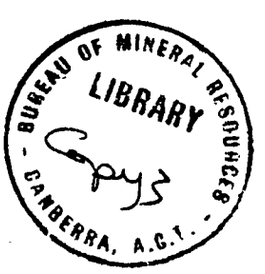
COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1965/63

INSTALLATION OF A SEISMOGRAPH AT KALGOORLIE, WA 1964



by

I.B. EVERINGHAM

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ILLUSTRATIONS

SUMMARY

A three-component, short-period seismograph was installed in a storeroom of the Kalgoorlie airport in November 1964 as an outstation of the Mundaring Geophysical Observatory of the Bureau of Mineral Resources. It will help to fill a gap in the distribution of Australian observatory stations and should provide useful data on local and regional events and also on teleseisms.

1. INTRODUCTION

A three-component, short-period seismograph was installed at Kalgoorlie early in November 1964 as an outstation of the Mundaring Geophysical Observatory. Staff of the Observatory set it up, will carry out periodical tests and adjustments, and will analyse the records. The Department of Civil Aviation has arranged for a member of its staff to attend to the seismograph daily and mail the undeveloped records to Mundaring.

2. PURPOSES

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The station is on the Precambrian Shield 520 km from Mundaring and about 1700 km from Adelaide. It helps to fill a gap in the distribution of Australian stations and should provide useful data on local and regional events and also on teleseisms. Some immediate uses for the Kalgoorlie data are as follows:

(a) It is proposed to study events that frequently cause damage in mines in the Kalgoorlie area. Information supplied by Lake View and Star Ltd lists 46 events during 1957-1961, of which 19 caused damage. Reports of damage have been kept in the files of the Perth Observatory since 1916. It is of some practical importance to study the nature of these events. There does not seem to be sufficient evidence to ensure that they are not rockbursts.

(b) Records from Kalgoorlie will be used individually and in conjunction with those from other stations to locate earth tremors. It is possible that there are active zones within about 200 miles of Kalgoorlie, but they have not been detected, as the tremors may be small and too far from Mundaring to be detected by that station.

(c) It should be possible to study local crustal structure by means of seismic waves generated by local tremors, rockbursts, and distant earthquakes. This will aid geological understanding of the area.

(d) By measuring time-delays to P waves from distant earthquakes it will be possible to study the upper mantle of the earth and compare effects at Kalgoorlie with those at other Australian stations.

(e) Results from the station will be distributed to international organisations for use in various researches and for the routine location of larger earthquakes in Australia and overseas.

3. SITE SELECTION AND INSTALLATION

P.M. McGregor made preliminary arrangements for the siting of the equipment and found that the airport was the most convenient site; it was almost clear of industrial noise from the mines and railways, it had the necessary power supplies, including an emergency supply in case of mains failures, and has staff available for the changing of records. Permission was granted by the Regional Director of the Department of Civil Aviation (DCA), Perth, to use space at the airport.

I.B. Everingham, assisted by N. Keating, installed the equipment during the period from the 2nd to the 6th November 1964 in a storeroom near the airport entrance (see Plate 1). The site is marked by a bronze plaque that indicates the position:

Latitude : 30° 47' 01.2"

Longitude : 121° 27' 28.8"

Elevation of the site is 1200 ft and the building is situated on shallow alluvium that covers basic metasediments of Precambrian age.

The equipment was transported to the site from Mundaring by road in a 30-cwt runabout and a Holden station wagon. The loads were:

(a) Holden station wagon: Benioff recorder, radio, chronometer, and sundry equipment.

(b) 30-cwt truck: two Benioff horizontal seismometers, the recorder dark-room, bench, and sundry equipment.

Apart from the wrapping of the recorder in a polythene sheet for dust proofing, no special methods were required for transportation of the equipment, which arrived intact and in working order.

The equipment was set out as shown in Plate 2.

The recorder was built into a prefabricated, light-proof, plywood cabin, eight feet wide, six feet deep, and six feet high. It was designed to house all the instruments if necessary, but the rest of the equipment was placed outside the cabin where lighting is normal so that the operator may easily see the instruments other than the recorder if it is necessary to make adjustments or changes on instruction from Mundaring.

Routine operation commenced at 1400 hours Western Standard Time on 6th November 1964.

