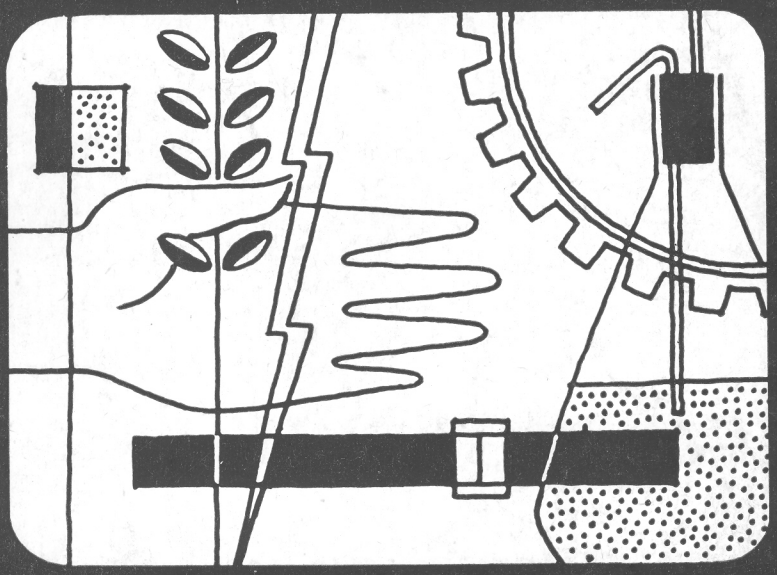
1952

annual report



engineering experiment station
georgia institute of technology


RESEARCH

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THE ENGINEERING EXPERIMENT STATION
1951-1952

By Gerald A. Rosselot* and Fred W. Cox, Jr.**

During the fiscal year 1951-52, Georgia Tech's Engineering Experiment Station continued and expanded its services to industry and its contributions to national defense research. Development of natural resources, both regional and national, public health research and participation in Georgia Tech's educational program are among the other broad areas in which the Station served usefully.

Measured by the yardstick of balance sheet data and growth curves, the Station set new records in 1951-52—both in dollar value of research performed and in number of persons employed—and it also made some significant additions to its research facilities. Thus, judged both from the standpoint of research activity and from the longer-term goal of expansion for greater service, the past year saw gratifying progress made.

Many, perhaps a majority, of our research projects cannot be discussed in detail at this time in view of security considerations and the proprietary interests of industrial sponsors. However, we hope that the overall statistics presented herein and the summaries of projects that can be mentioned will provide a reasonably informative picture of the Station's activities over the year recently completed.

PROJECT OPERATIONS

Of the 116 projects conducted by the Station during the year, 60 were performed for industrial sponsors. The Station itself financed 16 projects of potential benefit to industry and shared the cost of three other projects with industrial groups interested in the possibilities for technological advances that those projects promised. The remaining 37 projects represented the Station's participation in the Federal Government's extensive research program. By far, the greater portion, 94.2 per cent, of the Government-provided funds went into defense research, the other 5.8 per cent having been expended on projects directed toward improvements in public health and the development of our nation's natural resources. Contractual agreements for industrial and Government research accounted for $1,220,954 or 92.3 per cent of the Station's income in fiscal 1951-52.

The 56 new projects initiated during the year had authorized budgets totaling more than $636,500, and substantial expansions in the budgets of several were awaiting approval at the year's end. On June 30, 1952, there existed an estimated backlog of $1,400,000, available or assured, for contract research.

Figure 1 shows graphically the growth in number of projects conducted under industry, Station and Government sponsorship, which took place over the last ten years. This chart illustrates rather strikingly how our services to industry have been increased during that period.

In order to indicate the nature and scope of the research conducted by the Chemical Sciences, Physics and Mechanical Sciences Divisions, brief summaries of the unclassified and non-confidential projects carried on during 1951-52 will be presented later in this report, beginning on page 4.

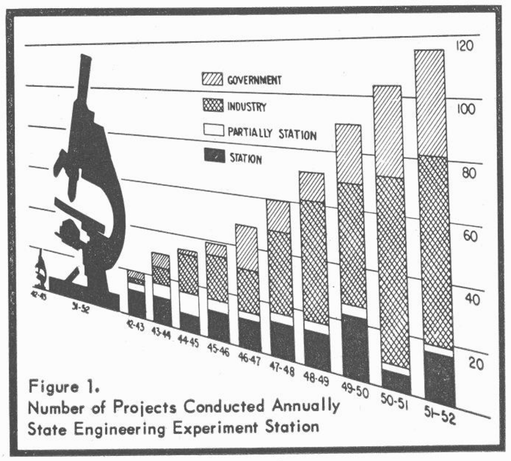


Figure 1.
Number of Projects Conducted Annually
State Engineering Experiment Station

*Director
**Assistant Director

PATENT ACTIVITIES

In the course of the year's project operations, staff members made discoveries leading to 21 records of invention and five applications for patents.

The patent applications included a method for soldering to thin metallic films, a method for coating silicious materials with metal and machinery for cleaning and sizing peanuts.

PUBLICATION ACTIVITIES

As might be expected in view of the confidential nature of almost all of our Government research and much of our industrial research, the number of our publications, other than project reports, has not risen in proportion to the increase in our research operations. However, the 39 publications of our staff in 1951-52 compare favorably with the numbers produced in other years and indicate that we are keeping up our basic research and are reporting it. Where security conditions have warranted such action, we have constantly sought to have significant research results declassified for publication in technical journals.

Judging from the number of items appearing in technical and abstract journals, *The Research Engineer* is receiving widespread recognition and is serving well its purpose of disseminating information on our research activities. During the past year numerous daily papers over the country picked up and ran stories on developments first reported in this publication.

EDUCATIONAL SERVICES

Valuable experience and needed financial assistance were provided during the year to 81 graduate students and 57 undergraduates through part-time employment by the Station. Two holders of Westinghouse Fellowships were given training in the Network Calculator Laboratory. In addition, the Station suggested to a prospective sponsor that his research might well be conducted by a graduate student under a fellowship—with the result that a worthy student received support for further studies under the Johnson Fellowship in Chemistry. Two other graduate students wrote their master's theses on project work they performed at the Station.

The Station assisted Georgia Tech in obtaining four new faculty members, three with doctorates, through cooperating in joint faculty-Station appointments. It also assisted 13 of Tech's Schools in maintaining high-caliber men by employing 55 faculty members on a part-time basis.

Several of the Station's specially equipped laboratories were made available for independent student and faculty research.

PERSONNEL

Between June 30, 1950, and June 30, 1951, the Station's increasing volume of research required expansion of the full-time staff from 78 to 186; and, as of the latter date, part-time personnel totaled 80. During the past year the continuing growth in our operations was met largely by expanding the part-time personnel to 182. Our full-time staff was increased only slightly—to 189.

Of the research personnel employed in 1951-52, 51 were faculty research associates, two were research professors, one was a research associate professor, 13 were research physicists, one was a research chemist, 39 were research engineers, 59 were research assistants and 42 were technicians. They were assisted in their work by 20 graduate students and 57 undergraduates.

FACILITIES

Obtaining space for our constantly growing research activities was a chronic problem throughout the year. Consolidation of complementary facilities in multi-purpose laboratories has helped to alleviate the problem somewhat, as in the case of our new analytical and organic chemistry laboratories. Two of the buildings recently made available to us have been converted for exclusive use in microwave and electronics research. New electronics laboratories have also been installed in a third building, while radar test facilities have been erected on the roof of the Hinman Research Building. Much needed storage space has been provided by construction of a 6,000-square-foot building at Research Area No. 2.

Temporary measures to provide required space include assignment to the Station of

about half of the Modern Languages Building and a house on the campus, in addition to renting by the Station of two houses near the campus. At the close of the year these were being refurbished for research in the fields of fluid mechanics, acoustics, electronics and radar. Although this additional space temporarily alleviates the research housing problem, anticipated growth will soon necessitate new measures.

