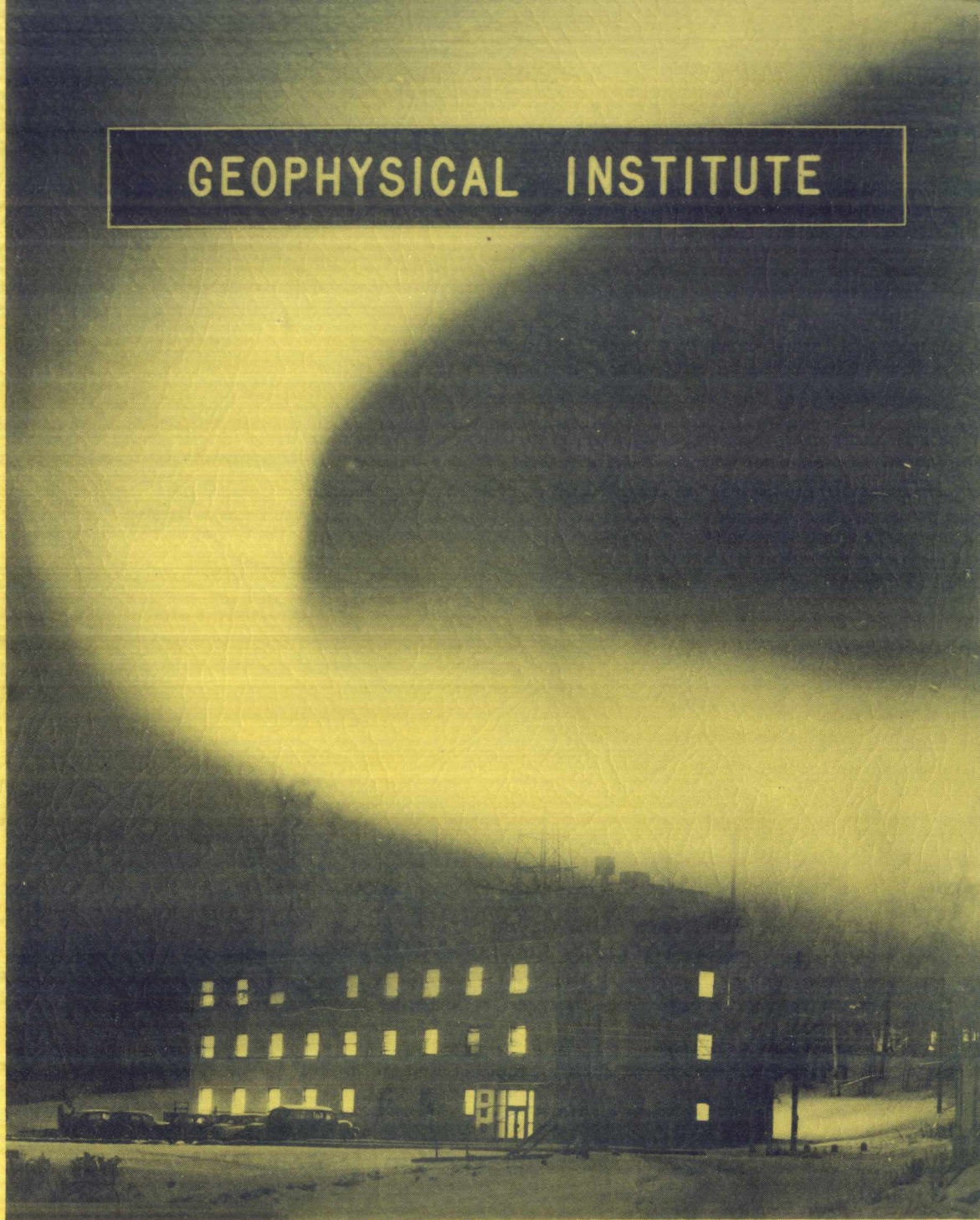


GEOPHYSICAL INSTITUTE

UNIVERSITY
OF ALASKA

COLLEGE
ALASKA

UAG R75



AN OPTICS FIELD SITE FOR AURORAL STUDIES

by

K. C. Clark and G. J. Romick

Scientific Report Number 1

IGY Project No. 1.14

NSF Grant No. Y/1.14/177

Principal Investigator: C. T. Elvey, Director

GEOPHYSICAL INSTITUTE

AT THE

UNIVERSITY OF ALASKA

Scientific Report Number 1

AN OPTICS FIELD SITE FOR AURORAL STUDIES

by

K. C. Clark and G. J. Romick

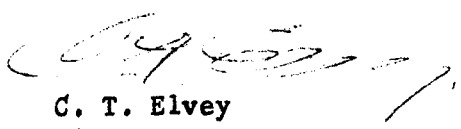
IGY Project No. 1.14

NSF Grant No. Y/1.14/177

Submission Date:

July 1958

Principal Investigator


C. T. Elvey
Director

AN OPTICS FIELD SITE FOR AURORAL STUDIES

K. C. Clark* and G. J. Romick

Geophysical Institute
University of Alaska
College, Alaska

CONTENTS

	Page
1. Introduction	1
2. General Construction	1
3. Operation of Instruments	6
3.1 Sky view and location	6
3.2 Supports for instruments	8
3.3 Facilities for each major instrument	8
a) Hunten scanning spectrometer	8
b) IGY patrol spectrograph	10
c) College meridian mirror spectrograph	13
d) Huet prism spectrograph	13
e) Roach scanning photometer	14
f) All-sky camera	16
g) Future installations	16
4. Auxiliary Facilities	16
4.1 Electric power: circuit details	16
4.2 Other services	19
5. Summary	21

* On leave from University of Washington 1957-1958.