4. INSTRUMENTATION

The instruments installed were mainly Benioff equipment which was originally at Mundaring but which was replaced by the World-Wide Standard Seismograph (WWSS) instrument. Details are as follows:

Recorder:	three-channel Benioff recorder using photographic paper at a speed of 60 mm/minute and galvanometers having a free period of 0.25 second.
Seismometers:	Willmore (vertical), free period approximately 1.0 second. Benioff (horizontal), free period 1.0 second.
Time-marks:	minute marks (four seconds) from chronometer. Radio time-marks (six pips) from the local broadcast station of the Australian Broadcasting Commission (ABC) when available between 0600-2400 hours Western Standard Time. Recorded all traces.
Power:	250-volt, 50-c/s mains, DCA emergency power supply ten seconds after mains failure.

The Benioff recorder is modified slightly as follows:

(a) The addition of a constant-voltage transformer for the record-lamp power supply to ensure a light spot of even intensity.

(b) By-passing the attenuator on the vertical component channel, because no attenuation is required when using the Willmore seismometer.

Plates 3 and 4 show circuit diagrams of the auxilliary components. The time-mark system provides normal minute marks from a transistorised relay that has been added to the Mercer chronometer; it also puts radio time-pips on the records. This is done by the radio time-mark programmer (Plates 3 & 4), which, on receiving an hour pulse from the Mercer chronometer, turns on the radio for approximately two minutes. The radio is tuned to a Kalgoorlie station of the ABC and receives the hourly time-pips, which are passed through a 1000-c/s filter and recorded on the seismogram by means of relay operation.

The d.c. power supply unit supplies 24 volts for the chronometer relay and the radio time-mark programmer. These three units were designed and manufactured (by G. Woad) at the Mundaring Observatory for use at remote field stations.

Through the kind offices of the Department of Civil Aviation, an officer of that Department visits the equipment daily. He winds the chronometer, changes records, checks the operation of the hourly time-marking device and the recorder, and puts calibration pulses on each record.

It will be necessary to calibrate the seismographs with the Willmore calibration bridge as soon as possible. The horizontal components were adjusted to the same periods, damping, and trace amplitude (when the calibration pulse is applied). However, in the present calibration of horizontal seismographs it is assumed that the seismometers have equal electro-mechanical properties and although this is normally the case it is not necessarily so. It is important to match the horizontal seismographs because they will be used to measure directions of local seismic events.

The maximum working magnification of a seismograph is controlled by the local ground noise such as microseisms, industrial noise, and wind-generated vibrations.

At the Kalgoorlie site, preliminary results show that the gain will be limited by industrial noise from the mines ($T = 0.25$ second) and by wind-generated vibrations of the building ($T = 0.25$ to 1.5 seconds). It will be necessary to run the instrument for several weeks before finally deciding what damping and magnification is best for permanent settings. The magnification decided on initially is at least 25,000 at a one-second period and probably about 50,000 at a half-second period (by comparison with the WWSS).

At present the galvanometer is overdamped on all components. The horizontal seismometers are critically damped and the vertical seismometers are underdamped. The overdamped galvanometers make the magnification relatively smaller at the higher frequency range and subdue the 0.25-second mining noise. Nothing can be done to reduce the wind noise on the records apart from burying the seismometers away from the recorder. It is fortunate that this noise is not persistent and does not affect more than a small percentage of the recording time.

Preliminary magnification curves will be drawn by comparisons with the Mundaring WWSS records.

6. RECOMMENDATIONS

The following recommendations are made :

(a) The equipment should be calibrated.

(b) The officer who changes the records should be taught to record seismograph free periods, etc., and they should be measured at regular intervals. Calibration circuits will need to be designed to simplify the procedures.

(c) The routine data should be treated similarly to the Mundaring data and regular bulletins should be compiled and transmitted.

