THE UNIVERSITY OF MICHIGAN
COLLEGE OF ENGINEERING
Department of Aerospace Engineering
High Altitude Engineering Laboratory

Quarterly Report

HIGH ALTITUDE RADIATION MEASUREMENTS

1 April, 1967 - 30 June, 1967

(Frederick Lester)
Fred L. Bartman

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Abstract

This report is a summary of project activities during the period 1 April 1967 to 30 June 1967. Laboratory testing and development of the IRIS interferometer, preparations for the next balloon flight, and work on laboratory measurements of CO_2 transmission are described.

I Introduction

This is the 18th quarterly progress report on contract no. NASr-54(03) covering the period 1 April, 1967 to 30 June, 1967. The project effort during this time was divided among the following tasks:

1. Laboratory testing and development of the IRIS interferometer
2. Preparations for the next balloon flight.
3. Laboratory measurements of CO_2 transmission.
4. Report writing.

II Laboratory Testing and Development of the IRIS Interferometer

The development of a Mylar beam splitter received most emphasis during this three month period.

The reflectance of a thin film such as Mylar, is determined by interference between its two surfaces. It is hoped that a Mylar film can be made with suitable thickness for good reflectance over the range of 11 to 28 microns.

The Union Carbide company was contacted regarding the material paralene which can be made in very thin films. It was determined that Union Carbide is working with Perkin-Elmer to develop a paralene thin film beam splitter under contract to Goddard Space Flight Center. In order to avoid a duplication of effort, it was decided to devote our development efforts to another material, Mylar.

The thinnest Mylar film available is 3.75 microns thick. Reflectance tests indicate that a 2.75 micron thick film of Mylar will produce a beam splitter suitable for the wavelength range of 11 to 25 microns. It has been decided to try to stretch the 3.75 micron film to the necessary thickness. So far, efforts have resulted in a satisfactory 16% stretching of a five inch diameter piece of Mylar. A 26% stretching is needed, and can probably be achieved since the material will not fail until it is stretched 43%. The stretching device used is shown in figure 1. The Mylar, which is fastened between two of the outer aluminum rings is pulled down over the inner cylinder, which has a rounded smooth lubricated top surface, by means of the 8 adjusting screws. After stretching, the material is clamped into the beam splitter frame and then removed from the stretching device.

A thin film of this type, stretched tightly over the frame which holds it, is an excellent drumhead. Small changes of air pressure (acoustic vibrations) easily excite vibrations in the film which are unacceptable in an interferometer beam splitter. A new holder, having a solid cross piece across the center of the beam is being designed and constructed to eliminate vibrations.

A new mirror drive having a separate pick up coil was designed and is now under construction.

A program of measurements of sky spectral radiance, looking upward from the ground, was started. However the beam splitter was found to be fogged after one day of operation due to a low rate of flow of the dry nitrogen purging gas. This beam splitter is now being repaired.

III Preparations for the Next Balloon Flight

A. Texas Instruments IRIS Instrument

The hardware which was fabricated for use with the T. I. IRIS on the next balloon flight was taken to the Texas Instruments Co. for a check out. It was found that an error had been made in locating the instrument mounting holes in the "ice tray" on which the instrument will be mounted. This error was easily corrected.

Further discussion of the mode of operation of the instrument during the balloon flight yielded the following results.

1) It is not practical to try to operate at sea level pressure because it would be difficult to make the instrument housing pressure tight. Also, this pressure would not provide a "spacelike" environment for the instrument.

2) The instrument will be operated at the balloon ambient pressure (7 mb approximately). To eliminate voltage breakdown, the detector bias voltage will be decreased from 400 volts to 240 volts.

3) The decrease in instrument sensitivity due to the decreased voltage will be compensated for by removing the Irtran window.

4) A door will be added to the earth port. It will normally be closed and will open only after the balloon reaches float altitude.

The additional hardware necessary for these changes was designed and constructed.

The 25 liter liquid nitrogen supply dewar was received from the manufacturer. It was tested and found to operate satisfactorily. The time interval of operation that this supply will provide for the T. I. IRIS instrument will not be known until that instrument is received and operated at the proper temperature.

The problem of changing the format of the T. I. IRIS digital data from serial to parallel form without use of the frame, word and bit "sync" pulses appears to be a formidable one. A tape of T. I. IRIS digital signals has been received and an attempt is being made to solve this problem on the CDC 160A computer.

B. The MRIR Radiometer

The MRIR auxiliary mirror system for direct sun signals was tested and found to have a marginal amount of holding force. Thus an impact could move the mirror out of its proper position.

A position servo system was designed and built to give positive positioning of the mirror. The high gear ratio electric motor used in the serves to lock the mirror in position of each step.

C. Balloon Flight Systems

The scanning photocell for measurement of sun azimuth angle has been tested with sun signals. This device has also been operated in the environmental test chamber at temperatures down to -65° C and at low pressures corresponding to balloon flight altitudes. A final adjustment of the photocell signal amplitude is required before the flight.

The camera control box has been rebuilt and tested. The pulse duration of the camera actuating signals has been adjusted. The cameras were operated in a test using this control box with the gondola programming unit. Arc suppression diodes were added to the coils of the relays in the camera control box, to prevent interference which had been causing erratic operation of the programmer logic.

Because of the changes in the MRIR auxiliary mirror drive system, and because inspection showed many poor soldering joints, the miscellaneous control box was rewired. The unit was then successfully tested for operation of the:

1) MRIR auxiliary mirror.

2) MRIR and U. M. IRIS doors.

3) Gondola spin jets.

4) F. A. T. booms

The inverter which is to be used to operate the T. I. IRIS warm black body positioning device was built. This unit is complete except for the high reliability transistors which have not yet been received.

Ten new "block" thermistors which are used to measure temperatures at various points on the balloon gondola were assembled and wired.

The Thermotron environmental test chamber was received on 1 April 1967. It was installed and ready for a final check out by the factory representative on 21 April 1967. The chamber met all specifications in the final test. After this test, additional electrical and fluid feed-thrus were installed and a shroud which will be liquid nitrogen cooled for simulation of the outer space thermal radiation environment was designed. The chamber will be completely ready for environmental testing of components when this shroud is built and installed.

The EMR model 4140 tunable discriminator was received and placed in service. This unit is a fully tunable pulse averaging telemetry discriminator. Center frequency and output filter characteristics may be set from the instrument's front panel, by an external programmer or by computer control. In addition to laboratory experimental uses, the unit could be programmed to sample the IRIG FM/FM channels at a down range reception point on future flights if needed. Thus, such a down range station could record the multiplex signal, and be assured of proper reception by sampling various channels instead of using a complete bank of discriminators.

A complete set of calibrations of 12 free air temperature thermisters has been completed. The Dymec 2401 B Integrative Digital Voltmeter developed noise again and was returned to the Hewlett Packard repair facility. A Dymec Model 2401C demonstration unit was loaned to us for the calibrations and performed very nicely. This calibration data is now being processed and will be reported on in the next quarterly report.

