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# MAWSON GEOPHYSICAL OBSERVATORY.

## ANNUAL REPORT 1965

*by*

*J.E. HAIGH*

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## ILLUSTRATIONS



1967/28

## SUMMARY

From February 1965 to February 1966, the author was Observer-in-Charge of the Mawson Geophysical Observatory, Antarctica. The seismic and magnetic observatories were maintained in accordance with standard procedures.

Some modifications to supplementary equipment were made, including a stabilised frequency drive for the seismic recorder and an automatic magnetic scale-value current controller.

During the return voyage to Australia, several landings were made around the Antarctic coastline, where regional magnetic observations were made.

## 1. INTRODUCTION

The Geophysical Observatory at Mawson, Antarctica, was opened in 1955, with the installation of a three-component normal-run La Cour magnetograph (Oldham, 1957). Since then, the instrumentation has been expanded to include an insensitive three-component La Cour magnetograph, a three-component Benioff seismograph, and a horizontal bar fluxmeter magnetograph.

## 2. MAGNETIC OBSERVATORY

### La Cour magnetographs

Two three-component La Cour magnetographs were operated continuously throughout the year (one normal and one low-sensitivity), with regular absolute observations to control baseline values and scale values.

The major cause of record loss was failure of the clockwork drive motors. It has been reported that these motors are quite capable of continuous service for at least six months, and it is therefore recommended that any motor that consistently fails in less than this time should be returned to Australia for servicing. In the past this has been left to the observer at the station, and, in recent years, the short life between servicing has come to be accepted as normal.

Time marks for the magnetic records originate from the La Cour pendulum clock in the Geophysics office, and pass, via time-mark lines, to the magnetic hut. Because the lines pass through the busy main camp area, they were often broken by vehicles crossing them. Late in the year, the lines were incorporated into the armoured cable of the camp telephone system. This terminated at the Auroral Office and from there open cables were run to the magnetic hut. After this modification no further time line difficulties were experienced.

Further loss of time marks was caused by failure of the transistor in the transistorised time-mark relay. Because this was a 12-volt unit operating from 6 volts, its operation was never very positive, and in April it was replaced with a 6-volt unit. This necessitated considerable rewiring of the monitor board in the cold porch of the recording hut.

In the scaling of closely spaced absolute observations, uniform intensity time marks are a distinct advantage. A unit for automatically timing the length of absolute time marks was designed and built. This was incorporated into the monitor board during rewiring. The complete circuit is shown in Plate 1.

When the foot switch in the absolute hut is pulsed, the time-mark relay locks on for a predetermined period, which can be varied from about $\frac{1}{2}$ to 4 seconds. Once a suitable time is chosen, time marks of uniform intensity are automatically obtained to mark the absolute observations, leaving the observer free to record the results without having to worry about the length of time marks. An auto-manual switch provides normal control if desired.

The La Cour clock in the office operated satisfactorily except for one stoppage that was remedied by servicing, and for stoppages during blizzards, caused by the pendulum being stopped by the shaking of the building.

The temperature in the variometer hut is thermostatically controlled to about 0°C. Several times during the year the heaters failed, firstly because the radiator bars burned out, and secondly owing to damage of the thermostat transistor by inductive transients from the control relay. The transistor was replaced and protected with a diode, so no further failure from this source is likely.

In the normal scale-value equipment, the current through the Helmholtz coil was controlled by a 500-ohm 'helipot'. This has a maximum current rating of 4 mA., but under the conditions of use in the scale-value circuit, it was called upon to pass up to 40 mA. The life was consequently short, and the increase of scale-value current was often erratic. This meant that about five minutes was required for the variometer to attain equilibrium before the scale-value spot was recorded. To overcome this, a scale-value current source in which the time constant was controlled by a transistor was designed and built (Plate 2). The control circuit for the output transistor would increase the current exponentially, with a time constant of about 10 seconds, but the characteristics of the transistor, coupled with a current-limiting resistor, produce a more rapid approach to the final value than a pure exponential. In practice it is found that the current is sufficiently constant (within 0.25% for 10 seconds) to allow a reading after about 40 seconds. The current flow in the coil can be reversed when the current has fallen to 0.5 mA, which requires about 30 seconds. The total time for a single observation is thus reduced from about 6½ to 1½ minutes.

An examination of the record after an applied scale-value pulse shows no sign of oscillation after the 40-second increase, and it may be possible to reduce this time without producing oscillation of the variometer.

Short times for completion of scale-value measurements are desirable, both from the point of view of the observer who may have to stand in the cold porch for long periods and, what is more important, because the reliability of the measurements is improved with shorter completion times.

It has been suggested that measurements of scale values should be confined to magnetically quiet days. The scale value of the variometer changes only slowly and the reliability of measurements on quiet days is much greater than those on even mildly disturbed days. With this in mind, it is perhaps much better to obtain one good scale-value measurement (perhaps containing two or three sets) per month than to have five or six measurements at regular intervals but with lower reliability.

