66/37
3

COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1966/37

COPY 3

014971

MUNDARING GEOPHYSICAL OBSERVATORY,

ANNUAL REPORT 1964

by

P.M. McGREGOR

The information contained in this report has been obtained by the Department of National Development as part of the policy of the Commonwealth Government to assist in the exploration and development of mineral resources. It may not be published in any form or used in a company prospectus or statement without the permission in writing of the Director, Bureau of Mineral Resources, Geology and Geophysics.

RECORD No. 1966/37

MUNDARING GEOPHYSICAL OBSERVATORY,

ANNUAL REPORT 1964

by

P.M. McGREGOR

The information contained in this report has been obtained by the Department of National Development as part of the policy of the Commonwealth Government to assist in the exploration and development of mineral resources. It may not be published in any form or used in a company prospectus or statement without the permission in writing of the Director, Bureau of Mineral Resources, Geology and Geophysics.

CONTENTS

ILLUSTRATIONS

SUMMARY

1964 was the sixth year of operation of the Mundaring Geophysical Observatory. Routine observations were continued in geomagnetism, seismology, and on the ionosphere, and the results were distributed to appropriate centres. A seismological station was established at Kalgoorlie in November.

1. INTRODUCTION

Activities of the Mundaring Geophysical Observatory to the end of 1963 have been given in two previous Records (McGregor, 1966a and b). The first included descriptions and plans of the establishments, descriptions of procedures and equipment, and an outline of its history up to the end of 1962. The present Record summarises operations during 1964.

2. STAFF

Occupants of staff positions were:

Geophysicist Class 3 (Observer-in-Charge)	P.M. McGregor
Geophysicist Class 2	I.B. Everingham
Geophysicist Class 1	P.J. Browne-Cooper (13th Feb. to 16th Oct.)
	P.J. Gregson (from 2nd Oct.)
Technical Officer Grade 2	A. Parkes
Technical Officer Grade 1	G. Woad
Clerical Assistant Grade 1	Miss D.M. Belcher (to 9th September)
	Miss T.D. Dunning (from 7th September)
Assistant Grade 1	N. Keating

Others employed were:

Geophysicist Class 1 (Antarctic)	R.J.S. Cooke (20th Jan. to 4th Feb.)
	J.E. Haigh (22nd Sept to 23rd Oct)
University students (vacation 1963/64)	P.J. Browne-Cooper
	S.S.W. Hui
	C.J. Kosina
(vacation 1964/65)	Miss L.F. Quin
	V.N.E. Robinson
Gnangara Assistant	R.N. Gaskell

Absences of regular staff members, other than for recreation leave, were:

Officer	Reason	No. of days
Everingham	Attendance at symposium	10
McGregor	Duty at Macquarie Island	22
Woad	Military camp	10
	Military course	10
		Total 52

Sick leave absences amounted to another 25 man-days.

At the Hobart symposium on crustal structure (24th to 29th August) Everingham presented a paper showing the crustal structure in south-western Australia. This was derived from data obtained during the field projects described by McGregor (1966a and b), and has since been issued as a Record (Everingham, 1965b; also see Chapter 6).

The main objective of McGregor's travel was to train the 1965 geophysicist at Macquarie Island, between visits of the relief vessel in December 1964 and March 1965. During the stay, the dynamic response curves for the rapid-run magnetograph were obtained (using a rotating magnet), a new damping chamber was fitted to the H variometer, the Z variometer was refocused, and orientation tests were made on the normal magnetograph.

Addresses were given by McGregor on the Observatory's work to the Western Australian Branches of the Professional Officers' Association and the Astronomical Society.

The provisions of a consent agreement and an arbitrator's determination affecting staff rostered to the "general" routine (Geophysicists Class 1, Technical Officers) were applied during the year. These were increased payment for ordinary Sunday duty (from half to a full day's pay) (Determination 78/1964, from 25th June 1964) and extra leave for Sunday duty (PSB Circular 64/3, from 1st January 1963). Effectively, the second provision adds one week's leave per year for each observer.