D. Balloon Gondola Assembly

When construction of the various instruments and control units permits these items are mounted in their proper position on the balloon gondola. The balloon gondola assembly, as of 15 September 1967, is shown in 10 photographs in figures 2-11.

Figures 2 and 3 are photos of the side of the gondola on which the IRIS interferometers will be located. The U. M. IRIS, its 10 liter liquid nitrogen dewar and the 25 liter liquid nitrogen dewar for the T. I. IRIS are shown. The IRIS programming unit which is shown at the bottom of the gondola will be moved upward to the main compartment, adjacent to the U. M. IRIS. The scanning photocell which is used to determine gondola aximuth is shown at the top of these two figures (and in six of the other photos) as well.

Figures 4 and 5 show the side of the gondola as the observor moves to the right of the side already shown. The units now seen include the U. M. IRIS electronics package, the pressure altimeter, the Maurer cameras, a ballast container and the NIMBUS MRIR. Figure 6 is a close-up of two Maurer Cameras and the MRIR as viewed from this side of the gondola.

Figures 7, 8 and 9 show the next side of the gondola, again moving to the right. The master programming unit, telemetry chassis, miscellaneous control box, camera control box, 2 additional cameras, a regulator power, the battery compartment and crash pad. Figure 9 is a close up view of the MRIR from this side of the gondola.

Figures 10 and 11 show the programming side of the gondola programming unit and one of the two dry nitrogen jets which are used to spin the gondola, the other jet is shown in figures 4, 5 and 6.

IV Laboratory Measurements of CO_2 Transmission (by Henry Reichle)

Significant progress has been made in the work on the infra-red transmission of CO_2 during this quarter. The Perkin Elmer Model 221 Spectrophotometer that is being borrowed from the Langley Research Center of NASA has arrived and has been installed and checked out by Perkin Elmer. A set of 40 meter long path cells has been borrowed from Professor E. A. Beattner of the school of Public Health and is now being refurbished. Fig. 12 shows both the spectrophotometer and the cells in the laboratory.

A study of the adsorption and desorption of CO_2 on cell wall surfaces has been performed using the Model 221 spectrophotometer and cells available in the laboratory. The results of this study indicate that the CO_2 desorbed by the cell walls could significantly influence the composition of the gas in the cell and hence, the accuracy of the data. During the next quarter the Model 221 spectrophotometer will be modified and a data system designed such that the data will be in a form suitable for magnetic tape recording. The refurbishing of the 40 meter cells will be completed and the problem of sample gas composition will be studied.

V Report Writing

A. Reports Published

1) Quarterly report 05863-14-P, High Altitude Radiation Measurements, 1 April 1966-30 June 1966. The University of Michigan, Department of Aerospace Engineering, Ann Arbor, Michigan, April 1967.

2) Chaney, L. W., Loh, L. T. and Surh, M. T., A Fourier Transform Spectrometer for the Measurement of Atmospheric Thermal Radiation, The University of Michigan, Department of Aerospace Engineering, Technical Report 05863-12-T, Ann Arbor, Michigan, May 1967.

B. Papers Presented and Lectures Given

1) Bartman, F. L., The Remote Sensing of Atmospheric Radiation, presented at the American Society of Photogrammetry (Great Lakes Region) Spring Technical Meeting, 5 May, 1967. Ann Arbor, Michigan.

2) Chaney, L. W., Fourier Transform Spectroscopy, lecture given at the University of Michigan Summer Conference on Precision Radiometry, June 12-16, 1967, Ann Arbor, Michigan.

3) Bartman, F. L., Atmospheric Radiation Processes, and The Reflectance and Scattering of Solar Radiation by the Earth, lecture given at The University of Michigan Summer Conference on Atmospheric Physics, June 5-9, 1967, Ann Arbor, Michigan.

VI Future Work

During the next quarter, the project effort will include:

1) Data Analysis and theoretical investigations.

2) Interferometer Development.

3) Balloon Flight Preparations.

4) Laboratory Measurements of CO_2 transmission.

5) Report Writing.

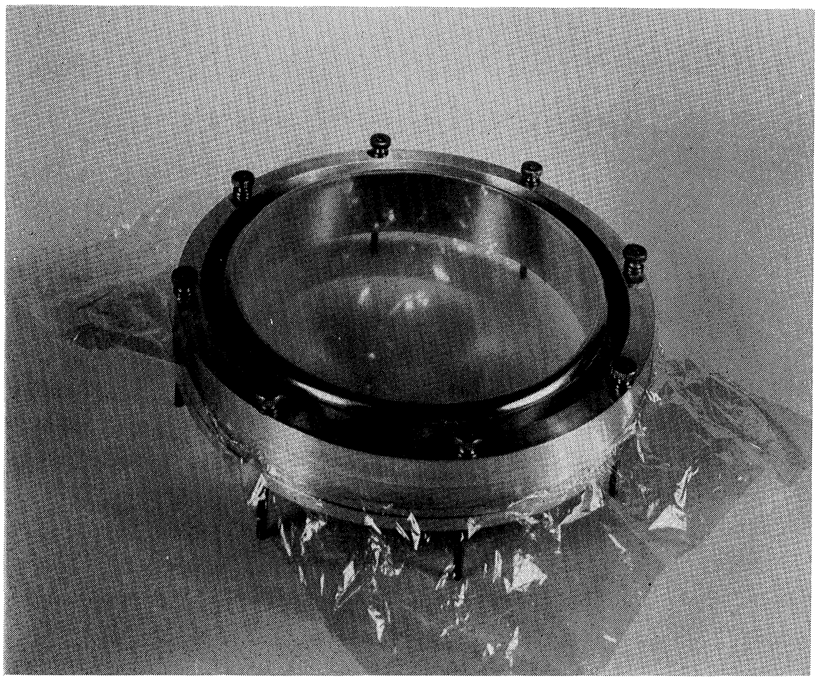

Figure 1. Frame used for stretching Mylar.

