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RECORDS:

RECORD NO. 1968/12

WILKES GEOPHYSICAL OBSERVATORY ANNUAL REPORT, 1964

by

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SUMMARY

The magnetic and seismic observatories at Wilkes, Antarctica, were kept in continuous operation during 1964.

The Ruska normal Z variometer was replaced by a La Cour variometer.

A new seismic hut was erected at Wilkes and pier construction was completed during the year.

Several changes were made to the timing, control, and power supply systems at the Observatories.

1. INTRODUCTION

This record describes the operation of the Wilkes geophysical observatory during 1964. The author was in charge of the magnetic and seismic observatories from 21 January 1964, when he relieved R. Whitworth, until 8 February 1965 when relieved by P.J. Browne-Cooper. Previous work at the observatory has been described by Underwood (1960, 1963), Jones (1961), Burch (1962), and Whitworth (in preparation).

Magnetic results are published separately as reports by the Bureau of Mineral Resources, and seismological data have been sent to International Seismological Centre.

At the January 1964 Australian National Antarctic Research Expedition change-over at Wilkes, a new seismic hut was to be built. A site was chosen but only very little construction work was carried out during the change-over. By the end of the year all major construction of the piers and inner hut were completed. Details of the hut are given in Chapter 4; the site is shown in Plate 1.

A La Cour Z variometer was installed as a replacement for the Ruska normal Z variometer.

2. MAGNETIC

Buildings and maintenance

The windward walls of the variometer building were painted. Considerable work was needed to repair the magnetic buildings' corridors; these needed a lot of attention as several pieces of canvas were missing or were badly torn by the wind.

The variometer building was further tied down with stainless steel cable and brass fittings. This prevented any further light leaks developing in the roof-to-wall joints after high winds.

The meltwater and flooding problems of past years were still present but to a lesser degree; record loss due to these causes was small. The main melt problem was snow accumulating on roofs and melting in the sun, the resultant water dripping into huts and in some cases on to instruments and causing some record loss. This problem was best prevented by sweeping any accumulated snow from the hut roofs early in the norning.

Considerable effort was made to pump dry the melt water pools by the magnetic hut. This was successful and perhaps reduced the Z variometer jumps as compared with previous years. The freezing of the melt water has been suggested as a cause of jumps in previous years (Underwood 1963).

Magnetographs

There are two Ruska magnetographs at Wilkes, a normal-run and a rapid-run. Details of the magnetographs are given in Table 1.

The rapid-run recorder operated successfully throughout the year with only one day's loss due to instrument failure. There were other small losses due to various minor causes. The only attention required by the magnetograph was levelling of the variometers, mainly Z and occasionally H, particularly during the summer months.

The rapid-run Z scale value was again very erratic and the instrument was clamped occasionally to try to stabilise the value, but the scatter was still very large throughout the year.

The normal recorder failed on several occasions, the two causes being the clockwork drive failure and slipping of the clutch mechanism. The drive was replaced by a spare and the clutch mechanism was repaired by fitting small pieces of shim brass behind each of the three pressure pads of the clutch system. The recorder operated successfully after these alterations.

A La Cour variometer was taken to Wilkes to replace the Ruska normal Z variometer. This instrument had been giving erratic trace jumps and scale values that had been getting progressively worse over the years. These changes introduced some uncertainty and difficulties in the adoption of baselines for Z.

It was initially suggested that the La Cour support and magnet be fitted in the Ruska variometer housing. This proved to be impossible with the facilities available at Wilkes.

The Ruska was removed on 10th February and replaced by the La Cour. There was a large difference in the strengths of the magnets of the two variometers so some alterations were necessary to the D variometer system.

The values in gammas of the fields of the other variometer magnets at the D variometer were given by Berkley (1959) as follows:

Component	H	H_T	H_S	Z	Z_T	Total
F_E	11	-13	-37	250	218	429
F_N	4	34	-11	-416	41	-348

F_E and F_N are the east and north fields through the D variometer; H, H_T, and H_S are the H variometer, temperature, and sensitivity magnets; Z and Z_T are the Z variometer and temperature magnets.

The strength of the La Cour Z magnet given by the maker is 92 c.g.s. The values for the Ruska are: recording magnet 586 c.g.s. and temperature magnet 340 c.g.s.