3. OPERATIONS

Works programme

Contractors carried out the following jobs, all under the 1963/64 programme:

(a) Office: installation of sink heater in amenities room; painting of residence (interior), darkroom, lavatories, and boundary fence; repairs to bitumen on drive and parking area; machine-shop floor levelled.

(b) Gnangara: exterior painting, all buildings.

Equipment

Apart from a number of hand tools and machine accessories, these items were purchased:

Decade attenuator box, HP350D, 0-100 dB.
Variable transformer, Yamabishi, 0-250V, 5A.
Transistor radio, National R307.
Lathe cabinet.

Several items were constructed by Woad. They are listed in the chapters discussing the equipment for which they were made.

The annual stocktake of all accountable stores was made, with Department of Supply assistance, in November. Surplus and obsolete items were inspected by a Board of Survey and sentenced appropriately.

Power plant and vehicles

The weir site power plant operated satisfactorily throughout the year; no record was lost through power failure. The cylinder head of unit No. 1 was found to be cracked in July and was repaired by the Stores and Transport Branch.

The 30-volt DC system was renewed in October. Three heavy-duty vehicle batteries replaced the 2-volt glasscell bank which had

started life at Watheroo about 1950. A charging panel was incorporated, and the system was kept on continuous trickle-charge.

To facilitate the adjustment of the AC mains frequency, a panel with precision frequency meter and synchronous clock was mounted above the mains-failure unit. It is difficult to adjust the frequency to better than 0.5 c/s, but the new panel provides an unambiguous indication of the frequency, in contrast to the vibrating -reed meters.

A Holden sedan and a station sedan were on hire (Type 6) from the S & T Branch throughout the year, covering a total mileage of 20,000. No accidental damage was caused to the vehicles.

Fire precautions

Annual precautions were observed before the summer season. These comprised the checking and recharging of all extinguishers, overhaul of knapsack sprays, and the clearing of all growth from around fences and buildings. At Gnangara, Forestry staff burned off the site in November.

Library

Periodicals purchased under contract were accounted for; forty-eight volumes received during 1961-63 were bound.

Books and journals were lent as requested to various local organisations, on the co-operative basis organised by the Library Board of W.A.

Visitors

The observatory was visited by: Messrs Ingall and Barringer (AMEG); Dr Clew (Toronto); Mr Britton (USCGS); Mr McDermott (Texas Instruments); Messrs White and Denham and Dr Parkinson (BMR); and about 30 members of the W.A. Science Teachers' Association.

4. GEOMAGNETISM

Observatory

A mains-failure unit was built, and installed in the "Auxiliary" house in March. It is shown schematically in Figure 1A and is part of the planned replacement of mechanical by electrical drives. Its present function is to provide vault lighting during mains failures, of which there were two in 1964. The battery is charged during the weekly visit for control observations.

Construction of a new control panel was begun; it includes a regulated (1%) 6-volt supply for the recorder lamps (see "Miniwatt" Digest, July 1962).

As a result of BMZ comparison observations made in February and July (see below), a difference of 12 gammas was found between pier Sm and an external (tripod) station. This was rather surprising because of the small pier differences measured within the absolute house. In December an area surrounding the absolute house was surveyed with BMZ 120. Readings were made at 10-ft intervals on three lines (N, M, and S), 100 feet long (E-W). The lines were 18 feet apart, line M passing through

the centre of the absolute house. Station differences were subsequently referred to Pier Nw, and are shown in the following table.

Station	W5	W4	W3	W2	W1	0	E1	E2	E3	E4	E5
Line N	-1	+1	+4	+3	0	+5	+8	-1	-2	+1	+2
Line M	+5	0	+7	+15	-	-	+2	-1	+1	+1	+1
Line S	+5	+3	+1	-1	-1	0	-3	-1	+5	+7	+5

Values are the differences (Station - Pier Nw) in gammas

They are generally small (most being within the accuracy of determination). Because the comparison tripod station was near station ME4, the difference of 12 gammas to Pier Sm appears anomalous, and will be investigated in 1965.

