replaced by the light-source/photocell assembly, a commercial item purchased from Askania, Germany.

A hole was cut in the top of the seismometer pressure case, above the end of the boom, and the perspex window was fitted over it. This allows visual observation of the boom position with the case fitted.

Two small dowels were fitted into the base plate at diagonally opposite corners and corresponding holes drilled in the pressure case. This ensures that the alignment of the light-source/photocell assembly is maintained when the case is removed and replaced. (Plate 1)

A small front-silvered mirror was cemented with Araldite to the front surface of the limit stop screw to reflect the light beam back onto the photocell. A second mirror was mounted on the inside surface of the front of the pressure case and angled so that a reflection of the limit stop screw, the zero pointer, and the scale on the limit stop plate was visible through the top window (Plate 2).

Seismometer drift compensator (Plate 3)

The seismometer drift compensator unit is designed to fit into the seismic recording system chassis (Drawing No SRD 1) and will normally be used in this chassis. It can be used separately, but no outside cover is available and the components are exposed and unprotected.

The compensator unit chassis (Dwg No ZSA 5, Fig. 6) contains six plug-in cards:

Servo-Amplifier (2 cards) Dwg No ZSA 1 - Figure 2
Current Regulator (1 card) Dwg No ZSA 2 - Figure 3
D.C. Convertor (1 card) Dwg No ZSA 3 - Figure 4
Regulator Board (2 cards) Dwg No ZSA 4 - Figure 5

The D.C. Convertor card operates from a +12 volt D.C. input on pins 1 and 18 and provides two D.C. outputs: +20 V between pins 26 and 29 and -20 V between pins 28 and 27. These two voltages are the inputs to the first regulator card, which contains all the regulator circuits with the exception of the two output transistors Q1 and Q4. The output transistors (BDY60s) are mounted on an aluminium heatsink which also has a third BDY60, a zener diode 1ZC1275, and a 4.7K resistor mounted on it. These three components are in circuit if the compensator is operated from 24 volts D.C. to reduce the supply to 12 volts and provide some stabilization. The outputs from the regulator cards are +15 V D.C. and -15 V D.C. which are connected to the Servo-Amplifier card on pins 14 and 15 respectively.

The servo-amplifier (Figure 2) consists of an Analog Devices low-drift operational amplifier P501A which feeds the connected bases of a BFY50 transistor and an AY6102 transistor. These transistors are emitter-coupled, and the two feedback polystyrene capacitors are connected to this commoned output so that the total amplifier drift is minimized. These commoned emitters supply the control current to the seismometer calibration coil via a 68-ohm current-limiting resistor (The voltage between this point and ground is displayed on a 15-0-15 volt meter mounted on the chassis front panel). There is a second output to the calibration coil from the collector of a second BFY50. This provides a step function, for calibration of the seismometer, when the "CALIBRATE" switch on the chassis front panel is operated.

The current regulator card operates from 12 volts D.C. and supplies a constant current to the 6-volt lamp in the light-source/photocell assembly. The current can be varied by a 1K Trimpot, and its value is shown on a 0-500 milliammeter. Both are mounted on the chassis front panel. The value of this current determines the gain of the servo-system.

Assembly

After the seismometer has been assembled in the usual manner, the boom centred, and the cover clamped, connect the multi-core cable supplied between the seismometer and the seismic recording chassis. The connexions to the seismometer are shown in Drawing No SRD-1 Sht1a (Fig. 7) and must be followed exactly. However, the connexions to seismometer output coil may be reversed if necessary to obtain the correct polarity to the TAM5 seismometer amplifier. Connect seismic recording chassis to a 12 volt D.C. supply.

Initial adjustments and tests

1. After switching power on, adjust lamp current to 270 milliamps with the 1K Trimpot.
2. Disconnect lead from Terminal 1 at rear of seismometer.
3. Disconnect light green lead from +ve terminal on photocell and connect Avo meter, or similar meter, on 50 microamp range between lead and terminal.
4. Check that boom is central and adjust if necessary.
5. Adjust light-source/photocell assembly to obtain zero current on the Avometer using the four adjusting Allen screws in the mounting. The six mounting screws will have to be slackened slightly during this adjustment.
6. Check that boom is still central. If not, repeat 4 and 5.
7. Reconnect lead to Terminal 1 and displace boom upward between one and two scale divisions using the vernier adjustment. Note the reading on the Avometer and also the ambient temperature. Wait between five and ten minutes and then check that the Avometer reading is smaller, that the 15-0-15 voltmeter reads between zero and one volt, and that the ambient temperature is unchanged.
8. Switch amplifier off for a few minutes to discharge capacitors. Displace boom downward between one and two divisions. Switch amplifier on, and note the reading on the Avometer (reverse of reading in 7) and the ambient temperature. After five to ten minutes check that Avometer reading is smaller, that the 15-0-15 voltmeter reads between zero and minus one volt, and that the ambient temperature is constant.
9. If both these tests give correct results the system is serviceable. If either 7 or 8 is incorrect, the servo-system is faulty and must be repaired.

