COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1965/185

MAWSON GEOPHYSICAL OBSERVATORY WORK,

ANTARCTICA 1963

by

I.E. BLACK

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SUMMARY

This Record describes the operation and maintenance of the Mawson seismic and geomagnetic observatories during 1963. I was resident geophysicist in charge of these observatories from February 1963 to February 1964.

Results of scientific work will be published in separate reports.

1. INTRODUCTION

In 1955 a geomagnetic observatory was established at Mawson by W.H. Oldham (1957). He installed a three-component normal-sensitivity La Cour magnetograph. Since that year the geophysical programme has expanded to include an insensitive three-component La Cour magnetograph, a bar-fluxmeter magnetograph, and a three-component Benioff seismograph.

2. VOYAGE TO MAWSON

M.S. Nella Dan left Melbourne on 9th January 1963 bound for Heard Island, Mawson, and Davis. The ship arrived at Heard Island on 26th January 1963 and I went ashore at Atlas Cove in the afternoon of the 28th to carry out absolute observations. Unfortunately strong wind, poor light, and lack of time prevented me from observing H and Z, but a good value of D was obtained using a previously determined azimuth.

The ship arrived at Mawson on 2nd February.

3. CHANGE-OVER 1963

During the change-over period of ten days the outgoing geophysicist (John Branson) and I calibrated two components of the seismograph (Branson, 1965), and successfully compared the Mawson absolute geomagnetic instruments with those brought from Melbourne.

The proton magnetometer, taken to Mawson for the first time, failed to operate properly because its tuning circuit did not have sufficient range to enable the instrument to measure a magnetic field of the strength that exists at Mawson.

On 10th February I officially took over the position of Observer in Charge at the Mawson geophysical observatory.

4. MAINTENANCE AND BUILDING IMPROVEMENTS

Office (see Plate 1)

During the year I completely repainted the inside and outside of the office. To make a good job of the exterior of the building it was necessary to remove all the old paint from the walls with a blowlamp. This extra work could have been avoided if in the previous year bituminous paint had been used to paint the office exterior. The paint applied in that year peeled badly because it had an oil base and was applied directly over bituminous paint. I used bituminous paint and recommend that its use be continued in future years because of its ease of application, its lasting property, and the ease with which weathered parts can be touched up neatly.

Several wet snowfalls occurred in the summer months and the office skylights leaked badly. To overcome this I applied a rubber compound called Hornex to the joints of skylights and roof. This prevented further leaking.

I improved the exterior of the office further by removing the pipe rack which had been built on an office wall in an earlier year. Not only was this rack ugly but the weight of the pipes was a constant hazard to the wall. Besides pipes, the rack also supported the forty-four-gallon fuel drum supplying the office oil heater, so it was necessary to build a new stand for the drum. I built this stand using steel piping. With the pipe rack gone it was possible to put the drum closer to the heater, thus reducing the length of fuel pipe outside the building by about

8 ft. I also raised the drum, thus increasing the head of fuel to the heater. These modifications should considerably improve winter operation when the fuel supplying the heater thickens with cold.

Absolute house

During the year I repaired a badly broken panel on the exterior of the hut, repainted the floor, completely repainted the exterior, and weatherproofed the windows with Hornex. I also repaired a broken leg on the BMZ shelter and repainted the shelter.

Variometer house

I repainted the windward walls of the hut and caulked several cracks in the roof and exterior walls with putty. Rubber around the piers in the hut was in poor condition and often needed repair after blizzards.

I repainted the battery box.

Seismic hut

I repainted and carried out minor repairs to the outside of the hut. The rubber around the seismometer and galvanometer piers was replaced.

Proton magnetometer shelter

At Wilkes, trouble had been encountered with the proton magnetometer, and this was thought to be due to low temperatures affecting the operation of relays. Accordingly Melbourne Office instructed me to build a simple heated shelter to keep the instrument warm when it was brought to Mawson for the change-over comparisons. I used a large A.N.A.R.E. case for this purpose, windproofing it on all sides, and built a 500-watt radiator to heat it. The shelter proved quite effective.

5. MAGNETIC OBSERVATORY

Normal-sensitivity La Cour magnetograph

The normal magnetograph recorded continuously throughout the year except for occasional drive stoppages and adjustments.

During the year, the optical system was adjusted for three reasons:

(a) To improve the quality of all traces.

(b) To shift the H temperature trace farther away from the baseline, in order to eliminate the use of the reserve temperature trace.

(c) To shift the Z trace into a better position on the magnetogram.

Insensitive La Cour magnetograph

The insensitive magnetograph needed no attention, and operated continuously except for occasional drive stoppages.

Magnetograph control observations

Absolute geomagnetic observations, and H and Z scale-value determinations, were made, on the average, four times per month. Care was always taken to do these during geomagnetically quiet periods.

Thermostatic control of variometer hut (see Plate 8)

During the year, the temperature in the variometer hut ranged from about plus five degrees centigrade to minus twenty-five degrees centigrade.

It was therefore desirable to introduce controlled heating into the hut, firstly to make it more comfortable for the geophysicist when he changed the records or had to spend a long time in the hut, and secondly to avoid making tedious temperature corrections to the magnetograms. Engineer Don Creighton kindly designed a non-magnetic transistorised thermostat employing a thermistor and operating from the 6-volt D.C. supply to the hut. The thermostat was designed to keep the hut at any temperature between plus five and minus five degrees centigrade. I designed a suitable switching unit operating from the transistor circuit to control the radiators in the hut. The unit employed a relay, microswitch, and A.C. contactor. The combined circuit is shown in Plate 8. I built the transistor unit into the magnetograph control panel and placed the thermistor on the pier next to the variometers of the normal-sensitivity magnetograph. The relay, microswitch, and A.C. contactor I built into the magnetograph battery box, which is some distance from the hut. This was to prevent these magnetic components from affecting the variometers. The thermostat operated very successfully and kept the instruments within a range of two centigrade degrees except in the summer months, when the sun heated the hut a few degrees above the setting of the thermostat.

Before the heaters in the hut could be used I found it necessary to dismantle, redesign, and reinstall them because previously they had been installed with inadequate thermal insulation to operate as 1000-watt units.

The final switching arrangements permits controlled heating power of 1000 to 4000 watts in 1000-watt steps.

La Cour magnetographs time-mark control

The La Cour clock, which supplies time-marks to the magnetographs, operated well throughout the year. As the weight cord was in poor condition I replaced it during the year. Unfortunately the nylon cord sent from Melbourne for the purpose was of the wrong diameter so that it was necessary to use cotton twine. I ordered nylon cord of the correct size for 1964.

I installed a 0 to 4 mA meter in the office in series with the magnetograph time-lines so that a regular check could be made on the time-mark circuit during the day. The time-lines run from the office to the variometer hut situated about half a mile away and they break occasionally, particularly in the section where they pass through the camp. The detection system proved its worth several times.

Bar-fluxmeter (see Plates 4 and 5, and Appendix 1)

Bar-fluxmeter record loss was heavy early in the year, owing to (a) paper jamming in the camera and (b) the fluxmeter spot drifting off the camera as a result of temperature variations in the hut. The camera trouble was traced to the vee-pulley that drives the spring and so drives the take-up spool. This pulley was badly worn and allowed the spring to slip. A new pulley was cut on a lathe by the engineer, and the camera gave no further trouble. I made many attempts to control the hut temperature thermostatically in an effort to reduce losses due to drifting of the trace, but was forced to abandon these attempts because the seismic galvanometers were affected when the heater switched on and off - the torsion in the galvanometer ribbons depended upon temperature, and the sudden change in temperature as the thermostat operated caused periodic uneven spacing of lines on the seismograms. I overcame most drifting losses, however, by making a reserve spot system for the fluxmeter from prisms taken from the disused BMR seismic recorder.