The following table gives calculated values of the fields through the D variometer assuming that the La Cour magnet was in the same position as the Ruska recording magnet. The magnet is oriented north pole north. The H fields are the same as in the above table.

Component	H	H_T	H_S	Z	Total
F_E	11	-13	-37	40	1
F_N	4	34	11	66	-39

When the instrument was finally set up and the D corrector magnet removed it was found that there was a resultant D baseline value change of about 80 minutes, representing an orientation change of eight minutes in the D magnet. This is equivalent to an east field at the D variometer of about 200 gammas, which is due to the La Cour not being at the same position on the pier and the magnet being at a different height.

The change of over 300 gammas in the C field (F_N) did not affect the D scale value. There was no control magnet on the D variometer.

After the La Cour variometer was installed there was a one-minute parallax error in the Z trace until 11th May when the height of the variometer was raised about 4 cm on brass foot-plates to eliminate it.

The final arrangement of the La Cour is shown in Plate 2.

The La Cour variometer was a considerable improvement on the Ruska. A constant scale value existed for the remainder of the year. There were a few jumps in the baseline values owing to jumps in the Z traces; in some cases all three traces (Z, baseline, and temperature) jumped equal amounts suggesting that the whole variometer moved in some way. These jumps appear to be associated with cold snaps and sudden changes in temperature as mentioned by Underwood (1963).

Temperature coefficients

The Ruska Z variometer used magnetic compensation and the temperature trace was from a bimetallic strip system mounted in the variometer housing. The coefficients used in previous years were accepted and the baseline values were adjusted for several jumps that occurred.

The La Cour variometer uses optical compensation with the temperature trace coming from the compensator. When the La Cour was set up the strip was set at a known arbitary length and shortly after was put through a temperature cycle. The normal magnetograph room heaters were turned off and the rapid-run room heater left on. The idea was to keep the rapid-run at as constant a temperature as possible and compare rapid-run Z values with the La Cour Z values. The result of this test was that the compensation was twice as much as was necessary so that the length of the bimetallic strip should be halved.

When the variometer was raised to remove the parallax error on 11th May, the compensator strip length was halved. On the 18th May a temperature cycle was carried out over 13 hours with BMZ and both variometer temperatures being read hourly. A least squares analysis of the results gave an approximate coefficient of -1.6 gammas /^{o}C. Analysis of the remaining Z baselines for the year yielded a value of -1.3 gammas /^{o}C. This last value was adopted as temperature tests carried out over a short time are subject to error. The main source of error is the temperature gradient across the instrument causing differences between the thermometer and variometer magnet.

The variometer temperature coefficient and the thermograph coefficient remained constant for the remainder of the year even though there were some jumps in the traces and resultant baseline value changes.

The baseline values at 5^{o}C were relatively much better than in previous years at Wilkes and the baseline values were adopted at 5-gamma intervals compared with 10 gammas of the previous year. The main reason for this was the constant scale value and very few trace jumps compared with previous years. See Table 1 for 1964 standard deviations.

A summary of the Z variometer coefficients is given in Table 2. For the thermograph, (+) indicates increasing temperature up the page; for the variometer (+) indicates increasing baseline value with temperature.

From the results of the temperature test on 18th May an attempt was made to determine the rapid-run Z coefficient. The results were rather scattered but the coefficient is of the order -4 gammas /^{o}C.

An attempt was also made using multiple regression analysis to find the H variometers' temperature coefficients from the temperature cycles of 18th May. The results obtained were normal H + 0.8 gamma/^{o}C and rapid-run H + 0.5 gamma /^{o}C but the standard deviation for the normal H was 0.5, which puts the results in some doubt; and as the coefficient is small, zero coefficient was used for the H baseline adoptions.

Orientation

The La Cour Z variometer was tested on 18th February after it was set up and the exorientation was found to be 0.7° north pole up. Secular variation will decrease the exorientation with time.

A D orientation test was carried out on 11th February but owing to difficulty in understanding the direction of the orientation benches the results were not calculated until the author's return to Australia. The results are shown in Table 3.

The tests were made using the deflector magnet method (McComb, 1952). The BMZ tripod was used to support the magnet for the Z variometer test. The D test was made using the existing orientation benches. No tests were made on other variometers.