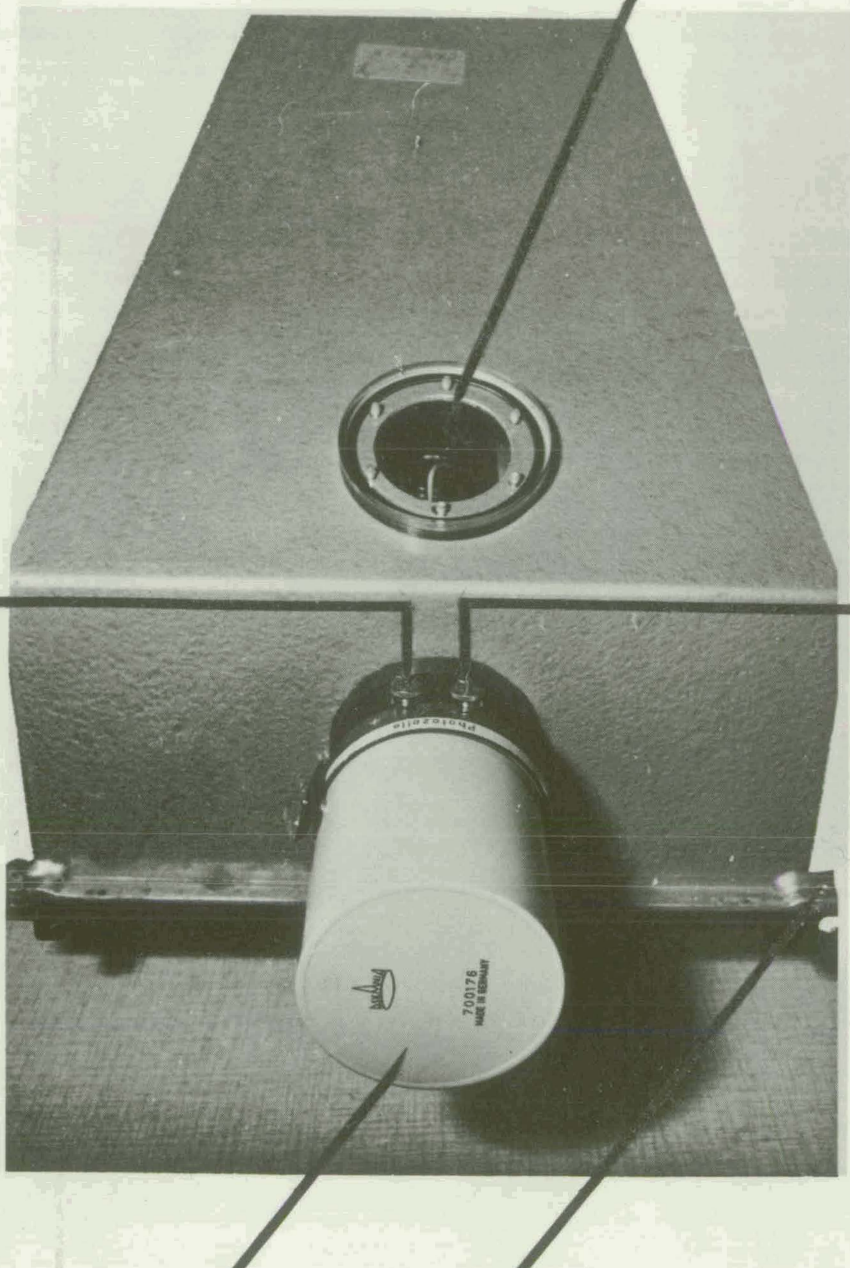
Adjustment in use

The only adjustment needed is mechanical recentring of the boom when the reading on the 15-0-15 voltmeter reaches either +11 volts or -11 volts. The amplifier must be switched off and time allowed for the voltage to return to zero before the boom is recentred.

