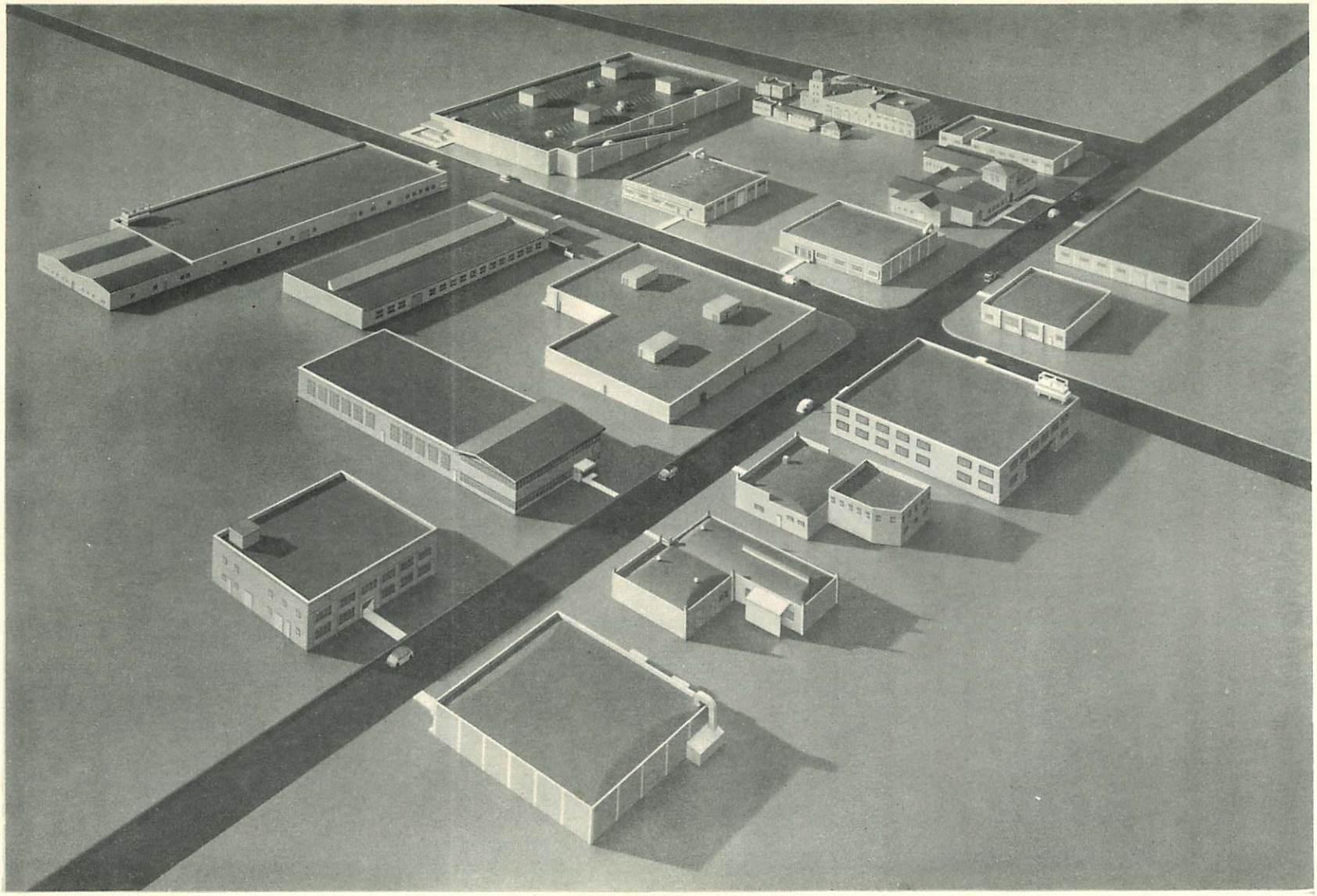


LIBRASCOPE FACILITIES

CONTENTS

1.0 INTRODUCTION

From a modest beginning in 1937, Librascope has advanced rapidly into the complex fields of system engineering, computers for military and commercial applications, and other sophisticated electronic devices. A unique facility for utilizing and combining mechanical, electrical, magnetic, electronic, and optical techniques has established Librascope as a major competitor in the design and production of a wide range of computers, computer components, military weapon systems, navigation devices, and industrial control and data-processing systems.

The stability of the company stems from its balance of commercial and military contracts and the steady expansion program that has kept pace with the demands of ever-increasing obligations. The success of this program of carefully planned growth is exemplified by the acceptance of Librascope's products by both the military services and industry. As an example of this diversification, Librascope is today a prime supplier of antisubmarine fire control equipment for the Navy and is, in addition, the designer and producer of one of the most popular general-purpose computers in industrial use. On the basis of its record of achievement, Librascope is prepared to accept new obligations and to assure equal success.

1.1 HISTORY OF LIBRASCOPE

Librascope's history began when a balance computer was invented, built, and successfully marketed in the spring of 1937 by Librascope's founder, Lewis W. Imm. This linkage-type weight and balance computer, called a "Librascope," was used in aircraft loading operations. The success of the "Librascope" was followed closely by the development of a power computer and a flight computer for the growing aircraft industry.

In 1939 the company received a corporate charter as Librascope, Incorporated. In early 1940 an assignment from the U.S. Navy for a small ballistic computer brought Librascope into the field of fire control where it has become widely recognized.

In 1941, Librascope, Incorporated, broadened its resources by becoming a subsidiary of General Precision Equipment Corporation.

National military needs absorbed the entire Librascope output during World War II. Antiaircraft Barrage Computer Mk 7, perfected and mass-produced by Librascope, was perhaps the company's most notable contribution to the war effort. During this same period, Librascope developed prototype antisubmarine attack directors, predecessors of Attack Directors Mk 4 and Mk 5. In 1943, the company received the Army-Navy E to which four stars were added by the war's end.

In 1948, the Brandon Scientific Development Corporation of New York joined Librascope. The personnel and equipment thus absorbed strengthened Librascope's ability to design and develop optical and computing devices.

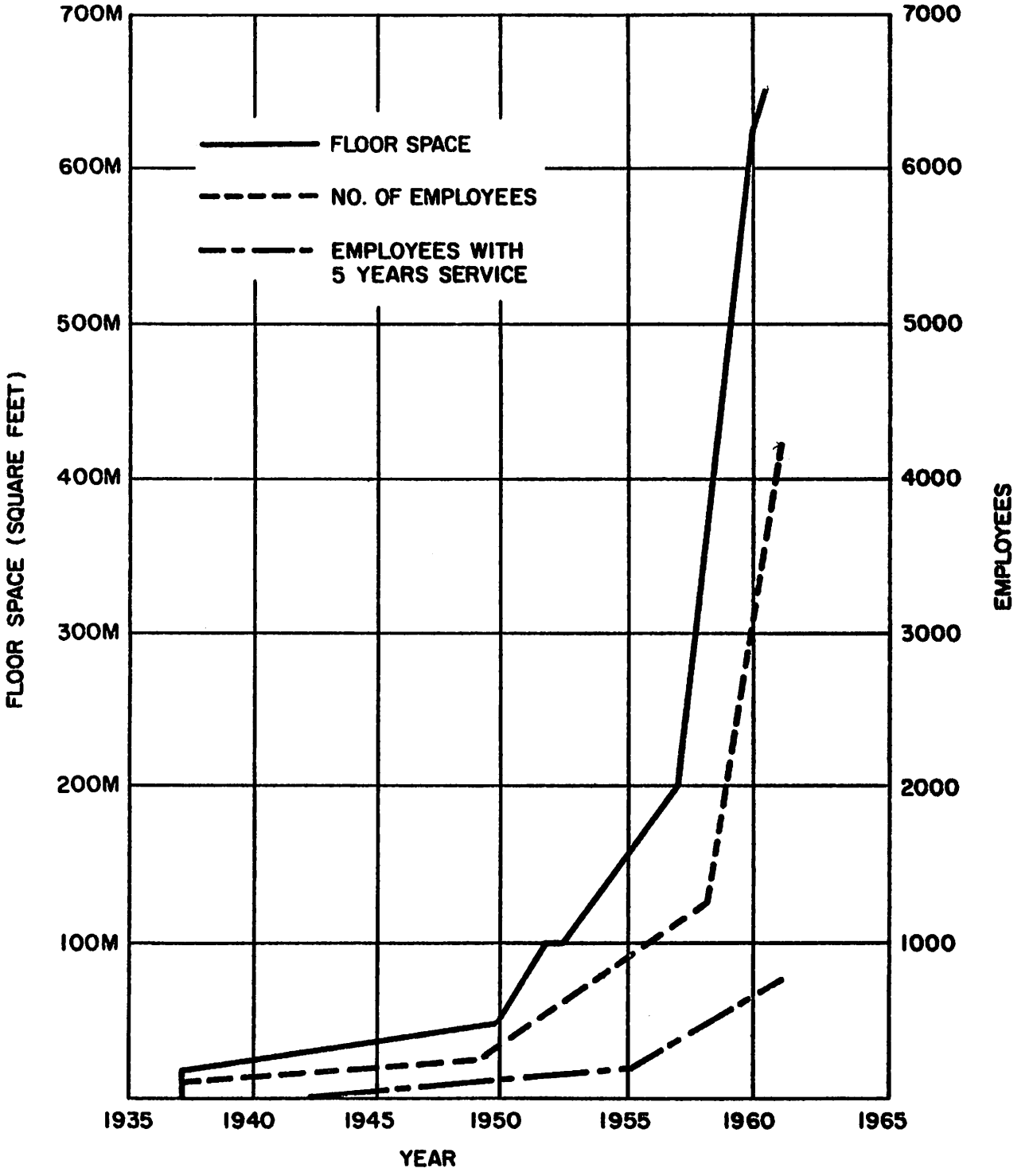
In 1954, the Minnesota Electronics Corporation of St. Paul, specialists in magnetic decision elements for digital computers, became an important part of Librascope's Commercial Division.

Precision Technology Incorporated, another subsidiary of General Precision Equipment Corporation, was absorbed by Librascope, Inc., in 1957. It had been formed a few years earlier to design and develop specialized test instrumentation and equipment for the Atomic Energy Commission's nuclear weapons laboratory. It became first a department of Librascope's Engineering Division and is now the Sunnyvale Branch of Librascope Division, specializing in missile ordnance, optical instruments, ground based data processing systems, and special devices.

Librascope's activities in fire control systems development and production have continued during the post-war period, but the company has devoted increasing attention to products for commercial and industrial applications. Currently, Librascope's expanding line of computing and automatic control equipment includes general-purpose digital computers, small-scale and large-scale digital data processors, digital and analog computers for fire control and navigation, totalizing flow computers, analog-digital shaft encoders, plus scores of other precision instruments and components.

In January of 1960, Librascope became one of the four divisions of General Precision, Incorporated; a newly formed subsidiary of General Precision Equipment Corporation. General Precision, Incorporated consists of four divisions specializing in highly advanced technological products for military and industrial use. The coordinated operating policy of GPI permits a high degree of specialization in the particular areas of competence of each division, supplemented as required by the facilities and specialized techniques of the other GPI divisions. In short, GPI's policy of coordinated precision technology permits the engineers and technical personnel of each GPI division to seek the best solution for the customer by the application of all relevant techniques within the total capacity of the whole GPI group.

Today Librascope employs over 4100 people, and the company's facilities have been increased to approximately 650,000 square feet of working area.



Personnel and Floor Space Vs Time

Principal GPE Producing Companies

General Precision, Inc.

Librascope Division, Glendale, California

GPL Division, Pleasantville, New York

Kearfott Division, Little Falls, New Jersey

Link Division, Binghamton, New York

GPE Controls, Inc. (Formerly Askania Regulator Co.)
240 East Ontario Street, Chicago, Illinois

Graflex, Inc.
Box 1371, Main Post Office, Rochester 3, New York

The Hertner Electric Co.
12690 Elmwood Avenue, N.W., Cleveland, Ohio

Pleasantville Instrument Corp.
250-270 Marble Avenue, Pleasantville, New York

Shand and Jurs Co.
2600 Eighth Street, Berkeley 10, California

The Strong Electric Corp.
87 City Park Avenue, Toledo 1, Ohio

General Precision Systems, Ltd.
Bicester Road, Aylesbury, Bucks, England

Principal Sales and Service Companies

National Theatre Supply Co.
92 Gold Street, New York 38, N.Y.

1.2 PERSONNEL INFORMATION (LABOR FORCE)

The Librascope employee is above industry average in the training received, loyalty, and knowledge of the team concept required to produce highly reliable, precision equipment. Our programs for employee motivation, training, and self-improvement have not only raised the quality of work but have also resulted in a remarkably efficient, stable labor force.

The employee turnover rate, including voluntary and involuntary terminations, is only 2% per month. Two out of every three electronic assemblers at Librascope have been employed more than one year. Over 800 of our employees have tenures of more than five years.

1.2.1 Labor Relations

Production and maintenance employees at Librascope are represented exclusively by Local 1600 of the International Association of Machinists. This union was originally certified as bargaining agent by the National Labor Relations Board in 1943. No other labor union has intervened as bargaining agent.

Labor relations have been remarkably stable. Negotiations have followed a fairly consistent pattern, with the last five years showing a trend toward the long-term contract. In 1956 the parties departed from the 1-year contract tradition and executed a 2-year contract. The only strike in the history of negotiations occurred in 1958. It had none of the serious character that marks most industrial disputes. Wage and fringe provisions were tentatively agreed upon before the strike, the only real issues being certain language governing the application of written job descriptions and the length of the contract. Within one week the parties resolved their differences.

Our current 3-year contract, which expires August 1964, contains the usual strike clause. Experience of the parties under the 3-year contract provides sound reasons for continuing this trend in the future.

1.3 ORGANIZATION AND CORPORATE STRUCTURE OF LIBRASCOPE DIVISION

Early in 1960, Librascope adopted an organizational structure which combines the operational mobility of small units with the resources of a large organization. It is similar to the decentralized structures adopted in recent years by the Armed Forces.

Each Librascope branch operates independently on projects in its special field. Authoritative decisions are made by branch officials who are close to the project and, therefore, thoroughly familiar with it. The Branch Manager is directly and solely responsible to the President of Librascope Division. Each branch may call upon the facilities and resources of the Division organization or of the parent company for support of its project; or it may use the special abilities and facilities of any or all of the other branches.

This structure eliminates red tape which plagues many large companies. Communications are simplified. Each project receives the prompt top-level attention which it should have.

The charts on the following pages show the Division organization and its relationship to the Branches. Comparison with the Branch organization chart will show that the departmentalization of the Branch is just as complete and self-sufficient as that of the Division.

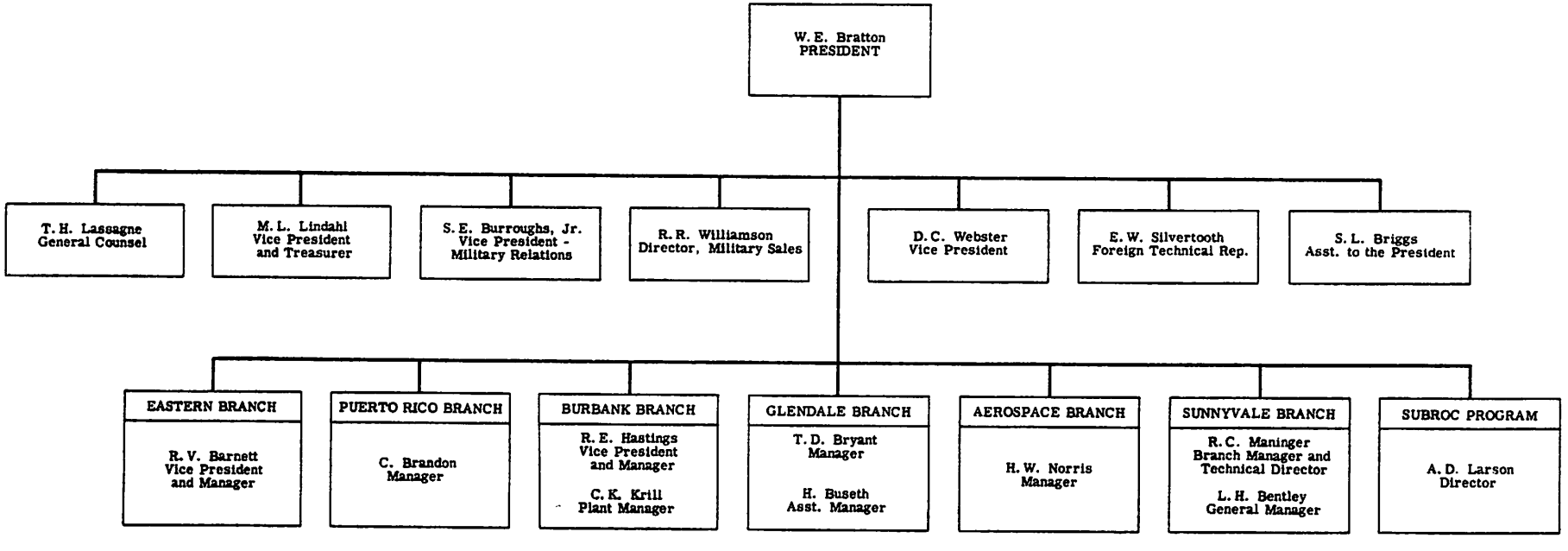
GENERAL PRECISION, INC. LIBRASCOPE DIVISION

LIBRASCOPE MASTER ORGANIZATION CHART

Approved W E Bratton
W. E. Bratton
15 December 1960

I

Supersedes 1 October 1960



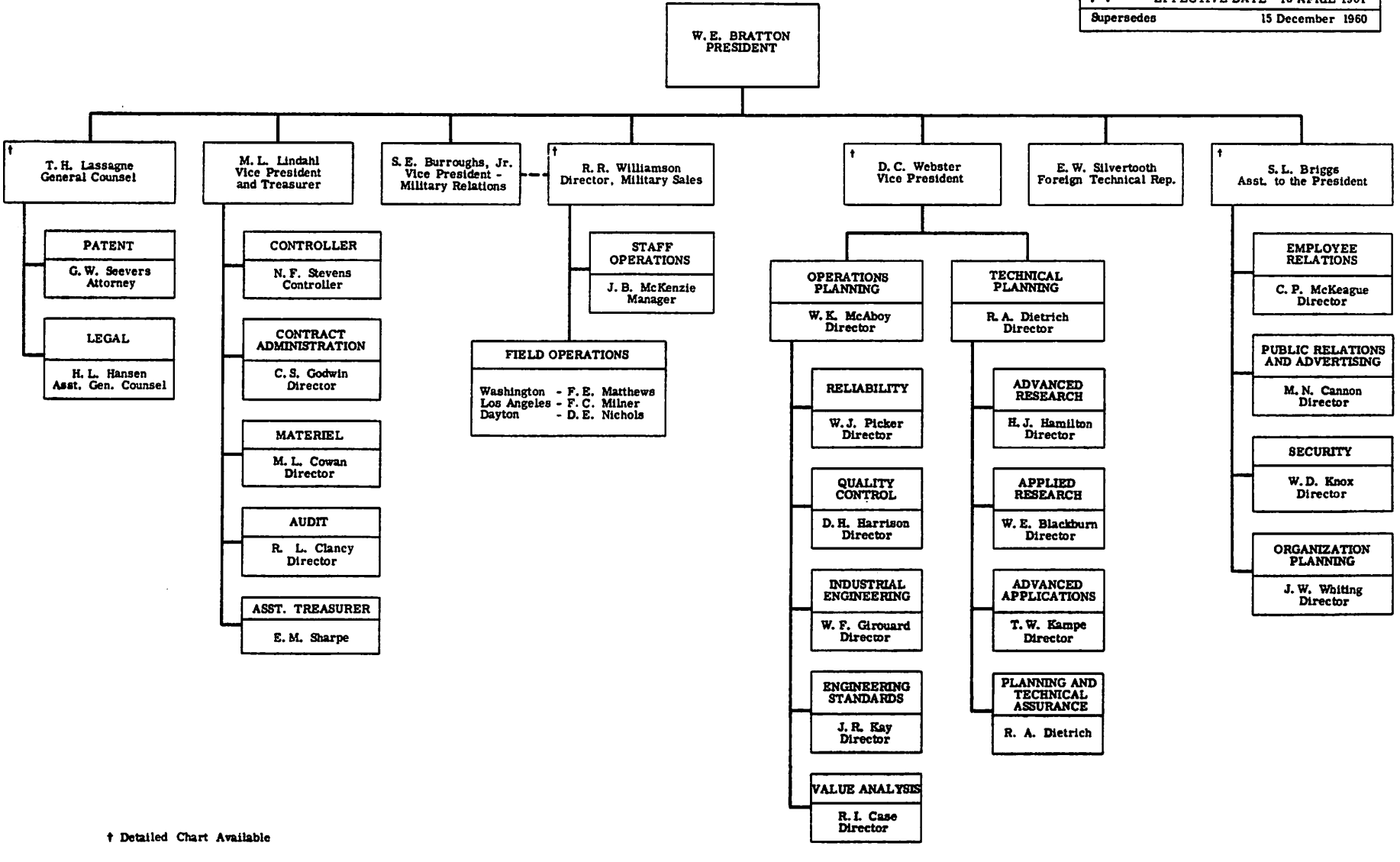
GENERAL PRECISION, INC. LIBRASCOPE DIVISION

LIBRASCOPE DIVISION ORGANIZATION CHART

Approved W E Bratton

I-1 EFFECTIVE DATE 10 APRIL 1961

Supersedes 15 December 1960



† Detailed Chart Available

1.3.1 Librascope Branches

1.3.1.1 Glendale Branch. The Glendale Branch specializes in engineering and manufacturing systems for military and other government use.

Its products include shipboard fire control systems for the Navy's ASROC (surface-borne antisubmarine weapon), SUBROC (submarine-borne antisubmarine weapon), and Polaris programs; and reports, manuals, handbooks, specifications, and other technical publications for the Navy, Air Force, and commercial customers, such as General Electric Company, Minneapolis-Honeywell Company, Douglas Aircraft Company, and Remington Rand Division of Sperry Rand Corporation.

This branch has three major operating departments: Engineering, Manufacturing, and Quality Control. The Engineering Department is divided into sections devoted to specific fields of engineering and engineering services, including Surveillance Equipment, Installation Engineering, Advanced Projects, Technical Documentation, Manufacturing Support, Publications, and several sections devoted to individual projects.

The Manufacturing Department is the largest of all Librascope manufacturing facilities and is available to other branches as required.

The Quality Control Department prescribes production test procedures and tolerances compatible with specifications and standards, and monitors the results. Being directly responsible to the Branch Manager, this department has the authority to enforce compliance with high quality requirements.

1.3.1.2 Burbank Branch. Development and production of commercial computing, data processing, and process control systems and components are the province of the Burbank Branch. Its computers and control systems include the LGP-30 and RPC-4000 general purpose digital computers; The Libratrol-1000 industrial process control system; and the RPC-9000 business data processing system.