Among the more notable additions to the Station's facilities during 1951-52 were the new ceramics laboratory and the x-ray diffraction laboratory. Significant new equipment included recording x-ray spectrometers, nuclear research equipment and much needed heat-treating facilities for the Machine Shop. An electrostatically shielded room was set up to screen out interference that might hinder electronic research, and the photographic laboratories were provided with a large enlarger and other needed equipment.

INCOME

Table I lists the sources of Station income during the past fiscal year, while Figure 2 compares them with similar figures for previous years.

TABLE I

Sources of Station Income

Source	Amount	Per Cent of Total
Research Agreements	$1,220,953.76	92.3
Board of Regents Appropriation	69,000.00	5.2
General Education Board—Board of Regents	29,970.00	2.0
Endowments	6,816.05	0.5
TOTAL	$1,323,739.81	100.0

As has been increasingly true in recent years, sponsored research accounted for by far the greater part of the Station's income in 1951-52. However, the funds made available by the Board of Regents and the General Education Board, together with the relatively small sum from endowments, have assisted importantly in financing broad programs of research in basic industrial problems and new uses for natural resources and in securing and holding outstanding personnel.

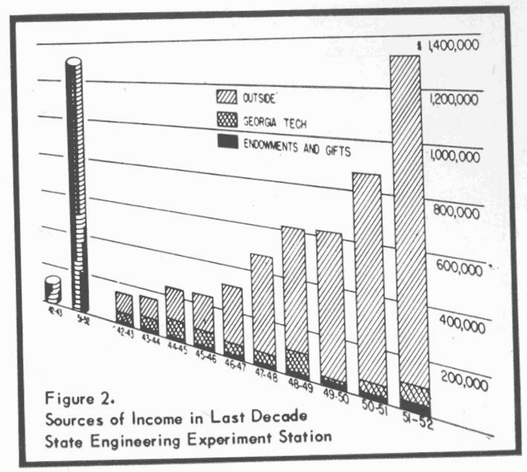
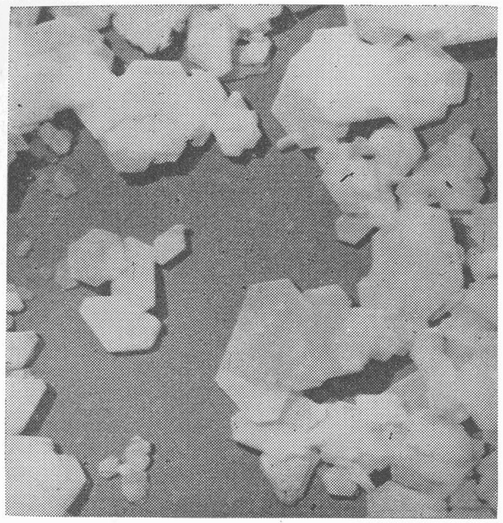


Figure 2.
Sources of Income in Last Decade
State Engineering Experiment Station

While representing only a modest 5.2 per cent of the Station's total budget, the $69,000 made available by the Board of Regents made possible significant steps toward the goal of research activities adequate to provide Georgia with the industrial developments it needs to balance an economy now largely based on agriculture. With these funds the Station carried on during the past year 11 research projects of a more or less fundamental nature. These projects were designed either to contribute to a better understanding and better utilization of Georgia's raw materials and agricultural products or to develop fundamental knowledge and methods that will enable the Station to render better service to the industry of the State. These projects, described later in the project summaries, have dealt with the following subjects: properties of Georgia kaolins; problems of the naval stores industry; a water-grinding process for extraction of oilseed; machinery requirements, industrial engineering problems and industrial relations problems of the peanut industry; the origin of turbulence in fluid systems; the theoretical and practical aspects of computation engineering, including nomography; a simple telemetering system for transmitting several channels of information over a com-



Georgia kaolin magnified 12,000 times by electron microscopy. Research on this resource is being financed with State funds.

munication system; methods for making glass-to-metal seals; a special fuel-injection system for internal-combustion engines; applications of radioisotopes in industry; and a fundamental study of the uses of microwave spectroscopy in industry coupled with the design and development of suitable equipment for such uses.

Fiscal 1951-52 was the third year that funds were made available to the Station by the General Education Board and Board of Regents matching funds. While representing only about 2.0 per cent of our total budget, these funds were most effective in helping us secure and maintain the top-quality administrative and scientific personnel essential for superior performance of our functions.

THE RESEARCH INSTITUTE

Georgia Tech Research Institute, which serves essentially as the contractual agency for the Station, continued in 1951-52 to lend financial stability to our operations, to perform numerous services in patent matters and to increase our contacts with industry. Its President, Vice-President and Advisory Council, the latter composed of prominent Georgian civic leaders and business men, have assisted greatly in bringing our services to the attention of those who can benefit from them. Their activities have done much to foster appreciation of the value of research in Southern industries.

STATION DIVISIONS

Each of the Station's three cooperating divisions—Chemical Sciences, Physics and Mechanical Sciences—has as a major purpose the strengthening of our facilities and staff for research in its own general field. New projects are assigned to the division under which the major portion of the work will be conducted, and the other divisions render assistance as required. Thus, administration and supervision of each project are centralized in one division, while the entire facilities and abilities of the Station are available for its prosecution.

The three Station divisions are assisted in their work by three service groups, the Mechanical and Engineering Design Services, the Technical Information Service and the Photographic and Reproduction Services. In addition to its service functions, the Technical Information Service conducts outside-sponsored literature research, while some of the research assigned to the Mechanical Sciences Division is performed by the Mechanical and Engineering Design Services.

As previously explained, national security requirements prevent description of much very significant research, and many of our industrial projects cannot be discussed at this time out of respect for the confidence in which they were conducted for their sponsors. Thus, we cannot present a complete resume of our research operations during the past year. However, the remainder of this report will be devoted to summaries of the non-confidential projects conducted under the various Station divisions and service groups in the hope that they will provide a representative, though incomplete, picture of our accomplishments in 1951-52.

THE CHEMICAL SCIENCES DIVISION

On the basis of their primary contributions to society in general, the 17 major projects conducted during the past year by the Chemical Sciences Division could be classified in four broad categories—public health, national defense, industrial development and utilization of natural resources.

Although directed toward quite specific objectives, some of these projects hold substantial promise of useful contributions in more than one of the above categories.

Effect of Vapors on Bacteria

The last statement is substantiated in example by a study which we are presently making for the National Institutes of Health. Its primary objective is to determine the relationship, if any, between the physical activity of certain chemical vapors and their ability to "sterilize" air, that is, to kill air-borne bacteria or to remove them from the atmosphere. The results of these studies may be applied to purification of the air in homes as well as in hospitals, theaters and other public places. Conceivably, the results could also be of great value in defense against bacteriological warfare. Most of the past year's work on this project was concerned with setting up the necessary laboratory facilities and establishing methods for separating very small living particles from air samples.

Bacterial Mortality at Low Temperatures

Our earlier work on the preservation of food by freezing has led to the current study of the effect of low temperatures on bacteria and other forms of microbial life, a project also sponsored by the National Institutes of Health. In general, the results of this study have confirmed those previously obtained, and they are expected to be of value in interpreting previous data on the conditions under which microorganisms can best be controlled in frozen foods—with consequent benefits to both the producers and consumers of these foods. In addition, the study should serve to extend the fund of basic information on the effect of low temperatures on living cells.

Chlorination of Amino Acids

In an effort to provide the public with safe, palatable drinking water, the Station has been conducting a research program on the bactericidal mechanism of chlorination for the National Institutes of Health. Working on the assumption that the organic chemical compounds formed by chlorinating bacteria are responsible for the disagreeable odor and taste of treated water, Station researchers have been studying the taste-producing and odor-producing effect of chlorination upon various amino acids and other compounds of biological origin. A combination of ultraviolet spectroscopy with chemical analysis has permitted interpretation of many of the reactions occurring between chlorine and the amino acids, and the investigation of most of these reactions has been completed. Taste has been found to result from the reaction of chlorine with alanine, proline and phenylalanine. The garlic-like odor produced by the reaction of chlorine with arginine is believed to result from the production of nitrogen trichloride, while the organic residue seems to be the source of odor in the case of the three previously named compounds. Twelve other amino acids have been studied, and some of the complex ones having aromatic and mixed-atom rings have been found not to develop tastes upon chlorination. At present, emphasis is being placed on chlorination of algae and the living material itself. Cultures grown in the laboratory are being subjected to various conditions prior to chlorination.

