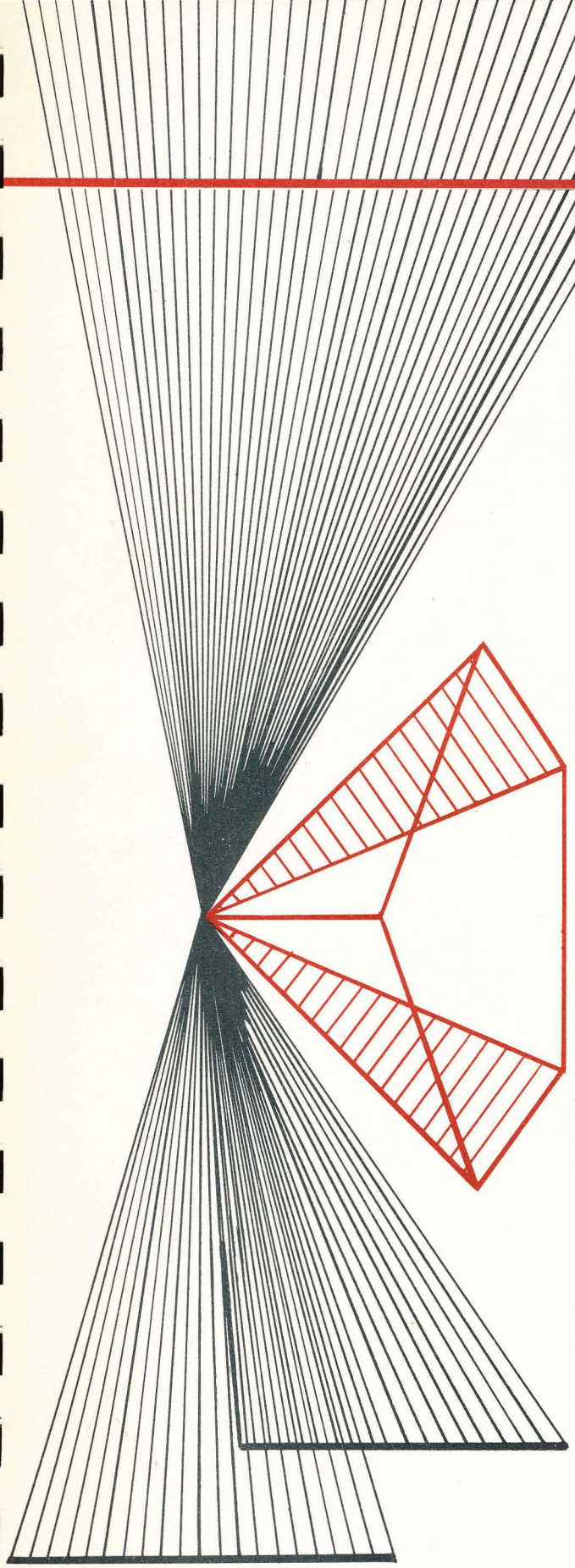


PSL

NEW MEXICO COLLEGE OF A&MA

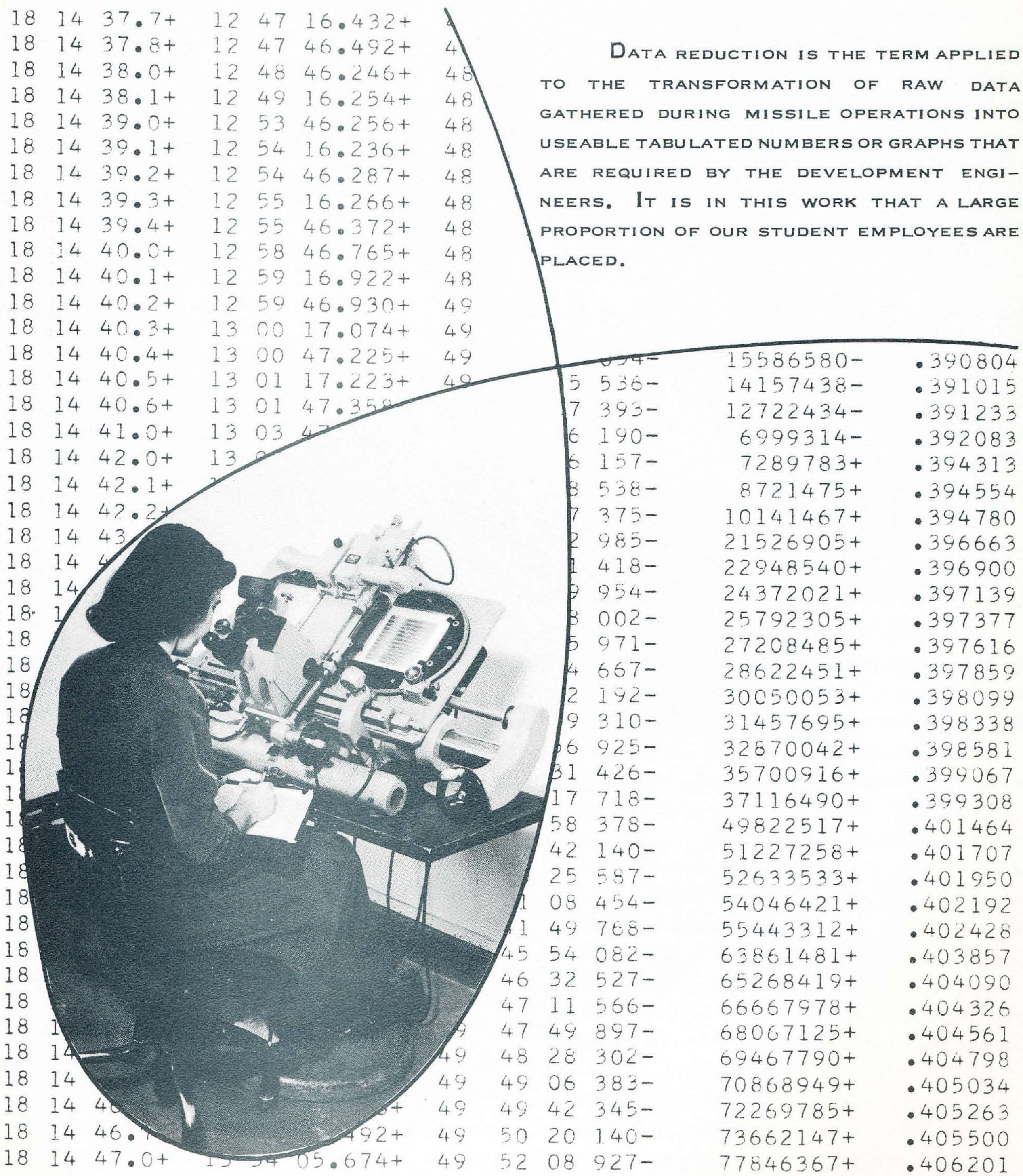
Fiscal Year 1 July 1957 - 30 June 1958

UNDER THE DIRECTION OF DR. GARDINER AND HIS IMMEDIATE ASSISTANTS, C. I. RICKETTS AND R. K. SHERBURNE, THE PHYSICAL SCIENCE LABORATORY HAS GROWN FROM A SMALL ORGANIZATION IN 1946 TO ITS PRESENT SIZE, WITH FACILITIES, BESIDES THOSE ON THE NMCA&MA CAMPUS, AT WHITE SANDS MISSILE RANGE, NEW MEXICO; PATRICK AIR FORCE BASE, FLORIDA; FORT CHURCHILL, CANADA; AND QUITO, ECUADOR.

TABLE OF CONTENTS

DATA REDUCTIO

DATA REDUCTION IS THE TERM APPLIED TO THE TRANSFORMATION OF RAW DATA GATHERED DURING MISSILE OPERATIONS INTO USEABLE TABULATED NUMBERS OR GRAPHS THAT ARE REQUIRED BY THE DEVELOPMENT ENGINEERS. IT IS IN THIS WORK THAT A LARGE PROPORTION OF OUR STUDENT EMPLOYEES ARE PLACED.



BALLISTIC REDUCTION

ANNA H. GARDINER

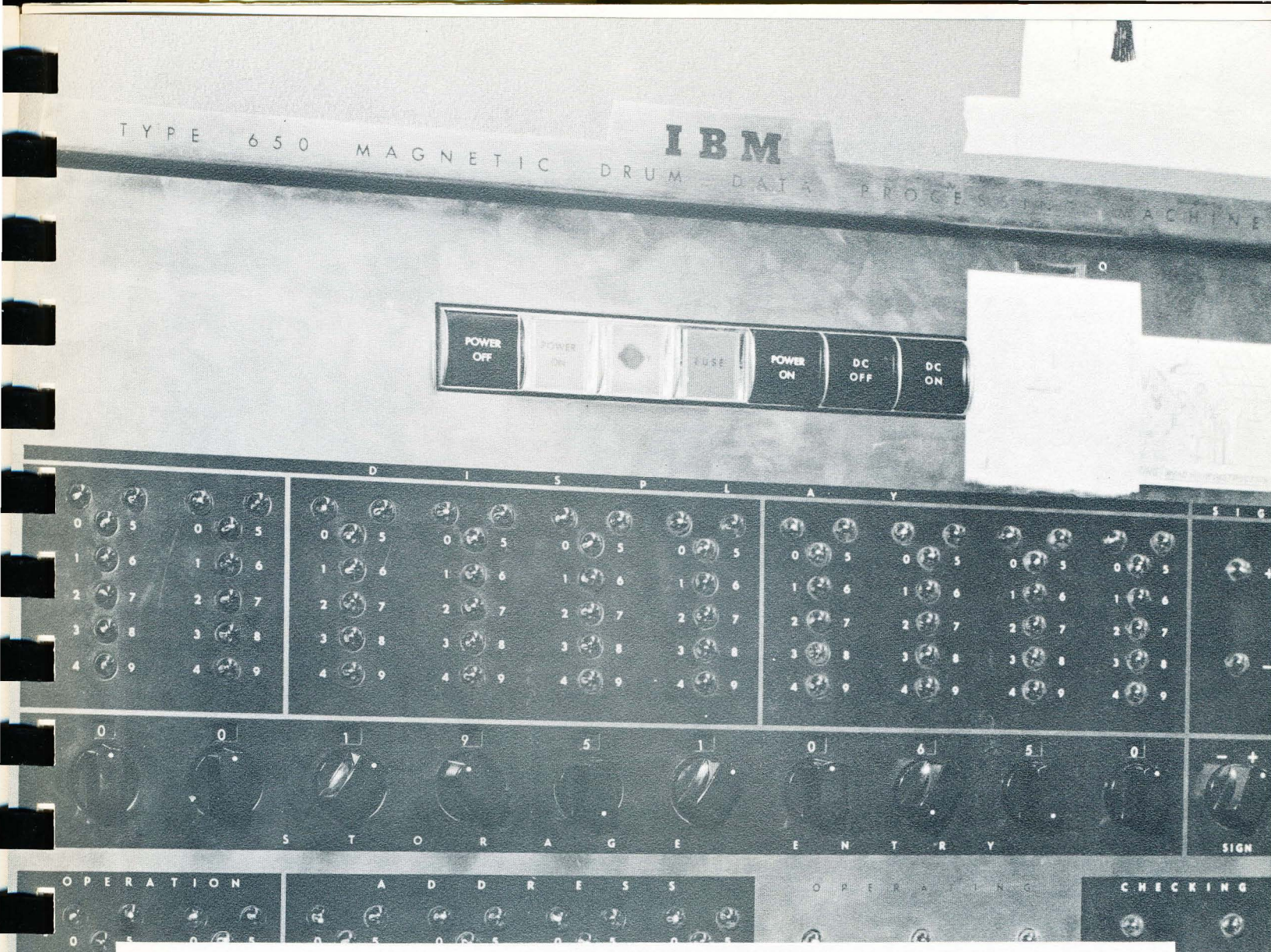
THE BALLISTIC REDUCTION SECTION WAS THE FIRST ONE ORGANIZED IN THE PHYSICAL SCIENCE LABORATORY, BEGINNING WORK IN THE SPRING OF 1946 BY COMPUTING THE TRAJECTORY OF THE FIRST V-2 MISSILE FIRED AT WHITE SANDS MISSILE RANGE. FROM THAT TIME UNTIL THE PRESENT THE SECTION HAS PARTICIPATED IN THE REDUCTION OF ALMOST EVERY TYPE OF FIELD INSTRUMENTATION WHICH HAS BEEN USED AT THE PROVING GROUND. THE RECORDS FROM ALL ASKANIA CINETHEODOLITES WERE COMPUTED HERE UNTIL THE ACQUISITION OF AUTOMATIC FILM MEASURING AND COMPUTING EQUIPMENT AT THE PROVING GROUND AT WHICH TIME THE REDUCTION WAS MOVED TO THEIR COMPUTING LABORATORY. THIS SECTION MEASURED AND COMPUTED DOVAP, RADAR, REFLECTION DOPPLER AND SMALL AMOUNTS OF OTHER TYPES OF REDUCTION, CARRYING ALL OR PART OF THE LOAD UNTIL AUTOMATIC REDUCTION COULD BE PERFECTED.

AT THE PRESENT TIME THIS SECTION IS IN FULL CHARGE OF THE DATA REDUCTION FOR ONE MISSILE. THIS MEANS THAT THIS SECTION PERFORMS THE REDUCTION OF ALL TYPES OF INSTRUMENTATION USED TO STUDY THE PERFORMANCE OF THIS MISSILE, INCLUDING A PRELIMINARY DATA REPORT AND A MISS DISTANCE REPORT. BESIDES THIS, FIXED CAMERA REDUCTION FOR THE SOUTH BRANCH OF THE MISSILE RANGE IS DONE. THESE CAMERAS, AS IMPLIED IN THEIR DESIGNATION, ARE KEPT IN A CAREFULLY ORIENTED FIXED POSITION AND THE MISSILE IN FLIGHT PASSES THROUGH THE FIELD OF VIEW OF THE CAMERA WHILE SUCCESSIVE EXPOSURES ARE MADE AT TIMED INTERVALS. TARGETS, WHOSE AZIMUTH AND ELEVATION FROM THE CAMERA'S NODAL POINT ARE SURVEYED IN THE FIELD, ARE IN EACH FRAME OR PICTURE AND SUPPLY THE INFORMATION NEEDED TO CONVERT THE MISSILE POSITION ON THE FILM INTO THE ANGULAR POSITION OF THE LINE OF SIGHT TO THE MISSILE. USING THIS INFORMATION FROM AS MANY STATIONS AS ARE AVAILABLE THE MOST PROBABLE POSITION OF THE MISSILE IS FOUND, AND VELOCITY COMPONENTS, TANGENTIAL VELOCITY, ACCELERATION, THE DIRECTION OF THE MISSILE AXIS AND MISSILE ROLL ARE OBTAINED AND PUBLISHED IN REPORT FORM. ONE THOUSAND SEVENTY-ONE SUCH REPORTS WERE PUBLISHED IN THE PAST YEAR.

ANOTHER TYPE OF FIXED CAMERA IS THE BALLISTIC CAMERA. THESE CAMERAS ARE USED AT NIGHT AND USE STAR IMAGES FOR ORIENTATION OF THE CAMERA. THIS INSTRUMENTATION REQUIRES CAREFUL TIMING OF THE EXPOSURE OF THE STARS AND IS CAPABLE OF HIGH ACCURACY. A FEW SUCH REDUCTIONS HAVE BEEN DONE.

THIS SECTION ALSO DOES REDUCTION OF RADAR INSTRUMENTATION ON SOME OF THE MISSILES FIRED AT WHITE SANDS MISSILE RANGE. THIS WORK INVOLVES READING RADAR BEAM POSITION FROM DIRECT WRITING PAPER RECORDS OF VARIOUS TYPES, AND THE MISSILE DEVIATION FROM THE RADAR BEAM OBTAINED FROM THE RECORDS OF CAMERAS PLACED ON THE RADAR ITSELF AND LOOKING ALONG THE BEAM. THIS INFORMATION IS PUBLISHED IN REPORT FORM. THIS YEAR REPORTS HAVE BEEN ISSUED FOR 61 MISSILES AND 74 TESTS OF RADAR PERFORMANCES.

ANOTHER TASK IS THE REDUCTION OF THE BALLISTIC CAMERA PLATES USED TO CALIBRATE THE MINITRACK SATELLITE TRACKING STATIONS LOCATED AT BLOSSOM POINT, MD.; FT. STEWART, GA.; ANTIGUA, BRITISH WEST INDIES; HAVANA, CUBA; SANTIAGO, CHILE; ANTIFAGASTO, CHILE; LIMA, PERU; JOHANNESBURG, SOUTH AFRICA; WOOMERA, AUSTRALIA; AND SAN DIEGO, CALIF. THIS GROUP HAS UNDERTAKEN THE COMPLETE REDUCTION OF THE CALIBRATION PROCEDURE.



Most of the optical film is measured on comparators capable of one micron accuracy. Nine of these comparators, a Zeiss stereo-comparator and two comparators for measuring ballistic camera plates, are in use. Two of the comparators are equipped to punch digitized output into IBM cards. A front projection Telereader is also used for measuring and recording information from some types of film. Radar beam information is measured manually. Computations are done on desk calculators and on an IBM 650 data processing machine. Besides the units comprising the 650, a 407 accounting machine, three key punches, one verifier, a reproducer and a sorter are in use.

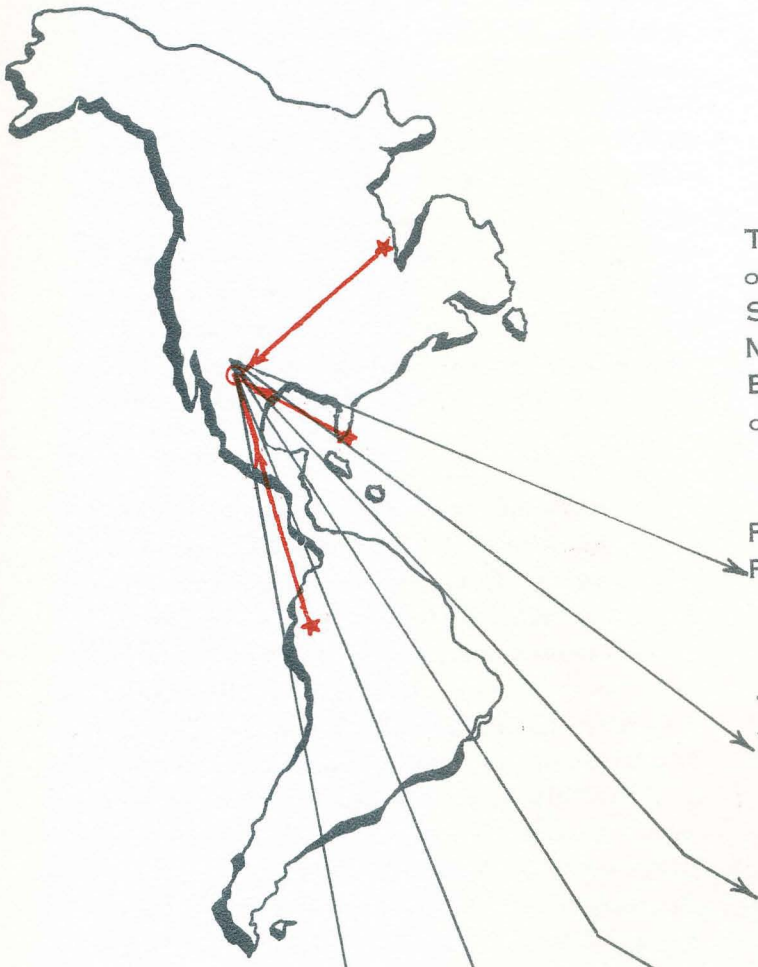
The 650 data processing machine was delivered in August 1957 and since that time programs have been written to perform all but one of the computing operations used. Several special programs have been written to compute variate differences, variances, Telemetry and other tedious computations for DRD-S/WSMR. Programs have been written and data computed for other sections of the laboratory upon request. Some work has been done for other divisions of the college. Sixty-eight thousand cards containing weather data for New Mexico from 1896 to the present have been punched and verified recently for the agronomy department. Machine work on an extensive statistical study of sheep marketing conditions in the Southwestern Region was also done.

STUDENT HELP IN DATA REDUCTION

MOST OF THE WORK DONE IN THIS SECTION IS PERFORMED BY STUDENTS OR STUDENTS' WIVES. THIS NOT ONLY PROVIDES FINANCIAL AID BUT IS ALSO VERY EXCELLENT EXPERIENCE WHICH WOULD BE INVALUABLE IN FUTURE JOBS. LAST YEAR 67 STUDENTS EARNED $27,280.00; ELEVEN STUDENT-WIVES EARNED $12,827.00 IN ADDITION, 40 FULL TIME PEOPLE HAVE BEEN EMPLOYED BY THE SECTION.

DURING THE YEAR A GENERAL REPORT ON THE REDUCTION OF FIXED CAMERA DATA HAS BEEN PUBLISHED AND DISTRIBUTED TO INTERESTED DATA REDUCTION FACILITIES. SEVERAL SPECIAL PROJECTS, MOSTLY EVALUATION AND ACCURACY STUDIES, HAVE ALSO BEEN PERFORMED.

FIELD OPERATIONS



The Physical Science Laboratory field operations are scattered from White Sands Missile Range to Fort Churchill, Manitoba, Canada, and Patrick Air Force Base, Cape Canaveral, Florida, and include such diverse operations as the

RECORDING OF INFORMATION RADIOED FROM ROCKETS IN FLIGHT

TESTS ON FUZES OF MISSILE WARHEADS

MISSILE RANGE SUPPORT

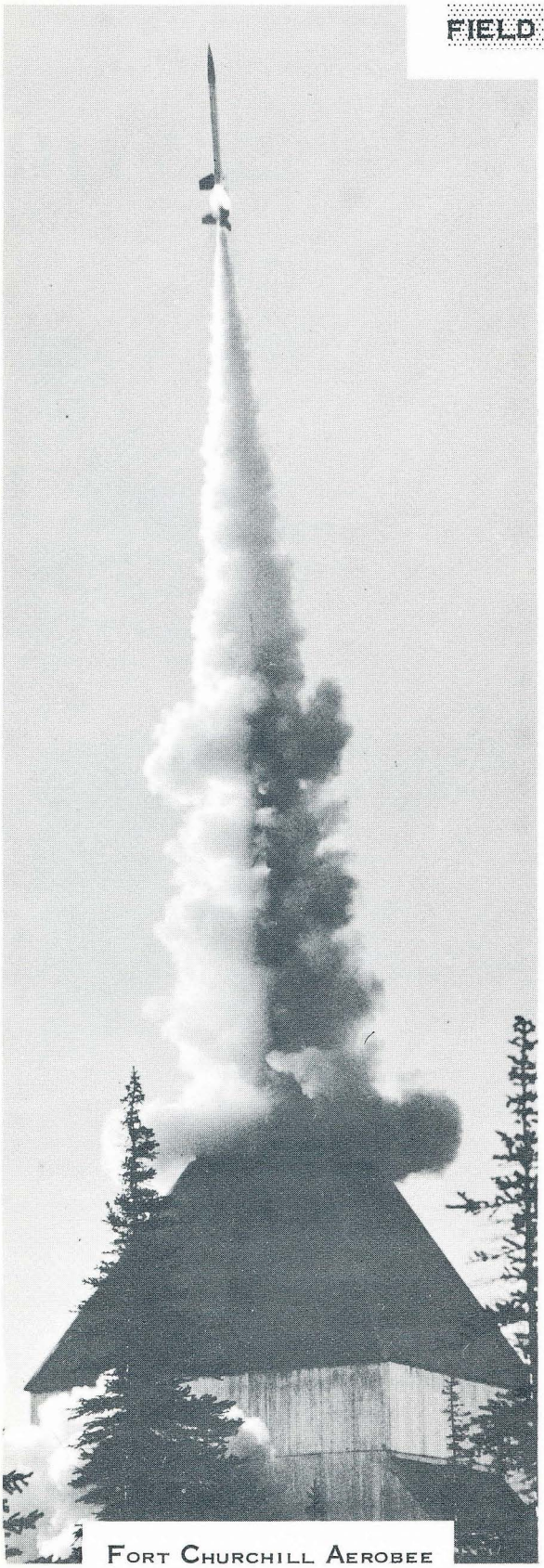
FILM PROCESSING

PROVIDING OFFICIAL TIME FOR MISSILE FLIGHTS

MAINTENANCE AND OPERATION OF A MISSILE COMPUTER

FIELD INSTRUMENTATION FOR RESEARCH ROCKETS

R. A. Bumgarner



Fort Churchill Aerobee

Since the initiation of V-2 Upper Air Research firings at White Sands Proving Ground in 1946, the Physical Science Laboratory personnel have been engaged in support programs. The work has consisted primarily of on-site testing, operating, and maintaining telemetering equipment, both in the ground receiving stations and in the rocket. Following the initial work with the V-2 the program was extended to include the Viking and Aerobee sounding rockets and has since involved the launching vehicle for the Vanguard earth satellite.

Although most of this work has been done for the Naval Research Laboratory, Washington, D.C., some telemetry support has been provided for a number of Cajun sounding rockets, instrumented by the Air Force Cambridge Research Center, Laurence G. Hanscom Field, Massachusetts. Since the fall of 1946, all the firings in which the group has been involved have been a part of the International Geophysical Year program. These included the Aerobee-Hi and Cajun launchings at Fort Churchill, Vanguard test vehicles and satellite vehicles at Cape Canaveral, and Aerobee firings at Holloman Air Development Center and White Sands Missile Range.

Specifically the support given on these programs involves providing personnel in the field on a continuous basis who perform preflight testing and preparation of telemetry and beacon equipment for each rocket; assume prime responsibility for maintenance and

operation of the permanent ground recording equipment; and conduct the coordinated telemetry tests as often as required during rocket preparations.

The performance of this work at these various locations has required considerable rotation of individuals during the 1957-58 year. An Aerobee firing requires a crew of six people and a Vanguard launching normally calls for fifteen. Simultaneous operations in Canada and Florida have at times required as many as twenty people to be away from the main laboratory concurrently. In order to cover such commitments most efficiently, an "Instrumentation Personnel Pool" has been employed with considerable success. Under this plan the members of the pool are shifted from one operation to another to handle peak workloads at one location when they can be spared from another project that is operating on a lighter schedule.

Under the Vanguard contract during the 1957-58 year, seven launchings were supported including the successful satellite launching in March 1958. Telemetry and beacon usage was confined to first and second stage vehicles and involves three separate types of systems; (1) the pulse-position modulation system, (2) the pulse-width modulation system, and (3) frequency modulation system. The Physical Science Laboratory personnel maintained and operated three pulse-position modulation recording stations. In addition to these tasks, during each launching operation, two people are required to track a missile with the TM antennas. An additional man is stationed in the blockhouse at the launching site.

At Fort Churchill, eight Aerobee and three Cajun flights were telemetered and support was provided on fourteen other flights during the year. In these vehicles only one telemeter system, the pulse-position modulation system, was used. The Physical Science Laboratory personnel are responsible for operation and maintenance of two complete ground stations and for the testing, preparation, and installation in the rockets of the transmitting units and associated batteries and antennas.

Five Aerobee-Hi and three Cajun flights at Holloman Air Force Base were telemetered and permanent ground equipment at Parker Station, White Sands Missile Range was maintained.

Very high records of performance have been established by all of these field groups. Individual performances have contributed heavily to the quality of instrumentation and excellent coverage obtained on these flights. During the coming year work will continue in all of these areas.

Installing Aerobee Antennas

IONOSPHERE STUDIES

W. L. Joosten, Jr.

For several years, the Naval Research Laboratory, Washington, D.C., has been studying the ionosphere by the means of radio signals transmitted from rockets. The technique consists of transmitting two signals simultaneously while the rocket is in the ionized region of the atmosphere. One frequency, the reference frequency, is chosen high enough that it is unaffected by the ionosphere. The other frequency, the data frequency, is chosen low enough that in traversing the ionosphere it travels at a reduced speed. At the ground receiving station both frequencies are received and compared. From an analysis of the recorded information the index of refraction, electron density, earth magnetic field strength, high ion density, and collision frequency between free electrons and neutral molecules can be determined.