During the winter months it was noticed that the photographic paper appeared to be expanding slightly while on the drum, resulting in a slight convergence of the baselines across the magnetogram. This was apparently due to slight differences in humidity between the cold porch, where the paper was stored, and the recording room, which had a small amount of drift snow leaking in around the instrument piers. The trouble did not occur later in the year after the rubber seals round the piers had been repaired.

Early in the year, the normal-run Z temperature trace faded and disappeared. Considerable experimenting failed to regain the spot, and it was decided to use only the H temperature trace for temperature recording. A comparison of the H and Z temperature traces up to the time of loss showed good correlation between the temperature of the two variometers.

Baseline adoptions

H-variometer temperature. A datum for temperature recording is established by daily reading of the thermometer in the H-variometer. A daily plot of the temperature datum shows a wide scatter with frequent jumps for no apparent reason. In many places the datum changes linearly over a period of from a few days to a month or more, and this cannot be accounted for by changing the adopted value of the temperature sensitivity.

The only reasonable explanation is that the temperature compensation is not consistent, either because the prism support is loose, or because the bimetallic strip is fatigued. The fact that the temperature coefficient derived from readings over a short period shows a reasonable constancy throught the year tends to support the latter supposition, for a loose support might be expected to change the coefficient.

Horizontal intensity. The H baseline adoptions for 1965 are also complicated by the inconsistent temperature compensation. In particular from mid-April to the end of May, the baseline has a large series of jumps following a particularly severe excursion of temperature from the normal. This excursion was produced by heater failures and it is unfortunate that because of time spent on repairs, the number of absolute observations in this period is less than is desirable.

An attempt was made to clarify the baseline values by scaling equivalent points on the normal and insensitive H traces. However, it was found that the large temperature effect on the insensitive record, coupled with the large scale-value, caused minor effects on the insensitive record to swamp any jumps on the normal-run record.

D baselines. The D-variometer operated well during the year and the adopted baseline values agree well with previous results.

Z baselines. The original Z baseline value adoptions show a sudden step-up of some 50 gammas at the beginning of April, and a corresponding step-down in mid-August. These correspond to times when the 0 to 20°C thermometer was used for the BMZ absolute observations. It seems likely that this step is due to erroneous temperature readings, probably caused by mercury from the thermometer thread being caught in the upper reservoir. This thermometer was returned to Australia for re-calibration, but this may not throw much light on the past baseline values, as the Defence Standards Laboratories always shake down all mercury into the thread before calibration.

The whole position of BMZ temperature corrections is unsatisfactory at the moment, and it seems highly desirable that thermometers should be interchanged each year and re-calibrated. It should also be stressed that the thermometer thread should be checked to see that it is complete before each set of absolutes.

The calibration of a thermometer from Macquarie Island was found to be in error when it was checked in 1966 and there seems no reason to suppose that other thermometers may not also have errors.

An inspection of the Z baseline plot with regard to the thermometers used suggests a small error between the -10 to + 10°C and + 10 to + 30°C thermometers, as well as the larger error for the 0 to -20°C one. For 1965 the +10 to +30°C thermometer has been taken as a standard. It is interesting to note that the intercomparison of the proton precession magnetometer with the BMZ, using this thermometer, gives an apparently erroneous value for the I.M.S. correction. More will be said of this in the section on intercomparisons.

For purposes of adoption, the baseline values from April to August have been given a 54-gamma correction, which brings both ends of the baseline for this period into line with values using other thermometers.

Bar fluxmeter magnetograph

The bar fluxmeter recording camera continuously gave trouble early in the year. The camera was modified by Branson (1965), who fitted a power drive to the take-up spool. The drive pulleys and belts were fitted inside the camera body and were inaccessible. The pulleys were quite small and the continuous spring belt slipped easily.

The camera was modified by the author, by placing large drive pulleys on the outside of the camera where they were accessible for servicing, and by replacing the drive belt. The camera, although not entirely satisfactory, gave much less trouble after these modifications.

The current of the recording trace lamp was controlled by a series rheostat, which consisted of a 50-ohm, 2-watt potentiometer. As only about 4 ohms of series resistance was required, and as this had to pass about $1\frac{1}{2}$ amps, a small section near one end of the potentiometer was severely overloaded and the contact was badly burnt. There were many 'dead spots' on this part of the rheostat and unless great care was taken, the lamp would go off altogether. A bump on the switchboard near the rheostat was sufficient to turn the lamp off.

A new rheostat was wound using heavy gauge nichrome wire wound on the former from a 50-watt potentiometer. This has a total resistance of 10 ohms, is capable of carrying at least 2 amps without overheating, and was normally operated near the middle of it's range, so the control of lamp intensity was quite good.

The control switchboard in the seismic hut was in the recording room and was difficult to work on while records were on the drum. The hut was rewired with the switchboard in the cold porch to allow work on it in normal light. The fluxmeter lamp intensity control was incorporated in this switchboard. Unfortunately it was not possible to complete all the details of the wiring before changeover, and some had to be left for the next observer.

During the early summer, the temperature in the seismic hut rose considerably and the fluxmeter galvanometer developed rapid drifts. Even the reserve traces did not remain within recording range and several days' records were lost.

