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WILKES GEOPHYSICAL OBSERVATORY WORK, ANTARCTICA 1961

by

W.M. Burch

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ILLUSTRATIONS

SUMMARY

This Record describes the operation of the seismic and magnetic observatories at Wilkes, Antarctica, during 1961. Scientific results will be published later.

1. INTRODUCTION

The seismic and magnetic observatories at Wilkes were established by the United States of America for the USNC-IGY Antarctic programme in 1957.

The writer was Geophysicist-in-Charge of both observatories from 18/1/61 to 17/1/62 with the 1961 party of the Australian National Antarctic Research Expedition (ANARE). He relieved W.K. Jones and was relieved by R. Underwood. Work done in previous years has been described by Underwood (1960) and Jones (1961).

The scientific results of the year's work will be tabulated in separate reports.

2. SEISMOLOGICAL

Grenet seismograph

A Grenet short-period vertical seismograph was sent to Wilkes from Macquarie Island for installation during 1961. Unfortunately it proved impracticable to instal the instrument with the existing facilities in the seismic vault. The project was postponed, therefore, pending direction from Melbourne.

General

No major construction or alteration work was done in the seismic hut, but a few minor changes were made, affecting the time-mark recording, and these will be discussed in Section 5 of this Record.

One project in connexion with the melt-water problem has proved well worth while and may be of some benefit to future observers. It involved the construction and installation of an electrically heated drain to keep the seismic hut free of melt-water.

Flooding has been a major problem during the summer months for the past three years at least. The melting period usually lasts from the beginning of December until well into March. In the past, some hours of record has been lost each day, and occasionally damage to galvanometers has occurred.

This loss and damage was caused by the rapid drainage of water from around the pier during the operation of an electric pump, which had to be used to keep the water below the level of the pier top. During the worst part of the melt, in mid-January, pumping was required almost continuously and, as a result, the seismic records were practically unreadable on some days. Several different pumps were tried in order to discover whether the effect on the seismographs could be reduced, but to no avail.

In February 1961 a trench was dug through a ten-foot-high bank of ice from the seismic hut across to a melt-water pool, a distance of 30 ft. A length of ordinary rubber hose 1¼ in. in diameter was obtained and some nichrome resistance wire was threaded through it. The resistance of the wire was designed so that it would dissipate about 300 watts along its length when the mains supply of 110 volt A.C. was applied across it. The rubber pipe was then laid in the trench, so that the upper end was level with, and adjacent to, the floor of the seismic hut, and the lower end reached the melt pool (see Plate 1). With the power on, the melt-water was able to flow freely away without freezing and blocking the drain.

The device proved to be entirely successful and was found to operate without fault during blizzards and in air temperatures down to 0°F. Probably even less power than 10 watts per foot would do the job equally well.

Another necessary job completed in the seismic hut was the fitting of a precise thermostat to the existing electrical heater. After this had been done the room temperature varied only a few tenths of a degree and there was no appreciable drift of any instrument during more than six months.

3. MAGNETIC

Construction

A major construction programme was carried out during April and May in the standard variometer room of the magnetic hut. This involved the demolition of the original instrument piers and their replacement by concrete piers with a slate top.

The initial design was for the new concrete piers to be raised from bedrock, but this proved impracticable and a compromise was made. The major problem encountered was the permanently frozen ground in which the original wooden piers were situated. This ground was a mixture of gravel and sand bound in ice, in which the piers were embedded to a depth of about 3 ft. A bronze crowbar and steel ice-pick were used for some hours in an attempt to shatter the frozen ground, but the only results were the destruction of two ice-picks and the blunting of the crowbar.

It was then decided to try heating the ground with a Herman Nelson gasoline heater. A one-foot-square hole had to be cut in the northern wall of the hut, to allow entry of the pipe supplying the heated air. Unfortunately the thermal conductivity of the ground was so low that it was necessary to scrape the melted slush away as it formed. But because the temperature in the hut rose to 200°F, it was possible to remain there only a short time (see Plate 2).