Our studies of techniques for quantitative analysis of chlorine compounds in water are understood to have influenced the recommendations for procedures to be incorporated in the next edition of *Standard Methods for the Analysis of Water and Sewage.*

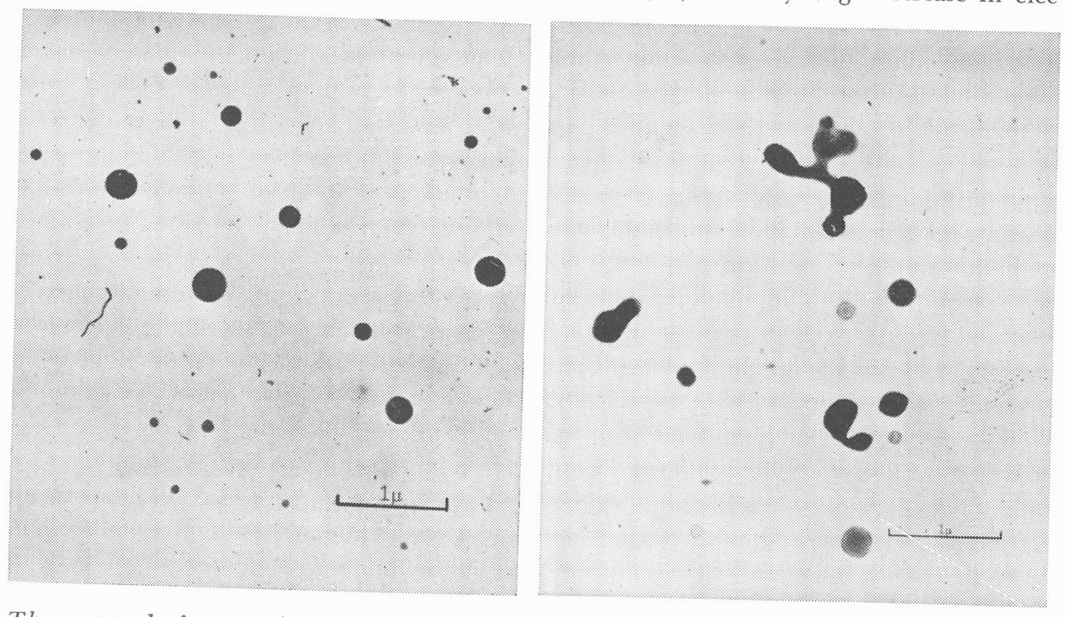
Fine Particles Research

One of the projects currently being conducted by the Micromeritics Laboratory is concerned with the study of existing or new methods for determining the characteristics of fine particles. Methods for determining surface area and measuring particle size have been studied extensively because these parameters are common to all powdered materials regardless of their other properties such as chemical composition, density, etc. A surface-area method involving the adsorption of a fatty acid from an organic solution has been developed and has been shown to be particularly valuable for materials unsuited for gas adsorption analysis because of their thermal instability, reactivity or other properties. This method usually requires only a short time and offers to industry a means of process control that was

previously impractical because the conventional gas adsorption analysis required at least a full day. However, more rapid gas-adsorption techniques have also been developed and found useful. The present work centers around study of particle properties directly related to surface area but also related to the chemical composition and structure of the material, such as heat of adsorption, catalytic activity, total adsorptivity, etc.

Another project of the Micromeritics Laboratory involves aggregation of finely divided matter suspended in air. This project, sponsored by the Chemical Corps, naturally has implications on the removal of noxious contaminants of air whether they occur as the result of industrial operations or enemy action. Both solid particles and liquid droplets suspended in air are known to aggregate and perhaps settle out with the passage of time, the cause being generally attributed to electrical forces. However, there is little agreement in the literature as to all of the factors entering into aggregation, and uncontrolled variables are believed responsible for many observed discrepancies in expected behavior. Experimental studies made here during the past year indicate that water and other vapors markedly affect the degree of aggregation of fine particles. Whether this effect is related to electrical charges and whether the discrepancies noted by previous investigators can be satisfactorily explained are questions to be answered by further investigation.

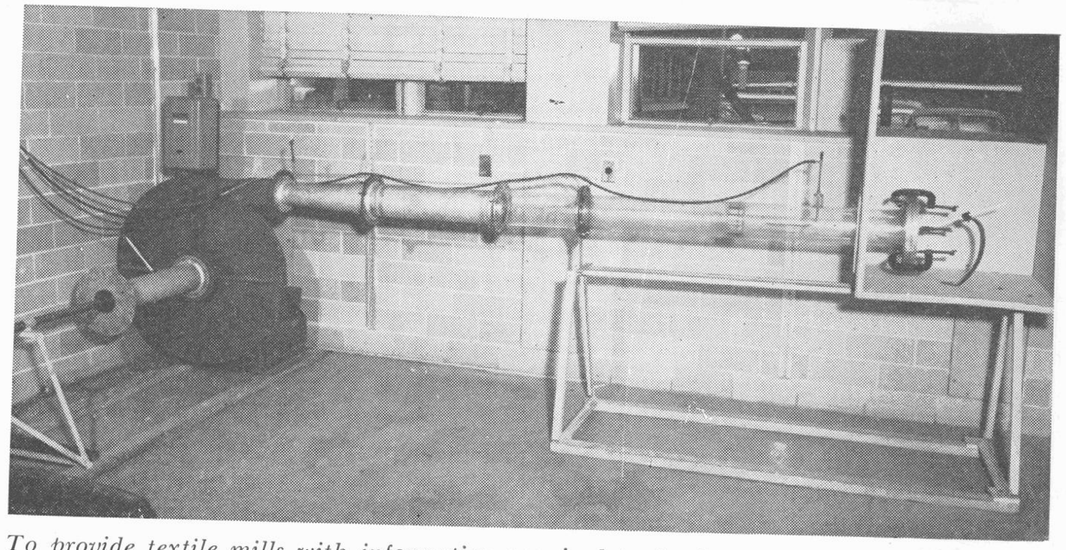
The Micromeritics Laboratory's services to industry in 1951-52 included particle size measurements of ferric oxide samples, surface area determinations on a number of Georgia clays and determination of particle size distribution in petroleum "tank bottoms." Information and assistance were given to groups from the Atomic Energy Commission's installations at Los Alamos and Oak Ridge, from Redstone Arsenal (Huntsville, Alabama) and from a large soft drink company.



The removal of contaminants from the air we breathe is one goal of the Station's aerosol research. These electron micrographs show the effect of increased humidity on the aggregation of ammonium chloride particles. Such aggregation may make airborne particles large enough to settle out.

Properties of Materials at Low Temperatures

For some time the Station has been investigating the electrical and magnetic properties of certain chemical elements and their compounds at temperatures down to 1.5° K (1.5 Centigrade degrees above absolute zero). The search for the occurrence of superconductivity (extremely large decrease in electrical resistance) in these substances at such temperatures was continued during the past year, using a magnetic method for the superconductivity measurements. The materials studied include: the borides of tungsten, molybdenum, titanium and thorium; molybdenum carbide; niobium nitride; and a series of niobium-tantalum alloys. Niobium nitride, the only substance to exhibit superconductivity above 1.8° K, gave a magnetic transition over the range 16.8° - 14.6° K. The work of the Station and other laboratories indicates that the physical structure and distribution of the major and minor constituents of compounds such as the borides, carbides and nitrides are important factors in determining whether superconductivity will be observed. Particle-size measurements made on the Station's specimens showed that at least 50 per cent of all of the powder particles had sizes greater than one micron.



To provide textile mills with information required to produce synthetic fabrics meeting the parachute designer's specifications, the Station is studying the permeability of chute cloths made from various synthetic fibers. The above permeometer was specially designed here to measure air flow through fabric samples.