LIST OF FIGURES

Figure		Page
1	Exterior View of Laboratory	3
2	Plan View of Roof Structure	4
3	Arrangement of Optical Equipment	5
4	Horizon Visibility from Roof	7
5	Adjustable Support for Huet Spectrograph	9
6	Interior View, Looking East	11
7	Exterior View, Looking East	12
8	Interior View, Looking West	15
9	Ground Plan	17
	A - All-sky Camera	
	B - Optical Building	
	C - Buried Power Cable	
10	Electrical Circuits	18
11	Electrical Circuit for Heaters and Blowers	20

An Optics Field Site for Auroral Studies

1. Introduction

Because of its location at the southern edge of the auroral zone, the Geophysical Institute at College is well situated for spectroscopic studies of aurora. A list of equipment currently being used locally for these observations includes the Huet prism spectrograph, the IGY patrol spectrograph, the College meridian mirror spectrograph, the Hunten scanning spectrometer, the all-sky camera, the Roach scanning photometer, scanning interference filter photometers, and a Perkin-Elmer infrared monochromator. In past years some of these and other instruments have been operated at the campus site of the main Geophysical Institute building. However, with the recent increase of scattered light background from mercury street lights and winter ice fog, it became imperative to re-establish most of the optical equipment at a remote location. The region of the Geophysical Institute field laboratories near Ballaine Lake, lying about one mile north of College and sheltered by an intervening low ridge, has proven to be a good site for these studies. The new optics field laboratory, incorporating many features of specialized design and simple construction, has proven highly convenient in the first season of operations and will be described in this report. This description serves as a reference for those who plan similar field stations elsewhere and as a record of present facilities for those who may wish to arrange to share in their use.

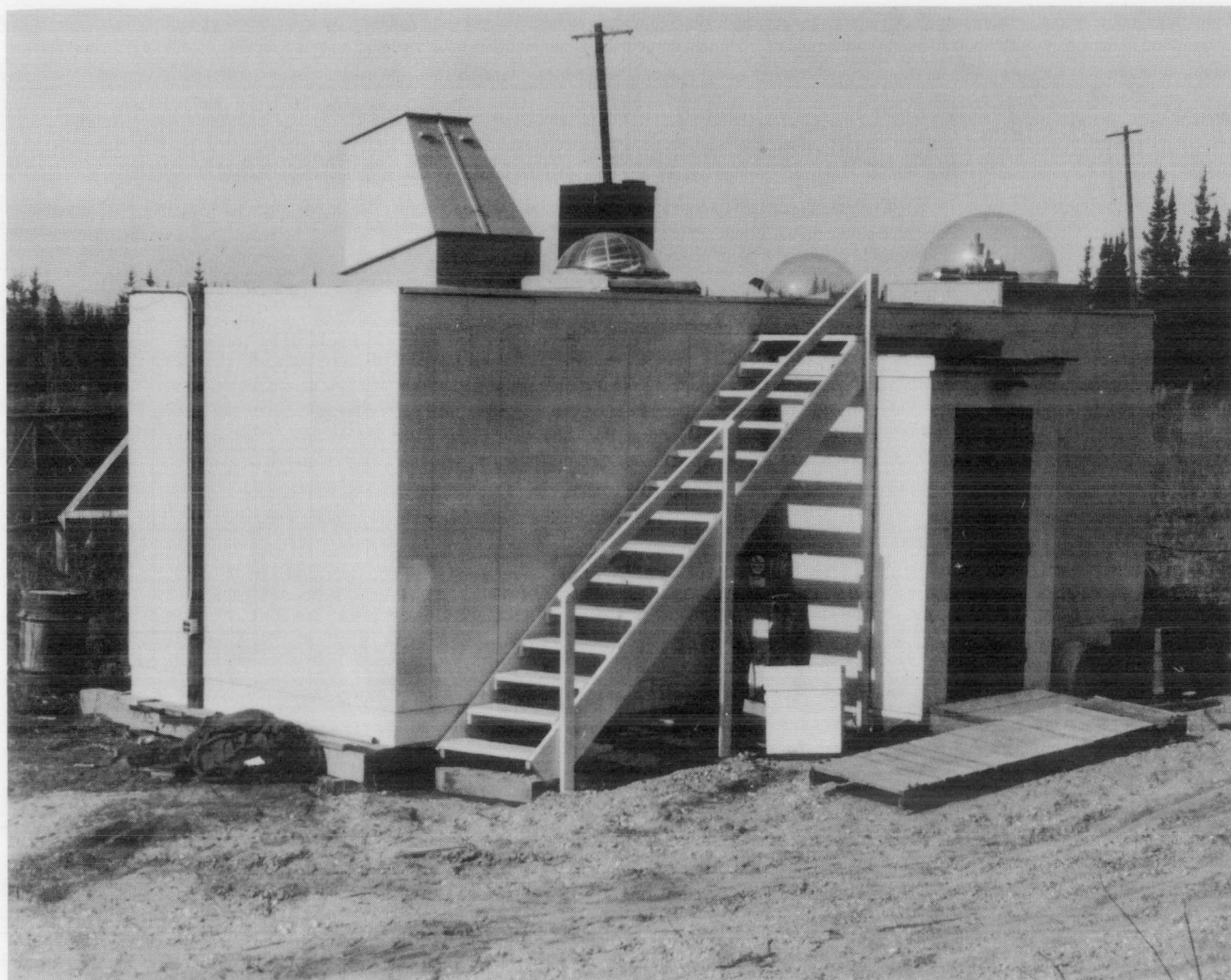
2. General Construction

A commercially available prefabricated walk-in refrigerator forms the basic building, having dimensions of approximately 30' x 10' x 10' and

(metal-sheathed) wall panels well insulated with 6 inches of Fiberglass. These unit panel sections of 2' x 10' size permit rapid and rigid assembly with interlocking bolts and allow a wide variety of modification in roof layout for mounting of optical equipment. Sections of ordinary insulated wood roof replace prefabricated panels where optical access to the sky is desired. The use of plastic domes and other devices make possible convenient indoor operation of instruments in the arctic winter. Two of these domes are reserved for viewing use by operating personnel; the operation of specific instruments in their mountings will be described in a later section. Additional exterior modifications include a durable roof overlay of 2" x 12" planks and tar coat, a stairway with hand rail, and a standard double doorway entry to replace the heavy single refrigerator door. The building is painted inside and out. Fig. 1 shows an overall exterior view of the laboratory; Fig. 2 shows the plan of roof structure as seen from above, and the arrangement of the equipment is shown in Fig. 3.