Absolute instruments

The absolute instruments used throughout the year were QHMs 492 and 494, CIW 28, BMZ 236; QHM 493 and BMZ 211 were used for field work (Whitworth, in prep) and these instruments were intercompared with the observatory instrument during the year. Two sets of simultaneous observations were observed with BMZ 121 and BMZ 236. QHM 493 was returned to Melbourne in February 1965 for intercomparison at Toolangi Observatory. The observatory instruments were intercompared with instruments from Melbourne at the change-over at the beginning and end of the year. Details are shown in Table 4.

3. SEISMIC

Seismographs

The seismographs at Wilkes are a three-component long-period set of Lehner-Griffith design with nominal seismometer period of 15 seconds and galvanometer period of 90 seconds, and a Grenet vertical short-period seismometer with a BMR recorder. No calibration details are available for the short-period set. Details of the long period set are given by Whitworth (in prep.).

The long-period set operated successfully throughout the year with small losses due to seismometer and galvanometer drift. The drive motor for the recorder failed and was replaced. At the same time the recorder was given a general clean and lubrication. After this the set recorded satisfactorily.

Several minor faults developed with the Grenet recorder. There were jumps in the trace, the cause of which is still unknown, but they were almost completely eliminated by cleaning and lubricating the whole recorder system. Sometimes when trace jumps occurred the paper fell off the drum, which resulted in considerable record loss until the fault was corrected. The recorder drive motor failed and was replaced by a long-period recorder motor, modified to fit the BMR recorder.

The Grenet seismometer had to be re-set once after the boom had jammed against the stops. Its operation was in general satisfactory.

During the melt season when water dripped into the hut the galvanometer mechanism froze when the temperature fell. The galvanometer drifted owing to the large diurnal temperature changes. The installation of a small thermostat heater (larger than that installed by Whitworth) in the porch area eliminated both the drift and freezing problem.

New seismic hut

Details of the hut are shown in Plate 3. Essentially it consists of an outer hut for the recorders and an inner hut for the seismometers. The galvanometer and seismometer piers are set on the bedrock and isolated from the hut floors; around each is a concrete wall from bedrock to floor level. The inner hut rests on the wall surrounding the seismometer pier.

At the change-over the outer hut was erected and partly tied down. The remaining construction proved a long slow process as there was no building tradesman with the wintering party. Most available spare time was spent on this construction work with considerable help coming from the electrician.

The major task was the concreting of the piers and the walls. The method of construction was to cart cement, sand, etc. and the concrete mixer into the hut and do all the mixing inside. This allowed for better working conditions and, as the hut could be heated, the use of warm water and ingredients. This prevented the concrete freezing before generating its own heat.

The first part of the construction was the main seismometer pier and sub-foundations for the galvanometer pier and the walls surrounding it. This part of the construction was completed at the beginning of 1964. Little progress was made during the winter months. In spring a new start was made, and the concreting of the galvanometer pier and walls and seismometer hut wall was completed. The surfaces inside the galvanometer and seismometer hut walls were raised above the outside rock level by filling with concrete in an effort to prevent melt water seeping into the pier area. The inner hut was erected and all sealing and tying down completed. The height of the seismometer pier was measured by the surveyor by levelling from station B2 (45.48 ft). The pier is 42.55 ft above mean sea level. The direction of the hut (long side) is North $97\frac{3}{4}^{\circ}$ East.

'Local earthquakes'

Full details of local earthquakes in the Wilkes area are outlined in a paper by Browne-Cooper, Small, and Whitworth (1967).

4. TIMING AND CONTROL CIRCUITS

A considerable number of changes were made to the timing and control circuit during the year. The main modifications were: installation of a new time-mark programming unit, new emergency power supply system, installation of a fine adjustment to the rate control on the Times chronometer, and building a small stroboflash type unit to read the Times chronometer more accurately.