Attempts to carry out short-pulse calibration of the fluxmeter proved unsuccessful because the lamp intensity was too low to record on rapid-run (100mm/min). The lamp intensity could probably be safely increased by using a higher supply voltage, provided care was taken when turning the lamp on. With the heavy duty rheostat now in circuit, it should be possible to run the lamp on 8 volts instead of 4 volts, using a higher series resistance. An 8-volt tap is available on the present supply transformer. For rapid-run operation it would then be necessary only to reduce the series resistance.

The difficulty in timing short current pulses for the test (i.e. 0.1 to 1 second) was overcome by providing a temporary mechanical timer using a one-rev-per-second synchronous motor and pulse locking relays. However, if similar tests are to be attempted in the future, it would be advisable to build and test a timer at Head Office before sending it to the station. The requirement for the test is a single rectangular current pulse, which can be controlled from 0.1 to 1 second in length, from 0.01 to 0.5 mA, in amplitude, and which can be reversed in polarity.

## 3. SEISMIC OBSERVATORY

The three-component Benioff seismograph recorded continuously throughout the year except for minor breaks for servicing.

Initially the time-mark relay of the N-S component trace was inoperative, and had been disconnected. The relay unit was stripped and cleaned, and worked well after reassembly. However, when it was replaced in the recorder, it was found that all three relays were erratic. This was traced to the failure of a 350-$\mu$F, 50-volt capacitor.

The seismic time-lines suffered breakages early in the year until they were incorporated in the armoured telephone cable, after which they gave no trouble. The time-mark unit was modified slightly to give an hour mark about 20 seconds long starting exactly on the hour. This replaced the old system where the hour mark fell between two minute marks.

The Mercer Chronometer used for seismic timing is not considered adequate for the job. At best, its rate of change is regular and can be maintained at a few tenths of a second per day, and at worst may be quite irregular - up to seconds per day. Although it is adequate while the rate of change is regular, it is impossible to interpolate accurately to one-tenth of a second when the rate is irregular.

The application of time corrections to seismic scalings is a laborious process and adds considerably to the time required to prepare a bulletin. It is strongly recommended that a form of timing be provided which can be adjusted to have an absolute rate of less than one-tenth of a second per day, thus eliminating the need for any corrections to time marks. Because the history of crystal clocks within the BMR has not been altogether satisfactory, the provision of a tuning fork chronometer should be investigated. A chronometer of this type is in operation at Wilkes station and has a better performance than has been claimed by the manufacturers. It is possible to keep its rate within 50 milliseconds per day, thus elimenating the need for any corrections to time marks.

The seismic recorder motor was driven directly from the mains power supply. This means that the accuracy of timing any event depends on the stability of the generator frequency between one minute-mark and the next. Measurement of the length of consecutive minute-marks on the recorded traces show variations up to 1 second, and these almost certainly extend into the shorter regions between time marks. To achieve an accuracy of one-tenth of a second under these conditions is impossible.

To overcome this, an amplifier was built to drive the seismic recorder, the input to the amplifier being a 50-c/s standard frequency signal derived from the crystal clock in the Auroral Section. The circuit incorporated high-speed changeover relays to switch the recorder back to the mains supply in the event of amplifier failure. The motor winding loaded the amplifier in such a way that the waveform was distorted. This caused chattering of the changeover relay, and was overcome by tuning the motor windings with a 3.7-$\mu$F parallel capacitor.

Installation of the amplifier and safety relays involved considerable rewiring of the seismic hut, and in the process the Stabilac was moved from the recording room to the cold porch. The amplifier circuit and hut wiring diagram are shown in Plates 3, 4, and 5.

With the installation of the amplifier the drum speed became uniform and the timing accuracy was considerably improved.

Routine processing of seismic results was carried out, and daily preliminary bulletins were sent to Melbourne. Two-monthly final bulletins were sent out for most of the year. On return to Australia final analyses were punched on cards and sent to I.S.R.C.

## 4. MAGNETIC INSTRUMENT INTERCOMPARISONS

During the changeover of 1964/1965 and 1965/1966, instrument intercomparisons were made between the observatory absolute instruments and comparison instruments sent from Melbourne. Two comparison QHMs (174 and 300) were used, and gave values for I.M.S. corrections reasonably consistent with previous values. QHM 300 remained at Mawson as an Observatory instrument and QHM 302 was returned to Australia. The intercomparison of declinometers gave consistent results.

BMZ 62 was intercompared with wide-range BMZ 211 and with the proton magnetometer. The same thermometer (+ 10 to + 30°C) was used for both BMZs. The I.M.S. correction for BMZ 62, derived via that of BMZ 211, gives a value reasonably consistent with results from previous years. However, the I.M.S. correction derived from the comparison with the proton magnetometer, although internally consistent, is about 25 gammas different from the expected value. It is the author's opinion that the I.M.S. correction derived from the proton magnetometer observations is by far the more reliable figure, and it has been used in the 1965 Z baseline adoptions.