Recorders

The Eschenhagen normal magnetograph (20 mm/hour) was operated continuously, at the Gnangara site. Two and one-half days' record was lost through exposure of traces, and no H record was produced after 8 p.m. on 30th December. At that time the H magnet abruptly turned through about 10°; the cause of this could not be determined.

Two other more or less abrupt changes in baseline values occurred, one in H (+7 gammas) in June, and one in D (1.0' W) in October. They occurred some time between the weekly absolute observations but thorough inspection of the magnetograms did not reveal any discrete ordinate changes. It was assumed, therefore, that the changes were spread uniformly over the week involved.

Apart from these rather disturbing events, the magnetograph performed well, as indicated by the following table:

Element	Baseline values	Scale values	Standard Deviation BL	Standard Deviation SV
D	$2^{\circ}46.9'$ - $2^{\circ}46.1'$ $2^{\circ}47.0'$ - $2^{\circ}47.1'$	1.07'/mm	0.16'	-
H	23812 - 23807 gammas 23814 gammas	2.49 & 2.50 gammas/mm	1.5 gammas	0.01 gammas/mm
Z	53212 - 53203 gammas	5.25-5.27 gammas/mm	2.9 gammas	0.02 gammas/mm

At the office the visual H variograph was kept in operation at a sensitivity of 8 gammas per microamp (1 gamma per mm). Advice was issued to the Associate Regional Warning Centre whenever this record indicated that Magcalme conditions had been met in the previous 24 hours.

The micropulsations recorder (dH/dt) was run on those week days that included the three Regular World Days each month. To determine whether spurious pulses recorded by it were due to a magnetic or mechanical cause, a rapid-run variograph was run in conjunction with it for part of August. It was set up in the laboratory and comprised a La

Cour H variometer (1 gamma per mm), an Eschenhagen-type recorder with drum rate 240 mm/hour, and an array of 6 lamps, switched on in turn at each drum revolution; time-marks were applied by pulsing the scale-value coil. Simultaneous recording of the events on both recorders showed that they are a magnetic effect, and that the loop record closely approximates the time derivative of H.

The variograph was installed by Browne-Cooper as part of his training for Antarctic duty. It was also used in the design and testing of a damping chamber for the rapid-run variometer at Macquarie Island.

Magnetometers

Weekly control observations were made. The instruments used, and corrections applied to bring the results to provisional BMR standard, were:

Instrument	Component	Correction
Askania No. 508810	D	+0.5'
QHM No. 291	H	-12 gammas
292	H	-19 "
293	H	+1 "
BMZ No. 120	Z	+318 "

The first four corrections were derived from previous comparisons (and in the case of the QHMs the deduced drift rates).

Comparisons made during the year to check the BMZ correction, and to standardise Antarctic instruments, were:

Date	Purpose	Result, gammas
29th Jan	Antarctic	H.293 = H.172-40
3rd Feb		= H.302-6 = H.154+104
3rd Feb	Antarctic Mundaring	Z.P. = Z.211+197* Z.P. = Z.120+317
10th July	Mundaring	Z.221 = Z.120-340

*Z.211 values corrected to pier Sm from external station (pier Sm-Ext. -12 Gammas)

Z.P. is value of Z given by MNZ-1 (F) and QHM293 (H).

The results of the Mundaring comparisons are very satisfactory. The first differs by only 1 gamma from the 1963 proton magnetometer comparison, and the second is in close agreement with it when the correction to BMZ221 is applied.

At the time of the July comparison additional observations were made to check the field (Zs) of supplementary magnet 120/2 which is required at Gnangara; the makers' value was shown to be correct. This result eliminated a possible explanation of a 30-gamma discrepancy between comparisons made in 1956 (at Watheroo, without Zs) and 1959 (at Gnangara, with Zs). It was necessary therefore to absorb the discrepancy over the three years, when preparing mean hourly values data.

Data and publications

Data were distributed on the weekly, monthly, and annual schedules given in the Reports for 1962 and 1963. In addition, mean hourly ordinates on the five magnetically quiet days each month were sent to WDC.A, as a check on values derived digitally by that organisation.

In accordance with IAGA Resolutions 5 and 19.1 (Berkeley General Assembly, 1963), K-indices from January were based on H and D only, and components of K-indices were transmitted to the C + K Centre. Further, the components for 1960 to 1963 were deposited there.