Components and instruments it produces include shaft position-to-digital converters, storage drums, read/record heads, differentials, integrators, X-Y plotters, sine-cosine mechanisms, and planimaters.

This branch has its own Quality Control, Engineering, Production, and Purchasing Departments, each of which is directly responsible to the Plant Manager.

1.3.1.3 Aerospace Branch. The Aerospace Branch, through specialization, has become extremely aware of the problems of building equipment for missile and aircraft environments. In the six years of its existence, and even prior to that time, its personnel have been building operational equipment designed to perform reliably and safely in aircraft and missiles.

As a result, the Aerospace Branch is a recognized leader in the airborne computer field.

The branch's successes include the CP-209, which is the Navy's first digital airborne bombing and navigation computer, and the AN/ASN-24, which is the first small and versatile digital computer to solve complex computing problems. Aerospace's latest accomplishment, an offshoot of the AN/ASN-24, is the development of the guidance computer for the Centaur Vehicle. In this large-scale venture, the branch is cooperating with Convair Astronautics and Minneapolis-Honeywell.

In the course of producing this equipment, the Aerospace Branch has attained a proficiency in the integrated design of equipment for the airborne and space-borne environments.

This has come about not only because the personnel in Aerospace are outstanding within their own fields, but also because they have learned to work together as a team. Consequently their talents are merged and complementary.

Since each project team works on a given package from its inception to its final checkout and delivery, the team members are aware of the consequences of their design. This feedback process yields optimum results in the design of airborne and space-borne equipment.

1.3.1.4 Sunnyvale Branch. The Sunnyvale Branch consists of two major departments. The Ground Systems Department specializes in ground-based data processing systems for air traffic control, vehicle guidance, automatic checkout and launching of missiles; optical instruments; and photogrammetric equipment. The Special Projects Department specializes in advanced techniques in missile ordnance such as EBW Systems (exploding bridgewire), which perform rocket motor initiation, stage separation, and thrust termination with greater safety than conventional squib-operated systems.

The technical ability of this branch has been used to advantage by many organizations. The University of California Radiation Laboratory engaged Sunnyvale Branch for applied research in the fields of controlled fusion and special weapon devices, and to develop and fabricate reactor instrumentation, acceleration instrumentation, high temperature instruments, and electronic cameras and accessories for UCRL's research program.

The Sunnyvale Branch has served as technical coordinating contractor for the Martin Company, Denver Division, during the first phase of a printed cable study. In this program,it conducted extensive studies of printed strip cable.

The Sunnyvale Branch has had design and prototype fabrication responsibility (covering component development, system layout, and final cabling design) for the fuzing section of the Navy's ASROC missile.

The proven ability of the Sunnyvale Branch has been used by several missile contractors in the United States defense program. A partial list of this branch's customers includes the Lockheed Missile System Division, Bendix, Philco, Hughes, Douglas, North American Aviation, and Convair.

Following is a list of some of the components, instruments, and systems developed and fabricated by the Sunnyvale Branch for various missile programs:

Image Converter Cameras and Accessories

Microwave Telemetering Systems

Transient Light Meters

High-Speed Mechanical Framing Cameras

High-Speed Mechanical Streaking Cameras

High-Speed Mirror Turbines

High-Resolution Oscilloscope Cameras

Schlieren Camera Systems

High-Intensity Light Sources

Eddy-Current Metal Inspection Instruments

Low-Noise Instrument Amplifiers

Very-Low-Frequency Instrumentation

Fast-Pulse Generators and Amplifiers

High-Temperature Signal and Power Distribution Systems

Fuzing Components, i.e., Transistor Timers, Impact Switches, Transistor Integrators

Various Test and Ground Support Equipment

Thrust Termination Devices for Solid-Propellant Rocket Engines

Solid-Propellant Engine Igniters

Explosive Bolts

Primacord Initiators

High-Explosive Detonators

Technites, which are proprietary high-energy chemical sources for propulsion, heat generation, shock wave generation, and mechanical work.

Exploding Bridgewire Missile Power Sources and Electronic Systems

Missile Safety Destruct Systems

Complete EBW Missile Ordnance Systems

Proximity Scorers

Field Firing Systems for Exploding Bridgewire Devices

2.0 QUALITY PROGRAM

The indoctrination, training, and motivation of every employee is as much a part of Librascope's quality program as the more direct quality functions described in this section. No matter how remote from the product a particular job may seem to be, it would not exist if the product failed to meet customers' requirements. The pride and performance of the person doing that job is an ingredient of the spirit and performance of the entire company.

To maintain the high quality of Librascope products, supervisory personnel at all levels are responsible for maintaining the following conditions for quality within their respective jurisdictions:

All personnel shall be properly supervised and adequately instructed.

All personnel shall be trained to be quality conscious.

All standards, procedures, and specification must be written, realistic, and enforced.

Adequate tools and means of measurement and test shall be available.

Facilities and a program for training personnel shall be maintained.

Records shall be kept in such a manner that experience may be used to improve the product.

Good housekeeping shall be practiced.

Directors of departments which implement the quality program report directly to top management in each echelon of Librascope Division and its corporate relatives. Implementation of the program is carried out under the categories of reliability, standards, and quality control.

These categories are so interrelated that when they are performed by different departments, the distribution of some functions may be a matter of agreement between the department directors or assignment by management.

Reliability concerns how long a piece of equipment will meet its functional requirements in its anticipated environment. Standards deals with measurements which have been established by rule or usage. Quality control sees that the product conforms to customer needs which may be derived from standards, from reliability information, or may be specified by the customer.

Incoming Functional Test. All vendor and subcontracted items which require functional testing for acceptance are inspected in accordance with Quality Control Instructions (QCI's) which interpret the Engineering drawings and specifications and instruct the inspector. The QCI tells what parameters are to be inspected, the equipment which is to be used, and the step-by-step procedure to follow in performing the inspection. In certain instances, a Quality Control Report may be required to record results of the inspection.

The test equipment is purchased or designed and built in accordance with the requirements set forth by the Project Test Equipment Planning Committee. This committee is made up of a member from each of the following: Quality Control, Production or Development Engineering, Industrial Engineering, and Production Test.

In most cases vendor-supplied and subcontracted items receive 100 percent inspection, and accordingly statistical sampling plans are seldom required or used in the receiving inspection. However, when statistical sampling plans are used, they are in accordance with MIL-STD-105.

Final Functional Acceptance Test. Final functional tests are performed by the Production Department with verification by Quality Control. These final tests are designed by Engineering and approved by Quality Control. The test documents contain the operational requirements, the test procedures, and space for recording the test results.

Material Review. Control of questionable or rejected material is accomplished by forwarding it to a bonded material review area where a decision will be made by the Material Review Board (MRB) to "use as is," "repair," or "scrap." A unanimous vote of all members of the board is required to "use as is" or "repair." The MRB is made up of a cognizant representative from Engineering, Quality Control Engineering, and (when required) the customer. Accurate records are kept of all MRB decisions.

Vendor Rating. An approved Librascope source of supply file (vendors and subcontractors) is maintained. This file is kept by Librascope part number and by types of products or services available. Unanimous approval by Engineering, Purchasing, and Quality Control is necessary to constitute an approved Librascope source of supply. The file is kept current by careful analysis of the source's performance as indicated on Quality Control and Purchasing records.

Quality Control Manual. The Librascope Quality Control Manual describes in detail the aforementioned controls and the necessary supporting activities and records. This manual is written well within the objectives of MIL-Q-9858, and a controlled copy will be supplied upon request.

Quality Control Instructions. Quality Control engineers, working with the Technical Publications Department, design and prepare Quality Control Instructions for all Librascope products. The Quality Control Instruction is a document which provides comprehensive written instructions for execution by inspectors to assure that materials and products will be inspected under controlled conditions in compliance with a clearly defined basis for acceptance or rejection.

A Quality Control Report is also devised to be used as a checkoff sheet by the inspector and to provide a detailed record of the inspection.

The Quality Control Instruction provides the inspector with a list of the documents necessary, equipment required, and the detailed step-by-step instructions for performance of the inspection. The use of a Quality Control Instruction is designated on operation sheets, and the inspection print file provides the instruction to the inspector automatically, along with other necessary documents, when the print is issued for inspection.

2.1 DIVISION QUALITY CONTROL

2.1.1 Organization

The Division Director of Quality Control is responsible to the Division Director of Operations Planning.

2.1.2 Function

The Division Director of Quality Control is responsible for the following:

(A) Determination of the basic policy and design of the quality control system applying to all Branches of the Division.

(B) Publication and control the Division Quality Control Manual, which delineates and establishes the basic quality control policy and system for the Branches.

(C) Coordination of the quality control functions, procedures, and standards with the other product assurance activities of the Division; namely, Reliability, Standards, Industrial Engineering, and Value Engineering.

(D) Coordination of the quality control activities of the Branches to assure uniformity of procedures, forms, records, data, standards, etc., when such uniformity may be desirable and/or necessary from the Division viewpoint.

(E) Assisting the Branches to establish and maintain an effective and economical quality control system, consistent with the corporate quality control policy.

(F) Information to customers, prospective customers, and to industry, concerning Librascope's quality control system and capabilities.

(G) Representation of the Division on all quality control matters in General Precision, Inc., and Industrial organizations concerned with quality control.

(H) Serving as chairman of the Librascope Division Quality Control Council, whose membership consists of the Quality Control Manager from each Branch and whose task is to assist in the coordination of activities as stated in paragraph (D).

(I) Nomination of qualified persons for Branch Quality Control Managers whenever a vacancy exists.

(J) Provision for the interchange of quality control information between Librascope Branches, and between the Librascope Division and other General Precision Divisions.

(K) Operation of the Division Metrology Laboratory.

(L) Periodic reports to management on the effectiveness and efficiency of quality control in the Branches.

2.1.3 Metrology Laboratory

The Metrology Laboratory is a Librascope Division facility serving all Branches of the Division and is designated a BuWeps Secondary Standards Laboratory by the Western Primary Standards Laboratory, Navy Weapons Plant, Pomona, California.

2.1.3.1 Metrology Laboratory Organization. The laboratory is responsible to the Division Director of Quality Control. It consists of the following sections:

(A) Librascope BuWeps Secondary Standards Laboratory - Electrical

(B) Librascope BuWeps Secondary Standards Laboratory - Physical

(C) Instrument Repair and Calibration Laboratory, including repair parts stock

(D) Division Equipment Pool, including the Loan Pool.

2.1.3.2 Metrology Laboratory Function. The laboratory is operated in accordance with the Standards Laboratory Information Manual (SLIM) BuWeps, Navy.

The basic functions of the laboratory are as follows:

(A) Maintenance of Librascope BuWeps Secondary Standards Laboratories

(B) Making reports and keeping records, as follows:

(1) Reports and records for the military as required by the BuWeps Test Equipment Calibration Program prescribed in the SLIM Manual.

(2) Records of evaluation acceptance, assignment, location, calibration, recall period, and maintenance of all test/measurement equipment as appropriate and required.

(3) Calibration records for the customer when required.

(C) Coordination of procurement of all test or measuring equipment to be used by the Division and the Branches.

(D) Acceptance (including initial evaluation and calibration) of all test/measuring equipment.

(F) Periodic calibration and maintenance of all test or measuring equipment.

(G) Maintenance of the Division Loan Pool for test/measuring equipment available to the Branches.

2.2 DIVISION STANDARDS

The Librascope Division Standards Department is a unit of the Operations Planning Department, The Standards Director is responsible, through the Operations Planning Director, to the Vice-President in charge of Operations and Technical Planning. Its functional subdivisions are:

(1) Engineering and Manufacturing Standards and Specifications

(2) Finishes, Processes, Materials and Purchased Parts

(3) Specification Control Drawing Coordination

(4) Communications

The objective of the Librascope standards program is to improve the quality and reliability of its products while reducing costs, by holding in check the variety of parts and engineering practices involved and by facilitating the interchangeability of parts.

The function of the Standards Department is to achieve the greatest practical uniformity of items of supply and engineering practices by collecting and disseminating engineering criteria, terms, principles, and lists of materials, processes, and parts which have been established by common agreement, usage, or rule.

The Division Standards Department is a clearing center to avoid duplication or conflict of effort among the branches, and between the other members of the General Precision corporate family and outside organizations.

The Division Standards Director is chairman of the Librascope Standards Committee, whose other members are the branch representatives. His department reviews all standards generated by the branches for consideration as Division or General Precision, Inc., standards, and as chairman

of this committee, he assigns the preparation of new or modified standards to the appropriate branch. As the representative of Librascope Division on the General Precision, Inc., Standards Committee, he submits Librascope's recommendations for changes or additions to standards of the parent company.

He also represents Librascope in the discussions of standards and specifications to be promulgated by industrial societies and government agencies. In turn, he collects data on the application of materials and processes from these and other sources and disseminates them to all branches.

Division Standards reviews all specifications control drawings to effect standardization and avoid duplication. Allocation of blocks of drawing numbers to the branches is controlled by this department.

The Division helps Branch Standards departments to indoctrinate personnel in the application of Division standards.

In addition to publishing and distributing division standards and data from outside the division, the Division Standards Department is responsible for publication and maintenance of Librascope's "Preferred Electronics Parts" list and "Hardware Catalog", based on data from the Reliability and Quality Control Departments and other sources.

2.3 DIVISION RELIABILITY

The Librascope Division Reliability Department is a unit of the Operations Planning Department. The Reliability Director is responsible, through the Operations Planning Director, to the Vice-President in charge of Operations and Technical Planning. The department is subdivided into a Reliability Analysis Group, Component Applications Group, and Reliability Test Group.

The Division Reliability Department functions in a dual role. For the Division, it is a Reliability Advisory Staff. For each Branch, it is a Reliability Support Service.

As Division Reliability Advisory Staff, the department functions as follows:

(A) Represents Librascope Division on the Reliability Committee of the parent company, General Precision, Inc. This committee is composed of a staff member from the parent company and the Reliability Directors from all of its divisions. The committee meets every two months to coordinate reliability policy.

(B) Assists in establishing reliability programs in the branches to meet the specific requiremcnts of each branch.

(C) Monitors reliability progress in each branch and keeps Division Management informed.

(D) Follows developments in the field of reliability and disseminates news to the branches.

A member of the Division Reliability Department attends the meetings of the Electronic Components Reliability Center (ECRC) at the Battelle Memorial Institute. This is a program sponsored by major industrial firms which are large users of electronic components. The ECRC produces research reports on the reliability and performance of electronic parts and on reliability techniques. These reports are available only to the sponsors.

Librascope is a member of the Interservice Data Exchange Program (IDEP). Through this program, reports are obtained on all tests conducted by major contractors involved in component evaluation for ballistic missile programs of the Army, Navy, and Air Force.

As Branch Reliability Support Service, the Department functions as follows:

(A) Analyzes design of electronic, electro-mechanical, and mechanical systems and subsystems to determine whether recommended reliability practices have been followed.

(B) Assists design in reliable applications of components and materials. Recommends reliable sources of supply.

(C) Predicts reliability characteristics of systems and components.

(D) Analyzes failures and recommends corrective measures.

(E) Operates all major environmental test equipment which provides conditions of shock, vibration, altitude, humidity, noise interference, salt spray, temperature, and combinations of these conditions.

Within the department these functions are distributed as follows:

Reliability Analysis Group:	Prediction Failure analysis and correction Design analysis Liaison with other activities
Component Applications Group:	Component application advice Component and system evaluation Participation in test planning and design review Liaison with other activities
Reliability Test Group:	Test planning Test operation

3.0 LIBRASCOPE FACILITIES

The Librascope laboratories and production facilities are conveniently located near main highways and key rail lines in Glendale, California. These facilities occupy 610,000 square feet on 40 acres.

Invention, research, and development are long-range engineering assignments. The successful resolution of these distinctively creative functions requires great and essential supplementary support. Librascope engineers have available, therefore, every possible tool, test equipment, and measuring device, and some of the most specialized instruments to aid them in the successful completion of their various projects.

Production Engineering. The Production Engineering Department coordinates the design, development, and production activities at Librascope. During the development phase of a contract, Production Engineering monitors a product's design to assure optimum producibility and economy of manufacture. When necessary, Production Engineering initiates design changes for incorporation into the design drawings and the prototype model. Knowledge gleaned during prototype manufacture is reflected in the final production unit.

Responsibility for initial activity on a Librascope-manufactured product rests mainly with the design engineer who serves as project manager through the development phase. Chief responsibility then transfers to a production engineer until all contract obligations are fulfilled. By working closely with the designer during development, the production engineer gains sufficient background information to assume his project management responsibilities during the production phase.

Production Engineering assists Production in trouble shooting, in establishing manufacturing procedures, and in interpreting specifications. Production Engineering also lends technical assistance to the Inspection Department.

Purchasing Department. The Purchasing Department has 56 members who are on indirect charge. Last year the Department's purchases amounted to $15,000,000.

In soliciting proposals and quotations, competitive quotations are used as much as possible.

Procurement is organized on a commodity basis and is divided into two functions; the purchase of parts and standard components, and subcontracting and outside production. This arrangement is sufficiently flexible

so that specific buyers can be assigned to specific projects if and when this procedure is desirable.

The Purchasing Department has a follow-up function apart from its buying function. Follow-up is based on periodic information received from vendors regarding the status of the scheduled delivery of required items. The specific method employed is in accordance with the requirements of the point of requisition, such as engineering or manufacturing.

The Purchasing Department is headed by the Manager of Materiel and comprises an Assistant Purchasing Agent and 24 buyers who are assigned to perform the two functions of parts purchasing and subcontracting.

Procurement Plan. Librascope has a Make or Buy Committee, which meets on a regular monthly basis, or more often, as the need arises. The purpose of the committee is to institute and administer a program whereby the decision of making or buying an item or service is analyzed and made in such a manner as to reflect the best decision commensurate with company policies regarding capital expenditure, price, quality, schedules, plant capacities, and security.

The actual mechanics of the parts coding operation (which is the individual part make or buy decision) occurs as a routine consideration of the Industrial Engineering Department.

Librascope has subscribed to the Small Business Program and exerts every effort to make sure that subcontractors with whom we place orders have been advised of this participation. On Order Department Form No. 472, the question is asked whether or not small business has had an opportunity to submit quotations on this order. As part of our participation in the small business program we submit on a semiannual basis the amount of dollars that have been spent with small businesses as compared with those that have been spent with large businesses.

Field Service Training. The Field Service Group is composed of engineers and technicians capable of maintaining and repairing all equipments manufactured by Librascope. In addition, this group is capable of maintaining and repairing associated system equipments produced by other manufacturers. Field Service is provided for the Shipboard, Airborne, and Special Devices Departments.

In addition to helping the customer keep his equipment operating with a minimum of down time, Field Service personnel instruct the customer in maintenance procedures and adjustment. They also provide liaison between the plant and the customer.

Field Service men are assigned, when practical, to specific equipment early in the design stage. This insures that with the first delivery of the equipment, Field Service personnel are capable of assisting with

installations if required, and can provide adequate maintenance support from the beginning.

Some Field Service men are stationed permanently at locations near concentrated Naval facilities selected by the Bureau of Naval Weapons. Other Field Service men remain at the plant on call as needed.

Field Service personnel provide a feedback of information for Engineering, Quality Control, and Reliability on equipment in the field so that product improvement may be achieved in operational and maintenance capabilities.

Technical Publications. Librascope's Publications Section is staffed by competent specialists thoroughly familiar with all military specifications. The broad scope of the publications which have been produced includes: military handbooks, technical reports, parts catalogs, Ordnance Classification of Defects (OCD's), factory acceptance tests, technical film reports, military specifications, technical brochures, training courses, and training films. As an integral part of the Librascope Engineering Department, the Publications Section benefits from a close liaison with top-grade scientists and engineers. Qualified personnel on all levels are always available for technical assistance and accuracy control. The Publications Section is justly proud of a record of over ten years without the rejection of a publication.

The Publications Section consists of over a hundred writers, artists, editors, typists, and production experts. It includes former Army, Navy, and Air Force personnel.

The writing group is experienced in the preparation of publications for electronic, mechanical, electromechanical, and optical instruments of many types. They are qualified to handle the most advanced technical writing assignments and are constantly working within tight-deadline engineering schedules.

The art service group combines artistic talent with technical know-how to provide a complete facility for the design, layout, and preparation of artwork for reports, illustrated parts breakdowns, and military manuals. The group is staffed with airbrush and commercial artists (some with studio and advertising agency experience) and technical illustrators highly qualified to prepare perspective and isometric drawings, exploded views, airbrush renderings, and retouched photographs.

The layout and reproduction group provides complete facilities for the production of reports, manuals, and parts catalogs. This group is well organized to meet the most stringent deadlines. Layout and production prepare all types of material to be reproduced, including IBM reproduction typing, makeup, collating, and binding. For work requiring a vendor printing service, this group, working from original art and manuscripts, assures prompt and economical services.

Among the many satisfied customers of the Librascope Publications Section are:

Bureau of Naval Weapons
Navy Bureau of Personnel
Navy Bureau of Ships
Navy Special Devices Center
Wright-Patterson Air Development Division
U. S. Naval Ordnance Test Station, Pasadena
Douglas Aircraft Company
Remington Rand Division, Sperry-Rand Corporation
Control Instrument Corporation
Royal Precision Corporation

Security Clearance. Librascope is cleared for TOP SECRET. All engineering personnel have at least CONFIDENTIAL clearance, and individuals are cleared for the higher classifications as required.

All areas where classified material is handled or stored are enclosed by physical barriers, and access is controlled by guards. Lists of authorized personnel are provided for each area. Admission of others is by personal identification and establishment of their need to know.

Optical Laboratory. The Optical Laboratory has extremely accurate and delicate equipment for designing optical instruments and test fixtures, and for assembling, inspecting, and collimating optical elements. In Librascope's air-conditioned, constant-temperature, precipitron-protected, glass-enclosed optical assembly area, gauge builders, experimental machinists, and instrument makers specialize in narrow tolerance assemblies. The Librascope Optical Department has a large inventory of equipment which includes: Interferometers, Monochromatic Light Sources, Sphereometers, Dynascopes, Spectrometers, Project Optical Comparators, Beam Splitters, Dioptometers, Strain Indicators, Collimators, Optical Benches, and many special optical instruments unique with Librascope.

Model Shop. Production contracts call into action the many and varied major production facilities concentrated in the Model Shop and present a composite of practically every phase of production activity. Here, the diversity of operations is reflected in the wide range of equipment required. Massive milling machines, tiny jeweler's lathes, punch presses, borers, saws, and grinders all enact important roles in fabricating prototypes of all kinds. The Model Shop also has a large assortment of arbor presses and complete wiring and soldering equipment. Librascope's own printed circuit plating and processing facilities function in this department, and the electronic checking devices section of the model shop with its meters, power supplies, oscillographs, etc., is complete in every detail.

