

RESEARCH
CAPABILITIES

American  Optical
COMPANY

RESEARCH CENTER





The Challenge Ahead

There can be little doubt that man is now engaged in the greatest scientific revolution of all time. Almost daily we hear of new discoveries, startling developments or dramatic innovations taking place in one branch of science or another — and optics is no exception.

With the intricate optical systems at his command, man can perform prodigious visual feats. He can scan the outermost reaches of space, or bring the moon within a hundred miles. He can see in the dark . . . explore the inaccessible areas of the earth . . . witness, with amazing clarity, the microscopic aspects of a living cell.

And this, of course, is just the beginning. For, as man's ability to see is extended, so too are his horizons . . . and the opportunities in optical research are more promising, more challenging than ever. We have only begun to explore the vast potential of fiber optics and infrared devices. The laser may soon permit vastly improved communications systems throughout the world and in space. Modern microscopy, while highly developed, has yet to answer medicine's urgent need to examine the minutely small in greater detail.

To exploit these new opportunities — and to probe even deeper into advanced areas of vision — American Optical Company has expanded the scope of its research activities. This booklet describes these activities for you.

As you read these pages, perhaps you'll discover that AO's unique capabilities could be of help to **you**. If so, we would welcome the opportunity to discuss the application of our skills and talents to the solution of a particular problem . . . or to the formulation of a sound research and development program for your future.

PRESIDENT

Photograph taken with an AO developed 36" focal length aerial camera lens.

Areas of Activity

The Research Center of the American Optical Company is located on the grounds of the Company's main plant in Southbridge, Massachusetts. This Center, which occupies more than 40,000 square feet of floor space and is superbly equipped and staffed, constitutes a modern scientific headquarters capable of conducting the most advanced types of optical analysis, experimentation and design.

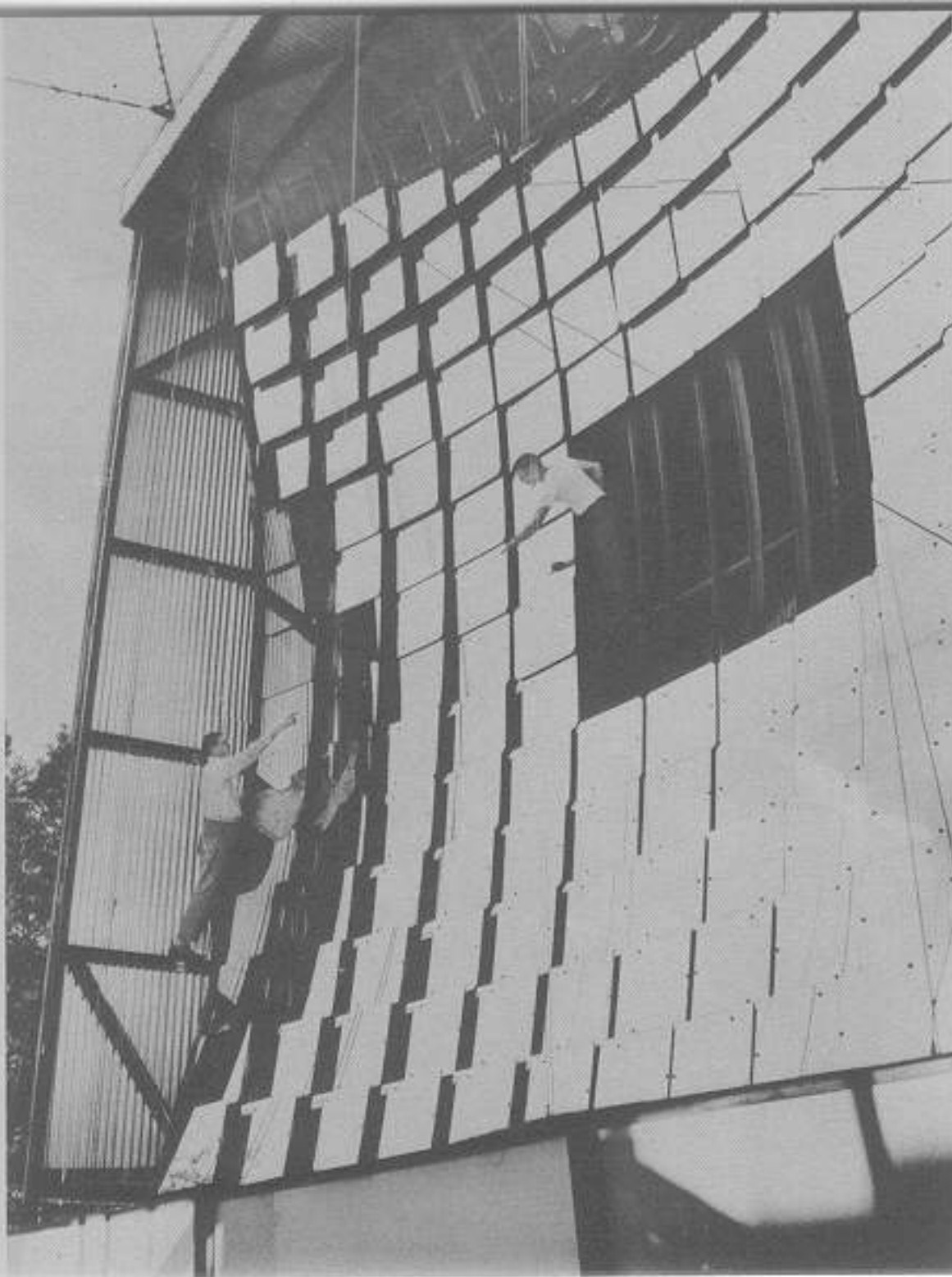
Current efforts at the Center are directed toward a variety of projects in biological, physical, and geometric optics, as well as glass technology and optical thin-films. Outstanding capabilities exist in the relatively new areas of fiber optics, infrared devices, and lasers.