Texts to accompany the Watheroo Mean Hourly Values year-books 1948-50 and 1951-52, and Gnangara magnetograms 1957 through 1960, were sent to headquarters.

Requests for miscellaneous Watheroo and Gnangara data or magnetogram copies were attended to. Some of these originated locally, and others from Canada, France, Nigeria, South Africa, and the USA. Some advice and data on local Sq patterns were supplied in February to Dr Burrows in connexion with the detection, by rocket soundings, of the ionospheric current system above Woomera (Burrows & Hall, 1965).

Annual means and secular change

Provisional annual mean values (derived from hourly ordinates on the 5 quiet days each month) and the algebraic difference from 1963.5 values were:

D	$-2^{\circ}51.7'$	(+0.6')
H	23,916 gammas	(-15 gammas)
Z	-53,501 gammas	(-4 gammas)

These results show that the trends since 1957 are continuing steadily.

5. IONOSPHERIC PHYSICS

Ionosonde

The Cossor ionosonde was operated on the standard quarter-hourly soundings schedule, with an additional expanded-height fixed-gain sounding at 01 minutes. Values of F2 critical frequency were reported for 93 percent of the time, and as they are probably not readable on 3 percent through ionospheric causes, record losses were acceptably low. The major causes of loss were failure of the camera take-up, and film run-out; ionosonde failures accounted for only 12 hours' loss.

Following a symposium on ionospheric irregularities held at Sydney in August, a programme of "special" soundings by Australian stations was drawn up. The programme required recordings at 1-minute intervals from about 5 a.m. to 10 p.m. on the Regular World Days in October and December, and will continue at 3-monthly intervals during 1965. It was not practicable to use the Landis programme machine for this schedule, so a separate unit was constructed (Fig. 1B). This provides the necessary delay between the minute pulse (operating the dating mechanism) and the sweep starting pulse, as well as the means of selecting any combination of continuous and normal soundings.

The special programme consumed about 180 ft of film in 24 hours. Because the camera capacity is about 110 ft, records were changed at 9.30 a.m. and 4.30 p.m. After extraction of routine data, the films were deposited with the Ionospheric Prediction Service,

Sydney, where they will be available to interested scientists.

Other continuous soundings were made during two intervals on 10th October, to cover the launching and an overhead pass of the S-66 satellite.

Several modifications were made to the ionosonde system. These included the replacement of gas regulators in the 250V power supply to the display and video sections, by an electronic regulator (Langford-Smith, 1953, Fig 33.14). This was completed in August, and resulted in a marked improvement in the stability of the display.

Replacement of the original antenna loads produced some improvement to the power/frequency curve. The loads now comprise IW composition resistors potted in epoxy resin. The transmitter load is a series arrangement of two bundles of ten 3000-ohm resistors in parallel; the receiver load is two 1200-ohm resistors in parallel.

Other changes in the ionosonde, suggested by a report obtained from the NBS, Boulder, were the fitting of screening around the receiver, an injection filter (30 Mc/s) between the v.f.o. and the 1st receiver mixer, and modifications to the pulse dividing network in the transmitter. The first two gave no improvement, but the last increased the pulse amplitude and squared it, resulting in a small increase in transmitted power.

Data and publications

The data derivation and publication programme remained the same as at the end of 1963.

Monthly median values of F2 critical frequency (fo F2) indicated that a minimum was reached during the year in accordance with the solar cycle. The annual mean value at noon was 6.0 Mc/s, in reasonable agreement with the value expected from the relation with sunspot number applying since 1960.

6. SEISMOLOGY

Standard system

World Standard Seismograph System No. 44 was operated throughout. Record losses were 27 component-days when recorder lamps were not switched on, and minor unavoidable amounts during routine system tests. From April these tests were made each month, as part of the "general" routine.

It was found that the periods of the seismometers (both systems) could change by up to 3 percent per month, but were generally satisfactory. On the other hand, the LP galvanometer periods varied erratically by up to 6 percent. Adjustments were therefore made only after departures persisted for about 3 months.