It is assumed, in the absence of any positive evidence, that the difference between the two corrections is due to a thermometer error. It should be noted that even if the thermometer is in error, it will give an apparently consistent I.M.S. correction, because it was used with both BMZ observations. In this case, the correction derived from the proton magnetometer is the only reliable one, and for this reason has been used for the adoptions.

In this case, provided the thermometer error has not changed, the observations during the year using that thermometer will be correct when the I.M.S. correction is applied. Of course, observations with other thermometers will not necessarily be correct. It is obvious from the above discussion that it is imperative that the same thermometer is not used for observations with the two comparison instruments. Ideally the thermometer used to calibrate the BMZ in Melbourne should travel with it and be used exclusively for the rest of the intercomparison. Also the thermometer most used during the year should be used on the station BMZ for the intercomparison.

Far more stringent requirements should be laid down for the intercomparison observations, and very detailed instructions should be written out by someone who has been at the station. In 1965/1966, detailed instructions were sent to the station, but they were not practicable for an Antarctic station. In one respect this is worse than no instructions, as it unsettles the observer, if he cannot carry out the instructions.

## 5. STATION MAINTENANCE

During the year, the Geophysics Office was painted inside and out, the exterior with bituminous silver paint. Black (1965) recommends the use of this paint and this is seconded by the author. The other buildings of the Observatory are in need of painting but the lack of sufficient suitable paint precluded this in 1965.

Various wiring connections in the office that were loosely arranged round the walls were collected into a switchboard near the chronometer and radio. The wiring diagram for this is shown in Plate 6.

The rewiring of the seismic hut has been mentioned previously; it was arranged in such a way that one master switch controlled the whole seismic recorder, and one controlled the fluxmeter recorder. This slightly simplified the record change and reduced the possibility of recording lamps being left off. A warning light in the cold porch reduced the possibility of the whole recorder being left off.

The rubber seals around piers were replaced in all three instrument huts.

## 6. REGIONAL MAGNETIC

On the return journey to Australia, a landing was made at Kista Rock ( 69°30'S, 64°30'E), where H and Z observations were made, at Lorton Island (69°21.4'S, 75°37.5'E), where Z and D observations were made, and at Davis where D and Z observations were made.

Unfortunately, very high winds at Lorton Island and Davis made H observations impossible, and heavy cloud prevented an azimuth reading at Kista Rock.

## 7. ACKNOWLEDGEMENTS

I wish to thank all members of the 1965 Mawson expedition for their assistance and in particular the following:

Dr. Scott Cameron who helped with the geophysical routines at the station and with the field observations on the return journey.

Electronic engineer Greg Martin, who designed the seismic recorder drive amplifier.

I.P.S.O. physicist Gil Webster, who assisted with refinements to the amplifier.

Cosmic-ray physicist Attilla Vrana, O.I.C. Brian Woinarski, and Meteorological observer Mike Poulton, who all assisted with the geophysical routines while the author was on field trips.

Radio technician, John Gordon, who spent many hours re-organising the telephone communications to accommodate the seismic and magnetic time lines and the 50-c/s standard frequency signal from the Auroral Office to the seismic hut.

Surveyor Max Corry, who assisted by determining the azimuth mark for D observations at Lorton Island.

Geophysicist Robin Cooke, who gave considerable help and advice during and after the changeover period.