Late in the year the fluxmeter movement suddenly became stuck. I found it necessary to dismantle the fluxmeter and adjust a small brass bracket above the coil to free it. Before putting the fluxmeter back in service, I decided to alter its installation in the hut. In the old arrangement, the fluxmeter and camera were installed on a common wooden framework attached to a small concrete pier. This was unsatisfactory because it was impossible to take paper from the camera without violently disturbing the fluxmeter. I removed the wooden framework and reinstalled the fluxmeter on the concrete pier. I built a separate wooden stand on the floor for the camera. This arrangement was most satisfactory. I installed a new safelight over the camera to facilitate record changing.

Wind noise on the bar-fluxmeter traces was high early in the year. This noise was eliminated by building a rock wall to protect the bar from the wind. I did not re-erect the old masonite shelter which had been dismantled to remove the H and Z bars, because records of previous geophysicists (Kirton, 1960; Hollingsworth, 1962) stated that the cover filled with drift. Hollingsworth stated that wind-noise was caused on the trace by snow linking the cover to the bars.

I successfully calibrated the bar-fluxmeter by winding a coil in the form of a circular helix around the bar and passing a series of sinusoidal currents of known strengths and frequencies through the coil. By measuring the deflections recorded on the trace for each frequency a scale value for that frequency was determined. Appendix 1 gives details of this calibration.

Water in bar

While winding the calibration coil in the heated office, a considerable quantity of water drained from the bar. The bar did not appear damaged as a result of this, and I ordered material from Melbourne to re-weatherproof it.

6. SEISMIC OBSERVATORY

The old seismic installation

The seismic installation prior to my arrival at Mawson consisted of a vertical Benioff seismometer driving a galvanometer of free period 0.2 seconds, and two horizontal Benioff seismometers each driving a galvanometer of free period 70 seconds. The seismometers had a natural period of 1.0 seconds. Recording was done via a 30-mm/min three-channel, one-drum recorder built in the BMR workshops and modified at Mawson by Merrick in 1960 (Merrick, 1961).

The above installation suffered from two important disadvantages. Firstly, the recorder was not capable of giving a seismogram of the quality obtainable from a precision-built instrument, and secondly, the long-period galvanometers were affected by temperature changes to such an extent that they often produced almost useless records. It was therefore desirable to alter the seismic installation by employing a new recorder and temperature-stable galvanometers.

Installation of Benioff recorder and 14-second galvanometers (see Plates 2, 3, and 6).

A Benioff 60-mm/min three-channel seismic recorder was taken to Mawson to replace the BMR recorder. Two galvanometers, each with a free period of 14 seconds, were taken to replace the galvanometers with free periods of 70 seconds. It was hoped that the new galvanometers, because of their shorter period, would be less affected by temperature changes than the old. This proved to be correct.

I began the installation of the new recorder and galvanometers on 16th February 1963. Prior to this I had discovered that the damping resistances used in both horizontal seismometer circuits were incorrect. The seismometers had been underdamped since 1961. They had been wired with a 250-ohm signal coil configuration and a 187-ohm damping coil configuration. The damping coils fed into 562 ohm and the signal coils into 750 ohm. A resistance of 250 ohm had been placed in series with the seismometer side of the 500-ohm attenuator boxes. The seismometers cannot be critically damped under these conditions. (Ref. Operating and Maintenance Manual Benioff Seismometers).

In order to obtain critical damping of the horizontal seismometers I found it necessary to alter their coil configurations. I also altered the coil configuration in the vertical seismometer because the impedance of the original configuration was found to be outside the range of the Willmore Calibration Bridge (Branson, 1964).

To install the Benioff recorder it was necessary to remove part of an interior wall of the hut and rebuild part of the workbench.

Because of lack of time at the beginning of the year, I was unable to build a proper stand for the recorder, so I placed it on wooden blocks on the floor of the hut. Later in the year, with the help of the carpenter John Davidson, I built a wooden stand for the recorder and installed it in place of the blocks.

The old method of running cables from the attenuator boxes to the galvanometers was unsatisfactory. These cables ran across the floor of the hut and were continually being trodden upon. I removed these cables, replaced them with lighter shielded ones, and ran these new cables along the ceiling. Lighter cables were used because the outgoing geophysicist thought that the old cables contracted with temperature decrease and caused the galvanometers to move on the pier. I replaced the 70-second galvanometers used in the old seismograph with the 14-second galvanometers. When rewiring the seismograph I used banana plugs and sockets between the seismometers and the attenuator boxes to enable the seismometers to be easily disconnected from the galvanometers. This made it easier when work had to be done on the seismometers.

The new seismograph was in operation from 24th February 1964. It recorded over 900 teleseisms over a period of approximately twelve months.

Hut earthing

When tracing the earth wire from the hut I discovered that the wire did not run to earth, so I installed a new earth wire of bare, multi-stranded copper wire and ran it directly from the hut to the sea. The seismometers, shielded cables, and galvanometers, were all earthed.

Seismograph and bar-fluxmeter time-mark control (see Plate 7)

Minute and hour marks for the seismograph and bar-fluxmeter were supplied by a Mercer chronometer kept in the office. Lines of telephone cable connected the chronometer to the instruments, which are about half a mile away.

Early in the year the hour-mark contact broke and I installed a new one. Trouble was also encountered with failure of minute marks, owing to dirty contacts. The dirtiness resulted from arcing as the contacts opened and closed. This trouble was overcome by installing a transistor relay in the time-mark circuit, thereby reducing the current through the contacts from 13 mA to 1 mA.

The chronometer performed well throughout the year. Its rate was a function of temperature and could be altered by changing the temperature of the thermostatically controlled office. This fact proved quite useful, for it saved stopping the chronometer to adjust it.

Deflections on the seismograph records

From time to time during the year, particularly in the winter months, spurious deflections occurred on the seismograms. Two types of deflections occurred and these were most severe on the long-period records. The first type of deflection was in the form of a "bay" lasting for about half a minute. These bays were traced to ice cracking beneath the hut. I actually observed a "bay" occur and heard the simultaneous crack of the ice. The second type of deflection was more serious. It took the form of a sudden deflection of the trace to a new position and the continuation of the trace in that position for up to half an hour, after which time the trace would suddenly deflect back to its original position. The deflection frequently occurred almost simultaneously on the long period records and sometimes on the short period ones as well. This, together with the fact that the galvanometers required frequent relevelling, suggests that the pier changes level. Pier movement was also suggested by Kirton in his record of the year 1959 (Kirton, 1960).

Long-period fluctuations

Long-period fluctuations as described in the records of Hollingsworth (1961) and Branson (1965) appeared on the long-period records. I eliminated these fluctuations by constructing and fitting styrene foam covers to the horizontal seismometers (Plate 3). These covers were heated by a 60-watt lamp fitted at their highest point.

With the carpenter's help I also built and fitted a door to the seismometer room to keep out draughts from the cold-porch.

Drift snow under the seismic hut

The seismic hut at Mawson is open beneath the floor, and drift snow accumulates beneath the hut, causing trouble by linking the seismometer piers to the hut floor. Vibration of the hut, particularly during high winds, is therefore transferred to the seismometers. This results in almost useless seismic records. I partially overcame this difficulty by packing bags of coke between the floor of the hut and the ground, thus preventing to some degree the entry of drift snow. Canvas was ordered to replace the bags for 1964.

Time-line protection

Near the seismic hut the seismic time-lines pass over a camp road. On several occasions the lines in this section were damaged by vehicles. To overcome this inconvenience I passed the time-lines through waterpipes and bolted the pipes to the rock.

7. RADIO RECEIVER

An Eddystone radio receiver is kept in the office so that the Mercer chronometer and La Cour clock can be checked regularly against time signals broadcast from WWV, WWVH, JJY, and BPV.

During the year a new radio office was built and I obtained an aerial that was no longer required by the radio branch. I installed a steel pole outside the office to terminate the aerial and ran the wire to the top of a nearby Kelly and Lewis mast. The new aerial was longer and higher than the old one, and improved radio reception considerably.

Several defective valves were replaced in the receiver during the year and the set was realigned by technician Ron Grafton.