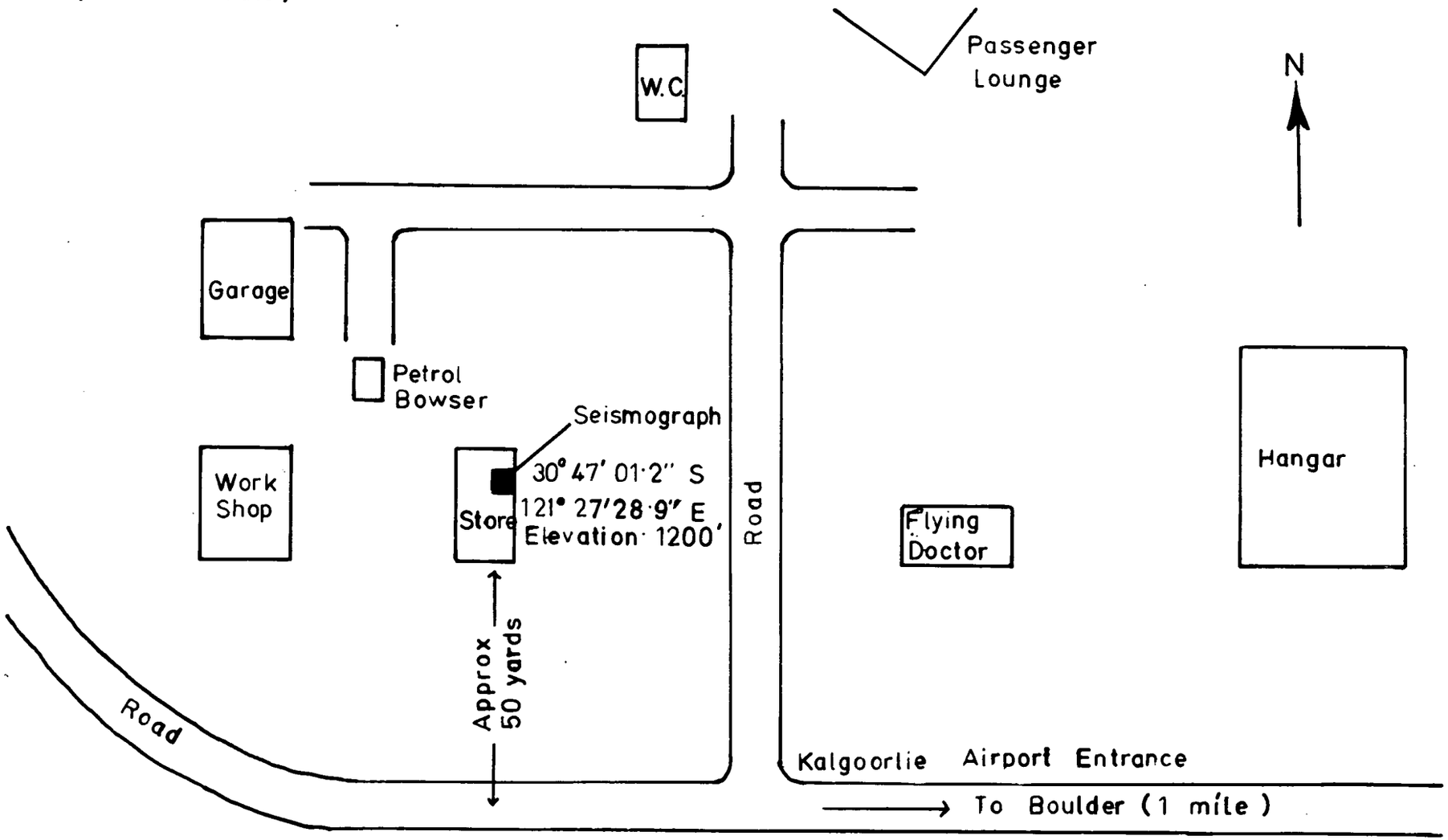
(d) The station should be visited after a settling-down period of about eight weeks and minor faults cleared, magnifications reset if necessary, periods and damping remeasured, wind noise tests carried out, and improvements to the system made wherever possible.

(e) The Willmore vertical seismometer may have to be buried (remotely from the recorder) if wind-generated noise is excessive. If this is necessary and the results show a sufficient improvement in the vertical signals, the horizontal seismometers could later be similarly set up.

7. ACKNOWLEDGEMENTS

The co-operation of the Deputy Director and staff of the Department of Civil Aviation, Western Australia is gratefully acknowledged. The use of the DCA building to house the equipment and the help of DCA staff in running it have greatly simplified the installation and operating procedure of the seismograph.

(Not to scale)