## 8. REFERENCES


| | | |
|---|---|---|
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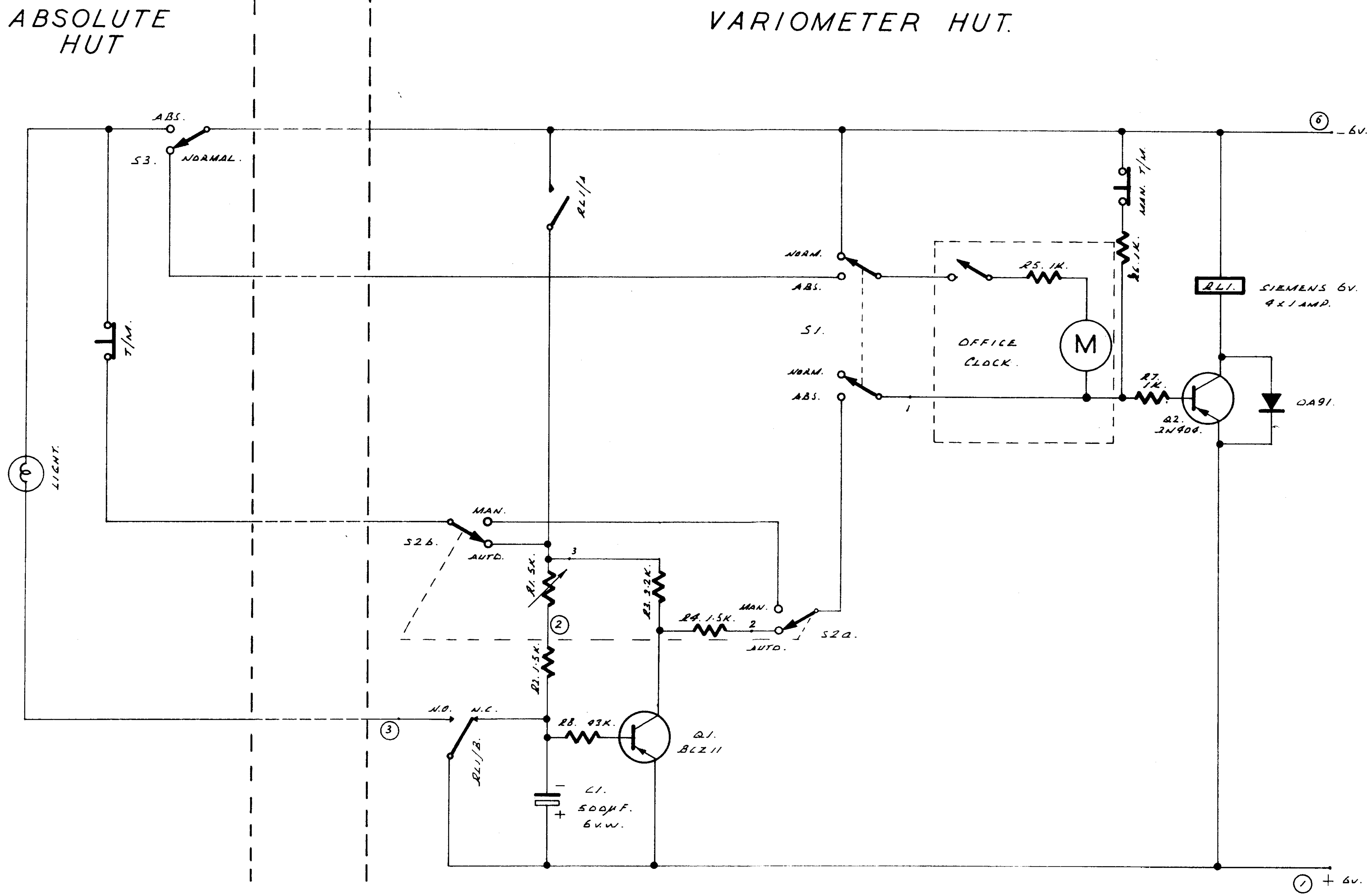
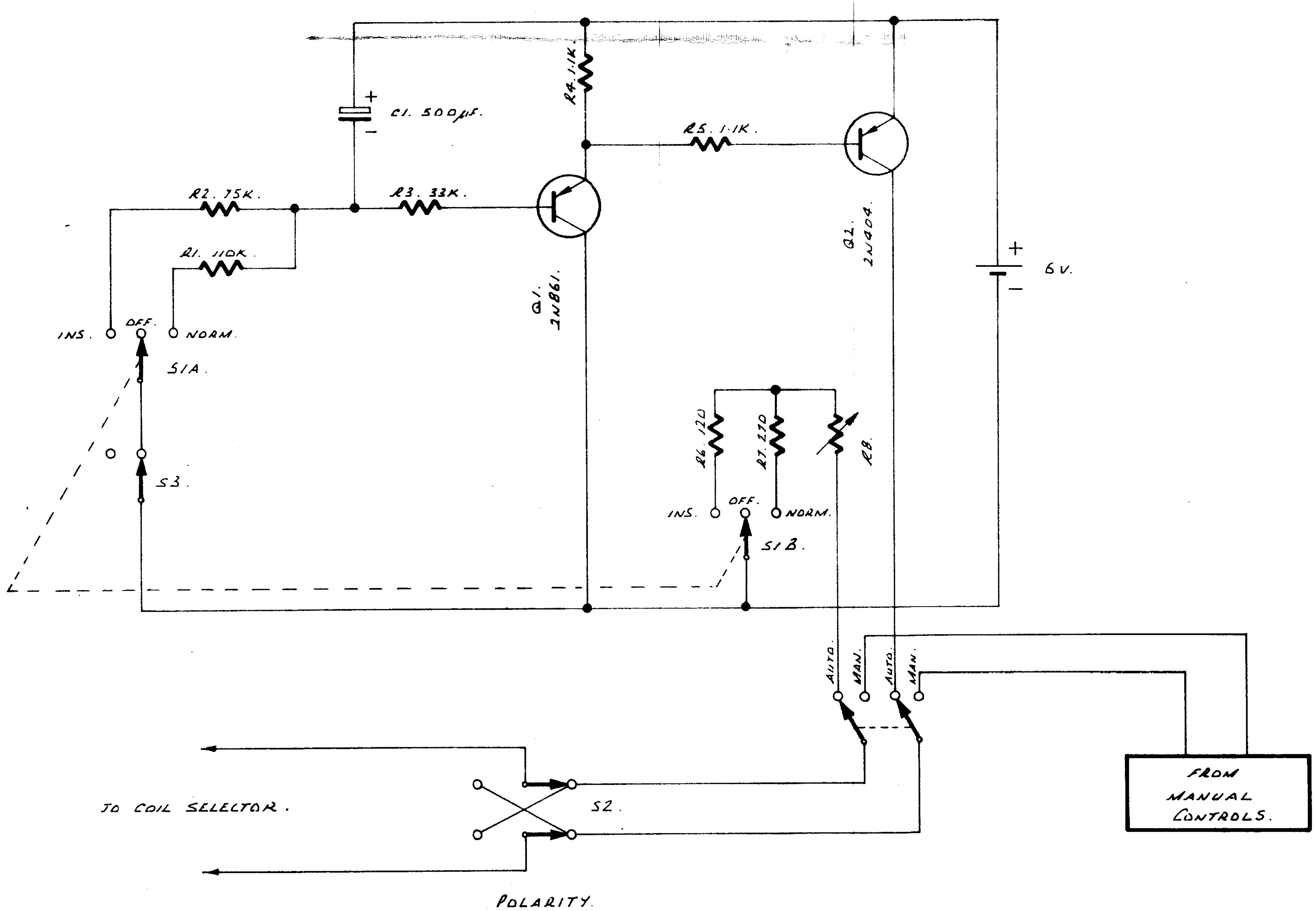
| BRANSON J.C. | 1965 | Mawson Geophysical Observatory work, Antarctica 1962. <u>Bur. Min. Resour. Aust. Rec.</u> 1965/184. |
| BLACK I.E. | 1965 | Mawson Geophysical Observatory work, Antarctica 1963. <u>Bur. Min. Resour. Aust. Rec.</u> 1965/185. |