RELOCATED PERSPEX WINDOW

PHOTOCELL OUTPUT TERMINAL +VE

PHOTOCELL OUTPUT TERMINAL −VE



LOCATING DOWEL

PHOTOCELL/LIGHT ASSEMBLY

PLATE 1

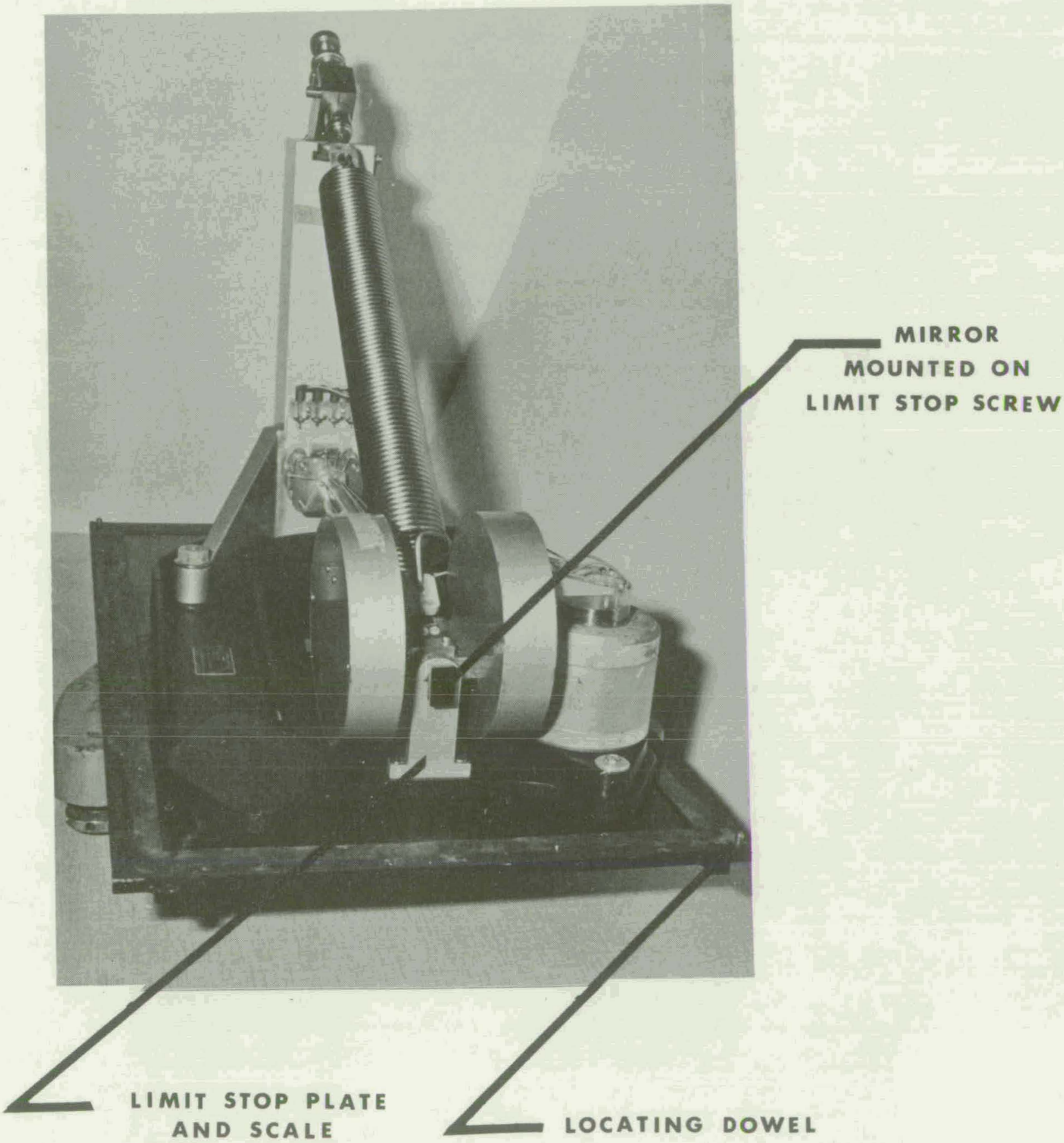

MIRROR
MOUNTED ON
LIMIT STOP SCREW
LIMIT STOP PLATE
AND SCALE
LOCATING DOWEL

PLATE 2