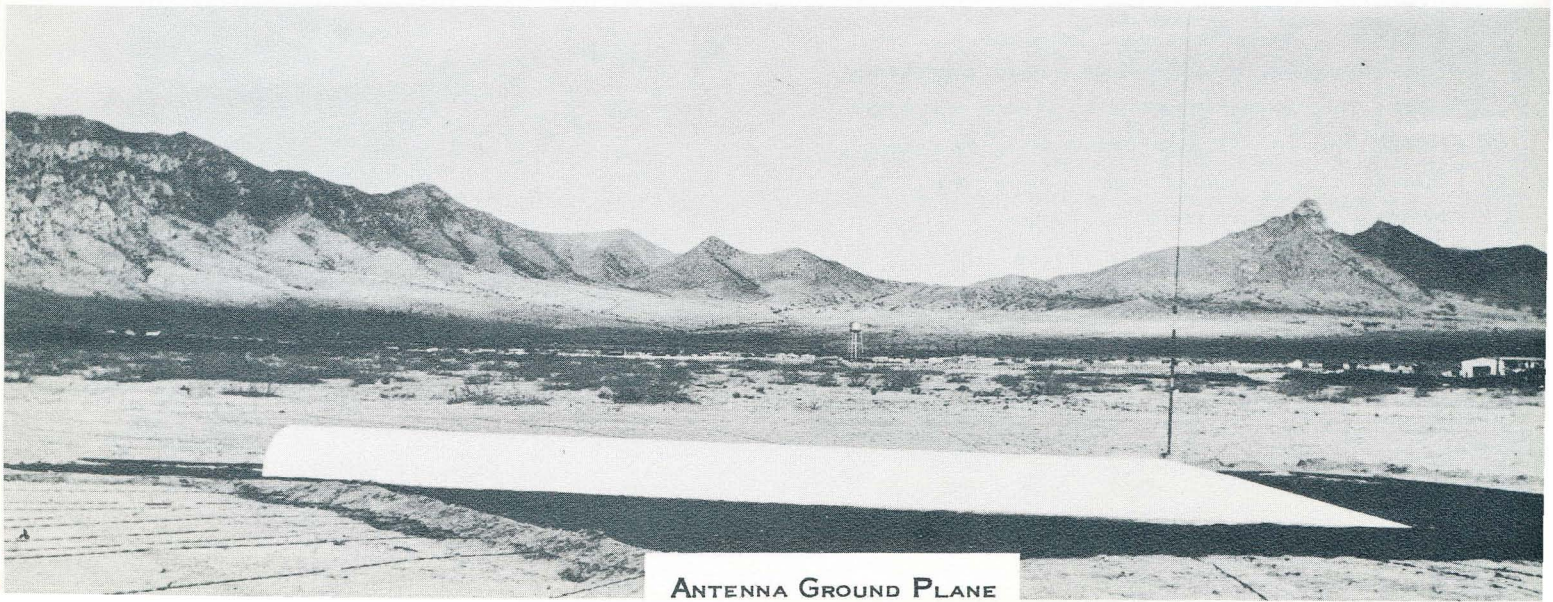
During 1957, a doppler frequency-shift method of tracking missiles was incorporated into the ground station along with phase-shift missile tracking system in order to determine whether or not tracking of missiles by a single station is feasible. These tests are continuing.

Another problem being checked is ionization in the immediate vicinity of the rocket. Ionization is produced by the antennas.

The Physical Science Laboratory field group maintains and operates the data gathering ionosphere ground stations for the Naval Research Laboratory. Continuous design and development of the electronic equipment in the ground stations are necessary in order to increase the accuracy and reliability of the recorded data. The group also assists the Naval Research Laboratory in the reduction and interpretation of the information. This work is carried on both at White Sands Missile Range and at Fort Churchill.

In addition, this group also operates a ground plane for use in determining free space parameters of rocket-borne antennas at White Sands Missile Range. This ground plane is the only one of its kind in the United States.

During the past year, one report entitled "Analysis of a Circularly Polarized Turn-Stile Antenna" by W. L. Joosten and Eugene D. Lee was published. Another report in process by the same office is "A Theoretical Analysis of a Voltage Controlled Oscillator."



Antenna Ground Plane

TALOS TELEMETRY

H. R. Gardner

Through telemetry, many dozens of measurements made during missile flight can be simultaneously and continuously recorded at a ground station consisting largely of electronic equipment such as radio receivers, audio frequency filters and discriminators, timing and communication amplifiers and calibration and test equipment. The Talos telemetry group provides personnel, supplies, and services required for the operation of two frequency modulated telemetric ground stations.

The information transmitted from the missile is presented on the ground in a variety of forms. Immediate visual monitoring equipment such as cathode ray oscilloscopes and direct writing recorders present the data at the instant it is happening in the missile. This type of presentation is immensely valuable to personnel operating the test since they can determine that all parts of the complicated missile guidance system are functioning properly down to the last second before firing, thus obtaining immediate information during the flight of the missile.

For postflight analysis, a more accurate form of presentation is made by the Miller oscillograph recorder that produces varying traces on rolls of photographic paper 12 inches wide and 100 to 200 feet long. These records make it possible to determine changes in missile operations apparent to 0.001 of a second. The same information is also recorded on magnetic tapes that can be replayed at the Physical Science Laboratory playback station for rapid reproduction of flight functions.

One telemetric station called Red Wagon is located adjacent to the missile hangar and is primarily concerned with checking the missile in advance of its scheduled flight. Using rapid photographic processing equipment in the station, the records of these tests can be available to the analyst within 15 minutes after the test has been performed. This station is also used during missile flight. The personnel of the station analyze the functioning of the telemetric system of the missile as well as operate and maintain the enormous amount of electronic and electromechanical equipment in the station.

The second station is located near the missile firing area in the Weapons Control Radar Building. This station provides visual monitoring facilities for the Talos if it is functioning properly prior to its flight. The personnel stand alert and ready to flash a signal to the missile firing panel in the event any difficulty should arise. The monitoring checks and flight records are also recorded on tape. Tapes from both stations along with the calibration tapes from the Red Wagon are sent back to the tape playback station for analysis.

During intervals between missile tests and equipment maintenance periods, personnel work on the development and construction of new equipment or circuitry which will increase the reliability or the efficiency of operation of the stations.

Desert Ship and Red Wagon telemetric stations together recorded approximately 850 operations, many of which were recorded at both stations. During approximately one out of every fifty operations, some equipment malfunction caused a partial loss of

information on either tape or graphic recordings. However since one recording medium provides back-up for the other, there was no actual loss of data. In the case of loss of information on an oscillograph recording, for example, the tape recording is played back and new oscillograph records are made after the faulty equipment is repaired.

Continual maintenance on audio discriminators is carried on. Once each month linearity curves are run on each discriminator. Those discriminators whose linearity is approaching the minimum acceptable value are replaced with spare units; they are later realigned when time permits.

During the course of the year approximately 200 electron tubes were replaced in the equipment, as well as several hundred miscellaneous components such as fuzes, pilot lamps, resistors and condensers.

In one type of missile test timing marks are recorded once every second for several minutes, starting at "zero" time. A recent improvement was the design and construction of circuitry that emphasizes every tenth pulse on the records to facilitate time identification during data reduction.

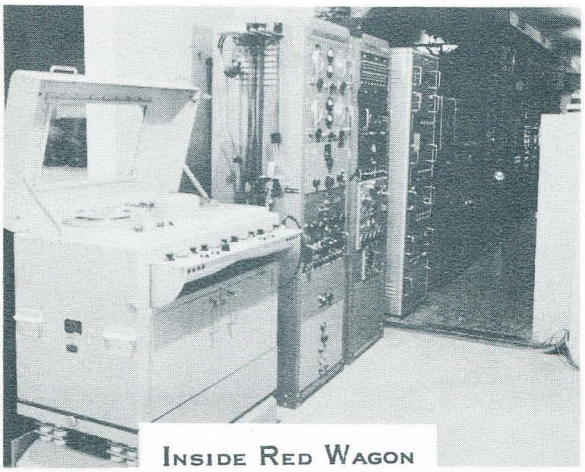
An earlier project made easier the identification of the precise time of firing.

Several Red Wagon patch panels were rewired such that, when all patching cords are removed from the panel, the equipment is automatically connected together in the proper manner and sequence for normal operation. Thus, after a special operation requiring many patch cords to connect the equipment in some other-than-normal manner, the station can be returned to normal in the most rapid manner -- by merely pulling all patch cords.

At Desert Ship where one particular recorded function often has driven the recording pen beyond its limits, frequently destroying the pen, a device was built which would allow full pen motion in the normal operating range. This would limit the off-scale signals to a value safe for the pen.

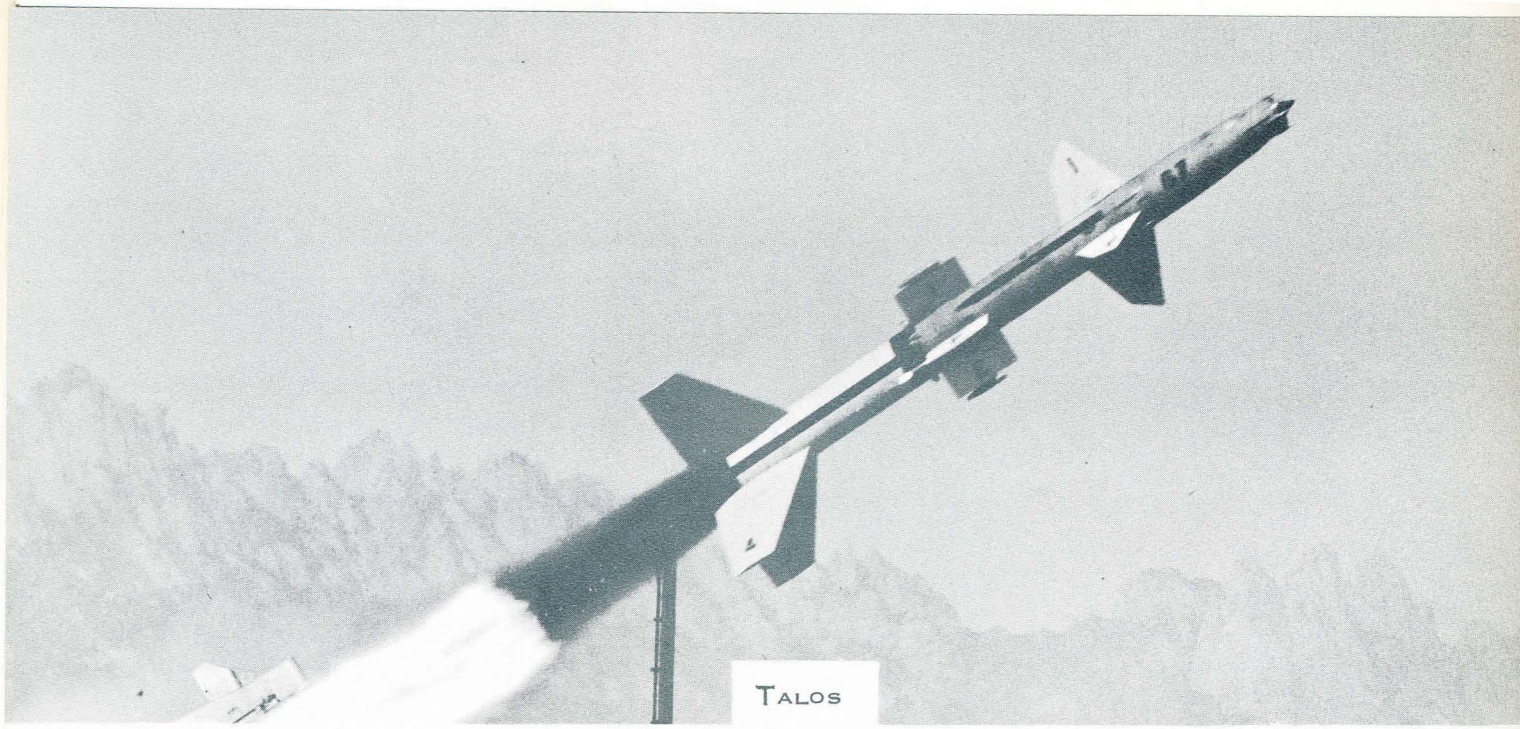
It is significant that in spite of an increased number of tests and increased amount of data produced per test, the number of men required to operate and maintain one ground station has been continually reduced. Future plans call for further refinement and simplification in the ground station equipment, for example, construction of a device which will convert low frequency A.C. signals to D.C. analog information. This will eliminate laborious counting of individual cycles that is now necessary in analyzing certain types of recorded information.

This work was performed under contract with the U. S. Navy Bureau of Ordnance.



Inside Red Wagon

RED WAGON AND HELICAL ANTENNA



Talos

TALOS FUZE TESTS

P. C. White

During World War II, a considerable improvement over the contact or percussion fuze was made by the development of the variable time or proximity fuze. Such a fuze sends out radio signals and receives the reflected energy from the target in order to detonate the associated warhead at the optimum position. The original development was for artillery and anti-aircraft shells, but it was only natural that this type of fuze be extended for use in guided missile warheads.

The fuze system usually includes more than simply the detonation operation. A safety and arming device makes it possible to destroy any missile that is not operating properly. In order to prevent detonation of the self-destruction charge while the missile is near the launcher, the safety and arming electronics must include a safe position that is in control until the missile is safely away from the launching area.

The basic research and development for the Talos Fuze is the responsibility of the Naval Ordnance Laboratory in Corona, California. The Physical Science Laboratory group conducts tests on the fuze system at White Sands Missile Range. In carrying out this work, it is necessary to maintain a considerable amount of precision test equipment for checking out the fuze and trouble-shooting of the system when difficulties arise. In order to retain records of the fuze operation during flight a telemetry station is maintained.

In addition to the normal fuze testing, current experiments are being conducted to determine temperature and vibrations existing in the missile during the flight.

This work will continue on into the coming year.

TALOS RADAR INSTRUMENTATION

G. E. Garing

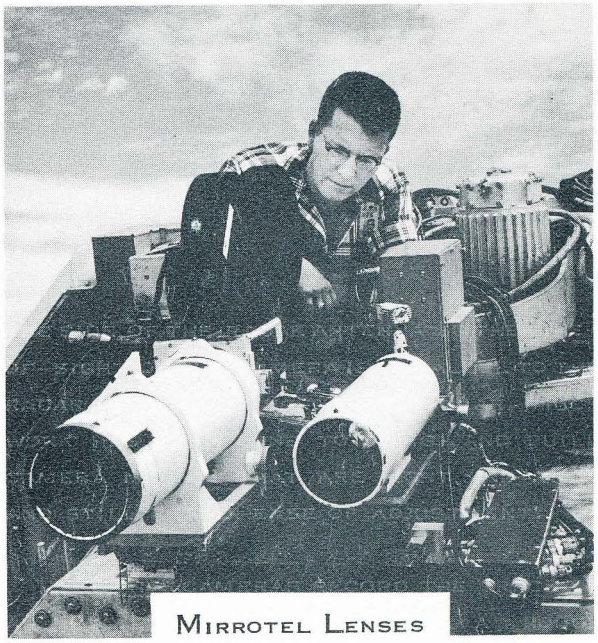
The purpose of the Talos Radar Instrumentation group is to develop, and as required, operate and maintain instruments for the collection of data for radar equipment used in the flight testing of Talos missiles; and also to provide personnel, supplies, and services for the production of systems evaluation data. This work is done for the U. S. Bureau of Ordnance and U. S. Army Ordnance.

The group operates two stations. One, the boresight cameras on the four radar sets at the Army Talos Defense Unit and the second, the two radar sets at the Navy Weapons Control Radar Building. Five different makes of cameras; 35mm Mitchell, 35mm Cameraflex, 16mm Cine Special II, 16mm Multidat, and a Fairchild Oscilloscope camera obtain the records during the Talos flight. For the Navy, two closed circuit television systems are maintained and operated. One TV camera is mounted on the tracing radar using a 40-inch Mirrotel Lens and the other TV camera is mounted on the guidance radar, also using a 40-inch Mirrotel Lens.

During the past year, several improvements have been made toward decreasing the weight of the boresight equipment on the guidance radars, since too much weight mounted on the radar antenna often leads to rough or oscillating operation. To further improve this situation, the platform on which the cameras are mounted has been lowered and set directly above the axis of rotation. This, along with the use of counter-balance weights, appears to have eliminated the above problem. The boresight and TV cameras are mounted on the side of the radar antenna so the line-of-sight of the camera is parallel to the radar beam. During the past year, much work has been done to design and build camera mounts that are light and rigid and still retain ease of adjustment.

Other cameras record the trace on an oscilloscope to obtain a rough estimate of "miss distance".

The group maintains and operates the timing equipment built by the Talos instrumentation group to supply range timing to all other data gathering stations that are being used by the Talos Defense Unit and the Navy Weapons Control Radar Building. The timing requirements of the various recorders are varied and give rese to many problems in providing the accurate time reference that is fundamental to a good flight analysis.



Mirrotel Lenses

TALOS COMPUTER SERVICES

J. E. Masterson

Since its installation at White Sands Missile Range, the TACOS computer has operated without failure during missile programming to target. This computer was designed and constructed at the Applied Physics Laboratory, The Johns Hopkins University, Silver Spring, Maryland, maintaining close association with the Physical Science Laboratory at all times in order to facilitate operation of the computer upon its installation at White Sands Missile Range. The laboratory personnel are responsible for the setup of the computer, prove-in and check-out of new or modified equipment.

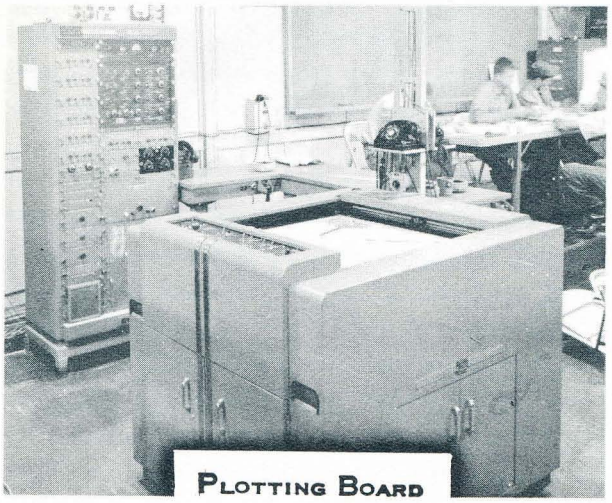
For the United States Navy, this group provides engineering field services for the computer which is located in the Weapons Radar Building, White Sands Missile Range. These services include routine preventive maintenance of equipment, operation of programmed tests and exercises and the operation of the equipment for Talos flights. Since Navy personnel are used in the operation of the equipment, the laboratory group has the responsibility of training these men in the operation and maintenance of the computer.

In addition to three types of missile programs, various additional requirements are dictated by missile performance evaluation or range requirement. These have involved the solutions of first and second order differential equations that may have second and third degree terms in various combinations. Specific equations are first solved mathematically and a master function plotted on the computer recorder paper. The necessary analogues are made for instrumentation and scale factors, and the final computer solution is checked against the master copy.

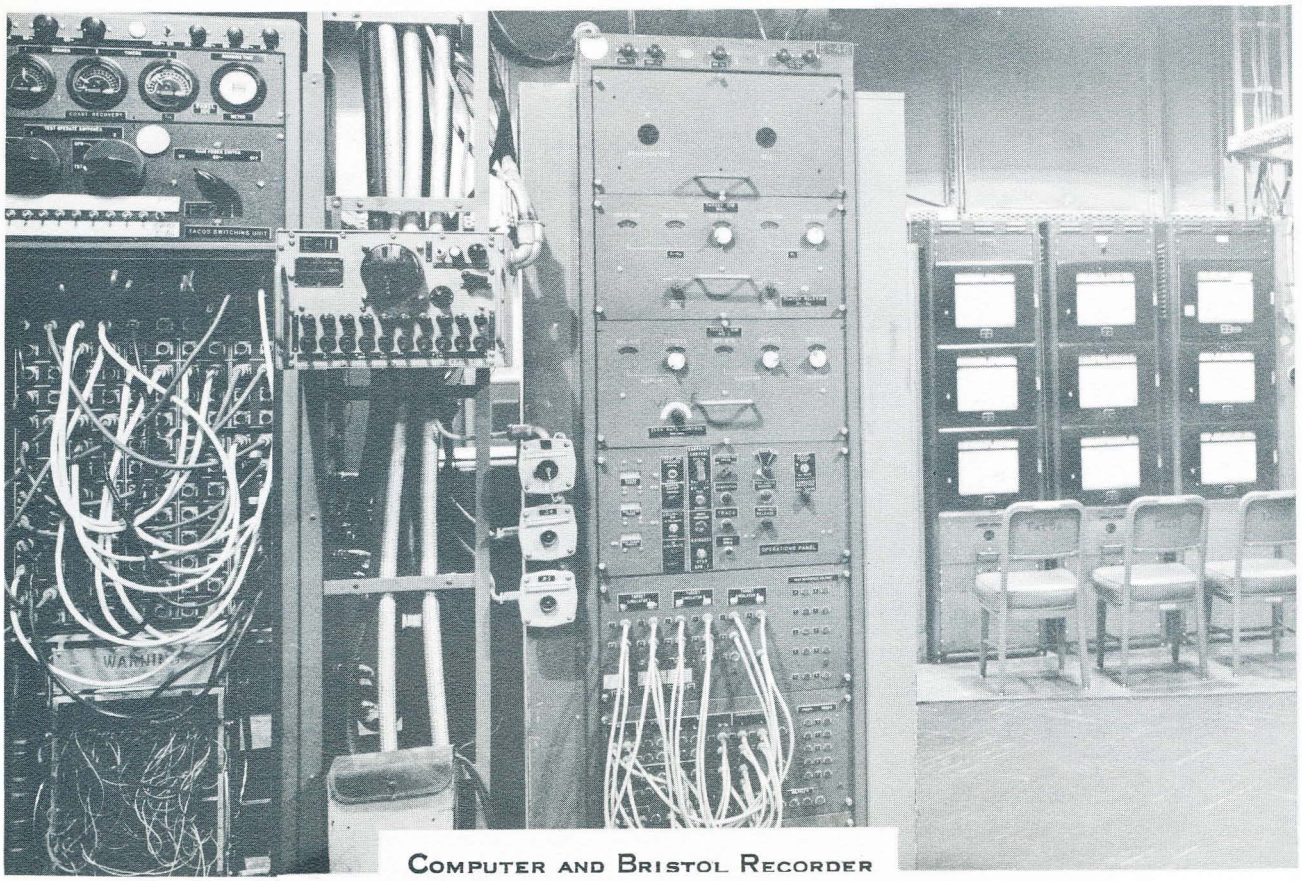
Occasionally, a missile performance curve is specified which cannot be described in convenient mathematical terms. In such cases, the curve is plotted on a mask and the function then generated by means of an instrument called the "Photo-former".

The Launcher Order and Capture Computer was built and installed under conditions very similar to TACOS, the research and development computer. The Launcher Order and Capture Computer, however, required several permanent modifications in order to meet every changing missile specification or existing tolerance.

Assistance was rendered to Sperry Gyroscope, Inc., and the U. S. Navy at White Sands Missile Range in the setting up and evaluation of the Ex-7 computer that involves the Talos Battery Computer and recording equipment.



Plotting Board



COMPUTER AND BRISTOL RECORDER

INSTRUMENTATION FOR OBTAINING X, Y, AND Z PLOTS, THE TARGET AND MISSILE POSITION WAS INSTALLED IN THE TACOS COMPUTER EQUIPMENT FOR USE FOR THE PLOTTING BOARD IN THE FIRING AREA.

SINCE ONLY TWO PEN-ARMS ARE AVAILABLE ON THE PLOTTING BOARD, LIMITING THE PLOT TO X-Y, Y-Z, OR X-Z PLOTS OF TARGET AND MISSILE, OR PLOTS X, Y, Z, OF EITHER THE TARGET OR THE MISSILE, A METER TYPE ALTIMETER WAS CONSTRUCTED FOR VISUAL OBSERVATION OF TARGET ALTITUDE PRIMARILY TO FACILITATE EVALUATION OF POGO TARGETS.

THE CLASSROOM INSTRUCTION AND CONTINUOUS OPERATIONAL TRAINING THAT HAS BEEN CONDUCTED FOR THE U. S. NAVY PERSONNEL HAS BEEN SUCCESSFUL TO THE POINT THAT PERSONNEL ERRORS HAVE BEEN NONEXISTENT ON FIRING RUNS.

TACOS OPERATIONS ALSO INVOLVE THE RECORDINGS FOR VARIOUS SHIP INSTRUMENTATION EVALUATIONS AS WELL AS PROCEDURES FOR SHIPBOARD SYSTEMS READINESS TESTS.

DURING THE LAST FISCAL YEAR, FORTY-TWO GROUND SYSTEM EQUIPMENT CHECKS WERE MADE ON COMPUTER GEAR AND RADAR MATERIAL. THIS GROUP ALSO PARTICIPATED IN FIFTY-THREE MISSILE FIRINGS.

FUTURE PLANS INVOLVE SIMILAR OPERATIONS WITH MORE OF A TACTICAL TYPE OF PROGRAMMING SHIFTED TO THE EX-7 COMPUTER, WHILE TACOS WILL OPERATE PRIMARILY FOR THE RESEARCH AND DEVELOPMENT PROGRAMMING.

TALOS DOCUMENTATION LIAISON

R. L. Smith

The purpose of this work for the Applied Physics Laboratory, The Johns Hopkins University, is to coordinate missile system test data by documentation. In order to accomplish this, the group has several responsibilities that include preparing system test proposals; gathering, reviewing, annotating, and submitting system data to the Physical Science Laboratory; instructing data reduction personnel regarding additions or changes in the reduction procedures which are used; preparing system test results; preparing periodic reports of system test status, activity, and accomplishment; and providing technical coordination between the Applied Physics Laboratory, U. S. Navy, Bendix Aviation Corporation, Radio Corporation of America, Physical Science Laboratory, and other facilities as required in the Talos program.

During the past year, more than 80 system tests and 63 missile flights were handled. During the coming year, these activities will be continued and modified as it is made necessary by changes in the missile test operations.

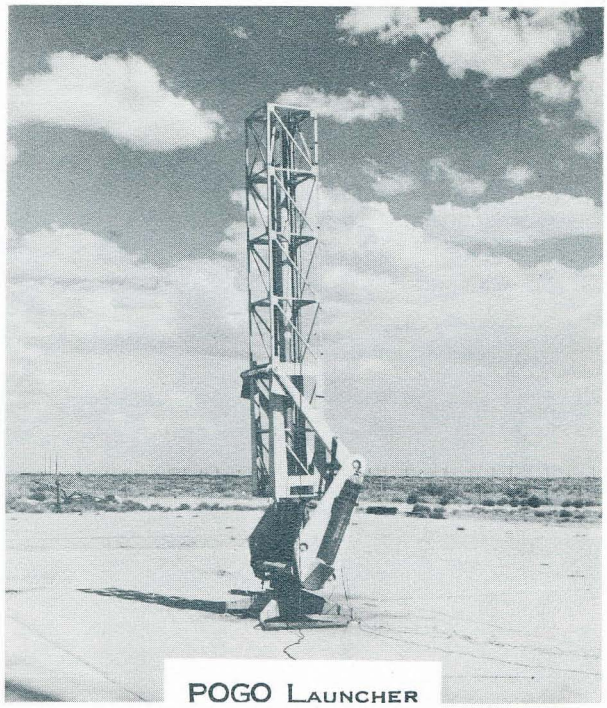
POGO OPERATIONS

N. H. Hannum

Guided missiles require targets for systems testing during the development of the missile system. The primary function of the POGO field group is to provide these targets. In order to fulfill the varying altitude requirements of the different systems, two types of targets, POGO HI and POGO LO are used. Below 42,000 feet a silvered parachute is dropped by an aircraft. Above 42,000 feet in the region of the atmosphere where it is more difficult or impossible for aircraft drones to operate, the POGO HI system is used. This target is capable of reaching altitudes of over 100,000 feet.