Production Machine Shop. The Production Machine Shop is well equipped for the manufacture of precision components to meet the rigid standards and specifications required for military environments. High quality machines of both American and European manufacture are used. For greater versatility and precision, major Machine Shop facilities are Librascope-designed.

Facilities in the Machine Shop are grouped into these sections: boring lathe, milling, grinding, gear cutting, and precision drill.

Jig Boring Department. Considered to be the finest precision shop in Southern California, the Jig Boring Department shares a major part of maintaining Librascope's high standards of tolerance. All materials, standards, and machines in use are kept in a closed room at 70° F. Uniform moisture content is regulated by automatic temperature and humidity controls. Librascope-designed metal boxes are used to store all metal standards to prevent absorption of heat normally retained in wooden frames. Librascope also makes its own boring bars exclusively for all repetitive work. The very best in European and American equipment is used to provide the fine precision specifications demanded by the exacting standards at Librascope.

The most skillful of machine technicians are required to operate and maintain the delicate machines used in Librascope's Jig Boring Department. In addition to the giant Lucas Boring Mill, Sip Jig Bore, and DeVlieg Spiramatic Jig Mill units, many Hauser, Autometric, Moore, Bryant, and special Librascope-built units are included in the equipment inventory.

Boring Department. Speed, efficiency, and economy are attained in this department through special equipment designed and adapted by Librascope. Here Librascope-designed machines use center hole templates for precision boring on repetitive work for large economy runs.

Lathe Department. One of the first steps from development to production begins in Librascope's Lathe Department. Here both engine and turret lathes, in a wide range of sizes and versatility, bore from 0.0002 to 16 inches in diameter and up to 65 inches in length. Here, too, tooling and measurements are checked for protection. Standard, heavy duty, precision, toolmaker's and jeweler's lathes, as well as chucking machines, are included in Librascope's efficient Lathe Department.

Milling Department. Librascope's completely equipped Milling Department specializes in milling castings to close tolerances. One of the many unique adaptations of machinery in this department allows milling machines to be used for precision layouts as well as for precision milling. Critical milling operations are completed on a wide range of the latest, most modern horizontal, vertical, and omniversal equipment. The Librascope Milling Department is capable of handling work up to 32" × 32" × 54".

Grinding Department. It requires the most exacting of foreign and American machinery to meet the close tolerances (to 0.0002) which prevails throughout the Librascope Grinding Department. Librascope was the first plant (and still is one of the very few in Southern California) to install a Gardner Double-Disc Grinder for high-speed production. Working with extreme accuracy, this machine grinds both sides simultaneously. While precision is always the primary consideration, high-speed production is also achieved by Librascope's superb equipment and highly skilled personnel.

The equipment inventory of the Librascope Grinding Department presents a representative cross-section of the world's best machinery for grinding purposes. Cincinnati, Gleason, Norton, Brown and Sharpe, Fortune-Werke, Thompson, Gallmeyer, Reid, Delta, Stanley, and many other famous grinding machine manufacturers are represented here. But even the foremost American and European manufacturers were unable to furnish some of the highly specialized grinders required for Librascope's ultra-precision work. Many of these units were designed and built by Librascope technicians and craftsmen.

Gear Cutting Department. Librascope's Gear Cutting Department is noted for producing the closest possible tolerances, often exceeding the machine manufacturer's specifications for his own equipment. AGMA precision class helical, internal and external spur gears, spiral, zerol and hypoid bevel gears, as large as 7 inches and as minute as 3/32nd of an inch in diameter, are produced here. Super-precision Vinco AGMA master gears check the accuracy of all gears produced at Librascope.

A full complement of gear generators, gear shapers, testers, and redliners from Gleason, Fellows, and other noted gear machinery makers is found in the inventory of the Librascope Gear Making Department.

Precision Drill Department. Although drill press operations are normally broad tolerance, use of especially-designed fixtures permit operators to hold tolerances of 0.0003 inch where required. The wide variety of machines include radial, single-spindle, multi-spindle, and precision presses.

Simulation Laboratory. The Simulation Laboratory is composed of Librascope-designed equipment for checking out military fire control devices under conditions simulating actual use.

Electronics Laboratories. Each engineering department maintains an electronics laboratory engaged in circuit research, development, and design. In these laboratories electronic portions of new Librascope products are developed, and theory is translated into fact. Miniaturized and advanced circuitry composed of solid-state elements predominate.

Personnel, facilities, equipment, and experience to maintain, calibrate, and standardize all types of electronic instruments are kept at the top level at Librascope. Extreme accuracy and precision are standard procedure, with calibrations made to 0.01 percent or better, and with secondary standards checked against primary standards whenever necessary. Equipment in the Electronics Laboratory is both diversified and complete, new equipment being added whenever needed for projects at hand. Over 35 different types of machines, tools and test instruments in this department include: lathes, drill presses, jig bores and accessories, height gages, gage blocks, micro-projectors, potentiometer indicators, binocular microscopes, strobotacs, cathode ray oscillographs, voltage regulator power supplies, dynamometers, viscosity cups, force indicators, force measuring device, torque wrenches, and all types of torque-testing equipment.

Subassembly Departments. With four major assembly lines under one roof, Librascope operates with an exceptionally high degree of scientific exactness. Librascope engineering requirements call for meticulous exactitude on all parts and component assemblies. This is assured by a stationized line flow which eliminates errors, lost time, and wasted motion. Some fine precision work must be done by hand under microscopes. Dust-free areas are used where required for precision mechanical assembly.

Final Assembly. Here is the focal point of Librascope's entire plant operation. All the theorizing, planning, engineering, and drafting that has gone before materializes in Final Assembly where all the various parts, components, and subassemblies are carefully coordinated into complete production units.

Inspection. Constant inspection during every phase of production maintains the extremely high standards of accuracy established at Librascope. Inspection stations, equipped with the finest inspection devices, are located at critical points throughout the entire plant for on-the-job inspection. For especially minute checking, some work is performed in a special glass-enclosed dust-free area served by its own precipitron. In addition to all the standard devices generally used, Librascope uses many rare measuring instruments to ensure that every company product is as close to perfection as human skill and modern science can get it.

Final Inspection. Here each unit receives Librascope's final "OK." Here the acme of exactness is maintained. Final Librascope inspection must assure that each unit comes up to all specifications as to accuracy and limit of operations. A complete check, internal and external, is made on each instrument.

Calibration of dials are checked for veracity. Instruments that have internal illumination are checked for lighting. All paint or other finishes must be free of imperfections. Even the details of the nameplates and insignia are double-checked and verified. This is the last stage before Librascope's finished product is delivered to the customer.

4.0 RESEARCH AND DEVELOPMENT

The major contracts for research, development, and production-demonstrating capability in electromechanical computing devices, optical and infrared equipment, fire control equipment, and digital computers are shown below.

FEASIBILITY STUDIES

P.O. or Contract	Subject and Description	Customer
AF 33(616)5757	Airborne Digital Computer Study Program	Wright Air Development Division, ARDC
DA-44-009-ENG-3480	Error Analysis of Vehicular Navigation	Fort Belvoir
AF 33(616)5916	Study and Development of Inertial Accelerometers	Wright Air Development Division, ARDC
AF 33(616)5987	Study of Inter-Unit Signaling in Complex Weapon Control Systems	Wright Air Development Division, ARDC
33465	Feasibility Investigation for Star Tracker Modification to Track Venus in Daylight	Johns Hopkins University
	Study of the Properties of Field Emission	Company Project
	Thin Films	Company Project
	Photo Conductors	Company Project
	Advanced Computer System Control Study	Company Project

DESIGN AND DEVELOPMENT

FAA/BRD-207	Magnetic Tape Control for ATC Data Processor	Federal Aviation Agency
NOrd 16719	Design and Manufacture Models of Plotters Mk 16 Mod 2	Bureau of Naval Weapons
89-17129	Centaur Guidance Computer	Minneapolis-Honeywell Inertial Guidance Center

DESIGN AND DEVELOPMENT - Continued

P.O. or Contract	Subject and Description	Customer
B.O. 963	Pointing Computer for Project "Skyscraper"	Bendix Systems Division
AF 33(616)6659	Fabrication of Service Test Model, Digital Airborne Computer	Wright Air Development Division, ARDC
AF 33(616)5128	Fabricate Experimental Flight Model of Airborne Digital Computer	Wright Air Development Division, ARDC
NObsr 72689	Design, Develop, Construct, Test, and Furnish Experimental Models of AN/SAC 5 Optical Communications Set, Spare Parts Manuals, Reports, etc.	Bureau of Ships
AF 30(602)1771	Develop Model of Stereoplotter Projection	Rome Air Materiel Area
21250	Star Tracker Systems	Johns Hopkins University
G-18943-6	Design and Fabricate Air Traffic Control Data Processor	General Precision Laboratory
SR 1058-A	SUBROC, Digital Computer Design	Goodyear Aircraft
SR 1058-A	SUBROC, Functional Design	Goodyear Aircraft
SR 1058-A	SUBROC, Prototype Digital Computer	Goodyear Aircraft
E-220-904	Research Services for Development of Interim Computer	Electric Boat Company
NOrd 18830	Design and Development of Fire Control Equipment	Bureau of Naval Weapons
NOrd 18899	Engineering for Relay Transmitter	Bureau of Naval Weapons

DESIGN AND DEVELOPMENT - Continued

P.O. or Contract	Subject and Description	Customer
DA-04-495-ORD 3059	Digital Computer for Saturn Missile Program	U.S. Army Ordnance
AF 33(600)38550	Digital Camera Control System	AMC Aeronautical Systems Center
AF 33(616)6671	Experimental Model of Remote Sighting Sextant	Wright Air Development Center, ARDC
1651	Phase II of SAGEM	SAGEM
1652	Computer for Phase III of SAGEM	SAGEM
	Development of Infrared Detector	Company Project
	Development of Techniques for the Storage of Digital Information	Company Project
	Evaluation and Development of Intelligent Machines	Company Project
AF 33(600)41431	Design and Development of Two Digital Star Trackers	AMC, Aeronautical Systems Center
NOW 60-0463	Fire Control System Mk 113 Mod 5	Bureau of Naval Weapons
NOW (2)60-0614	Manufacture Stabilization Computer Mk 114 Mod 0	Bureau of Naval Weapons
NOrd 16692	Bridge Display Units	Bureau of Naval Weapons
NOrd 18953	Angle Solver Mk 17	Bureau of Naval Weapons
10135	Manufacture Prototype Group, ASROC	Minneapolis-Honeywell
NOas 57-788C	Digital Computer Subsystems	Bureau of Naval Weapons
NOas 57-788C	Computers CP-209/ASB	Bureau of Naval Weapons
AF 33(600)30490	Navigational Computer Sets AN/ASN-9	Wright Air Development Division, ARDC

DESIGN AND DEVELOPMENT - Continued

P.O. or Contract	Subject and Description	Customer
7-6B-391135	Viewfinders	Douglas Aircraft
AF 33(600)34777	SSMC-501 Time Code Generator, SSTR Time Code Reader, Decimal Display	Wright Air Development Division, ARDC
7B-638869	Camera Sights	Douglas Aircraft
8-7B-683308 8-7B-683307	Ground Speed and Distance Indicators	Douglas Aircraft
8B-803959	Pilot Sights	Douglas Aircraft
8B-901524	Camera Sights	Douglas Aircraft
8B-846720 8B-866771	Pilot Sights	Douglas Aircraft
P-258626	CP-185B Wind Computers	General Precision Laboratories
9-8B-861940	Pilot Sights	Douglas Aircraft
9-8B-861693	Viewfinders	Douglas Aircraft
N163-7409	Bombing Data Computers	U.S. Naval Avionics
N163-7409	Tracking Control Units C-2553/ASB-7	U.S. Naval Avionics
N163-7409	Control Indicators	U.S. Naval Avionics
N163-7409	Airspeed and Altitude Computers	U.S. Naval Avionics
DA-04-495-ORD-1551	Tape Cartridge	U.S. Army Ordnance
NOrd (Z) 18868	Attack Consoles for Fire Control of ASROC	Bureau of Naval Weapons
NOrd (Z) 18868	Position Indicators for Fire Control of ASROC	Bureau of Naval Weapons
NOrd (Z) 18868	Relay Transmitters for Fire Control of ASROC	Bureau of Naval Weapons

DESIGN AND DEVELOPMENT - Continued

P.O. or Contract	Subject and Description	Customer
NOW (2) 60-0527	Modification of Attack Directors Mk 5 Mod 5	Bureau of Naval Weapons
NOrd (2)-18952	Fire Control System Mk 113 Mod 2	Bureau of Naval Weapons
48315-5	Wind Memory Computers	General Precision Laboratories
10500-11-11/12	Depth Bomb Dispensers	Lockheed Aircraft
P-7363	Converters	Ryan Aeronautical
8505-35437	Differentials	Nortronics Division, Northrop
8505-35438	Differentials	Nortronics Division, Northrop
214-31221	Ball and Disc Integrators	General Electric Co.
FV-121154 LJJ-20943-N	Ball and Disc Integrators	International Telephone and Telegraph

5.0 STUDY PROGRAMS

Librascope has performed numerous investigations and study programs under industrial, government, and company sponsorship. For example; a study and development of inertial accelerometers, a study of inter-unit signaling in complex weapon control systems, an engineering study and design of SSB fire control systems, SUBROC and SUBIC studies, and the study of the properties of field emission. Brief descriptions of some of these studies are given in the following paragraphs.

Air-Routing Traffic Control. Librascope is working with General Precision Laboratory on the Air Routing Traffic Control program for the Federal Aviation Agency. Early in 1958 the Air Modernization Board selected the General Precision Laboratory as the prime contractor for the Air Traffic Control Data-Processing Center. The complete control problem consists of three phases: terminal, transition, and enroute. Librascope is providing the multiple data-processing system capable of handling the enroute and transition phases. The initial equipment has been delivered to NAFEC, Altantic City, where it will undergo system evaluation and testing by using an air traffic simulator as well as actual aircraft.

The initial configuration, designed to handle air traffic in the New York area, will be able to print and process 1600 flight-progress strips per hour, process 400 flight plans per hour and store a minimum of 1000 flight plans, sequence the arrival of 60 aircraft per hour, and monitor the departure of 60 aircraft per hour. In addition, communications will be set up with adjacent center inputs and outputs, electric typewriters, flight plan consoles, printer punches, SAGE, real-time clock, and enroute sector consoles.

Underwater Fire Control. The complexity of the Naval fire control problem is well known. The problem for underwater fire control is further extension of that complexity. Not only must the fire control equipment solve the difficult problem of launching an accurate attack against a moving target from a moving, unstable platform, but it must also control weapons which travel through the vastly different media of air and water.

Because the fire control systems studied and developed by Librascope for the Navy are classified, a detailed description of these systems cannot be given here. However, Librascope has gained and is maintaining leadership in the design, development, and production of antisubmarine fire control systems and components.

Probably the most significant fire control study undertaken by Librascope was one which led to the Navy's first shipboard digital computer for anti-submarine warfare, now in production at Librascope. The basic objective of the program was the recommendation to the Naval Bureau of Ordnance for an advanced underwater fire control system which would utilize fully the latest techniques in target location, data processing, computation, instrumentation, and humanization.

To assist in the system research and design of antisubmarine fire control systems, a Simulation Laboratory has been designed and constructed by Librascope. It provides the Navy with a means for testing and analyzing the dynamic performance of antisubmarine fire control equipment under controlled laboratory conditions that realistically approach actual attacks at sea. The equipment is subjected to simulated operational stresses, and the effects on its operation are recorded.

Tank Artillery Computer. An extensive study program was conducted in order to recommend an advanced computer concerned with super-elevation and lead-angle corrections for a 90mm tank gun. These corrections are required for both fixed and moving targets. With these corrections, accurate "first shot" aiming of the tank gun can be achieved.

The proposed computer has two storage media: magnetic tape and a magnetic drum. The program of mathematical operations required for the solution of the problem is prerecorded on the tape. The magnetic drum is used for temporary storage of data upon which mathematical operations are being performed. The problem solution time is one second, after which the two computer outputs are corrected.

The two principal inputs are range, which is obtained from the rangefinder, and azimuth rate, which is automatically introduced into the computer while the target is being tracked. Other inputs are ammunition type, percent range corrections, cross wind, cross-level angle, and horizontal and vertical corrections. The computer will solve problems for any one of four ammunition types. Corrections for super-elevation and lead-angle are servo outputs.

Vehicle Navigation System. Librascope is completing a Vehicle Navigation Study for Engineering Research and Development Laboratories, U. S. Army Fort Belvoir, Virginia. A detailed mathematical derivation of the position-error statistics associated with vehicle dead-reckoning navigation systems is presented. It is based on a linear error analysis of vehicle navigation equations. Statistics are combined to find the probability (P) that vehicle is within 2 percent of the actual position. Types of errors are also discussed.

Company-Sponsored Programs. Librascope has a continuous self-sponsored program for product research and improvement. The magnitude and success of this program is evidenced by the variety of Librascope products and by the company's high position in the fast-growing computer field. Such products as the LGP-30 digital computer, the AN/ASN-24 digital computer, and the many computer accessories and components, both digital and analog, are the result of imaginative, effective study programs.

Current studies lead into all phases of computer and components research and development. Many products for both military and commercial application have resulted directly from these programs. Additional representative studies include:

Interference Filters

Infrared Detectors

Magnetic Films

Electroluminescence

Thermoelectric Circuits

Digital Sensors

Solid-State Computer Elements

Converters, Analog-to-Digital

Evolution and Development of Intelligent Machines

Vehicle Presence Detector

X-Y Plotters

Miniaturized Digital Computer Components Packaging

Investigation of Analytical Instruments

Standardized Building-Block Computer Study. A study has been concluded for the Wright Air Development Center under contract number AF 33(616)5757 to provide a building-block approach to the design of computing equipment for airborne weapon systems. This study involved first the recognition of the fundamental requirement of the use of parallelism in order to obtain growth potential. The possible methods for obtaining parallelism were then analyzed in terms of their fundamental characteristics such as efficiency, reliability, etc.

This building-block approach will be applied to the proposed computer to obtain the additional desirable features:

(a) Extremely high adaptability which will permit the computing system to be increased on a building-block basis to meet new system requirements.

(b) A high degree of adaptability to new component developments when their incorporation seems warranted.

(c) Redundancy at a minimum cost in size, weight, and price.

(d) Continuous and automatic malfunction checking on each of the building blocks while they are operating.

(e) Automatic rejection of malfunctioning building blocks and subsequent effective solution of the problem by the balance of the computer system.

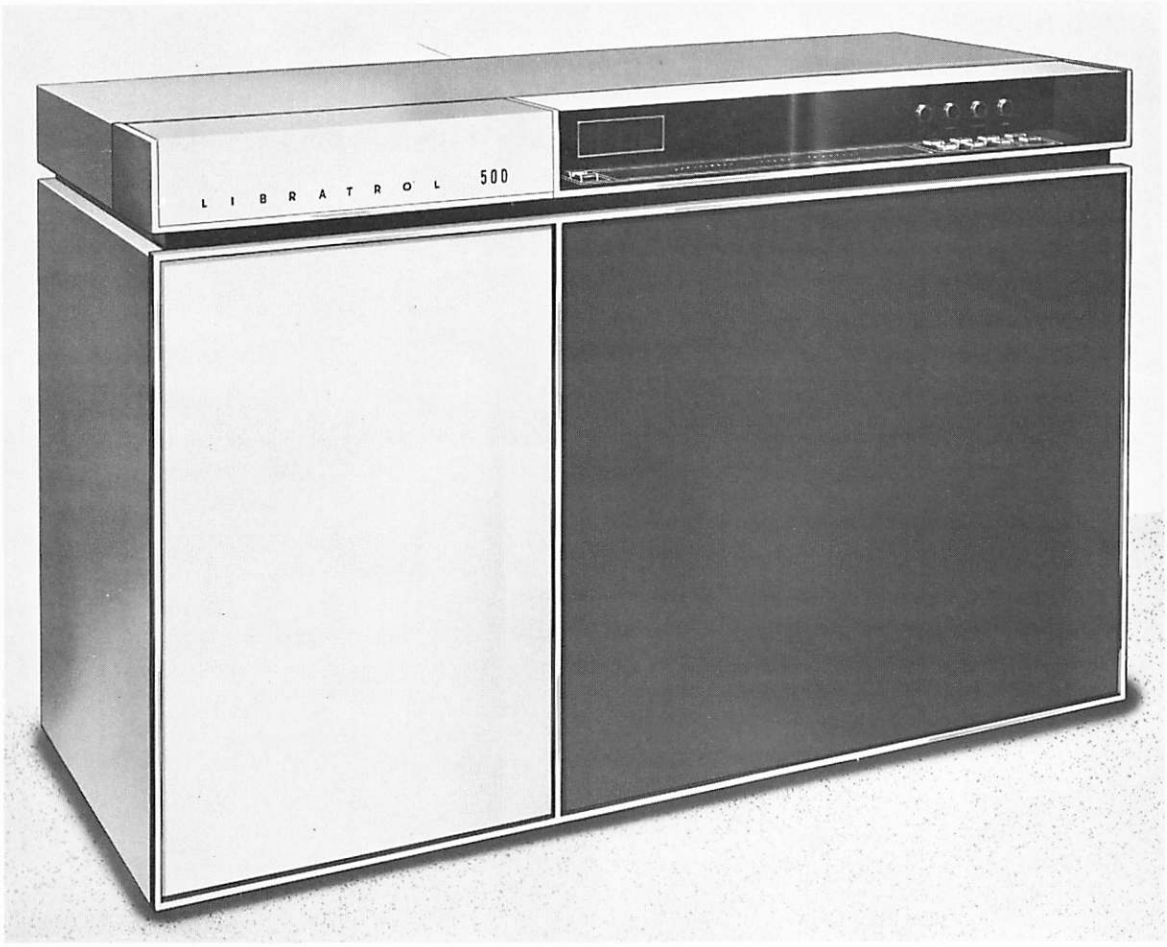
(f) Automatic re-insertion of the building block into the computer system if the malfunction is only temporary.

(g) Reduced calendar time for system development and modification.

(h) Reduced maintenance and training problems.

6.0 SYSTEMS AND COMPONENTS

Librascope has designed, developed, and manufactured computing, data-handling, and control systems and instruments for both military and commercial use. A few representative examples of these are described briefly in the following pages.



LIBRATROL - 500 COMPUTER

In September, 1958, Librascope announced the LIBRATROL-500, one of the first Digital Control Computers put on the market for on-line process monitoring and control. This machine incorporates in one console in addition to a 4096-word computer a commutator for scanning process variables, voltage-to-digital converter, digital clock, and output circuits for both digital and analog process controllers.

The LIBRATROL-500 system can handle voltage inputs at the rate of 60 per second, accomplishing an accurate conversion to digital (binary) form at the same time. It has a repertoire of 17 instructions for programming. A principal design feature is a 64-word recirculating line on the magnetic memory drum which acts on a high-speed buffer for real time input-output actions.