8. CHANGE-OVER AND VOYAGE HOME

M.S. Nella Dan anchored at Mawson on 17th February 1964. During change-over the incoming geophysicist Robin Cooke and I carried out a successful set of comparisons of the Mawson absolute instruments with instruments brought from Melbourne. BMZ 62 was also successfully compared with proton magnetometer MNZ 1. During the change-over I also calibrated the bar-fluxmeter. The official change-over ceremony took place on 24th February, and M.S. Nella Dan sailed for Davis on the 26th, arriving there on the 29th. At Davis I re-occupied the geomagnetic station by successfully observing H, D, and Z. This work occupied three days.

Geological work at Davis

The Geological Branch in Canberra wished to obtain some samples of dolerite from Davis for age determination, and I was asked by letter if I would oblige by collecting some. Five specimens were collected. Photographs were taken of the dykes from which the specimens were taken, and the position of each dyke relative to the camp was noted. I also recorded the width of each dyke and the bearing of the line of strike.

The ship sailed for Melbourne on 6th March.

9. ACKNOWLEDGEMENTS

I would like to express my gratitude to the following members of the 1963 Mawson and Davis expeditions.

Mawson: Cosmic ray physicist David Cooke who assisted in magnetograph and chronometer adjustments.
Auroral engineer Don Creighton who designed the thermostat for the variometer hut.
Carpenter John Davidson who willingly helped with my carpentary jobs.
O.I.C. Ray McMahon and ionospheric physicist Robert Schaeffer who performed the geophysical routines while I went on a five-day field trip to Gibbney Island.

Davis: O.I.C. William Young who found time to blast a dolerite dyke for me during the intense change-over programme.

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APPENDIX 1

BAR-FLUXMETER CALIBRATION

Method of calibration

To calibrate the bar-fluxmeter, I wound a calibration coil consisting of 219 turns of cotton covered copper wire around the bar using the cylindrical fibre glass cover as a former (Plates 4, 9). Sinusoidal currents of known magnitude and frequency were passed through the calibration coil, and the fluxmeter deflections were noted. Since the currents flowing through the calibration coil were known, the magnetic field change in gammas through the calibration coil could be calculated; for a particular frequency, the scale value in gammas per millimetre trace deflection could be determined.

To calculate the field due to the current through the calibration coil, I assumed that the formula for the field in an infinite solenoid would be adequate, since the length of the calibration coil was large in comparison with its diameter.

Data concerning the calibration coil

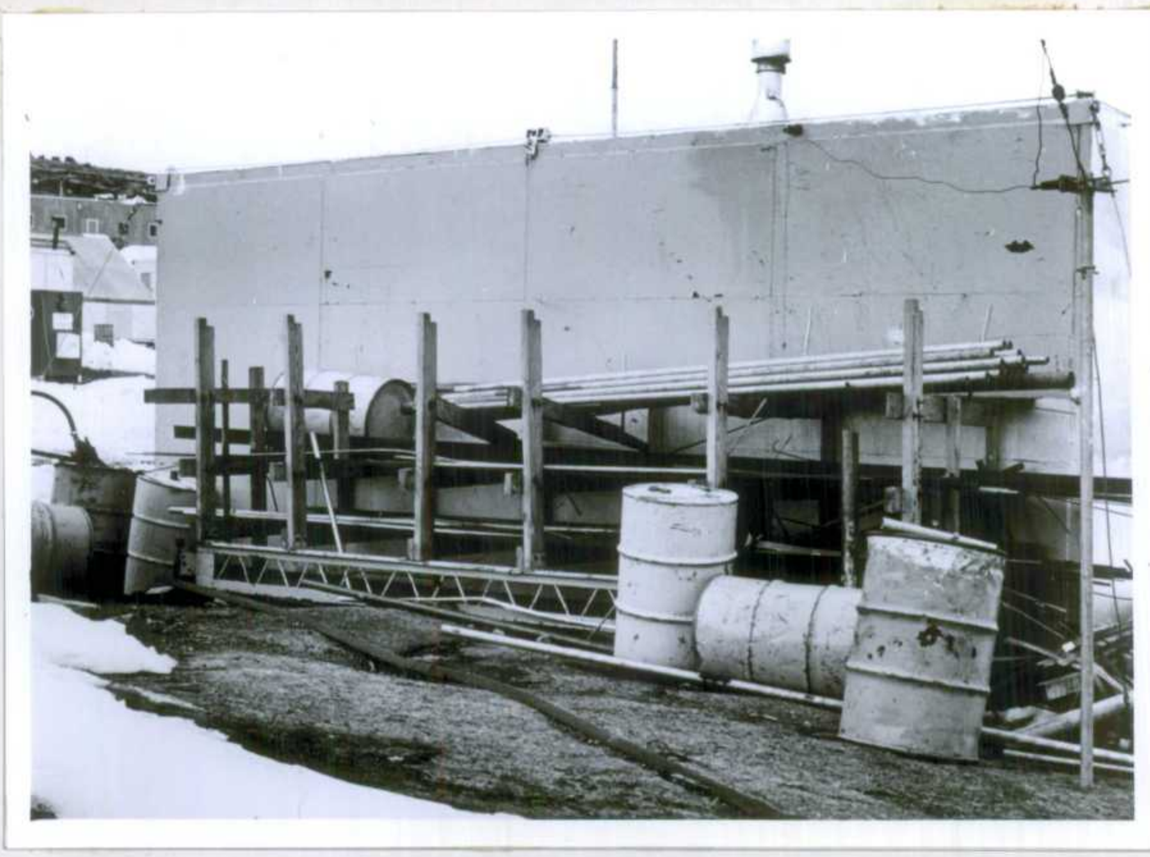
Length of calibration coil (L)	:	2.19 metre
Number of turns (n)	:	219
Peak calibration current (i)	:	4×10^{-4} amp.

The maximum field strength in the calibration coil is given by $(kni/L) \times 10^9$ gammas. Where k equals $4\pi \times 10^{-7}$ henry/metre. This gives a peak field of 50 gammas.

The observed and calculated values are tabulated below, and the results are plotted in Plate 10.

Period of calibrating magnetic field (sec)	Trace deflection (mm)	Bar-fluxmeter scale value (gammas/mm)
1		
2	17.5	2.86 (=50/17.5)
3	23.9	2.09
4	28.9	1.73
5	33.1	1.51
6	35.8	1.40
7	38.9	1.29
8	41.0	1.22
9	41.9	1.19
10	42.5	1.18
20	46.9	1.07
30	47.5	1.05
40	47.5	1.05
50	46.9	1.07
60	46.5	1.08
70	45.0	1.11
80	44.0	1.14
90	43.2	1.16
100	42.8	1.17
180	-	1.7 *
200	-	1.4 *
235	-	1.5 *
260	-	2.8 *
300	-	2.5 *