The basic system is a rocket which ejects a parachute near the peak of its trajectory. The parachute itself may be the target by providing radar reflections from a thin layer of metallic silver on the canopy. In other cases, infrared flares or other devices are suspended from the shroud lines to provide the requisite target. Although the system is being widely used, modifications are constantly being made to meet the changing requirements imposed.

In a normal operation some preparation must be made before the time that the target is needed. The launcher is carried uprange with a mobile caravan to a location as close to the target site as possible, and then by tilting the launcher the rocket is directed toward the region of space in which the target is to be placed. The amount of tilt in the launcher has to be determined in part by the local wind situation.



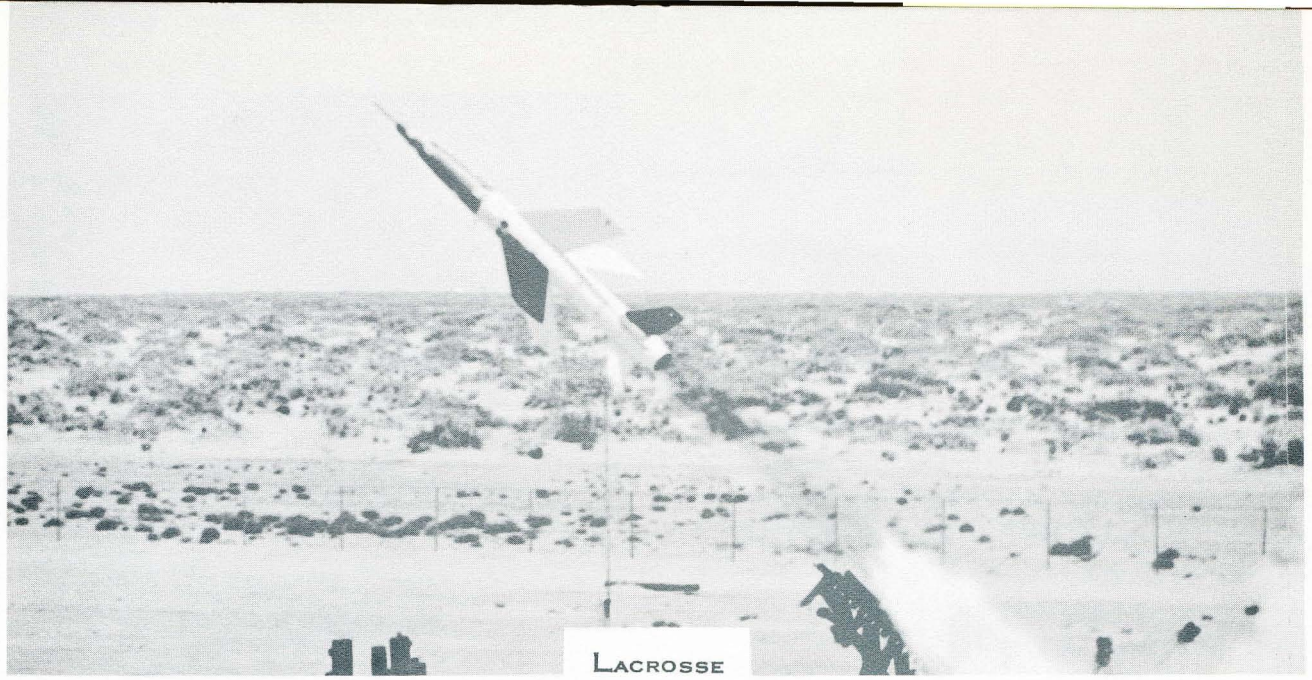
POGO Launcher

Although there are many types of targets that can be used in testing guided missiles, the capability of providing a low altitude and a high altitude target in one at a relatively low cost makes the POGO target system a very desirable one.

In addition to the primary function of providing operational POGO field support this group has also provided field assistance to the Physical Science Laboratory rocket section in its several research and development programs. These activities included range scheduling, motor preparation, wind measurements, radar plotting, and rocket recovery operations.

In the period 1 July 1957 to 1 July 1958 there were 28 POGO HI firings of which 18 were successful.

There were also 14 POGO LO operations during this period. Five of the missions were test drops and nine were operational. All of the operational efforts resulted in supplying the desired parachute target.



Lacrosse

FUZE TESTING FOR DIAMOND ORDNANCE FUZE LABORATORIES

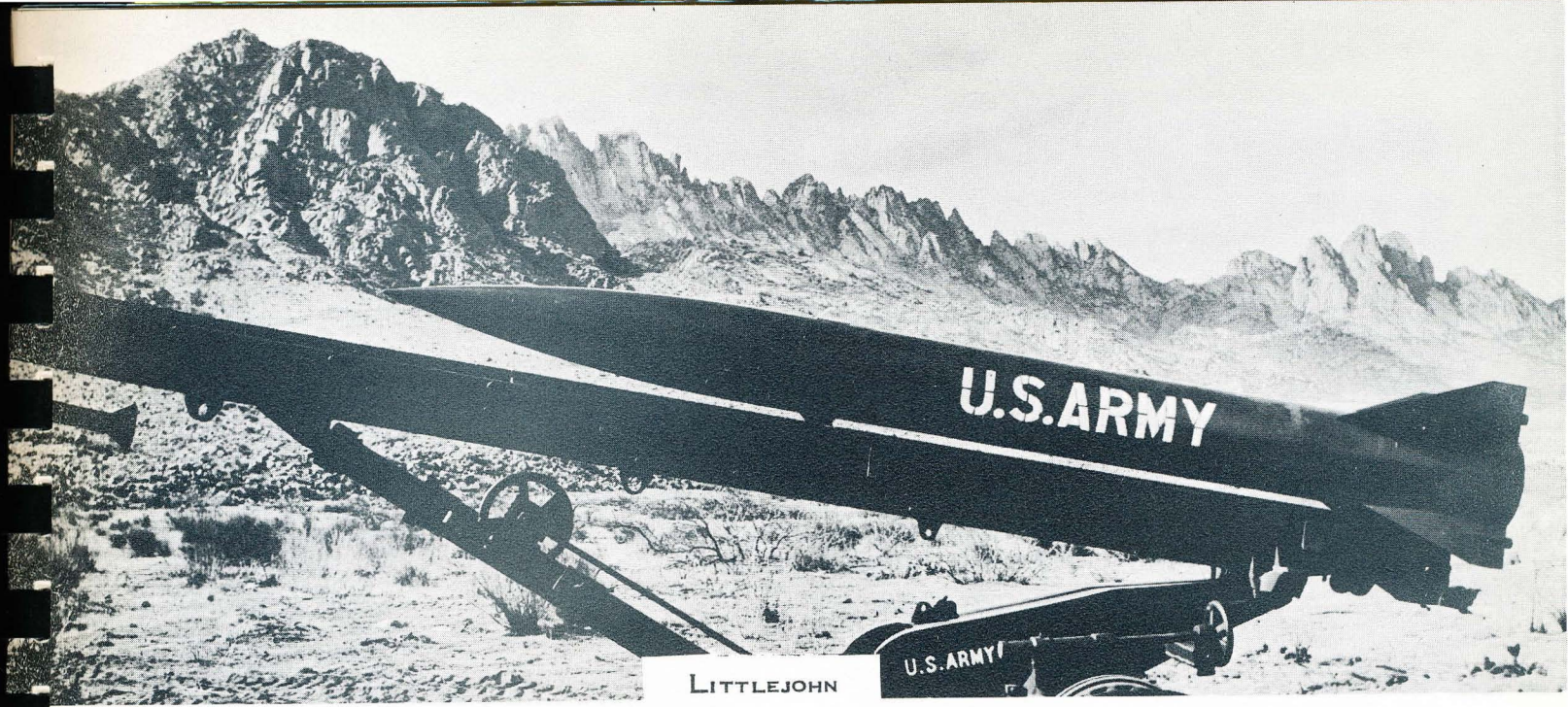
E. R. McDowell

Several electronic and pressure type fuzing systems have been developed for the U. S. Army Ordnance Corps. The fuzing systems were developed to be flown in conjunction with all types of explosive warhead systems. This laboratory's function is to perform preflight electronic checks, install flyable units on test vehicles, evaluate postflight telemetering records, write and publish technical flight reports and perform environmental studies when applicable. Along with this is the liaison work which is necessary between the field test station personnel and the design engineers concerning technical problems encountered in field operations.

Three different types of electronic fuzing systems for the Corporal, the Lacrosse and Honest John rockets are studied and several different types of fuzing systems are evaluated with respect to their vulnerability to presently developed electronic countermeasures equipment. A study of the fuze system for the Sergeant missile has been made by laboratory personnel. In the past twelve months, preflight checks, installation, monitoring, evaluation and recommendations have been performed and technical reports written, on forty-one missile fuzing systems flights.

In addition to the missile tests, a documentary film describing the fuze test operations was begun and is near completion.

The following electronic systems will be tested in the next few months: Sergeant, Redstone, Little John, and Corporal. The vulnerability studies on electronic countermeasures will continue and other tests are to be performed at Yucca Flats, Nevada. The tests during the past year have been at White Sands Missile Range and at the Yuma Test Station, Yuma, Arizona.



LITTLEJOHN

CHEMICAL CORPS WARHEAD TESTING

E. R. McDOWELL

SEVERAL DIFFERENT TYPES OF WARHEADS ARE BEING DEVELOPED BY VARIOUS AGENCIES FOR ROCKETS AND GUIDED MISSILES. CERTAIN CHEMICAL TYPE WARHEADS ARE BEING DEVELOPED BY THE U. S. ARMY CHEMICAL CORPS. THIS LABORATORY'S FUNCTION IS TO RECEIVE, CHECKOUT AND INSTALL EXPLOSIVE ELEMENTS IN THE WARHEAD. SUBSEQUENT TO THE FLIGHT TEST, LABORATORY PERSONNEL INSPECT AND REPORT THE CONDITION OF EACH IMPACTED MUNITION. THESE DATA ARE COMPILED AND A FINAL TECHNICAL REPORT IS PUBLISHED AND FORWARDED TO COGNIZANT DEVELOPMENT PERSONNEL WHO THEN MAKE A COMPLETE ANALYSIS AND EVALUATION OF THE ENTIRE WARHEAD SYSTEM.

THE OPERATIONS INVOLVE TWO DIFFERENT TYPES OF WARHEADS FOR THE CORPORAL GUIDED MISSILE AND ONE TYPE WARHEAD FOR THE HONEST JOHN ROCKET. THE WARHEADS BEING TESTED CONTAIN SEVERAL CONCEPTS OF CHEMICAL MUNITIONS. PURPOSE OF THE TESTS ARE TO OBTAIN A FUNCTIONAL CHECK OF THE WARHEAD AND FUZING SYSTEMS.

IN THE PAST TWELVE MONTHS PREFLIGHT INSTALLATION OF EXPLOSIVE ELEMENTS AND BOMBLET EVALUATION HAS BEEN PERFORMED ON TWELVE MISSILE OR ROCKET SYSTEM TESTS. THESE TESTS CAN BE DIVIDED INTO TWO GROUPS, NAMELY: (1) TWO TESTS ON THE CORPORAL GUIDED MISSILE, AND (2) TEN TESTS ON THE HONEST JOHN ROCKET.

TWO OTHER TYPE WARHEADS WILL BE TESTED IN THE NEXT FEW MONTHS, LITTLEJOHN AND SERGEANT. THE PRESENT CORPORAL GUIDED MISSILE AND HONEST JOHN ROCKET WARHEADS WILL CONTINUE TO BE TESTED.

THIS WORK WAS PERFORMED UNDER CONTRACT WITH THE U. S. ARMY CHEMICAL CORPS.

RANGE TIMING

A. F. Bowers

The purpose of the timing and control section is the generation and distribution of electrical pulses to provide time references for all types of instrumentation that are utilized at White Sands Missile Range. These electrical pulses are the means by which the data at the various stations are correlated. In order to accomplish this, several types of pulses are necessary: those that are repeated at a constant repetition rate such as (1) a one pulse per second continuous counting code whereby the code reading changes one count each second and (2) special function pulses such as "test zero" which is the instant of an event start.

An electrical pulse is obtained from a temperature controlled crystal. The steady frequency is fed through electronic circuitry to obtain the desired pulse rates. These signals are then distributed throughout the range over radio and by wire.

The Physical Science Laboratory group supplements the regular personnel working on the project and consists of an engineer, a supervisor, two electronic technicians and ten cooperative students.

There are four stations which the project assists in operating and maintaining for the U. S. Army Ordnance Corps: the generation station, the radio distribution station, and two wire line distribution stations.

During 1957-58, the group worked on 186 operations as well as doing the necessary maintenance required. This work will continue next year.

PHOTOGRAPHIC PROCESSING

L. C. Ward

The work of the Civil Service photographic processing crew is supplemented during the 4:00 p.m. to midnight hours by a crew of six cooperative students and their supervisor from the Physical Science Laboratory. These men process film and operate the chemical laboratory during these hours, five days a week.

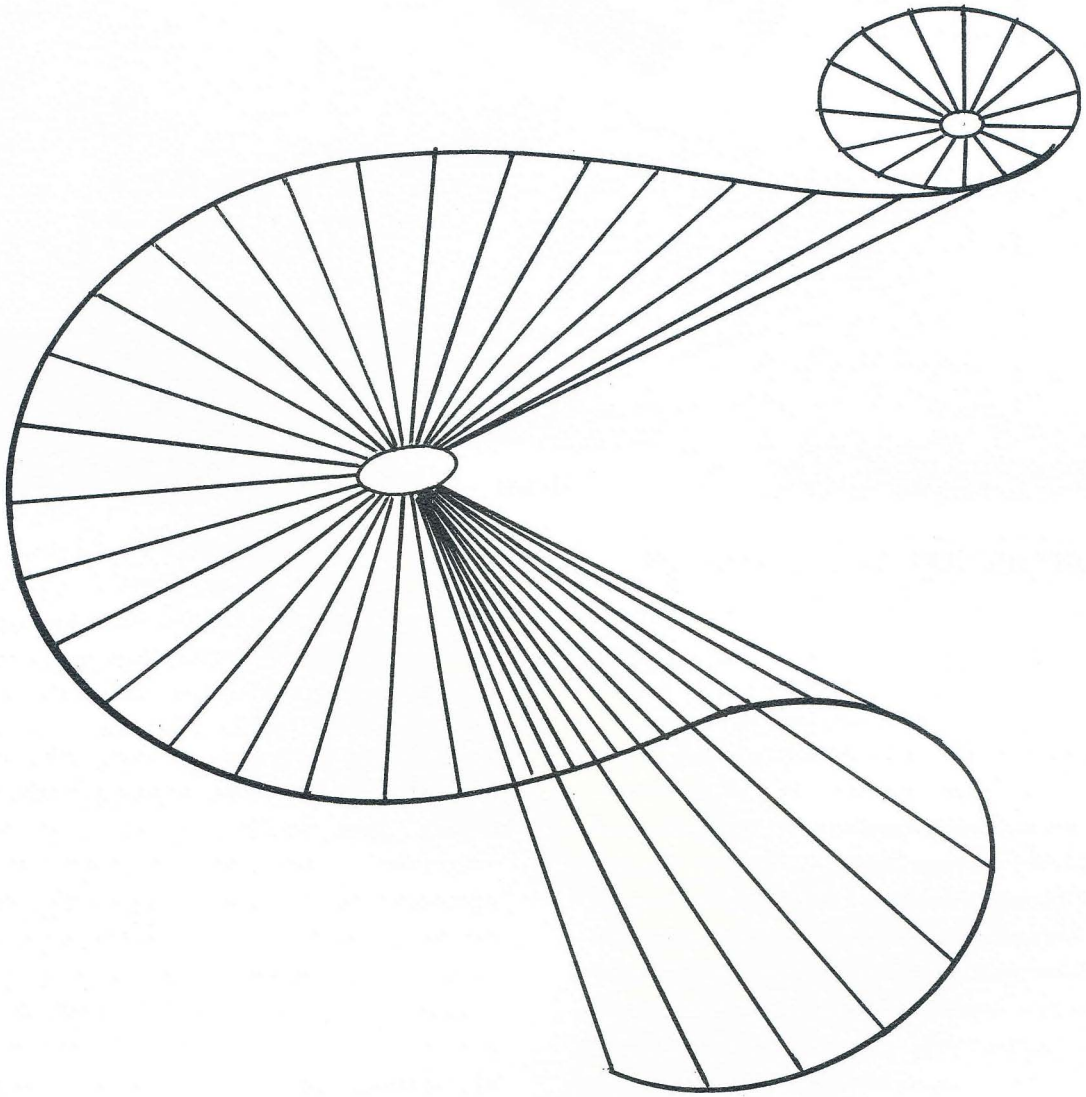
The major part of the work consists of processing film in the Houston Fearless 10-C processing machine. Some time is also devoted to the processing of Anscochrome color film, wide strip-film, photo paper, and the operation of the chemical control laboratory.

In the chemical laboratory it is necessary to mix and run analyses on chemicals, control the re-circulation of chemicals and recharge deionizer for the water.

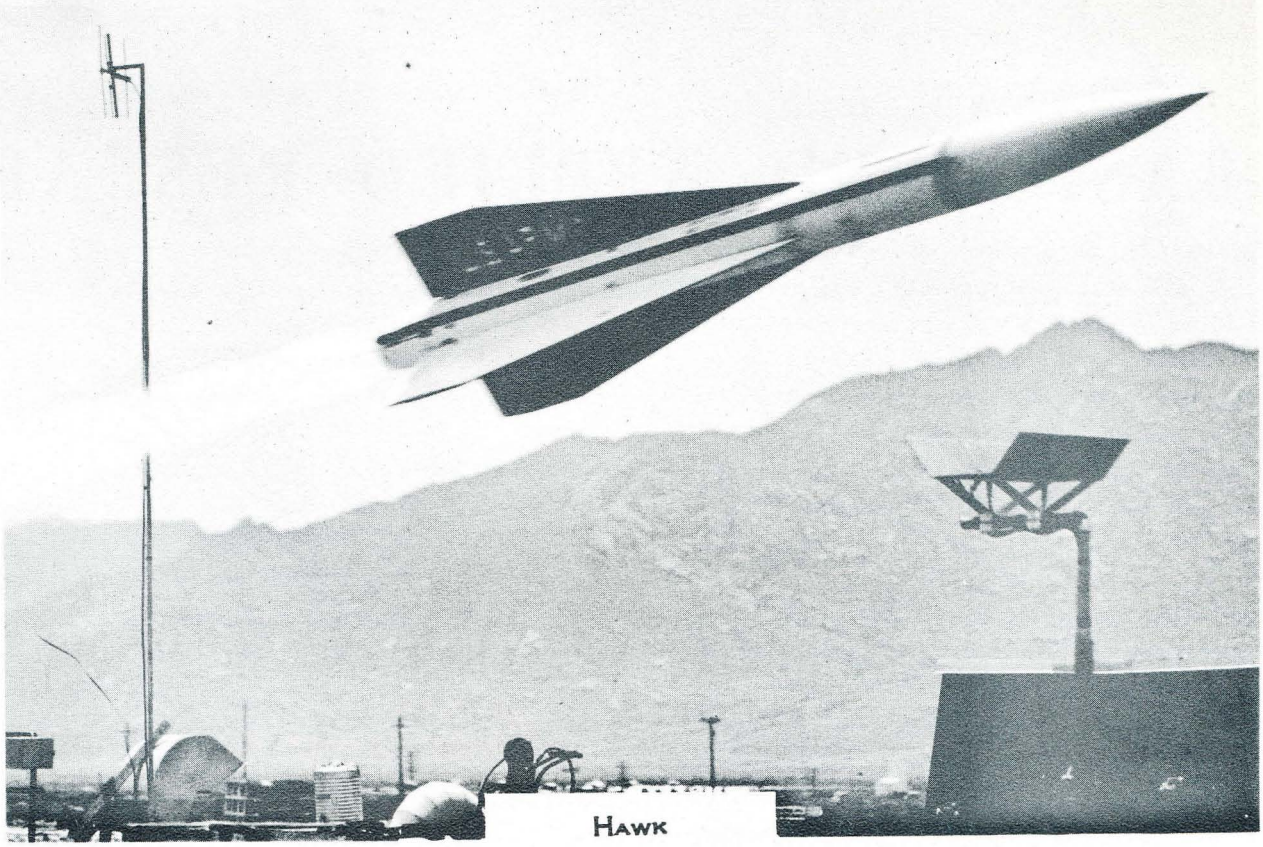
This work was performed under contract with the U.S. Army Ordnance Corps.

Co-op Students Leave For Work

BASIC AND APPLIED RESEARCH



During the year 1957–58 basic and applied research in the Physical Science Laboratory covered a broad spectrum of activities from theoretical studies in electronic countermeasures to assistance in production of educational films. Although most of the work was supported by funds from outside organizations, some projects such as solar energy investigations and solar spectroscopy research were made possible by money from within the laboratory itself. In all of the projects undergraduate and graduate students on an assistant or hourly basis assisted in the research.



HAWK

ELECTRONIC COUNTERMEASURES

I. L. CARBINE

SINCE 1954 THIS PROJECT HAS BEEN ENGAGED IN THE STUDY OF ELECTRONIC COUNTERMEASURES UNDER THE SPONSORSHIP OF THE U.S. ARMY SIGNAL CORPS, WHITE SANDS SIGNAL AGENCY LOCATED AT WHITE SANDS MISSILE RANGE. THIS WORK HAS BEEN COMPOSED OF TWO PARTS, A STUDY OF ELECTRONIC COUNTERMEASURES AGAINST SYSTEMS IN GENERAL AND THE STUDY OF THE EFFECTS OF COUNTERMEASURES AGAINST SPECIFIC MISSILE SYSTEMS. THE GENERAL STUDY OF ELECTRONIC COUNTERMEASURES IS A BROAD CONSIDERATION OF ALL POSSIBLE SIGNALS AND DEVICES THAT CAN HAVE AN EFFECT ON ELECTRONIC EQUIPMENT. THIS WORK INCLUDES THE THEORETICAL TREATMENT OF THE INTERFERENCE PHENOMENA AS WELL AS A SURVEY OF THE EQUIPMENT AND TECHNIQUES AVAILABLE TO THE FIELD OF ELECTRONIC COUNTERMEASURES.

THE GENERAL STUDY PROVIDES A BACKGROUND FOR THE SECOND PART OF THE WORK, THE STUDY OF SPECIFIC MISSILE SYSTEMS. TWO SUCH SYSTEMS HAVE BEEN ASSIGNED TO THE LABORATORY FOR DETAILED STUDY. THESE ARE THE LACROSSE AND THE HAWK. THE WORK ON BOTH SYSTEMS HAS FOLLOWED THE SAME PATTERN OF AN INITIAL STUDY FOLLOWED BY TESTS ON THE SYSTEMS TO SUPPLEMENT AND SUBSTANTIATE THE THEORETICAL CONCLUSIONS. THE RESULTS ARE THEN FED BACK TO THE DEVELOPING AGENCIES WHERE CHANGES ARE MADE IN THE SYSTEMS TO IMPROVE THEIR INSUSCEPTIBILITY TO ELECTRONIC COUNTERMEASURE. THE CHANGES THEN GIVE RISE TO ADDITIONAL STUDY AND RE-EVALUATION OF THE SYSTEMS.

IT IS ANTICIPATED THAT WORK UNDER THIS PROJECT WILL CONTINUE DURING 1958-59.

SEARCH FOR NATURAL SATELLITES

C. W. Tombaugh

Since December 1953, a systematic search for small natural satellites of the earth has been in progress. These small objects, illuminated by the sun, would be too small to be seen by the naked eye and would move through the field of view of large telescopes too rapidly to be either seen visually or recorded by the telescope's photographic equipment. However, a small telescope driven at angular speeds that match apparent angular speeds of the possible natural satellites would see these faint objects since the satellite's image would affect the recording photographic plate for the several seconds while it was being tracked. The angular tracking speed required to perform this operation depends on the distance of the satellite from the earth. Consequently, the equatorial and ecliptic planes of the sky were divided into approximately 200 concentric zones. In order to cover all the sectors of the circumference of a zone a dozen types of observational procedures were evolved to meet the requirements imposed by the earth's shadow and by satellite periods. To date, nearly 16,000 frames have been exposed and examined.

The first two and one-half years of photographic work was conducted at the Lowell Observatory, Flagstaff, Arizona. However, the region close to the earth in the plane of the equator is not visible from this location. To examine this region of the space around the earth a station has been operated at Quito, Ecuador. In May 1958 special observations were made for the U.S. Army Map Service with the assistance of AMS personnel at this station.

In 1957 at Presidio, Texas, and Las Cruces, New Mexico, a visual search in a family of ecliptic planes was undertaken. Because of the difficulties involved in searching a complete family of planes, the visual search using the human eye that is 500 times more sensitive than photographic emulsion, was used.

The project has had a threefold purpose: (1) to learn if the earth has any small natural satellites; (2) if such satellites exist, to chart their orbits so that their locations would be known continuously; (3) to develop observational equipment, methods and techniques for keeping track of artificial satellites.

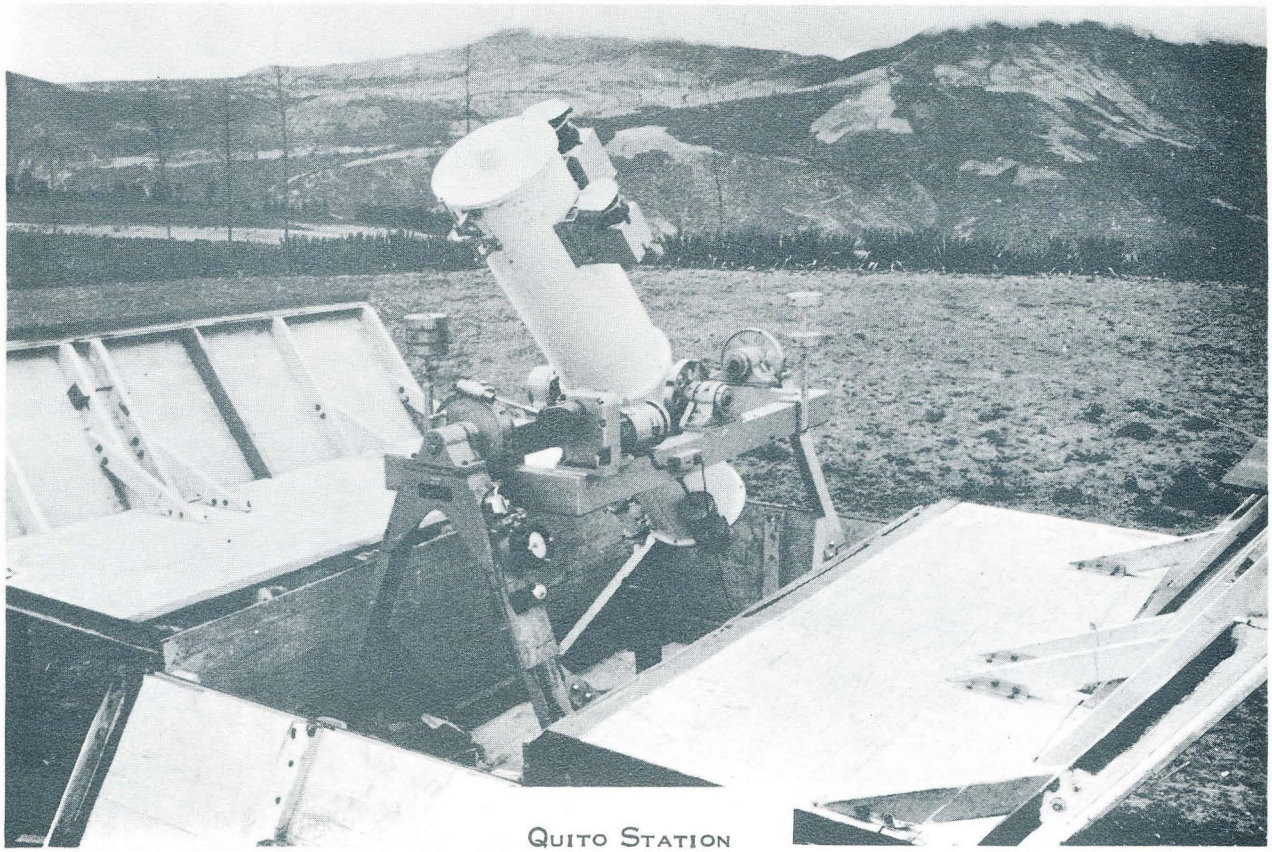
Although a few faint satellite suspects have been encountered none could be satisfactorily confirmed or recovered. Some were undoubtedly unusual defects in photographic emulsions. Others appear to have been tiny asteroids brushing past the earth in their eliptical orbits around the sun.