①, 1 REFER TO PIN Nos ON 2 SEPARATE SOURIAU CONNECTORS 5 PINS.

| BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS | DRAWING No. | SHEET | INSTRUMENT |
|---|---|---|---|
| | S1A | 1 | MAGNETIC TIMEMARK SCHEMATIC |

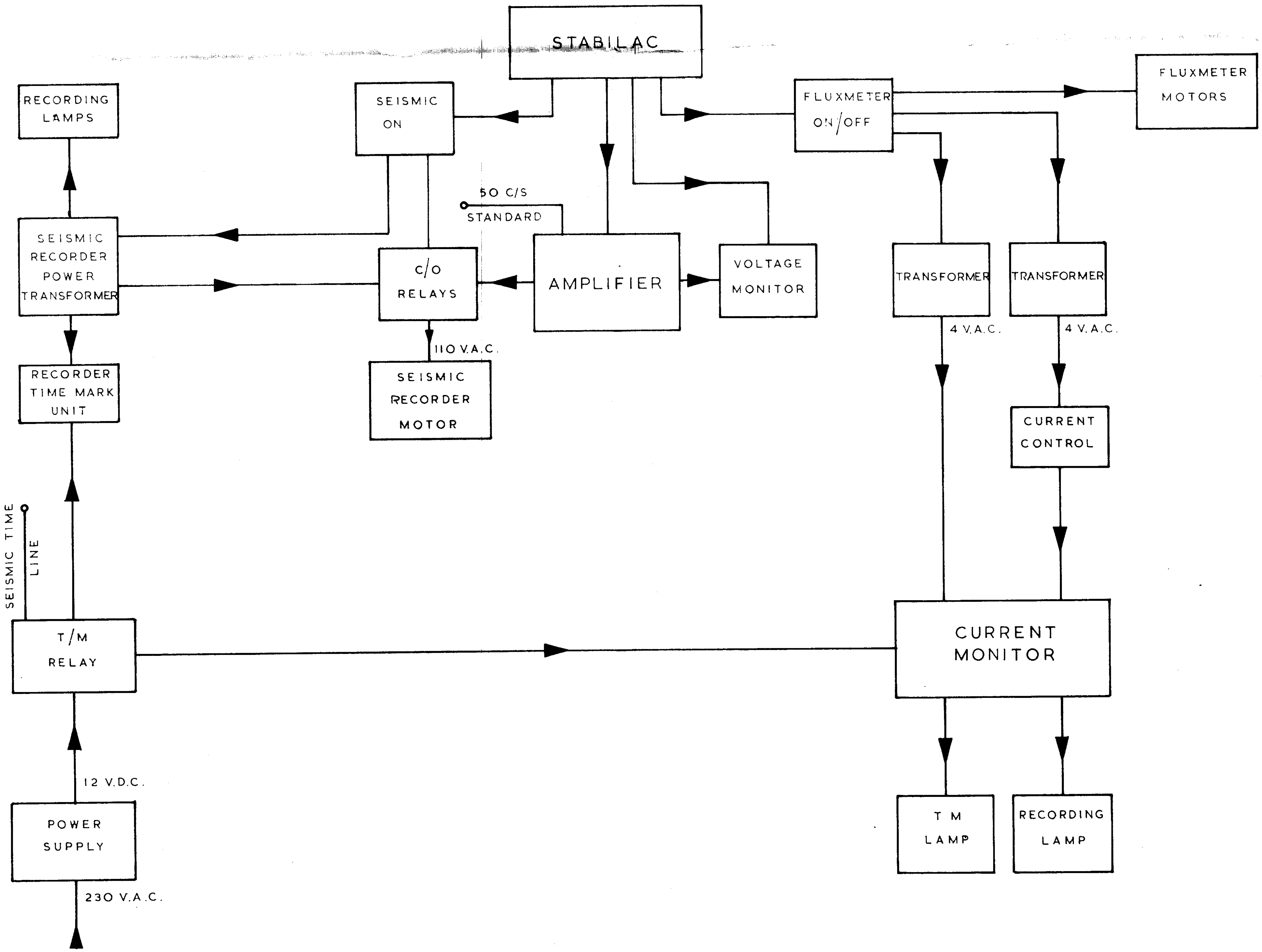
TO ACCOMPANY RECORD No. 1967/28 G 158-69




| BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS | DRAWING No. S1A | SHEET 2 | INSTRUMENT AUTOMATIC SCALE VALUE CONTROL SCHEMATIC |
|---|---|---|---|