SKETCH OF SEISMOGRAPH LOCATION AT KALGOORLIE AIRPORT

To accompany Record Nº 1965/63 G82/3-49

PLATE 1

SEISMOGRAPH LAY-OUT

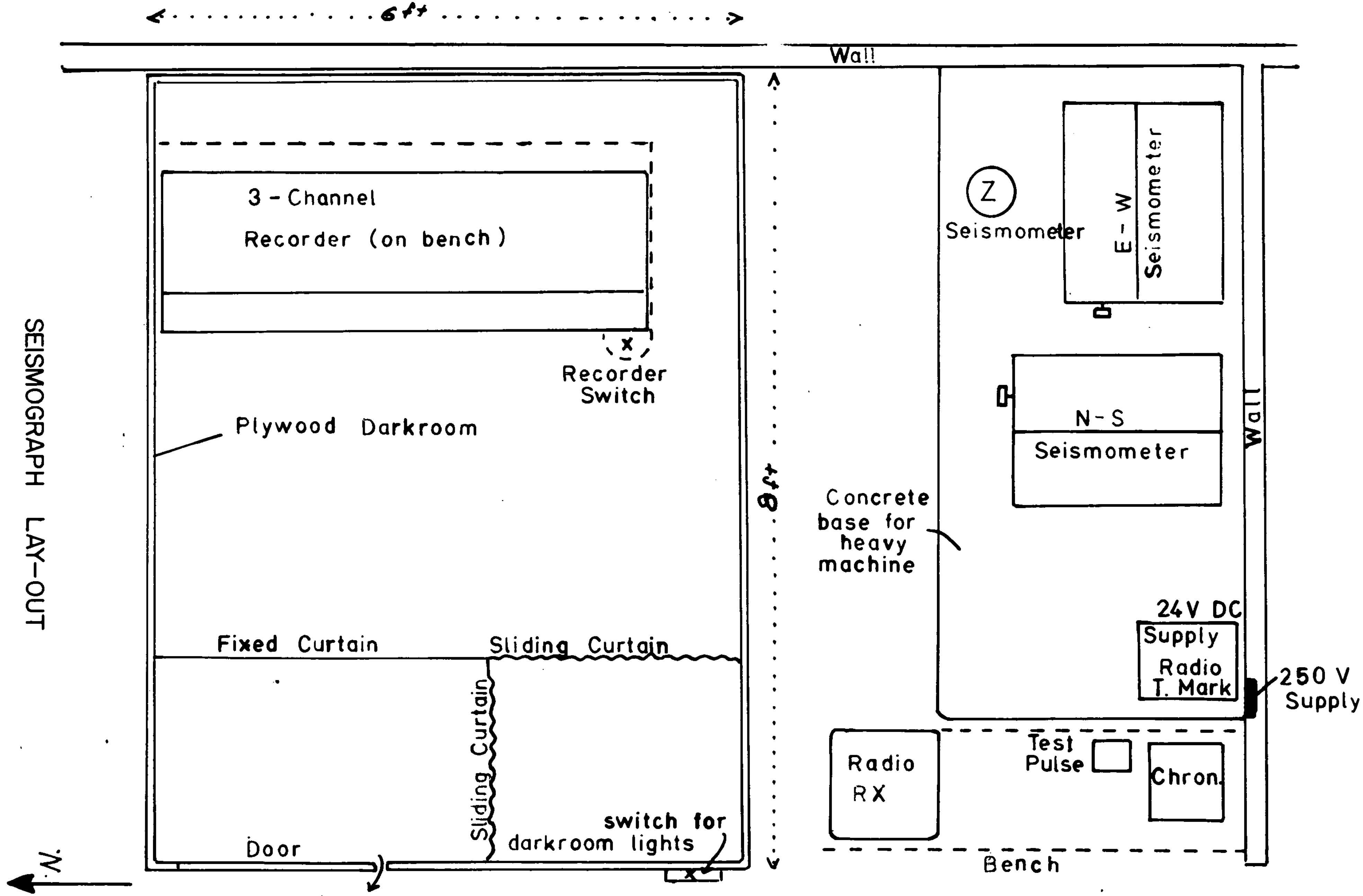
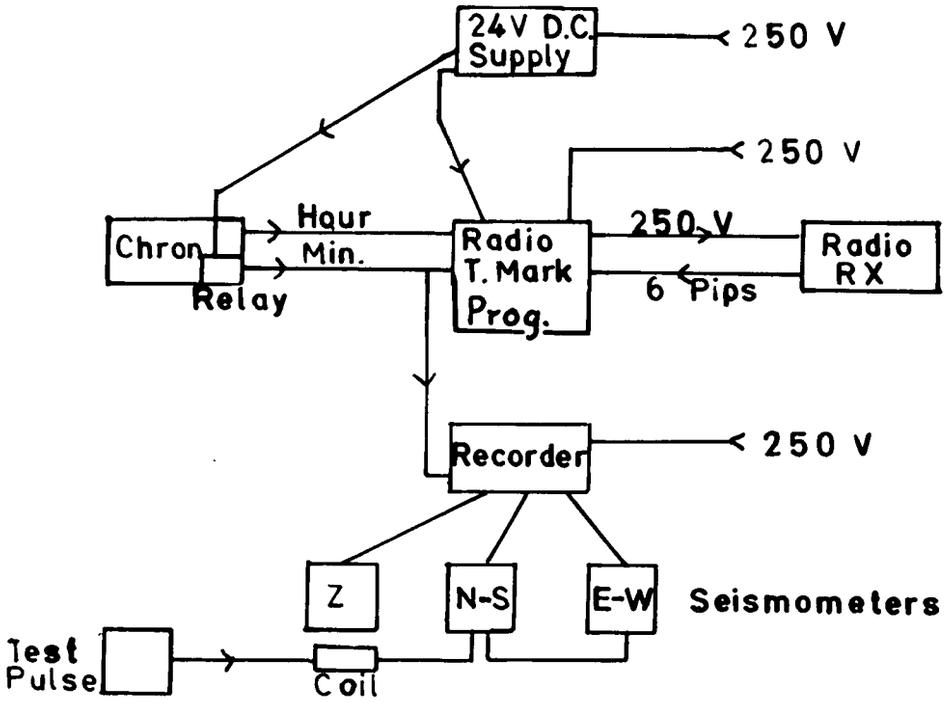