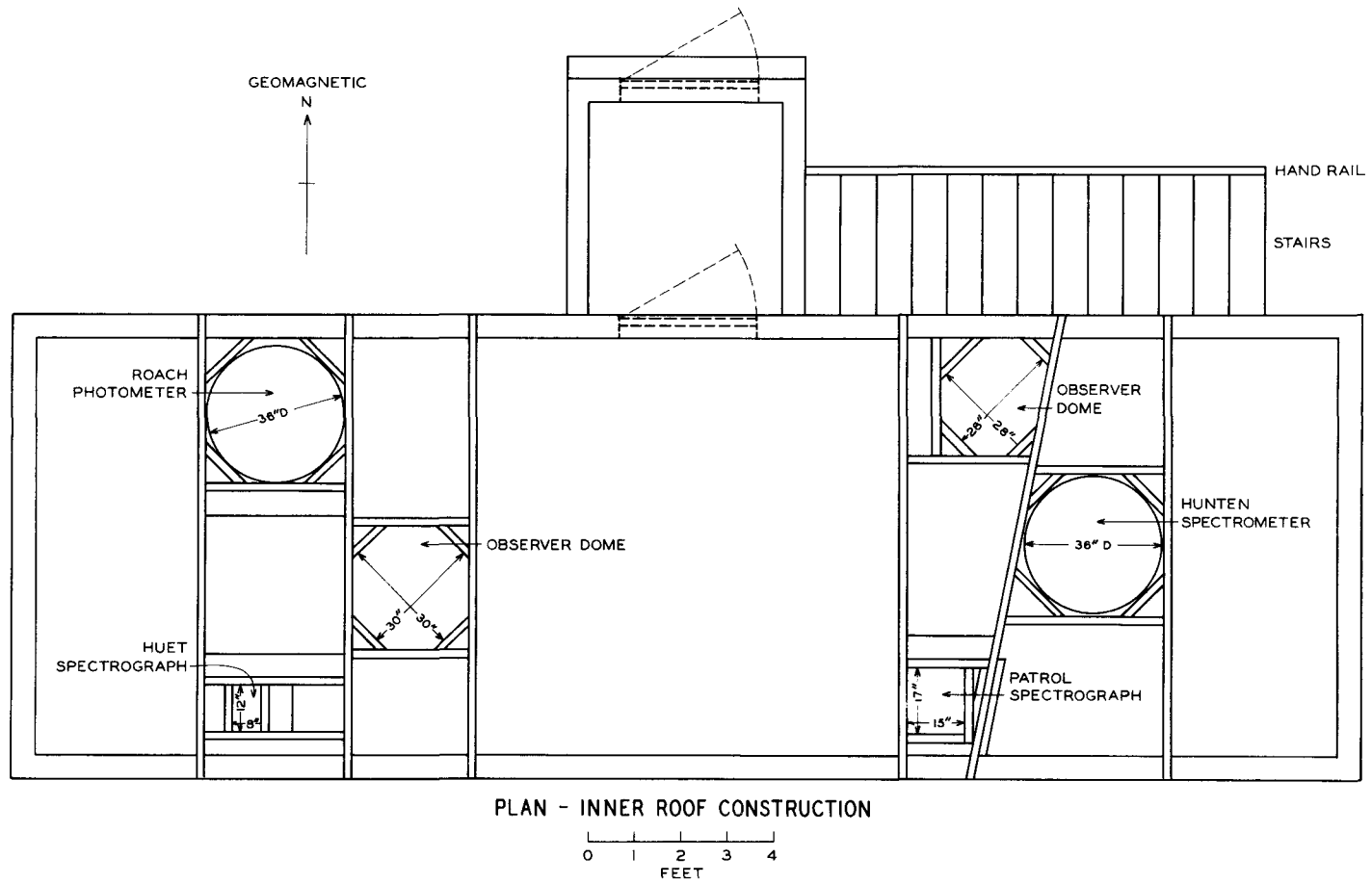
Because of the annual variations of frost level in the supporting frozen soil, shifts of foundation are to be expected. The building rests on the following simple base, which will permit periodic annual readjustments of level and orientation. Large timbers approximately (8" x 8" x 12') are laid on the leveled earth perpendicular to the long dimension of the building and about 4' apart. Across these a layer of 2" x 12" x 12' boards is placed to support the insulated floor panels of the building.

Heating and ventilating considerations are of high importance to optical operations as well as to living conditions. Because of the adequate insulation and moderate volume, it is possible and desirable to use all-electric heating. Local ice fog from combustion heating, which would settle in the



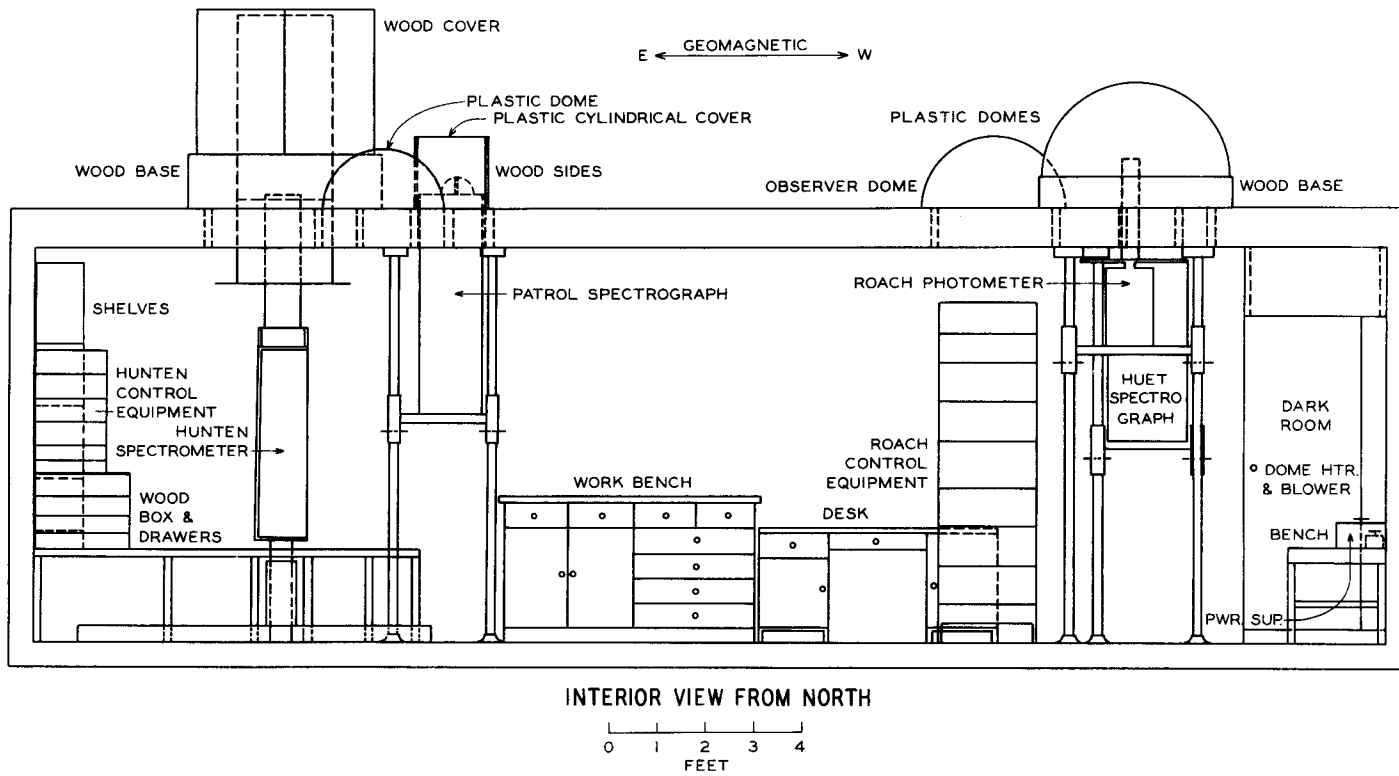
Exterior View of Laboratory.