TO ACCOMPANY RECORD No. 1967/28

G 158—70

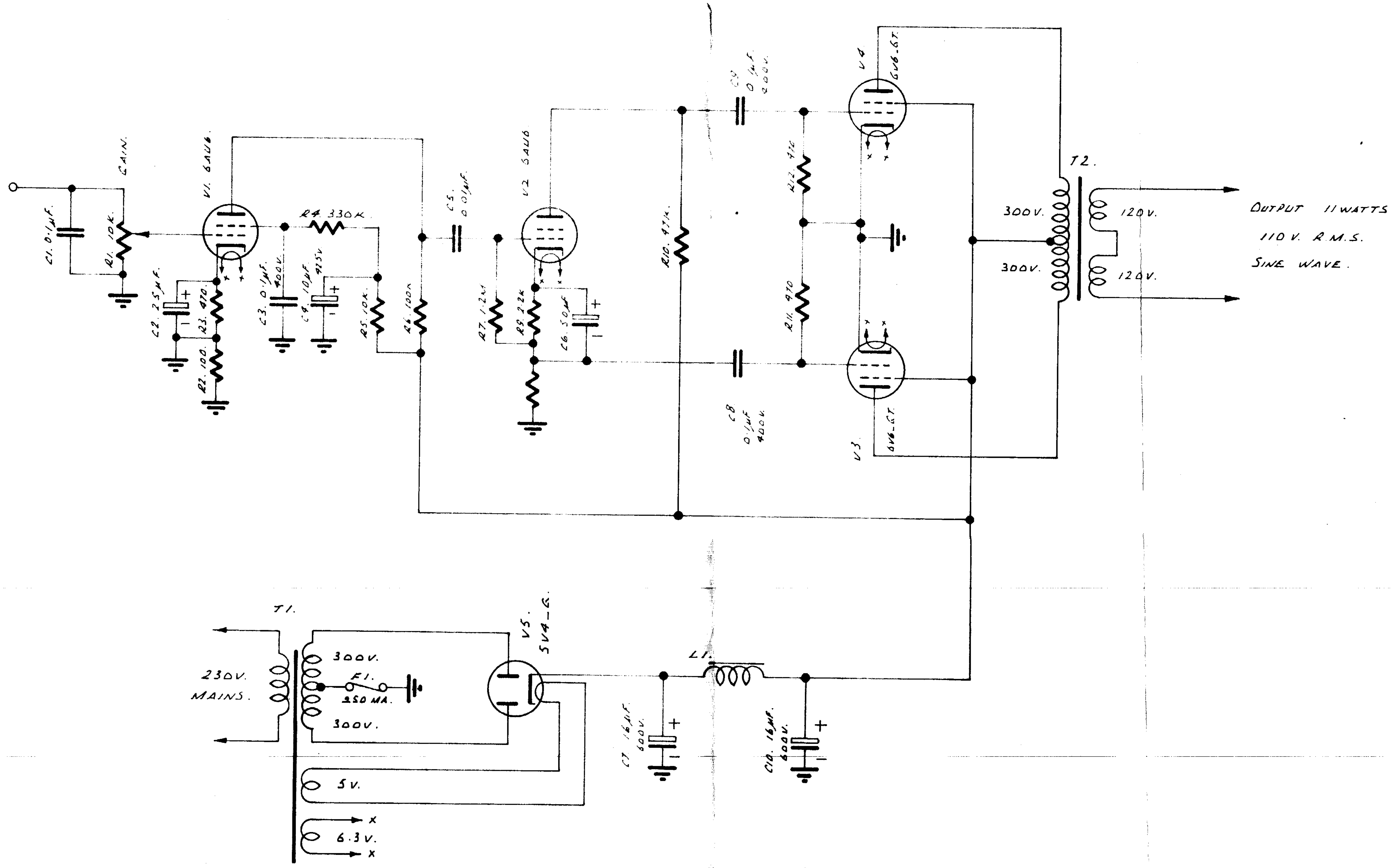



| BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS | DRAWING No. SIA | SHEET 3 | INSTRUMENT SEISMIC HUT CONTROL BLOCK DIAGRAM |
|---|---|---|---|