After two days of continuous heating a depth of eight inches was reached. A final attempt was then made with a worn-out pneumatic rock drill. The noise and carbon monoxide fumes from this device inside a room proved troublesome, but after forty-five minutes of drilling, a depth of one foot was attained, with a one inch diameter hole. At the bottom of the hole, one half an ounce of plastic explosive was placed and plugged. The only result of the explosion was the destruction of a bag filled with screenings used to sand-bag the blast hole. No shattering of the hole itself or the surrounding ground occurred.

After consultation with the Officer-in-Charge of the station, and the Chief Engineer, it was decided to abandon the idea of excavating to bedrock to remove the original wooden piers. A compromise was devised whereby the old piers were hacked off close to the ground and a bed of $\frac{3}{4}$-in. screenings was laid to a depth of eight inches. Two strips of copper busbar reinforcing were laid across the screenings, and the brass crowbar cut in two, was placed in vertically at the points proposed for the concrete piers.

Concrete was poured into a wooden former, so arranged that it was not in contact with any section of the hut, and laid to a depth of nine inches. Finally, two concrete piers eight inches in diameter were poured (see Plate 3).

After allowing two days for the concrete to harden, the slate slab was uncrated, placed in position, levelled, and cemented with plaster of Paris. A 2-ft-long section of the original plywood pier top was screwed to the remaining two wooden piers.

From then on the job was a routine one of replacing the instruments in their original recording positions, achieved to within five millimeters in each case. Without further trouble the instruments were operated in almost their original magnetic meridians and with similar trace ordinates (see Plate 4).

Reorientation

The magnetic meridian had altered more than 80 minutes of arc since the establishment of the observatory, so the horizontal instruments were reoriented accordingly.

The magnetic meridian chosen was N 84° 10.8' W, being the mean observed meridian for January to April 1961.

At the conclusion of adjustments, the ex-orientation angles, made westerly to allow for secular change, were :

H - 0° 53' West

D - 0° 18' West

Z - 0° 46' Low

The H and D orientation benches were altered to the new meridian above, and appropriate marks were placed on the walls of the room.

Physical constants for variometers

The only alteration to Berkley's (1959) published constants are :

(i) Recording Distances

Z - 1118 mm

D - 1012 mm

H - 804 mm

(ii) Supplementary Magnet Positions

D Corrector	-	10.63 cm
H Temperature	-	12.96 cm

From 21st May the Ruska standard magnetograph resumed full operation. The rapid-run instrument was operating from 17th May.

4. POWER SUPPLY

During the first half of the year, the power supply for both the seismic and magnetic instruments was completely rebuilt.

Wiring

All the electrical cables from the science building to the magnetic hut were renewed. The new cables were run along the top edges of the outside of the buildings from the science block to the plumber's shop. From a junction box on the wall of the plumber's shop, an armoured multi-cored cable was run across to the magnetic hut. It was shielded inside heavy aluminium girders where it passed under the vehicle road outside the plumber's shop.

Power source

The original power source for the seismic and magnetic programmes was D.C. from lead-acid accumulators; and for the rapid-run recorder motor and seismic motor, a separate 115-volt A.C. source was used. This arrangement was both clumsy and inefficient - clumsy because it required multiple wiring and maintenance of two independent power supplies in constant use, and inefficient because of (a) the enormous power loss between the science building and magnetic hut (30% of inserted power) and (b) the fluctuating trace intensities caused by slight variations in battery charge.

The system was modified to operate continuously from a single source of supply, namely the 115-volt regulated A.C. auxiliary outlet from the ionospheric recorder. Transformers in the seismic and magnetic huts stepped the power down to the lamp voltages as required (see Plate 5).

The result of this was completely uniform trace intensities at all times, no maintenance, and no adjustment of lamp currents in the magnetic hut.