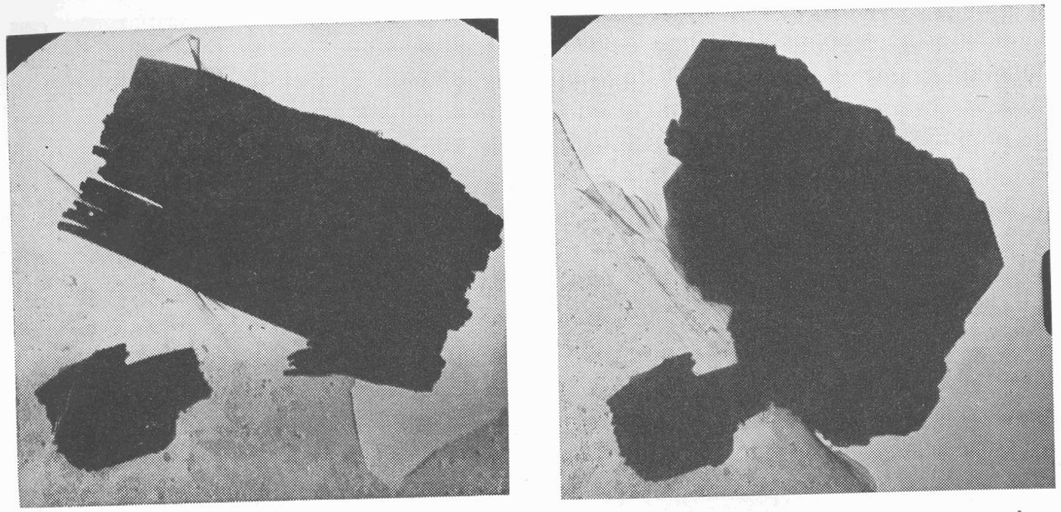
Defense Research

Several of the Chemistry Division's current projects cannot be discussed because of security restrictions. One of these, the objective of which cannot be revealed at the present time, has reached the point of field testing, and two three-month field trips were made during the past year.

In a project for the Air Materiel Command, data on permeability to air flow have been compiled for some 40 potential parachute fabrics. Studies to date indicate that a geometric characterization of a given cloth can be inferred from application of the principles of fluid mechanics to the flow through the cloth. If this hypothesis is further substantiated in tests now under way, it will constitute a useful contribution to the theory of air flow through fabrics. The results of this project are expected to have a definite effect on parachute design.

Industrial Needs for Raw Materials of Plant Origin

A survey of industrial needs for raw materials of plant origin is being conducted for the Division of Plant Exploration and Introduction, Bureau of Plant Industry, Soils and Agricultural Engineering, United States Department of Agriculture. The information obtained will be used to guide the sponsor in foreign exploration for plants to be introduced in American farming. The economic and industrial potential of this project is great, and it is expected to prove of value to the national defense by indicating possible sources of strategic materials



These electron micrographs, taken during research on Georgia kaolin, present two views of the same particle, one at 90 degrees of the other. They indicate that kaolin particles consist of many thin layers of hexagonal plates. The layer structure can be seen at the left, while projecting hexagonal plates appear at the right.

or acceptable substitutes for such materials. During the year, a comprehensive literature survey and a complete report of information obtained from personal interviews and correspondence with laboratories, trade associations and industrial organizations were made, completing the work specified under the original contract. However, this work is being continued in order to provide additional information of importance to industry, agriculture and the national defense.

Naval Stores Survey

In view of the past and potential value of the naval stores industry to Georgia and the general Southeastern area, the Station has initiated a project to compile information on better methods of production, possibilities for new or expanded uses, etc., of turpentine, rosin and related materials. At present, major emphasis is being placed on a literature survey which will reveal the present "state of the art" and should indicate promising avenues for future research.

Study of Georgia Kaolins

In order to obtain the fundamental information on the physical and chemical properties of Georgia kaolins that is required for solution of many of the kaolin industry's problems, the Station is conducting a basic research project in this field. The heads of the Electron Microscopy and X-Ray Laboratories and members of Georgia Tech's Schools of Chemistry and Ceramic Engineering are cooperating with the staff of the Chemical Sciences Division in this project.

Vegetable Oil Studies

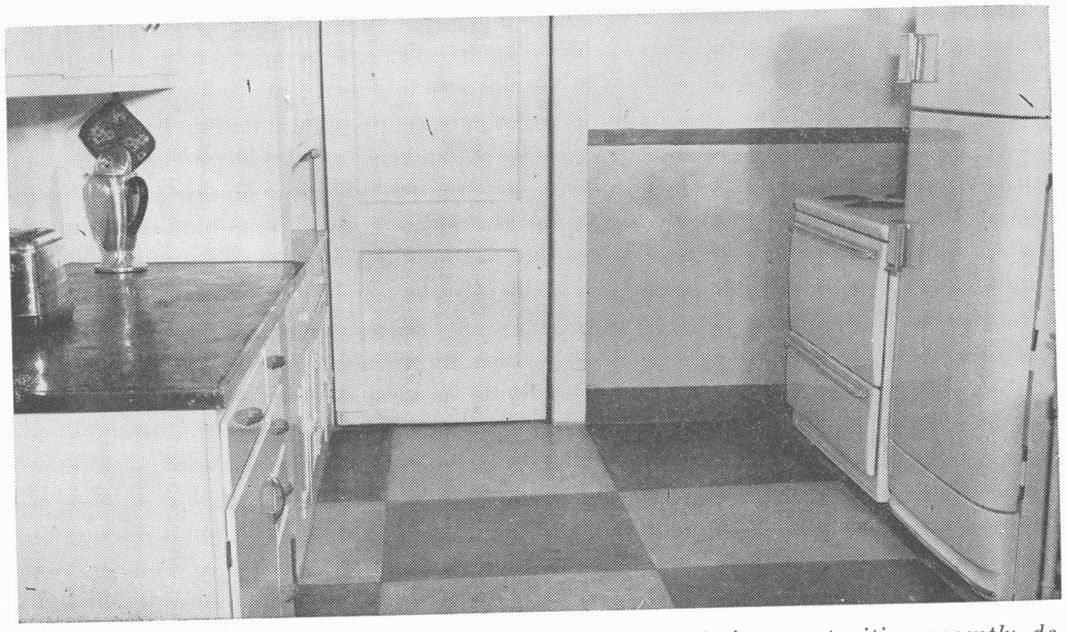
The Station-developed process for simultaneous extraction of oil and protein from various oilseeds by water grinding and centrifuging has been further improved during the past year. The most important technical advance has been elimination of the need for pebble-mill grinding. It was demonstrated that regrinding the wet marc from the first separation in a Morehouse mill and then reslurrying resulted in as low an oil content in the marc separated from the reslurried material as was previously obtained with pebble-mill grinding. With the new procedure the ratio of water to peanuts can be reduced to 5 to 1. A sponsored project based on the Station's extraction process was initiated during the year. A literature search on the subject has been made, and considerable experimental work has already been done.

Work of the Coatings and Applied Chemistry Laboratory

Product research involving coatings and coatings intermediates, plastics, elastomers, cements and related materials were conducted in this laboratory. The Laboratory's studies have often required preparation of series of compositions and evaluation of them by various test methods. Frequently special test methods and equipment for their application had to be developed when standardized tests were not adequate for the new products being investigated. A number of the Laboratory's studies enabled manufacturers to improve the quality and uniformity of their products and, at the same time, to achieve more economical operations by reducing wastes resulting from inadequate process control and incomplete knowledge of the variables affecting product quality.

New products of potential commercial importance have also been developed by the Laboratory. A good example is the trowelled-on flooring and surfacing composition recently developed for an Atlanta construction engineer who was seeking a low-cost flooring material for domestic and industrial uses. Research on his problem was successful in providing a product of unusual commercial possibilities. It possesses excellent adhesion to wood, metals, concrete and other common construction materials, resistance to abrasion and chemical attack, a slight resilience and an attractive appearance which can be adapted to a wide range of uses. Several modifications of the material have been developed for various applications, and a special sealer has been formulated to finish the surface. Means have been found to achieve uniform integral color in practically any shade desired. A number of test applications of the composition have been made and tested under a wide variety of service conditions. The success of the project, originally reported in *The Research Engineer,* has received notice in many technical publications and has been featured in both local and out-of-state newspapers. The resulting publicity has brought many inquiries concerning the commercial availability of the product.