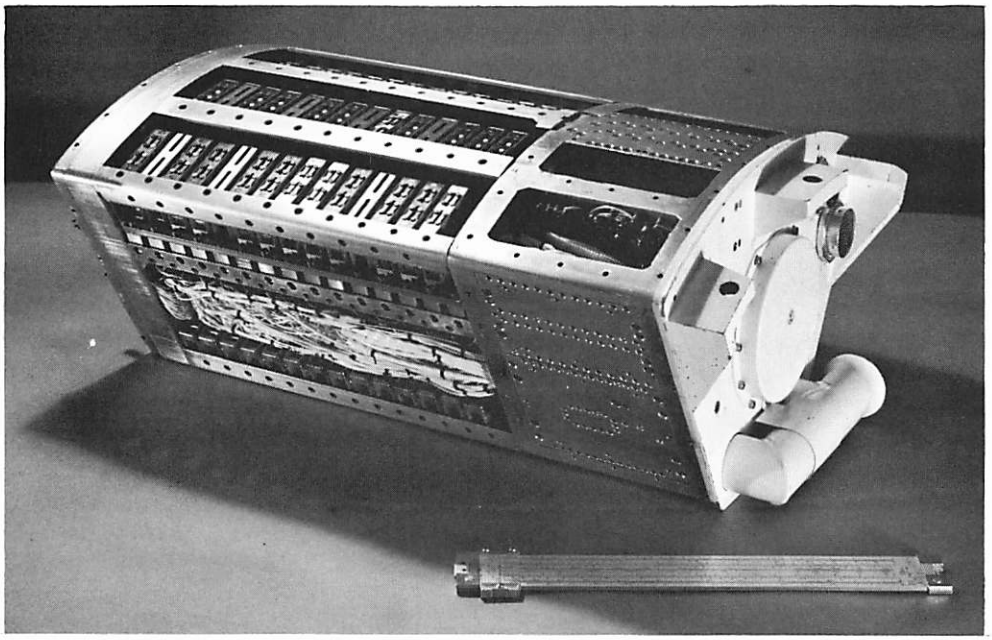
A total of six LIBRATROL-500 systems have been delivered, and all are currently in operation.

LIBRATROL-1000 SYSTEM

The LIBRATROL-1000 is a solid-state, process control computer system. It was first shown to the public in September 1960, and the first installation was made in 1961. Data is received from analog monitoring devices, converted to digital form, and processed by means of a digital computer. Accurate control information is provided either for a human operator or for automatic control elements of the external system.

The basic unit of this process control system is a highly-reliable, solid-state, general purpose digital computer incorporating magnetic drum memory with a capacity of 8008 32-bit words. A typical minimum command execution time is one millisecond. Organization is serial-binary, double-address, permitting the operand address and the address of the next instruction, as well as an added instruction, to be placed in one word.

Operating on the input data supplied by the process instrumentation, the computer performs the computation, logical manipulations, and switching required to effect the proper control operation.



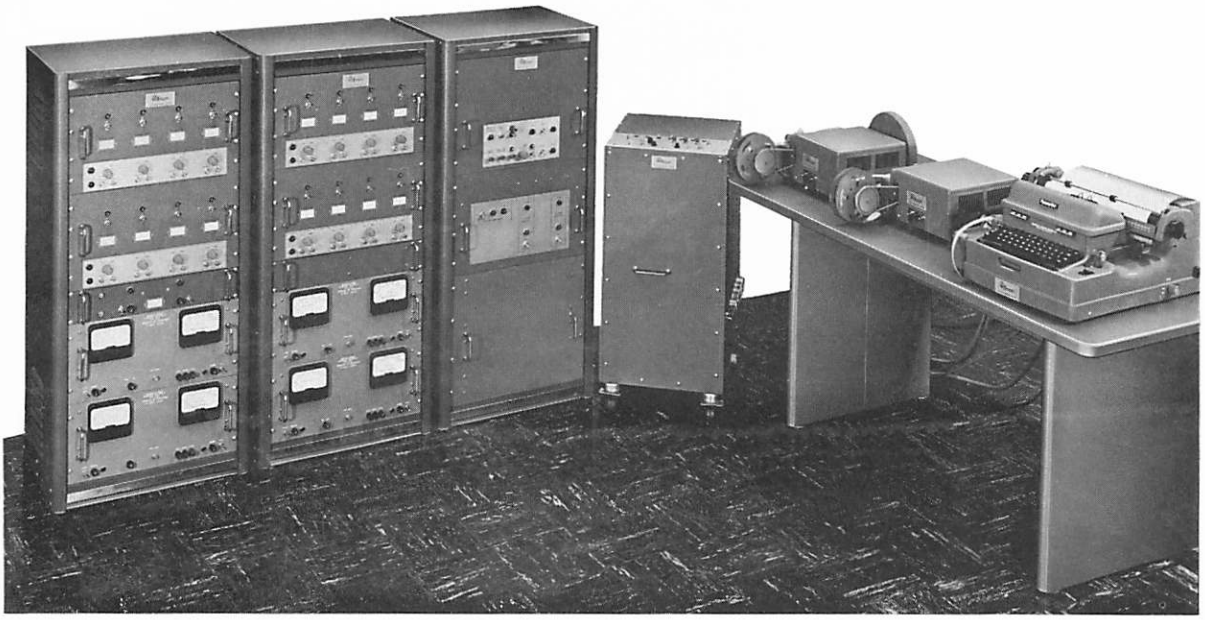
L-600 COMPUTER

Developed in 1959 and first announced in 1960, the Librascope L-600 Computer is a highly compact, solid-state computer of the general-purpose type, and is readily adaptable to a large number of possible applications. It is designed for military applications where space, weight, power, and environmental considerations are important. It contains a 3000-word magnetic memory drum, 420 silicon transistors, and 4000 silicon diodes. With a drum speed of 6000 rpm, the clock frequency is 140 kilocycles per second.

The computer is divided into four functional units: a general-purpose computing unit, an input-output, an integrator, and a velocity accumulator. The general-purpose unit can utilize up to 3000 words of memory storage, including 128 words of temporary storage.

The input-output unit accepts four inputs from up-down counters and processes each input at a rate of 2400 times per second. Digital output information from the computing unit is translated into analog form for use by the missile. The integrator section integrates input distance quantities, generates time and/or time-to-go values, and generates integrated output signals to digital-to-analog converters. The fast accumulator section performs accumulation of velocities at the rate of 2400 times per second. This information is then transferred at a slower rate to the integrator section.

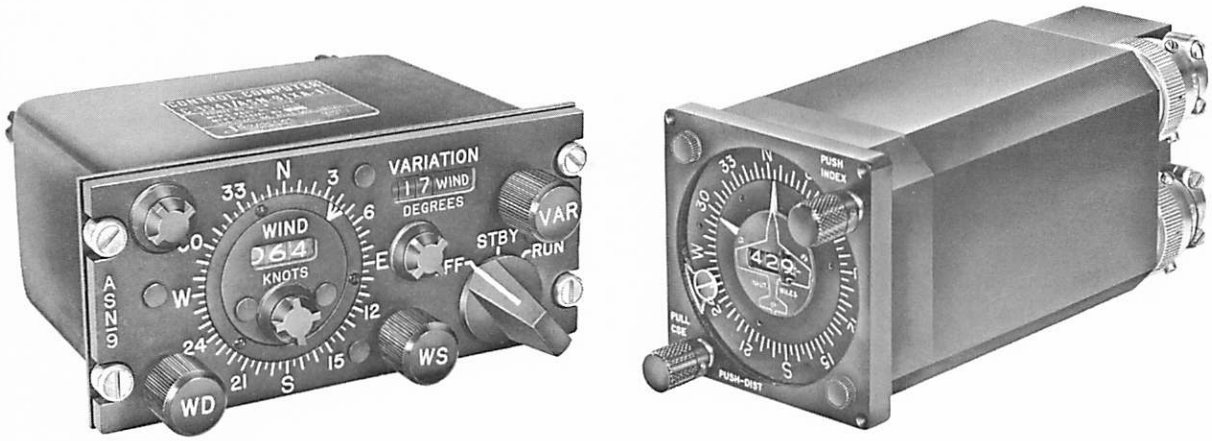
The computer weighs 56 pounds, occupies 0.9 cubic feet of space, and requires 210 watts of electrical power. It has been manufactured in pilot production quantities for a missile control application.



MODEL 208 DATA RECORDER

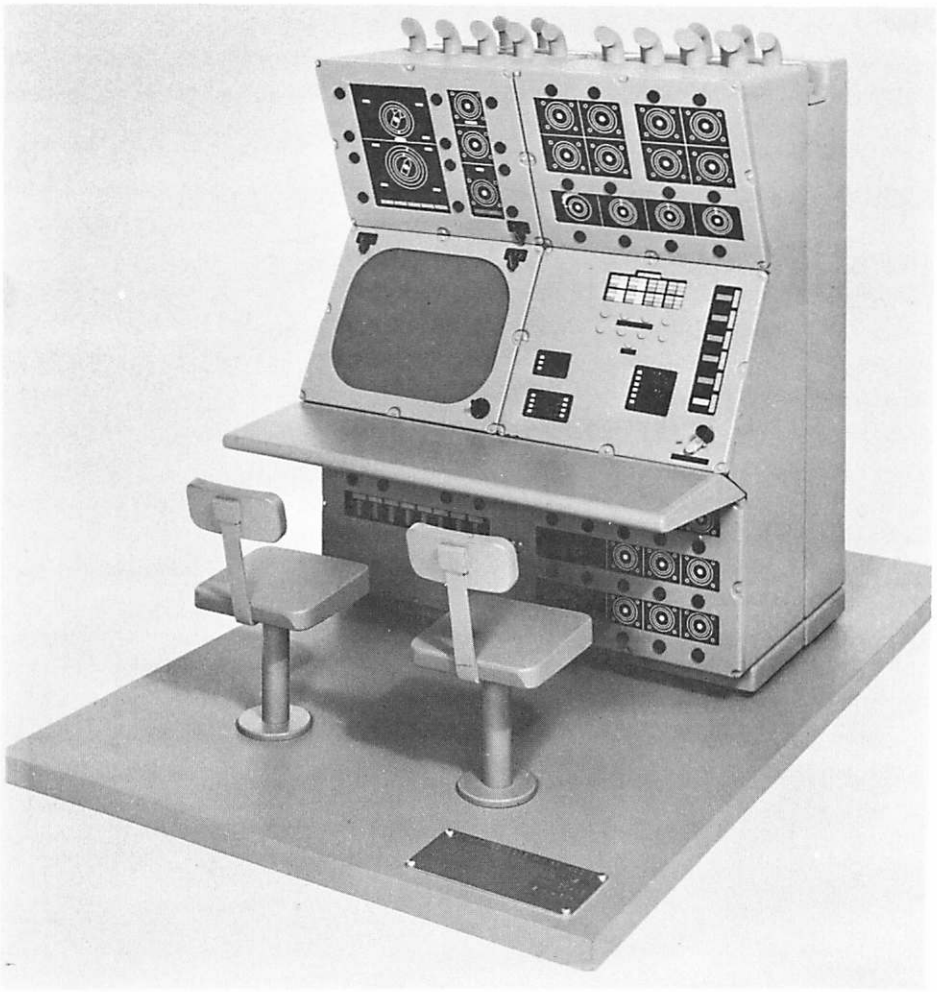
Late in 1954, the U. S. Navy asked Librascope to develop a very fast data recording system to use in the evaluation of the Mark 107 Anti-Submarine Fire Control System. The data was to be captured during actual tests at sea of the fire control system, and prepared for later reduction and analysis by computers.

The problem involved instantaneous scanning of 20 constantly-changing analog variables every 3 seconds, and storing the data on punched paper tape. These requirements were met by programming a scan matrix to sample 20 shaft-to-digital encoders and store the binary-coded readings temporarily on a magnetic drum. This scan-and-store operation was accomplished in 800 microseconds, and slightly over 2 seconds were then required to transfer the data to punched paper tape. The Model 208 Data Recorder System was first used in actual evaluation of the fire control system on the USS Dealey in 1955, and due to its flexibility was later used on two other vessels. It used subminiature vacuum tubes in the digital portion and was designed to accommodate 100 digitized inputs.



AN/ASN-9 AIRPLANE NAVIGATION COMPUTER

The AN/ASN-9 Airplane Navigation Computer is a dead-reckoning navigational computer. It is an electromechanical device designed to provide the pilot with steering and position information with a minimum penalty of weight and size. It is therefore ideal for use in light planes and helicopters. The computer can be used in flying to a predetermined destination or indicating at all times the direction and distance to home base. This permits the pilot to fly a tactical mission with relative freedom from navigation based on ground identification. The computer consists of an indicator and a control. Its total weight is 6. 5 pounds and its total volume is 0. 073 cubic feet.



MK 111 DIGITAL COMPUTER

In 1957, working under contracts with the U. S. Navy, Librascope began development of digital computers for use on board ships for anti-submarine fire control. The first result of this program was a digital computer for the Mk 111 Fire Control Group, pictured above. The Mk 111 consists of a control console with an integrated digital computer which is the heart of a revolutionary anti-submarine weapon system. The solid-state computer contains approximately 5000 silicon transistors and 25,000 silicon diodes, and has a magnetic drum memory of approximately 8000 words capacity. Approximately 450 printed circuit boards are used, and the circuits have been designed to operate over a temperature range of -20° C to +100° C. Although the present system does not require it, the input-output register is flexible enough in design to be used with other input-output media, such as magnetic tape, telemetry equipment, or another fire control computer.

FIRE CONTROL SYSTEM MK 113

Pictured above is the attack console of Fire Control System Mk 113. This system is submarine-borne and designed primarily for anti-submarine warfare. The system receives information relating to several targets from sonar, radar, optical instruments, or consort ship. It analyzes the information for target motion and position; solves ballistic problems and sends orders simultaneously to several weapons; and provides instrumentation and controls for monitoring and firing the weapons. The system includes all required indicating, transmitting, amplifying, and plotting equipment.

Design of the system employs the building-block concept which allows many configurations to meet various analyzing, attacking, and controlling requirements.

Librascope manufactures the following equipment used in Fire Control System Mk 113:

Digital Computer Mk 130

Attack Control Console Mk 50

Analyzer Console Mk 51

Attack Director Mk 75

Leveling Computer Mk 129

Amplifier Mk 140

Reference Sensing Element Mk 1

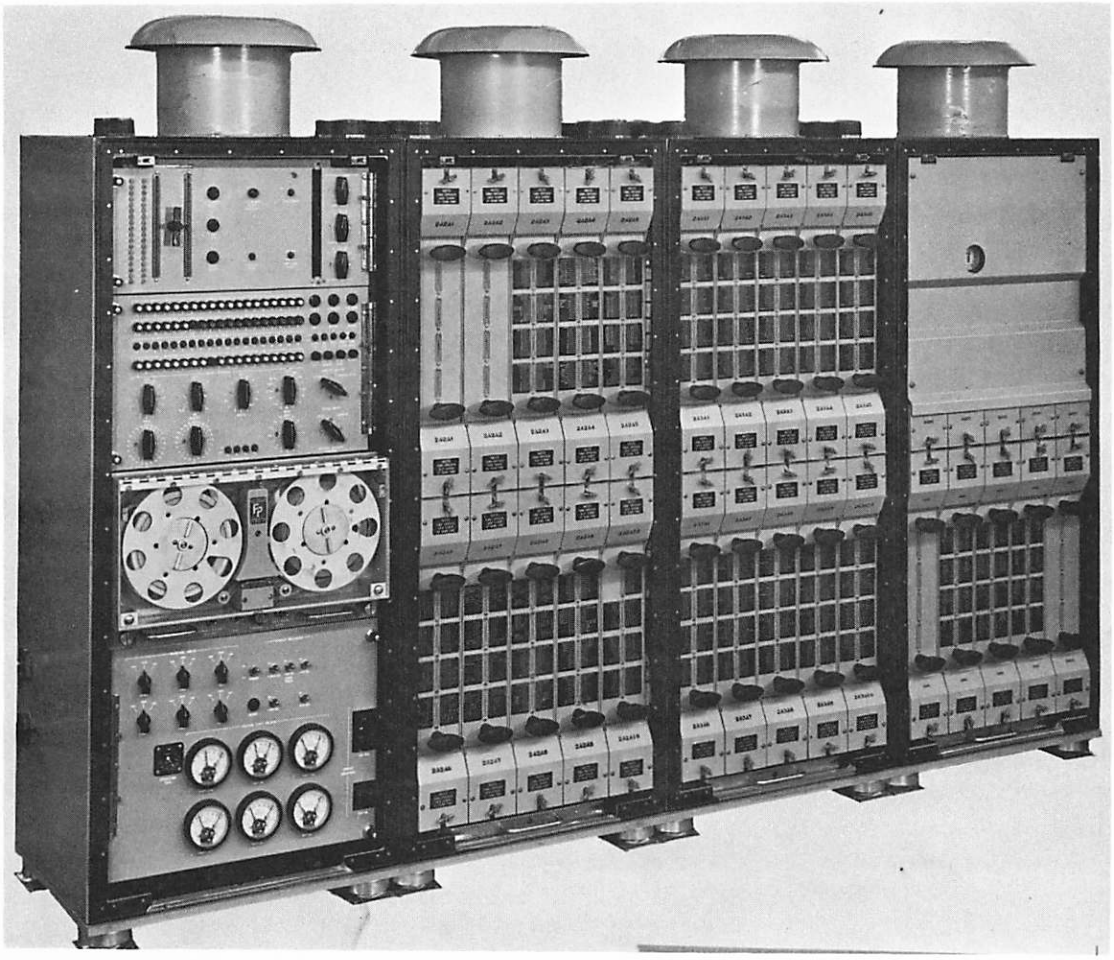
Reference Sensing Element Amplifier Mk 158

Weapon Monitoring Panel Mk 19

Missile Heater Controller Mk 24

Missile Simulator Mk 10

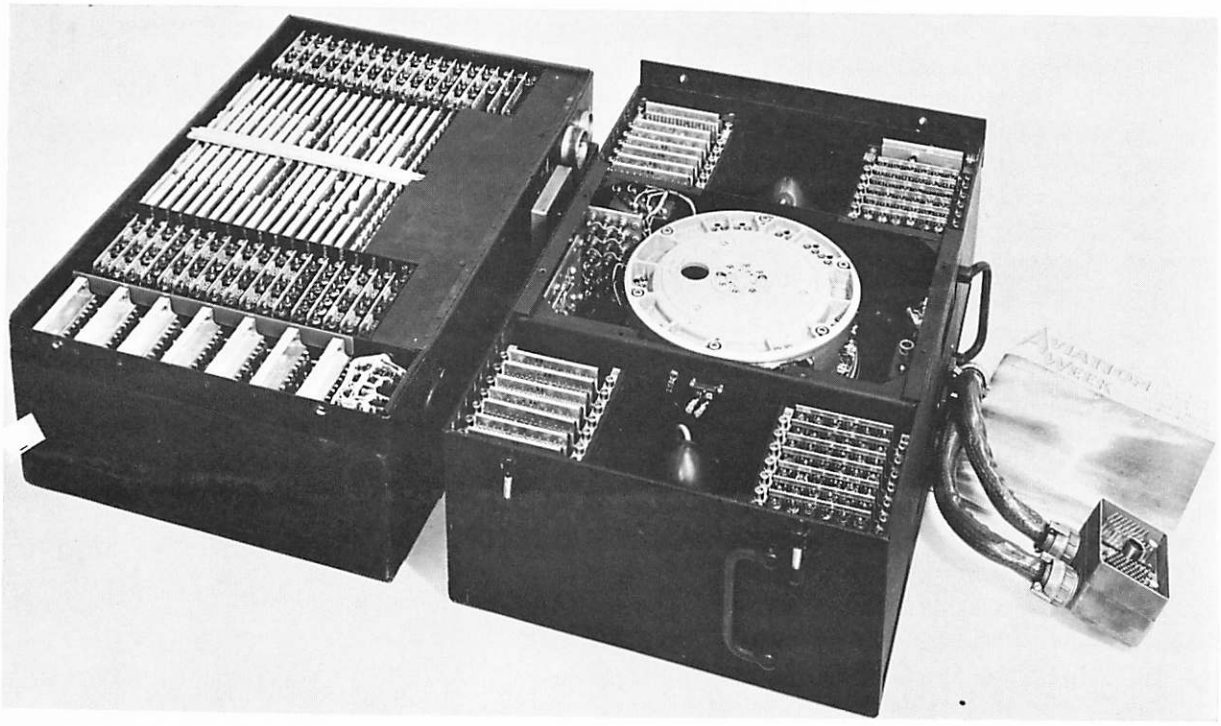
Stabilization Control Unit Mk 83



MK 130 DIGITAL COMPUTER

For the Missile Fire Control System Mk 113, a submarine/antisubmarine weapon control system, Librascope began in July 1958 to design and develop Mk 130 Digital Computer and Mk 50 Attack Console. Both digital and analog data may be handled in detail in this system. The digital inputs include switched-relay inputs, Flexowriter with paper tape, high-speed (330 characters per second) photoelectric paper tape reader, and a 152-bit input buffer. The output includes relays, indicator lamps, tape punch, and a 228-bit output capability.

Analog-to-digital conversion is employed for analog data. A 399-bit magnetostrictive buffer permits high-speed switching to output devices. The main working storage is a 4096-word core memory. The read and write cycle is 20 microseconds. Add time is 40 microseconds and multiply time 40 to 424 microseconds.