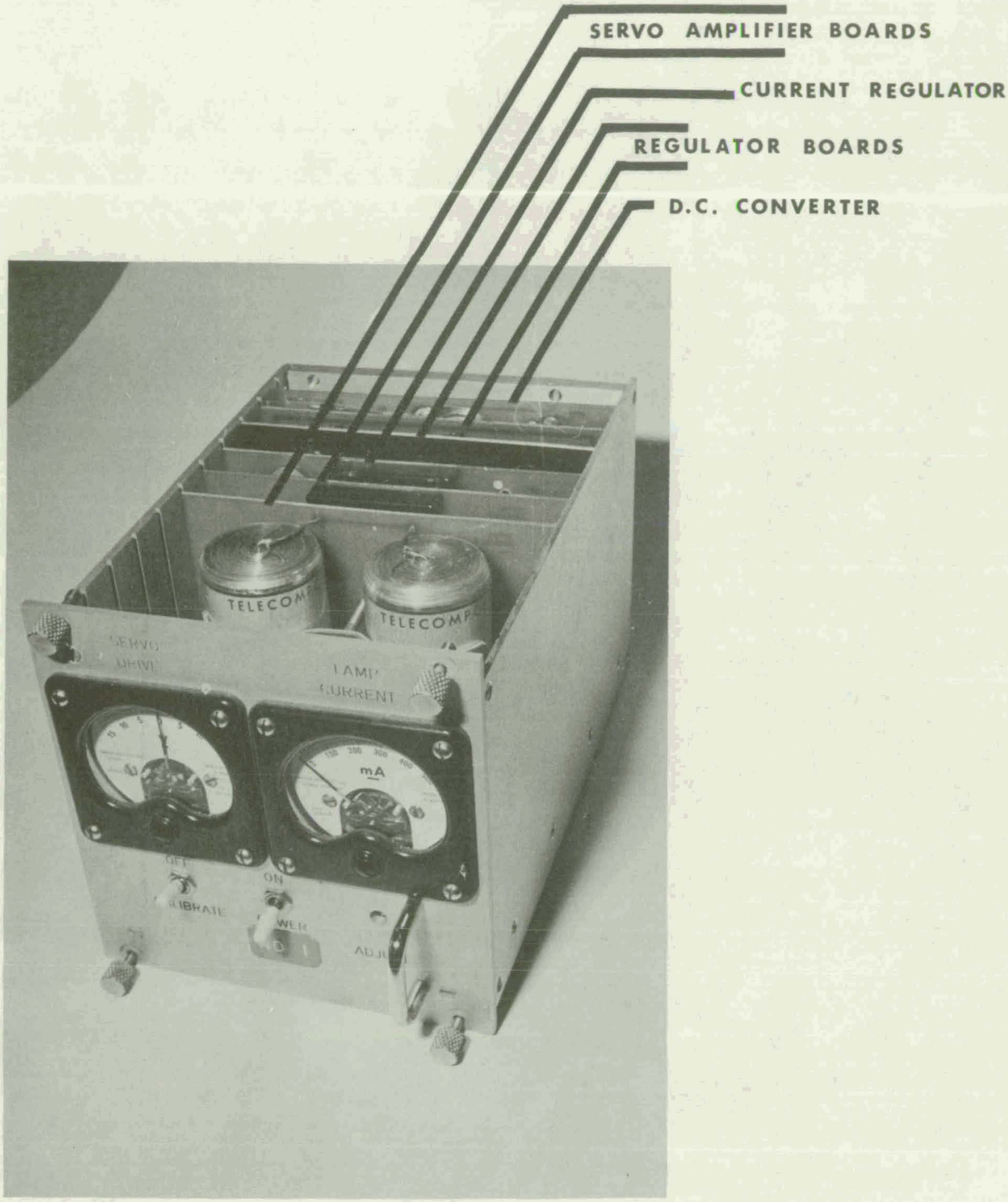

SERVO AMPLIFIER BOARDS
CURRENT REGULATOR
REGULATOR BOARDS
D.C. CONVERTER
SERVO DRIVE
LAMP CURRENT
mA
OFF
ON

PLATE 3

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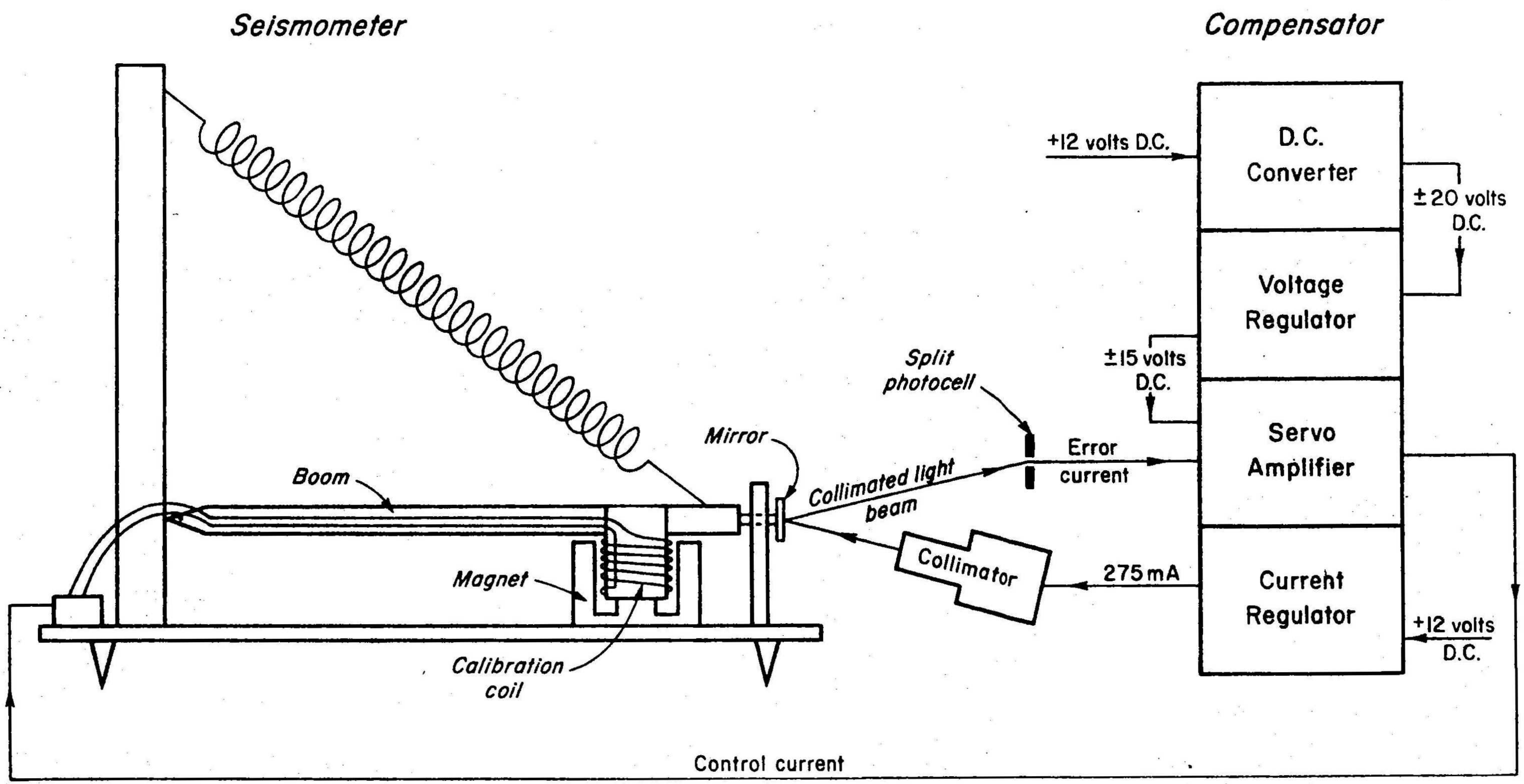
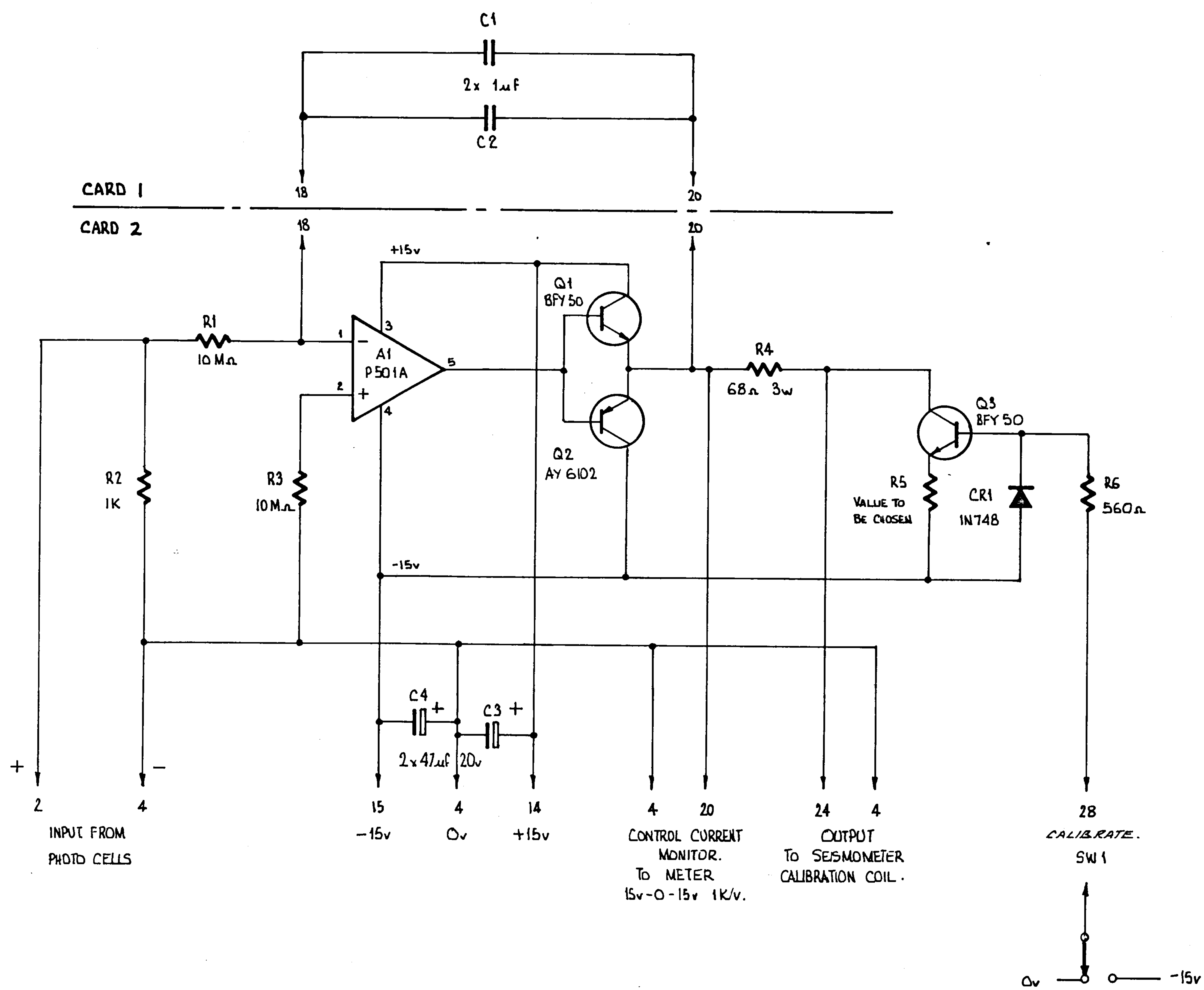