Five principal papers have been published and distributed by the group.

"Proposed Geodetic Triangulation from an Unmanned Orbital Vehicle by Means of Satellite Search Technique" by Clyde W. Tombaugh, Jet Propulsion, May 1955.

"Photographic Tracking of an Earth Satellite" by Clyde W. Tombaugh and Bradford A. Smith, Physical Science Laboratory, NMCA&MA, 10 April 1956.

"Proposal for Photographic Acquisition and Tracking of Artificial Satellites" by Clyde W. Tombaugh and Bradford A. Smith, Physical Science Laboratory, NMCA&MA, 25 May 1956.



Quito Station

"Interim Report on Search for Small Earth Satellites for the period 1953–1956" by Clyde W. Tombaugh, Physical Science Laboratory, NMCA&MA, 1 Oct 1956.

"By-Products of the Search for Natural Satellites of the Earth" by Charles F. Capen, Jr., Sky and Telescope, Feb 1957.

The search for natural satellites is nearing conclusion and will be brought to a close at the end of this year. Although the results have been negative, the search has nevertheless made a significant contribution to the general knowledge of the space content within the moon's orbit.

During the coming year, the group will focus its attention on geophysical research of the moon and planets. The main object of the study will be the planet Mars, which will make a close approach to the earth in November. Mars, the most controversial of all of the planets, will be photographed continuously throughout a four month period in an effort to learn more about its atmosphere, surface features, and seasonal changes. Of special interest will be the Martian "canals" and the "Maria", reported to be areas of a low form of plant life. In addition to Mars a close photographic surveillance will be kept on the planets Jupiter and Venus and the Moon. Since the Moon represents man's first interplanetary target for space travel, an intensive study will be directed toward its surface features and geology. A regular examination of Venusian atmosphere in the ultraviolet, and colorimetric studies of Jupiter's multicolored atmosphere, along with the above mentioned investigations, are expected to add much to our knowledge of the physical makeup of the moon and planets.

EDUCATIONAL FILMS

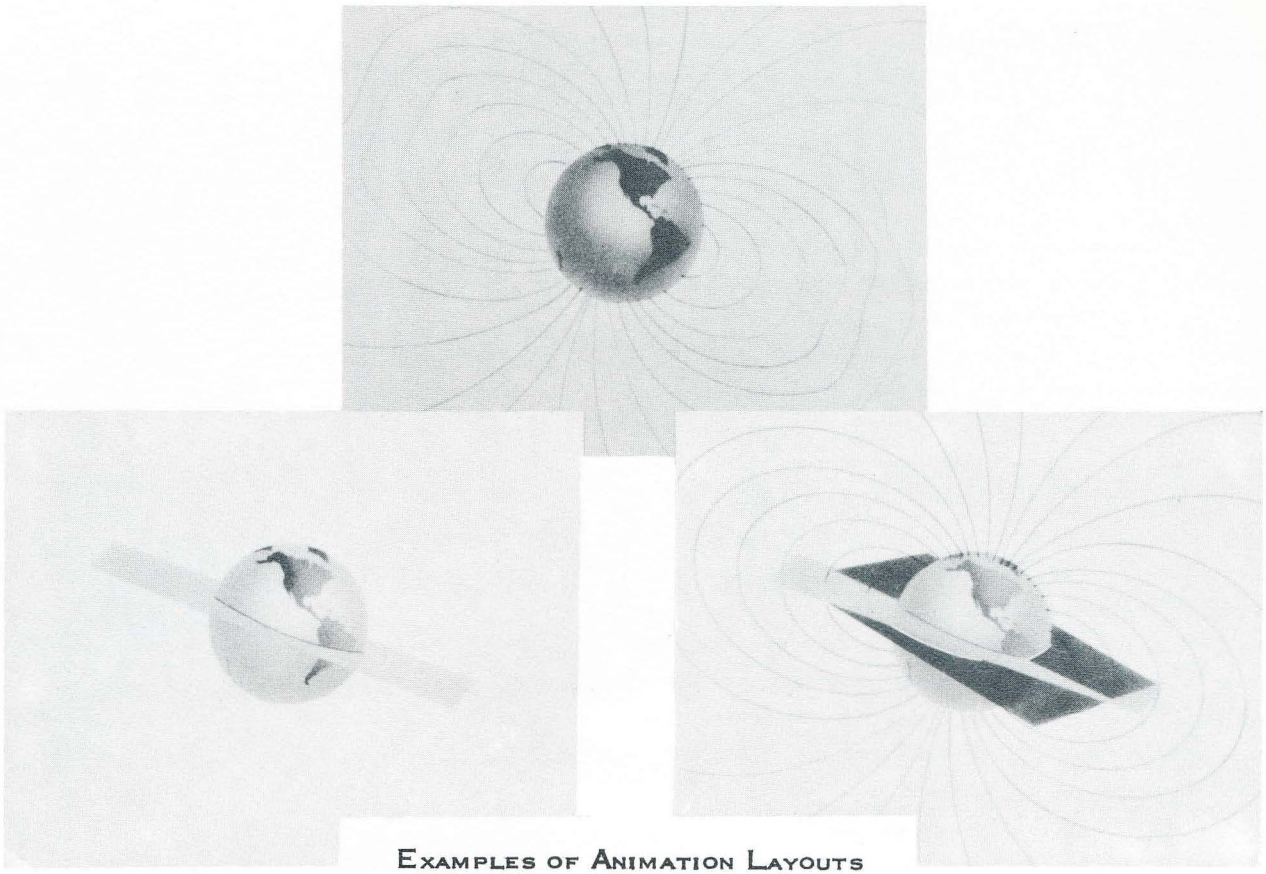
R. K. SHERBURNE

FOR THE PAST TWO YEARS THE PHYSICAL SCIENCE LABORATORY HAS BEEN WORKING WITH THE FILM UNIT OF THE LOWELL EDUCATIONAL FOUNDATION OF BOSTON, MASSACHUSETTS, IN THE PRODUCTION OF A SERIES OF THIRTEEN ONE-HALF HOUR EDUCATIONAL MOTION PICTURES THAT COVER THE VARIOUS SCIENTIFIC DISCIPLINES OF THE INTERNATIONAL GEOPHYSICAL YEAR. THE WORK IS UNDER THE AEGIS OF THE U. S. NATIONAL COMMITTEE FOR IGY AND HAS BEEN FINANCED BY THEM AND BY THE NATIONAL SCIENCE FOUNDATION, WITH THE DUAL OBJECTIVES OF INFORMING THE GENERAL PUBLIC OF THE MEANING AND SIGNIFICANCE OF THE IGY AND OF HELPING TO ATTRACT YOUNG STUDENTS INTO SCIENTIFIC CAREERS. THE SUBJECTS OF THE FILMS ARE AS FOLLOWS: (1) INTRODUCTION, (2) SOLAR ACTIVITY, (3) GEOMAGNETISM, (4) AURORA, (5) IONOSPHERE, (6) COSMIC RAYS, (7) METEOROLOGY, (8) OCEANOGRAPHY, (9) GLACIOLOGY, (10) SEISMOLOGY, (11) GRAVITY, LONGITUDE AND LATITUDE, (12) ROCKETS, (13) SATELLITES.

THE FIRST YEAR OF THIS PROJECT (1 JULY 1956 – 30 JUNE 1957) WAS THE PERIOD OF THE PILOT FILMS, AND SAW THE LABORATORY IN CHARGE OF SCRIPT RESEARCH, SCRIPT WRITING, TRAVEL AND SHOOTING ARRANGEMENTS FOR CAMERA CREWS, SUPERVISION OF ANIMATION DRAWING, AND ASSISTING WITH CAMERA DIRECTION AND WITH EDITING OF THE THREE PILOT FILMS (NOS. 2, 3, 4), WHICH WERE BROUGHT TO COMPLETION OR NEAR COMPLETION IN THE BOSTON STUDIOS OF WGBH BY THE END OF THE YEAR.

EACH OF THE SUBJECT MATTER AREAS WAS THOROUGHLY RESEARCHED IN THE LOCAL LIBRARY, IN PUBLICATIONS FROM OTHER

FILMING IGY



Examples of Animation Layouts

libraries, and in special publications of the IGY scientists. Interviews were also held with many of these scientists, and on the basis of all obtained information, a series of nine reports was written that explained the scientific problems being investigated and suggested how the films might develop the investigations into a "story".

Simultaneously, a series of sketches was drawn at the Physical Science Laboratory to guide the animation studio in preparing animated sequences for the films. Also during this period camera crews worked out of Boston to film "live" IGY activities around the world.

National television release is slated beginning in January of 1959, and distribution to audio-visual libraries in high schools and colleges is also planned.

In this project the laboratory has assisted in the production of a film series unique in educational film making. The grants under which it is being made are the largest ever made to educational television; the series itself is the most ambitious of its kind ever undertaken by educational television, involving, as it has, coverage of world-wide scientific effort during the International Geophysical Year. That it promises success is evident in the widespread favorable comment on the initial pilot film, both from the scientific community, which is notoriously critical of most efforts to "put science on film," and from certain Hollywood producers who are engaged in similar projects supported by private money.

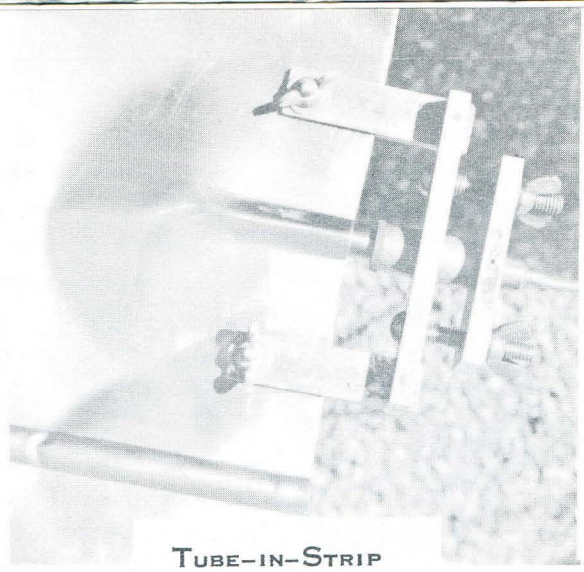
SOLAR ENERGY RESEARCH

ALBERT BURRIS

THE MAJOR WORK DURING 1957–58 HAS BEEN THE GATHERING OF INFORMATION ON THE FEASIBILITY OF SOLAR HEATING A DWELLING IN THIS AREA USING A SYSTEM OF REASONABLE CONSTRUCTION COSTS. A FEW HEATED AIR COLLECTOR SYSTEMS HAVE BEEN TRIED BY INDIVIDUALS WITHIN THE STATE, BUT THESE HAVE NOT BEEN VERY SUCCESSFUL. A RECENT DEVELOPMENT OF SHEET METAL STRIP KNOWN AS TUBE-IN-STRIP BY THE REVERE COPPER AND BRASS COMPANY HAS OPENED THE POSSIBILITY OF CIRCULATING AND HEATING WATER RATHER THAN AIR.

THROUGH AN AGREEMENT WITH DR. JACK SOULES, ASSISTANT PROFESSOR OF PHYSICS, NMCA&MA, AN EXPERIMENTAL SYSTEM HAS BEEN INSTALLED IN HIS HOUSE A FEW MILES SOUTH OF THE COLLEGE. UNDER THE TERMS OF THE AGREEMENT, THE LABORATORY MAY TAKE THE DATA ON THE SYSTEM FOR A PERIOD OF FIVE YEARS AND MAY ALSO MAKE MINOR CHANGES IN THE SYSTEM WHEN THIS SEEMS NECESSARY OR DESIRABLE. THUS, THE LABORATORY HAS IN EFFECT A FULL-SCALE SOLAR HEATING SYSTEM AVAILABLE FOR CERTAIN EXPERIMENT AND PERFORMANCE STUDIES AND AT A FRACTION OF THE COST ON CONSTRUCTING A COMPARABLE BUILDING COMPLETELY OWNED BY THE LABORATORY.

FLAT PLATE GLASS COLLECTORS THAT TRAP THE SUN'S HEAT IN MUCH THE SAME WAY AS AN ORDINARY GREENHOUSE OR HOTBED ARE PLACED IN THREE BANKS, ONE BEHIND THE OTHER, AND FORM AN INTEGRAL GROUP, PART OF THE ROOF OF THE HOUSE. THE TRAPPED HEAT BENEATH THE GLASS IS ABSORBED BY A COLLECTOR PLATE AND CARRIED TO A STORAGE TANK BY CIRCULATING WATER WITHIN THE "BUILT-IN" TUBES OF THE PLATE. THE



TUBE-IN-STRIP

HEATED WATER IS STORED IN AN UNDERGROUND TANK THAT HOLDS 2500 GALLONS, APPROXIMATELY ENOUGH TO RETAIN SUFFICIENT HEAT FOR THE HOUSE ON ONE RATHER COLD WINTER DAY.

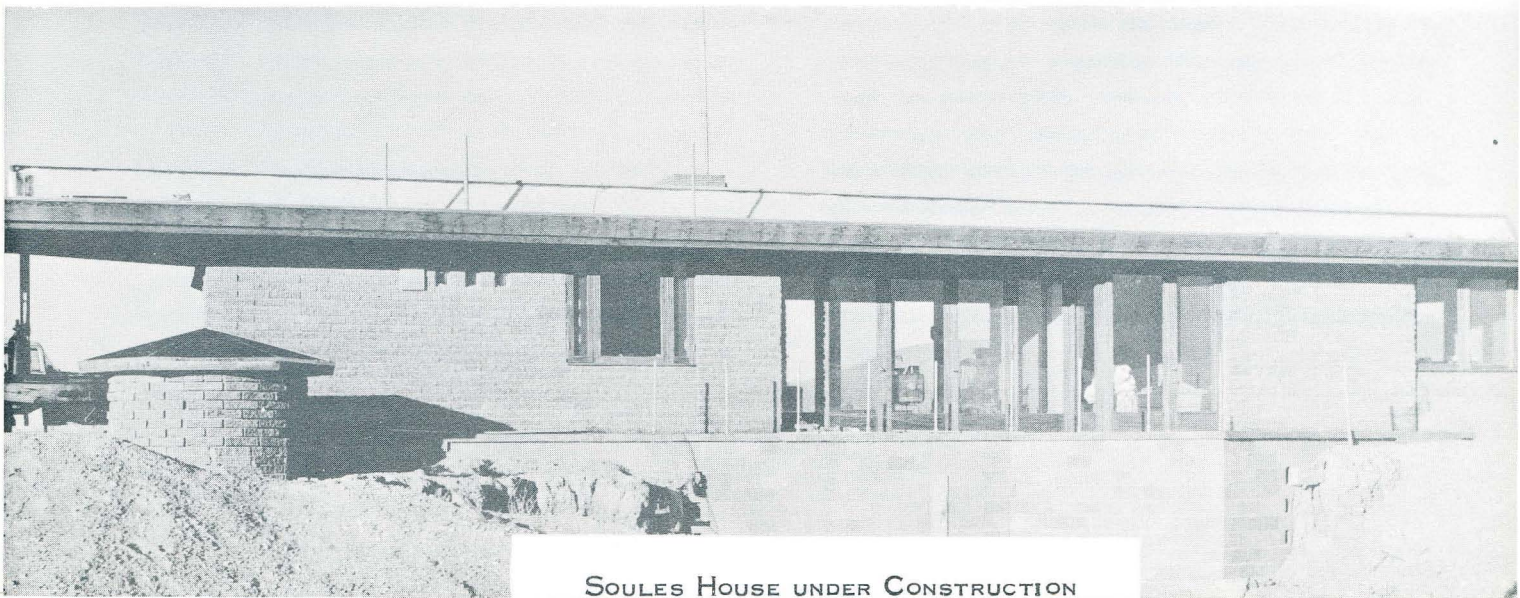
THE WATER WHICH TRANSPORTS HEAT FROM PLACE TO PLACE IS CONTAINED IN TWO CLOSED SYSTEMS: (1) TO TRANSPORT HEAT FROM THE COLLECTORS TO THE STORAGE TANK AND (2) TO CARRY THE HEAT FROM THE STORAGE TANK FOR USE IN THE HOUSE. WITHIN THE HOUSE AIR IS WARMED BY THE CIRCULATING WATER AND DISTRIBUTED TO ALL PARTS OF THE HOUSE BY A DUCT SYSTEM, MUCH AS IN THE CONVENTIONAL HOT-AIR CIRCULATION DESIGNS. A SIMPLE BUT EFFECTIVE CONTROL SYSTEM HAS BEEN DESIGNED WHICH MAKES IT UNNECESSARY TO MANUALLY TURN THE COLLECTOR PUMPS ON OR OFF. THE TEMPERATURE DIFFERENCE BETWEEN THE WATER FROM THE COLLECTOR AND THE WATER FROM THE STORAGE TANK IS MONITORED AND CIRCULATION IS MAINTAINED AS LONG AS THE TEMPERATURE DIFFERENCE EXCEEDS A PREDETERMINED VALUE. SOME INFORMATION IS OBTAINED FROM THERMO-COUPLES LOCATED AT PERTINENT POINTS AROUND THE SYSTEM AND IN THE SOIL AROUND THE STORAGE TANK.

INSTALLATION WAS COMPLETED IN JANUARY 1958, THEREFORE THE SYSTEM HAS NOT BEEN IN OPERATION FOR A COMPLETE HEATING SEASON; YET SOME PERTINENT OBSERVATIONS CAN BE MADE.

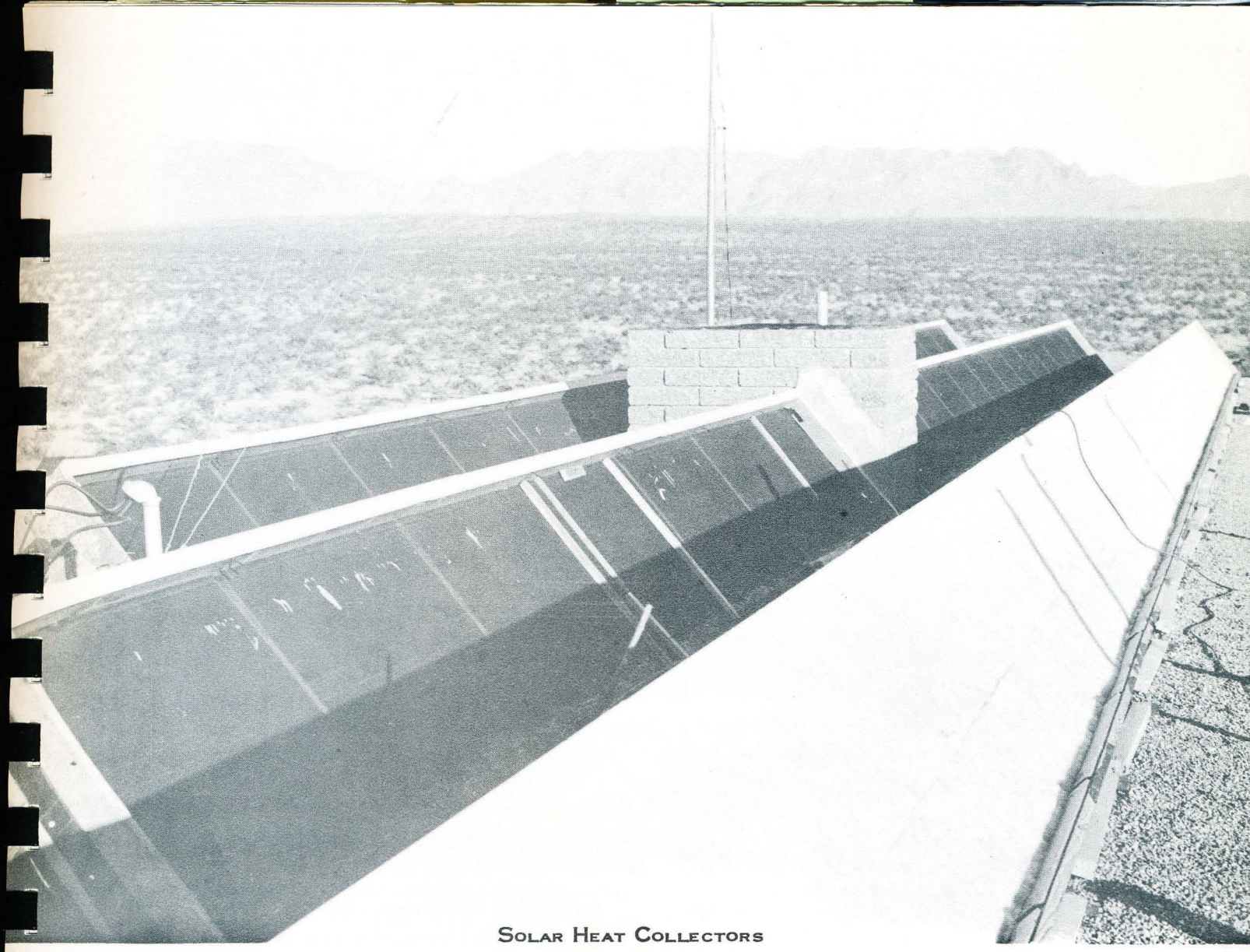
Sufficient solar heat was provided to enable the Soules family to live in the house all winter with only a fireplace for heat. At times the comfort level was not high, but tolerable. It is estimated that during the coldest winter months about one-half of the heat requirements was supplied by the solar system. From the latter part of February on, auxiliary heat was needed. Only minor mechanical difficulties such as a parted hose connection on one or two occasions and pump failure due to air in the system were encountered. No overheating in the collectors, as was feared might take place in summer months, has yet occurred. The water-antifreeze solution was left in the inoperative system to check this and only a moderate pressure has built up. The lack of summer overheating is due largely to the unfavorable angle of incidence of the sun's rays on the collector face. Changes in soil temperatures about the storage tank show that an undesirably large amount of heat is being lost to the ground. Burying the tank in the soil was an experiment to determine whether or not this would be the case. Ordinarily, the soil is dry, and therefore, a good insulator, but it has received considerable moisture during this summer. This has lowered the insulating property. It also became apparent that the collector system heat exchanger was either inadequate or that rust deposit from the tank water had impaired its efficiency.

Prior to the Soules solar heating system, the efficiency of the collector units was studied with a small test collector in the laboratory. Efficiency of the collector varied from about 75% at 90° F to about 35% at 145° F water temperature. A paper describing this work and the results of it was presented at the AAAS regional meeting in Las Vegas, New Mexico, in April 1958. The choice of the number of tubes incorporated in the collector-plates was determined by calculation of the temperature gradient across the sheet between the tubes. Preliminary measurements made on actual test items agreed rather well with the computed values. Some further work is being done on this to determine experimental values more precisely for comparison with the theory.

At the Physical Science Laboratory measurements of the amounts of solar energy per unit area per unit time incident on test collectors have been made.



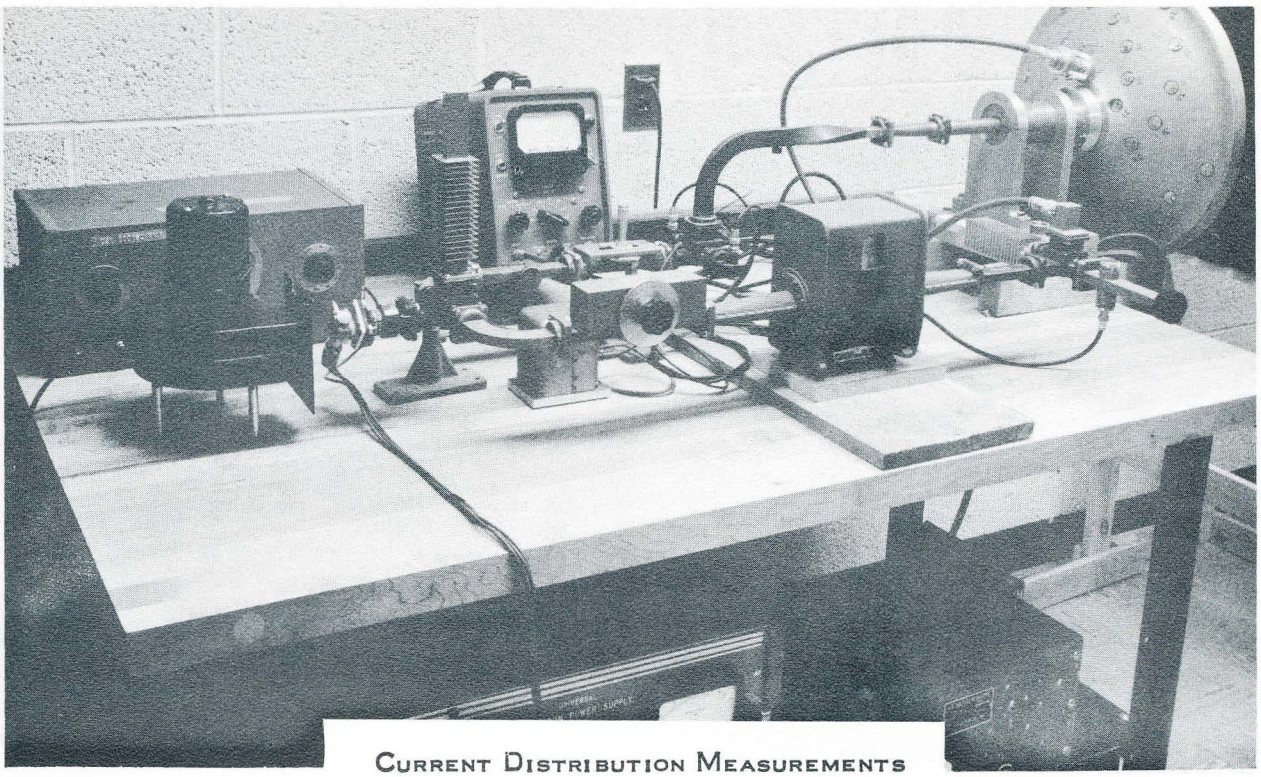
Soules House under Construction



Solar Heat Collectors

Immediate plans for the future are to complete the study of temperature gradients in the copper Tube-in-Strip material. Certain modifications are planned for the Soules solar house before the next heating season. The storage tank and lines to the house will be insulated. The heat-exchanger problem will be reconsidered and changes will probably be made in the pump location to get more reliable operation. More complete instrumentation will be installed. Cooling of water by radiation at night from the collectors may be investigated, depending upon the outcome of similar experiments with the small test collector.

Storage of heat is one of the basic problems of the utilization of solar energy for heating purposes. So-called chemical heat storage is quite promising, however, attempts at its use have been generally unsuccessful because of certain problems. It appears that considerable basic research may be needed before chemical heat storage can be made practical. Little work has been done in this area but it is planned to increase these investigations during the coming year. The design of the Soules house solar tank is such that chemical heat storage could be substituted for water storage if desired.



Current Distribution Measurements

MICROWAVE CURRENT DISTRIBUTIONS

R. W. Dressel

The distribution of electromagnetic radiation in space is governed by the distribution of currents in the generating source but the relationship is complex and requires special methods to deduce one from a knowledge of the other. This problem has been a subject of investigation resulting in the development of a method called the Current Transform Method for interpreting and calculating either the radiation field or the current distribution required. An extension of the investigation produced a technique for measuring the microwave currents induced in a continuous metallic surface. These measurements are made at 10,000 megacycles per second with a shielded image loop probe designed to respond to the amplitude, polarization and phase of the circulating current. Interesting results of these measurements have shown the presence of characteristic modes for the current distributions that can be systematically classified in terms of the conditions for excitation.