TO ACCOMPANY RECORD No. 1967/28 G 158-71

PLATE 4


RECORDERS
RECORDING ROOM
COLD PORCH
SWITCHBOARD
PILOT LAMP
230V A.C.
RL3
TIME MARK UNIT
REC. LAMP
SEISMIC RECORDER TRANSFORMER
110V.
RL2
SEISMIC DRIVE AMPLIFIER
230V
KEYSWITCH
1mA F.S.D. = 230V.
OA202.
M
FLUXMETER MOTOR
230V.
RL1.
230V A.C.
FLUXMETER MOTORS
STABILAC.
1000MF.
SEISMIC TIME LINES
T/M LAMP
REC. LAMP
ALL CONTACTS MAKE BEFORE BREAK. KEYSWITCH.
10mA. F.S.D. = 2 AMP.
4V
230V
10Ω. 50WATT.
BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS
DRAWING No. S/A
SHEET 4
INSTRUMENT SEISMIC HUT WIRING DIAGRAM
TO ACCOMPANY RECORD No. 1967/28
G158-72

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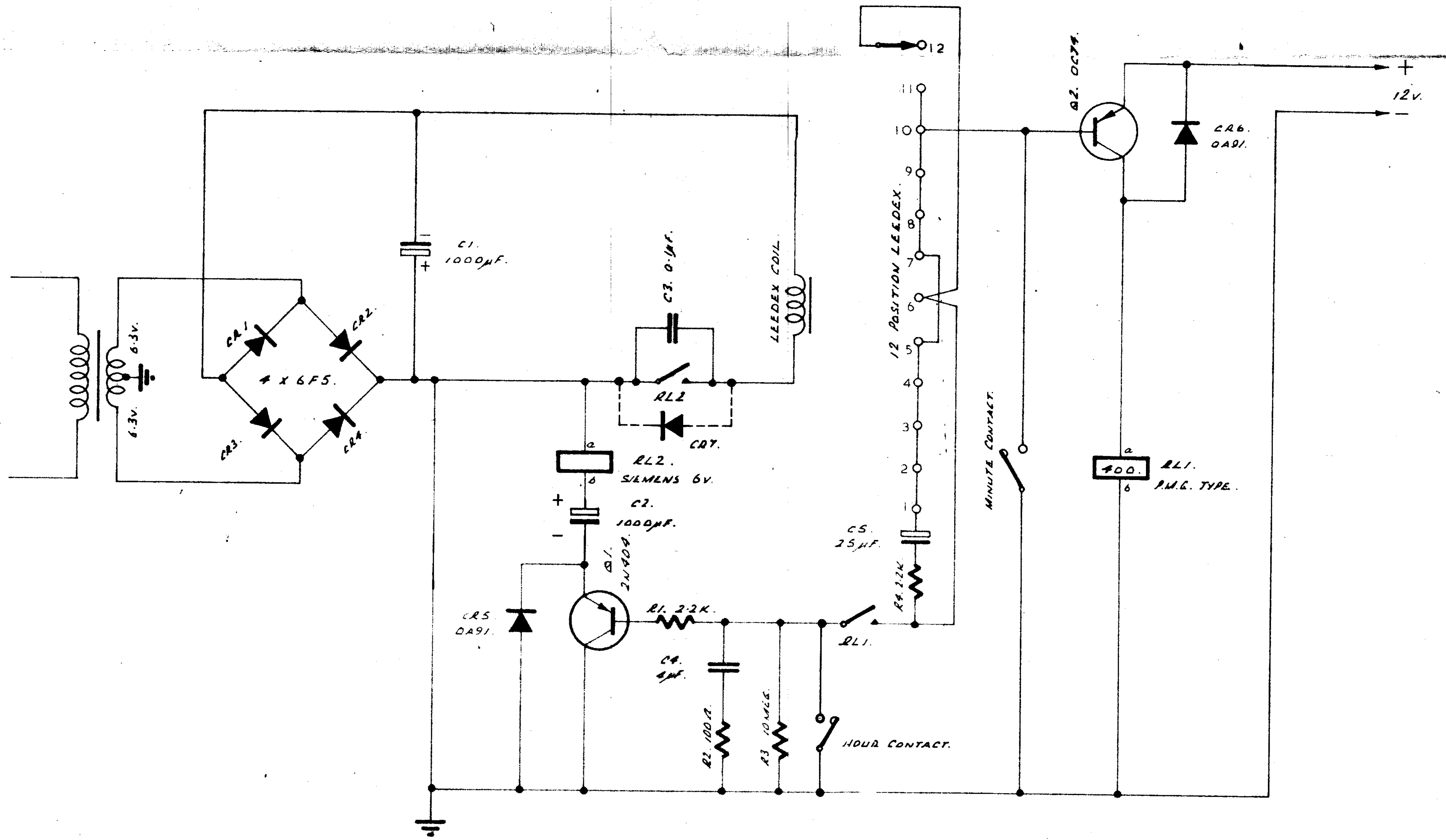


| BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS | DRAWING No SIA | SHEET 6 | INSTRUMENT GEOPHYSICS OFFICE SWITCHBOARD SCHEMATIC |
|---|---|---|---|

TO ACCOMPANY RECORD No. 1967/28 **G 158-74**