Progress has continued in the long-term studies directed toward development of bet-

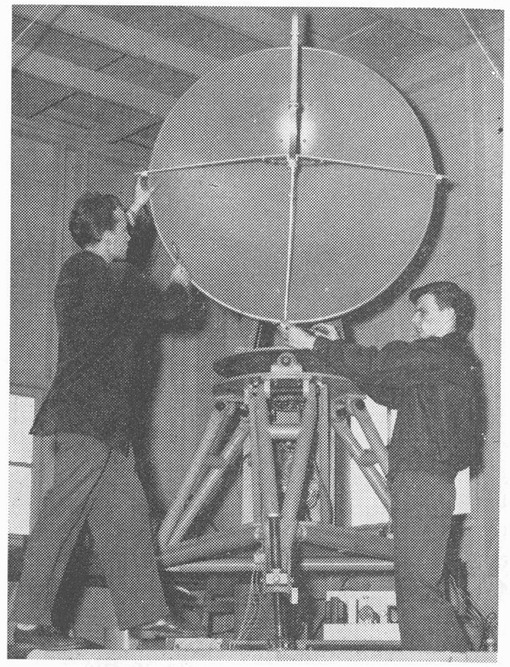


The floor of this kitchen is covered with the resilient surfacing composition recently developed by the Station for an industrial sponsor. The wall surfaces are also covered with the composition to which a coating of oil-base paint has been applied. The composition is believed to have unusual commercial possibilities.

ter paint systems for southern yellow pine. Southern yellow pine has never been as desirable a construction material as its availability, cost and other qualities might make it because of one big drawback—present paint systems will not give it the long-lasting coating essential to proper protection and pleasing appearance. The rapid spring growth and much slower summer growth of the trees is responsible for a piece of lumber showing within itself marked variations in porosity, moisture absorption and coefficient of expansion. Failure of present paint systems usually occurs at the juncture of spring and summer growth rings. In cooperation with the Southern Paint and Varnish Production Club, the Station is attempting to improve the performance of paint on this lumber by studies of the effects of formulation and application when exposed under controlled conditions. All of the paint systems for this program have been placed on exposure, and they are being examined and evaluated periodically. The systems will require three or more years of weathering before conclusions can be drawn.

A number of relatively short-term projects were undertaken for industrial sponsors during the year. One involved evaluation of two proprietary paints for exterior house top coats by normal exterior weathering methods. Another consisted of investigation of surface color treatments and waterproofing compositions for use on granite and marble memorial stones. In this case, weatherometer exposure tests were used to obtain an accelerated indication of the effectiveness of the treatments employed. Other projects included development and testing of surface finishes for cement-base wall tiles, testing and evaluation of finishes for wooden cabinets, determination of the effectiveness of mildewcides for fabrics, development of test methods for evaluating concrete flooring tiles, design and construction of special equipment for the immediately preceding project, testing of pretreated, painted and unpainted aluminum panels and determining the salt-fog resistance of painted steel panels.

Station-sponsored studies of the filtration of kaolin through filter cloth were also made, and a method was developed for measuring the adhesion of the cloth to the filter cake.



Specialized radar research for the Armed Forces constitutes a major portion of the Physics Division's project operations.

Indium and Indium-Rich Alloys

A Station-sponsored project was recently initiated to investigate the applications of indium and indium alloys in making glass-to-metal seals. Practical use of the resulting information has been made in attaching leads to thin metal films on quartz crystals for use in frequency control of electric circuits. The ability of indium and its alloys to bond a lead to thin metal films without absorbing a portion of the film has proved of importance in obtaining good contact. The techniques developed in this work show considerable promise of additional industrial and scientific applications.

Storage Life of Packaged Foods

The activated carbon-silica gel packet developed to increase the storage life of packaged potato chips has proved so effective that the sponsor has made it available to other food packers. During the past year, the effectiveness of the packet in preserving

foods other than potato chips was investigated. It proved very effective for increasing the storage life of packaged nuts. However, the storage life of crackers, dried milk, chocolate candies, sugar and peanut butter sandwiches was not significantly increased by the packet.

THE PHYSICS DIVISION

The quantity and quality of the Physics Division's research work is strikingly evidenced by the dollar value of the sponsored projects that have been entrusted to it by Federal agencies, industry and State organizations. In June, 1951, the Division's research expenditures were running at a rate equivalent to half a million dollars per year. By June, 1952, the rate had increased to some $864,000 per year, or slightly more than the Station's entire 1950-51 research budget.

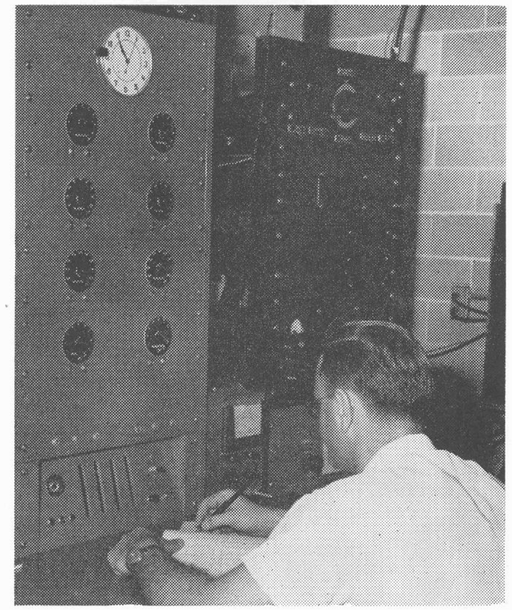
Some idea of the Physics Division's contributions to national defense may be gained from the fact that by far the major portion of its 1951-52 activities were devoted to research, design and development work on Government-sponsored projects — primarily in the fields of radar, electronics and underwater sound. Unfortunately, security considerations prevent detailed discussion of the problems studied and the significance of results obtained. However, what little can be said here may be taken as fairly indicative of the scope of the work now being conducted for agencies of the Armed Forces.

Radar Work

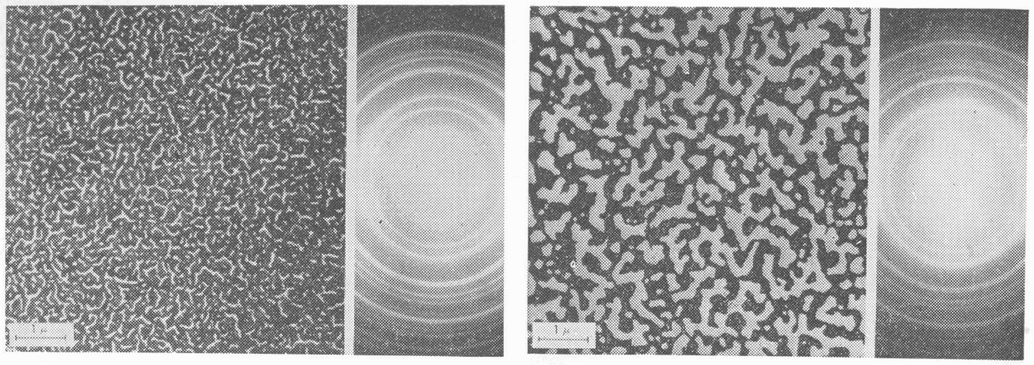
Five of the Physics Division's current major projects are devoted to radar research and development, while a sixth very important project concerns study of radar reflection characteristics. One of these projects involves a long-range program of broad scope, including theoretical investigations, design and construction of special microwave-electronic devices and computers, extensive data-taking at coastal sites, analysis and evaluation of these data and development of equipment based on results of the work. Some 50 persons are now employed in the various phases of this project, and the research program is expected to continue for at least three more years. The design and development phases of the project are being conducted in the Electronics Laboratory and the Microwave Laboratory, which were established in November, 1951, to provide the facilities and personnel to handle the engineering phases of Station projects involving radar systems and associated equipment.