Support for this work has come from the Applied Physics Laboratory of The Johns Hopkins University. One technical report has been written and a final report is in preparation covering the recent results of these investigations. A technical paper describing the Current Transform Method was delivered in August 1955 at the Boulder Laboratories of the National Bureau of Standards. Another paper was delivered in May 1958 at the annual meeting of the Southwestern Section of the American Association for the Advancement of Science.

FERRITE AND WAVEGUIDE STUDIES

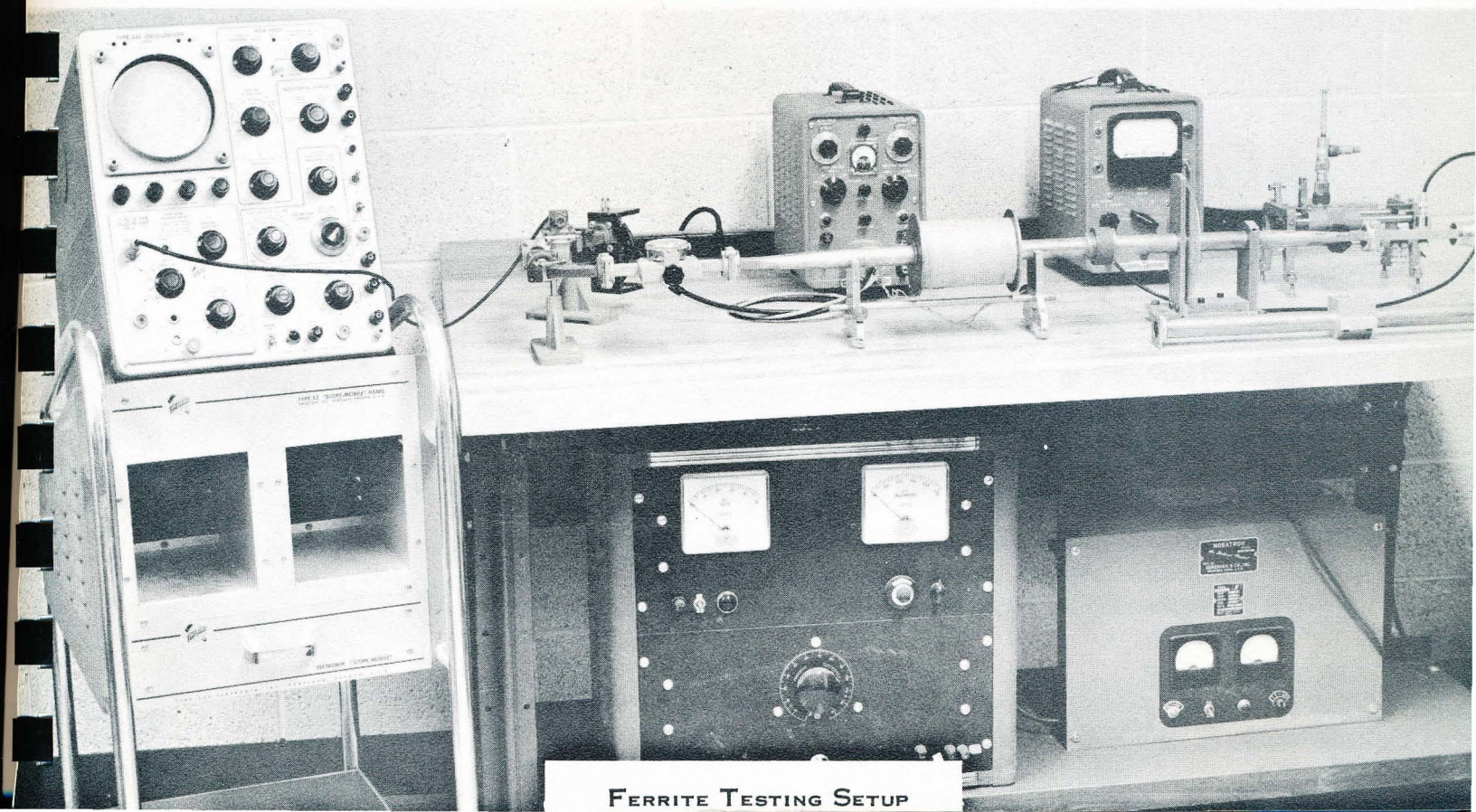
R. W. Dressel

The term "ferrite" applies to a general class of metallic oxides of which iron oxide is the chief component. One extremely interesting property of the ferrites is that they are "gyromagnetic", a term used to describe the interaction of the ferrite medium and an electromagnetic wave. When an element of ferrite material is introduced into a waveguide and magnetized by an externally applied field the state of polarization of the electromagnetic wave will be changed in proportion to the intensity of magnetization. Interference between reflected and incident waves within the guide thus depends upon the magnetization of the sample.

A study of these interference phenomena has been made over a frequency range from 8,000 to 12,000 megacycles per second. Interpretation of the measured data has been made in terms of theoretical results derived from an application of the scattering formulation of the field equations. It has been possible to reduce the very complex wave interactions to a relatively simple description involving only three pairs of independently measureable parameters.

Initial phases of the investigation were begun under a contract with the Applied Physics Laboratory of The Johns Hopkins University. More recently, the work has been supported by the Air Force Office of Scientific Research. A detailed technical report has been written and submitted to the Air Force and other interested organizations. In May 1958 a paper describing the results of the investigation was delivered at the annual meeting of the Southwestern and Rocky Mountain Section of the American Association for the Advancement of Science.

Two undergraduate assistants have performed most of the measurements and many of the required computations.



Ferrite Testing Setup

RESEARCH IN GASEOUS ELECTRONICS

H. B. Williams

Since 1949 this project, under sponsorship of the Applied Physics Laboratory, The Johns Hopkins University, has been gathering and interpreting fundamental information in the field of "gaseous electronics," a term applied to all phenomena which involve the ionization of atoms and molecules. The work has been performed at gas pressures of the order of one millionth of atmospheric pressure, using dry air, helium and hydrogen gases. Radio frequency power in the range 20-200 megacycles per second is applied to two disk-shaped electrodes, causing a glow discharge to appear between them.

A great deal of information has been obtained concerning this general type of phenomenon and considerable progress has been made in theoretical interpretation of the data. However, the observations have sometimes been spectacular and very difficult to interpret theoretically. Under certain conditions brilliant glowing clouds of gas appear between the electrodes which so far have defied theoretical description.

The project has published two papers:

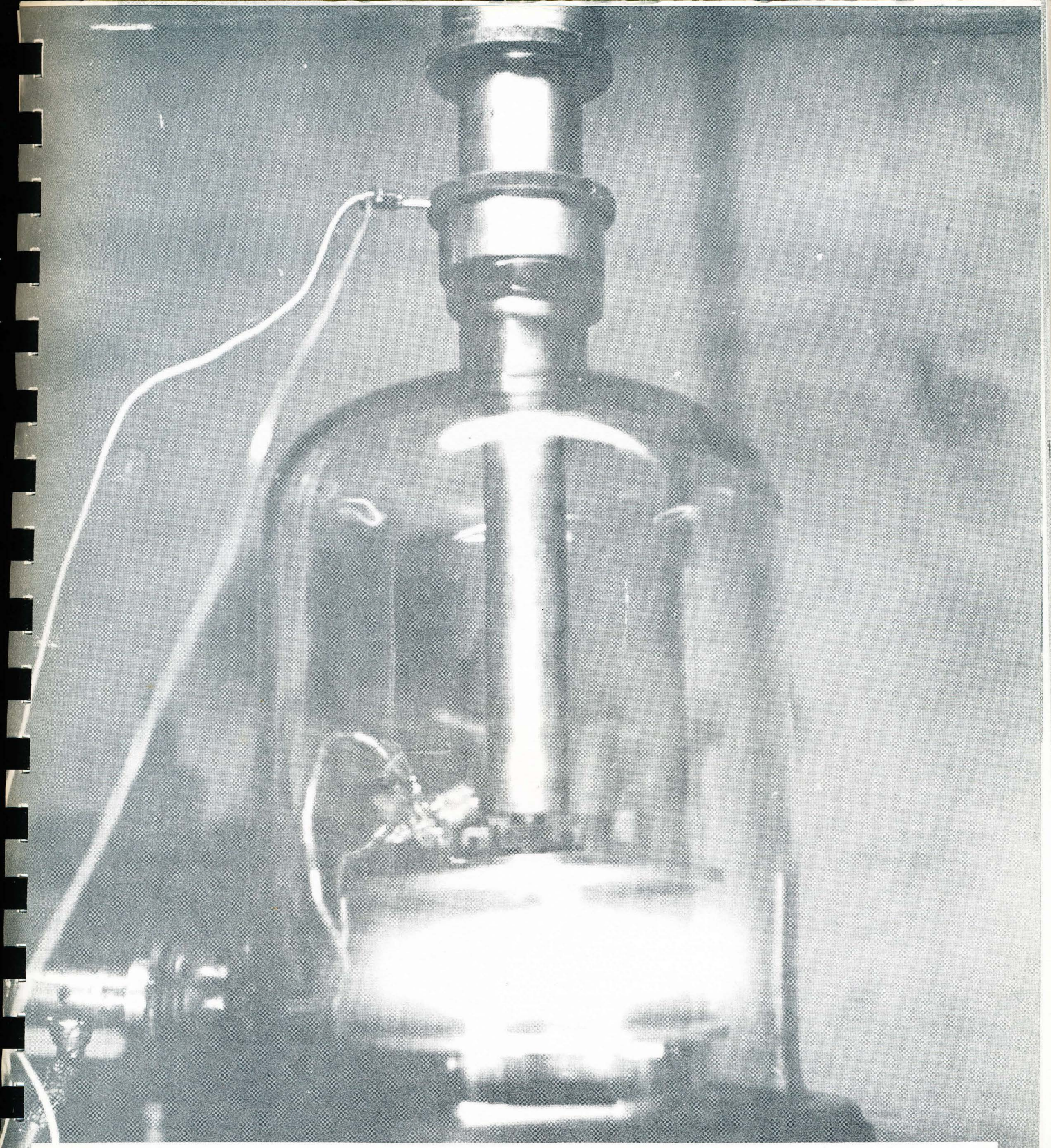
"The Secondary Electron Resonance Mechanism of Low Pressure High-Frequency Gas Breakdown" by Albert J. Hatch and H. Bartel Williams, Journal of Applied Physics April 1954.

"A Three Dimensional Potential Well" by H. Bartel Williams, Physical Review September 1, 1957.

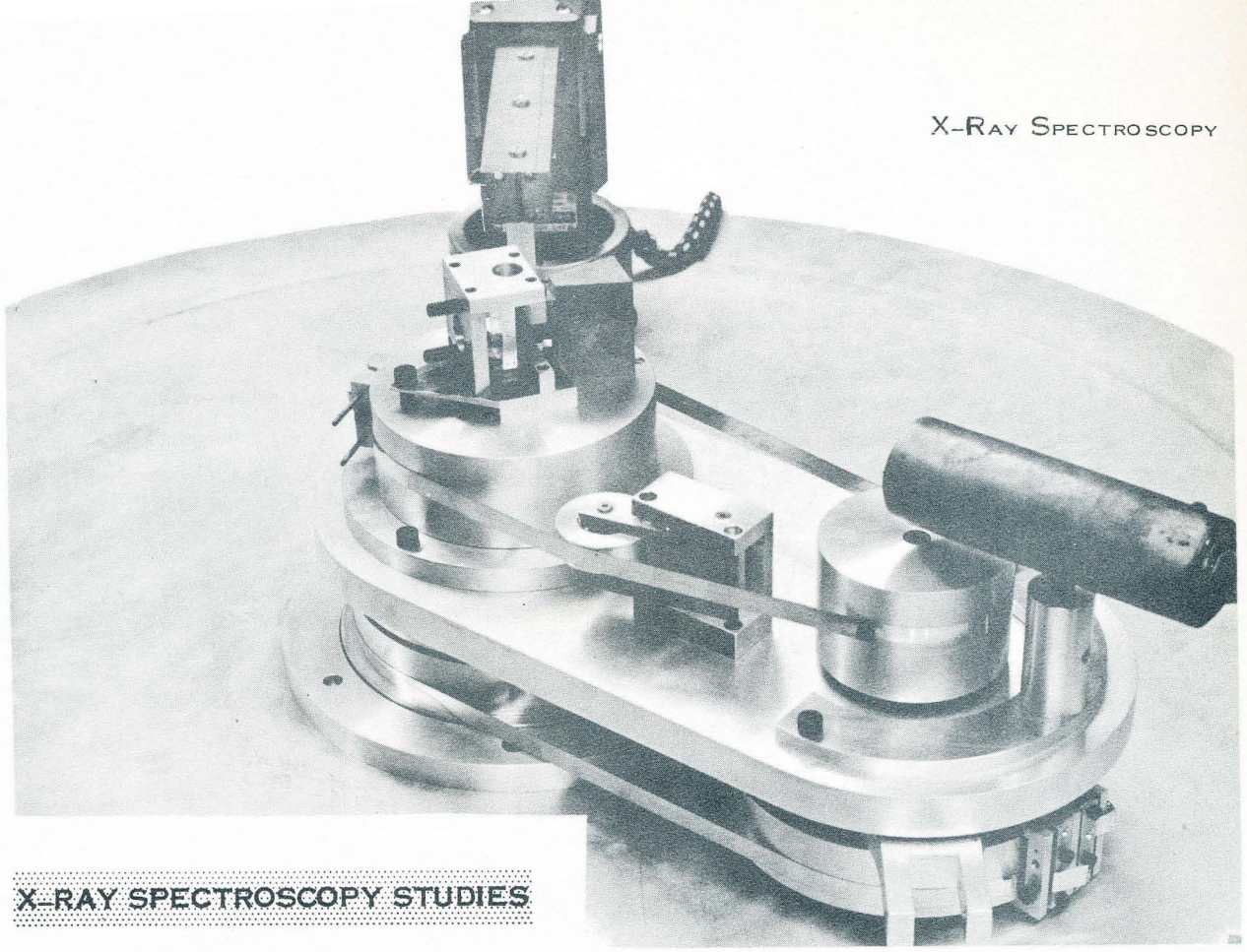
Another paper is now being presented for publication by Mr. Hatch and Mr. Williams and a fourth paper is under preparation by Mr. Williams. In addition the Handbuch der Physik quotes these papers as the definitive work in this branch of gaseous electronics. Six papers have been read before the Annual Gaseous Electronics Conferences.

During the year 1957-58 work has progressed in two distinct directions, namely, continuation of the study of the cause of the onset of the glow discharge, commonly referred to as "breakdown", and initiation of studies of the properties of the glow discharge after breakdown occurs.

One aspect of the study of the glow discharge after breakdown occurs has aroused interest throughout the scientific community. Under certain conditions after the glow has been started, a three dimensional potential well for positive ions (ions are trapped in a region in space) can be created. The significance of this is that ionized atoms can be held within the space of apparatus for an indefinite period of time without ever touching the walls of the apparatus. Thus it is possible to contain gases within the apparatus which have temperatures of millions of degrees, but which will not damage the walls of the container. This is an important aspect of producing power from thermonuclear processes (taming the H-Bomb for peace time use). It also is important in that it can duplicate conditions in the stars and therefore is an excellent laboratory tool for astronomers.



The project plans to continue work on the steady-state glow discharge. It is believed that this year will see the completion of the major effort in the study of causes of "breakdown". Plans are in process for the development and study of the "potential well".



X-RAY SPECTROSCOPY STUDIES

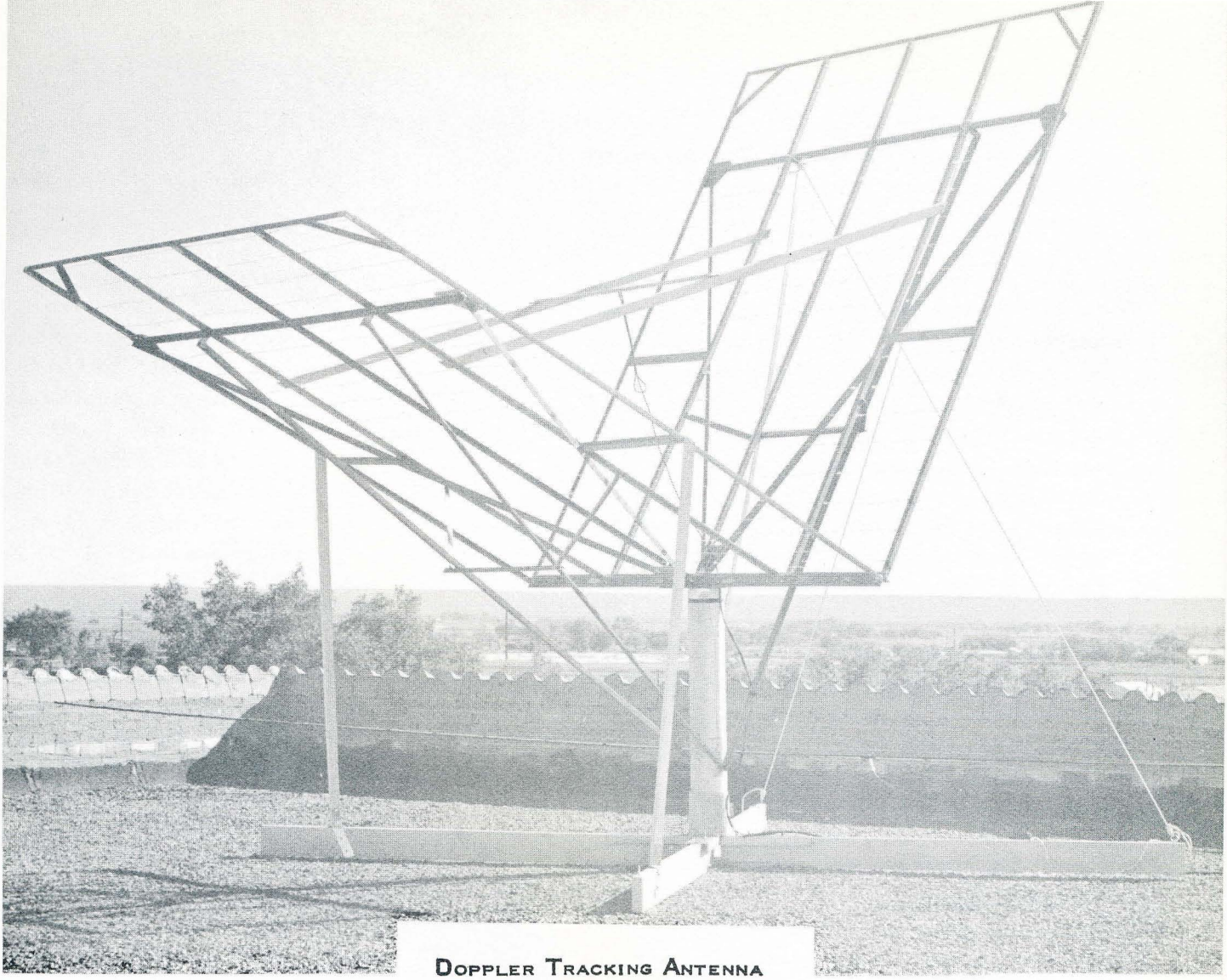
J. A. Soules

It is possible to investigate the structure and properties of crystals by measuring the manner in which X-rays are scattered and reflected as they pass through the test material. Because air at atmospheric pressure absorbs and scatters X-rays it is necessary to perform these experiments in an evacuated chamber.

A double-purpose X-ray spectrometer has been constructed, and preliminary measurements on single crystals using known X-ray patterns are in progress to determine the quality of the instrument. A complete electronic system for the protection and registration of the X-rays has been assembled and is in operation. For the detection of X-rays to wavelengths of ten angstrom units, two photon counter tubes using very thin beryllium windows have been prepared and are being tested. The steel bell forming the vacuum chamber and its associated parts have not yet been tested for vacuum tightness.

A preliminary problem will be a study of the fluorescence emission from ashed range grasses in an attempt to measure the existence of extremely small amounts of some elements. This project, undertaken in cooperation with the animal husbandry department, will serve as a practical test of the usefulness of the new spectrometer.

It was planned to make studies on artificial organic crystals. This work has been delayed due to a shortage of personnel, but is now underway again. Thin films of calcium stearate have deposited and there is considerable hope that large single crystals can be grown by the same method.



Doppler Tracking Antenna

SATELLITE DOPPLER TRACKING

R. J. Sabin and W. J. Joosten

A station for tracking artificial satellites is now being installed in the playback station. The tracking is accomplished by recording the apparent frequency shift of the satellite transmitter as the satellite passes over or near the station.

There are two primary difficulties in making useable and accurate recordings of the radio signals. The signal received from the satellite is about one ten-millionth of the strength of a signal from a local radio station and about one fifty-thousandth of the strength of a signal from a television station. Because it is so weak, extremely sensitive receiving equipment is necessary. The design of the receiving antenna also becomes of prime importance for obtaining the strongest signal possible. At present the antenna is also positioned to favor polar orbits which pass between New Mexico College of A&MA and

the University of Texas, Austin, Texas. For equatorial orbits, the antenna will be re-positioned for best reception from the particular orbit.

The second difficulty is maintenance of the stability of all recording and receiving equipment. The frequency shift is measured by comparing the satellite frequency to a reference frequency generated in the receiving station. If a change occurs in the reference frequency while recording a satellite pass, this produces an error in the recorded data. The stability of the reference oscillator will be such that the reference frequency will not vary more than one cycle out of a billion for periods of 30 minutes, nor more than one cycle out of a hundred-million for periods of a day.

The shift frequency will be recorded on tape along with the time signal generated and transmitted by WWV in Washington, D.C. A time signal derived from the reference oscillator will also be simultaneously recorded so that loss of the WWV time signal will not invalidate the data. The data are taken from the tape and fed into a computer to solve for the parameters which define the orbit of the satellite.

To increase the accuracy of determining these orbit parameters, a similar station will be in operation at the University of Texas. The two sets of data, taken approximately 600 miles apart, will be used to triangulate the orbit to provide increased accuracy.

This project was initiated in June 1958 so that construction and installation have just been started.

ELECTRONIC DEVELOPMENT

R. J. Sabin

This group is engaged in the development of new electronic circuitry. Emphasis is on miniature rugged circuits which can withstand severe environmental conditions such as are encountered in instrumentation of small sounding rockets. Several new or improved modified circuits have been developed during the past year. One of these involves the modification of a radar beacon, used in tracking missiles that are too small to be tracked by reflection signals, in such a way that events occurring in the missile during flight can be transmitted on the beacon signal. This was accomplished by encoding the missile events into special telemetering words that blank out certain groups of the radar return signals generated by the beacon transponder. This made it possible to obtain telemetered information without carrying the additional weight of a telemetering transmitter. This system was utilized in gathering data from experimental POGO rockets.

In another case standard telemetering equipment was modified for use in obtaining missile vibration, temperature and acceleration conditions in POGO research rockets. Telemetering circuitry using small rockets for measuring the concentration of ozone at high altitudes was developed for the Office of Naval Research. Another system was developed for electronically simulating the signals normally produced by fast-moving aircraft when being tracked by a continuous wave radar. This circuitry will be miniaturized and arranged in a compact package before it is put in actual use.

ANTENNA RESEARCH AND DEVELOPMENT

R. H. Duncan

The antenna group is engaged in both basic and applied research on electromagnetic phenomena. These efforts are directed toward a better understanding of the fundamentals of radiation from an antenna and providing antenna systems of the proper type for specific applications. Principally in the field of airborne and ground-based missile instrumentation, a number of different types of antennas have been designed, developed and installed by the group.

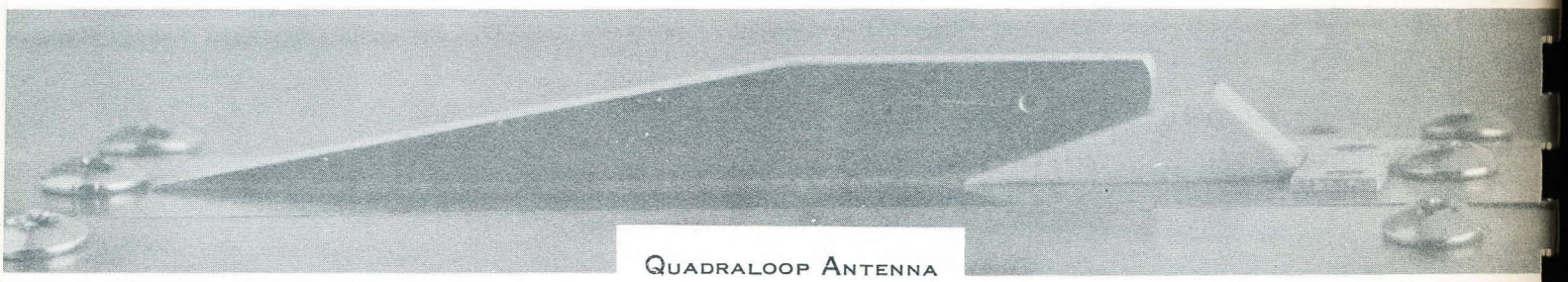
Under the sponsorship of the U. S. Naval Research Laboratory a quadra-loop antenna was invented and developed for project Vanguard. This antenna mounted on the side of a Vanguard launching vehicle was designed to provide a radiation pattern as omni-directional as possible, thus assuring reception of telemetering signals regardless of the orientation of the missile. The antenna properties are such that use on a wide variety of missile systems is possible using frequencies from a few megacycles to over 10,000 megacycles per second. Many designs within this frequency range have been applied to missiles having diameters from a few inches to several feet. In addition to project Vanguard these antennas have been used by the Air Force Cambridge Research Center, University of Michigan, Oklahoma State University, University of Dayton, and the laboratory rocket section.

Besides several helical antenna types that have been developed for use within the Physical Science Laboratory, thirteen high-gain three-element antennas were designed and fabricated in support of project Vanguard. These units are installed at Patrick Air Force Base to receive the telemetered signals from the rocket. Another helical antenna designed for 108 megacycles has recently been delivered to the Army Ballistic Missile Agency for satellite monitoring instrumentation.

Antennas in the form of a notch were designed several years ago to fit into the fins of an Aerobee rocket. Currently the antenna group installs and tunes the Aerobee notch antennas in rockets used by U. S. Naval Research Laboratory and the Air Force Cambridge Research Center.

Since missile antennas frequently operate in the low-pressure of the upper atmosphere and ionosphere, they are subject to a difficulty known as "breakdown" when ionized low-pressure gas creates a conducting path across the antenna elements. Breakdown of this type effectively short-circuits the antenna and prevents transmission of a powerful signal. Laboratory tests of breakdown characteristics have been devised using a vacuum chamber to simulate the important facets of missile flight related to antenna breakdown. All missile antennas designed at the laboratory for high-altitude use are tested for breakdown behavior.

Other specific antenna designs have been used in a missile target simulation program and in electronic countermeasures.



Quadraloop Antenna

Theoretical and experimental work for the Sandia Corp., Albuquerque, New Mexico, has been performed on antennas which are simply cylindrical surfaces with a narrow section of material removed. Excellent agreement between the theoretical predictions and experimental measurements was obtained. At the conclusion of the experimental work-phase a standard antenna was delivered to the Sandia Corporation. Three reports were published.

"The Impedance of a Complete Antenna System" by R. H. Duncan and A. D. Pierce, Physical Science Laboratory, NMCA&MA Jun 1957.

"Two Part Boundary Value Problems" by R. H. Duncan and A. D. Pierce, Physical Science Laboratory, NMCA&MA Aug 1957.

"Experimental Measurements on Slotted Cylinder Antennas" by C. C. Post and R. H. Duncan, Physical Science Laboratory, NMCA&MA Sep 1957.