Fig. 1



Plan View of Roof Structure.

Fig. 2



Arrangement of Optical Equipment.

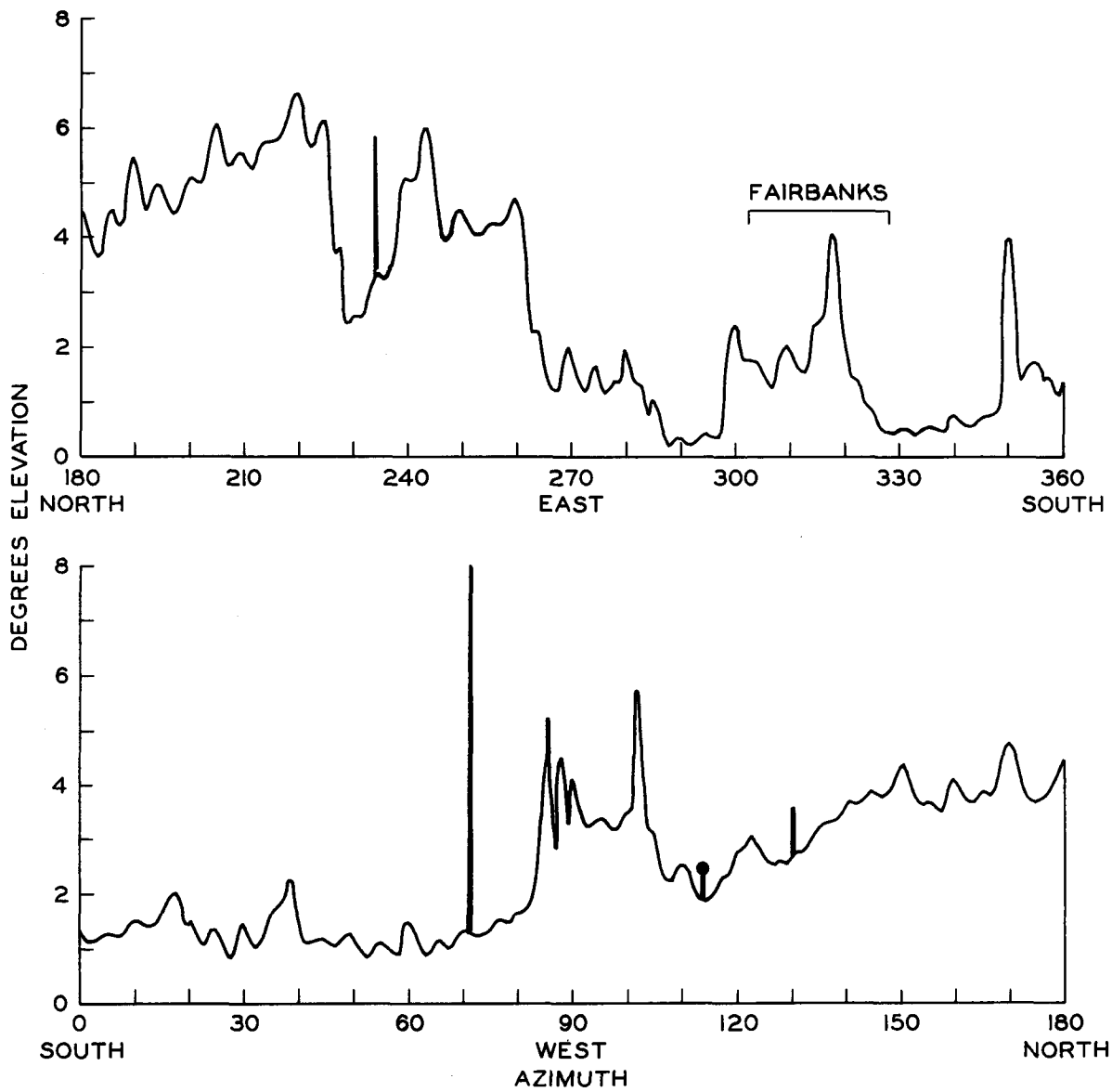
Fig. 3

quiet air and give scattered light background to photometric observations, is thereby completely avoided. Two thermostatically controlled commercial space heaters rated at 1650 watts maximum keep the building warm, and individual hot air blowers in the various domes prevent interior frosting or accumulation of exterior snow. One ventilating fan provides adequate circulation and together with the generally low atmospheric humidity has prevented any difficulty due to interior condensation of moisture.