Two other Physics Division projects now under way are similar in general nature and scope to the one just discussed, but their programs are directed toward the solution of different problems and are now in earlier stages of investigation. Another project involving the design and development of a special radar system has reached the point of final evaluation. A project devoted to laboratory investigation of a special type of radar antenna system was completed in March.

Work performed in the Microwave and Electronics Laboratories during the past year has led to the development of improved precision radars, one of which has been field-tested with satisfactory results. In addi-



Measurement of microwave frequencies with an accuracy of one part in ten million is accomplished with this Station-built device. Unknown frequencies within the range of one kilocycle to ten megacycles can be matched and thus experimentally identified.



The Electron Microscopy Laboratory has assisted in studies of the properties of thin metal films. These electron micrographs and diffraction patterns indicate the aggregation that occurs when very thin metal films are heated, this phenomenon being related to "aging" of metal-plated frequency control crystals.

tion, experimental radar systems designed for the collection of certain fundamental data were under construction at the close of the fiscal year.

An annotated bibliography on radar reflective properties and associated propagation phenomena was in preparation at the year's end. The task involves gathering all of the available information on the subject and abstracting it in such a way that critically appraised technical information is presented for the use of other workers in the field. By June 30, 1952, the project staff had examined some 1,100 reports and technical articles and had abstracted about 900 of them. Editing and indexing remained to be done. In addition to its use in the annotated bibliography, the collected material is expected to form the basis for a special textbook.

Acoustics Work

The current research on sound represents extension and expansion of an earlier project and is concerned with the evaluation of defense devices. The prospects for further broadening the scope of this work appear excellent, and the program may develop to proportions approximating the radar-electronics research.

Frequency Control Work

The problem of frequency control in electrical circuits has been studied under two major projects. The objectives of one, which is a joint undertaking of the Chemical Sciences and the Physics Division, include determination of the factors contributing to the aging of metal-plated quartz crystals and development of means for minimizing aging. A method of pretreatment effective in this respect has been discovered and is being tested. An improved method of mounting plated crystals also is being tested to determine its potential for minimizing aging. Some of the declassified results of studies carried out under this project were recently discussed before a meeting of the American Physics Society.

Under another project, the Physics Division has been investigating various methods, phenomena and devices that may prove useful for the control of frequencies in a range where present methods are inadequate. Two methods are being actively studied, and equipment for one of them has been constructed at the Station.

Electron and Optical Microscopy

Additions to the electron microscope and auxiliary equipment have placed us in a position to contract for practically any type of work for which electron microscopy is useful or believed to be useful. The Optical Microscopy Laboratory has been reasonably well-equipped at a very modest outlay by consolidating in one area a sizeable amount of Station-owned equipment.

During the year the electron and optical microscope facilities have been used to study various clay samples submitted by industry, to study the structure of dextran (blood

substitute) molecules, to determine solid contaminants in gasoline samples and for other industrial services. Assistance has been rendered to several other projects being carried on at the Station, notably those on thin metal films, aerosols and surface studies of fine particles.

X-Ray Diffraction and Radiography

Last year's objective of setting up a laboratory capable of offering a wide range of x-ray services to Georgia industry has largely been attained. The x-ray diffraction facilities are now adequate for handling almost any problem calling for use of the powder method—which covers the great majority of industrial problems. The facilities for radiography and fluoroscopy also are adequate for most industrial research and quality control needs. Under the title "X-Rays at Work for Industry" the usefulness of x-ray equipment and the availability of such facilities at Georgia Tech were recently pointed out through an article in *The Research Engineer*.

During the past year the X-Ray Laboratory has aided several Station projects by making grain-size determinations, phase investigations, compound identifications and studies of thin metal films. A radiographic and fluoroscopic investigation of the nailing effectiveness of a machine for attaching heels to military footwear was conducted for a private company. While not large in budget, this project typifies one of the major functions of the X-Ray Laboratory—serving small industries of the State.

Radioisotopes Work

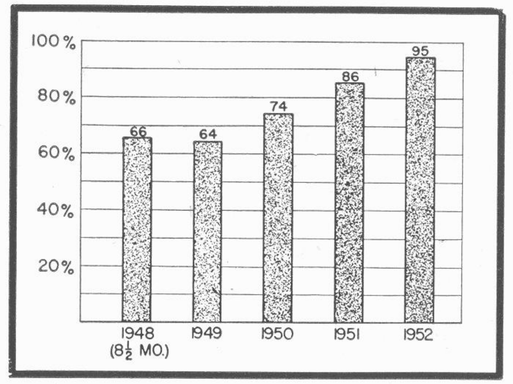
The many existing and potential applications of radioisotopes in industry and medicine make desirable a strong program to foster the use of radioisotope techniques in Georgia. Consequently, a Station-sponsored project for this purpose was initiated during the year. It includes a survey of the pertinent literature, a study of the properties of radioisotopes, establishment of requirements for their safe handling, development of laboratory facilities for their use and prosecution of an experimental program. Progress has been made in all of these areas, except the last which must await completion of the laboratory facilities. The head of this laboratory is a member of the committees on radiological defense of the Metropolitan Atlanta and Georgia Civil Defense Agencies. During the year advisory services were provided to these two agencies and to two Georgia companies.

Television Research

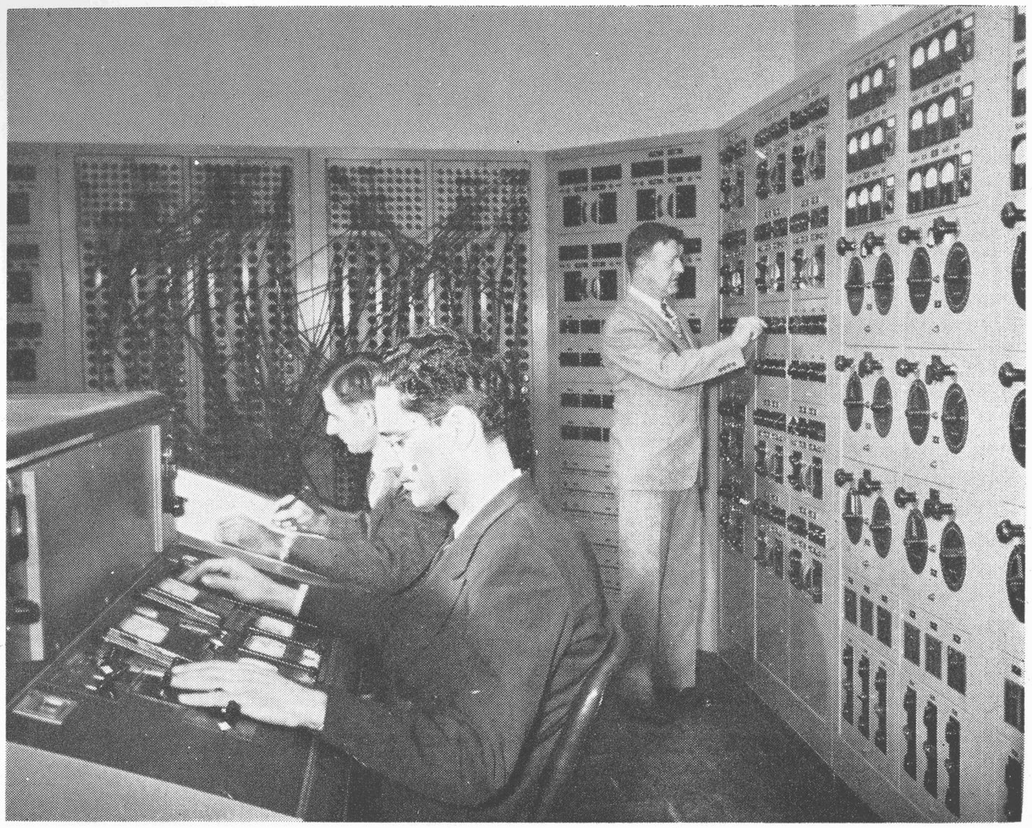
For some time the Station has been working on the development of a simple telemetering system for transmitting several channels of information over a communication system. During 1951-52, the performance of basic equipment constructed in the previous year was extensively analyzed, and a compact telemetering system designed on the basis of this experience is now being built. This device is expected to prove particularly useful for reliable transmission of information sampled at a rate of 60 cycles per second.