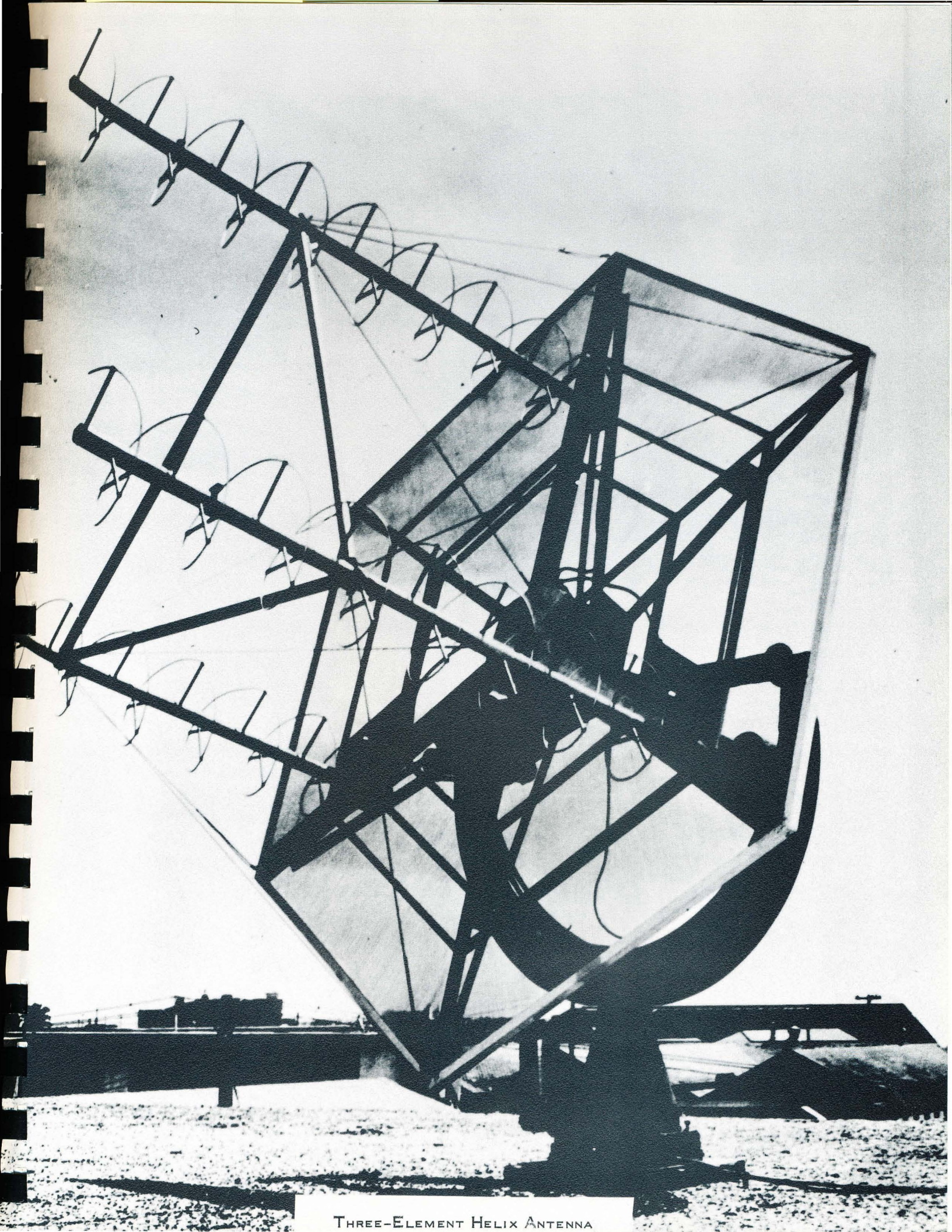
In order to facilitate recovery of the cameras parachuted into the ocean in the Hugo rocket operation a radio-frequency homing system was developed. These units provide a radio signal for Navy ships and aircraft for homing in the recovery of the camera package.

An antenna which uses the fore and aft portion of a rocket separated by an insulator as a radiating element was invented and developed for telemetry use on Cajun and other similar small diameter rockets. Since the antenna is essentially the missile itself, the aerodynamic and structural problems that beset other antenna designs are avoided. By using unique impedance transformers it is possible to connect instrumentation in one section of the rocket through the insulation to circuitry in the adjacent section. These antennas originally developed for Air Force Cambridge Research Center have been furnished to most users of the Cajun and Nike-Cajun rockets.

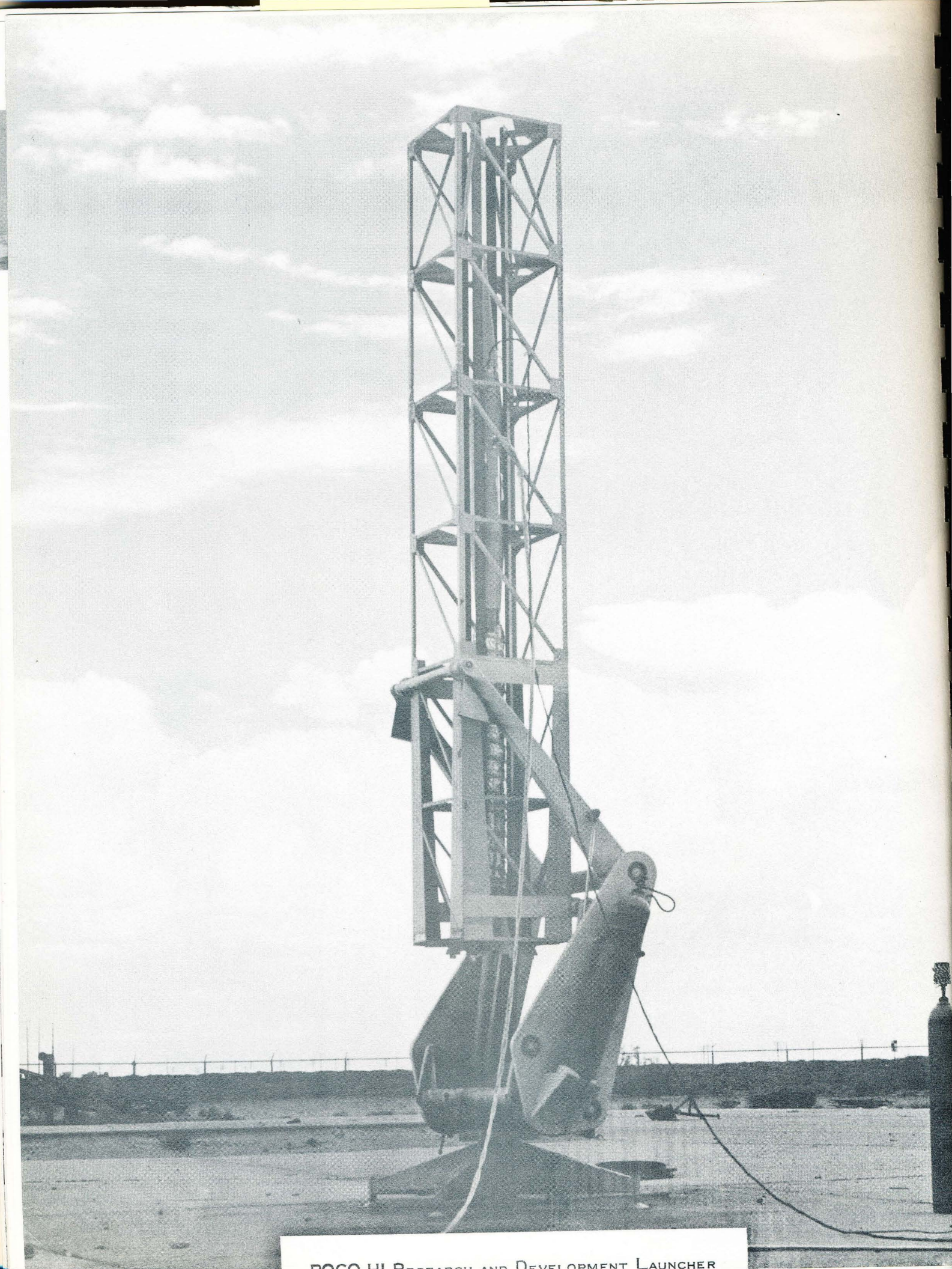
Recently work has been started to evaluate particular radiation and scatter problems associated with visual omnirange aircraft navigational facilities under the sponsorship of the Department of Commerce, Civil Aeronautics Administration.

Telemetry antennas for the new rockets Spaerobee, Iris, and Arcon are currently being designed for the U. S. Naval Research Laboratory.

During the coming year a criticism of general antenna theory, particularly as it applies to loop antennas, will be made for the Diamond Ordnance Fuze Laboratory.



THREE-ELEMENT HELIX ANTENNA



POGO III Research and Development Launcher

ROCKET RESEARCH AND DEVELOPMENT

R. G. Moore

For the past four and one-half years, the rocket section has carried on development of small rockets and parachute systems for the purpose of providing high-altitude radar and infrared targets for antiaircraft guided missile testing at military proving grounds. For the past two and one-half years, the rocket section has also been developing a recoverable instrument head for a high-altitude rocket in order to obtain photographs of hurricanes from above. Another project conducted during the past year involved development of high-speed movie camera packages for installation on the tail fins of antiaircraft guided missiles for the purpose of photographing the missile target and thereby determining how accurately the missile flies toward its target.

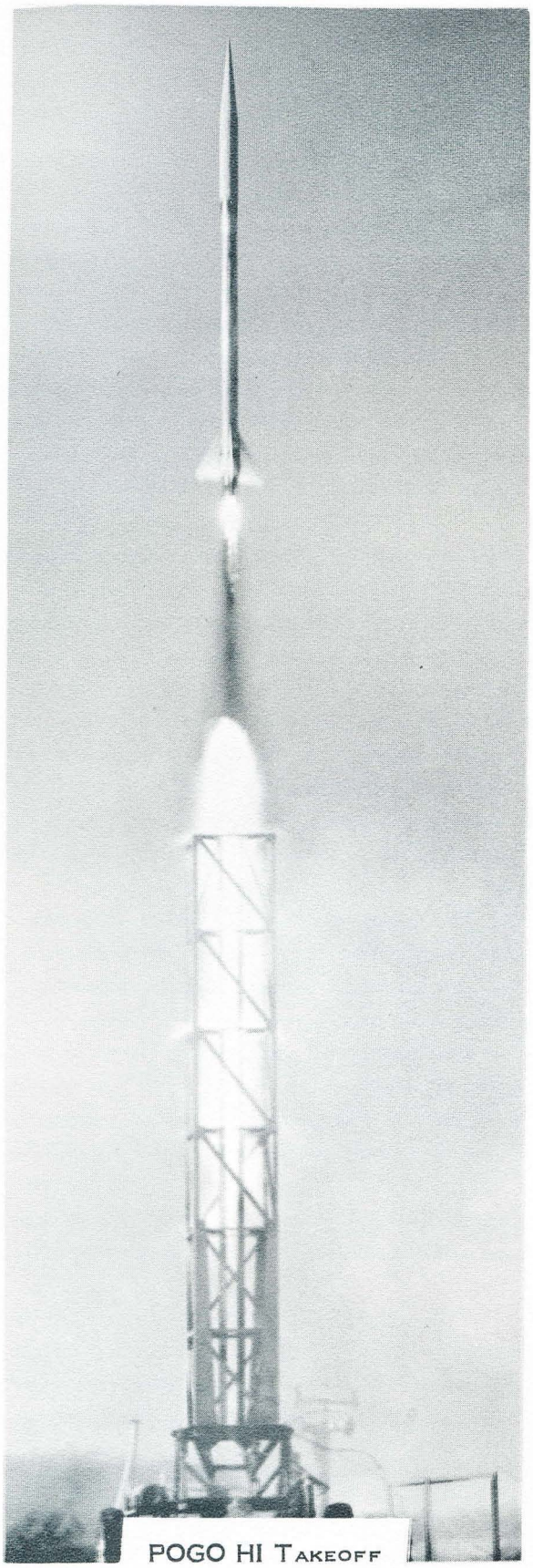
During the period of this report, the high-altitude radar and infrared target, POGO HI, underwent considerable revision and improvement. Several versions of this target now exist, and one of these has been placed in production for use at White Sands Missile Range, New Mexico; Naval Ordnance Test Station, China Lake, California; Holloman Air Development Center, New Mexico; Naval Air Missile Test Center, Point Mugu, California, and at sea. This version is being used as a target for Talos, Sidewinder, Sparrow, Nike-Ajax, and Nike-Hercules missile firings. The target consists of a twenty-four foot diameter parachute which is coated with a thin layer of metallic silver in a checkerboard pattern. The stabilizing weight for the parachute consists of a pair of infrared emitting flares. The silver coating on the parachute reflects electromagnetic energy and thereby acts as a simulated aircraft target for radar-guided missiles. The flares emit infrared energy simulating an aircraft target for heat-seeking missiles.

The target system is carried aloft by a solid propellant rocket. The parachute and attached flares are ejected at the peak of the rocket trajectory. This version of the POGO HI can be fired to peak altitudes in the range of ten to twenty miles. A portable launching system is used so that the targets can be placed where needed within the boundaries of a proving ground.

The cost of the POGO HI is a very small fraction of the cost of high performance drone aircraft and it is capable of reaching much higher altitudes than drones in about 60 seconds. This latter factor is very important when the cost per hour of operating a large proving ground is taken into account. The POGO HI is a useful target for a variety of guided missile evaluation firings wherein target speed is not a prime consideration.

The development phase of a larger version of the POGO HI was successfully concluded during this year and the target was placed into prototype production.

The parachute in this version is thirty-six feet in diameter. Four infrared flares are carried by the parachute.



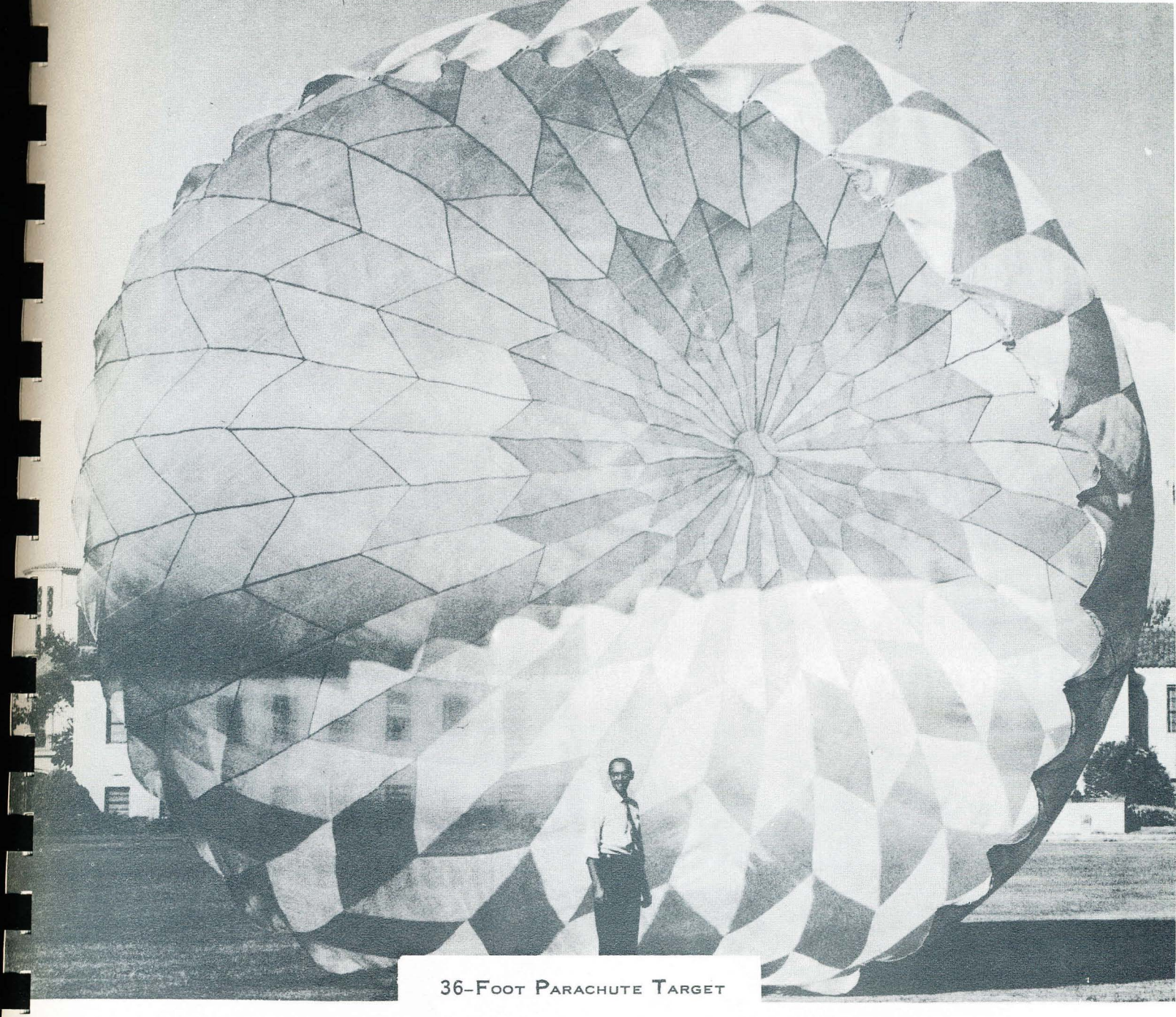
POGO HI Takeoff

The rocket vehicle for this target was enlarged in order to accommodate the larger parachute and flare package. This version was developed in order to simulate larger aircraft.

Still another version of the POGO HI target was employed at White Sands Missile Range during the past year. This version, known as POGO LO, is essentially the same target as the POGO HI, except that it is released from a jet aircraft. It has been found useful for routine missile component evaluation firings at relatively low altitudes.

Plans for the POGO target family during the next year include efforts to increase the versatility of the target by incorporation of a transponder into the system which will make the target appear to the attacking missile to move at high velocity, and by incorporation of a device which will automatically register the point of closest approach of the missile to the target. Other improvements contemplated involve a reduction in size of the rocket vehicle through use of improved solid propellant fuels and improved parachute fabrication techniques.

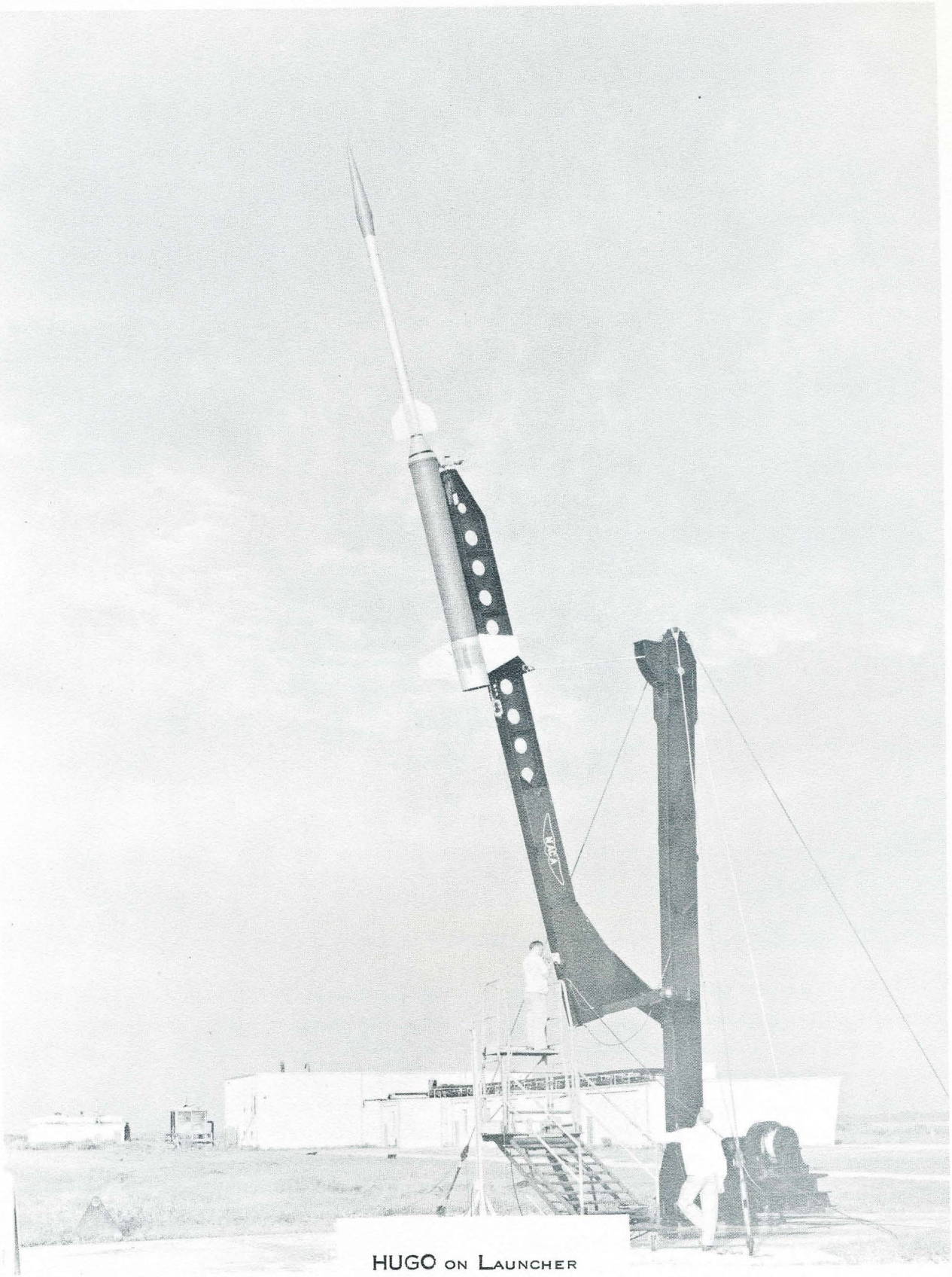
The second major program carried on by the rocket section during the past year was the Hugo photographic rocket. The program is sponsored by the Office of Naval Research on behalf of the U. S. Weather Bureau. The purpose of this program is to develop an instrument head for a two-stage high altitude sounding rocket. This head contains two movie cameras to photograph hurricanes and other weather phenomena from altitudes of about 75 miles above the earth. The head also contains a small heavy duty recovery parachute, a free-running radio transmitter, a radar beacon and a programming system to control inflight functions.



36-Foot Parachute Target

The instrument head is attached to a two-stage combination of solid propellant rockets called Nike-Cajun. The vehicle is launched from Wallops Island, Virginia, when large-scale weather disturbances, such as hurricanes, are within 500 miles of the island.

In an actual operation the first stage rocket motor is ignited and the rocket vehicle leaves the launcher. A radar transmitter-receiver located near the launcher tracks a radar beacon carried just behind the instrument head in the vehicle in order to determine the vehicle trajectory. The second stage then coasts upward for twelve seconds after first stage burnout until it is at 30,000 feet, then ignites and burns for three seconds. The burned-out second stage coasts upward to an altitude of 300,000 feet, at which point the programming system in the instrument head disengages the head from the empty



HUGO ON LAUNCHER

second stage motor and turns on the movie cameras. The instrument head coasts on up to a peak altitude of about 75 miles while the cameras continue to take pictures of the terrain and clouds below. As the head returns earthward the programmer blows the nose off, deploys a small recovery parachute and turns on a small locater transmitter. The body descends to the ocean at a speed of about 100 feet per second. Two ships and two airplanes carrying radio receivers and directional antennas attempt to pick up the radio signals and start toward the instrument head before it strikes the water. When the head hits the water, the parachute collapses, and the head, which is watertight and buoyant, floats. Sea dye marker is released into the water to aid recovery personnel in visually sighting the head, and the transmitter continues to radiate until the aircraft and ships have detected the homing signal and converged on the floating head. One of the ships then takes the head aboard and returns it to shore. The cameras are removed, and the film is developed.

Meteorologists study the obtained pictures and attempt to determine wind patterns in the storm by analysis of the structure of the clouds. This information is combined with radar pictures of the storm and with data gatered from instrumented aircraft and balloon flights into the hurricane in order to obtain a better understanding of the basic nature of hurricanes.

During this year, several single stage firings were conducted at White Sands Missile Range in order to test individual components of the Hugo system. The firings accomplished the desired objectives. In addition, test heads were parachuted from aircraft into the Salton Sea in California and into Caballo Lake in New Mexico to study the effects of water entry on system components. Again, successful operation was accomplished. Accordingly, instrument heads and Nike-Cajun rocket vehicles have been prepared for a demonstration firing and for attempts to photograph a hurricane during late summer and fall of 1958.

If this system is successfully demonstrated, it is planned to utilize it for the study of other large scale weather phenomena at other locations. Both inland and shipboard launchings are contemplated.

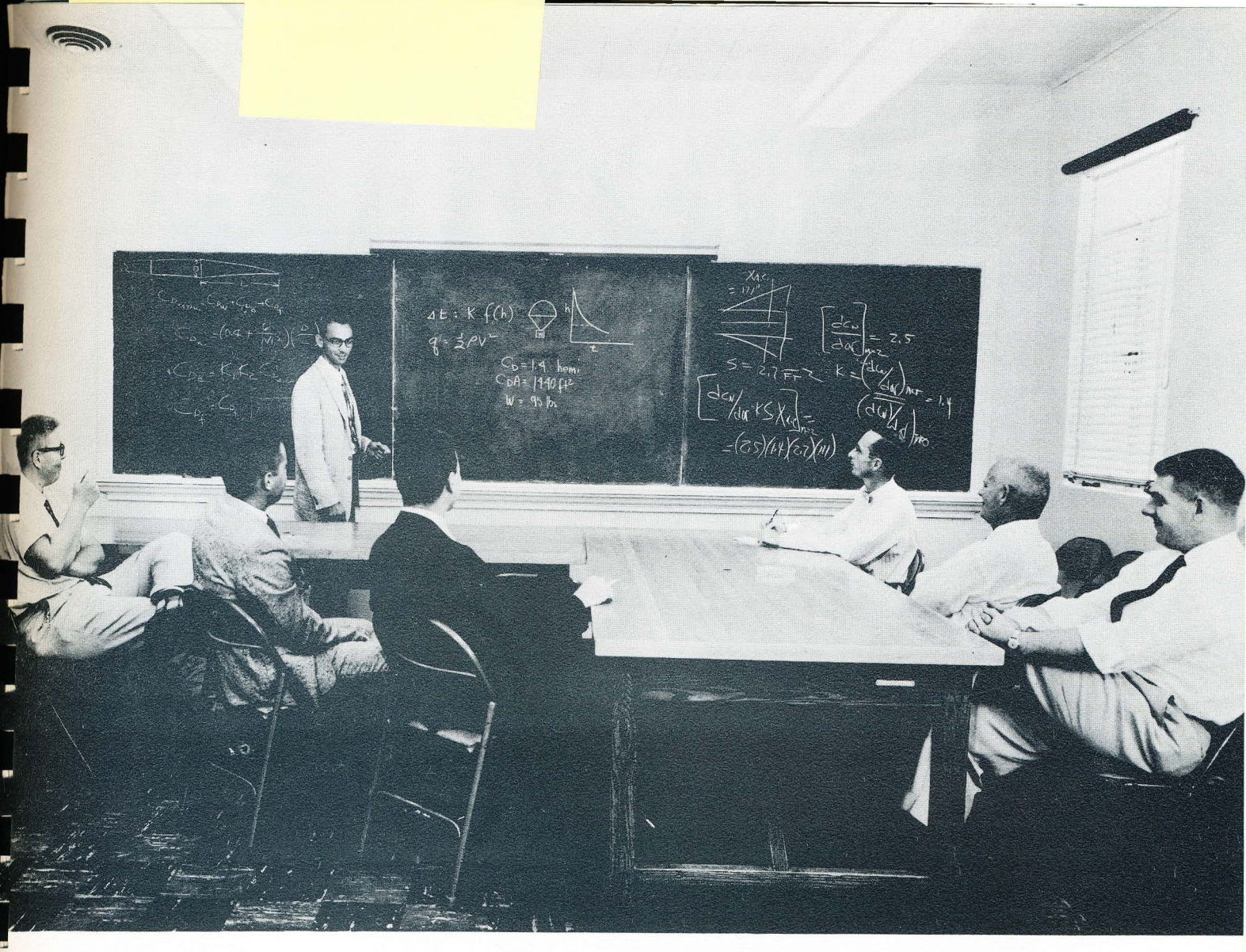
The third program conducted by the rocket section during the past year involved development of a high-speed movie camera package for installation on the tail fins of Talos missiles. This program was sponsored by the Bendix Aviation Corporation, Missile Products Division. The cameras look forward along the flight axis of the missile and photograph the target at which the missile is fired. Analysis of the films exposed during flight makes possible a determination of the accuracy of the missile guidance system shortly before and during missile-target intercept.