To perform effectively within these areas, the Research Center is organized on a "project" basis, with individuals selected from the senior staff to lead and work on assignments which utilize their individual specialties. In this way, the best professional skills are brought to bear on specific problems, and maximum speed is achieved in completing assigned tasks.

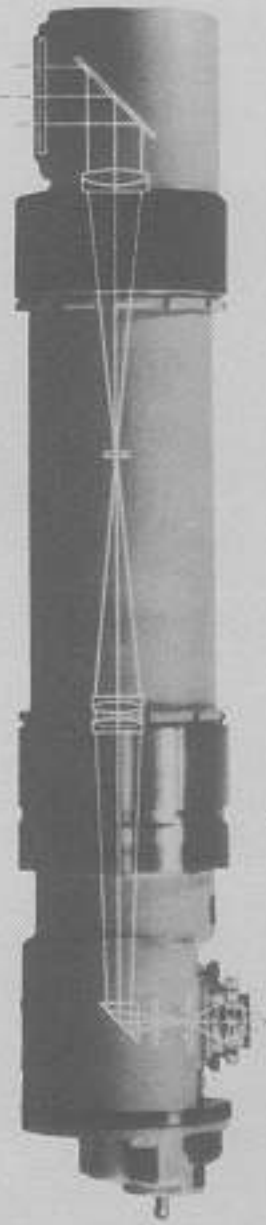
An ever increasing number of the Center's projects are derived from scientific institutions, business firms and various governmental agencies, including the three military services. Moreover, the scope and aims of these projects are as broad and varied as the sources themselves.

To provide a more specific insight into the capabilities of the Center, the following research area descriptions, including past achievements and current endeavors, are presented.





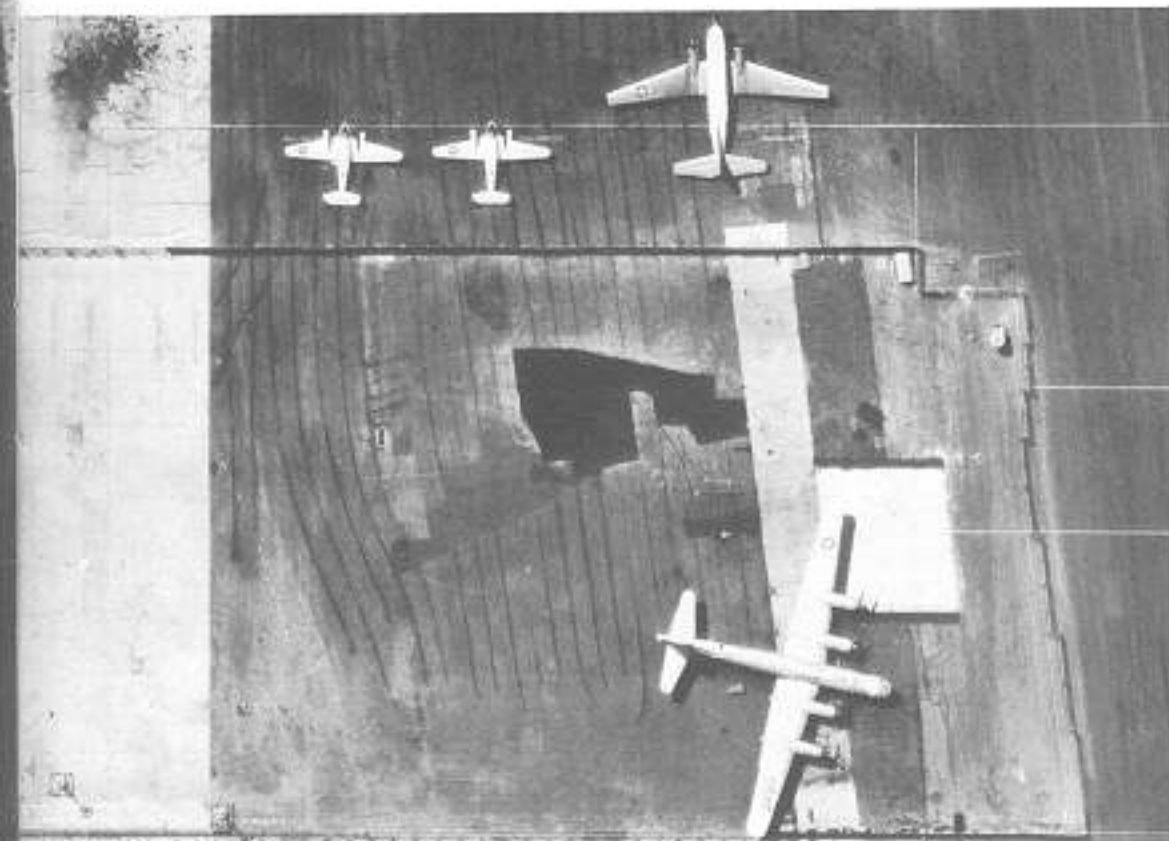
Army Solar Furnace at Natick, Massachusetts.



Mk 30 Periscope developed for the U. S. Navy.

Geometric Optics

American Optical Company has accumulated unmatched experience in design and development of high-resolution optical systems, and has pioneered developments in microscopes, telescopes, aerial camera lenses, bombsights, gunsights, and missile trackers. The Todd-AO motion picture system is also a Center accomplishment. In the current race to harness the sun, AO mirrors were developed for the Army's newest solar furnace. Largest of its kind, the giant apparatus simulates the thermal radiation which would be received by materials or personnel in the vicinity of nuclear weapons explosions.



Enlarged section of photograph on preceding page showing high resolution obtained.



Prototype of laser retina coagulator being used in eye surgery.