Studies of potential importance both to television telemetering and to standard television image production were also conducted. These were directed toward improvement in the apparent resolution of reproduced television images.

In an effort to provide television equipment useful in viewing fluoroscopic images produced in connection with cancer research, a thorough literature search of the subject was made. This work was conducted jointly with the Steiner Clinic and the Station's Radioisotopes Laboratory.



Industry has made increasing use of Georgia Tech's A-C network calculator, as this chart of annual use factors indicates.



Georgia Tech's A-C network calculator, while created and used primarily for the study of power systems, can be used to represent any linear electrical network and can thus be employed in many studies in which an electrical analogue can be drawn.

Study of Microwave Techniques

The first phases of a fairly extensive study of microwave spectroscopy were undertaken in an effort to develop applications to the chemical analysis of polar gases and vapors and to measurement of the dielectric properties of liquids and solids. Basic information is being compiled from the literature, and equipment is being designed and constructed. Personnel from Georgia Tech's School of Physics are cooperating in the preliminary phases which involve both fundamental investigations and the establishment of a microwave spectroscopy laboratory.

Power Transmission

By providing in miniature all of the elements found in actual systems for the transmission of electrical power, the Station's A-C Network Analyzer makes possible rapid solutions to problems which would otherwise require months of mathematical calculation. In speeding solution of the problems encountered by power companies in expanding their systems, the A-C Network Analyzer Laboratory facilitates the efforts of these companies to provide electricity to new homes and industries.

Again in 1951-52, as in the past, the A-C Network Analyzer was used almost continuously in commercial work, with a small but important amount of time being devoted to instructional purposes in cooperation with the Georgia Tech School of Electrical Engineering. Two graduate students on Westinghouse Fellowships were employed part-time in the Laboratory, thus gaining experience that will undoubtedly be of considerable value in their future careers.

Graphical Methods of Computation

The Station has for several years been conducting an investigation of the theoretical and practical aspects of nomography and related graphical methods in an effort to broaden the scope of their application and facilitate their use by engineers and other scientists. In the past year, much emphasis was placed on the problem of manipulating formulas to yield defining equations for nomographs. Because of its potential importance, work along this line is being continued, although results to date have not been particularly fruitful. Much greater progress has been made in devising methods for the simplified conversion of hyperbolic coordinates to Cartesian coordinates, and a table of functional values has been constructed to facilitate the computations involved.

A number of practical developments have resulted from the over-all study. Methods have been devised and applied to practical cases for constructing nomographs from irregular data, for representing systems involving two variables in such a way that they will be both compact and easy to interpolate, for drawing smooth curves by involute plotting, for constructing routine nomographs from standard scales and for constructing a simple gear-type mechanical nomograph to increase the range and accuracy of scales in nomographs of certain types.

The construction of nomographs suitable for the statistical processing of data is the objective of a complementary project. The selection of functions to be dealt with has been made on the basis of the usefulness of the computation for which they are employed and the time saving that their reduction to nomographic form would effect. Only those functions have been chosen which can be handled more quickly by nomographic methods than by machine or slide-rule computation. To date, approximately 25 such nomographs have been constructed.

Fluid Dynamics

Basic research in the field of fluid dynamics has been under way for about six months. Particular emphasis has been placed on a fundamental study of the origin of turbulence in fluid systems. Government support for a special program along this line may be forthcoming in the near future.

THE MECHANICAL SCIENCES DIVISION

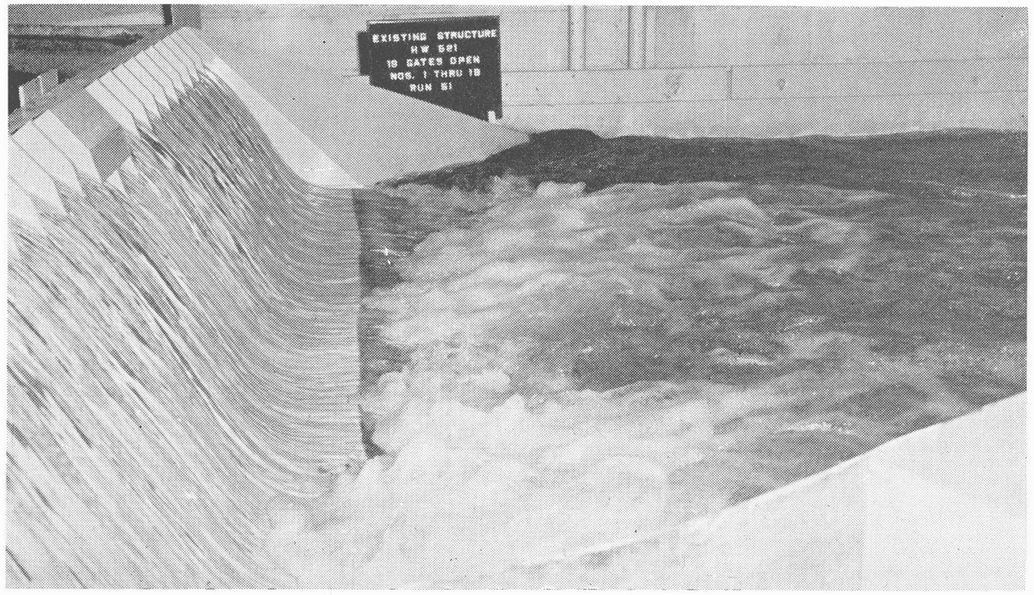
Through the current work of its Mechanical Sciences Division, the Station is contributing to agricultural and industrial progress, aeronautical research and aircraft design, power production and flood control, and other fields coming within the general scope of mechanics and mechanical engineering.

Peanut Industry Research

Development of methods and equipment for improved transportation, grading, unloading, storing, cleaning, conveying, processing and quality-selecting peanuts is the objective of a project being conducted jointly with the Georgia Experiment Station. This work, now in its third year, has resulted in the development and testing of several machines for cleaning and sizing farmer's stock peanuts, the design and testing of equipment for shelling and grading peanuts, and design, construction and testing of an electronic device for quality picking of shelled peanuts. During the year an air-blast cleaner was installed in the Red Diamond Mills at Cordele, Georgia. Tests of this machine during the shelling season will provide data on its effectiveness. A rotary-disc sizer is being similarly tested by the East Georgia Peanut Company.

An industrial engineering survey of the peanut industry is being conducted to determine, through study of existing plants and methods, what recommendations can be made for improvement. Upon completion of the survey a hypothetical plant layout will be prepared to include all suggestions for improvement.

The existing relationships between peanut growers, peanut processors and the Federal Government are being studied to determine the potential effects of technological improvements on their relations one with the other. The results of individual interviews, group discussions and conferences will be analyzed and reported.



Scale models are often used by the Hydraulics Laboratory in its research. This dam model was employed in studies concerned with remodeling and strengthening an existing dam of a Southeastern power company.

Hydraulics Research

One study for a large Southeastern power company, performed in cooperation with the School of Civil Engineering, reached completion near the year's end, and a second project for the same company was expected to begin shortly. The completed project consisted of suitably modifying the draft tubes of a powerhouse turbine to increase their hydraulic efficiency and reduce unit instability and vibration. The problem was solved through some 15 comparative tests of proposed alterations made on a transparent plastic model. The proposed work for the same company involves design of a powerhouse intake.

Research being conducted for the Surface Waters Branch of the U. S. Geological Survey's Water Resources Division has a dual purpose:

(1) to obtain basic knowledge of the mechanics of water flow through width-constrictions in open channels

(2) to develop, if possible, a practical method for computing the discharge through bridge waterways on the basis of field surveys of flood marks and channel characteristics.