PLATE 2

To accompany Record Nº 1965/63

G82/3-48



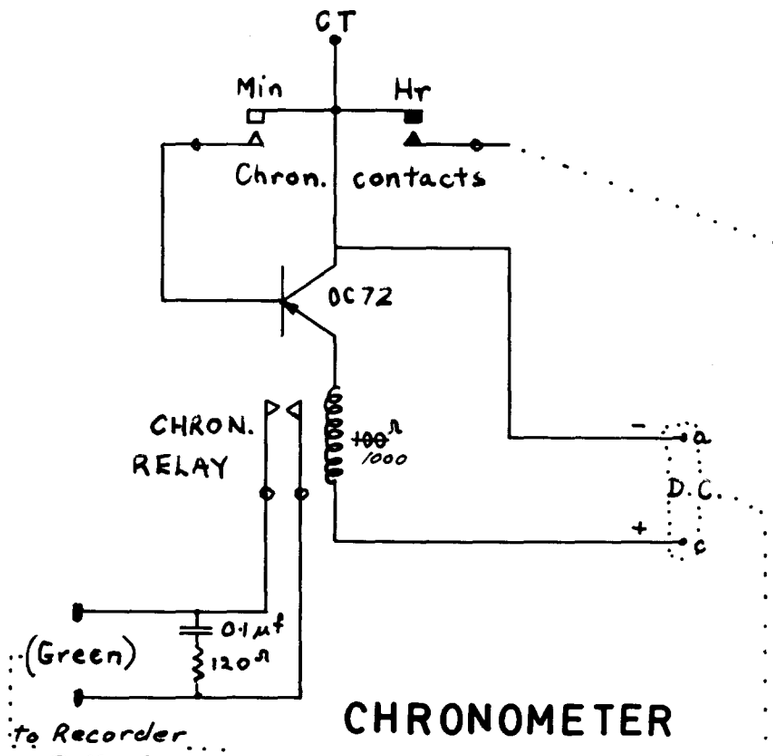
SCHEMATIC DIAGRAM of

KALGOORLIE SEISMOGRAPH

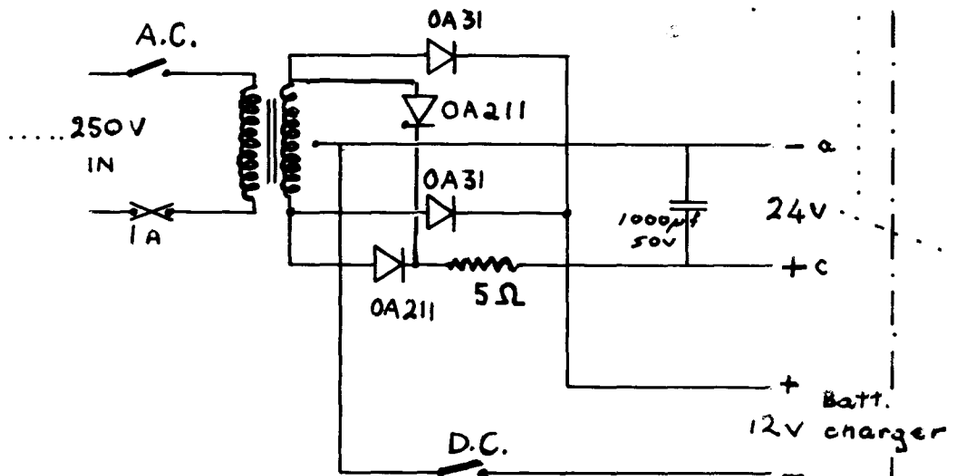
(Note: Test pulse circuit is temporary)