Times chronometer

This chronometer consists of three basic units, a mechanical unit, an electronic unit, and a time indicator unit. The mechanical unit contains a synchronous motor, reduction gearing to drive the contact assemblies, and time-setting devices. The electronic unit provides the basic precision frequency from a temperature and pressure compensated tuning fork. The time indicator unit consists of dials rotating at 1 rev/min and 1 rev/s, enabling seconds, tenths, and hundredths to be read. The chronometer has facilities for visual dials for hours and minutes, but these were disengaged during 1964, as they put considerable extra load on the motor. There are several sets of contacts and frequency standards available as output. The only one used was the 1-minute contacts.

The Times chronometer was modified by the installation of a fine control potentiometer in series with the existing rate control potentiometer. The fine control potentiometer was about one hundreth the value of the existing one. This allowed the rate to be adjusted to less than a fiftieth of a second a day under normal conditions (Whitworth, in prep.).

The chronometer was given a complete clean and overhaul once during the year and the system behaved satisfactorily after this.

When power failures occurred the Times chronometer stopped before its emergency power came into operation, owing to the relay chatter during the slow fall in voltage. This problem was overcome by using a sensitive, adjustable d.c. relay, operated by the mains supply, transformed to six volts and then rectified. The relay was used to switch on and off the mains supply to the chronometer. The mains voltages at which the relay switched were adjustable and set at values to ensure the chronometer kept going at all times.

Stroboflash unit

A small neon lamp was designed to flash when triggered by WWV or WWVH time signal pips from the radio (see Plate 4). The power for the unit was obtained from the auxillary socket on the radio and the input from the 500-ohm speaker output of the radio. With these flashes the 1-rev/s dial on the Times chronometer could be read to 0.01 second. With this unit and the fine rate adjustment the chronometer correction was kept less than 0.1 second for the remainder of the year. This unit was developed by Whitworth (in prep.).

Time Mark Programming Unit

The Time Mark Programming Unit (T.M.U.) is used to give three output programmes of contact closures for the three sets of records, the seismic (1 per minute, hour missing), normal magnetograph (1 per 10 minutes of 2 seconds duration, with hour of 4 seconds duration), rapid run magnetograph (1 per 5 minutes plus 59th and 1st minutes). The unit was operated by contact closure every minute from the Times chronometer and worked on a one-hour cycle.

The Time Mark Programming Unit was installed in August. This unit replaced the Simplex programming units, which had been giving trouble for many years. Even though the unit was protected against radio frequency interference the nearby ionospheric sounder caused some intermittent triggering of the unit, which gave rise to extra time marks on the traces.

Another problem was the duration of the input contact closure, which on the Simplex system was about $1\frac{1}{2}$ seconds. The T.M.U. input had a hold time of $\frac{1}{2}$ second to allow for noisy contacts and could therefore be triggered two or three times for one contact closure. This occurred many times and caused some time correction difficulties until the cause was located. The chronometer contact closure duration was reduced to three-tenths of a second.

Both the time indicator microammeters in the T.M.U. failed shortly after it was installed. These meters were of a cheaper type and were replaced by the correct type at the end of the year. Multimeters were used when the indicated time was to be read after the meters failed.

Emergency power supply

The emergency power system for all the recorders was rather clumsy involving both a 6-volt and a 12-volt inverter. This system was replaced at the end of the year. At Wilkes there are two independent mains power supplies, one from the power house and one from the garage. The magnetic and seismic recorders and lamps operate from the power house supply. A change-over relay was installed to switch to the garage supply when the power house supply failed. The chances of both supplies failing is very remote. The Times chronometer has its own standby inverter power supply if the power house supply fails.

The Times chronometer, the T.M.U., and this emergency power system should give Wilkes a very reliable timing and power supply system.

5. RECOMMENDATIONS

The basic ideas behind the new seismic hut design are good, but some design changes as indicated by Whitworth (in prep.) may be of some advantage.

The main point is that the hut be erected in the correct order. The idea was that the concrete foundations (walls and piers) should be carried out first. This was not done at Wilkes and as a result considerable extra work was involved in the preparation of the forming for the concreting and the concreting itself. It would in general be advantageous to get the concreting carried out at the change-over period when there is relatively more labour and builders at the base. The concreting is by far the most difficult task and can require many people to do it. The actual hut erection is a relatively simple task and can be done with fewer skilled men. The construction of the walls for the pier areas could be considerably simplified by the use of bricks as no form-work would be required, but it is not known if there is any structural objection to using bricks in the Antarctic.