3. Operation of Instruments

3.1 Sky view and location

From roof level at the field site the only obstructions to a clear hemispherical view are distant trees and low ridges which obscure only 5° at the horizon. Direct light from the University campus is blocked out by the southern ridge. See Fig. 4 for a diagram of horizon visibility. The all-sky camera is operated on a separate tower of equal height about 100 ft. away to enhance its clear view. As the primary purpose of the building is auroral observation, it is aligned so that the long side faces geomagnetic North, namely, 30° East of geographic North. The distant glow of the city of Fairbanks lies approximately geomagnetic East, and of the University campus, geomagnetic Southeast. Since any instrument pointed towards city or campus would pick up the spectra of street lights and signs, the low eastern portion of the sky near the horizon is not useable. Therefore, the instruments which protrude most above roof level are located generally to the East side of the building; in this way there is no great loss of useful sky to the other instruments. The location of this site, established with reference to the U.S. Coast and Geodetic Station nearby is $64^\circ 52'$ N. latitude and $147^\circ 50'$ W. longitude. Two supplementary all-sky camera stations



Horizon Visibility From Roof.

Fig. 4

have been placed in operation at Healy and Ft. Yukon to aid in close triangulation of the arcs and rays studied spectroscopically. These two locations and College conveniently lie on a geomagnetic North-South baseline. Their geographic coordinates are as follows:

Healy	63° 51' N. Lat.	148° 58' W. Long	125 km from College
Ft. Yukon	66° 34' N. Lat.	145° 17' W. Long.	223 km from College

3.2 Supports for instruments

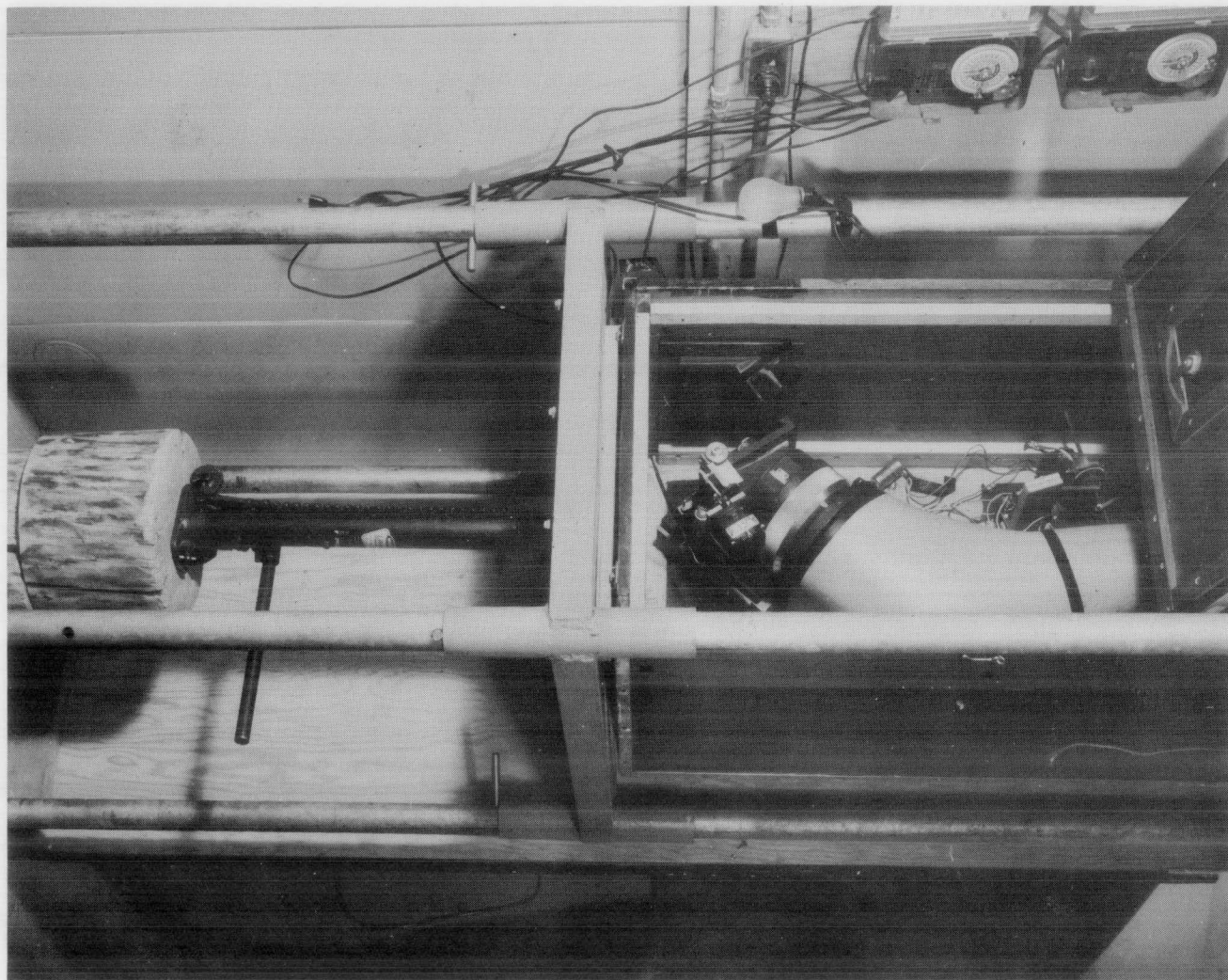
To provide accessibility for servicing and a simple method of raising heavy instruments by one person to an operating height at roof level, individual platform mounts support the Huet spectrograph, the IGY patrol spectrograph, and the Roach scanning photometer. These platforms of angle iron and wood have short sections of 2" pipe welded to each corner, and these pipes slide vertically on four upright supporting pipes mounted from floor to ceiling under the operating domes. Removable steel pins hold each platform at a desired level, and a 19" hydraulic jack with supporting blocks provides easy adjustment of height. This construction has the advantages of compactness, strength, and maneuverability in the restricted interior space and can be seen in the interior view of Fig. 5.

3.3 Facilities for each major instrument

a) Hunten scanning spectrometer

This instrument records on moving paper the intensity of the grating spectrum as viewed by a cooled photomultiplier detector. Through a continuous motor drive the grating is repeatedly swept through a desired spectral region. This instrument has been initially described by Hunten *

* D. M. Hunten, "A Rapid Scanning Auroral Spectrometer", *Canad. Journ. Physics* 31 681 (July 1953).



Adjustable Support for Huet Spectrograph.