To accompany Record Nº 1965/63

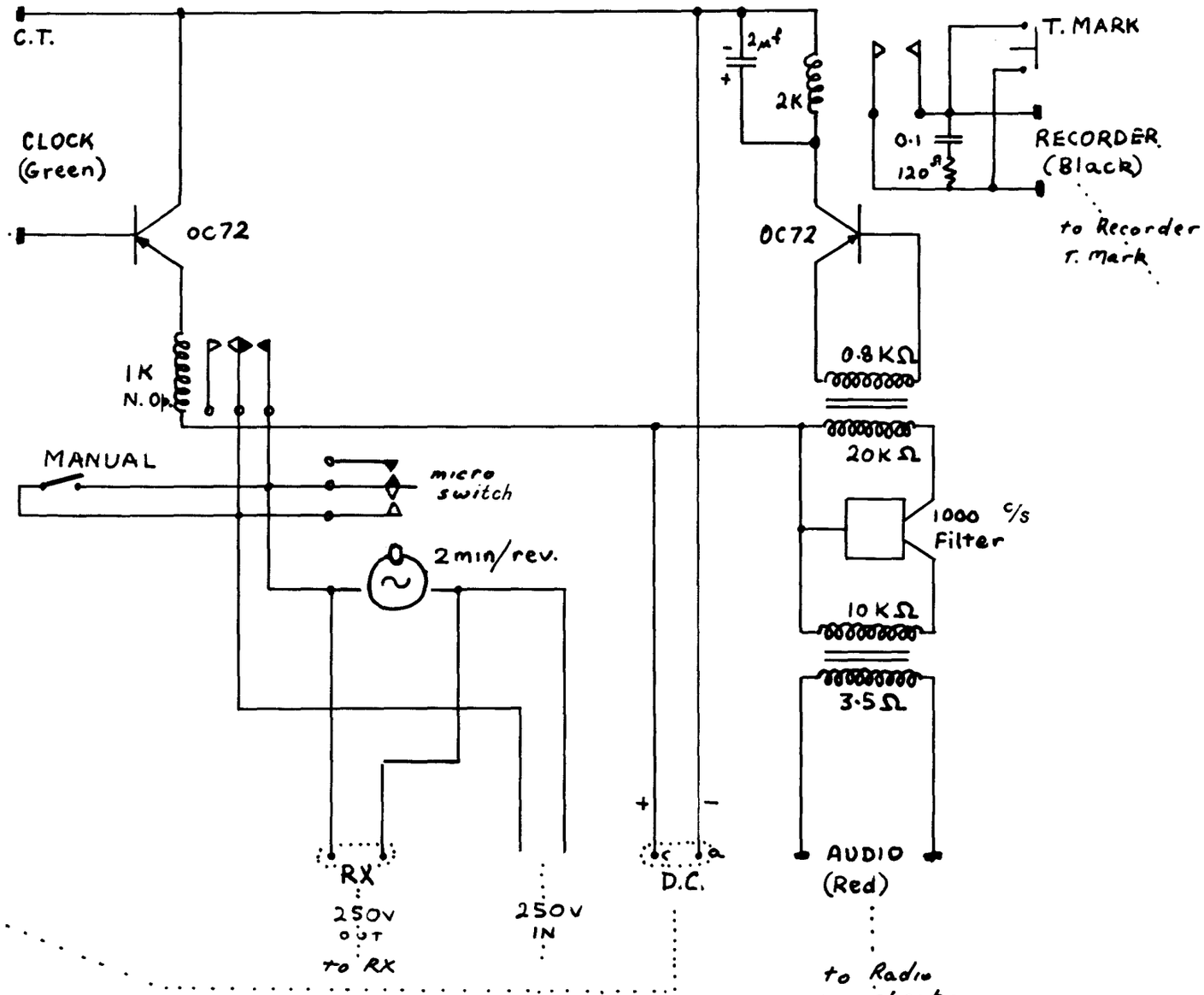
G82/3-47



CHRONOMETER



D. C. POWER SUPPLY



K - resistance 1000Ω
KΩ - impedance 1000Ω

RADIO TIME-MARK PROGRAMMER

To accompany Record Nº 1965/63

GB2/3-50