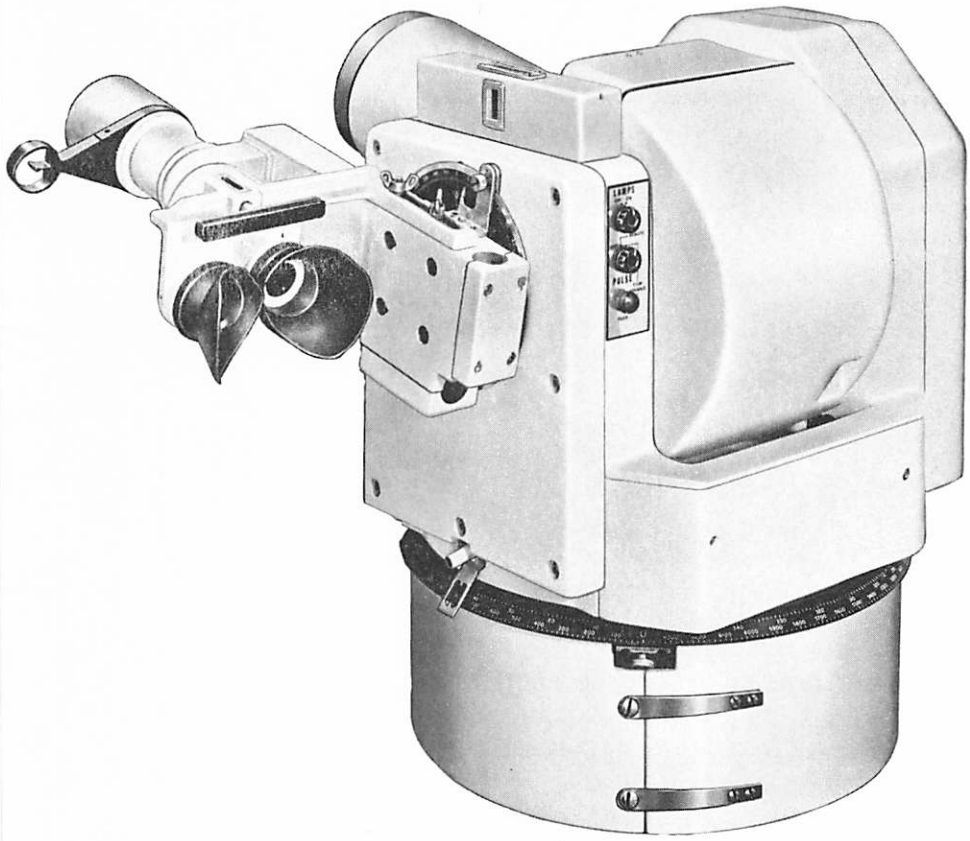


CP-209 COMPUTER

In 1952 Librascope began a theoretical study of digital techniques and began the building of prototype models of an airborne digital computer for military use. This effort led to a production contract in 1957 to supply the CP-209 Computer, a digital differential analyzer for installation in Douglas A3D-type aircraft. This instrument was the first airborne digital bombing and navigation computer to go into production for the Department of Defense.

In actual flight testing, the prototype CP-209 unit operated for 1000 hours without a single in-flight failure, and its extreme accuracy exceeded all expectations.

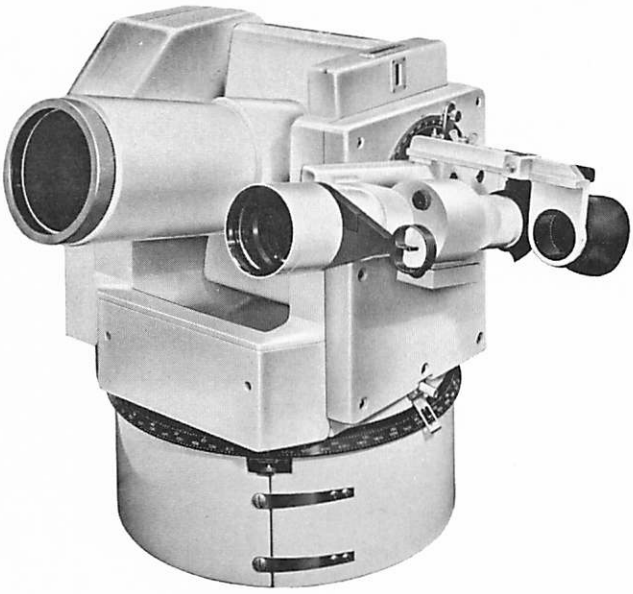
This computer uses 4500 silicon diodes, 100 silicon junction transistors, and 307 subminiature vacuum tubes. It communicates with control and position information elements in the aircraft through 26 input-output channels.

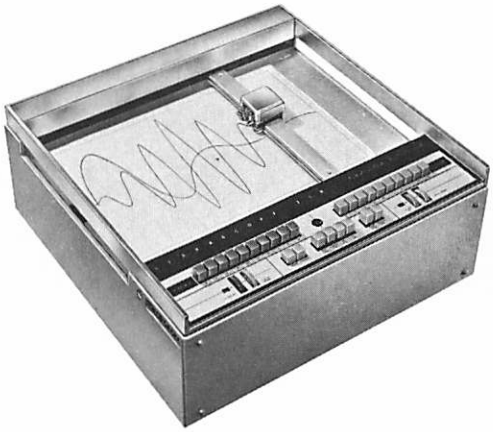


PULSED CINE PHOTOTHEODOLITE

Pulsed Cine Theodolites have been designed and produced by Librascope for the Air Force. Two or more of these instruments, controlled by a central station, are used together for tracking and ranging aircraft or missiles in flight. Flight path information is obtained from 35 mm photographs taken synchronously by each instrument. The photographs are taken upon demand pulse from the central station at a maximum rate of 10 frames per second. The angular direction of the optical axis of the instrument and frame number are recorded on each frame at the moment the picture is taken. The main lens has a focal length of 24 inches, at f/5.6, with a 2-1/2 degree field-of-view, and the shutter speeds are 1/100 to 1/200 second.

Film magazine capacity is 100 feet and no threading of the film is necessary. Photographic accuracy is ± 15 seconds of arc. The instrument is mounted on a concrete pedestal, but can be readily transported between pedestals at different locations. The main castings are thermally insulated to ensure negligible temperature gradients within the instrument at all times. Carbon main bearings are used for uniformity of breakaway and dynamic torque characteristics. For ruggedness and consistency, leveling is accomplished over a large spherical surface. Librascope's Pulsed Cine Photo Theodolite weighs approximately 135 pounds; instruments of this type generally weigh 700 pounds or more.

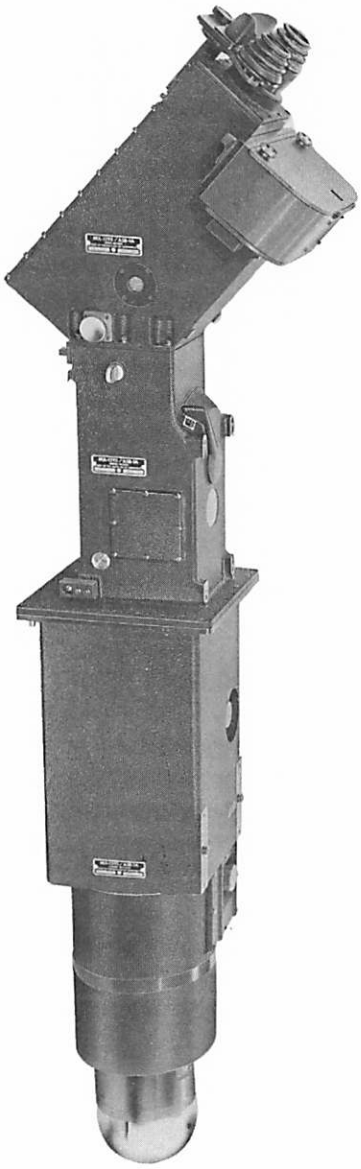




TAKE-OFF AND LANDING CAMERA

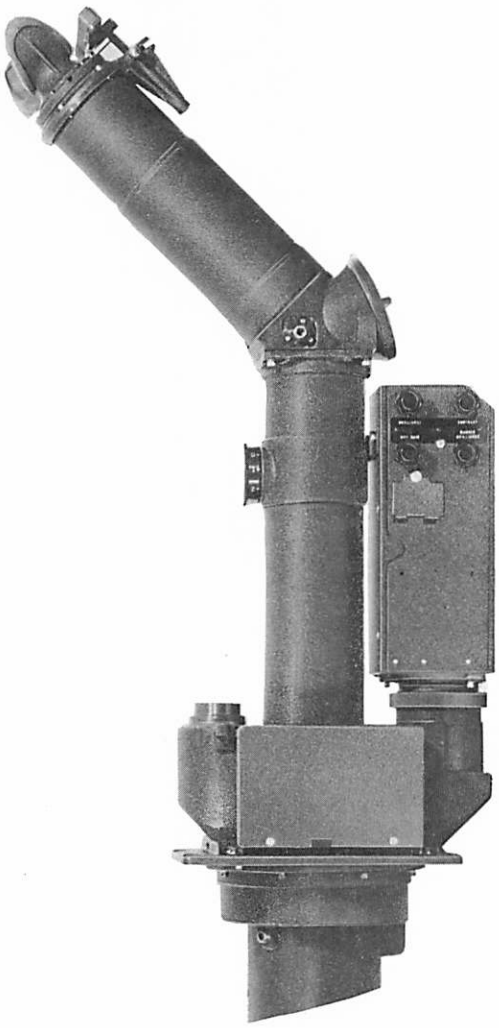
The take-off and landing camera is essentially the same as the previously-described pulsed cine phototheodolite. It is used by itself in tracking, on the assumption that the object being tracked remains within a single vertical plane at a known distance from the instrument. Computing elements, incorporated within the instrument housing, furnish electrical analog voltages to Librascope X-Y Plotters which are supplied with the instrument. These plotters, in turn, chart the horizontal and vertical position of the object in the reference plane, as well as the horizontal velocity, and the vertical velocity versus the horizontal position. This information is immediately available and can be checked, if necessary, from the photographic record produced by the instrument. The main lens has a 12-inch focal length, an f number of 5.0 and a 5° field. The control pulses for taking pictures are supplied by an accurate 10-pps local oscillator, or can be furnished from an external source at any rate up to 10 per second.

The weight of this device is 80% less than is usual for most units of this type.



PERISCOPE MX-1295/ASB-1A

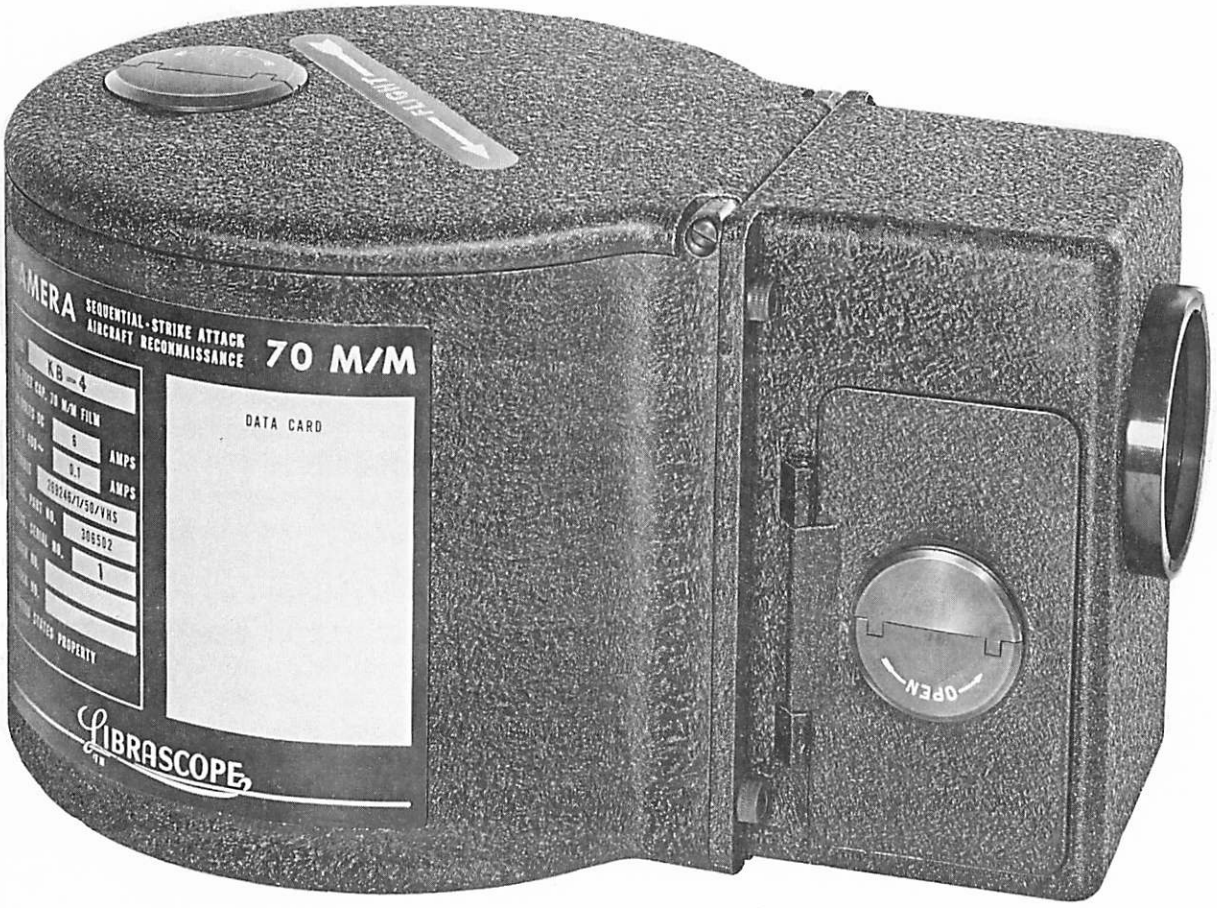
Airborne Periscope MX-1295/ASB-1A, the mechanical parts of which were designed by Librascope, has design features which include integral coordinate transformer and stabilization mechanisms, operable up to ±30 degrees roll and pitch, for maintaining a prism-directed line of sight accurate to four mils to a target located anywhere within a hyper-hemisphere. The periscope provides optical fields of view of 45 degrees at 1.5 power and 45-second resolution, or 11 degrees at 6.0 power and 15-second resolution. It also provides a radar image of the area about the selected target point and continuously indicates the location of a computer aim point by means of a reticle superimposed in the field of view. Nearly 150 of these periscopes have been built by Librascope under various production contracts.



RECORDING CAMERA FOR MX1681 PERISCOPE

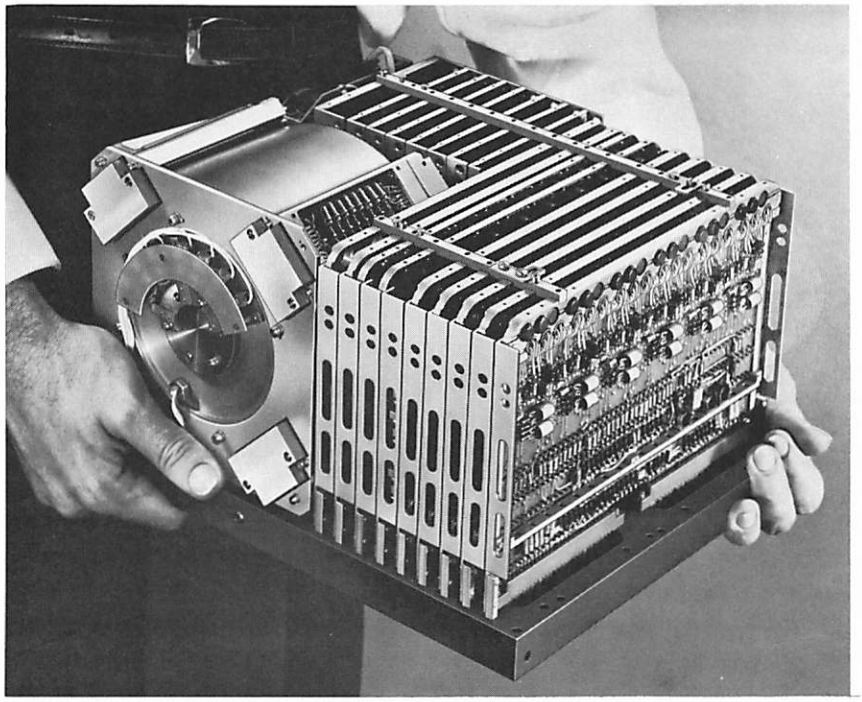
Recording Camera for MX1681 Periscope. The recording camera for the MX-1681 periscope was designed and developed for the U. S. Navy Bureau of Ordnance. It is a pulse-type camera, and can operate at speeds up to two frames per second.

The unit features a 100-foot capacity 70mm film magazine. The film sprockets and the picture plane are part of the magazine. No film threading is necessary when loading the magazine in the camera. An all-metal focal plane shutter with speeds of 1/25, 1/50, 1/100, 1/200, and 1/400 second is spring driven. A motor winds the spring when the film is advanced. On each picture frame, the camera records the frame number, time, typing on dual 1-inch data cards, and the signals of four on-off lights. These are all directly-recorded data and need no decoding.



KB-4 STRIKE CAMERA

The Librascope 70mm KB-4 Strike Camera is used in photographing air-to-ground rockets and bombs released from fighter aircraft. Photographs are taken before, after, and at point of impact. The camera is also used for low-altitude reconnaissance. After the film is loaded and initial settings are made, the camera operates automatically.



AN/ASN-24 COMPUTER

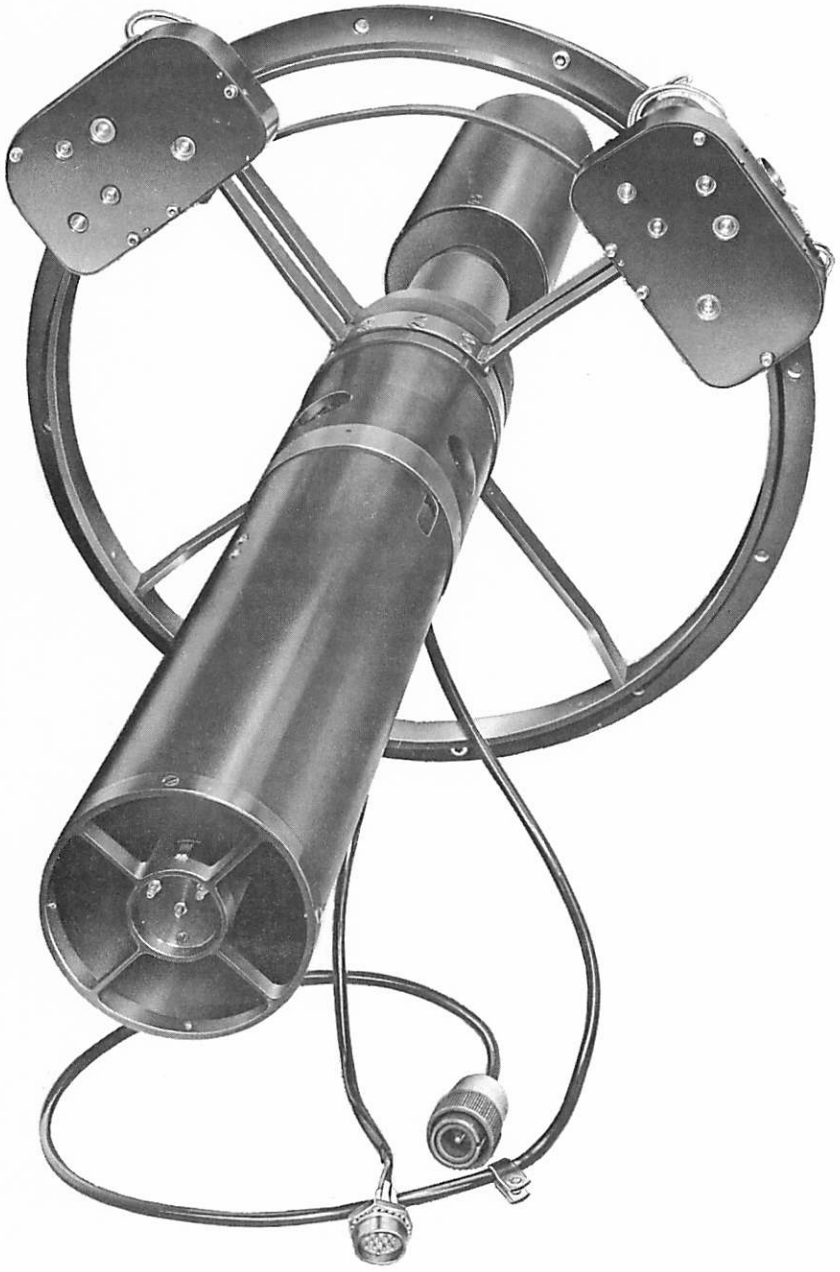
The AN/ASN-24 is an extremely compact, ruggedized service-environment, general-purpose computer. It is the result of a Librascope and Wright Air Development Center program, and was delivered to WADC in September, 1958, for laboratory demonstration and flight test. It is employed in navigation, guidance, weapon control, and space applications. A modified AN/ASN-24 is being used in the Centaur version of SATURN.

This computer employs a stored program which may be altered to accommodate new requirements. Input-output arrangement is also adaptable to a variety of applications.

The main memory storage is a 2048-word magnetic drum. Each word has 25 bits, permitting a resolution during computation to one part in 32 million. The solid-state circuit design permits operation from -65° C to +100° C. The computer weighs 32 pounds, has a volume of 0.8 cubic feet, and requires 120 watts of power.

Forty different computer operations include generation of discrete signals, extracting, and shifting, in addition to the basic add, subtract, multiply, divide, store, and transfer functions. Typical add time is 0.6 milliseconds, while multiplication time averages 2.5 milliseconds. Subroutines include trigonometric, inverse trigonometric, and square root functions.

The AN/ASN-24 complies with military specifications governing temperature, humidity, shock, vibration, and radiation.



STAR TRACKER

The Star Tracker was developed at Librascope for Johns Hopkins University under a Navy contract. This equipment, when pointed toward a star, "locks on" and then tracks the star. Incoming light is modulated at the focal plane of the objective by a semicircle shutter. The light is then directed by a field lens to a photomultiplier. When servos drive the target to the exact center of the field, the light is no longer modulated and the servos are nulled.

L-3000 SERIES DATA PROCESSING SYSTEMS

The computer, drum file, and program consoles shown above are components of the L-3000 Series Data Processing Systems, a family of large-scale, solid-state system designed for broad real-time data processing and computing. The first installation of an L-3000 system was made in 1960 at NAFEC, Atlantic City, New Jersey.

Major features of the NAFEC installation system include: (1) exceptional system reliability and flexibility; (2) a random access, random storage, high-speed, modular drum file having a maximum capacity of 14, 000, 000 bits in modules of 896, 000 bits and controlled by an automatic file control unit; (3) a computer console containing a 4000-word (224, 000 bits), 6-microsecond magnetic core memory, dual adder and extensive parity checking, with all arithmetic operations checked automatically; (4) a flexible input-output buffer that provides sophisticated capabilities for integrating operator consoles, tabular displays, and other input and output devices, such as teletype, digital data channels, typewriters, and printer-punch units.

Expandable memory and a file search technique based on record content as a key, rather than memory location, are outstanding features of all L-3000 systems.

In 1961, Librascope announced the L-3060 Data Processing System, a continuation of the L-3000 series. The L-3060 system features a faster memory cycle (2 to 5 microseconds), and both magnetic tape and magnetic disc file memory modules.