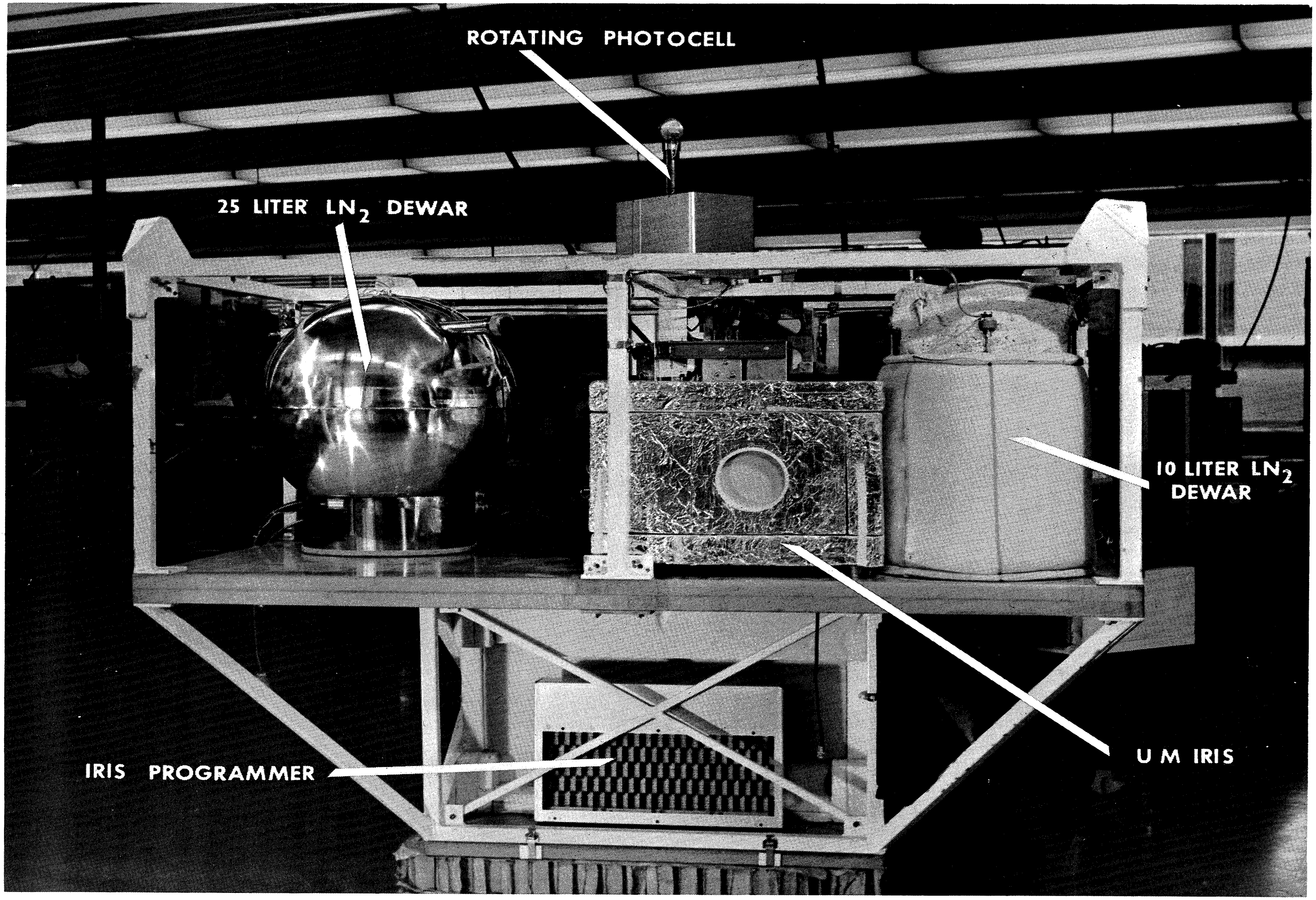

Figure 2. Balloon gondola showing U. of M. IRIS.

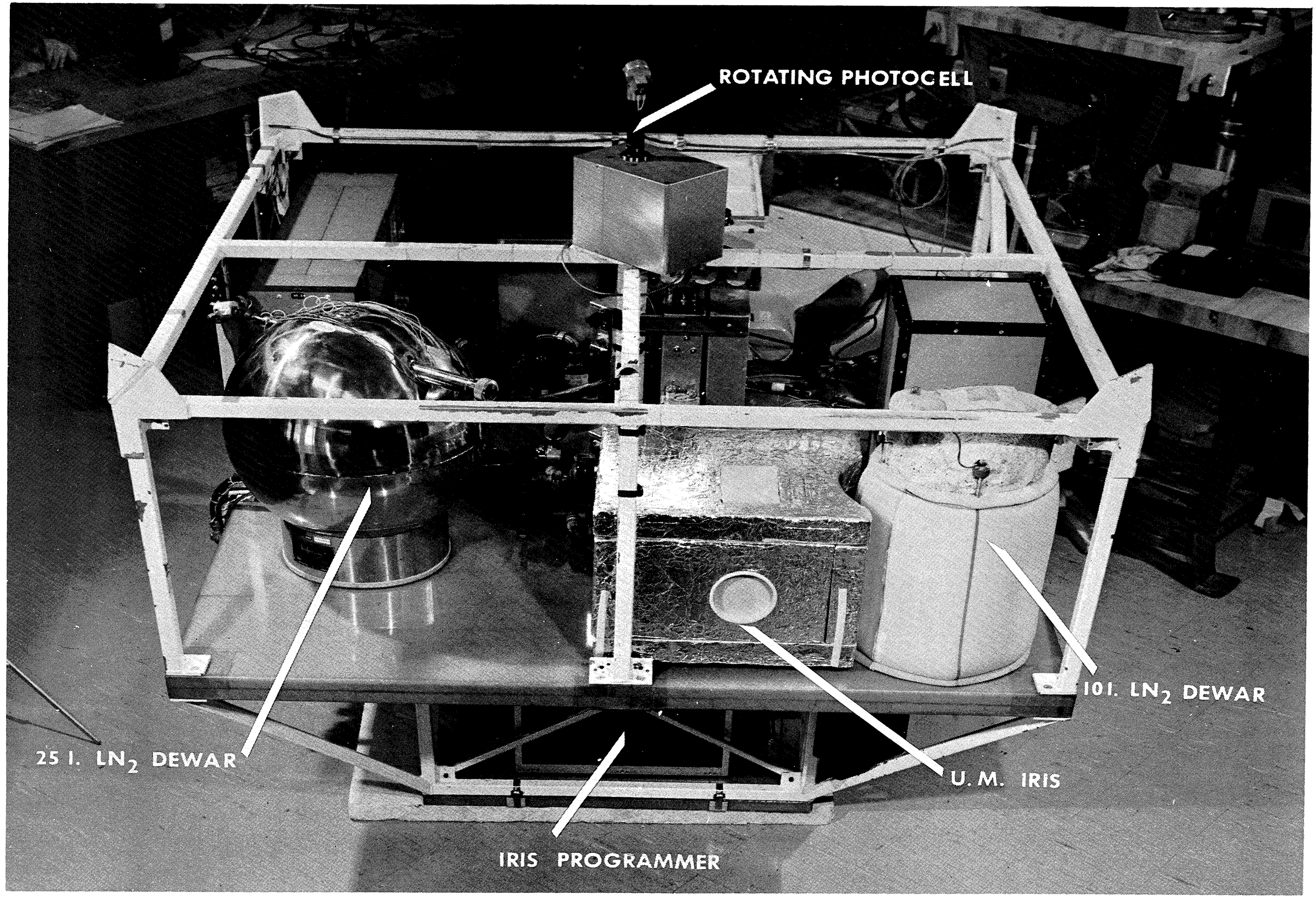

Figure 3. View of balloon gondola from above showing U. of M. IRIS.