The T.M.U. unit could be improved by the provision of a manual contact closure independently on each of the outputs. The present design is that the manual pulsing advances all circuits by one minute. This facility would be particularly useful when setting up the unit and also for checking individual circuits to the huts.

6. ACKNOWLEDGEMENTS

The author wishes to acknowledge the help given by the electrician J. Freeman, particularly for his part in the construction of the new seismic hut and also for carrying out routines when the author was absent from the station. The author also acknowledges the help and advice given by R. Whitworth, observatory geophysicist for 1963, who remained at the station during 1964 to carry out the field geophysical programme.

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UNDERWOOD, R.	1960	Wilkes geophysical observatory work Antarctica 1959. <u>Bur.Min.Resour.Aust.Rec.</u> 1960/114
	1963	Wilkes geophysical observatory work Antarctica 1962. <u>Bur.Min.Resour.Aust.Rec.</u> 1963/164.

TABLE 1

Magnetograph data

Magnetograph	Element	Nominal scale value	Standard deviation Scale value	Standard deviation Baseline
Normal	D	10.05	0.07	1.2
	H	25.15	0.03	3.9
	Z	20. 9	0.11	3.3
Rapid run	D	1.13	0.01	-
	H	5.15	0.02	-
	Z	6	-	-

D values in minutes; H and Z values in gammas

TABLE 2

Z Variometer temperature coefficients

	Ruska 1 Jan - 10 Feb	La Cour 11 Feb - 11 May	La Cour 12 May - 31 Dec
Thermograph ($^{\circ}$C/mm)	- 1.401	+0.67	+1.14
Variometer (gammas /$^{\circ}$C)	+ 4.86	-10.4	-1.3