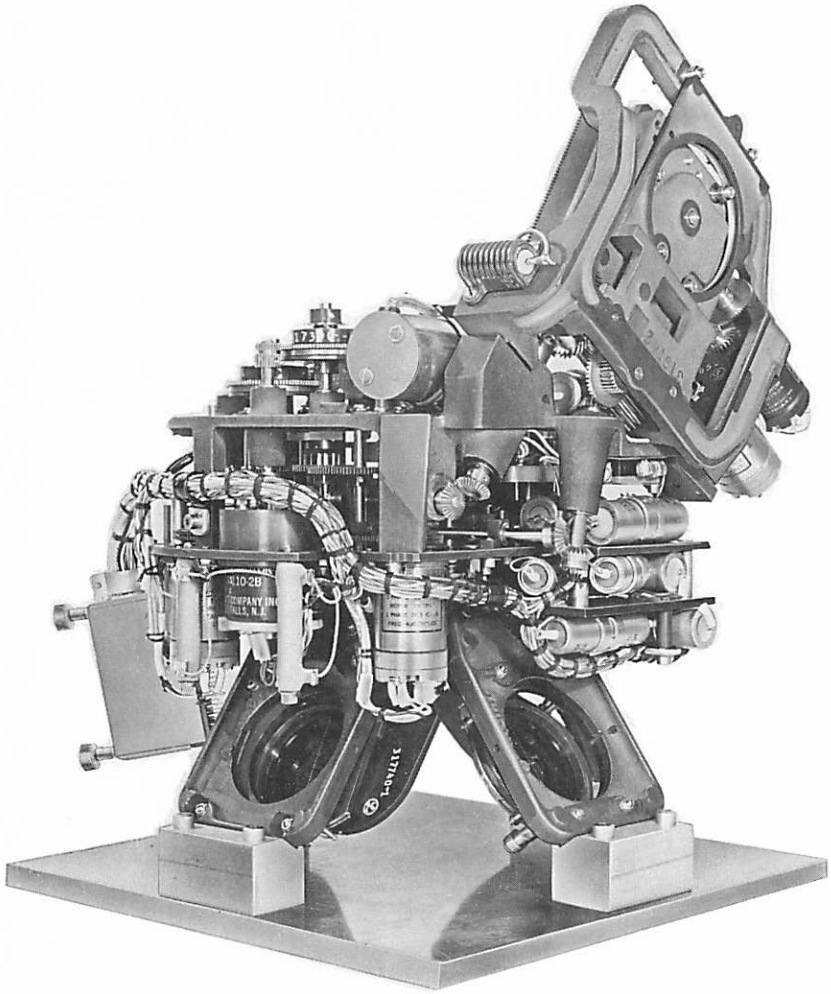


PHOTO-NAVIGATIONAL VIEWFINDER

The Photo-Navigational Viewfinder is currently being produced by Librascope for installation in Douglas A3D-2P aircraft. Through its use, an operator can monitor a battery of cameras to prevent incorrect overlap in photographs of terrain. Roll and pitch is automatically stabilized from the same signals used for camera stabilization. Manual drift and input to the viewfinder is simultaneously fed to the camera mounts.

Main functions of the viewfinder are: (1) to aid photo-reconnaissance pilots and photo-navigators in determining ground speed and drift, (2) to assist in maintaining track line flight, (3) to monitor image motion compensation to allow manual corrections, and (4) to provide field coverage indication for various cameras.

The viewfinder system consists of two viewfinders, one attitude indicator (for the pilot), two control boxes, one electronic package, two ground speed computers, and two data plates. The system provides for a forward oblique or a vertical view in narrow or wide angle to aid in locating photographic targets on the terrain and in determining exposure interval, ground speed, and drift. A traveling grid system in the wide angle field helps the operator monitor and correct image motion compensation.

RPC-9000 ELECTRONIC DATA PROCESSING SYSTEM

First announced in 1960, the RPC-9000 is a solid-state, medium-scale, automatic data processing system. The basic system includes a high-speed, internally-stored-program computer, a punched paper tape and typewriter input-output system, and a magnetic tape storage unit. Additional peripheral equipment includes high-speed paper tape readers and punches, punched card readers, and line printers.

The computer in the RPC-9000 provides the functions of calculation, internal storage, program control, buffering, and tape search. The electric encoding-decoding typewriter is used for direct computer input and output or for off-line tape preparation. The typewriter operates at a speed of 10 characters per second as an automatic output typing station. The punched paper tape console contains a 60-character-per-second reader, and a 30-character-per-second punch. All units can operate independently or together.

The magnetic tape storage unit provides a large capacity memory for the RPC-9000. Magnetic tape in an endless loop circulates continuously at high speed. Separate reading and recording stations permit record updating in the same cycle. Data may be filed in random order, or in any desired sequence. Information retrieval is on the basis of content, not location. Maximum capacity for one loop is 10, 000 records (approximately 1, 000, 000 alpha-numeric characters.) As many as 16 magnetic tape storage units may be connected on-line. Off-line file storage of quickly interchangeable tape cartridges is unlimited. The high-speed Elliott card reader is used for input. The magnetostrictive internal memory provides economical, rapid-access storage of 21, 504 bits.

AUXILIARY TAPE DRUM SYSTEM

The Librascope Auxiliary Tape Drum System performs the function of an additional 24,576-word memory storage for the FADAC computer. The tapes are stored in interchangeable cartridges, and this interchangeability provides the FADAC computer with the necessary program flexibility. Each cartridge may contain memory storage which is permanent or which may be revised according to FADAC computer program control. The unit illustrated is a laboratory model. Smaller units to Army specifications can be built.

This unique tape memory was supplied to the Department of the Army for arsenal use. A field army version is being proposed by Librascope. It is complete with read/write circuitry, power supply, magnetic heads, and tape transport. The unique system has an expandable storage of 19,267,584 bits in its present form. As supplied to the Department of the Army, it has 84 feet in a continuous tape loop. The average access time is four seconds.

The utility of this system is to provide a low-cost, compact, light memory essential to data processing in the field army environment. The same concept is presently supplied for business data processing in the RPC-9000. For field army application, this could be employed as a large data-processing memory. The militarized tape cartridge would be valuably employed in ballistic gun and missile data, traffic control, intelligence, parts inventory, and payroll data and storage.

The tape drum system operates from a 115-120V, 50-60 cycles AC RMS power source. Power connections are provided at the rear of the unit. There are ten channels on the tape. Six are information or drum load channels, three are used in tape timing, and the remaining one is a fixed block address. One ten-channel magnetic head is used for both reading and recording on the tape.

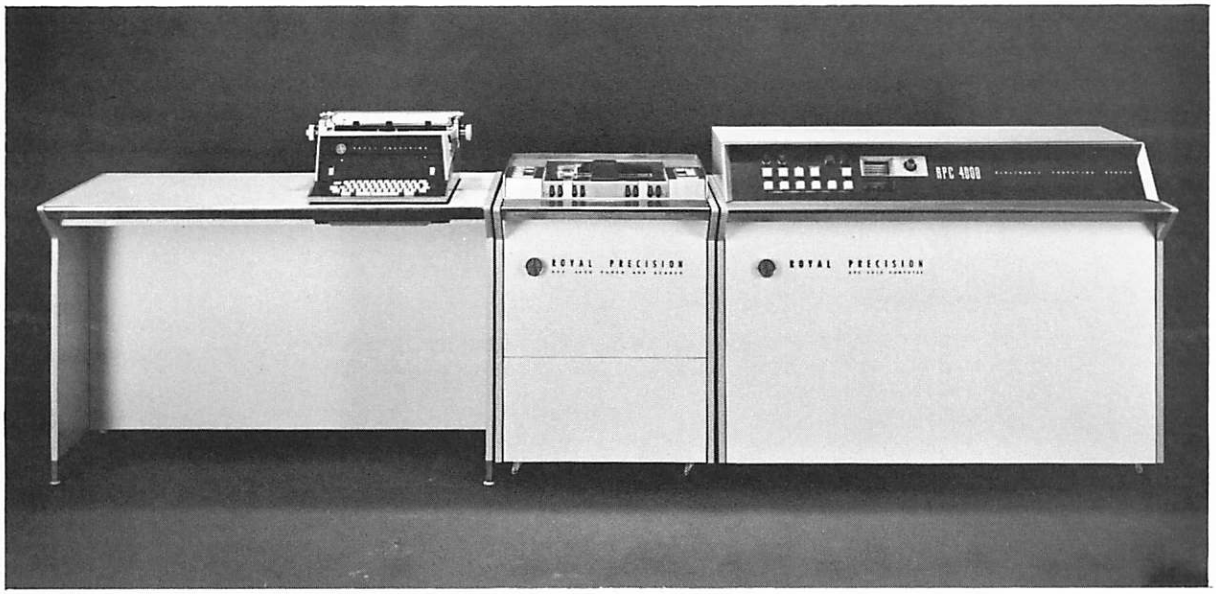
LGP-30 DIGITAL COMPUTER

To meet a growing need, Librascope began in 1954 the design of a desk-sized general purpose computer, which would be primarily useful for scientific and engineering calculations. The result was the LGP-30, pictured above. From 1957 to 1961, a total of 496 units of this machine were produced at Librascope.

The LGP-30 has a relatively simple command structure. Programming may be easily mastered by the engineer, and non-technical personnel may be trained very quickly to carry out routine computer operations. This eliminates detailed calculation and makes more time available for creative engineering.

The magnetic memory drum holds 4096 words. This feature gives the LGP-30 a memory capacity suitable for the majority of complex scientific problems that might be assigned to an automatic computer. Stored program operation means greater flexibility, since programs may be self-modifying.

An electric typewriter gives alpha-numeric entries or output by punched tape or keyboard. The computer is internally binary, permitting a desirable simplicity of design, yet the operator may enter information in customary decimal form and receive the results in decimal form.



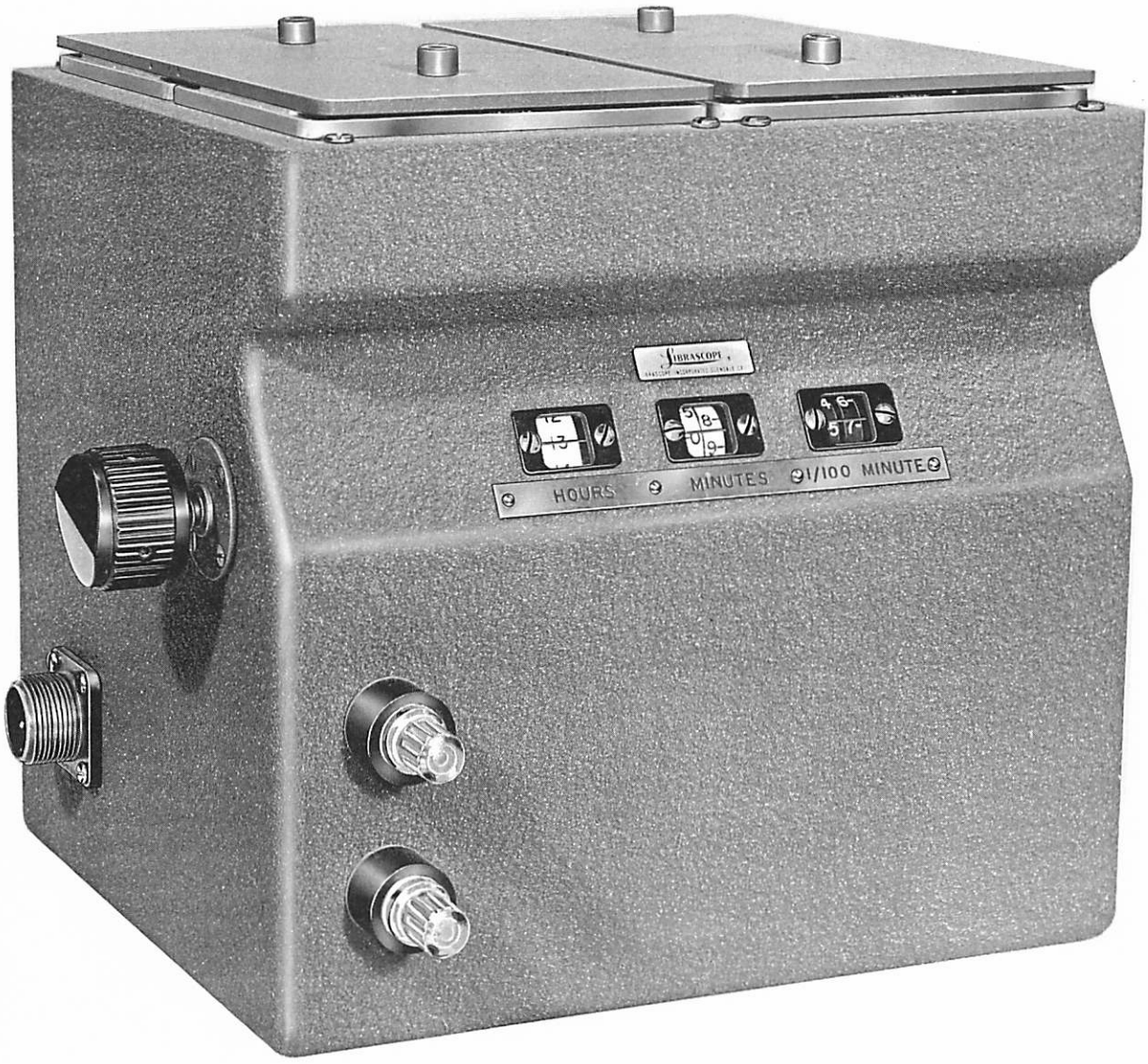
RPC-4000 ELECTRONIC COMPUTING SYSTEM

The RPC-4000, a completely solid-state electronic computing system manufactured at Librascope was announced in 1959. It is designed for engineering, scientific, business data processing, and management control functions. The RPC-4000 has a large memory, offers great problem-solving capacity and flexibility, and is easy to program and operate.

The heart of the RPC-4000 system is a solid-state computer with advanced design concepts that provide substantial computing speed and capacity in a low-cost unit. The magnetic memory drum stores 8008 words. Basic arithmetic is performed at a rate of 230,000 operations per minute.

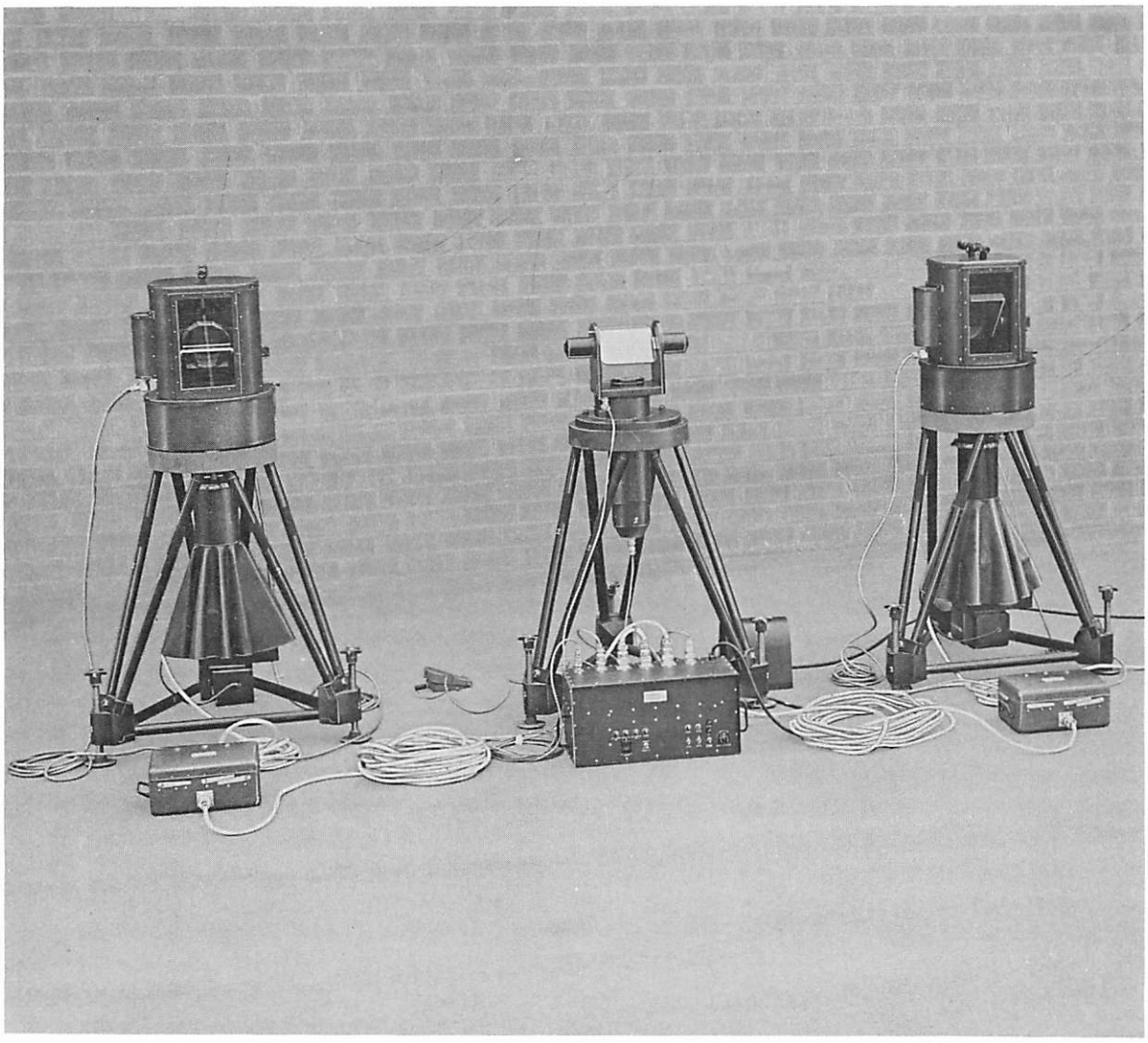
Standard input and output are provided by a tape-typewriter system, which includes a Royal electric encoding-decoding typewriter, complete with desk and chair, plus a tape punch-read console. Read speed is 60 characters per second; punch speed 30 characters per second. Typewriter, punch, and reader may be interconnected in any combination for both on-line and off-line operations.

A new 500-character-per-second photoelectric tape reader and a 300-character-per-second punch are available as optional input-output equipment. A magnetic tape unit and a line printer will be available soon. As many as 17 input-output devices (60, with minor modification) may be connected on-line to the basic system. All peripheral equipment is under automatic program control of the computer.



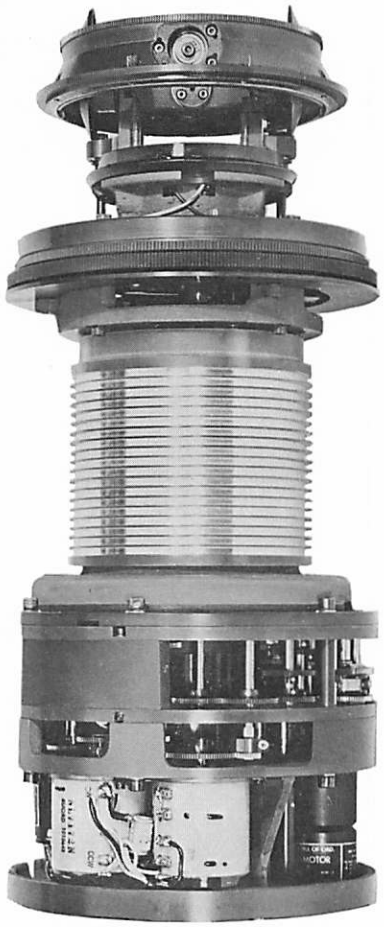
LIBRASCOPE REAL-TIME CLOCK

The Librascope Real-Time Clock is a source of accurately-spaced timing pulses. The internal time standard of the Real-Time Clock is an electronically-driven tuning fork. By using a fork having an appropriate natural frequency, the PRF of the instrument can be selected to suit each particular application.



STEREO-RANGING SYSTEM

Stereo-Ranging System. The stereo-ranging system, designed and developed for the Air Force, is used to obtain range data to photo-theodolite accuracy by stereo-photographic methods. Two separate synchronized units will track aircraft or missiles simultaneously. Their shutters are synchronized within one millisecond at one frame per second. Data which may be recorded directly on each frame includes azimuth and elevation angles, frame number, time, and typed data on a small card. This uses 70 mm film.

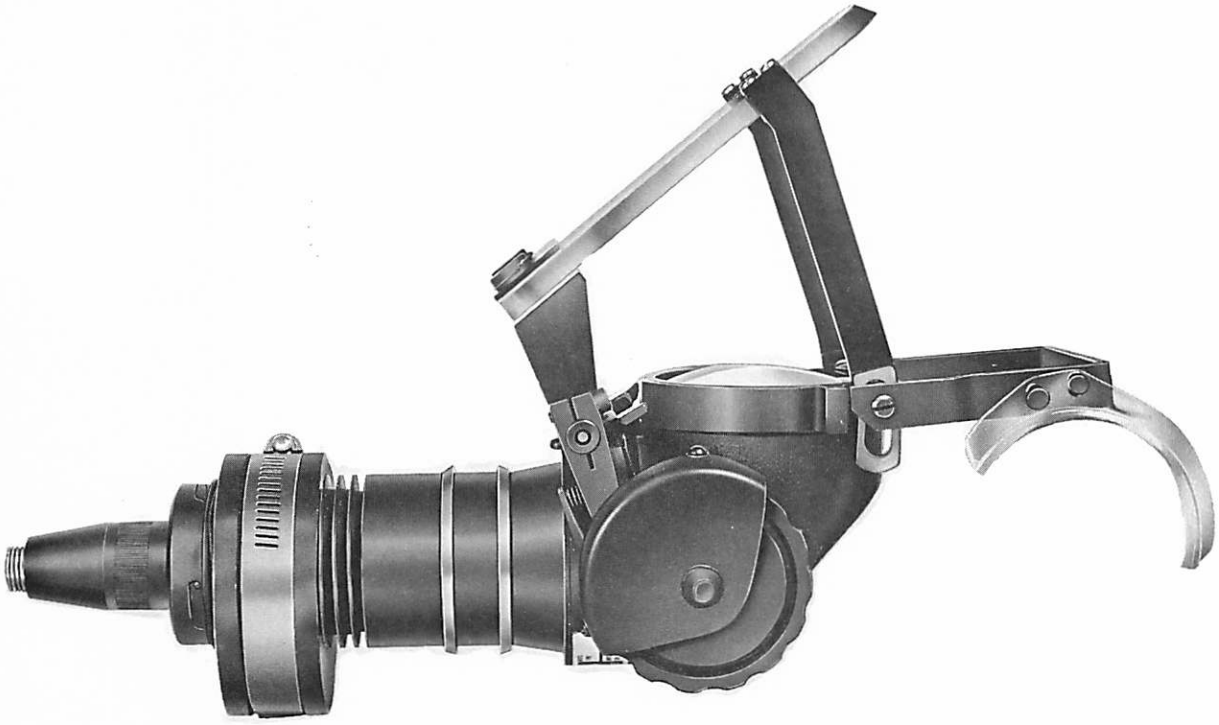


PERISCOPE MECHANISM

Periscopes. Librascope designed the mechanical parts of airborne periscope MX-1295/ASB-1A. Design features include integral coordinate transformer and stabilization mechanisms, operable up to ±30 degrees roll and pitch, for maintaining a prism-directed line of sight accurate to four mils to a target located anywhere within a hyper-hemisphere.