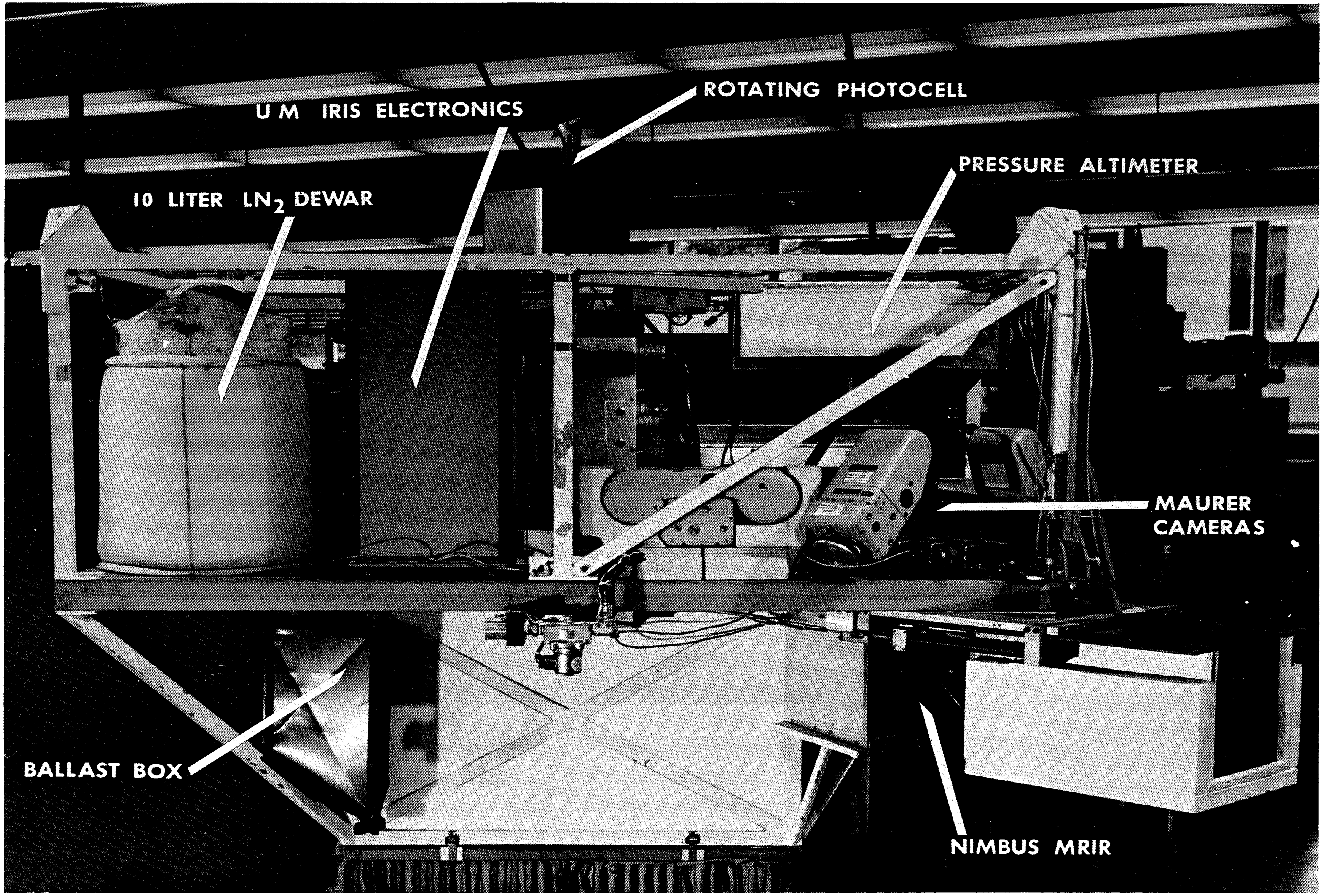

Figure 4. Balloon gondola showing U. of M. IRIS, Maurer cameras and MRIR.

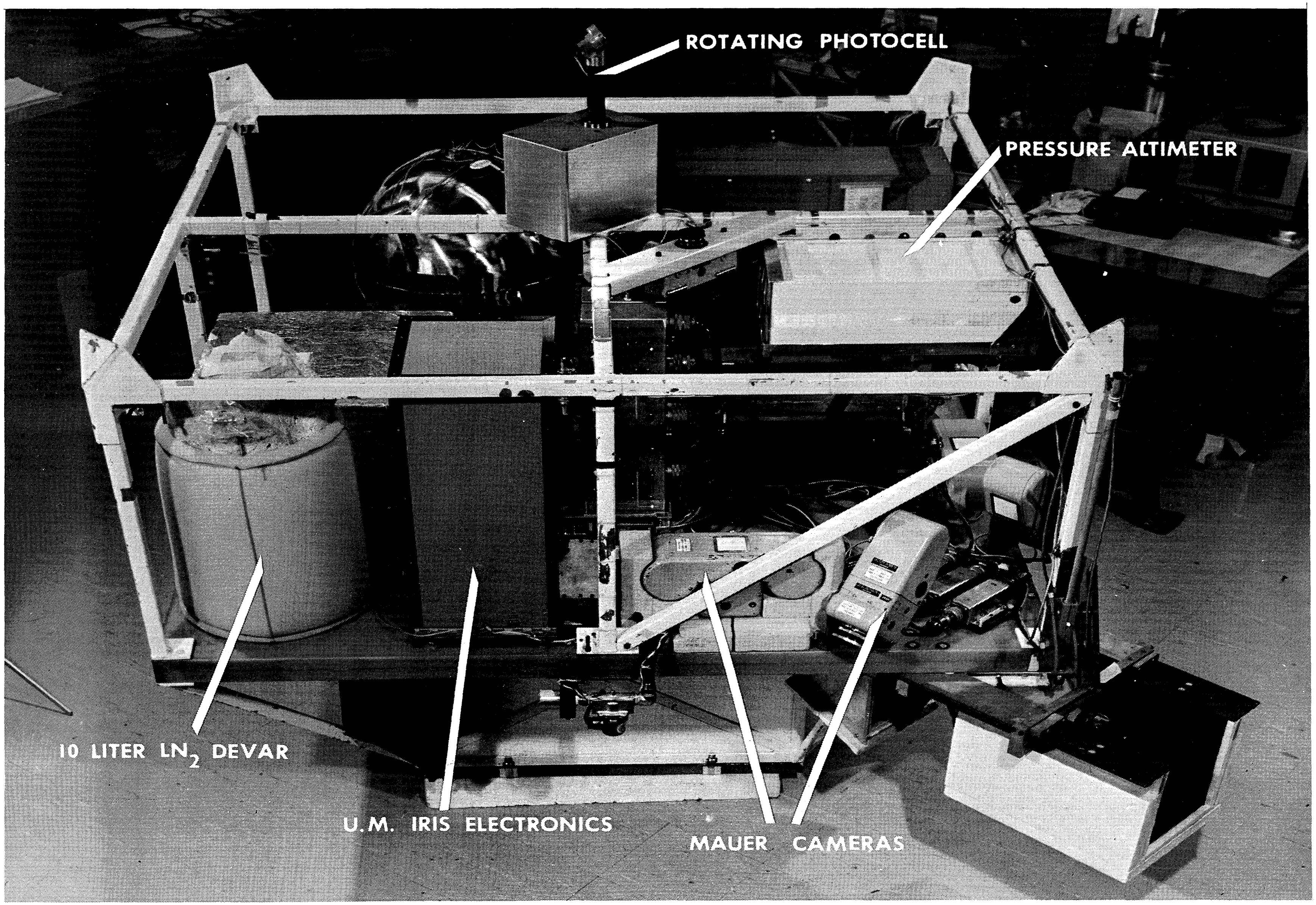

Figure 5. View of balloon gondola from above showing U. of M. IRIS, Maurer cameras and MRIR.