For standby power in case of power failures, an accumulator and inverter were arranged for automatic operation. The system proved its worth soon after completion when a power failure of almost two hours in the middle of the night was practically undetectable on the records.

5. PROGRAMMING WITH THE 'SIMPLEX'

Electronic chronometer

For installation in 1961 the USCGS supplied an electronic tuning-fork chronometer. When it arrived, the chronometer had a losing rate of 2 sec/day, but by adjusting the loading on the fork (an adjustment not listed or explained in the instruction manual) the rate dropped to about 0.1 sec/day. By the time the chronometer was finally installed in a constant-temperature room, with a regulated power supply, the rate dropped to 0.02 sec/day; this was better than the manufacturer's specifications.

Except after failures of the programme machine, the seismic and magnetic time marks rarely differed by more than 0.1 sec from WWV after 1st March.

Bead chain problems

The 'Simplex' programme unit is designed so that, for any given circuit, each minute of the 24 hours can be separately programmed. The programming involves a closed circuit for the transmission of time marks. This is accomplished by a chain of brass heads over 12 ft long (one bead per minute for 24 hours), threading around a pulley past a pair of contacts.

Normally the contacts remain open; to programme a particular minute a brass sleeve is clamped around the bead concerned, causing it to close the contacts as it passes through them.

For compactness, the chain is housed in a plastic reservoir, into which it is a fairly tight fit.

On the Simplex unit, there are three of these bead chain programmes. Two of them involve the full 24-hour programme, one for the rapid-run magnetograph, the other for the standard magnetograph. The third programme, which operates the seismic time marks, is only a one-hour cycle.

The largest single cause of time mark failure during the year was jamming of the rapid-run magnetic bead chain programme. Probably the cause of the jamming by this particular programme only, is the large number of programmed minutes, 14 per hour, each of which has a bigger bead.

During the year many remedies were tried, but the one that finally seemed to work was removal of the rubber cushion for the solenoid plunger, so that the jolt of the lock pulsing forward shook the bead chains, keeping them flowing through the reservoir. It has been operating successfully with this arrangement since November 1961.

'Telechron' delay motor

The system of synchronous motor and relay contacts designed to provide a time-mark pulse length independent of the chronometer driving pulse, proved to be delicate and unreliable. So when the Telechron motor burned out in February, the whole system was discarded and replaced by a reliable one involving two small relays. The new mechanism has operated without fault ever since.

The heart of the system is a highly sensitive relay controlled by a resistance/capacitance delay circuit with a long time constant (see Plate 3). The relay contacts became the equivalent of the duration switch on the old system, and remain closed for six seconds. An important feature of this device is that the time mark length can be easily controlled by varying the time constant of the circuit.

6. FIELD WORK

During August 1961, a geomagnetic station at Site 2, 51 miles east of Wilkes, was occupied for measurements of H and D.

On the return voyage to Australia via several thousand miles of Antarctic coastline, seven geomagnetic stations were occupied for measurements of D, H, and Z; these included five in hitherto unknown parts of Oatesland.

Results of these observations will be summarised in a later Record.

7. ACKNOWLEDGEMENTS

The writer wishes to acknowledge the assistance given in his work by S.W. Grimsley, and the cooperative advice tendered gladly on many occasions by Captain N.R. Smethurst, Officer-in-Charge of the station. The writer is grateful also to the Director, ANARE, for providing the photographs that accompany this Record.