Periscope MX-1295/ASB-1A provides optical fields of view of 45 degrees at 1.5 power and 45-second resolution, or 11 degrees at 6.0 power and 15-second resolution. It also provides a radar image of the area about the selected target point and continuously indicates the location of a computer aim point by means of a reticle superimposed in the field of view. Nearly 150 of these periscopes have been built by Librascope under various production contracts.

After developing the broad outlines during an optical design study, Librascope also designed and built four prototypes of periscope MX-1681 (XN-1)ASB as a possible replacement for the MX-1295 periscope.



PILOT'S SIGHT

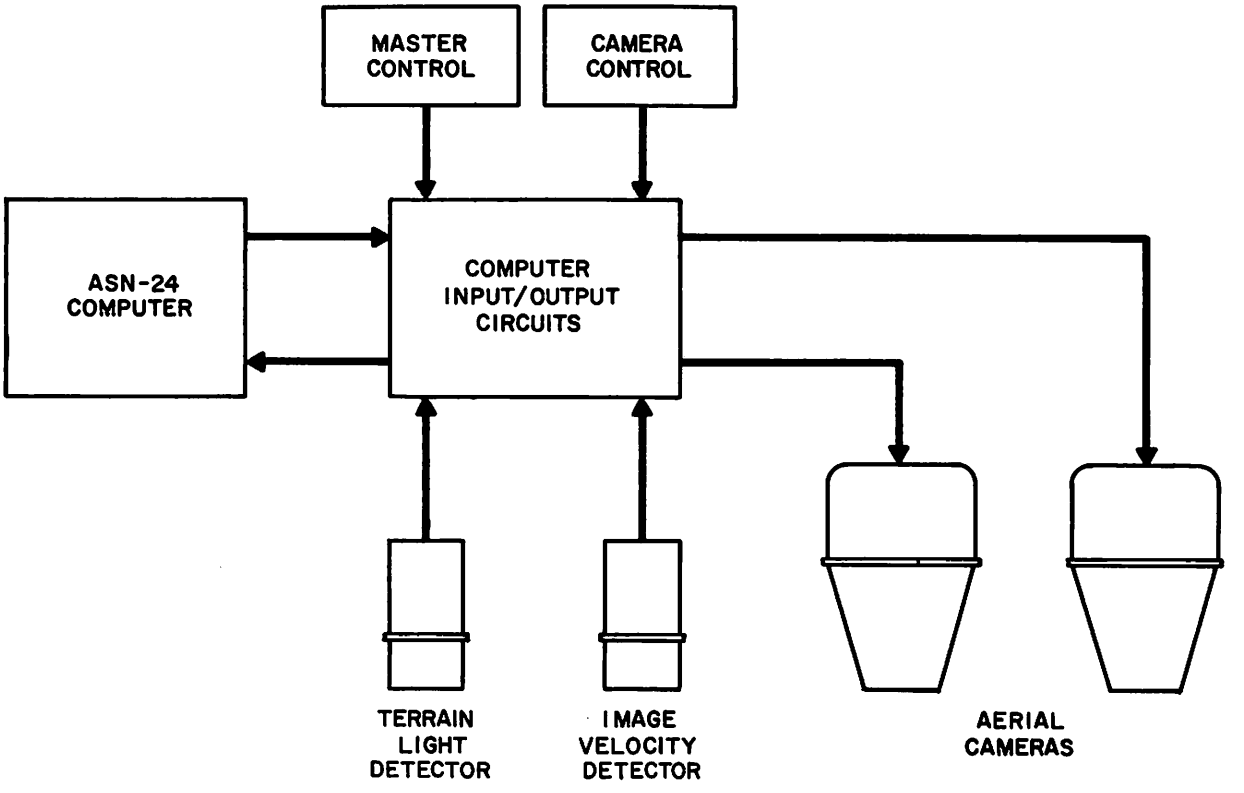
Pilot's Sight. Librascope has designed a pilot's fixed gun, bomb, and rocket sight for aircraft use. A compact instrument weighing only 2-3/4 pounds, it has an illuminated reticle superimposed on a 270-mil field of view by a high efficiency dichroic beam splitter with a 270-mil lead advance setting accurate to within 3 mils. The Company has already built several hundred of these instruments and currently is building several hundred more.

L-121 AND L-141 COMPUTERS

Following two years of development work, the L-121 and L-141 computers first became available in 1962. The L-121 is a general purpose digital computer, serial in operation, with single address instructions. It features a 4096-word magnetic disc memory with word length of 30 bits plus sign. It is designed for both scientific and data processing applications, and can accommodate up to 32 input-output devices.

The L-121 is all solid state in circuitry, and is built to highest commercial standards. The basic computer cabinet, shown above, is 31 inches wide, 18 inches deep, and 10-1/2 inches high.

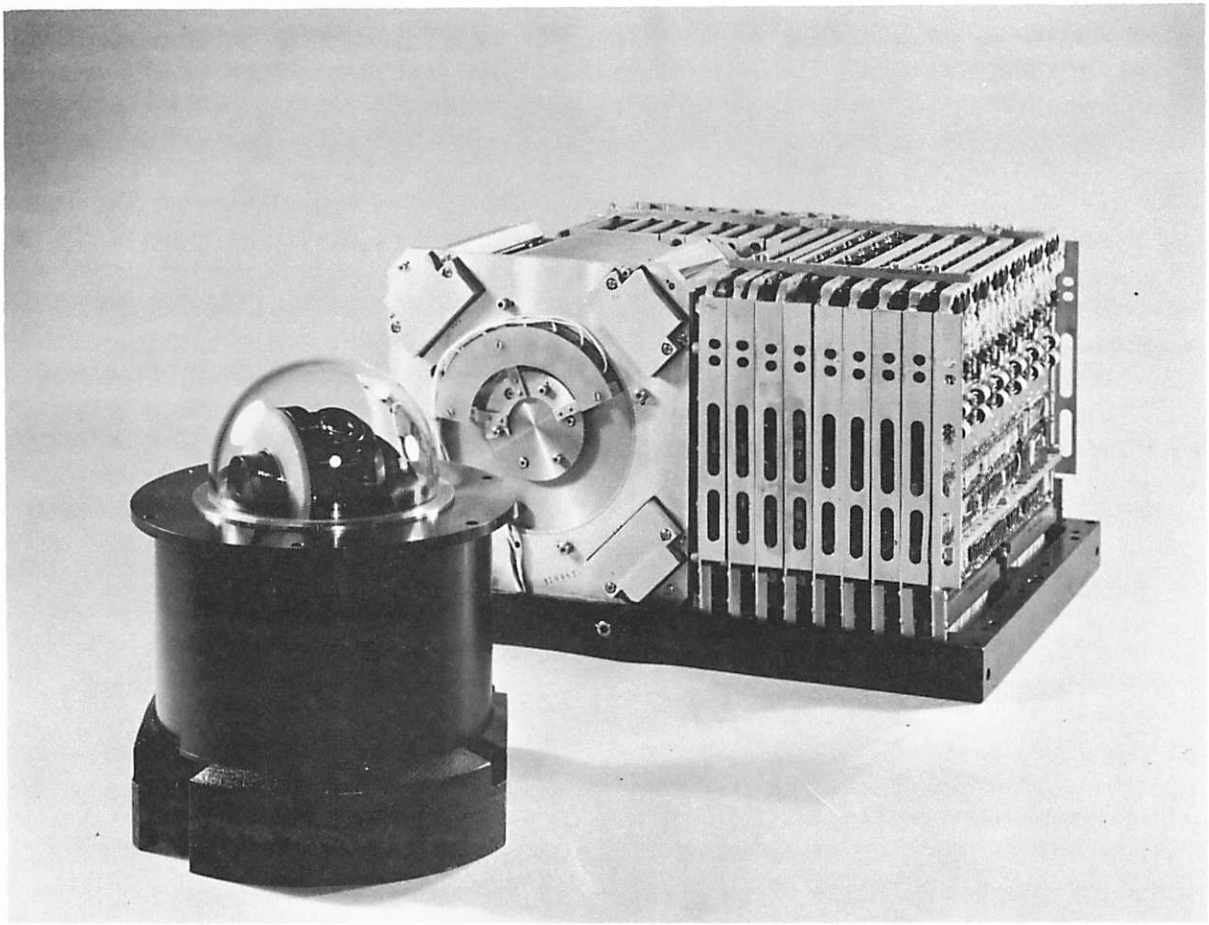
The L-141 is an Industrial Control version of the basic L-121 computer, and features an input-output buffer memory section which facilitates communication with an input commutator, voltage-to-digital converter, output control registers, etc.



DIGITAL CAMERA CONTROL SYSTEM

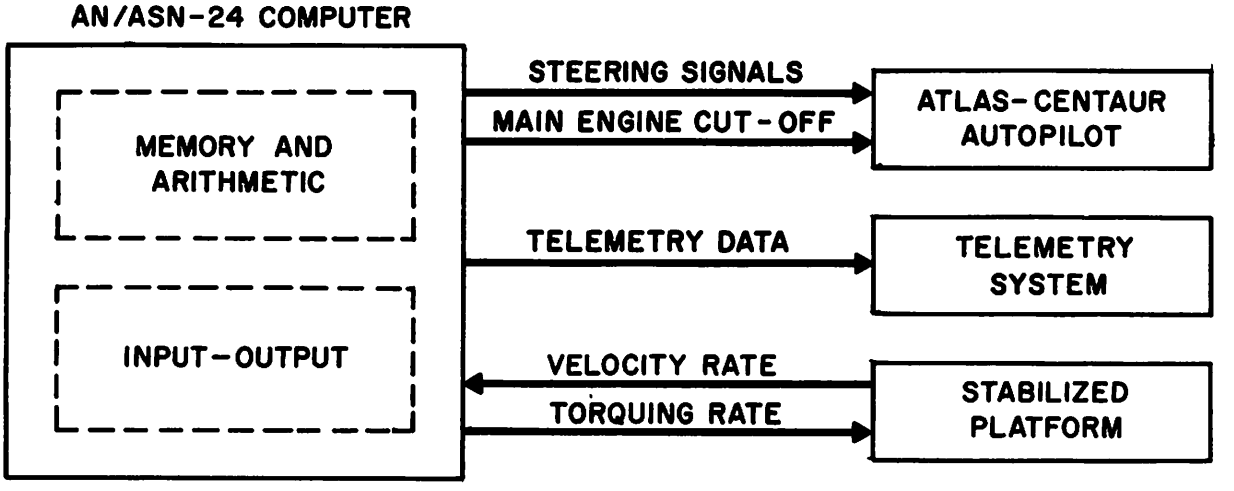
The Digital Camera Control System, sponsored by the Air Force, was aimed at developing the first complete digitally-controlled photo reconnaissance system. A design specification of .1% for Image Motion Compensation was not only met by Librascope engineers, but exceeded by a factor of two (2) and is considered by the contracting agency to be a major technical breakthrough in the field of high resolution aerial photography.

A digital computer similar to the ASN-24 (XY-1) was employed in this system to solve the entire camera problem, accepting photo parameter inputs and supplying outputs for shutter, aperture, and interval control. This system was delivered to ARL-WADD, Dayton, Ohio, in November 1961, and is presently undergoing tests at that activity.



DIGITAL CELESTIAL TRACKER SYSTEM

Developed by Librascope in 1957 under sponsorship of the Air Force, the Digital Celestial Tracker is a photoelectric startracker used as a navigation aid for aircraft. The AN/ASN-24 computer is used in conjunction with it to provide stored coordinates on 64 stars and/or planets, and to determine the position and heading of the vehicle. During daylight hours, a filter permits use of the sun as a reference. The AN/ASN-24 controls the scanning action and positioning of the startracker through closed servo loops.

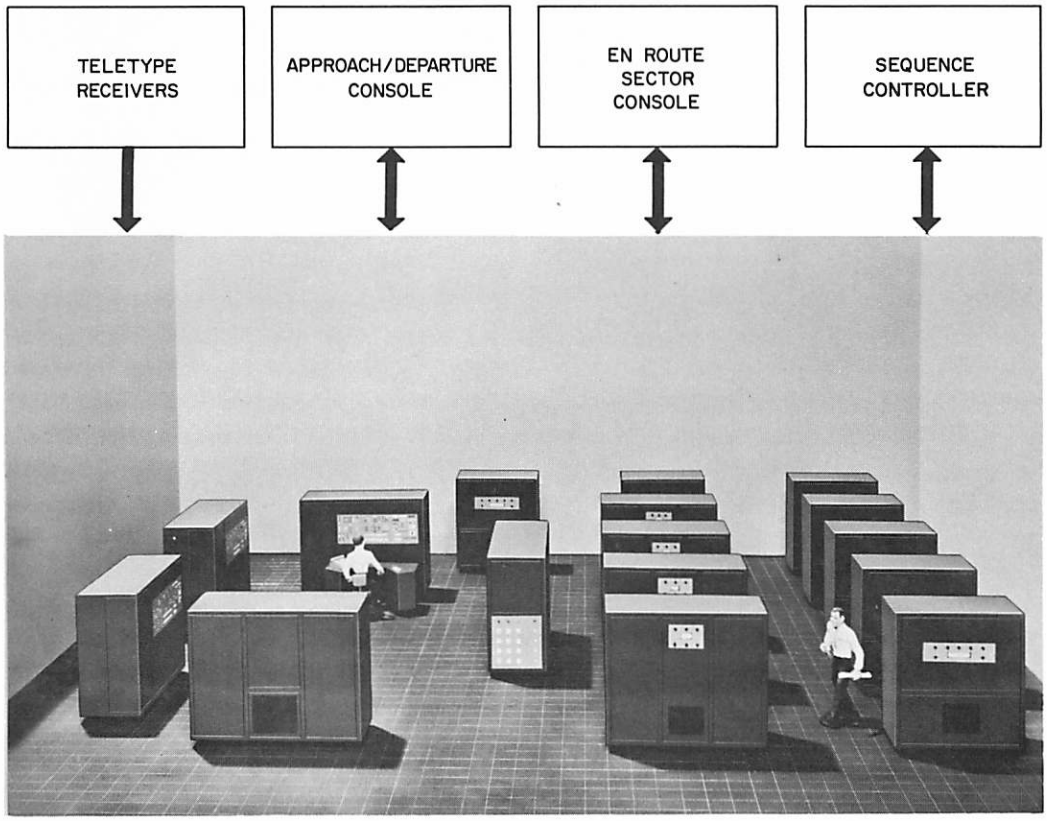


CENTAUR GUIDANCE COMPUTER APPLICATION

General Dynamics/Astronautics selected Librascope to supply the guidance computers for the Atlas-Centaur vehicle. The computer selected is a modification of the AN/ASN-24, developed in 1958 under Air Force and Librascope sponsorship.

For an interplanetary mission, the function of the Atlas-Centaur guidance system is to provide vehicle-attitude information to the autopilot during launch and subsequent powered phases of flight, to initiate engine cut off commands, and to develop steering signals for injecting the Centaur vehicle into the required hyperbolic escape orbit. The standard "Sigmator" section of the AN/ASN-24 computer permits digital integration of incoming time pulses from three platform accelerometers. After vehicle displacement has been computed, special digital-to-analog converters change the output commands into the form required by the guidance autopilot.

This computer system is currently operational in 1962 Centaur test shots being conducted by the National Aeronautics and Space Administration.

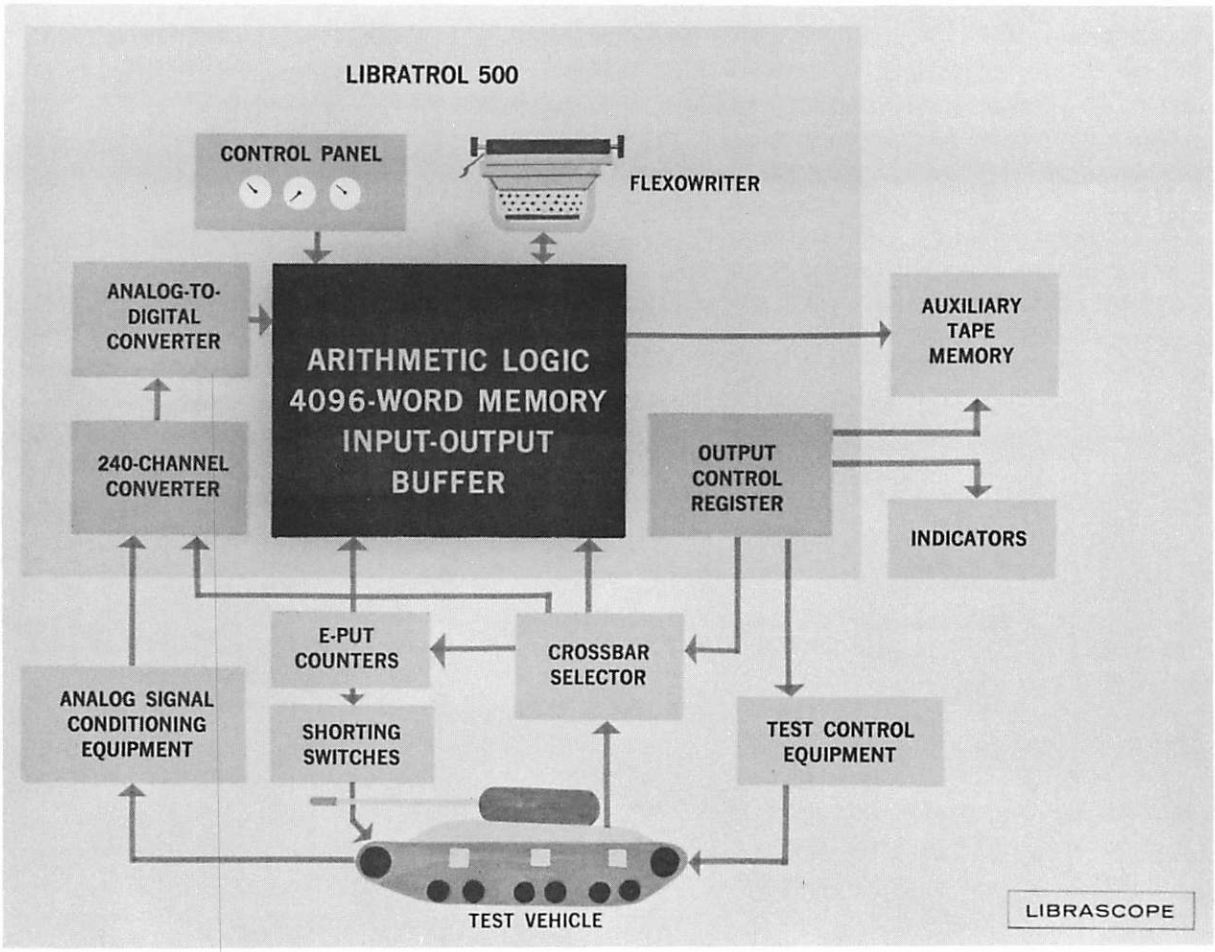


AIR TRAFFIC CONTROL

The Air Route Traffic Control System was developed in 1958 and 1959 under auspices of the Federal Aviation Agency. Librascope Division designed and produced the Data Processor portion as a subcontract to the GPL Division of General Precision, Inc. The entire prototype system was installed at FAA's National Aviation Facilities Experimental Center in Atlantic City, N. J. in 1960.

The system operates as follows: Before take-off, an aircraft's flight plan is entered into the Data Processor. At take-off time, the computer probes its memory to make sure that no conflict exists, after which a local controller authorizes take-off. While en route, if an unexpected storm causes an aircraft to slow down or deviate from its course, resulting in a potential conflict, the Data Processor will alert a controller at the En Route Sector Console. The Data Processor then helps the controller select and recommend the best alternate flight plan.

As the aircraft approaches a terminal, its position is fed directly into the Data Processor from radar. Then time to touchdown is calculated automatically and a proposed landing sequence is made up.

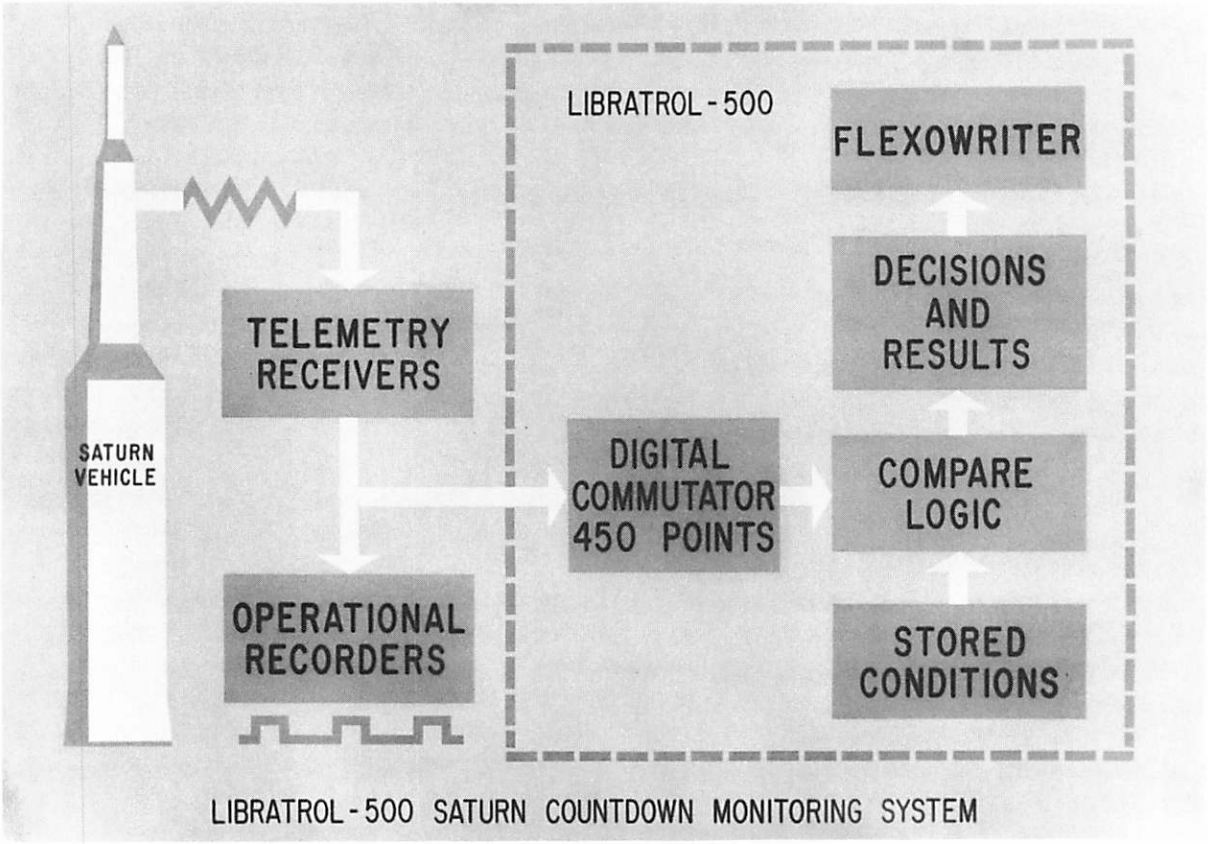


AUTOMATIC VEHICLE TESTING

In 1960, the U. S. Army Ordnance Corps at Frankford Arsenal selected a LIBRATROL-500 Digital Control Computer for the heart of its automatic checkout system for M-48 tanks. Librascope systems engineers and programmers worked with engineers from the Arsenal in the design of the final system, shown above in block diagram form.