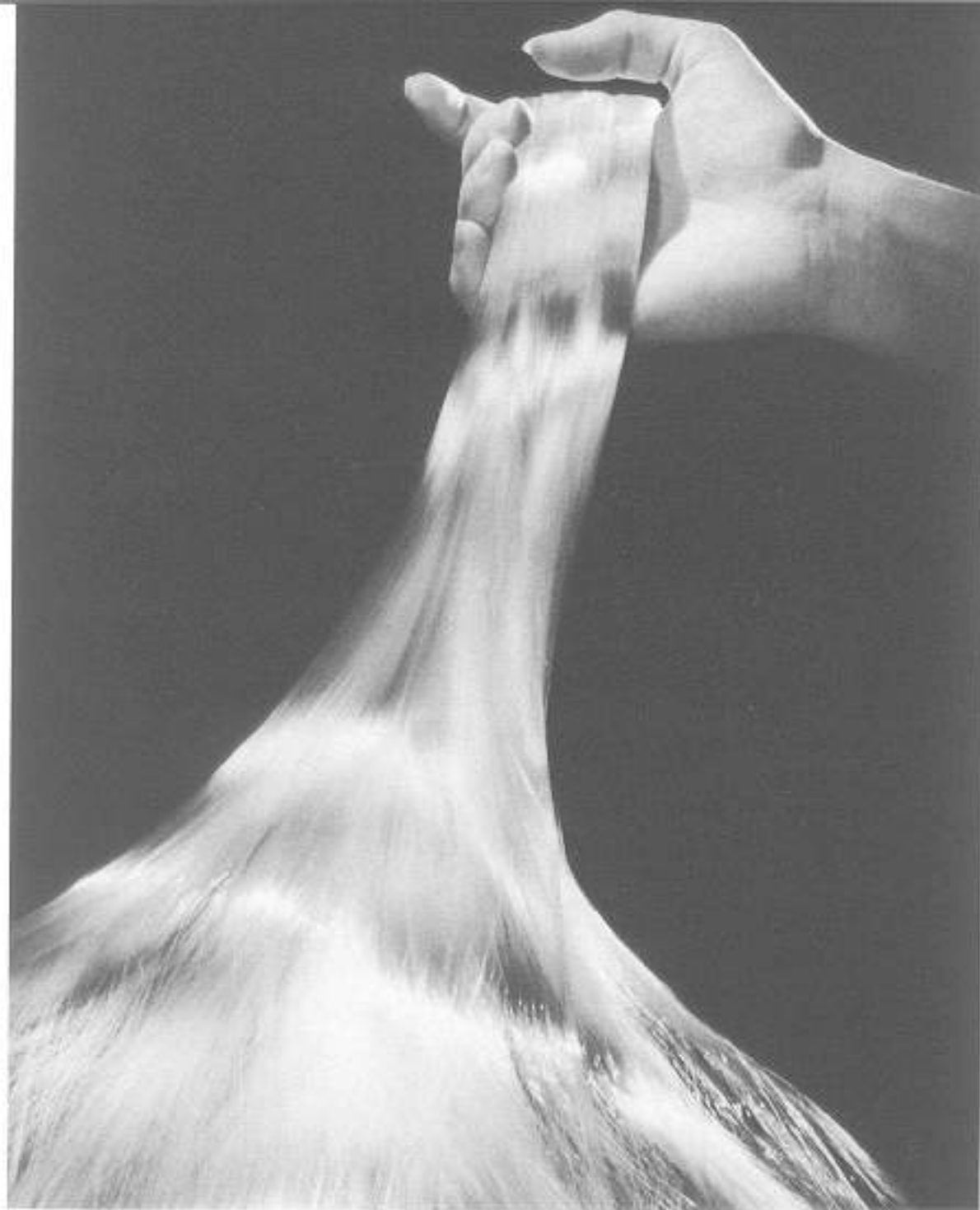
Medical Instrumentation

AO's interest in human vision has led to the development of a variety of instruments with medical applications. A recent accomplishment is the AO-Inoue microscope, which gives man, for the first time, a clear view of human cells dividing. Devices developed by AO also hold out great promise in blood analysis. Mean cell hemoglobin and mean cell volume are being determined accurately and directly by a diffraction technique involving a clinically-tested, red blood count meter. A hematocrit method and apparatus for platelet and white cell volume-percent determination has also been developed and tested. A fiber optics catheter inserted in the vein has helped accomplish continuous measurement of oxygen concentration in the blood. A new laser retina coagulator permits delicate eye surgery by use of an intense light beam instead of a knife.

Biological Optics

The biological optics section is vitally concerned with human vision in all its aspects, with particular attention being devoted to vision through instruments and microscopy. Original work includes comprehensive studies on night-driving luminances, the visual effects of colored glasses and human color discrimination. Results in the latter area have had direct and valuable application to the colors used in safety clothing, camouflage, rescue and retrieval apparatus and military marking systems. Visual problems related to instrumentation, especially phase, fluorescence and interference microscopy, have also been the subjects of several recent studies.



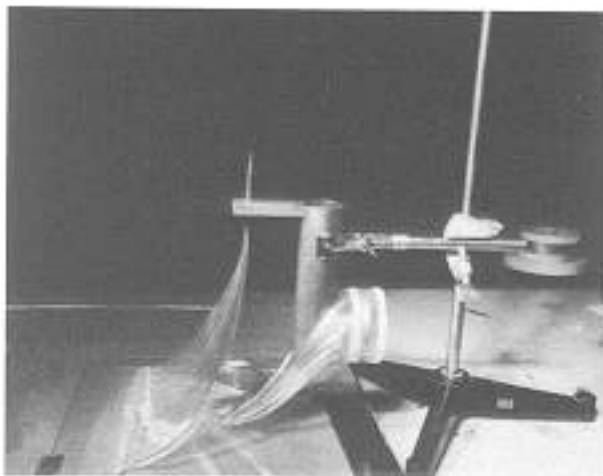


Fiber Optics

Fiber optics research has resulted in the development of unique new products for science and industry. These include flexible light guides which transmit cool, intense light between fixed or moving points, or into inaccessible areas. Flexible fiberscopes which transmit high-resolution images in any direction, and a variety of devices for transforming image shapes have also been forthcoming.

In addition, a number of cathode ray tube face plates have been developed by AO research. These include strip-shaped tube faces for recording either single-line information or alpha-numeric characters a line at a time, a full-face CRT for recording transient signals such as radar or oscilloscope traces, and metal pin CRT faces in either configuration for direct electrographic recording. AO has also perfected absorbing claddings to prevent stray light reflections from degrading CRT images.