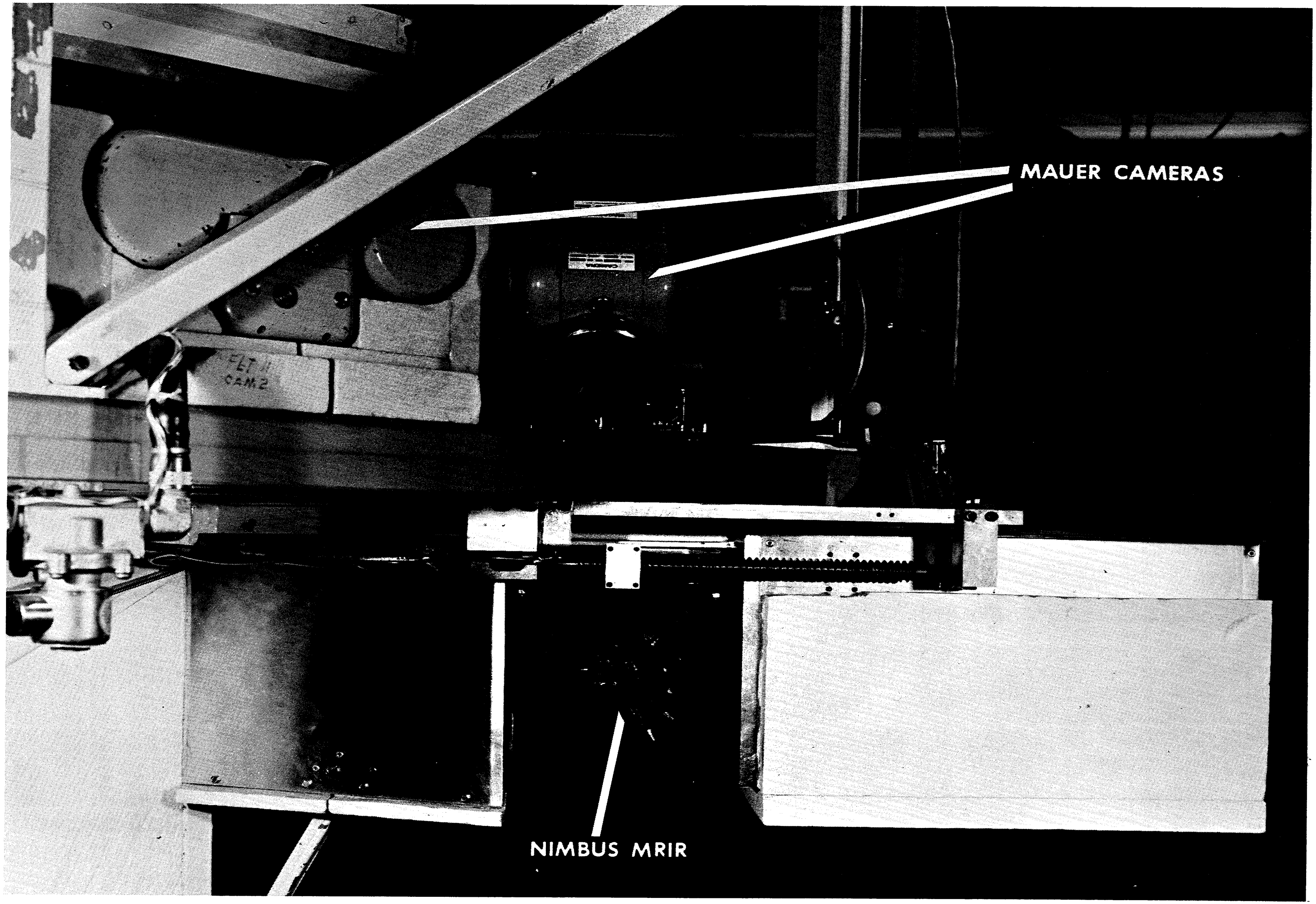

Figure 6. Close up view of MRIR and two Maurer cameras.