The frequency standard (crystal clock) performed reasonably well, and it was generally possible to control its rate within 100 ms daily. On six occasions sudden changes occurred; these ranged from 0.5 to 2 seconds per day and their cause (as in the past) could not be determined.

The wiring to the recorder lamps was replaced with some of heavier grade, after the original was found to have deteriorated.

A routine visit was made by a USCGS maintenance team (Messrs Britton and McDermott) from 21st July to 2nd August.

At the direction of the USCGS, use of the rotary drier was abandoned in November. These appliances cause distortion of the records. A drying cabinet was built, and proved to be most satisfactory; it is rapid, silent, and requires less operator attendance. It comprises a commercial steel cabinet (6' x 3' x 18") with a 100-watt convector in the base, and holes drilled in the top to allow free convection. The records are suspended by plastic clothes pegs attached to stainless steel rods.

Benimore system

This seismograph operated well and continued to prove worthwhile; it permitted the detection of double the number of impulsive phases that would otherwise have been detected. The recorder lamp was replaced by one of higher voltage (Philips 3871 c/23; 6.5V, 1.45A) after construction of a suitable lamp holder, giving improved records and reduction in losses through lamp failure.

Data and publications

Preliminary and Final data were distributed to the same centres as given previously. The monthly Bulletins and ISRC cards listed 896 events. From May the more comprehensive ISRC cards were used, and from December Mundaring and Kalgoorlie (see below) preliminary data were sent daily to the USCGS. In co-operation with the Chamber of Mines, macroseismic data for the mining area were supplied to the Kalgoorlie mining companies after comparison of their reports and recordings of very local events.

Amplitude values shown on USCGS Data Reports up to about October were unreliable, because of a misunderstanding by that organisation. After correspondence, and the listing of amplitudes in millimicrons to one decimal place, the published values became reliable.

Thirty-two local events were recorded, 24 being of magnitude (Ml) less than 3.5 and in the Yandanooka-Cape Riche Lineament. Of the others, three were located in the Lineament, one being felt (12th June) at Nyabing. Another two of special interest were:

(a) March 9th, 11 35 46: a probable rock-burst at Kalgoorlie, Ml = 4.7, Mb = 4.3;

(b) March 23rd, 22 41 10.9: an earthquake felt at Broome and Derby, recorded by Australian and overseas stations.

The USCGS was requested to re-determine the epicentre of the second, ignoring data of regional stations, to provide accurate information for local travel-time measurement. Subsequently (1965) copies of seismograms for 12 Standard stations were examined and a unified magnitude (m) of 5.4 was established for the event.

Projects

A field station was established at Kalgoorlie on 6th November, and has been fully described by Everingham (1965a). It is a hybrid short-period unit comprising a Benioff recorder and horizontal seismometers, and a Willmore vertical geophone. Its recordings showed that rock-bursts are occurring in the mining area, and that teleseismic P waves arrive there early compared with Mundaring. Because they arrive at Mundaring

early compared with eastern Australian stations (Cleary & Doyle, 1962) unusual conditions must exist beneath Kalgoorlie. The operation of this station for a few years is expected to provide useful data on the upper mantle in the region.

Construction and testing of a D.C. amplifier (Watt, 1960) was completed. It proved to be a useful instrument for short-term projects such as testing of seismometers and high-speed recording of quarry blasts.

The seismic refraction work done in earlier years was supplemented by recordings made by a BMR seismic party, and the derived crustal structure is given by Everingham (1965b). Results of local seismicity were up-dated and amended; a Record is expected to be completed in 1965. An offer by Dr D.J. Sutton of Adelaide to assist in the interpretation (by providing electronic computer facilities) of the 1963 phase velocity results was accepted. A joint paper on the recordings of 1956-57 Maralinga explosions was published (Doyle & Everingham 1964).

7. ACKNOWLEDGEMENTS

The assistance is hereby acknowledged of: The State Controller and staff (Department of Supply); The Regional Director and the Officer-in-Charge at Kalgoorlie Airport (Department of Civil Aviation); and Dr D.J. Sutton (University of Adelaide).