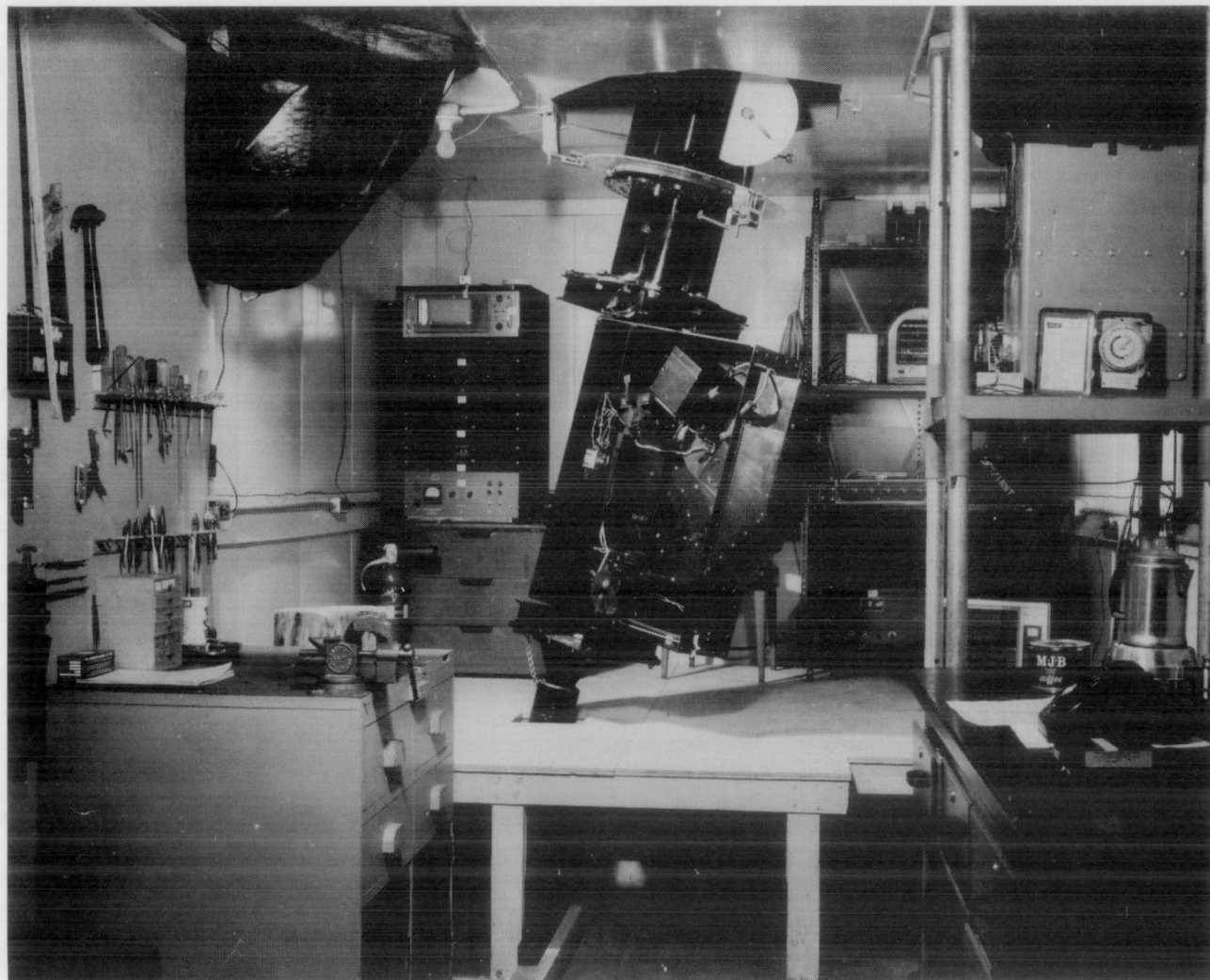
Fig. 5

The customary mounting and operation of this instrument have been altered at College to provide more versatile use in auroral studies. A detailed description of these changes is given in a separate report. The instrument is mounted to rotate about its optical entrance axis, and this is oriented toward the magnetic zenith, 13° from vertical. A scanning mirror system directs light from any portion of the sky to the spectrometer, and the sky scanning sweep, oriented relative to magnetic zenith, can directly follow along auroral rays with the entrance slit either parallel or perpendicular to them. The spectrometer can also be set at a desired wavelength for monochromatic photometry. Provisions are made for calibration with radioactive illumination standards.

Figs. 6 and 7 show the interior and exterior arrangements of this instrument. A hemispherical grid of angle markers in the adjacent observing dome can be tilted to be centered at magnetic zenith and is used in directing the spectrometer to the desired sky region. The mirror system can scan between horizons at any set azimuth and in normal operation is sufficiently high not to be obstructed by other installations. When not in use it is protected by a wood cover.

b) IGY patrol spectrograph

This instrument receives light from a North-South magnetic meridian with a 3° angular width. It can be located quite near other installations if the meridian path is kept clear. Spectra which are automatically photographed on a routine basis show angular resolution of spectroscopic features from North to South horizons. Exposure times are suitably programmed to show progressive changes through the night.



Interior View, Looking East.

Fig. 6



Exterior View, Looking East.

Fig. 7

A removable cylindrical dome of Plexiglas heated by a hot air blower protects the instrument from cold and accumulated snow. The sky lens is placed at the center of curvature of the dome and thus experiences no difficulty from spurious reflections. It has not been found necessary to paint the top of the instrument black. The elevator platform support permits the instrument to be operated completely from inside the laboratory and to be easily lowered for repairs. Fig. 6 shows this installation at the far right. It has operated best with its automatic day-night power control running but with a system of fixed exposure times replacing the photometric exposure control. Alternating exposures of 90 and 30 minutes regularly show emission from hydrogen and atmospheric sodium. The timing throughout is regularly synchronized to the WWV signal available in the building.

c) College meridian mirror spectrograph

This simplified instrument, designed and built recently at the Geophysical Institute, serves primarily to add critically needed speed in detection of hydrogen and other auroral emissions as resolved along the North-South magnetic meridian. It is described in detail in another report. The flat image of a suitably curved external slot, as formed by a convex all-sky mirror, is viewed from above by a camera through a transmission grating at minimum deviation. This instrument is enclosed in an all-weather heated box and is located on the roof top as shown in Fig. 7. It gives good sensitivity to hydrogen emission in 15 minute exposures. Weekly servicing is required.