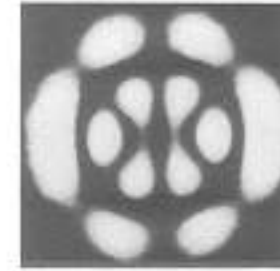
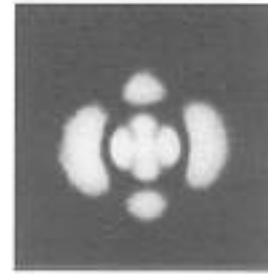
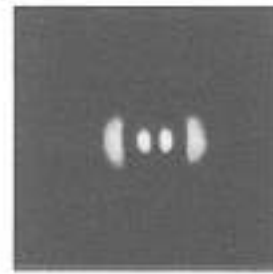
Potential applications, based on the transmission of light and images through flexible glass bundles, include advanced equipment in nuclear physics, complex devices for electronic computers, medical instruments of increased capability, signature encoders and decoders, advanced industrial inspection devices, illuminating and viewing devices, and field flatteners for camera lenses.



Glass fibers showing readout configurations from annular ring, to straight line, to solid circle.



Fiberscope being used to inspect interior of a length of tubing.

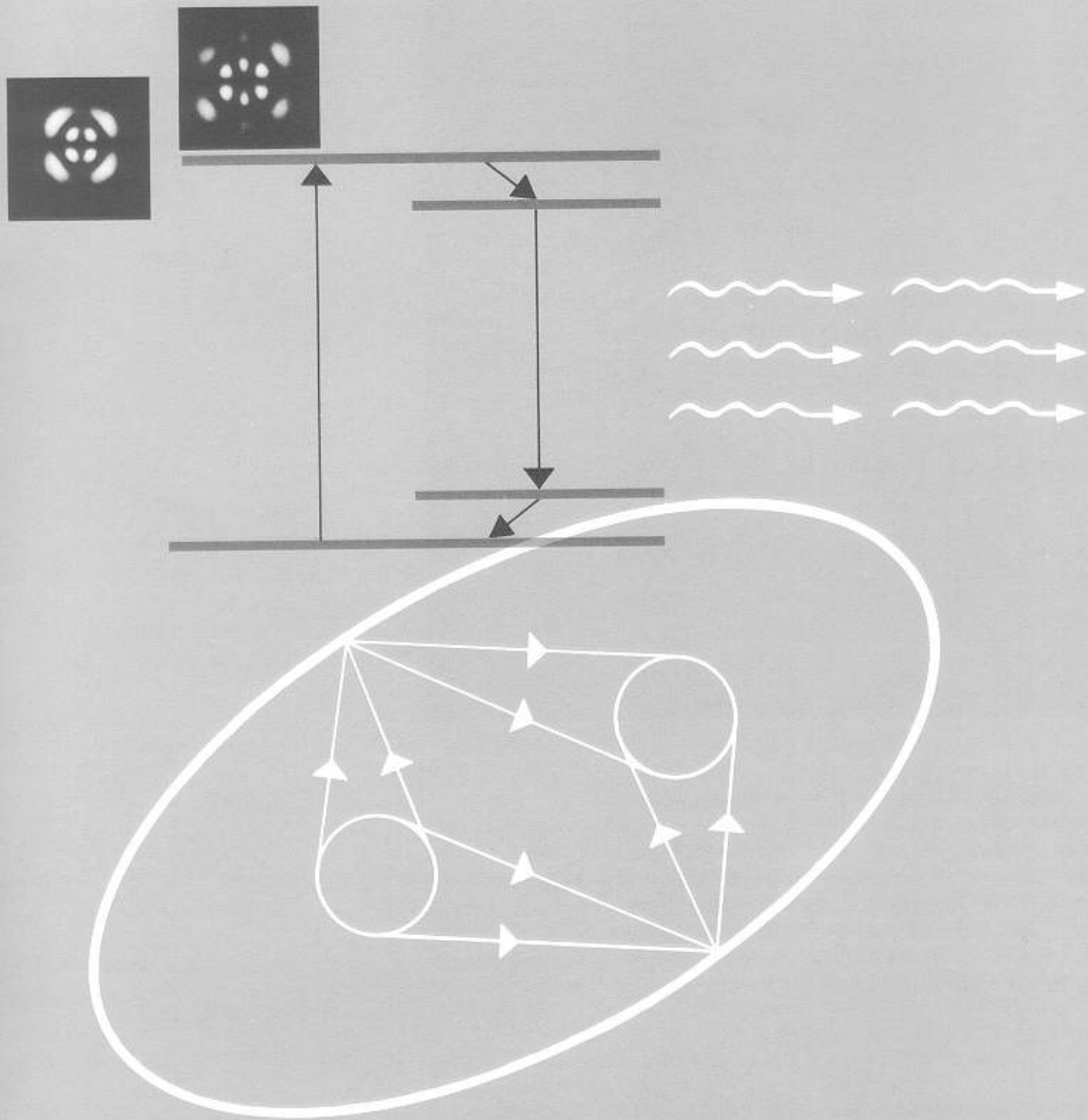


Physical Optics

Activity in the physical optics section is centered upon the study of images formed in microscopes and other optical instruments. Here, the effects of diffraction are considered for phase, interference and ordinary microscopy. Polarizing effects in the polarizing microscope are also investigated. In interference microscopy, techniques for measuring optical path difference have been developed with a precision of better than $1/300$ of a wavelength.

An increasingly important aspect of the staff's activities in physical optics involves the study of optical frequency waveguide modes in glass fibers. A systematic study of the radiation pattern from the end of a glass fiber has resulted in increased knowledge of the rods and cones of the eye, and in the placing of military contracts to determine the characteristics of dielectric end-fire antennae.