8. REFERENCES

BURROWS, K. and HALL, S.H. 1965 Rocket measurements of the geomagnetic field above Woomera, S.A. Journal of Geophysical Research, 70 (9), 2149-2158.

CLEARY, J.R. and DOYLE, H.A. 1962 Application of a seismograph network and electronic computer in near earthquake studies. Bull. Seism. Soc. Amer. 52 (3), 673-682.

DOYLE, H.A. and EVERINGHAM, I.B. 1964 Seismic velocities and crustal structure in southern Australia. J. Geol. Soc. Aust. 11 (1), 141-150.

EVERINGHAM, I.B. 1965a Installation of a seismograph at Kalgoorlie, Western Australia 1964. Bur. Min. Resour. Aust. Rec. 1965/63 (unpubl.)

EVERINGHAM, I.B. 1965b The crustal structure of the south-west of Western Australia. Bur. Min. Resour. Aust. Rec. 1965/97 (unpubl.).

8. REFERENCES (Cont'd.)

LANGFORD-SMITH, F. (ed.)	1953	Radiotron Designer's Handbook 4th ed. revised, 1221-1222. Sydney, Wireless Press for AWV Co.
McGREGOR, P.M.	1966a	Mundaring geophysical observatory, annual report 1962. Bur. Min. Resour. Aust. Rec. 1966/35 (unpubl.).
	1966b	Mundaring geophysical observatory, annual report 1963. Bur. Min. Resour. Aust. Rec. 1966/36 (unpubl.).
WATT, P.A.	1960	The application of a D.C. amplifier to seismic recording. Bull. Seism. Soc. Amer. 50 (3), 471-476.