SEISMOMETER DRIFT COMPENSATOR
BLOCK DIAGRAM

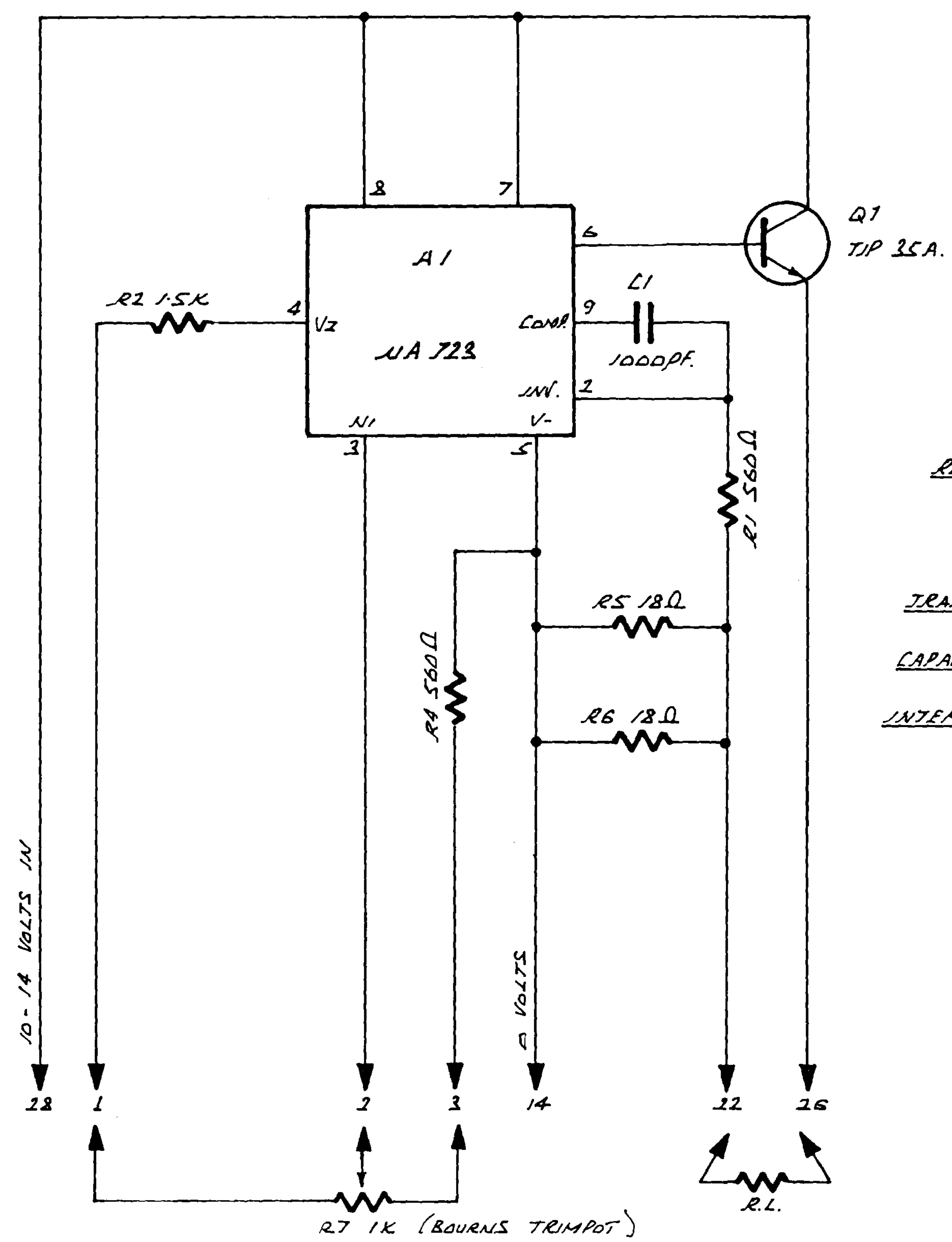
Fig. 1

ZSA sheet 6



Record No. 1975/141

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS CNR. CONSTITUTION AVENUE & ANZAC PARADE CANBERRA, A.C.T.	DRAWING No. ZSA	SHEET 1	INSTRUMENT SEISMOMETER DRIFT COMPENSATOR SERVO AMPLIFIER. SCHEMATIC. CARDS 1 & 2.