Laser research has been particularly noteworthy at AO. Work now being done in the field may someday revolutionize communications. Laser devices may make it possible to use light beams for carrying enormous amounts of information such as telephone calls, television programs and data messages. Also, sun-powered lasers may permit the use of direct sunlight as a power source. Recently, AO's research team announced a major advance in laser technology — a laser made of long glass fibers. This technique makes it possible to build larger lasers with more readily controlled output. AO scientists are exploring the practical potential of lasers in many scientific and industrial areas.





Chemistry

AO research in chemistry has contributed to the development of both liquid and solid photochromic materials of potential use — particularly in flash protection devices of military interest. AO has also received patents on infrared absorbing plastic materials of considerable interest as light-weight heat screens and thermal protection devices.

High-vacuum equipment used in deposition of thin films.



Thin Films

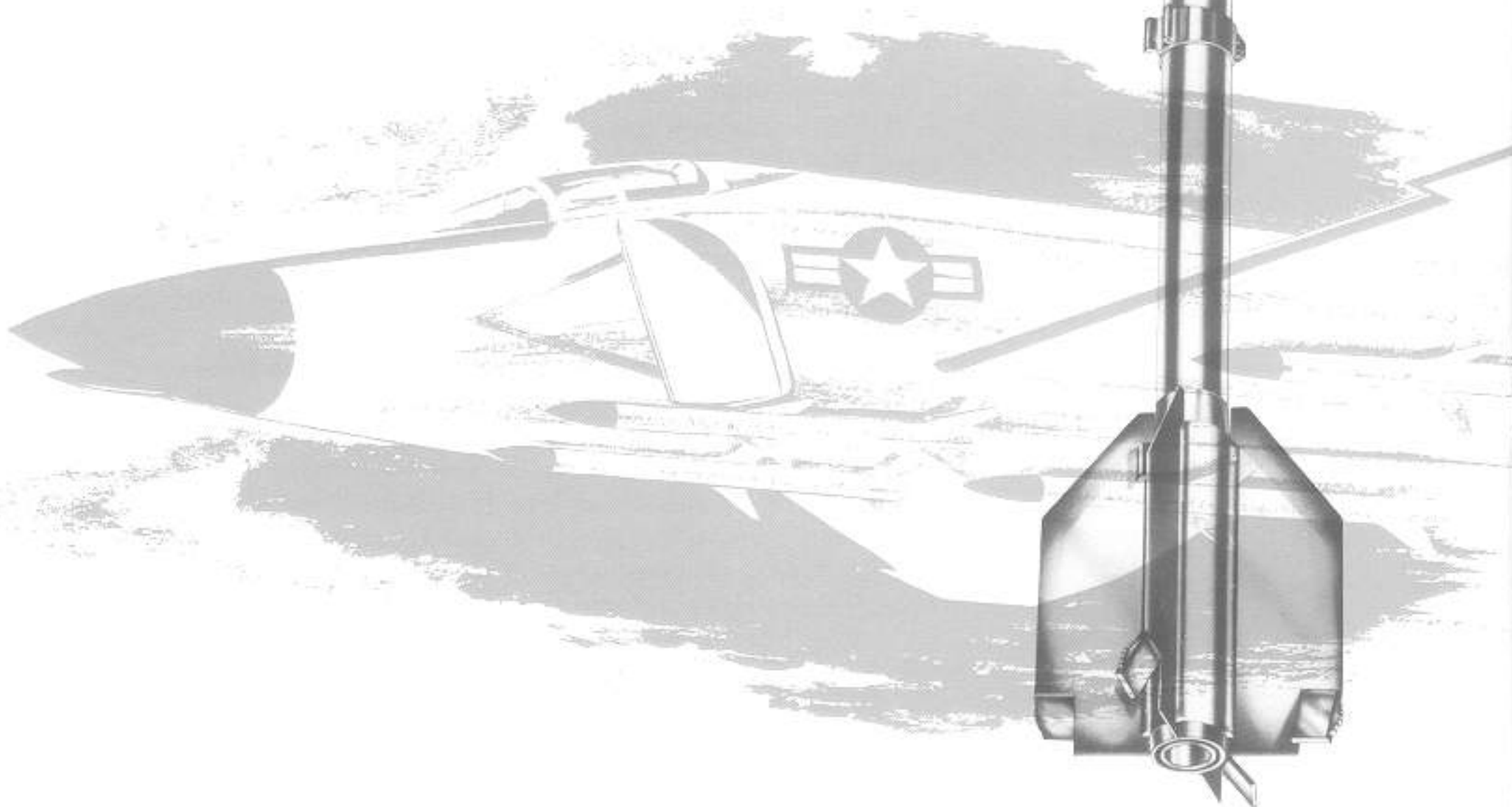
Research into thin films and reflecting coatings is a continuing activity at the Center. Low-reflectance coatings with two, three, or four component layers have been applied on different substrates to produce zero reflectance at one or more wavelengths, and to achromatize a low-reflectance band. Low-reflectance monolayers, for example, have been evaporated on substrates such as silicon, germanium, arsenic trisulfide, and strontium titanate. A low-reflectance bilayer has also been developed for use on arsenic trisulfide glass, while metallic coatings of aluminum, gold, silver, inconel, and nickel have been utilized to form mirrors and filters.

The staff has also been successful in producing dichroic beam-splitters, heat-transmitting mirrors, and both visible and infrared passband filters with cut-offs in the range from two to three microns. Currently underway is a program to calculate reflectance and transmittance, as well as phase change upon reflectance, of any number of layers, either absorbing or non-absorbing. A filter design may then be computed in advance to determine its suitability for a given application.