In the test procedure, the vehicle is placed on a dynamometer test stand, the hood is opened, and special transducers are attached. Under complete computer control, the transducers are interrogated in predetermined order, under varying engine speed and load conditions, and the readings are compared with values and conditions stored on the memory drum. Diagnostic routines pinpoint specific weaknesses or failures in the tank's performance, and the findings are automatically printed out on the Flexowriter sheet.

The LIBRATROL-500 Vehicle Checkout System was transferred early in 1962 to the tank engine and transmission assembly repair line at Letterkenny Ordnance Depot, Chambersburg, Pa., for operational evaluation.

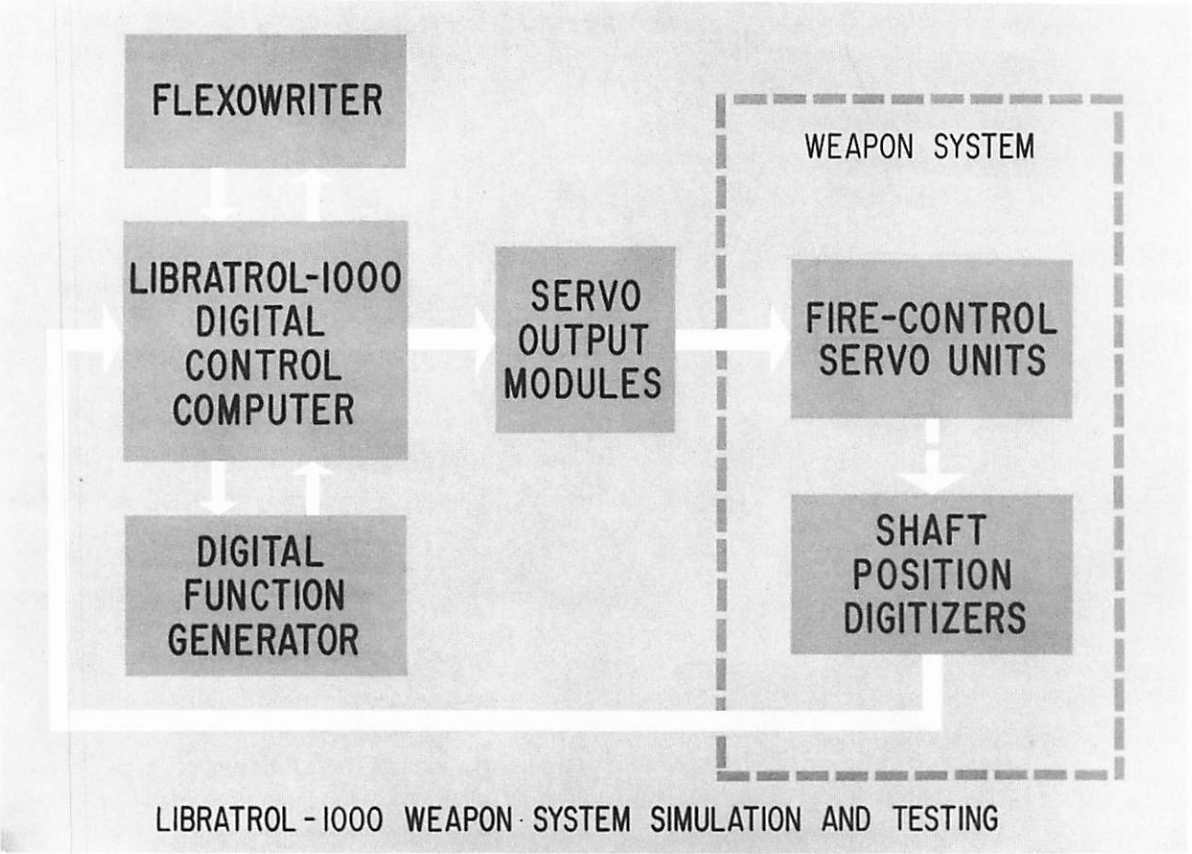


SATURN COUNTDOWN MONITORING

The above diagram depicts an application of the LIBRATROL-500 Digital Control Computer in a missile checkout system.

The National Aeronautics and Space Administration obtained a LIBRATROL-500 for this purpose in 1961. It was first applied to missile system simulation problems at the Marshall Space Flight Center, Huntsville, Alabama. In October, 1961, 450 additional digital input channels were ordered for the expandable system, and it was selected for the task of monitoring the critical pre-launch countdown sequence of SATURN-powered vehicles.

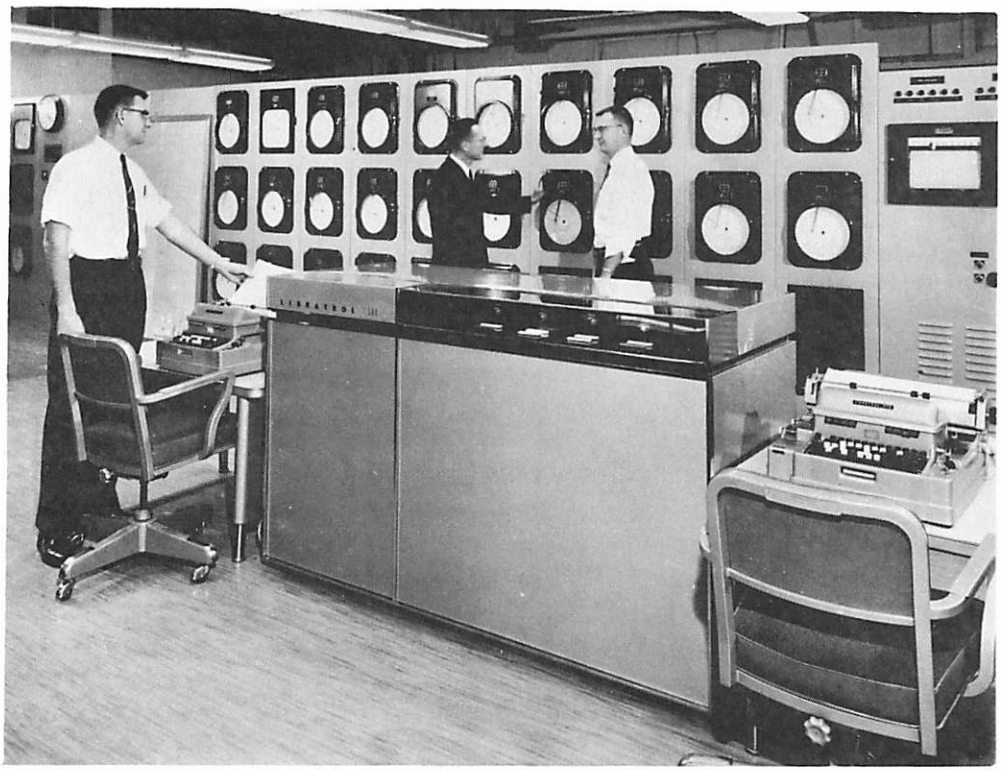
In February, 1962, the NASA/LIBRATROL-500 system was moved to Cape Canaveral, and is the first digital computer to be installed in the SATURN blockhouse. In operation, telemetry signals emanating from the instrument payload atop the missile are received both by the LIBRATROL-500 and a bank of strip-chart operational recorders. The computer compares, in real time, the sequence of pre-launch events against a stored program which specifies the correct pattern. This enables the Launch Director to have an immediate typewritten performance report following the launch, which would otherwise require several hours of chart analysis.



WEAPON SYSTEM TESTING

In 1961, the U. S. Navy purchased a LIBRATROL-1000 Digital Computer for use in simulation and testing of an anti-submarine fire control system at the Dynamic Simulation Laboratory operated at Librascope's Glendale facilities. A Digital Function Generator and Servo Output Modules section were incorporated in the standard LIBRATROL-1000 cabinet, using standard plug-in cards from the computer and fire control system.

The LIBRATROL-1000's drum memory is used to store a variety of simulated target runs which will cause the fire control system to be put through its paces. The response of servos in the weapon system is in turn monitored by the computer through the measurement of shaft encoder outputs in the system. The first such application of a commercial digital control computer, the installation, system design, and programming were performed completely by Librascope engineers.

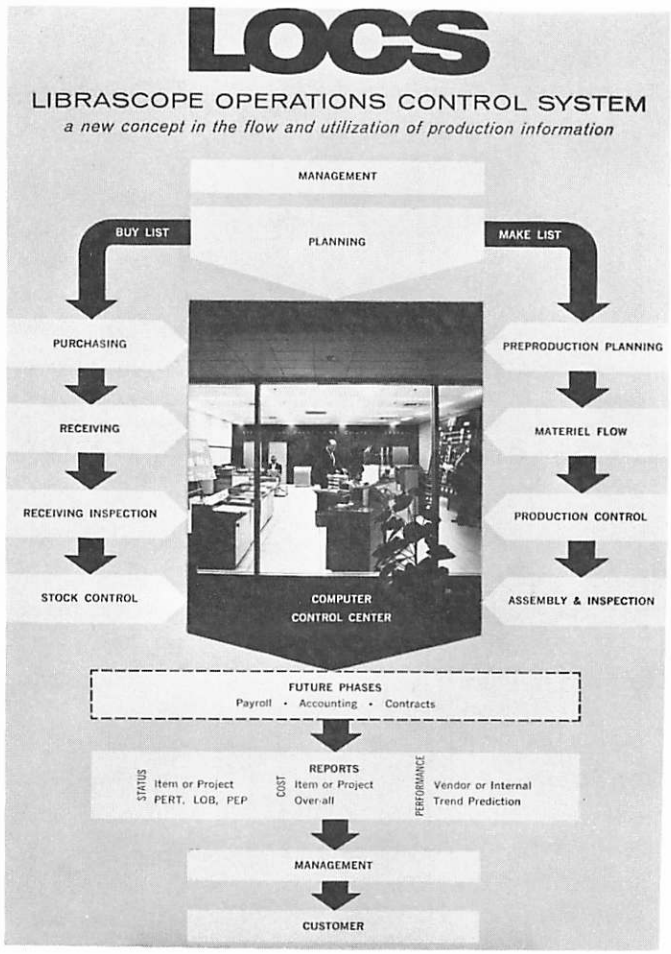


GAS DISPATCHING

Librascope pioneered in the first application of a digital control computer in the gas utility industry. Pictured above is the LIBRATROL-500 computer system, which was installed in 1959 in the Dispatching Center of the Public Service Company of Colorado. In this application, the LIBRATROL-500 scans 72 voltage input channels representing pressure, temperature and specific gravity of the flowing natural gas. From these readings, accurate flow computations are made, and the results are assembled in a typewritten form which presents the gas dispatches an hourly report on gas load distribution in Public Service Company's statewide network. On demand, this information will be typed out at any time during the hour.

In addition to this "on-line" function, the computer has time available for other work, and an off-line Flexowriter is connected for various network analysis and load prediction programs. The LIBRATROL-500 is programmed to switch back and forth between the on-line and off-line flexowriters by reference to an internal time clock.

Librascope systems engineers handled the integration of the LIBRATROL-500 into the existing telemetry network, and trained the customer's engineers to handle the programming and maintenance functions. The installation has enjoyed an unusually high up-time on a 24-hour per day basis of operation, 7 days a week.

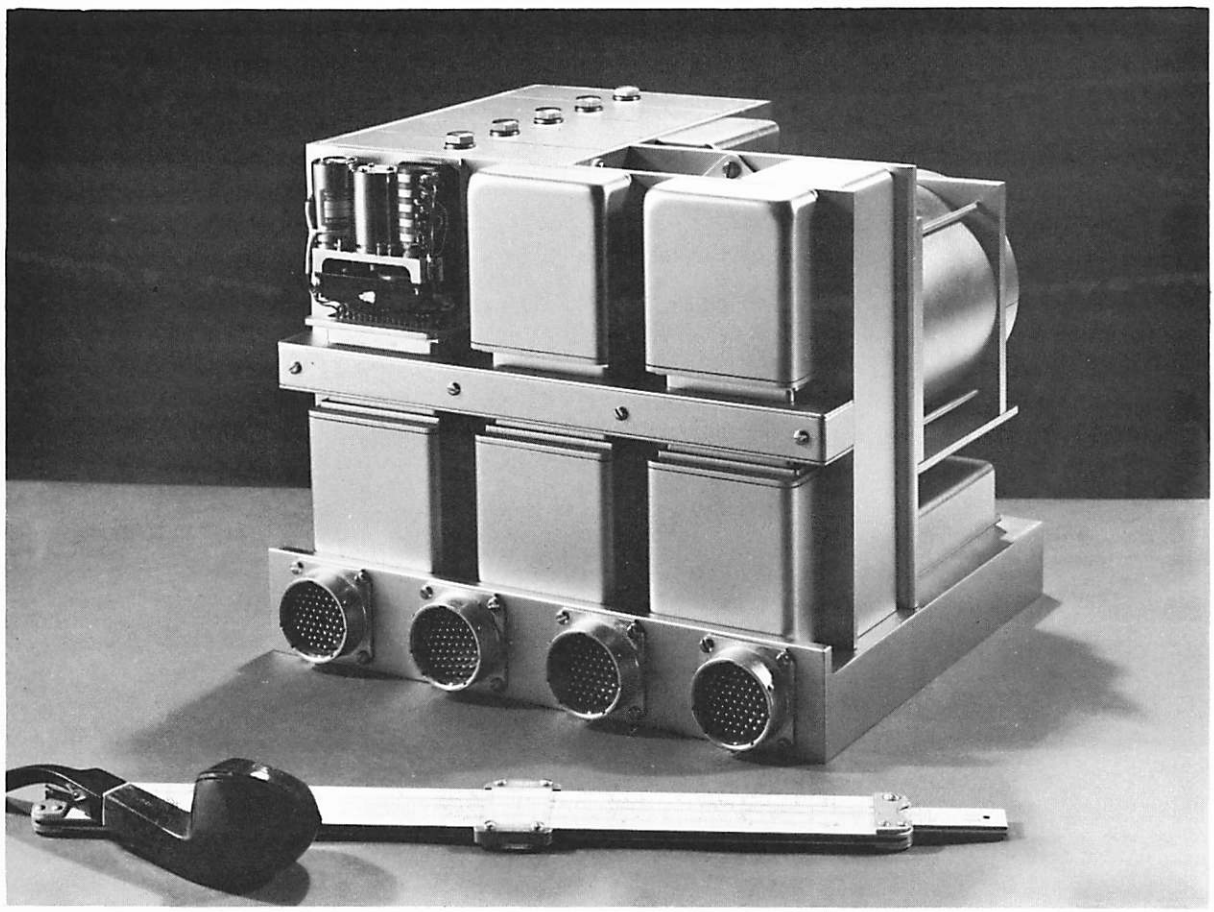


LOCS MANAGEMENT INFORMATION SYSTEM

Librascope's Operational Control System (LOCS) has been in operation since 1961 and is the result of several man-years of critical analysis of this and other companies' business operations. A true management information system incorporation Librascope - built data processing machines, the LOCS system provides a timely flow of information to decision-making personnel. This information includes production rates, costs, deliveries, vendor shipments, man-hours, schedules, and inventories. It is a management control medium for entire business complex --- or a series of complexes --- not just control of a single function such as accounting or inventory.

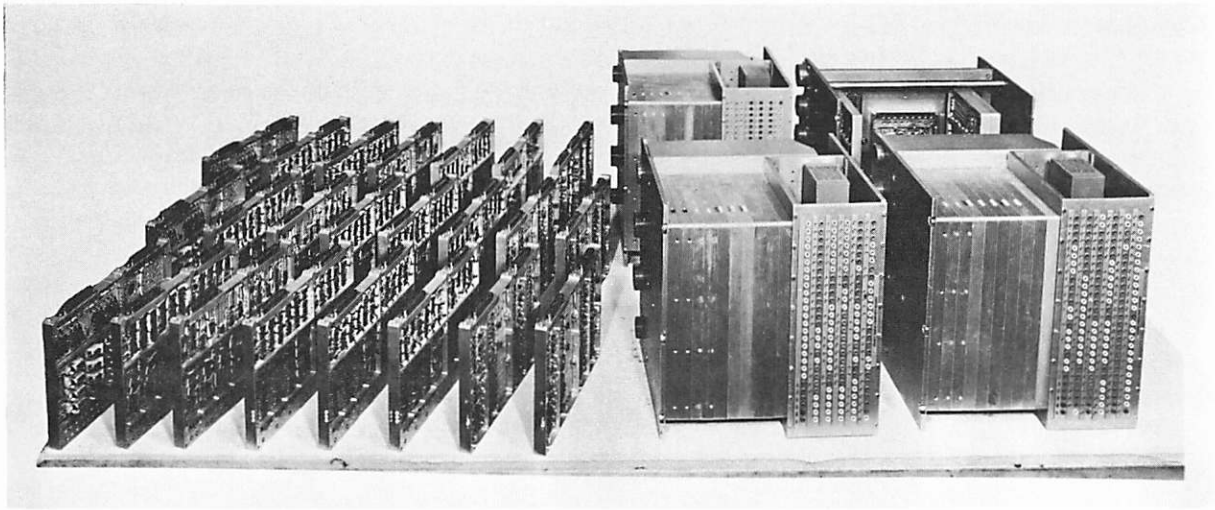
The system is kept informed on the progress of projects by information entered at remote dispatch stations. A comprehensive report on an entire project or the status at a single part can be immediately produced on demand.

Pictured above is a chart illustrating the flow of information in LOCS Phase I, as currently operational in Librascope's Glendale Branch.



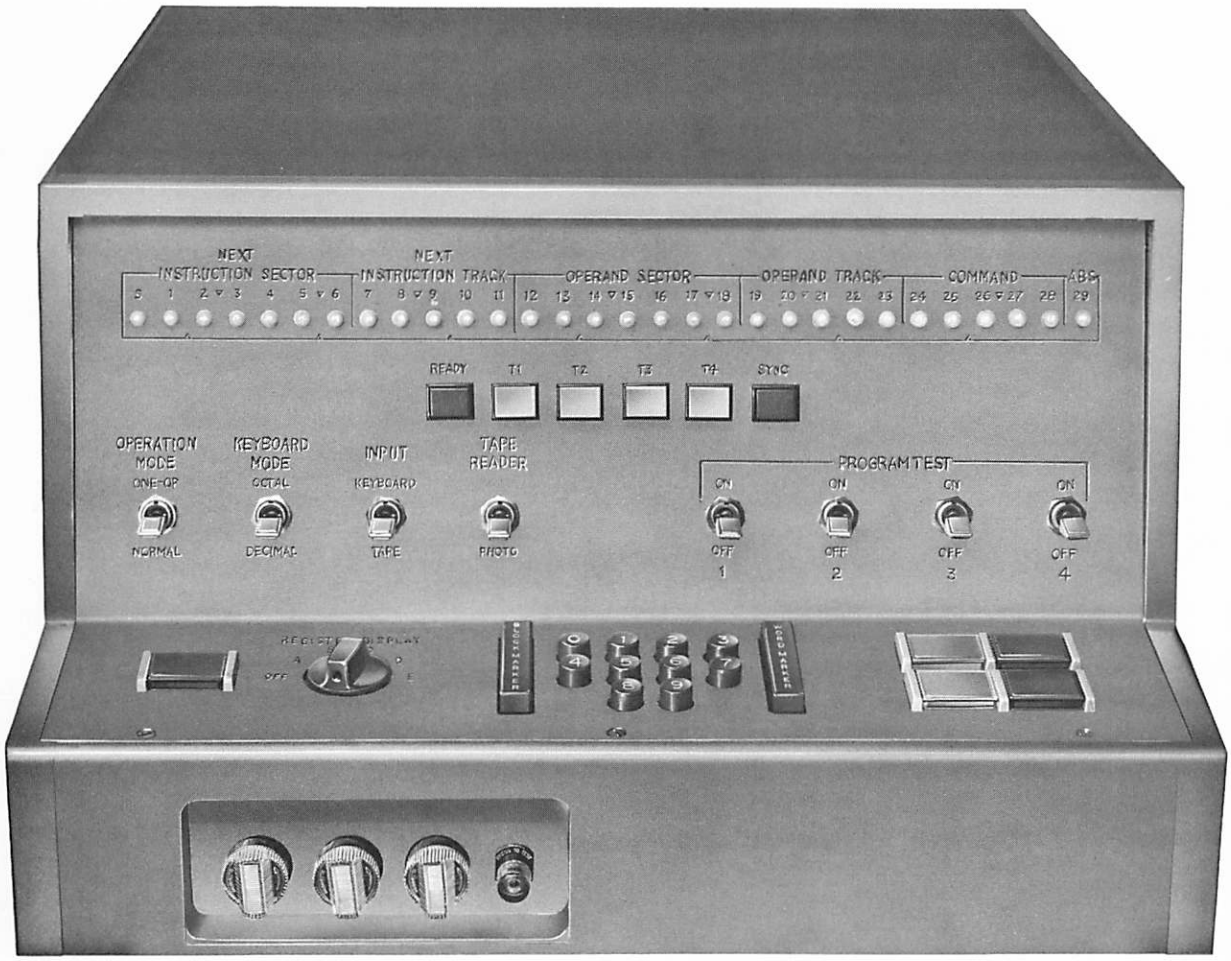
L-70 FLIGHT GUIDANCE COMPUTER

The above photograph shows the L-70---A new flight guidance computer weighing only 19-lbs. developed by General Precision's Librascope Division. It is a follow-on design to Librascope's 37-lbs. Centaur guidance computer. The L-70 has modular welded-circuitry construction and employs a gas-bearing memory drum. The latter weighs slightly over 5-lbs. and stores 112, 000 bits.



L-80 BUILDING BLOCK COMPUTER

Librascope's L-80 "Building Block" computer is the result of several years' thought and experience with high reliability requirements. This design concept provides continued computer performance at slight sacrifice in speed or accuracy whenever a failure occurs in one module. Pictured above in prototype form are four of the computer system's six modules. Left to right, rear: high speed computing module and memory module; foreground, general purpose computing module and service module. Two additional general purpose modules complete the system. Circuit Cards shown are for additional general purpose modules and for check-out and problem simulation equipment. Modules shown are equipped with plug-ins for testing.



L-2010 COMPUTER

General Precision's Librascope Division designed the L-2010 digital computer specifically for use in a military environment. It is a transistorized medium-speed general-purpose machine, and can handle a variety of input/output devices.

Memory capacity is 4096 words (disc), of 30-bit word length. It has 32 basic instructions. Logical elements are welded and encapsulated for maximum reliability. Standard input-output is electric typewriter and punched-tape machines.