COMPONENT LIST.

RESISTORS	R1 R4	560Ω	WELWYN	TYPE W21	2·5W.
	R2	1·5K	|	|	|
	R5 R6	18Ω	|	|	|
TRANSISTOR	Q1	TIP 35A.	SILICON.	N.P.N.	
CAPACITOR	C1	1000pf.	'VITRAMON'	TYPE VK.	
INTER - CCTS	A1	μA 723	'FAIRCHILD'	VOLT REGULATOR.	

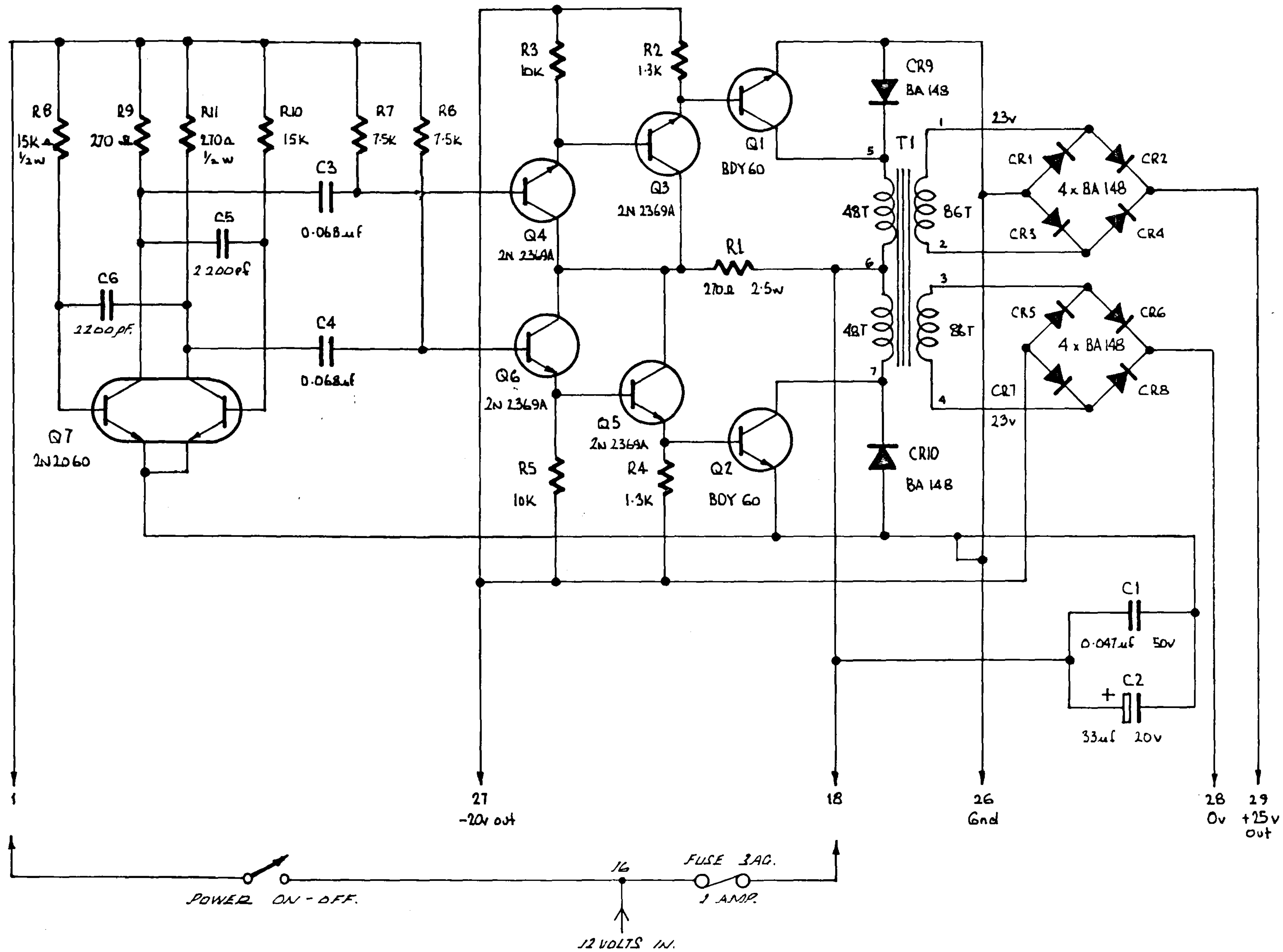
QUANTITY REQUIRED ——— 2 OFF.

FOR PRINTED CIRCUIT DETAILS
SEE 2SA - 2A.