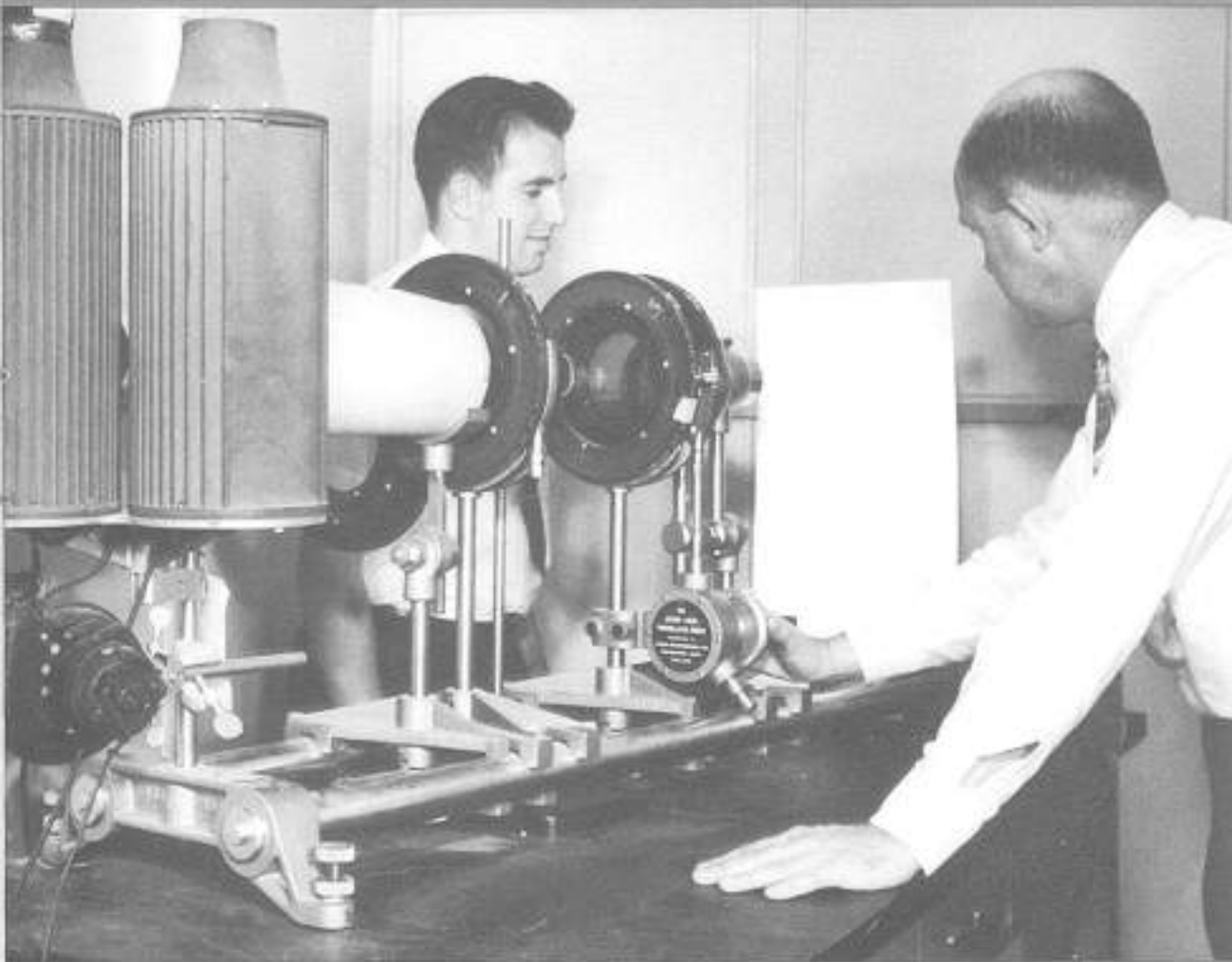
Infrared Systems

The staff has had extensive experience in infrared systems research, and for several years has been producing infrared materials, components and systems for the military. In fact, AO is now one of two domestic sources for arsenic trisulfide glass, the only low-cost, easily worked infrared refracting material transmitting from the visible out to the 13 micron region.

As a result of extensive studies of the fundamental aspects of infrared phenomena, the laboratory was selected to undertake major programs for the military, including the development, design, and prototype production of target-detecting devices for the advanced Sidewinder missile. In completing these assignments, the staff was required to develop new techniques and approaches in the handling of "exotic" materials such as arsenic trisulfide, strontium titanate, sapphire, and interference coatings. Recently completed projects employing infrared optical systems also include night-driving and gunner periscopes for the Army's M60 Tank and M88 Tank Recovery vehicles.



Observing strain patterns utilizing a polariscope.



Glass Studies

The Research Center carries out broad investigational programs into the raw materials used in optical elements. This entails comprehensive studies of the properties of glass and transparent materials, with emphasis placed on the precise measurement of internal structure, performance strengths, and rheological properties. Particular attention is paid to melting, molding, and annealing characteristics. Closely coordinated is the design, construction, and calibration of sophisticated test apparatus used to determine important indexes such as elastic modulus, softening points, thermal conductivity, and strain points.

The staff is also developing new types of glass for science, industry, and the government. Unclassified projects include the formulation of infrared-transmitting, acid-resistant, heat-absorbing and protective glasses. A rare-earth glass with trivalent neodymium as the active ion was developed by AO to make glass lasers possible.



Recording spectrophotometer used for determining transmission characteristics of various substances.