TABLE 3

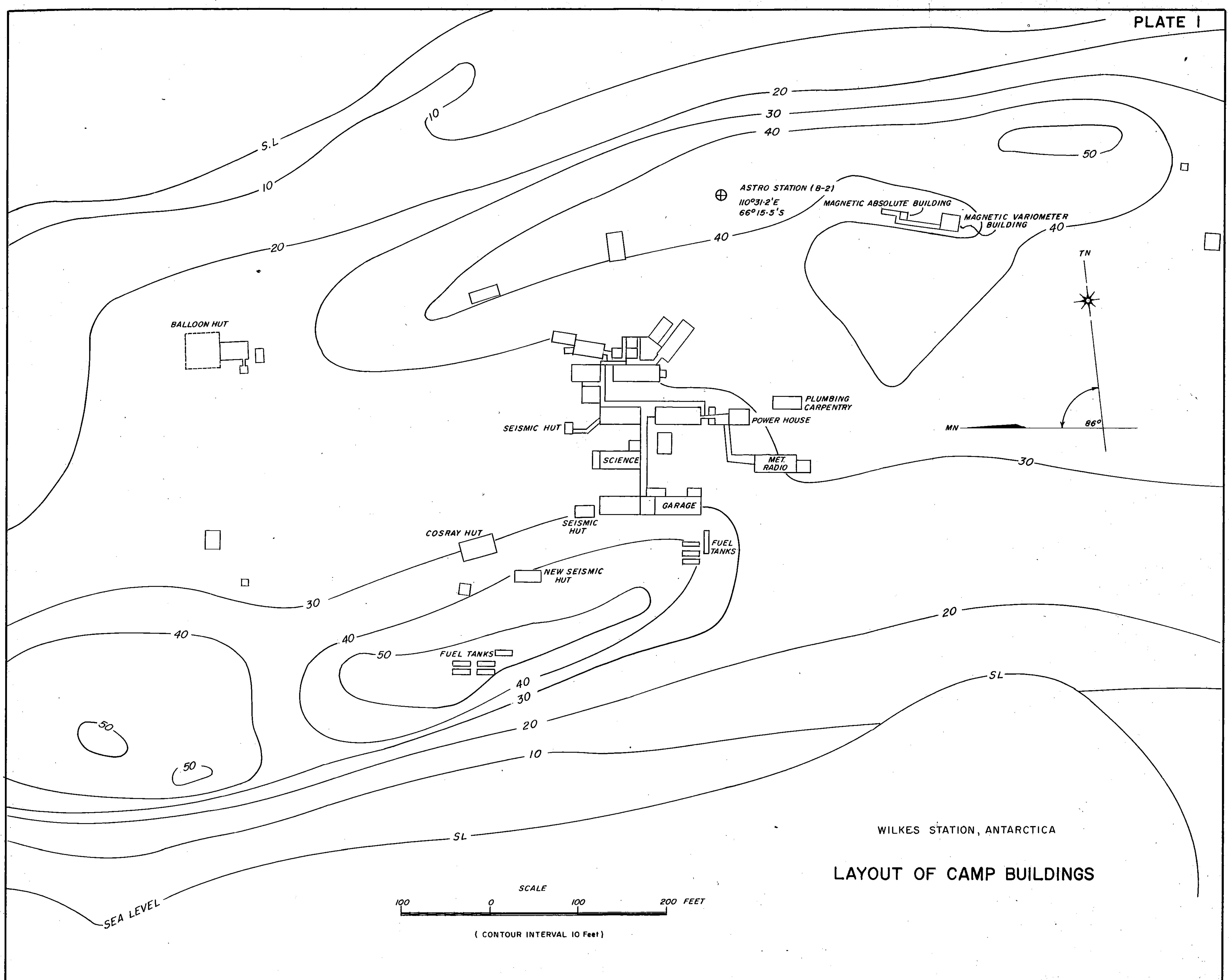
Orientation of variometer magnets

Variometer	Date	North Pole of magnet
La Cour Z	18 Feb 1964	N 0.7° up
Ruska D	11 Feb 1964	N 2° east

TABLE 4

Intercomparisons of magnetometers

Date	Instruments		
	Station	Comparison	Field
Jan 1964	CIW 28	ASK 339	
	QHM 492	HTM 154	QHM 493
	494		
	BMZ 236	BMZ 211/c	
		P.P.M (MNZ)	
Feb 1964	BMZ 236		BMZ 121/A
March			
Jan/Feb 1965	QHM 492	HTM 154	QHM 493
	494	QHM 174	
	BMZ 236	P.P.M. (MNZ)	



WILKES STATION, ANTARCTICA

LAYOUT OF CAMP BUILDINGS

(BASED ON DEPT OF EXT AFFAIRS PLAN 2/63/24)