d) Huet prism spectrograph

This instrument has a single flint glass prism and a speed of $f/0.7$. It is mounted on an elevator platform and oriented to receive

light from an angular field of 11° centered on magnetic zenith. To admit auroral light, a small single window glass is mounted slightly above roof level at a 13° angle and heated from below by a hot air blower. The plate holder moves perpendicular to the plane of dispersion at a speed which with the present slit length gives effective time resolution of 1 hour throughout the night. Automatic operation of shutters, drive motors, and a calibration lamp is obtained from pre-set timers, and changing of plates is required every 3 or 4 days. This instrument, with access doors open, is shown in Fig. 5.

e) Roach scanning photometer

This instrument is located at the east end of the laboratory and can easily be jacked up into its operating position in a heated hemispherical dome. An observer's dome is adjacent, and the photometer obtains an essentially unobstructed view except for the other installations in the direction of the Fairbanks glow. Using a birefringent filter of the Lyot type and a prefilter of the multiple layer interference type it records the intensity of an atomic emission line included in the pass band of the prefilter. The telescope, filter, and photomultiplier unit scan automatically in azimuth and elevation according to various programs and can cover the sky in less than four minutes. At present the instrument serves to record distributions of the oxygen green line 5577A. It is anticipated that its use will be extended to 6300 A (oxygen red) and 5890-5896A (sodium). Reflections from the dome caused by light from the interior are minimized for this and other enclosed instruments by the use of black curtains gathered at the ceiling opening. Fig. 8 shows the photometer and controls in position for operation.



Interior View, Looking West.

Fig. 8

f) All-sky camera

The College instrument is located on a separate platform at approximately the same height as the roof of the optics field site and at a distance of 100 ft. magnetic west of the door. This installation is easily serviceable from the field site and is kept separate in order to maintain a more nearly complete hemispherical view. The location may be seen on the ground plan of Fig. 9. The primary reference for orientation of both the camera and the field site building is a pair of survey stakes in a magnetic East-West line at the rear of the building.

g) Future installations

Space on top of the middle roof area is available for additional instruments, such as the College meridian mirror spectrograph, which has a self-contained heating system. Adequate full sky coverage is essentially available, with the exception of low East, for instruments two or three feet high and not too bulky. The East observer's dome might be employed for equipment, and further holes in the wood roof sections are possible if carefully planned. Cutting or further removal of metal roof sections should not be done, or the rigidity of the building will suffer.

4. Auxiliary Facilities

4.1 Electrical power: circuit details

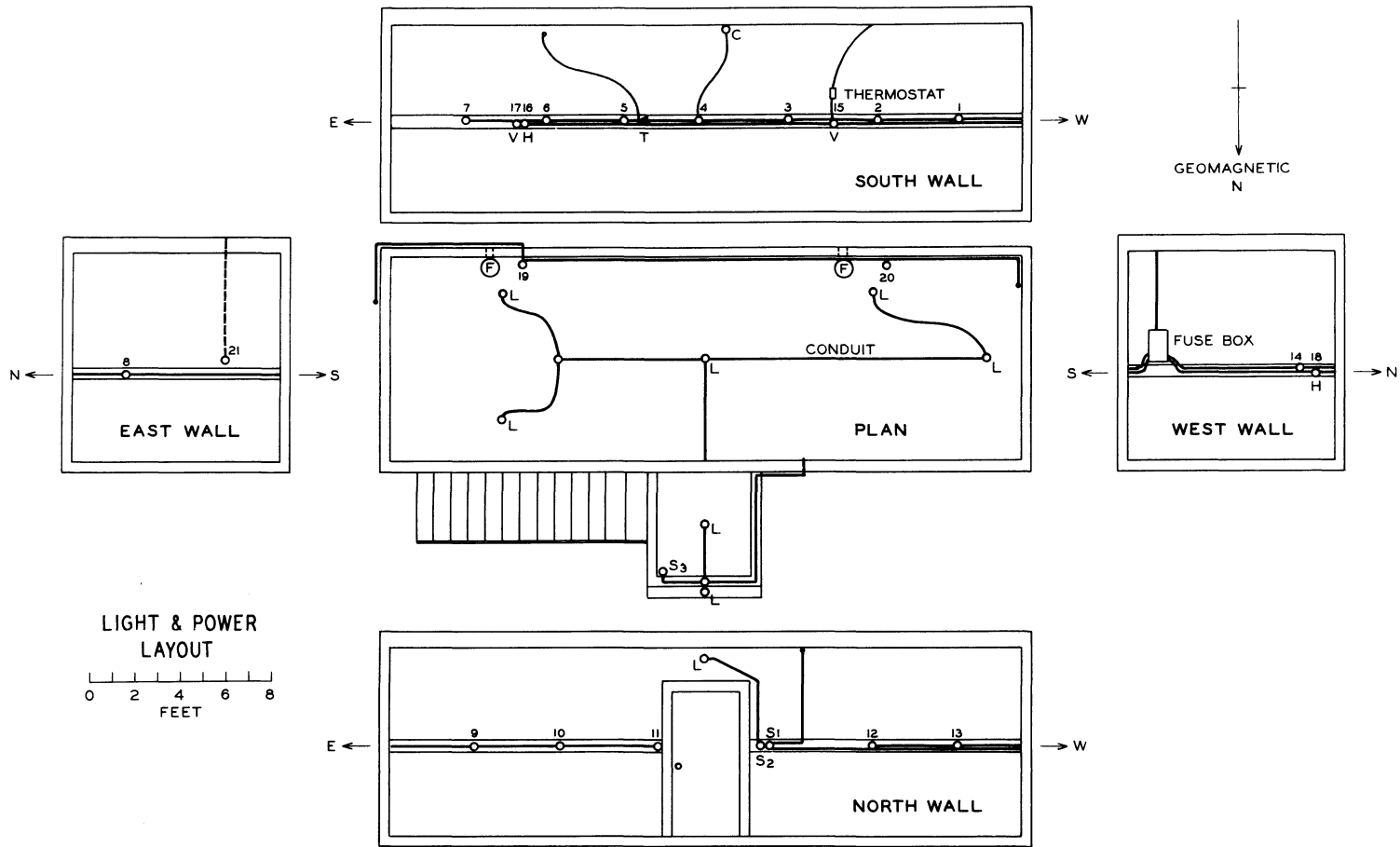
All electric power comes by underground cable from the main power transformer located on a pole approximately 100 yards geographic North of the building. Fig. 9 shows the position of this buried lead-covered cable. The available power is 60 amp at 220 volts 60 cycles/sec and is split into six 110 volt circuits at the fuse box located in the southwest corner of the building. Fig. 10 shows the electrical circuits of the building,



Ground Plan.