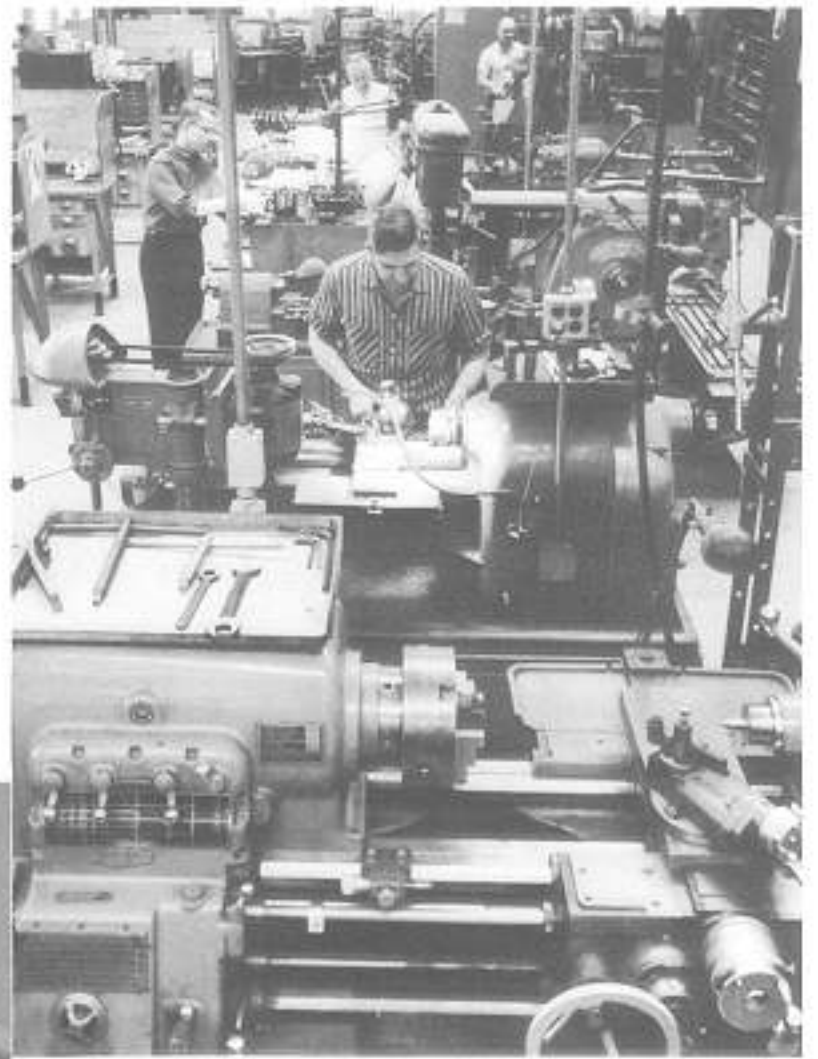
Personnel

The significant accomplishments of AO's research staff are directly related to a high level of individual ability. At the present time, more than two-thirds of the senior staff hold doctorate degrees in their chosen fields. Moreover, the professional experience of the entire research team — more than 120 scientists, engineers, and technicians — averages 10.5 years in a variety of commercial and university programs.

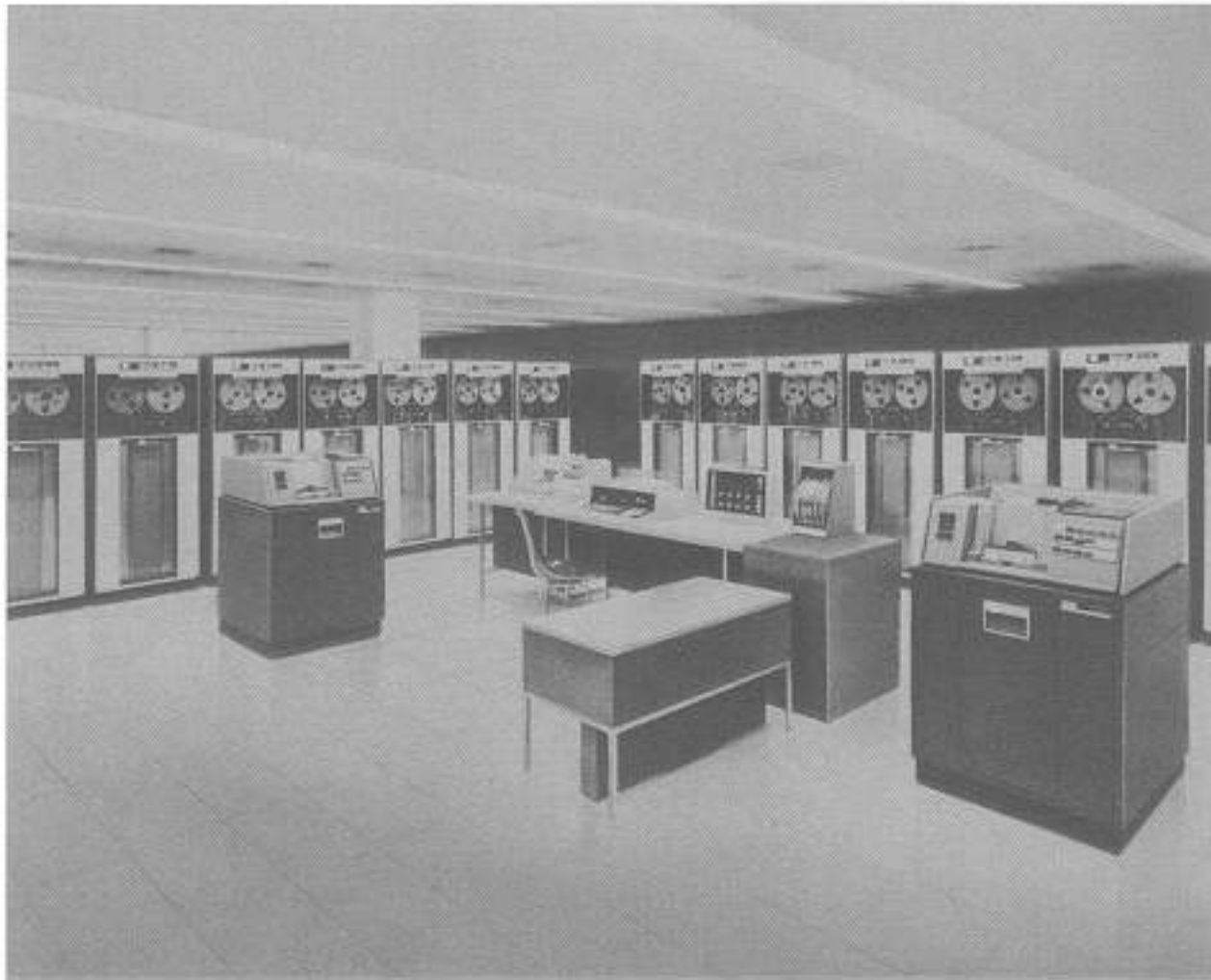
To assigned tasks, these people bring a marked degree of technical competence, plus insatiable curiosity. At AO, optical research is a challenging experience, with unlimited opportunities for personal and collective achievement.