8. REFERENCES

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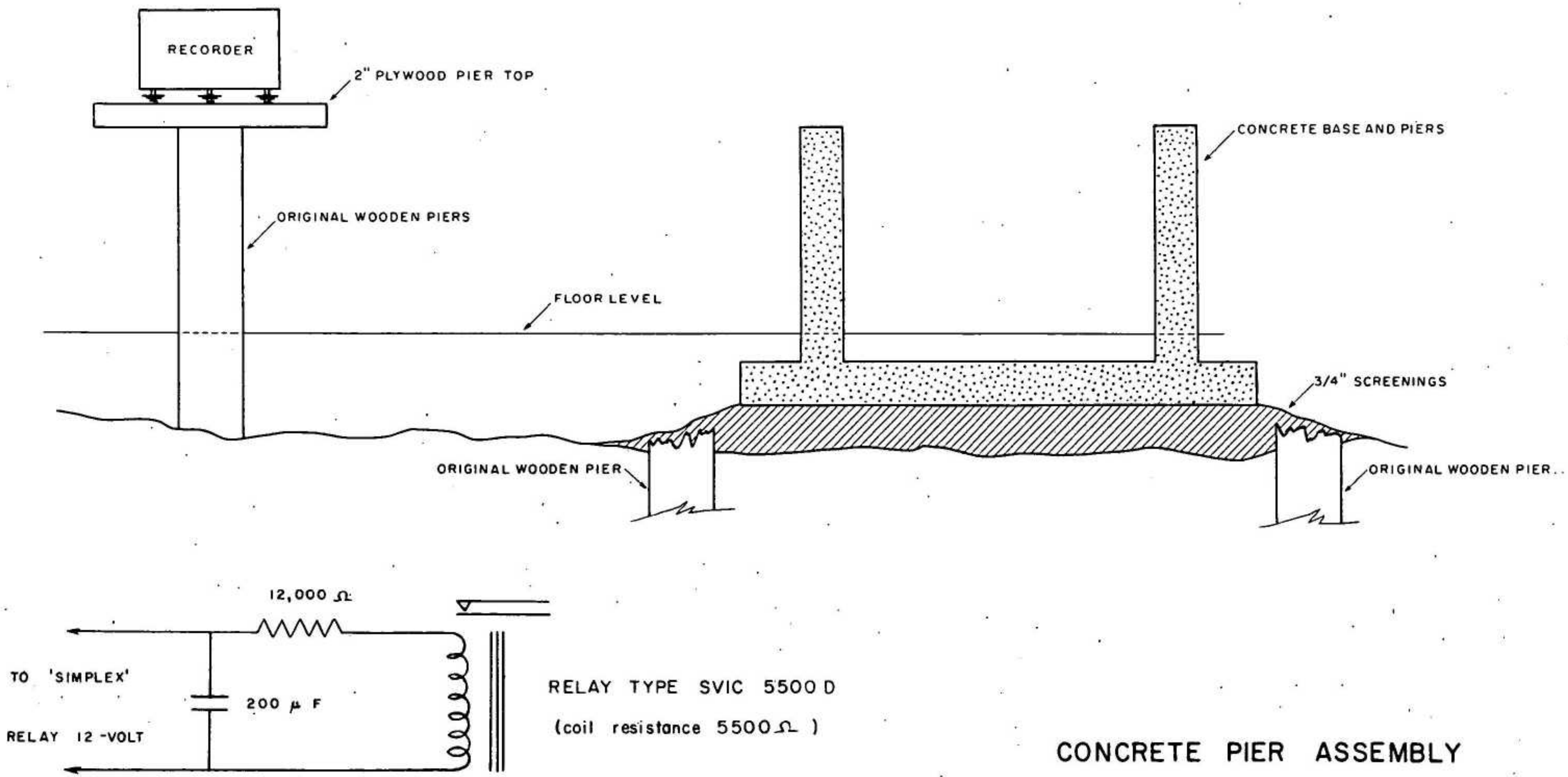
JONES, W.K.	1961	Wilkes geophysical observatory work, Antarctica 1960. Bur. Min. Resour. Aust. Rec. 1961/129.
UNDERWOOD, R.,	1960	Wilkes geophysical observatory work, Antarctica 1959. Bur. Min. Resour. Aust. Rec. 1960/114.