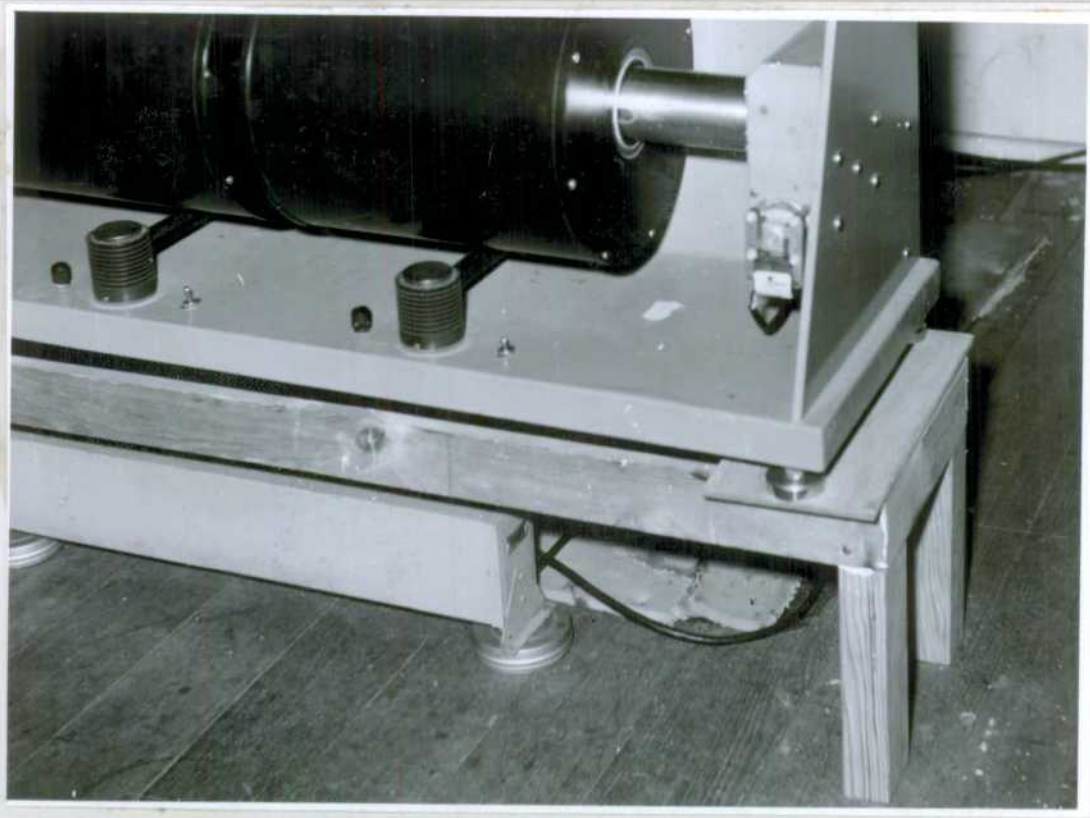
* These values were determined by comparing geomagnetic pulsations on the bar-fluxmeter trace with the same pulsations on the La Cour normal-run magnetograph trace.



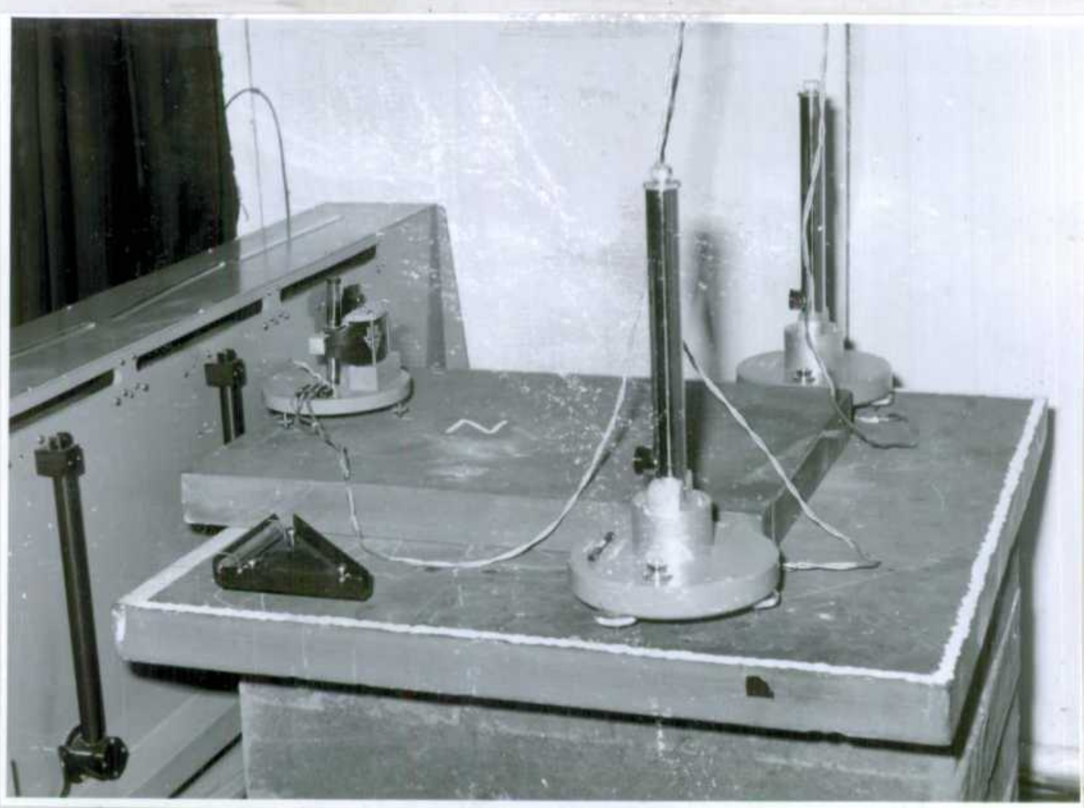
(a) The geophysics office before renovation.

(b) The geophysics office after renovation.

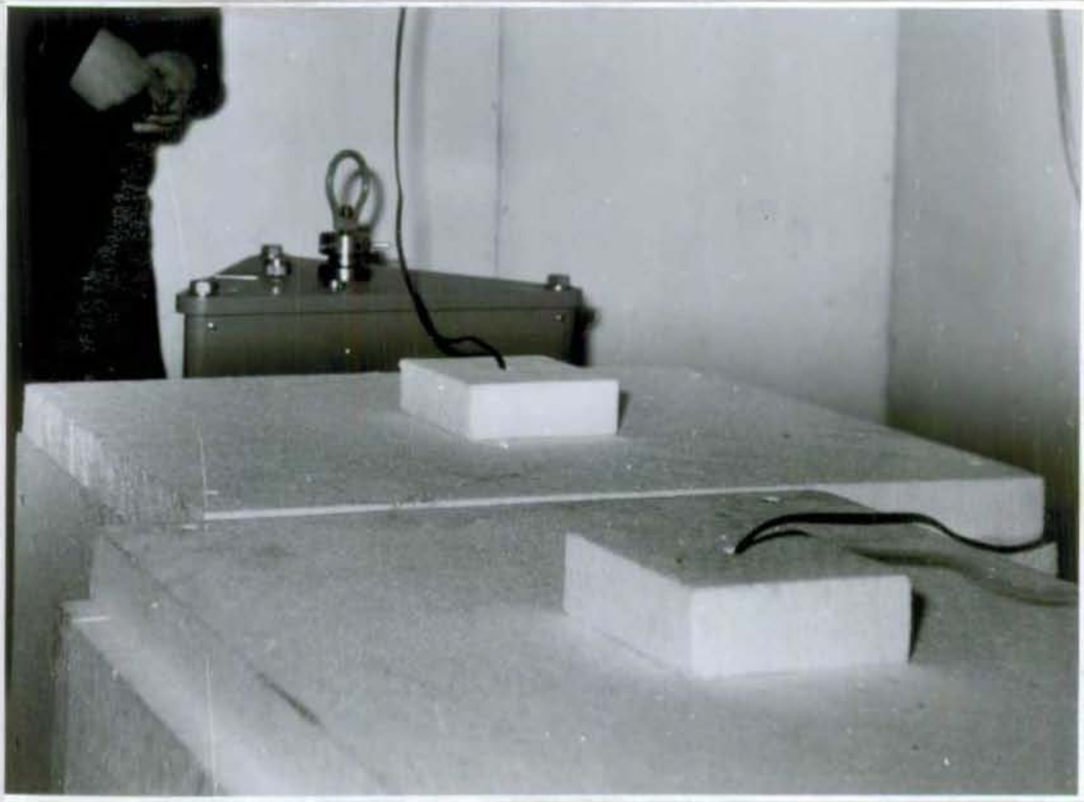
PLATE 2



(a) The Benioff 60 mm/min recorder and stand. The heater beneath the stand is to keep the recorder warm and thus prevent it labouring in cold weather.