AO's Director of Research, Dr. Stephen MacNeille, far left, discusses a project with members of his staff. Dr. MacNeille, who has had a distinguished career in industrial and governmental research, has been a guiding force in the pioneering achievements of the research staff.

Instrument shop.

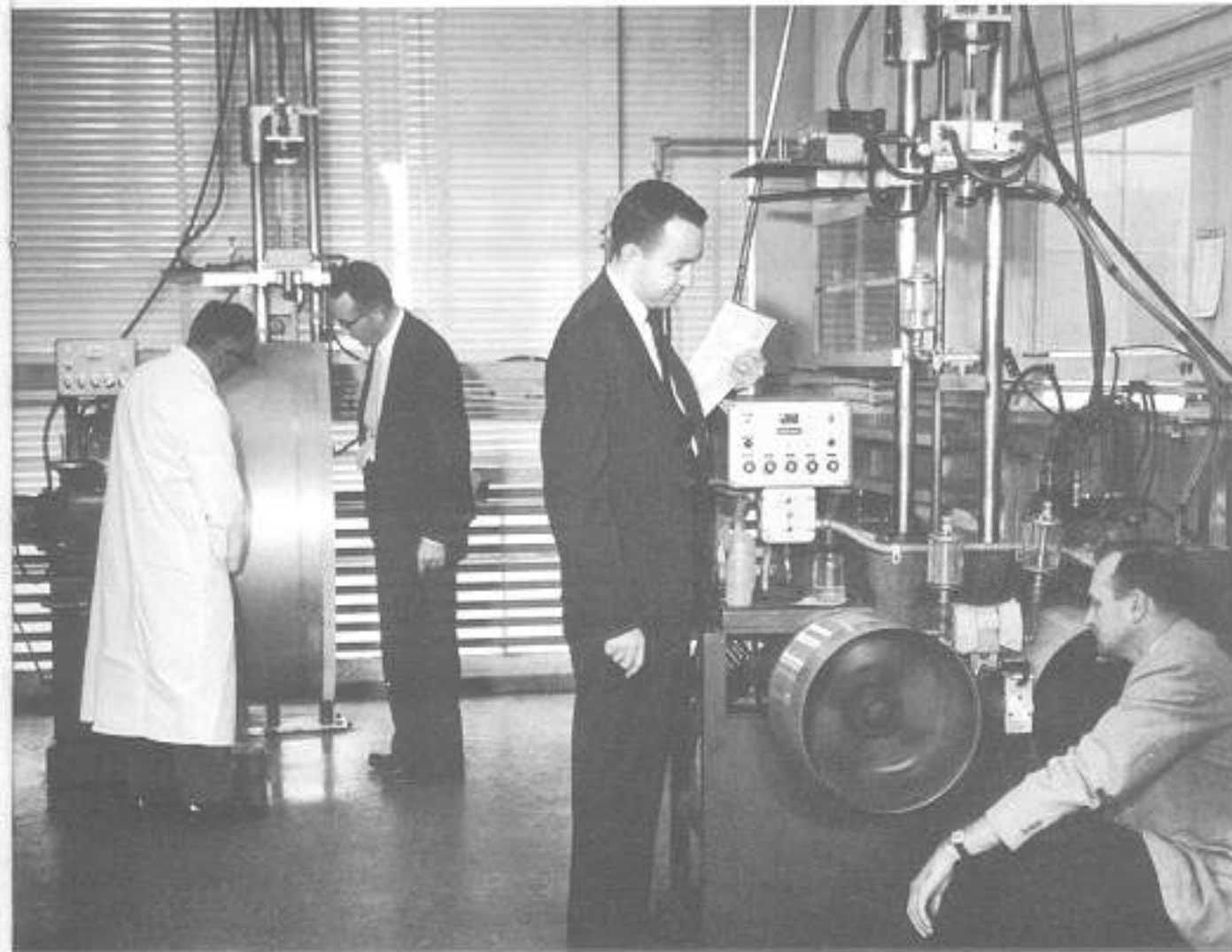


IBM 7070 computer facilities.



Research library.





Facilities

The facilities available to staff personnel within the Research Center include these laboratories:

These laboratories are equipped with such highly specialized instrumentation as electron and X-ray diffraction units, an electron microscope, various spectrometers, monochromators, spectrophotometers, spectrographs, and interference microscopes. Temperature cycling, shock, vibration, and helium leak detection, as well as standard laboratory equipment is also available for testing of developed products. In addition, the Center maintains its own technical library and machine shop, and has the use of LGP-30 and IBM 7070 computer facilities.

OPTICAL INSTRUMENTATION
GLASS DEVELOPMENT
INFRARED
PHOTOGRAPHIC
ELECTRONIC



Career Opportunities at AO

American Optical Company Research covers the entire range of "products to extend and protect the physical senses of man." Thus, there are challenging opportunities for specialists in many scientific disciplines. In the Company's Research Center at Southbridge, Massachusetts, satisfying careers await men and women with degrees in physics, chemistry, mathematics, metallurgy, electrical and mechanical engineering, and other fields of physical science.

Personal Development. The young scientist is encouraged and trained to move forward. He works with leaders in his specialty and has a great opportunity for learning and personal achievement. The experienced scientist has a chance to use research facilities unparalleled in the field, and to work in a truly stimulating atmosphere. AO encourages membership and participation in professional societies and clubs and attendance at seminars and forums. Writing of technical papers and other materials is also encouraged.

Salaries. An up-to-date salary structure is maintained to compensate individual ability and performance. Regular salary reviews are an integral part of this policy with increases granted on the basis of merit and added responsibilities.

Employee Benefits. Each AO employee has a package of plans designed to make his present, as well as his future, secure. Included are life, hospitalization and surgical insurance plans, a retirement program, and, of course, paid vacations and holidays.