PLATE I

HEATED DRAIN PIPE

EXCAVATING OLD MAGNETIC PIERS

WILKES 1961



CONCRETE PIER ASSEMBLY

AND RELAY CIRCUIT

PLATE 3

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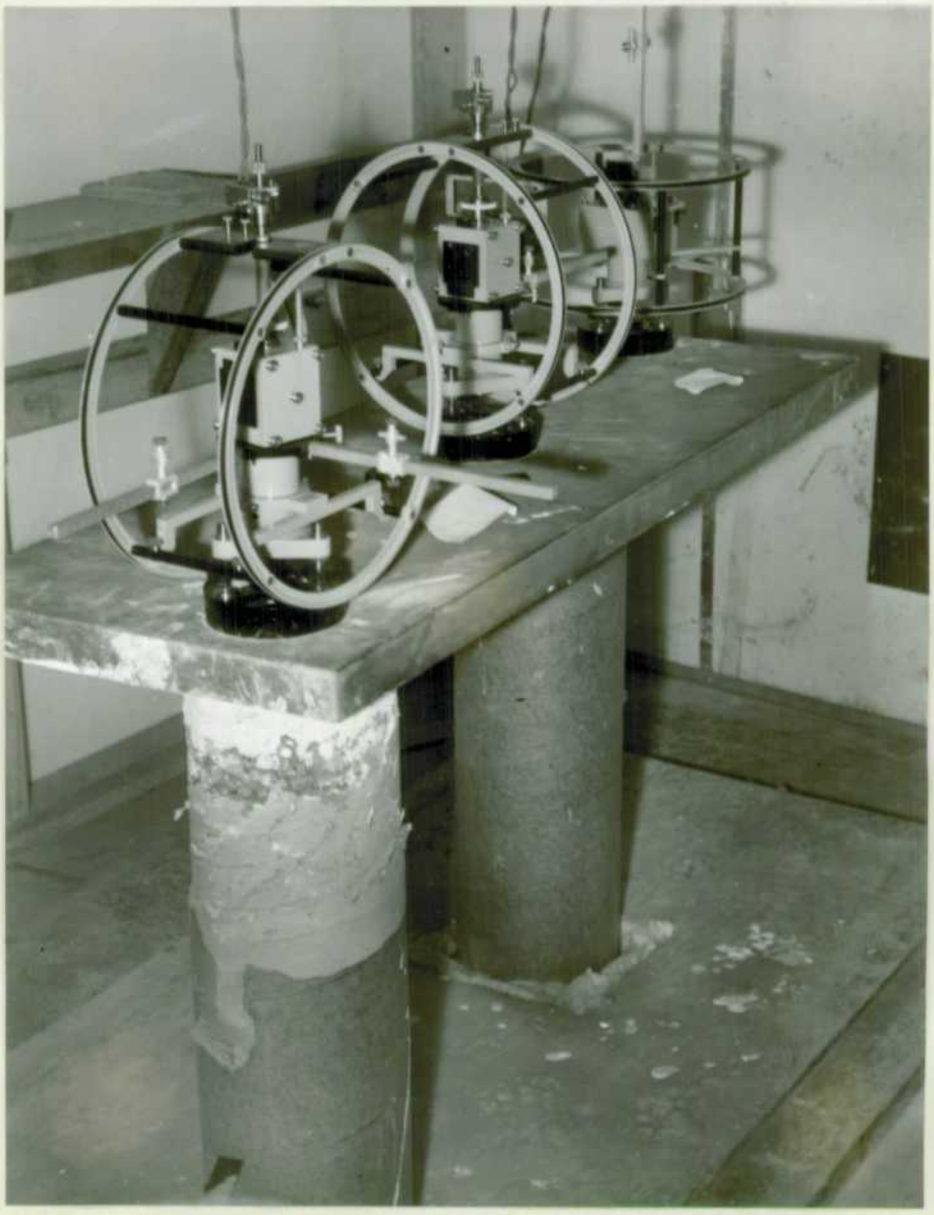