The camera package consists of a high-speed movie camera built into a streamlined housing which is bolted to the tip of the missile tail fin. Also contained in the housing are a power supply for the camera and a timing device to turn the camera on at the appropriate time. Since the camera itself is extremely rugged, no attempt has been made to disengage the package and parachute it to earth. It is merely allowed to impact while attached to the missile.

Mounting Talos Fin Camera

A pair of these cameras has been flown on one Talos missile and useful results were obtained. Several more flights are planned in the near future.

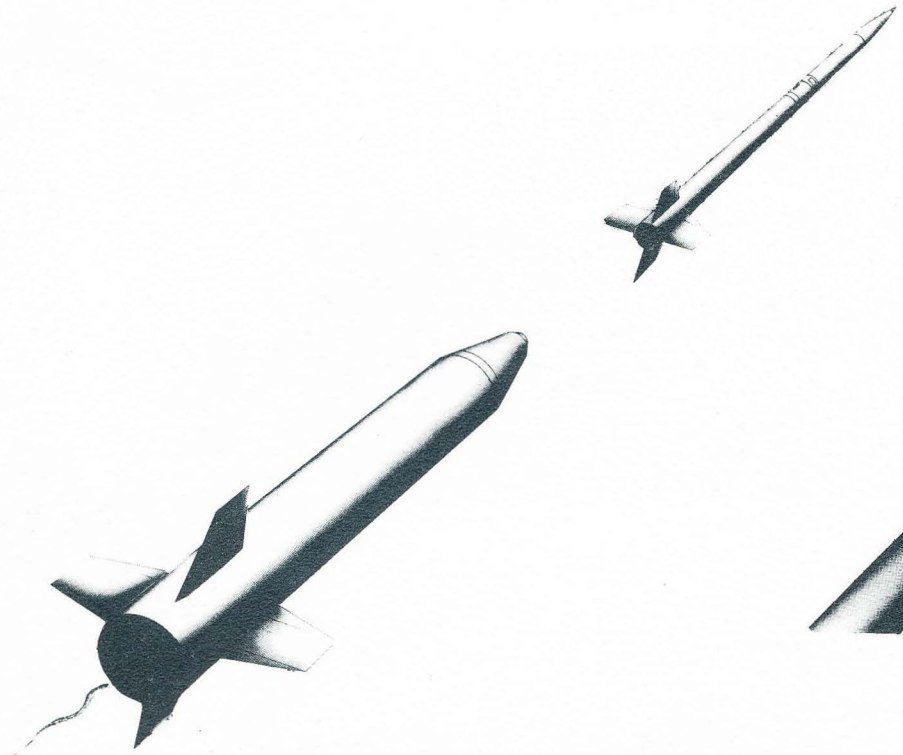
A program which was initiated at the close of this past year involves design of instrumentation and rocket airframes for general upper atmosphere research program sponsored by the Office of Naval Research. The rocket section is providing support for upper atmosphere experiments conceived by staff members of the Physical Science Laboratory and the physics department.



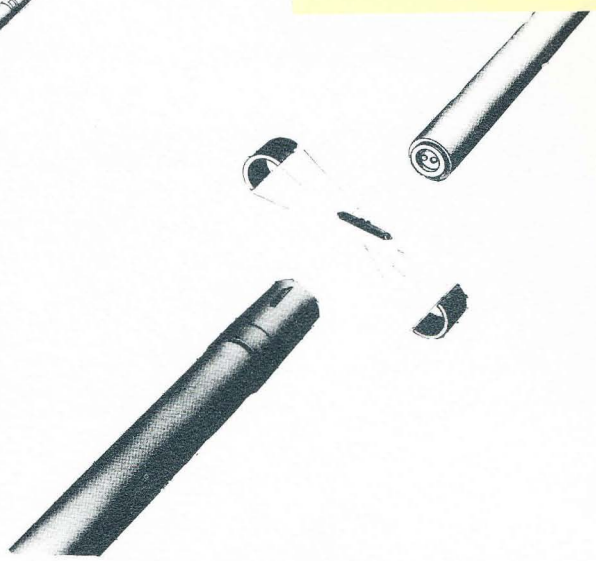
Rocket Design Conference

The first specific project undertaken in this program is the measurement of ozone concentration in the atmosphere at altitudes between 200,000 feet and surface. The initial project is being carried on in cooperation with Dr. Clarence Palmer of the Institute of Geophysics at the University of California, Los Angeles. It is planned to fire thirty small sounding rockets containing parachutes, ozone measuring instruments, and radio transmitting devices from three islands near the equator in the Pacific Ocean during the winter of 1959–1960. The parachutes and instruments will be ejected at the peak of the rocket trajectories and will descend slowly to earth, radioing ozone composition data to receivers located on the launching islands.

During the past year, the radio transmitting device for this project was designed and preliminary packaging design was undertaken. Integration of the measuring instruments into the rocket package will be accomplished in the fall of 1958, and test firings at White Sands Missile Range will be conducted in 1959.

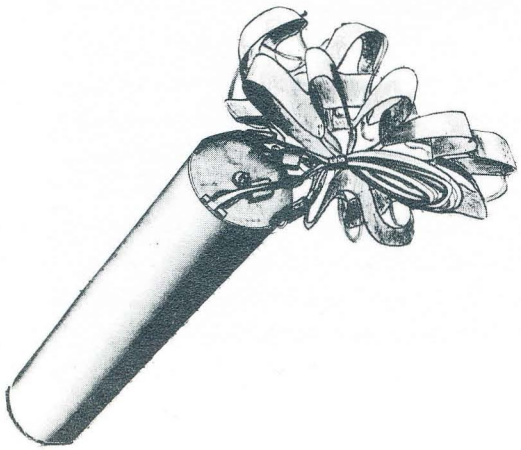


Booster Separation

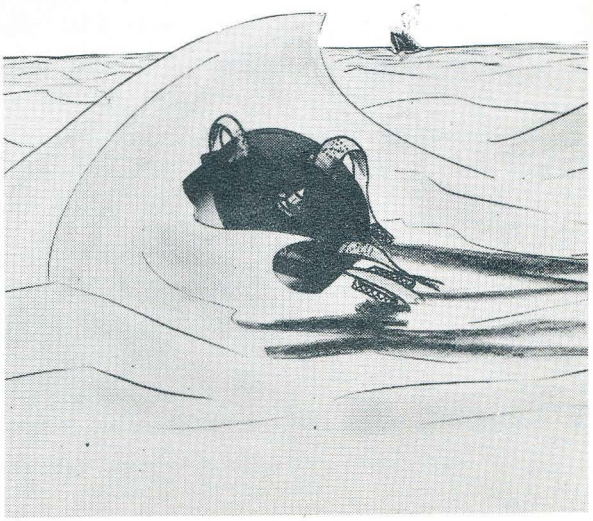


Instrument Head Release

HUGO FLIGHT SEQUENCE



Parachute Deployment

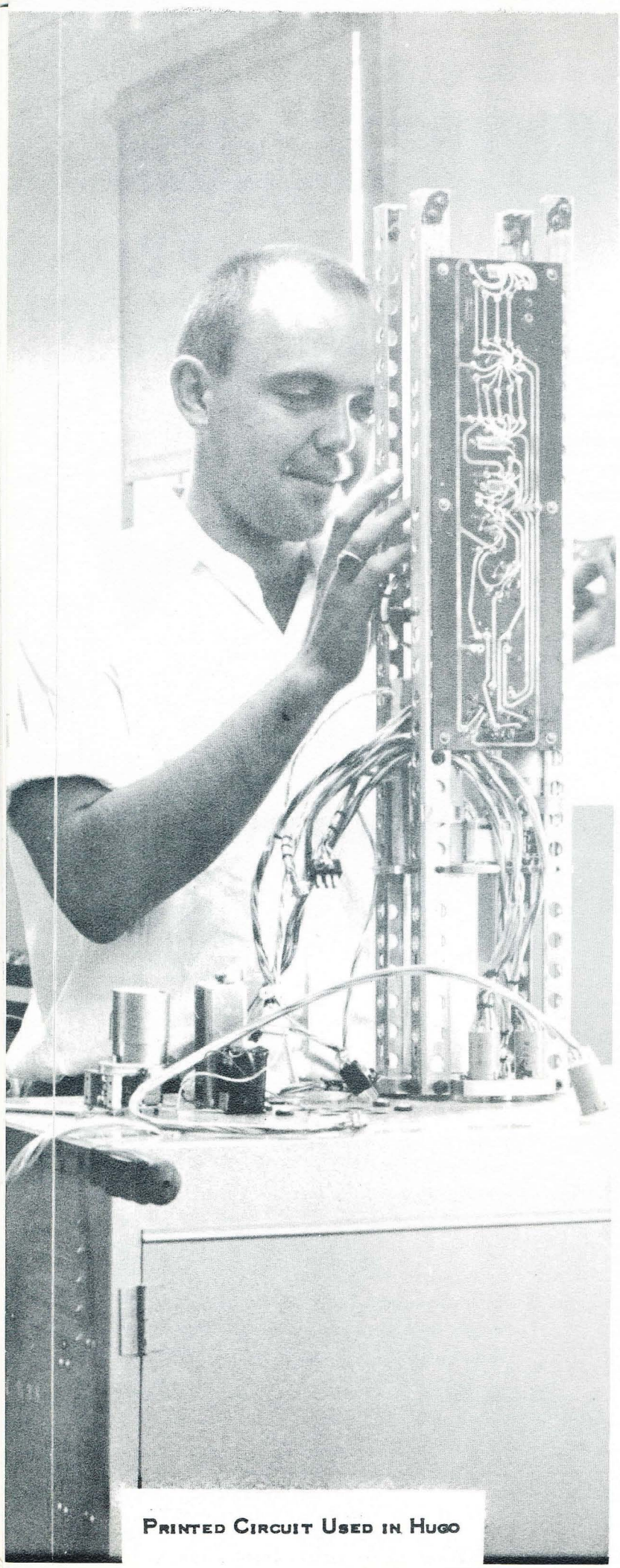


Recovery

LABORATORY SUPPORT

The varied activities of the laboratory necessitate many requirements for the support of these operations. Equipment and supplies must be handled and travel arrangements made. A program is needed to provide facility security as required by Department of Defense regulations. Reports of progress and procedures in laboratory work are written and must be printed for distribution. Photographs are often necessary and copies of graphs and figures are required in compiling these reports.

Some equipment must be constructed for special purposes requiring the existence of a machine shop. Similar problems but of an electronic nature require support. Also, especially where equipment is built to laboratory specifications by subcontractors, inspection in quality control is required. In order to transport personnel and equipment a fleet of passenger vehicles and trucks is maintained, serviced by the motor pool.



Printed Circuit Used in Hugo

ELEC...

K. F. Manz

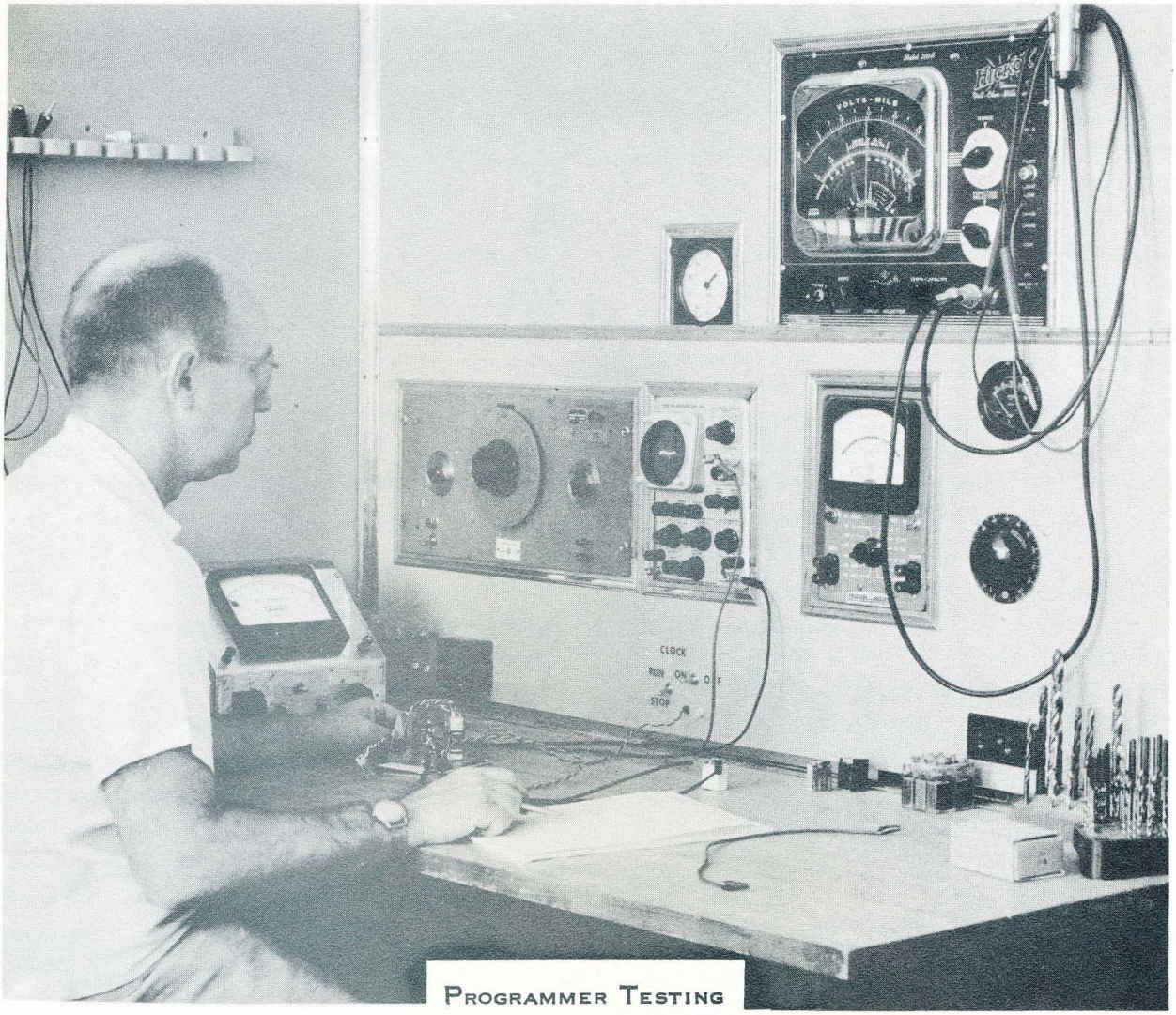
This section performs all electrical maintenance requested by laboratory sections. During the fiscal year 1957–58, a major portion of the work has been construction of electronic components for the rocket section.

A number of RC timers were built to provide the signal that separates the nose cone from the afterbody in the POGO HI target system.

In research and development rounds for Hughes Aircraft the instrumentation wiring for testing barometric switches and new timers was done so that information about the operation of these units could be telemetered to the ground on the signal from the beacon. In some tests, cameras were flown to obtain visual coverage of nose cone separation and parachute deployment. The wiring for the camera section of the missile was done in the shop.

In some POGO rocket operations a sequence of events; nose cone separation, parachute deployment, flare or crucible ignition must occur at the proper time. Electronic programmers have been constructed to perform this work. Many types of batteries, both dry and rechargeable, have been checked for use on the two types of programmers that are now in use and for a new type programmer utilizing the Haydon timer.

POGO LO targets are parachute targets dropped from planes. In order to recover the parachute a number of the shroud lines are released from the parachute when the target is no longer needed for the guided missile test.



PROGRAMMER TESTING

DURING THE PAST YEAR, THE SHOP HAS CONSTRUCTED 36 OF THE CIRCUITS REQUIRED TO PERFORM THIS FUNCTION AND HAS INTRODUCED SOME IMPROVEMENTS INTO THE ORIGINAL SYSTEM. SAFETY SWITCHES HAVE BEEN INTRODUCED TO PREVENT THE CIRCUIT FROM BEING ACTIVATED BEFORE THE SCHEDULED TIME. A HEATING ELEMENT SURROUNDS THE BATTERY PACK AND IS THERMOSTATICALLY CONTROLLED TO KEEP THE BATTERIES FROM BECOMING TOO COLD AT THE HIGH ALTITUDES WHERE THE ELEMENT AND BATTERIES MUST REMAIN.

THE MYTYMOUSE TRANSMITTER HAS BEEN DEVELOPED FOR USE IN RECOVERING PACKAGES DROPPED INTO THE SEA. THESE ARE USED IN THE HURRICANE PHOTOGRAPHY PROGRAM. VARIOUS TYPES OF CIRCUITRY WERE BREADBOARDED AND CHECKED FOR PROPER FUNCTIONING. CHECKOUT CIRCUITS AND BOXES FOR ALL ROUNDS WERE BUILT IN THE SHOP. PRINTED CIRCUITRY WAS USED IN SOME CASES. A MOBILE TYPE CONSOLE CHECKOUT BOX WAS BUILT FOR ONE OF THE ROUNDS. THE UNITS INCLUDE CHECKOUTS FOR ALL CIRCUITS, GROUND POWER FOR THE BEACON PACKAGE, AND MEANS OF ENERGIZING THE MYTYMOUSE TRANSMITTER PRIOR TO LAUNCHING.

SOME WORK HAS BEEN DONE IN THE SHOP FOR OTHER DEPARTMENTS ON THE COLLEGE CAMPUS. THIS INCLUDED COIL WINDING, AND ASSEMBLING OF SEVERAL TYPES OF CABLES.

MACHINE SHOP

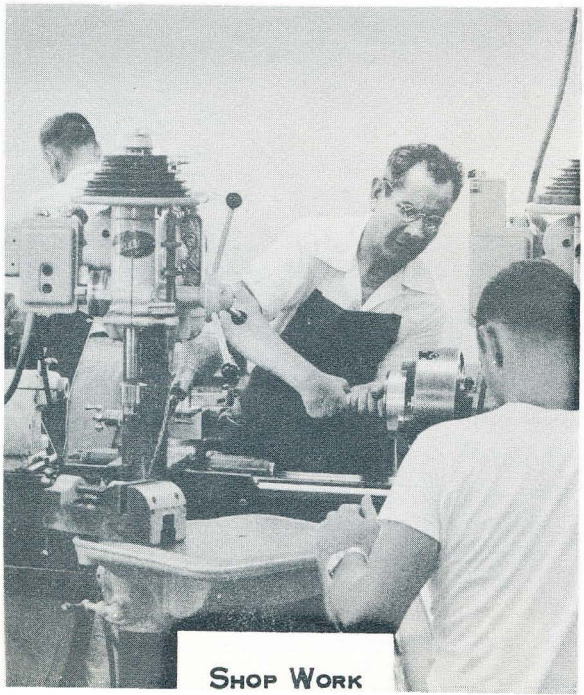
P. J. Manz

The machine shop is primarily engaged in the fabrication of parts and the maintenance and support of other laboratory sections. However, some production work has been done and many finished products of the shop are used at such places as China Lake, Point Mugu, and Wallops Island.

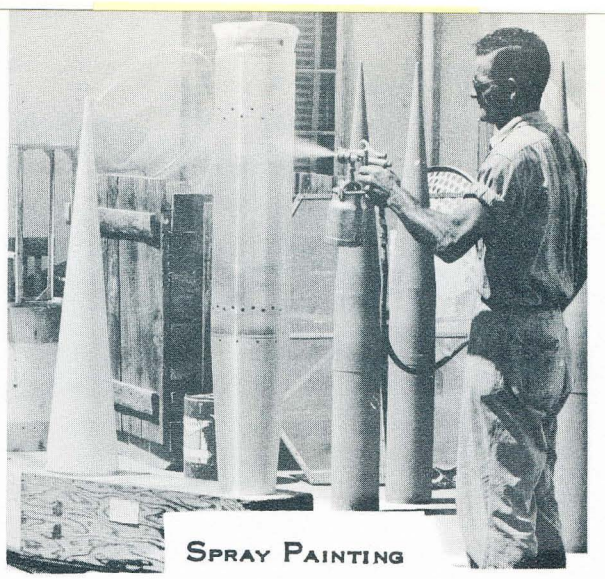
Telemetering and cutoff notch antennas for the Aerobee and Aerobee-Hi rockets, the prototypes of which were built by the shop about ten years ago, are currently being used in the International Geophysical Year programs.

Some early design work and complete fabrication of the POGO and HUGO type rockets have been major projects in the shop. The shop has also been instrumental in the production of some 100 POGO type missiles and over 200 programmers.

Requirements of high thermo-resistivity, erosion and corrosion characteristics have resulted in the extensive use of Inconel, stainless steel and monel and have required the acquisition of special tools.



Shop Work



Spray Painting

The machine shop has built thirteen Vanguard ground based telemetering antennas. These antennas are three-element helical arrays with screen wire at the base. Before leaving the laboratory, they are sprayed with a plastic protective coating to give high corrosion resistance against all climatic conditions. For the protection of many items, spray painting has become an important part of the shop activities. During the past year, the shop has been anodizing some items to protect them against corrosion. Red anodizing has been used on rocket programmers and green on aluminum parts of the SADAP card punch. Steel parts are protected by cadmium plating.

In order to meet the demands of deadlines and purchase orders associated with the expansion of the laboratory, a new vertical milling machine and new 14 1/2-inch Southbend toolroom lathe has been added. The present facilities of the shop include toolroom lathes, band saws, vertical and horizontal milling machines, hydraulic shapers, automatic surface grinders, drill presses and other precision machines. All tools and precision measuring instruments required for complete machine shop facilities are available and at the disposal of the seven staff machinists. Students are employed part-time for assistance and training.

QUALITY CONTROL

George Baker

The scope and task of quality control is to assure conformity to standards and the highest quality of workmanship in all phases of research and development, rocket production, and field operations. Quality controls are applicable to all missile components, motors, and instrumentation flown by the laboratory.

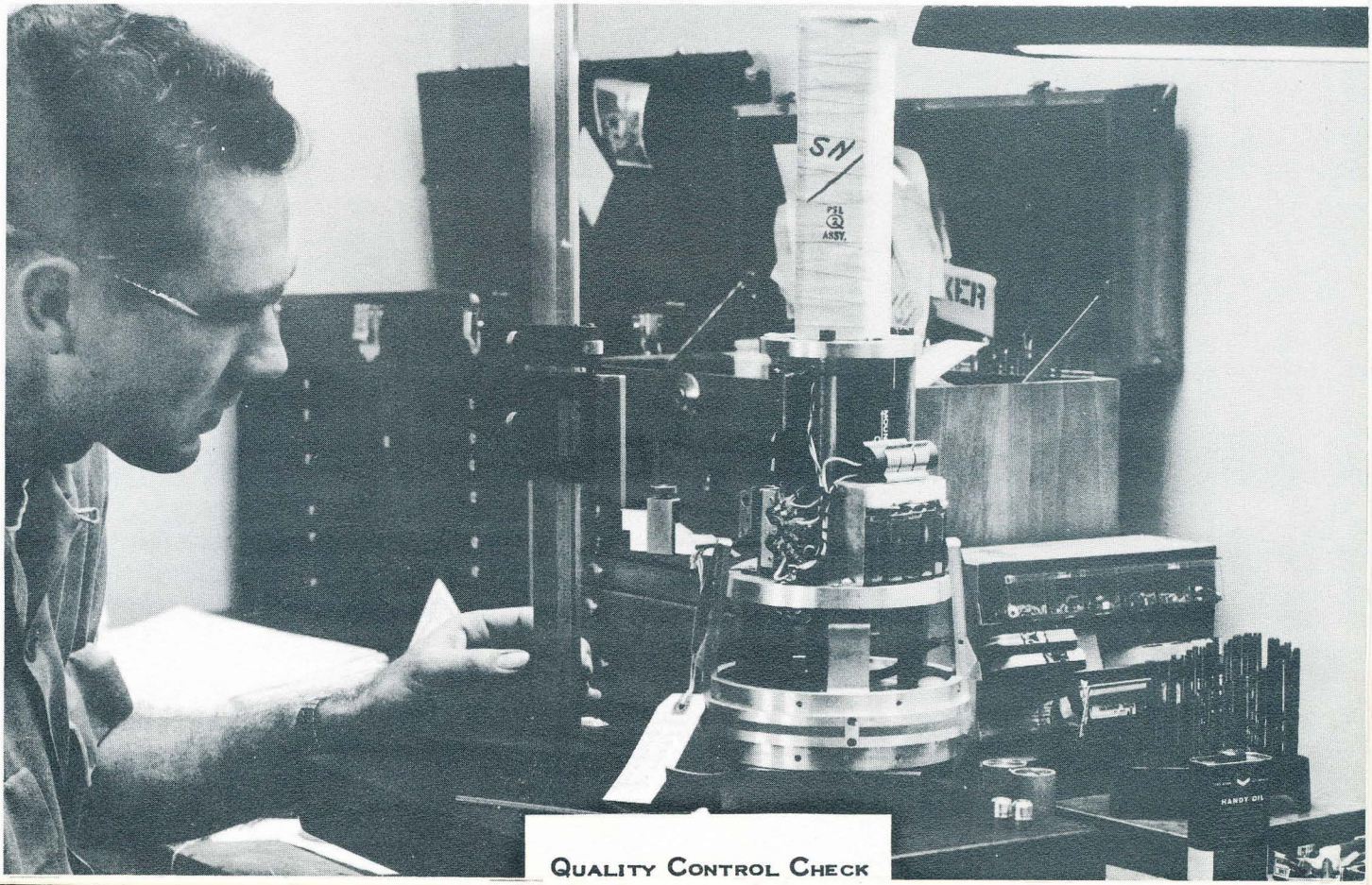
With the advent of production of the POGO HI and high altitude rockets, quality control has become very important. During the past year, the department has conducted eight source inspection trips at such facilities as China Lake, American Machine and Foundry Co., Buffalo, N.Y., and Elkton, Md., to inspect purchased products and to acquaint the sellers with problems of quality control which effect the operation.

During the past year, one-hundred and fifteen POGO missiles were checked for quality control. At China Lake, twenty-five repairs were needed as a result of inspections. Thirty Cajun motors were inspected at Elkton.

The results of this work have greatly decreased the possibility of defective materials and sub-standard products reaching consumers and facilities of the laboratory undetected before time of use, resulting in a savings of both time and money.

In addition to achieving the above savings, increased reliability and quality of workmanship have developed in laboratory shops.

Future operations in quality control will be to continue the inspection as needed, and to publish a quality standards manual which will be available to all departments and vendors as a guide.



Quality Control Check

POGO HI

SHOP WORK

REPORTS AND REPRODUCTION

E. E. Brittle

Although numerous data reports are prepared by the ballistics reduction section and the telemetry processing section, some data reports and all research and development reports are prepared by the reports office. These reports are edited, typed, and proofread by reports office personnel. The documents may vary in length from a few pages to fifty or more, and in addition to text material, contain tables, records, graphs, photographs, line drawings and charts.