TO ACCOMPANY RECORD No. 1968/12

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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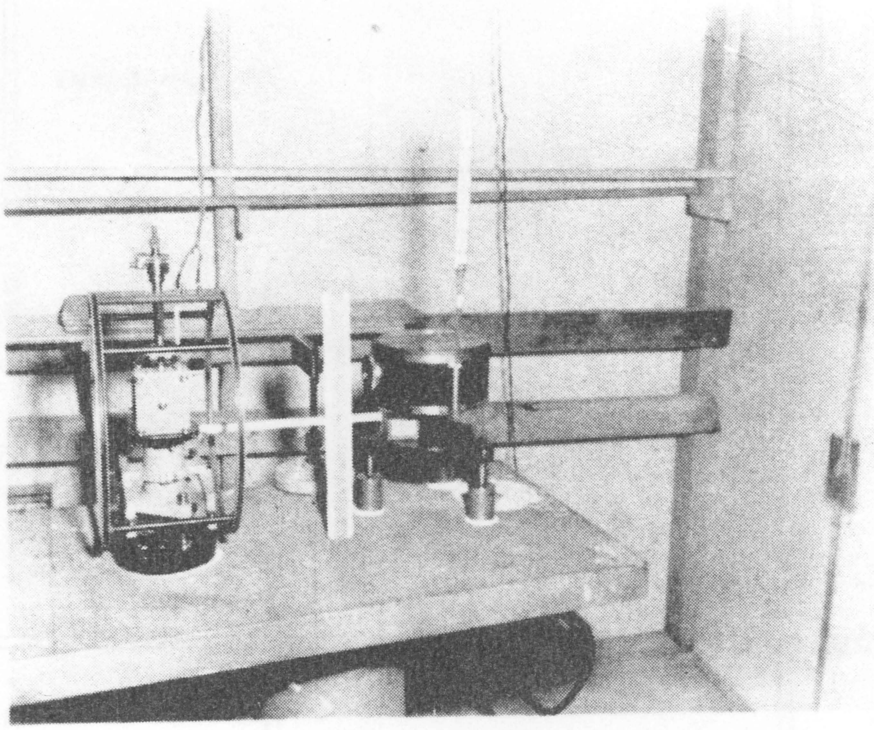
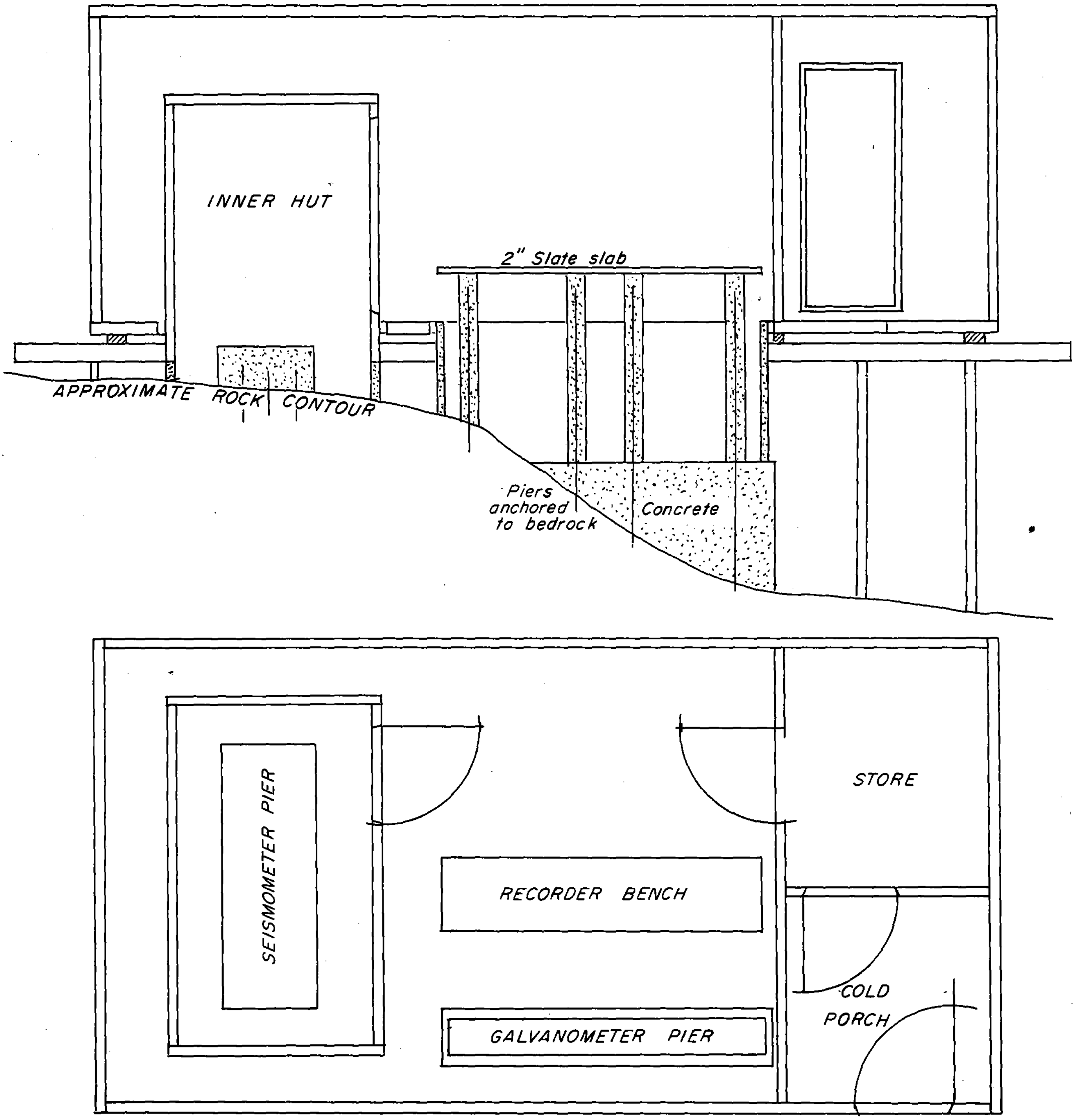