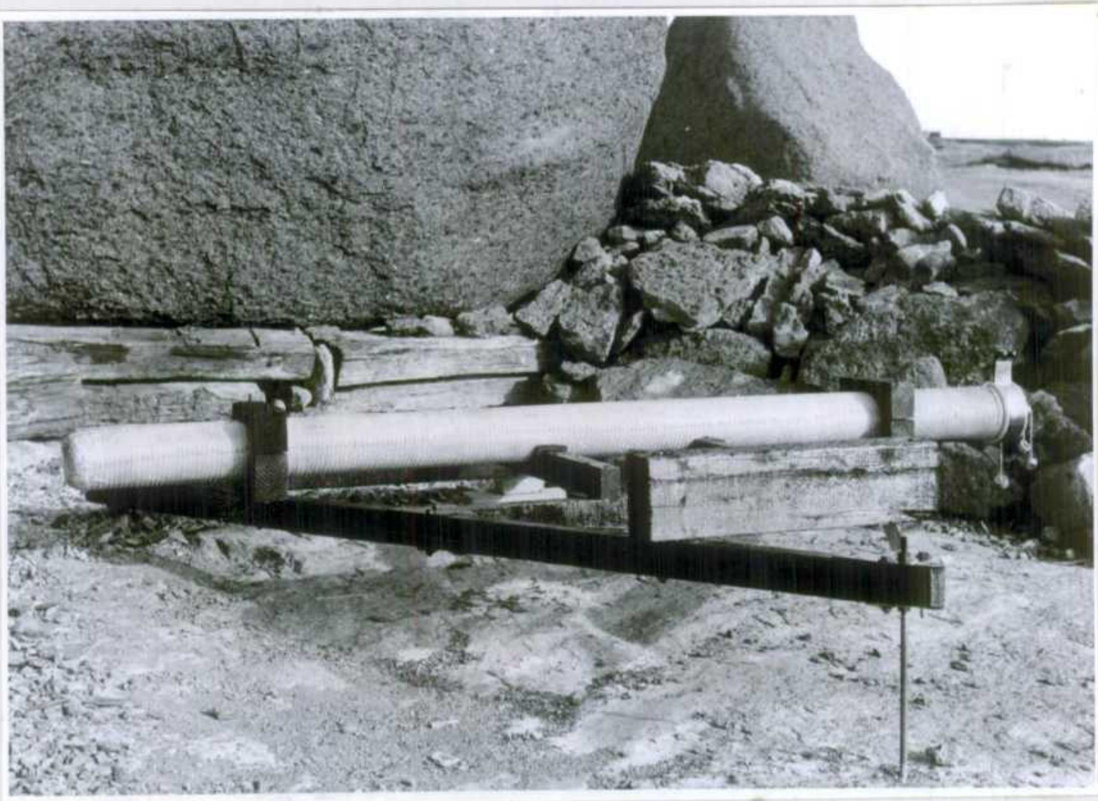
(b) The seismic galvanometers, pier and Benioff recorder.



(a) A view into the seismometer room showing the horizontal seismometers with their styrene foam covers. The vertical seismometer is also shown.

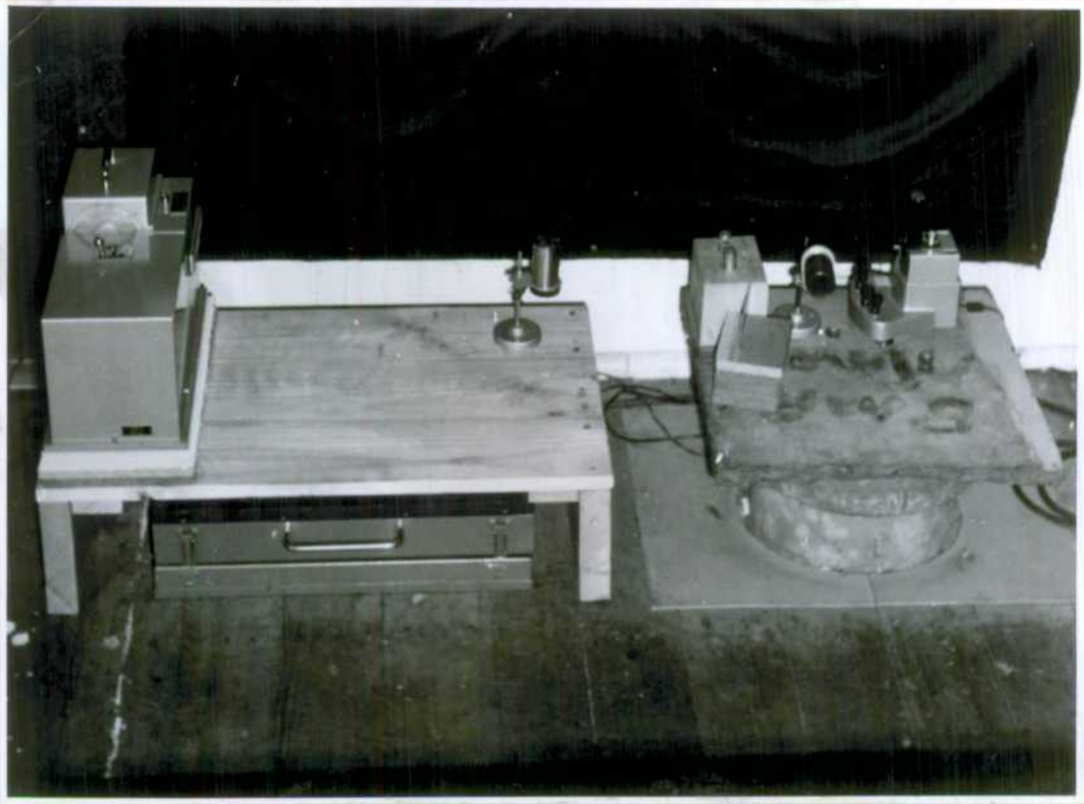
(b) The seismograph control boxes.

PLATE 4

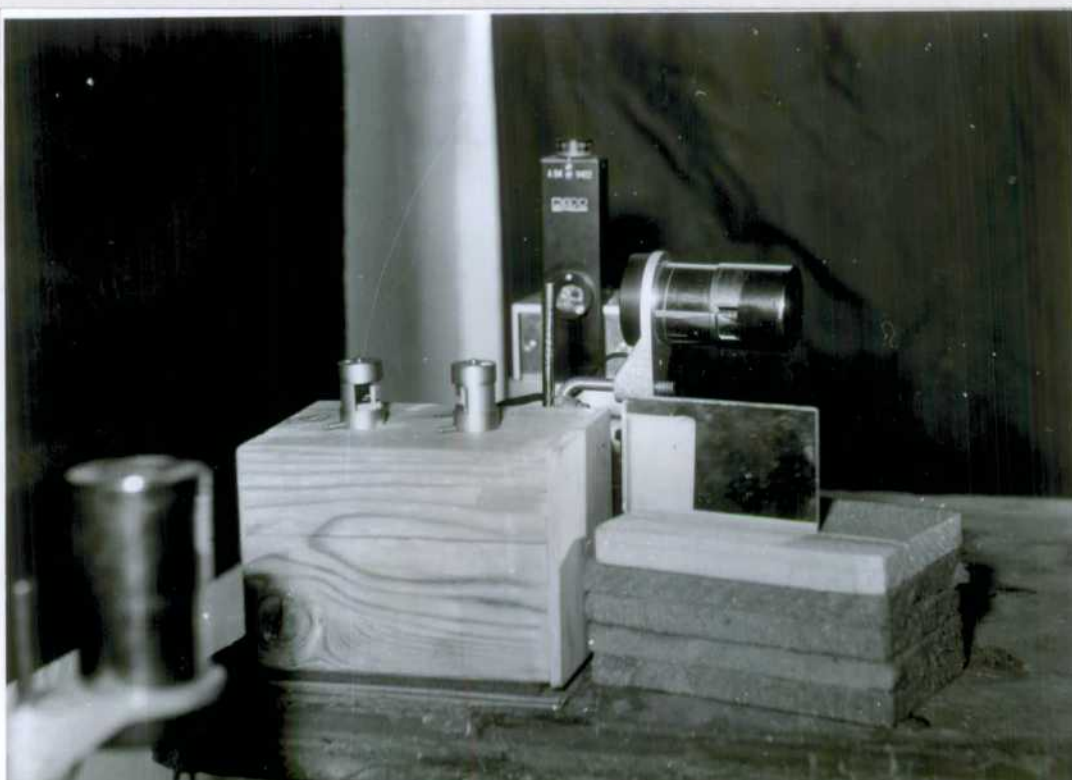


(a) The bar-fluxmeter bar, calibration coil and protective rock wall.