CARD 3

Record No. 1975/141

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS CNR. CONSTITUTION AVENUE & ANZAC PARADE CANBERRA, A.C.T.	DRAWING No. 2SA	SHEET 2	INSTRUMENT SEISMOMETER DRIFT COMPENSATOR CURRENT REGULATOR

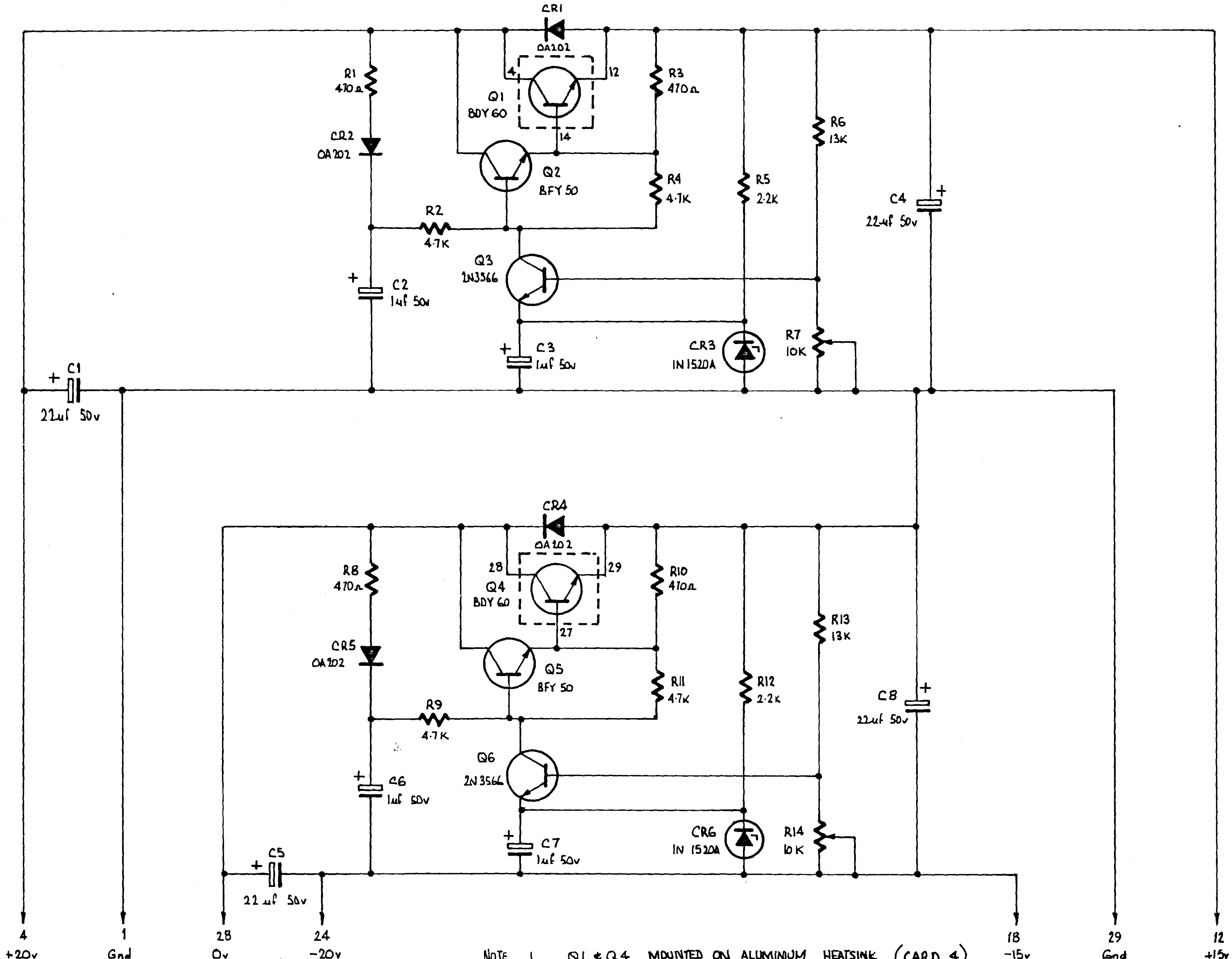


1. ALL CAPACITORS ARE CERAMIC WITH EXCEPTION OF C2.
2. ALL RESISTOR ARE ¼ W UNLESS OTHERWISE STATED.
3. T1 IS WOUND ON A TOROID BTX 2/43, 25.4mm, TYPE FX3017.
4. PRIMARY TURNS — 21B&S
   SECONDARY — 24 B&S

Record No. 1975/141

CARD 6

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS CNR. CONSTITUTION AVENUE & ANZAC PARADE CANBERRA, A.C.T.	DRAWING No. ZSA	SHEET 3	INSTRUMENT SEISMOMETER DRIFT COMPENSATOR PP2 D.C. CONVERTER.



NOTE 1. Q1 & Q4 MOUNTED ON ALUMINIUM HEATSINK (CARD 4)
2. ALL RESISTORS ARE ¼ W.

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CARD 5

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS CNR. CONSTITUTION AVENUE & ANZAC PARADE CANBERRA, A.C.T.	DRAWING No. ZSA	SHEET 4	INSTRUMENT SEISMOMETER DRIFT COMPENSATOR. PP3 REGULATOR BOARD.