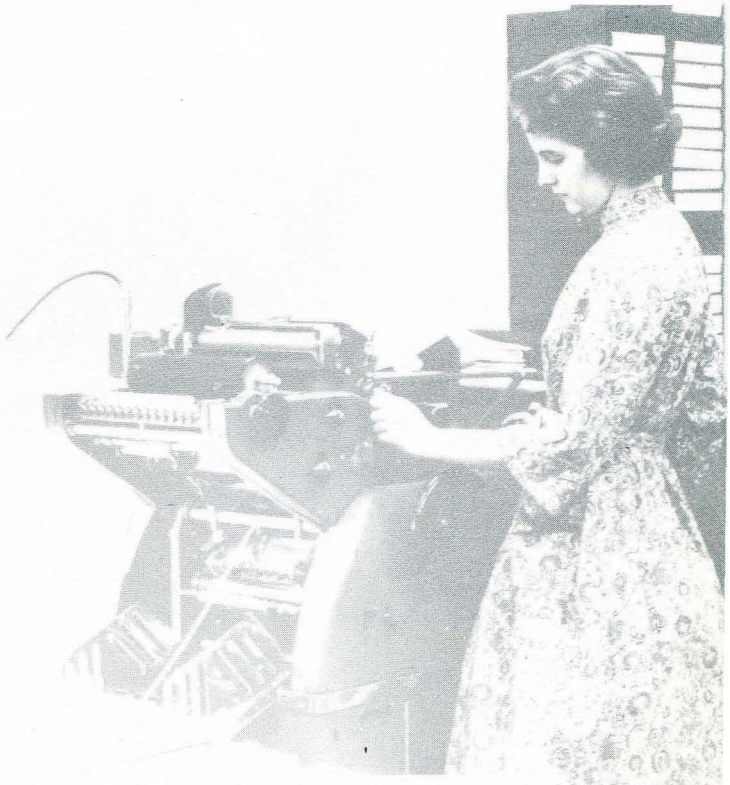
The personnel of this office review the latest report procedures, maintain reference material such as technical dictionaries, style manuals from technical publications, literature regarding current techniques of report writing, and make suggestions to authors in order to facilitate maximum efficiency in publishing reports. Limited rough draft typing is performed by the reports office as well as limited drafting insofar as time and equipment will permit.

In the reports library, files of documents originated by the Physical Science Laboratory are maintained. Documents that are received from other organizations through regular distribution are also filed in the library and a list of these reports is circulated to laboratory staff members. The documents then are available to the staff on request. During the past year, 225 technical reports originated by the Physical Science Laboratory were processed in this section.

Occasionally additional typing for other departments on the campus is done. This has included such things as Master's theses, engineering experimental station bulletins, institutional self-survey for the president's office, and work for the deans of engineering, students, graduate school, fraternities, sororities, the departments of biology, publicity, chemistry, physics and professional organizations.

The film processing department, although closely related to the reports work, supplies additional needs as well. This group is responsible for developing films of missile flight telemetry records in general and reproducing these film records by the Ozalid process.

After each missile flight one of three types of film, 5-inch, 9 1/2 inch, and 12-inch width by 200 feet length is developed according to the missile data desired. After the film is dried it is annotated by the Physical Science Laboratory's telemetry processing section.



Offset Reproduction

Darkroom Work

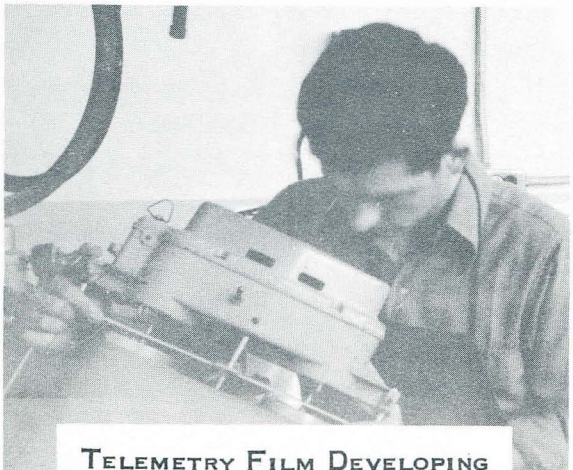
The film is then copied by the Ozalid process for use in hand reduction. The film is also used in missile data reports.

Also produced by Ozalid are line drawings, blueprint sketches and designs, and other data suited for this process. During the last fiscal year, an estimated 2 1/2 tons of Ozalid paper were processed and over $3,000.00 was needed to mail Ozalid records to agencies throughout the United States.

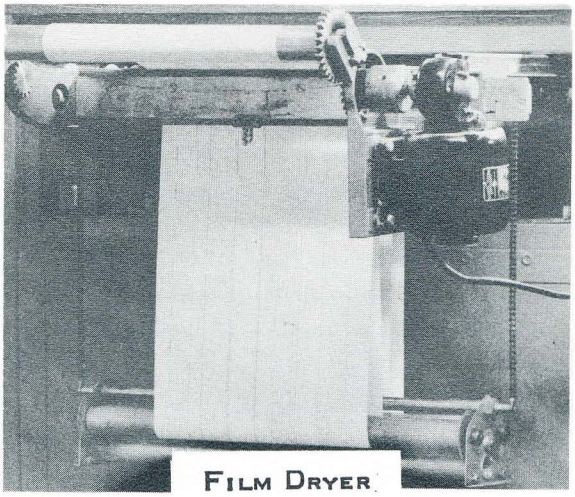
Motion pictures and still photographs of missiles in the field, missile components and electronic equipment constitute the main services performed by the photographic department. Complete darkroom facilities are available for processing and printing of black and white film. During recent months, work has been in progress on a 16 mm film in color which describes the Diamond Ordnance Fuze Laboratory operations at White Sands Missile Range.

At times technical motion pictures are used to record performance of missiles and missile components for evaluation by scientists.

Still photography is requested continuously by groups in the laboratory to record operations and to supplement text material in reports. There is available an active file of approximately 2,000 negatives for reference and reprints as well as an inactive file of nearly 4,000 negatives.



Telemetry Film Developing



Film Dryer

Much of the reproduction is done by the offset printing method. A copy camera is used to reproduce any line material including typed pages, graphs, charts, photographs, etc., and by the Xerography process, which utilizes a photographic - electrostatic powder method, Xerox paper masters are made. (However, all photographs must be processed on aluminum masters.) The advantage of using this technique is that large missile data reports can be prepared for offset printing with speed and economy. Each month an average of 1,200 Xerox masters are prepared to be included in technical reports.

Masters prepared by the various processes are delivered to the print shop for printing. Many of these are bound into reports and mailed. The two Multilith machines can each reproduce six thousand sheets per hour. Report preparation is assisted by the use of trimmers, a mechanical assembling device, a machine operated jogger to align edges of collected pages, and binding gear including stapler and plastic ring binders. This last year saw an average of 200,000 sheets of paper printed monthly from about 2,000 masters monthly. By the combined efforts of this section 2,309 individual reprints were prepared each month.

PURCHASING AND PROPERTY

ALLEN SAYLES

IT IS THE FUNCTION OF PURCHASING AND PROPERTY TO PROVIDE SUPPORT IN THE FOLLOWING AREAS: PROCUREMENT OF SUPPLIES AND EQUIPMENT, PROPERTY ACCOUNTING, TRAVEL ARRANGEMENT AND REIMBURSEMENT, AND OPERATION OF THE STOCKROOMS. IN CONNECTION WITH PURCHASING IT IS OFTEN NECESSARY TO OBTAIN PRICE INFORMATION AND CONTRACT APPROVAL. PREPARATION OF REQUISITIONS, RECEIPT RECORDS, AND PROCESSING OF PAYMENT VOUCHERS ARE ALSO FUNCTIONS OF THIS SECTION. DURING THE PAST YEAR, AN AVERAGE OF 261 PURCHASE TRANSACTIONS PER MONTH WERE PROCESSED REPRESENTING OVER $600,000 IN SUPPLIES, EQUIPMENT, AND SERVICES. SPECIAL SUPPORT IS PROVIDED FOR THE ROCKET SECTION WHICH PLACED OVER 900 ORDERS FOR SUPPLIES AND EQUIPMENT DURING THE FISCAL YEAR, REPRESENTING A MONETARY VALUE OF $500,000.

PROPERTY ACCOUNTING INCLUDES MAINTENANCE OF PROPERTY RECORD CARDS, VOUCHER FILES, AND PROCEDURES FOR THE CARE OF BOTH GOVERNMENT AND LABORATORY PROPERTY. AT PRESENT, THE LABORATORY HOLDS OVER 2,000 ITEMS OF GOVERNMENT PROPERTY VALUED AT NEARLY $800,000 AS WELL AS APPROXIMATELY $35,000 WORTH OF LABORATORY PROPERTY. SEPARATE RECORDS MUST BE MAINTAINED FOR EACH ONE OF APPROXIMATELY 40 CONTRACT ACCOUNTS.

THIS SECTION IS RESPONSIBLE FOR ARRANGING TRAVEL SCHEDULES, PROCURING RAIL OR AIR RESERVATIONS, PROCUREMENT OF HOTEL ACCOMMODATIONS, NOTIFICATIONS TO AGENCIES, SECURING CONTRACT APPROVAL, AND MAINTENANCE OF INDIVIDUAL TRAVEL RECORDS. IN ALL CASES IT IS ALSO NECESSARY TO PREPARE TRAVEL REQUISITIONS AS REQUIRED BY THE COLLEGE, AND TO PREPARE REIMBURSEMENT VOUCHERS FOR TRAVEL EXPENSES AND PER DIEM. IN THE LAST FISCAL YEAR MEMBERS OF THE LABORATORY MADE 200 TRIPS ON OFFICIAL BUSINESS.

IN ADDITION TO THE FUNCTIONS PREVIOUSLY DESCRIBED ALL REQUESTS FOR BUILDING REPAIR AND MAINTENANCE, ALL SHIPPING AND RECEIVING FUNCTIONS, ALL STORAGE AREAS AND MESSENGER SERVICE ARE COORDINATED THROUGH THIS SECTION.

MOTOR POOL

B. D. NAUL

IN ORDER TO PROVIDE TRANSPORTATION FOR PERSONNEL AND EQUIPMENT TO AND FROM WHITE SANDS MISSILE RANGE, TO THE VARIOUS OPERATIONAL LOCATIONS ON THE RANGE, TO AND FROM PATRICK AIR FORCE BASE, FLORIDA, AND TO THE OPERATIONAL LOCATIONS AT PATRICK AIR FORCE BASE, THE PHYSICAL SCIENCE LABORATORY OPERATED 26 VEHICLES CONSISTING OF SEDANS, PICKUPS, AND TRUCKS DURING THE PAST YEAR. THE LABORATORY GARAGE PERFORMS PREVENTIVE MAINTENANCE AND OTHER MAINTENANCE OF AN EMERGENCY NATURE ON THESE VEHICLES. DURING THE YEAR THESE VEHICLES TRAVELED A TOTAL OF 511,000 MILES. THE LABORATORY ALSO OPERATES AND MAINTAINS TEN SPECIAL PURPOSE VEHICLES FURNISHED BY THE GOVERNMENT.

(7) Proper storage by employees of the laboratory of classified documents. Periodic spot checks are made by the security administrator and guards during non-working hours. Containers are inspected to determine if each conforms with current regulations. The purchase of new security equipment is recommended when necessary.

All incoming registered mail is picked up daily at the U. S. Post Office by a designated representative at which time a receipt is signed. All mail is opened, date stamped, and logged in a master logbook and dispatched to interested persons.

A record is maintained of all borrowed reports and periodic checks are made to determine if the borrower has a need to retain the document. Semi-annual inventories of classified documents located in all sections of the laboratory are taken. All classified files are returned to originating organization by the security office. Documents are listed and returned to the originator or are destroyed, by burning, in the manner prescribed by the Department of Defense regulations.

One-thousand-one hundred and twenty-nine technical reports were received and processed by the security office during the fiscal year 1957-58.

Security Office

ADMINISTRATION

L. C. Hart

For the purpose of administration and operation, the laboratory is organizationally subdivided under the director into five main divisions: Data Reduction, Field Operations, Research and Development, Laboratory Support and Administration. In turn these divisions are broken into smaller groups each headed by a supervisor for handling specific problems.

The administration section consists of six staff members and three hourly employees, working in two main groupings, accounting and personnel records. It is the task of the administration section to handle personnel operations, prepare payrolls, and manage the accounting required to handle the 35 contracts with the laboratory. When new contracts are being prepared, this section assists in preparation of the budget estimate and with the negotiation of the final contract. Also, this section must complete all of the final fiscal report and accounting work required at the termination of the contract.

Last year the total payroll of the laboratory for its more than 380 employees totaled more than one and one-fourth million dollars. Of this nearly $900,000 was for staff and nearly $300,000 for the 277 students used in various phases of the work. In addition some $150,000 was paid to hourly employees, some of whom are wives of students.

In order to perform its various functions efficiently, particularly in preparation of payrolls and contract negotiations it is necessary for the administration section to work closely with the college business office, since these accounts are handled through funding procedures of the college. Because of this, a very high degree of cooperation is necessary, and does exist, between the laboratory and the various sections of the college business office.

STAFF

ABBOTT, ROBERT D. (1954)
Chief Technician

ADAMS, HARVEY G. (1958)
Assistant Mathematician
BS Mathematics, 1955
Southwest Texas State College

AKEN, VIRGINIA (1957)
Junior Analyst

AMMONS, ROBERT L. (1957)
Assistant Engineer
MS Mechanical Engineering, 1957
New Mexico College of
Agriculture and Mechanic Arts

ANDERSON, VICTOR P. (1956)
Technician II

ANDREWS, GLEN C. (1957)
Technician II
BS Mathematics, 1957
Texas Technological College

ARELLANO, THEODOLO F. (1955)
Technician I
BA Commerce, 1952
New Mexico Western College

ATMORE, RICHARD F. (1951)
Assistant Analyst
BS Agriculture, 1956
New Mexico College of
Agriculture and Mechanic Arts

BAILEY, DEVON W. (1956)
Technician I
BS Agriculture, 1955
New Mexico College of
Agriculture and Mechanic Arts

BAKER, GEORGE (1952)
Inspector
BA Business Administration, 1957
New Mexico College of
Agriculture and Mechanic Arts

BAKER, MARGARET M. (1955)
Assistant Reports Editor

BARNETT, DAVID O. (1957)
Junior Engineer
BS Electronics, 1957
American Television Institute

BARRON, RICHARD (1951)
Associate Physicist
MS Physics, 1950
Oklahoma State College

BEACH, WILLIAM D. (1956)
Technician II

BEAN, STEWART P. (1951)
Associate Engineer
BS Chemistry, 1950
New Mexico College of
Agriculture and Mechanic Arts

BOWERS, A. F., JR. (1953)
Assistant Engineer
BS Electrical Engineering, 1957
New Mexico College of
Agriculture and Mechanic Arts

BOYD, Glenda G. (1957)
Clerk-Typist

BRAZIL, ROBERT B. (1955)
Junior Analyst

BRIDWELL, BILLY D. (1957)
Technician I

BRININSTOOL, WALTER F. (1953)
Technician II

BRITTLE, EDWARD E. (1952)
Administrator
BS Journalism, 1952
Richmond Professional Institute

BUMGARNER, RAYMOND A. (1948)
Associate Engineer
BS Electrical Engineering, 1950
New Mexico College of
Agriculture and Mechanic Arts

BUNYEA, WALTER C. (1956)
Associate Engineer
BS Electrical Engineering, 1951
New Mexico College of
Agriculture and Mechanic Arts

BURRIS, ALBERT (1946)
Physicist
PHD Physics, 1944
Michigan State College

BUTLER, IDA N. (1957)
Secretary
BA Business Education, 1955
Henderson State Teachers College

CARBINE, IVAN L. (1947)
Engineer
MS Electrical Engineering, 1958
New Mexico College of
Agriculture and Mechanic Arts

CAUDILL, LOUIS B. (1957)
Technician II
BS Secondary Education, 1951
New Mexico College of
Agriculture and Mechanic Arts

CHAMBERS, JANET L. (1957)
Scientific Aide

CHAVEZ, RAY B. (1947)
Associate Analyst
BS Mechanical Engineering, 1950
New Mexico College of
Agriculture and Mechanic Arts

CLEVELAND, E. L. (1951)
Associate Physicist
PHD Physics, 1950
Pennsylvania State University

CLINE, DOROTHY M. (1958)
Clerk-Typist

COBURN, HORACE H. (1954)
Assistant Physicist
PHD Physics, 1955
University of Pennsylvania

COLE, JAMES W. (1956)
Technician I

COMBS, CHARLES M. (1951)
Associate Engineer
BS Chemistry, 1951
Texas Western College

COMTE, DONN J. (1957)
Draftsman

CONKLING, RANDALL (1958)
Associate Mathematician
PHD Mathematics, 1952
University of Florida

CONNELL, HAROLD L. (1952)
Assistant Engineer
BS Electrical Engineering 1952
New Mexico College of
Agriculture and Mechanic Arts

CONRAD, GEORGE R. (1957)
Assistant Engineer
BA Aeronautical Engineering, 1953
University of Detroit

COOPER, JERRY B. (1952)
Technician II

CORRELL, RAYMOND L. (1957)
Junior Analyst
BS Education, 1955
New Mexico College of
Agriculture and Mechanic Arts

CREIGHTON, OMA L. (1957)
Clerk-Typist

CROSS, JOHN L. (1953)
Chief Technician

CUSTER, RICHARD J. (1957)
Junior Engineer
BS Mechanical Engineering, 1957
New Mexico College of
Agriculture and Mechanic Arts

DANELIAK, EDWARD T. (1954)
Assistant Engineer
BS Television Engineering, 1953
American Television Institute

DAVIS, JAMES H. (1954)
Technician I

DAVIS, RAYMOND L. (1956)
Technician III

DAVIS, ROBERT J. (1957)
Junior Engineer
BS Electronics, 1957
American Television Institute

DAVIS, THOMAS G. (1956)
Technician II
BS Agriculture, 1954
New Mexico College of
Agriculture and Mechanic Arts

DAW, HAROLD A. (1954)
Associate Physicist
PHD Physics, 1954
University of Utah

DODD, JOANNA (1956)
Technical Aide

DRESSEL, RALPH W. (1950)
Chief Physicist
PHD Physics, 1950
University of Illinois

DUNCAN, RICHARD H. (1954)
Physicist
PHD Physics, 1954
University of Missouri

EBY, MAURICE J. (1952)
Chief Photo Technician

ECKLUND, ROBERT E. (1954)
Assistant Engineer
BS Television Engineering, 1953
American Television Institute

EGERMEIER, ROBERT P. (1955)
Assistant Engineer
MS Mechanical Engineering, 1957
New Mexico College of
Agriculture and Mechanic Arts

ENGLE, EDWIN E. (1955)
Technician II

ESTRADA, MATEO J. (1956)
Technician II
BA Business Administration, 1955
New Mexico College of
Agriculture and Mechanic Arts

FAIRCHILD, HANFORD H. (1947)
Chief Electronics Technician

FIELDS, HAROLD L. (1953)
Assistant Physicist
BS Physics, 1953
New Mexico College of
Agriculture and Mechanic Arts

FOLTZ, VIRGINIA E. (1954)
Scientific Aide

FORSYTH, JOSEPH H. (1956)
Associate Producer
MA English, 1949
Columbia University

FRAZER, CAROLYN I. (1956)
Assistant Reports Editor

GARDENHIRE, CHARLES L. (1957)
Junior Mathematician
BS Mathematics, 1957
West Texas State College

GARDINER, ANNA H. (1946)
Mathematician
MA Mathematics, 1925
Yale University

GARDINER, GEORGE W. (1934)
Director
PHD Physics, 1929
Yale University

GARDNER, HUGH R. (1953)
Assistant Engineer
BS Electrical Engineering, 1953
New Mexico College of
Agriculture and Mechanic Arts

GARING, GERALD E. (1953)
Assistant Physicist
BS Physics, 1953
New Mexico College of
Agriculture and Mechanic Arts

GOOD, EMILY W. (1957)
Assistant Physicist
MS Physics, 1949
University of North Carolina

GONZALES, RAYMOND (1954)
Assistant Engineer
BS Electronics, 1953
American Television Institute

GREENWALD, CHARLENE F. (1957)
Clerk-Typist

GRIFFIN, LLOYD C. (1957)
Assistant Engineer
BS Electronics, 1953
American Television Institute

HAAS, HERBERT W. (1951)
Associate Engineer
BS Electrical Engineering, 1950
New Mexico College of
Agriculture and Mechanic Arts

HAAS, WALTER H. (1954)
Assistant Mathematician
MA Mathematics, 1941
Ohio State University

HACKLER, GEORGE R. (1954)
Assistant Physicist
BS Physics, 1954
New Mexico College of
Agriculture and Mechanic Arts

HALL, DAVID C. (1957)
Junior Physicist
BS Physics, 1957
West Texas State College

HANNUM, NORRIS H., JR. (1954)
Assistant Engineer
BS Biology, 1954
New Mexico College of
Agriculture and Mechanic Arts

HART, LEON C. (1955)
Administrator
BA Business Education, 1956
New Mexico College of
Agriculture and Mechanic Arts

HATTENDORF, ELIZABETH (1954)
Junior Analyst

HENNIGH, KEITH E. (1951)
Associate Mathematician
BS Mathematics, 1951
Eastern New Mexico University

HILAND, CATHERINE J. (1957)
Junior Mathematician
BS Mathematics, 1954
Spelman College

HOFFMAN, HENRY E. (1957)
Junior Engineer
BS Electrical Engineering, 1957
American Television Institute

HOWELL, JACK S. (1956)
Junior Engineer
BS Electrical Engineering, 1957
New Mexico College of
Agriculture and Mechanic Arts

HOY, ASA T. (1956)
Technician II

HUGHES, ROBERT E. (1956)
Technician II

HUGUNIN, HAZEL M. (1951)
Secretary

HUSTON, ELEANOR L. (1957)
Clerk-Typist

INGRAHAM, RICHARD (1958)
Associate Mathematician
PHD Physics, 1952
Harvard University

ISAACKS, BILLIE W. (1957)
Administrative Aide

JELLISON, CORINE C. (1956)
Chief Draftsman

JIMENEZ, ERNEST (1953)
Chief Technician
MA Languages, 1952
New Mexico College of
Agriculture and Mechanic Arts

JOOSTEN, WESLEY L., (1954)
Assistant Engineer
MS Electrical Engineering, 1950
Texas Technological College

KALLENBACH, RICHARD L. (1956)
Technician II

KEARNS, MARY E. (1951)
Reports Editor

KLEINE, HOWARD J. (1956)
Assistant Administrator
BS Business Administration, 1956
New Mexico College of
Agriculture and Mechanic Arts

LA FLEUR, WALTER (1956)
Assistant Physicist
BS Physics, 1955
New Mexico College of
Agriculture and Mechanic Arts

LANKFORD, SHIRLEY (1954)
Administrative Aide
BS Business Administration, 1956
New Mexico College of
Agriculture and Mechanic Arts

LEDBETTER, GRACE D. (1958)
Administrative Aide

LEDBETTER, JOHN B. (1957)
Photo Technician
BA English and Journalism, 1953
New Mexico College of
Agriculture and Mechanic Arts

LEE, EUGENE D. (1955)
Assistant Engineer
BS Electrical Engineering, 1955
New Mexico College of
Agriculture and Mechanic Arts

LEMON, FRED J., JR. (1957)
Junior Engineer
BS Electrical Engineering, 1957
New Mexico College of
Agriculture and Mechanic Arts

LOVE, ELTON W. (1957)
Assistant Administrator

LUCERO, DOLORES S. (1953)
Assistant Mathematician
BS Mathematics, 1956
New Mexico College of
Agriculture and Mechanic Arts

MC CLERNON, FRANCES (1957)
Secretary
BA English, 1932
New Mexico College of
Agriculture and Mechanic Arts

MC DANIEL, ROBERT E. (1956)
Assistant Physicist
MS Physics, 1952
University of Kentucky

MC DOWELL, EDWARD (1953)
Associate Engineer
BS Electrical Engineering, 1953
New Mexico College of
Agriculture and Mechanic Arts

MALLAR, WILLIAM (1948)
Chief Technician

MANZ, KARL F. (1957)
Chief Technician

MANZ, PHILIP J. (1948)
Chief Machinist

MARRUJO, CARMEN A. (1954)
Technician II

MARRUFO, RAMON D. (1951)
Chief Machinist

MASTERSON, JAMES E., JR. (1950)
Associate Engineer
MS Electrical Engineering, 1950
Texas Technological College

MARQUEZ, MELCOR G. (1951)
Associate Engineer
BS Electrical Engineering, 1951
New Mexico College of
Agriculture and Mechanic Arts

MATLOCK, JOE M. (1956)
Technician II

MAURE, JOHN J. (1956)
Technician I

MAYFIELD, ROGER E., JR. (1956)
Technician II

METZER, MARTIN M. (1957)
Junior Engineer
BS Electrical Engineering
American Television Institute

MILLER, LEON F. (1954)
Assistant Chemist
BS Zoology, 1954
New Mexico College of
Agriculture and Mechanic Arts

MILLER, MADELEINE M. (1956)
Bookkeeper
MA Education, 1952
New Mexico College of
Agriculture and Mechanic Arts

MONJAR, VERNON (1954)
Assistant Engineer
BS Television Engineering, 1953
American Television Institute

MOORE, R. GILBERT (1949)
Engineer
BS Chemical Engineering, 1949
New Mexico College of
Agriculture and Mechanic Arts

MOSELEY, NORMAN B. (1957)
Junior Administrator
BA Business Administration, 1956
New Mexico Western College

MOZER, CHARLES F. (1955)
Assistant Physicist
BS Physics, 1956
New Mexico College of
Agriculture and Mechanic Arts

MURRELL, ARTHUR S. (1955)
Technician I

NAUL, BILL D. (1956)
Mechanic
BS Agriculture, 1954
New Mexico College of
Agriculture and Mechanic Arts

NODA, TOM T. (1954)
Assistant Engineer
BS Electronics, 1953
American Television Institute

ORONA, JOSE V. (1956)
Junior Engineer
BS Electrical Engineering, 1956
New Mexico College of
Agriculture and Mechanic Arts

OTERO, JOE L., JR. (1953)
Technician I

PACE, ORVILLE E. (1956)
Technician II

PAUL, DAVID N. (1952)
Chief Technician

PETERSON, DONALD G. (1957)
Junior Engineer
BS Electronics, 1957
American Television Institute

PETERSON, RICHARD C. (1955)
Technician I

PITTMAN, BETTY J. (1956)
Secretary

PIZANA, TONY J. (1952)
Technician I

POPE, WILLARD W. (1956)
Draftsman

POST, BARBARA J. (1951)
Draftsman

POST, CECIL C. (1956)
Assistant Physicist
BS Physics, 1956
New Mexico College of
Agriculture and Mechanic Arts

QUESENBERRY, JOSEPH (1957)
Junior Analyst
MRE Religious Education
Southwestern Baptist Seminary

RATLIFF, ROGER B. (1954)
Assistant Physicist
BS Physics, 1954
New Mexico College of
Agriculture and Mechanic Arts

RICKETTS, C. IRA (1947)
Chief Engineer
BS Electrical Engineering, 1942
University of Minnesota

RITCHEY, LOGAN A. (1955)
Chief Technician

RIVERA, JOE L. (1952)
Technician II

ROBINSON, JIMMIE C. (1955)
Assistant Astronomer
BS Astronomy, 1953
University of Arizona

RUSSELL, RODGER W. (1951)
Photo Processing Supervisor
BA Psychology, 1955
New Mexico College of
Agriculture and Mechanic Arts

SABIN, ROBERT J. (1952)
Associate Engineer
BS Electrical Engineering, 1946
Rice Institute

SAYLES, ALLEN, JR. (1953)
Administrator
BS Agriculture Economics, 1940
New Mexico College of
Agriculture and Mechanic Arts

SCHNELL, DANNY L. (1957)
Technician II

SHERBURNE, RUSSELL K. (1952)
Chief Physicist
PHD Physics, 1950
Brown University

SIDMAN, Patricia (1955)
Administrative Aide

SIMS, JAMES R. (1952)
Junior Analyst

SMITH, BRADFORD (1957)
Assistant Astronomer
BS Chemical Engineering, 1954
Northeastern University

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BS Electrical Engineering, 1956
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Iowa State College

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