(b) A close-up photograph of the bar-fluxmeter bar showing the calibration coil, metal collar and terminals.



(a) The bar-fluxmeter recording section showing left to right: recording camera, illumination lamp for fluxmeter and mirror, reserve prisms, mirror to reflect light from the lamp on to the graticule in the camera, timemark lamp and fluxmeter. The bar-fluxmeter control box is shown under the table.

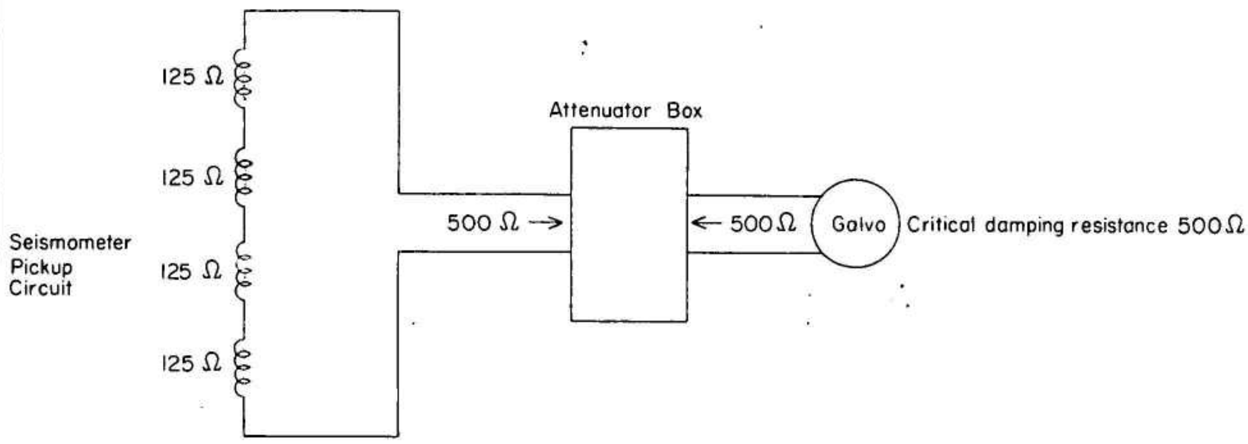


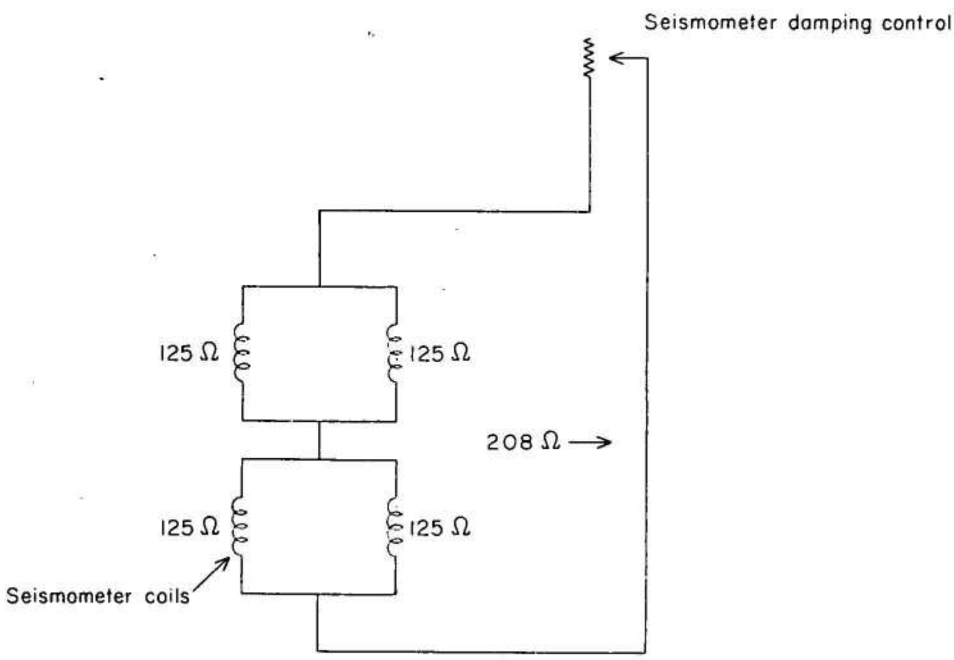
(b) The fluxmeter and optics.