FIGURE 6

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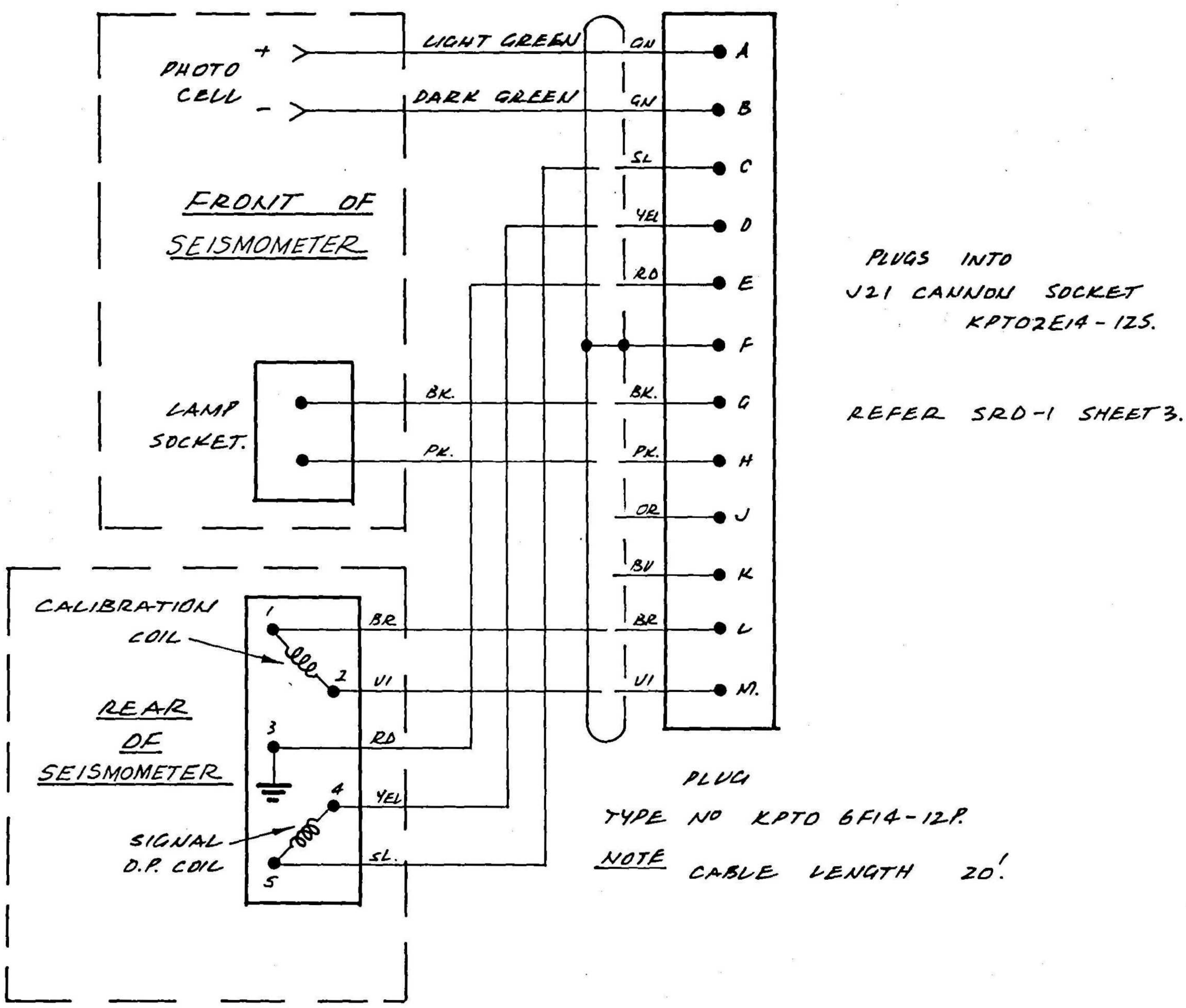
FIGURE 7



Record No. 1975/141

TOLERANCE EXCEPT WHERE OTHERWISE STATED ±

MACHINED FINISHES EXCEPT WHERE OTHERWISE INDICATED TO BE NOT LESS THAN CLA-63 VALUE.

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS GEOPHYSICAL LABORATORIES CNR. CONSTITUTION AVE. & ANZAC PDE. CANBERRA, A.C.T.	MATERIAL	INSTRUMENT SEISMOMETER INTERCONNECTING CABLE.	
	DATE 24-1-73 NAME P.B.	SCALE	DRAWING No. SRD-1 SHT. 1a

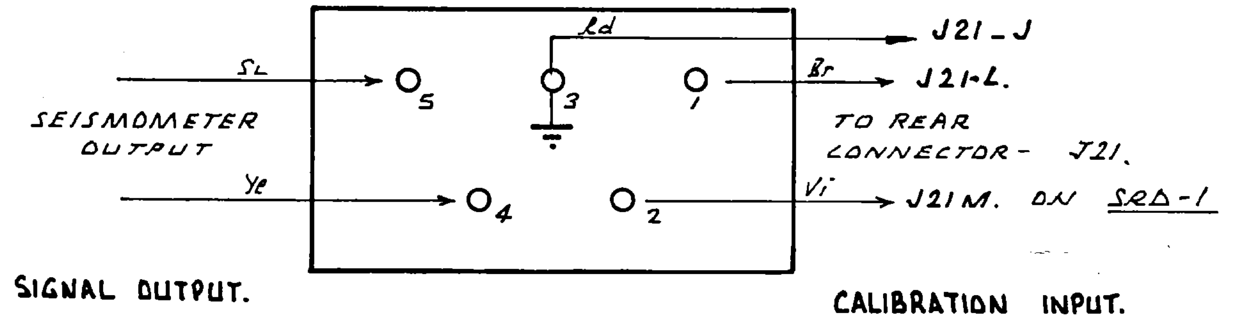
DRAWN	DATE	C'K'D	AMENDMENTS	ISSUE
F. CLEMENTS	7·8·72			1
P. BRYAN	24-1-73		VARIOUS	2
R. GAN.	19-2-73		VARIOUS DESIGNATIONS ADDED.	3
R. GAN	29-11-74		VARIOUS	4

REAR CONNECTOR J7

PIN 1 — 0 VOLTS - GROUND
2 — +24 VOLTS
3 — +12 VOLTS
4 —
5 —
6 —
7 — PHOTOCELL +
8 — " —
9 — PHOTOCELL LAMP.
10 — " "
11 — SEISMOMETER - TERMINAL 1.
12 — " " 2.

METER M1 — +15-0--15 VOLTS
" M2 — 0 - 500 ma
FUSE F1 — 1 AMP. 3AG

SEISMOMETER TERMINAL BLOCK



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CNR. CONSTITUTION AVENUE & ANZAC PARADE
CANBERRA, A.C.T.

DRAWING No.	SHEET	INSTRUMENT
ZSA	5	SEISMOMETER DRIFT COMPENSATOR - CHASSIS WIRING