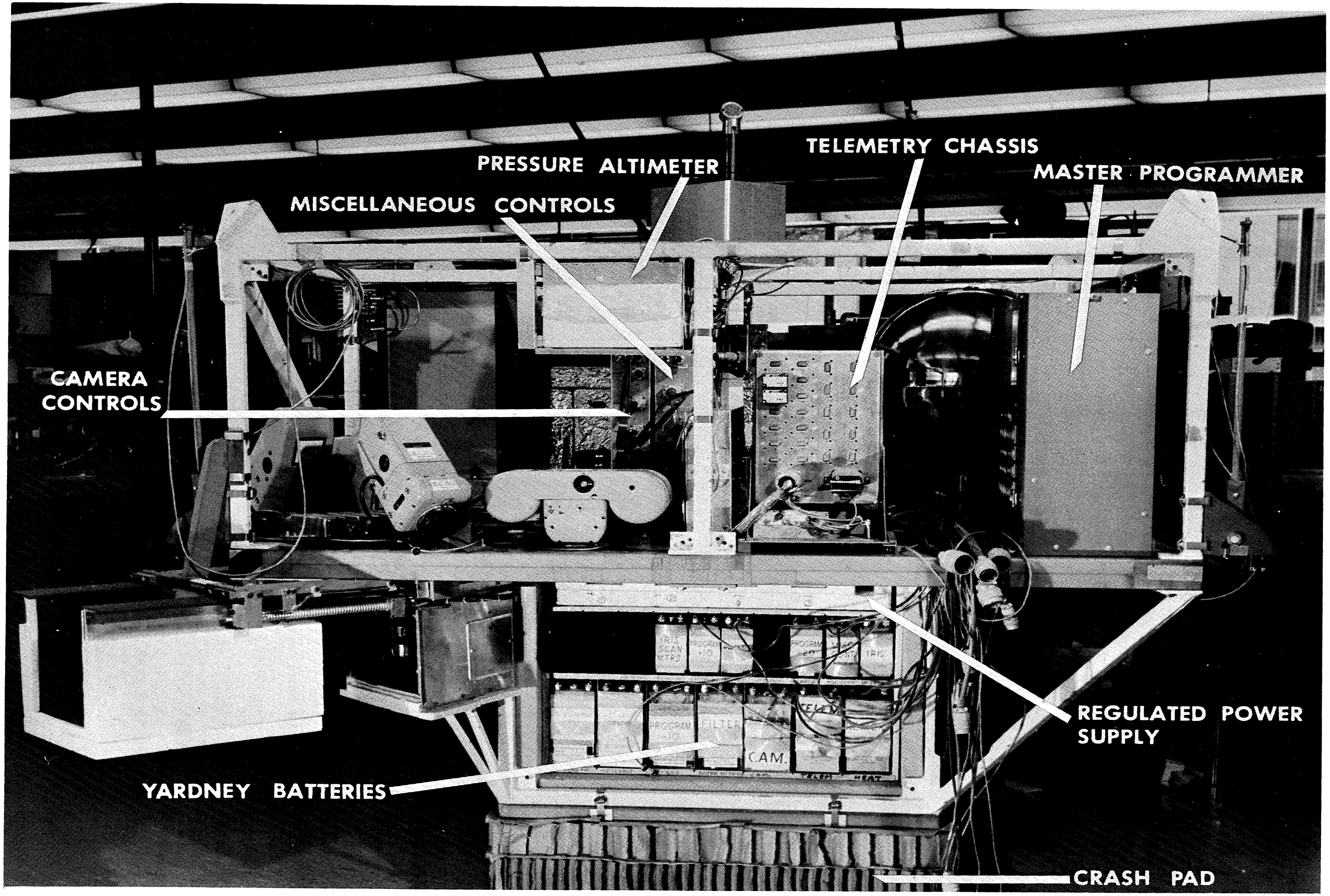

Figure 7. Balloon gondola showing battery compartment telemetry chassis and control units.

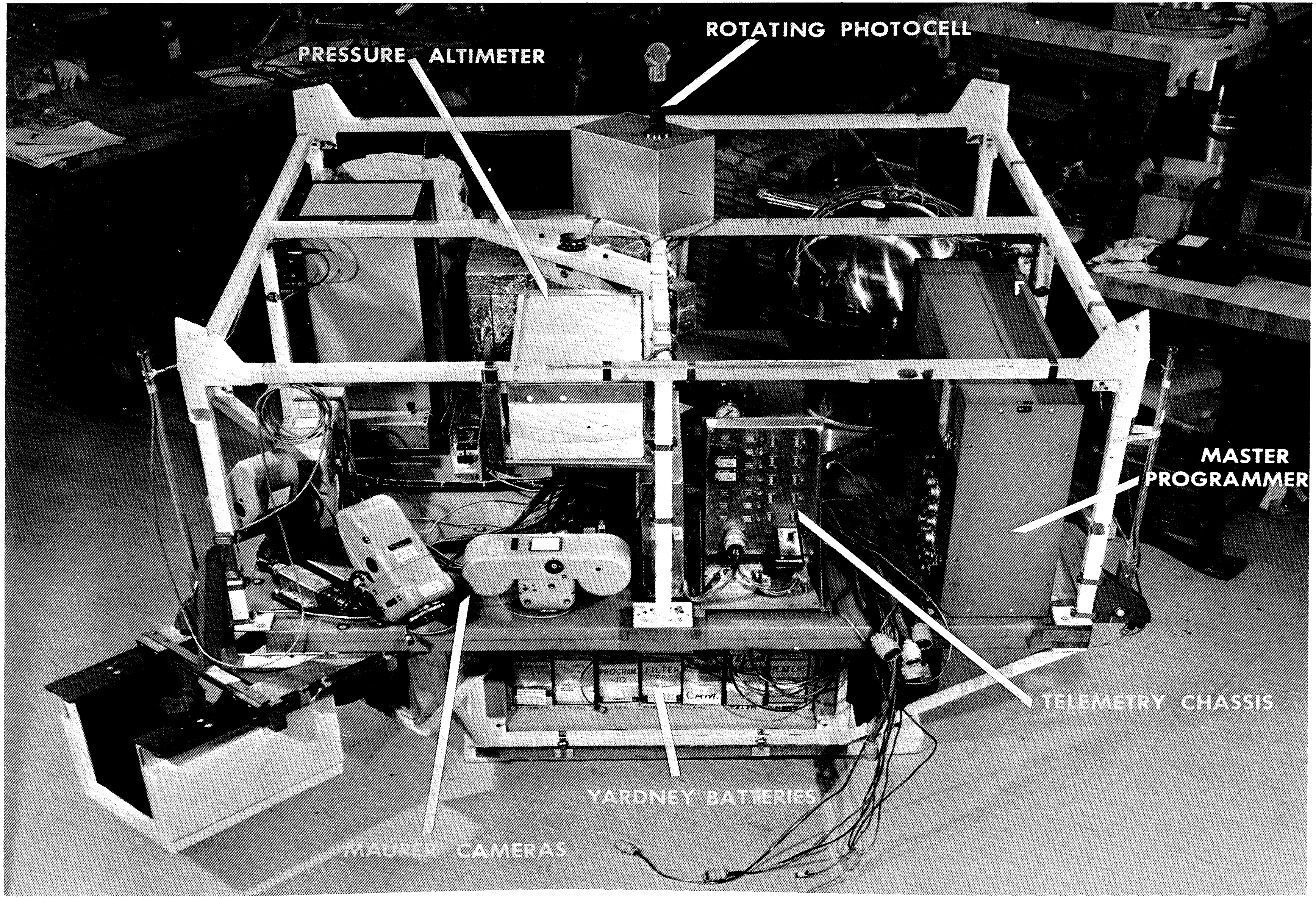

Figure 8. View of balloon gondola from above showing battery compartment, telemetry chassis and control units.