PLATE 6

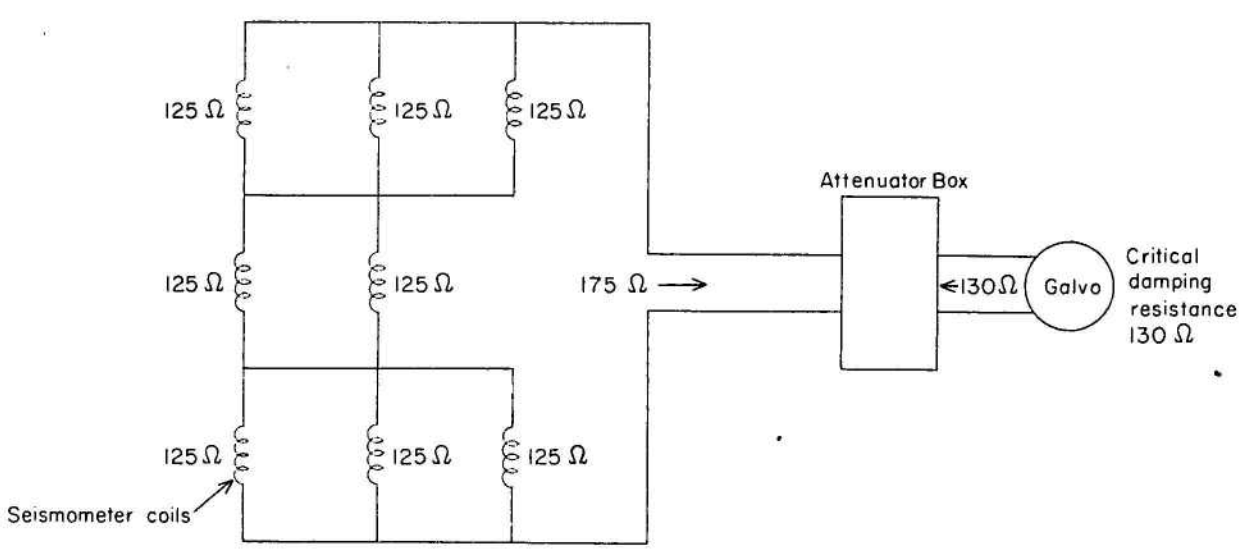
SEISMOGRAPH CIRCUITS

Long-period Seismographs





Short-period Seismograph



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SEISMOGRAPH AND BARFLUXMETER TIMEMARK CIRCUIT

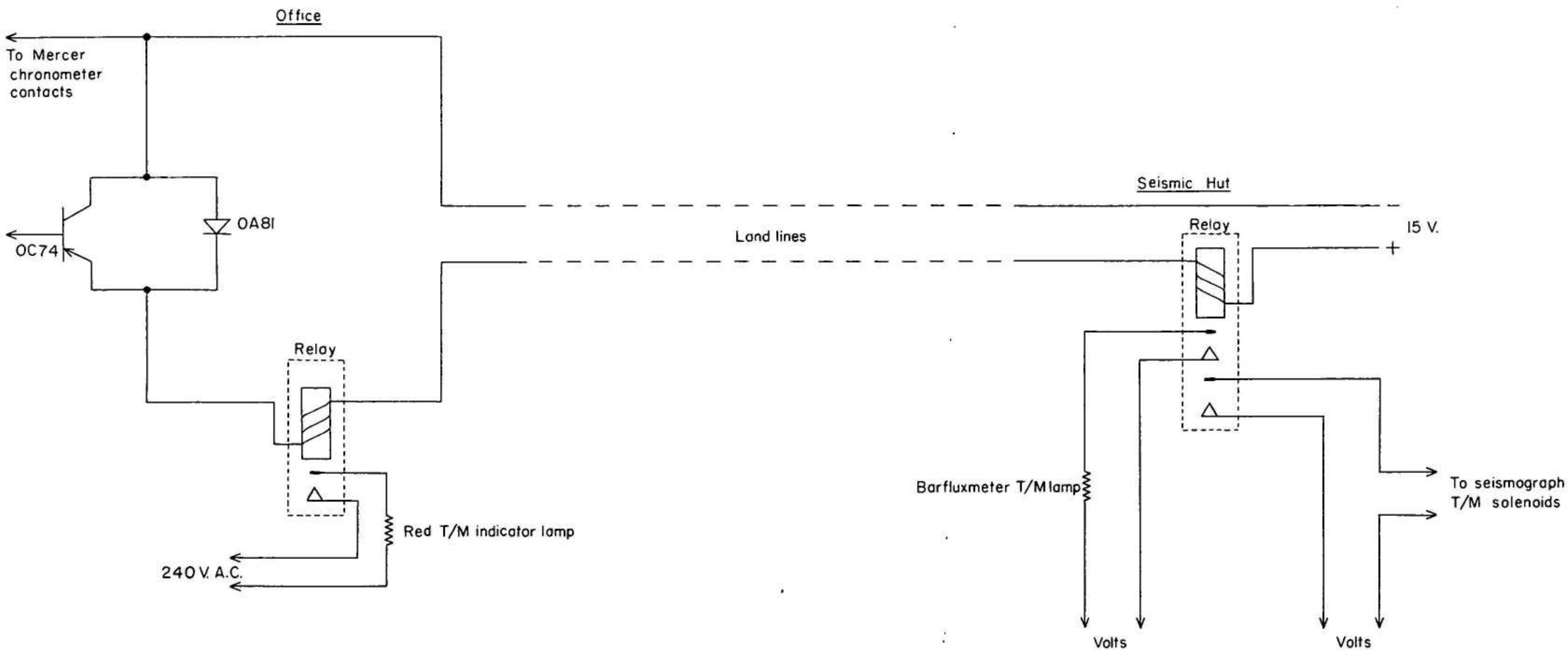

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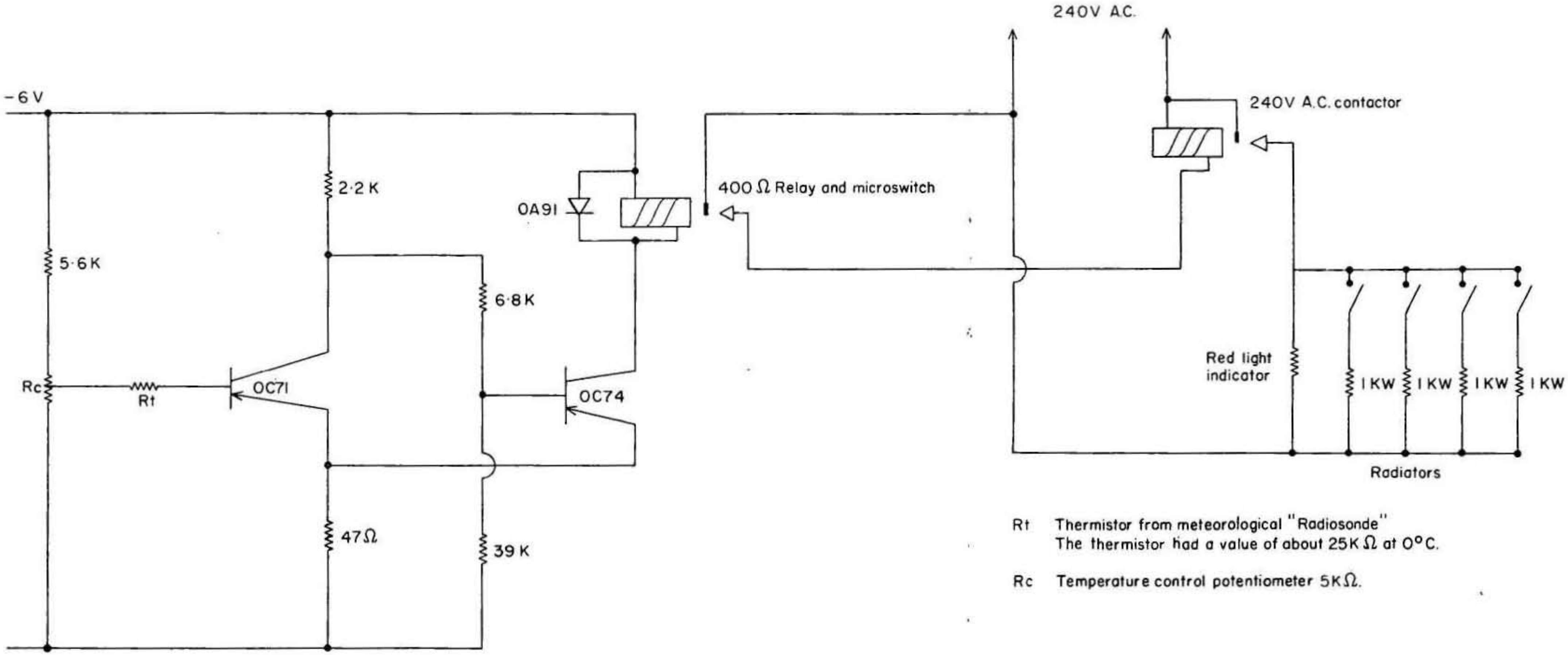
PLATE 7

VARIOMETER HUT TEMPERATURE CONTROL CIRCUIT



Rt Thermistor from meteorological "Radiosonde"
The thermistor had a value of about 25K Ω at 0° C.

Rc Temperature control potentiometer 5K Ω.