- A - All-Sky Camera
- B - Optics Building
- C - Buried Power Cable

Fig. 9



Electrical Circuits.

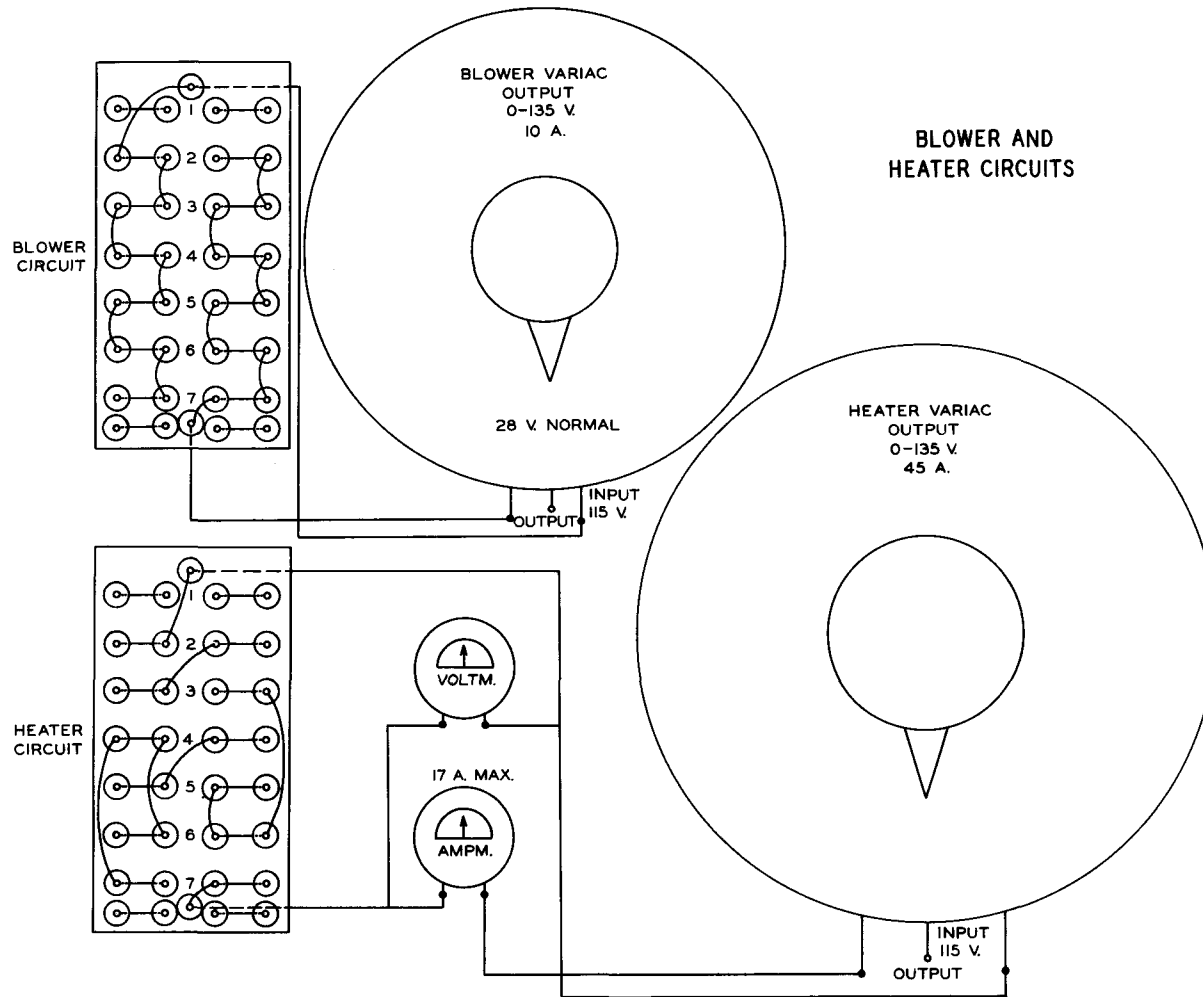
Fig. 10

including the positions of the outlet boxes, lights, switches, heaters, and ventilating fans. Fig. 11 shows the separately controlled circuit for the heaters and blowers in the various domes. Exterior power outlets are available on the roof for equipment and repair operations, and there are convenient outlets on the east wall for automobile headbolt heaters.

4.2 Other services

A photographic darkroom is constructed in the southwest corner with adequate but limited facilities for film changing and processing. City telephone service is present. A loud speaker connection with WWV time signals and a wire from a secondary standard time signal (independent of ionospheric blackouts) are available. The building is furnished with work bench, hand tools, storage cabinets, and desk. While an interior color of flat black would have been ideal in regard to the optical operations, a light pink color was chosen and found highly preferable in preventing psychological fatigue during protracted winter operations.

As the field site is easily accessible throughout the year from the main Geophysical Institute building, full use can be made of the central supporting facilities at the Institute for spectroscopic and photometric studies. These include offices, processing laboratories, standard and specialized microdensitometers, film projectors, an electronics shop, an extensive reference library, and the constant interchange of discussion among many interconnected areas of geophysical research.



Electrical Circuit for Heaters and Blowers.

Fig. 11

5. Summary

To serve as a guide for future users and for those who plan similar constructions, this report describes the conversion of a prefabricated walk-in refrigerator to an arctic field laboratory for optical auroral studies at the Geophysical Institute. This new facility incorporates certain specialized design features for these researches and has proven very satisfactory in its first winter season of operation. The installation and use of its present major instruments are described. This equipment includes a Hunten scanning spectrometer in a sky-scanning mount; an IGY patrol spectrograph, the College meridian mirror spectrograph, the zenith Huet prism spectrograph, and a Roach scanning photometer. Details of construction, layout, electrical circuits, and other facilities are given.