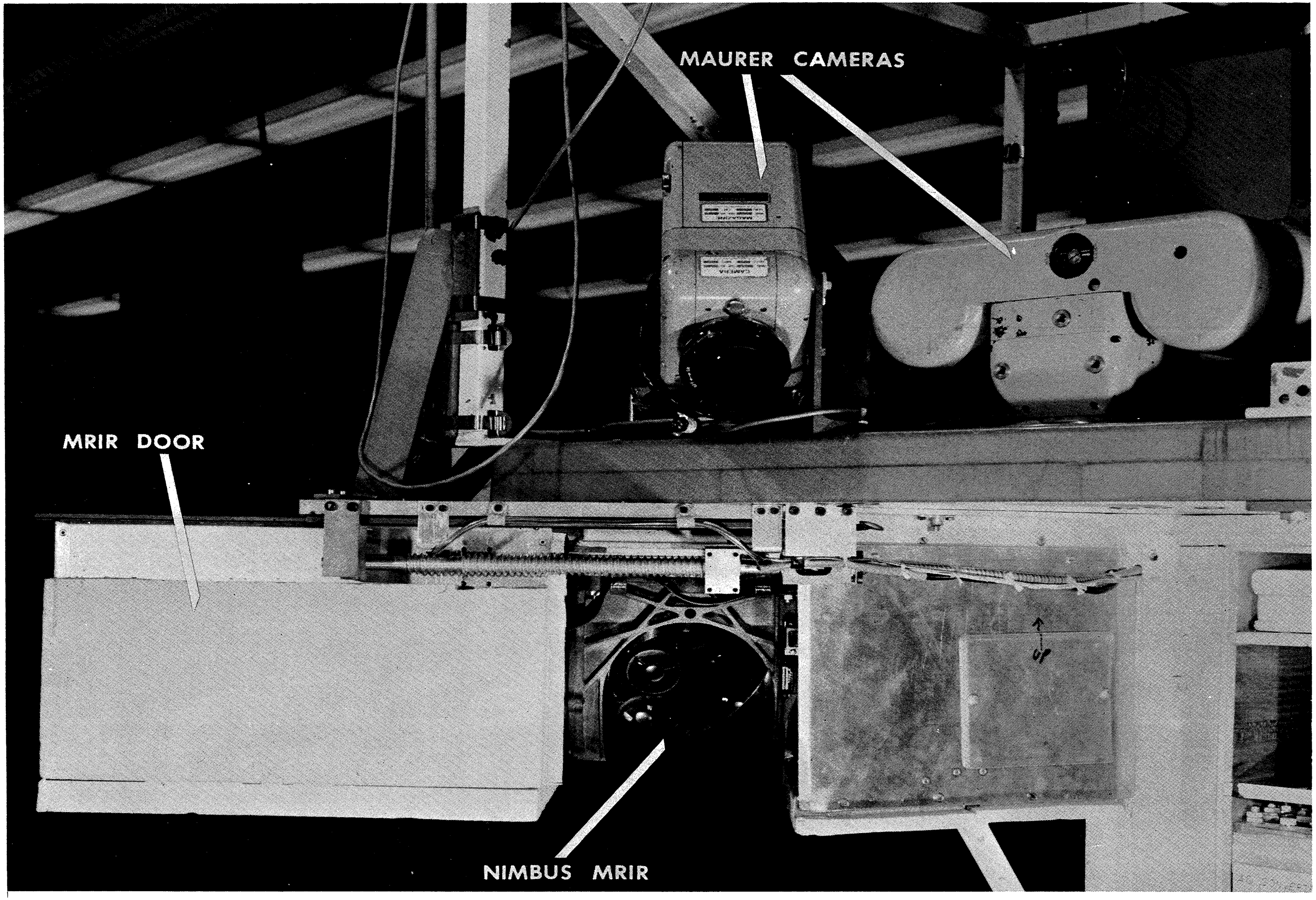

Figure 9. Close up view of MRIR and other two Maurer cameras.

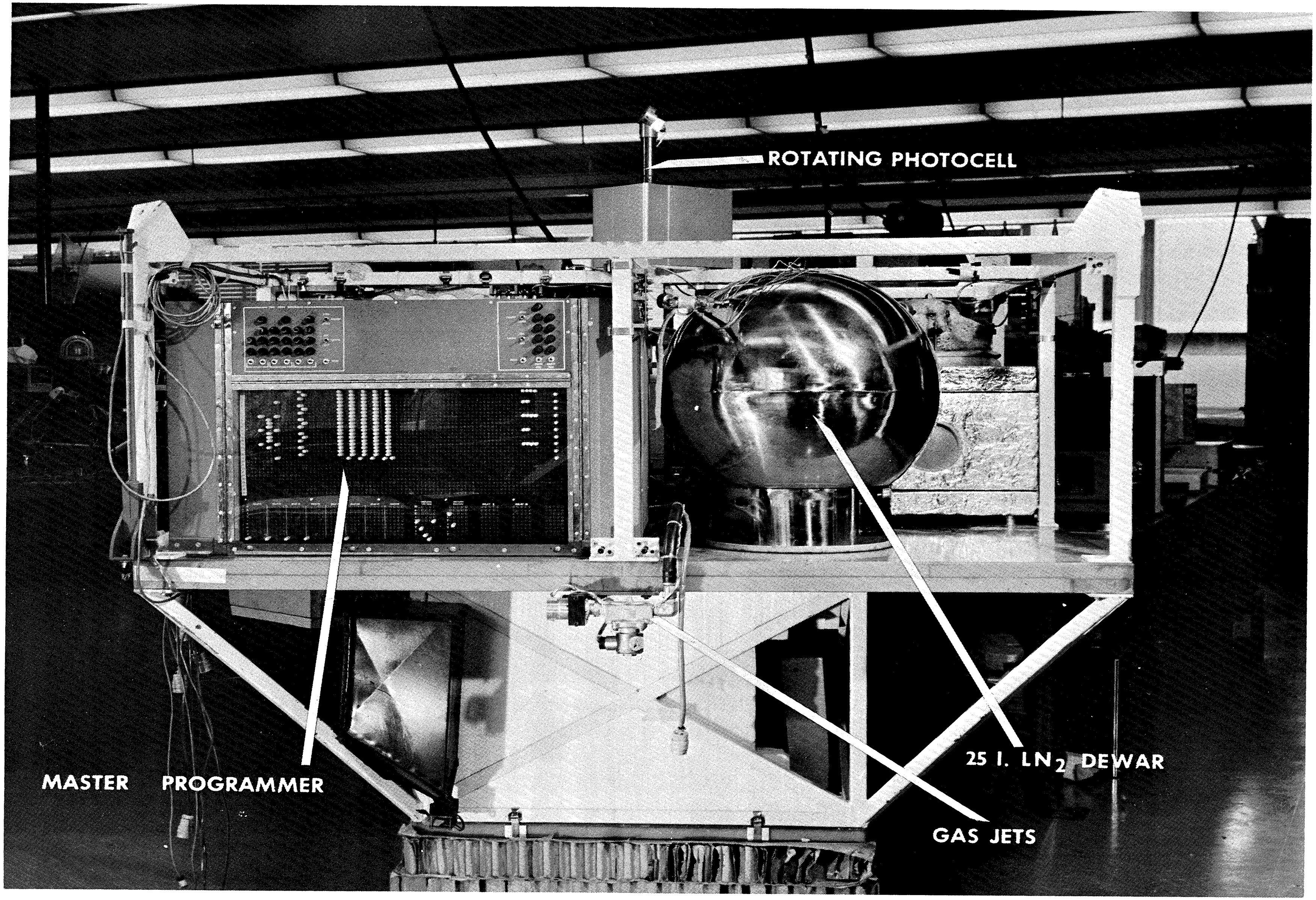

Figure 10. Balloon gondola showing programming side of gondola
Programming unit.