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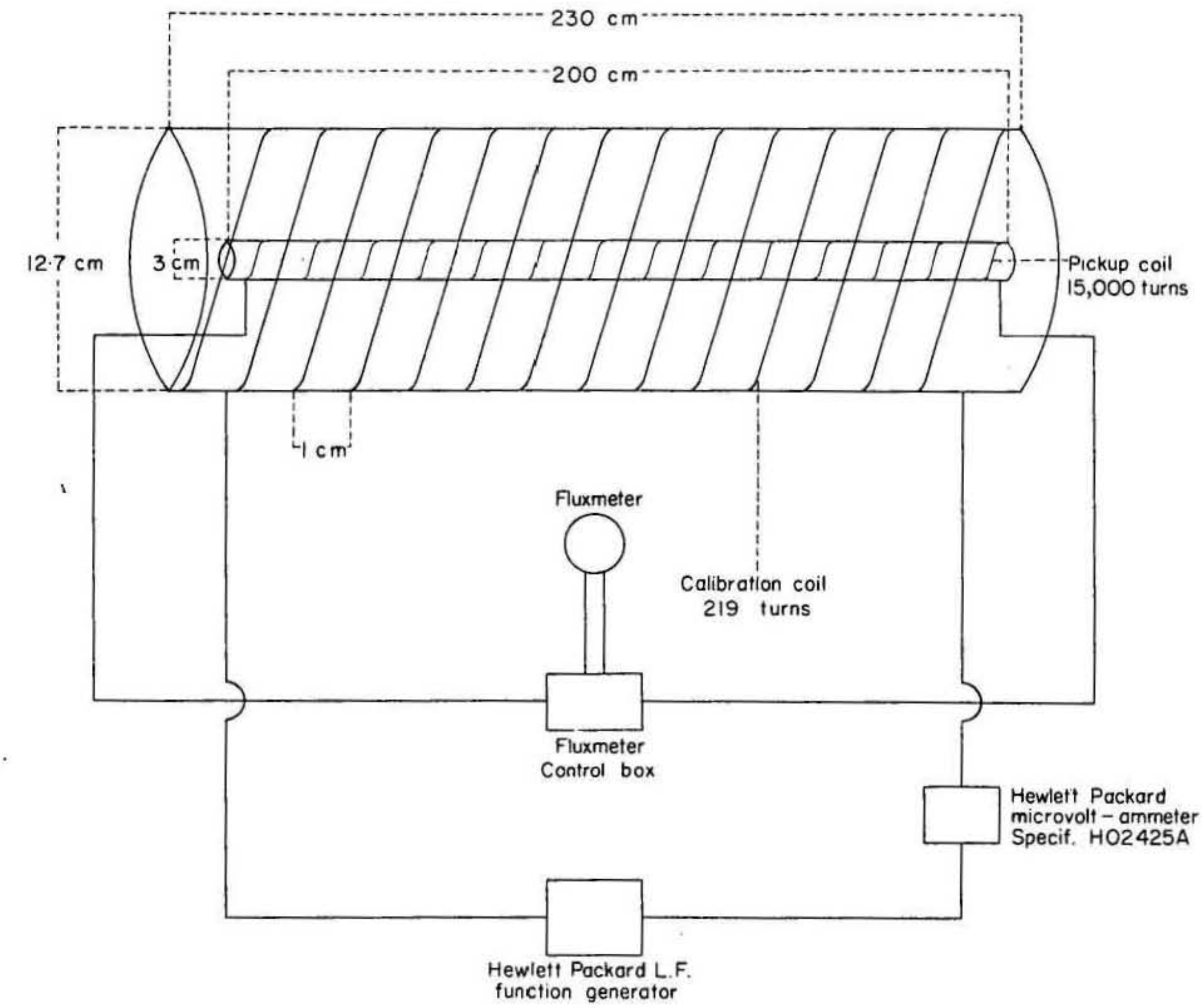
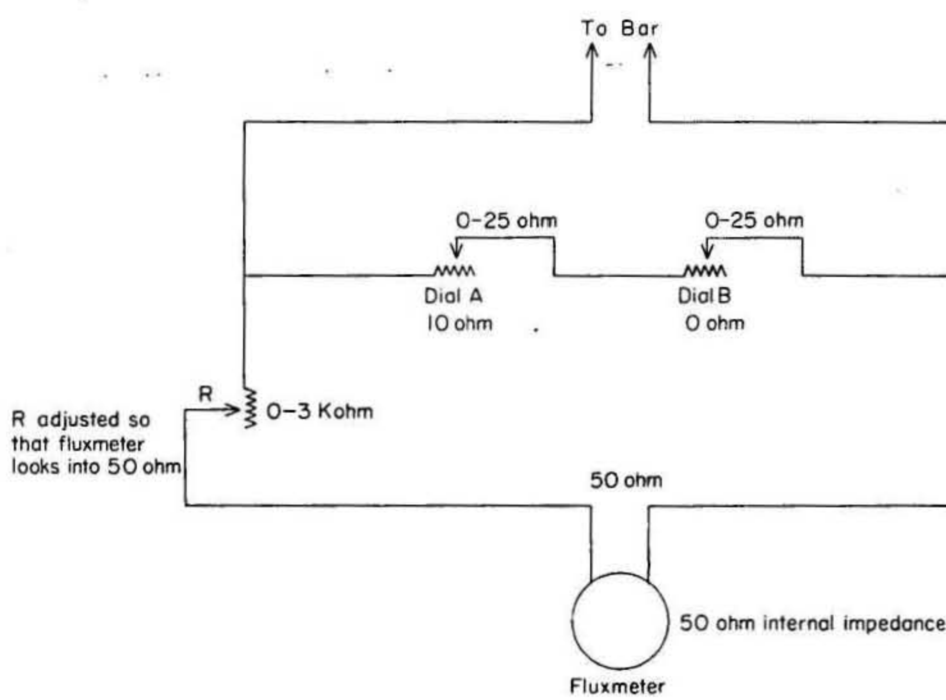
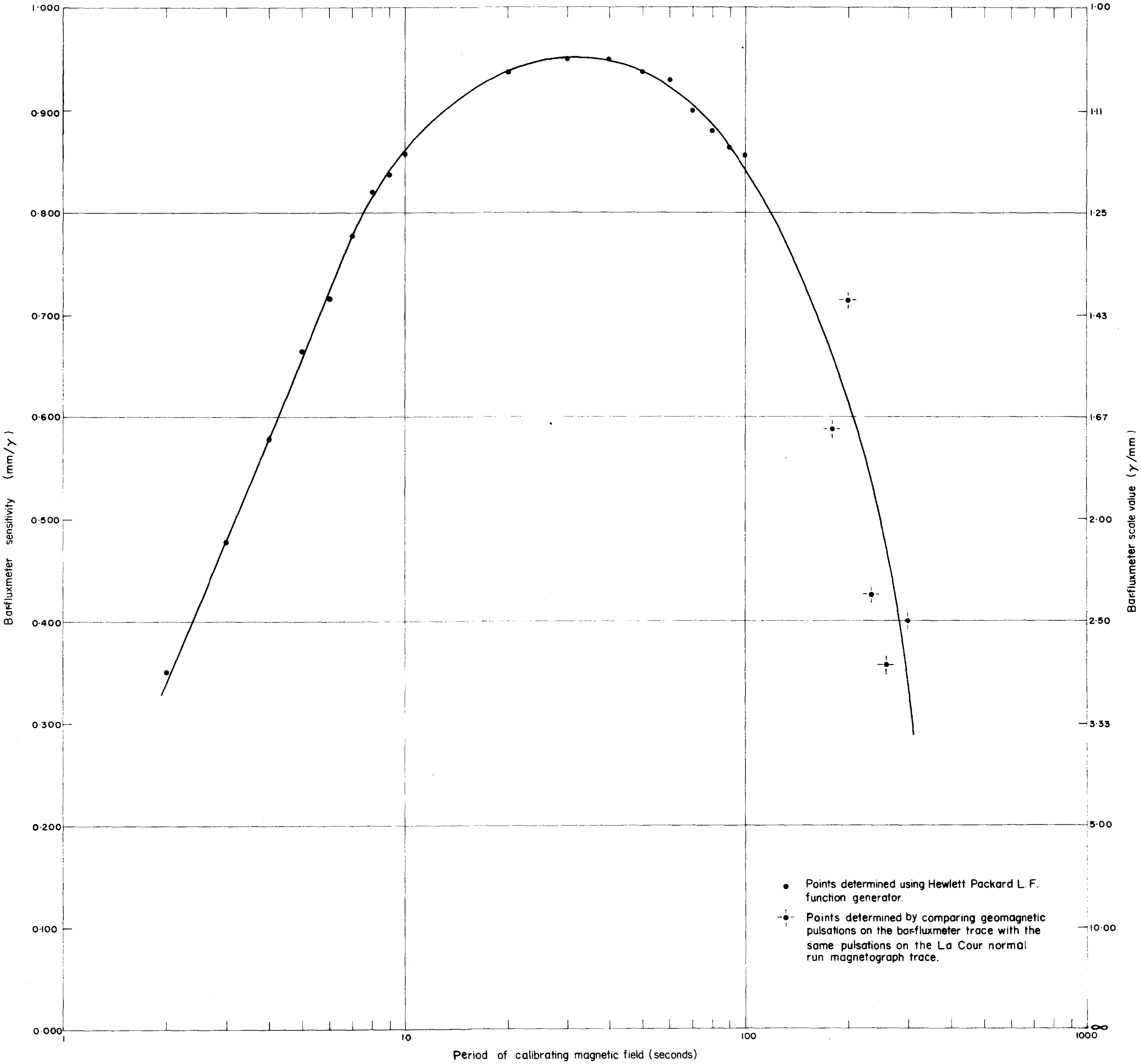
PLATE 8

Circuit used to calibrate the bar-fluxmeter



Bar-fluxmeter – Control box circuit





BAR-FLUXMETER CALIBRATION CURVE