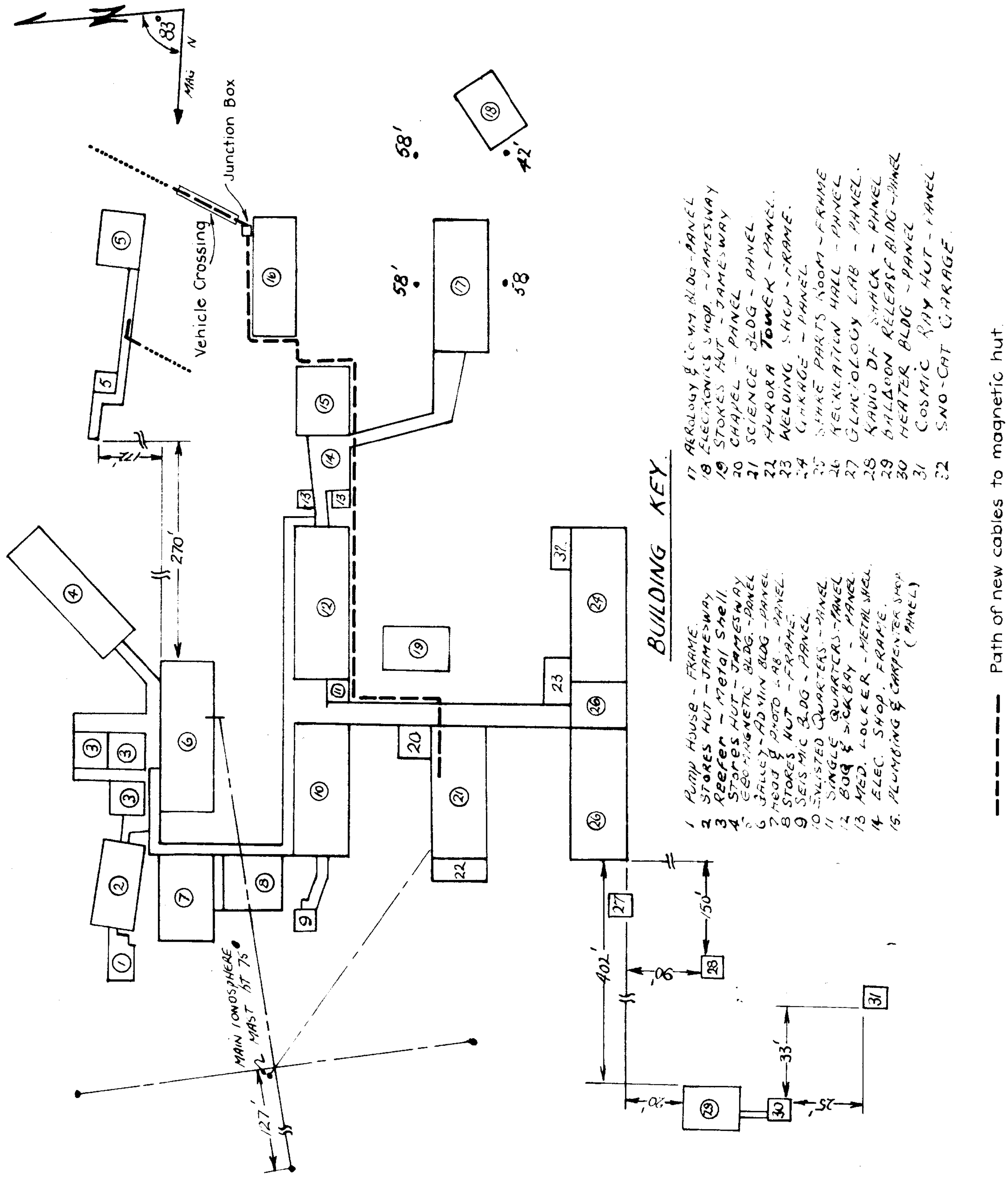


NEW INSTRUMENT BENCH COMPLETE

PLATE 5



WILKES GEOPHYSICAL OBSERVATORY
STATION LAYOUT

WILKES '1962

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