FIGURE 1A

MAINS FAILURE AND DC POWER SUPPLY

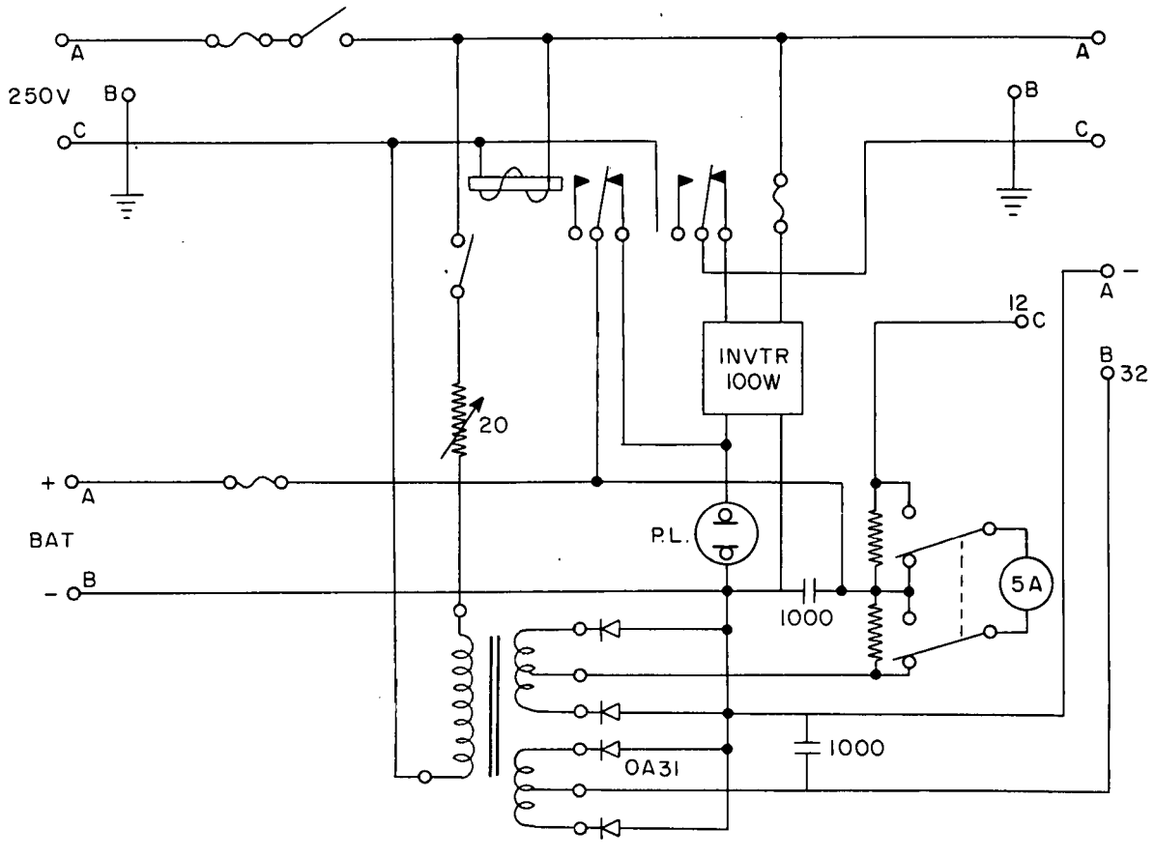
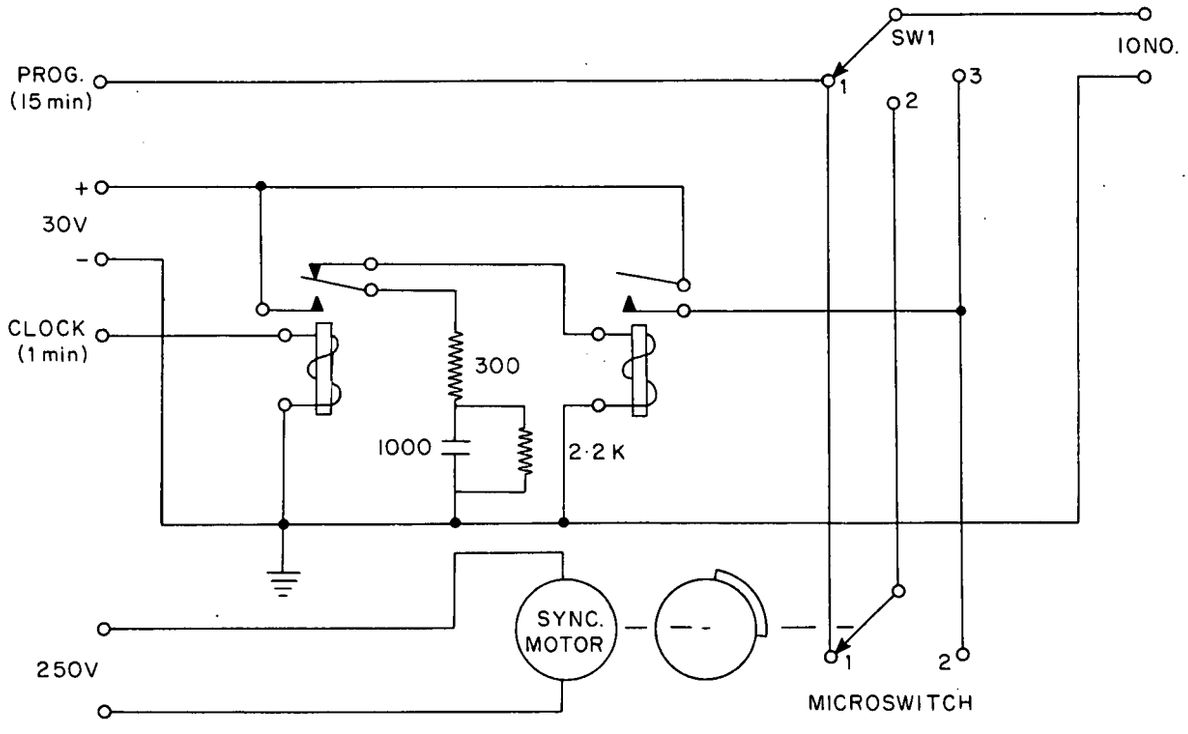


FIGURE 1B

IONOSONDE SCHEDULE SELECTOR



Schedules:- SW1: 1 — standard
2 — standard & selected continuous
3 — continuous

TO ACCOMPANY RECORD No. 1966/37
GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS G82/3-65