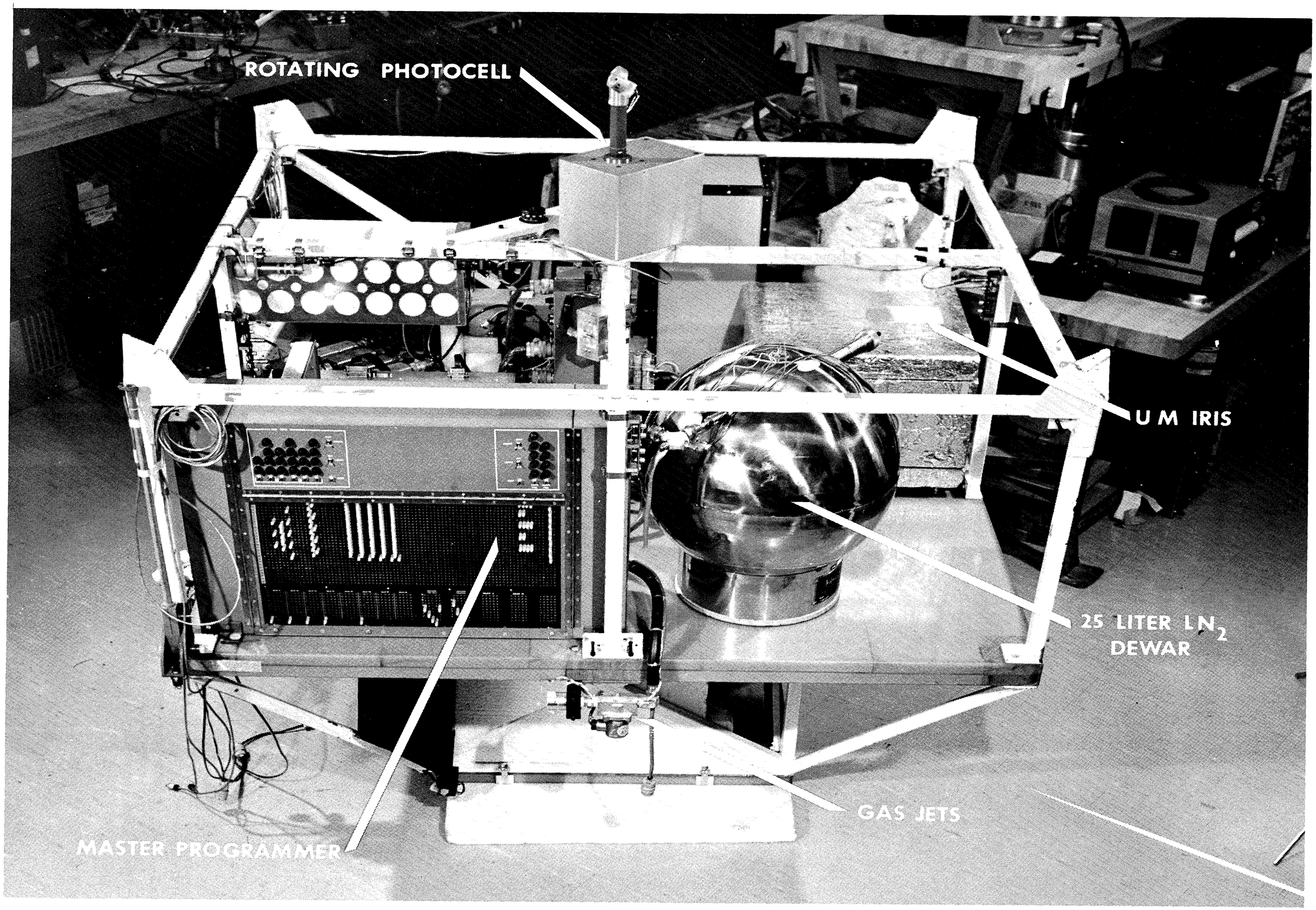

Figure 11. View of balloon gondola from above showing programming side of gondola programming unit.

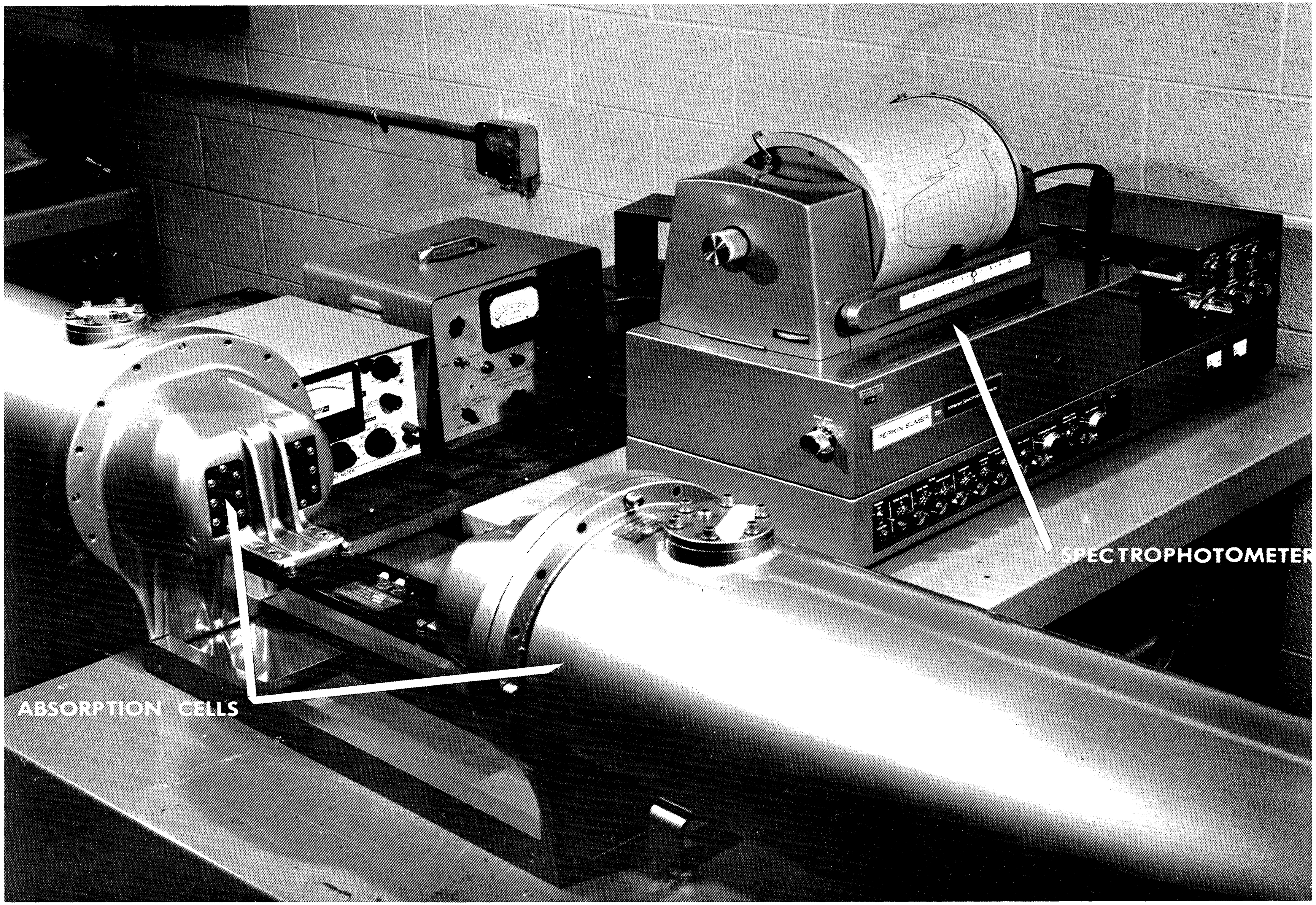

Figure 12. Photo of Perkin Elmer Model 221, infrared spectrophotometer and long path absorption cells.