LA COUR Z VARIOMETER SET UP

PLATE 3



SCALE: 4'=1"

WILKES, ANTARCTICA

SEISMOGRAPH BUILDING

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics

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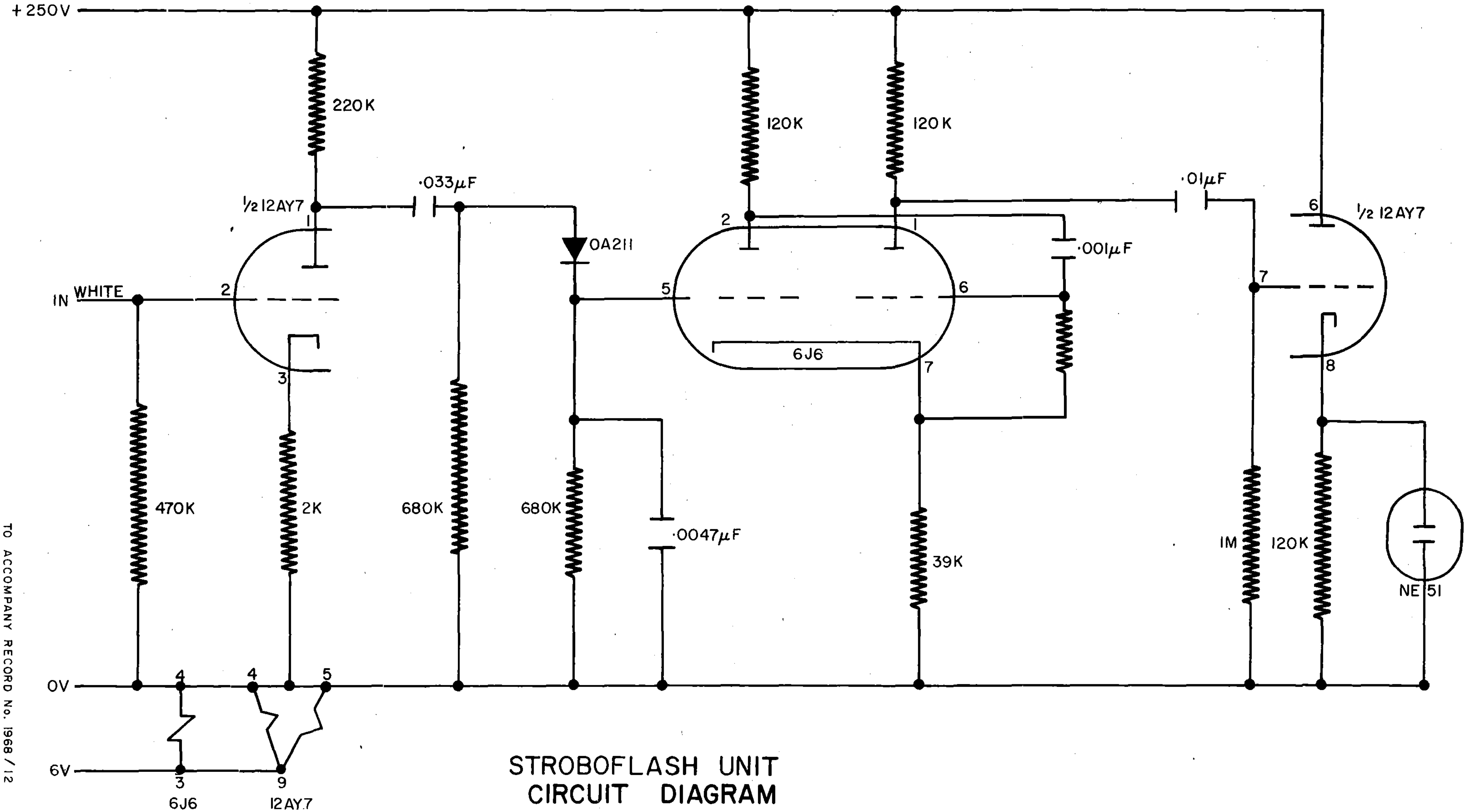
TO ACCOMPANY RECORD No. 1968/12



STROBOFLASH UNIT
CIRCUIT DIAGRAM

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PLATE 4

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