Laboratory studies have been successful both in establishing the relative influence of the various flow parameters and primary geometric variables and in permitting development of a general method for evaluating the discharge function. At the end of the year, the analysis was being extended to evaluate the effect of additional boundary conditions. Future research is expected to place emphasis on practical applications of the analysis. The work completed to date is believed to represent a real contribution to the field of applied fluid mechanics.

Aeronautical Research

Much of the Station's aeronautical research is concentrated on helicopter development. One project conducted by Georgia Tech's Daniel Guggenheim School of Aeronautics during the past year demonstrated the feasibility of an iterative solution for the wake distribution of vorticity of a lifting rotor in forward flight. The National Advisory Committee on Aeronautics has been asked to sponsor a study of the effects on mean induced velocity at the rotor arising from tilting the planes of the wake vortex rearward.

The final report on a study of the effect of twist and taper of helicopter rotor blades in vertical descent has been published as NACA Technical Note 2474. The work on means for eliminating the small-angle approximations commonly used in rotor theory has also been brought to a successful conclusion, and the results will be published as NACA Technical Note 2656.

Considerable progress has been made on a new project involving tests of helicopter-rotor models. The necessary equipment for the inclined flight tests of the present program has been designed and constructed. A model two-bladed flapping rotor has been so arranged on a revised test stand that it can be rotated about the vertical axis to change the rotor angle, and equipment has been added to measure flapping angles. Wind tunnel tests are scheduled for completion in the fall, and the final report will be submitted before the end of the year.

Investigation of the normal induced velocity in the vicinity of a helicopter rotor has been completed, and the final report has been submitted. The interference-induced velocity at the rear rotor of a tandem-rotor helicopter was found to be unexpectedly large. Studies indicated that previous methods of calculating the induced-power requirement tended, therefore, greatly to underestimate the true value. This project developed from preliminary research conducted by an aeronautics graduate student as part of the requirements for his Master's degree.

One of our current wind-tunnel projects involves testing of an important component for a Government research installation and, because of its nature, it cannot be discussed here. However, it can be stated that the Georgia Tech 9-foot wind tunnel continues to be put to good use. A project for the Glenn L. Martin Company has recently been completed.

Georgia Tech's success in applying the methods of hydraulic analogy to the problems of subsonic, transonic and supersonic aerodynamics has recently led to design and construction of a 20-foot by 4-foot water channel for the USAF Institute of Technology. This channel will be used in the engineering instruction of Air Force officers.

THE MECHANICAL AND ENGINEERING DESIGN SERVICES

The Mechanical and Engineering Design Services continued during the year to provide valuable assistance to the various projects, particularly in the areas of machine design and drafting. They have designed equipment, laboratory apparatus and instruments for the projects, have served in a consulting or advisory capacity to both the Station Staff and outside sponsors, have prepared numerous drawings and diagrams for reports, publications and patent applications and have supervised the Station's buildings. In addition, they have conducted a number of projects assigned to the Mechanical Sciences Division.

One of the projects involved study of the effect of various types of window treatment on the solar heat gain through ventilated and unventilated openings and the effect of the color of aluminum venetian blinds on daylight room illumination. Data from the investigation are being used as visual aids in the presentation of lectures to various chapters of the American Institute of Architects all over the country.

Two projects have been conducted for a large aircraft corporation, one of which consisted of a study of the corporation's propeller-balancing methods. The other project involved heat treatment of tool steel samples to determine their hardening properties.

Services to the Georgia Agricultural Experiment Station at Griffin included the construction of several motor-driven mixing frames of the type used in its mobile soil-testing units. A similar frame was also constructed for the Georgia Coastal Plains Experiment Station at Tifton.

A project conducted for Emory University's School of Psychology had as its objective the design and construction of a device to produce a single light pulse of variable duration from one millisecond to 2,000 milliseconds for use in certain fundamental studies on human vision. A suitable device, based upon a circular shutter rotating at constant speed with a variable aperture and a single-exposure trigger mechanism, was constructed for this purpose. Design and machine shop work on the modification of

a motor-driven fluid injector was also carried out during the year for Emory University and Grady Hospital's Department of Physiology.

THE TECHNICAL INFORMATION SERVICE

The growth of the Technical Information Service's staff and its operating budget during the past year and one-half is indicative of the increase in its services to the Station, Georgia Tech, industry and Government which has taken place over that period. In November, 1950, TIS had only five full-time staff members and one part-time employee. By June 30, 1952, the staff included ten full-time members and six part-time employees. This growth resulted from a sharp increase in sponsored literature research.

During 1951-52, the Technical Information Service was required to exercise "quality control" over more reports to sponsors than ever before. This editing and prior-to-printing inspection has helped to maintain good thought organization, readability and appearance in our reports, factors important to an organization whose major "products" are reports of research results.

Along the same general line, the Technical Information Service has edited numerous papers and articles prepared by Station staff members for publication in technical or scientific journals. It has, of course, continued to handle the editing and publishing of *The Research Engineer,* Station circulars and reprints, brochures, etc. In addition, its head is serving as assistant editor of *Chemical Literature,* the quarterly publication of the American Chemical Society's Division of Chemical Literature.

As its name implies, one of the Technical Information Service's major functions is providing technical information on request. This it has done by answering numerous requests from residents of Georgia and the Southeast, by supplying bibliographies, literature searches and technical data to the various Station divisions and by conducting two sponsored informational projects.

One of the sponsored informational projects consists of answering requests for technical information from companies in countries receiving Mutual Security Agency aid. Through channels established by the MSA, foreign companies send requests for needed technical information to productivity centers in their own countries. Those questions which cannot be answered at the respective productivity centers are translated into English and sent to the Office of Technical Services in Washington, D. C. Georgia Tech is one of the five organizations assisting the OTS in answering the questions it receives. During the past year, the Technical Information Service has answered more than 75 MSA-OTS requests for technical information, many of which required detailed and quite extensive searches of the technical literature and/or direct contact with American manufacturers in order to provide practical, reasonably complete and up-to-date information to the inquiring companies.

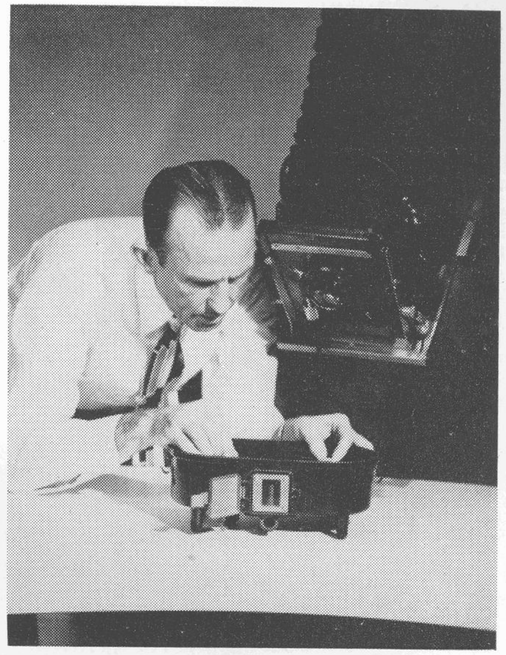
The other outside-sponsored informational project is the "Monthly Summary of Industrial Developments (Related to Petroleum Processing)" which is prepared for nine petroleum and petrochemical companies. Published during the first week of each month, the "Monthly Summary" constitutes a technical-economic digest of developments noted in a continuous survey of publications received by the 25th of the preceding month. Covering the leading journals in the petroleum, petrochemical and related fields, the "Monthly Summary" is designed to provide busy executives and top-level technical personnel with significant information which they could otherwise obtain only by regularly and painstakingly scanning 20-30 periodicals.

Preparation of records of invention and liaison between inventor, patent attorney and administrative officers of the Station and Georgia Tech Research Institute is another TIS function that has been accelerated by the higher level of Station research activity. The same is true of the technical public relations function which, again during the past year, has been carried out through the medium of press releases, articles in *The Research Engineer* and assistance in the preparation of addresses presented by various officials of Georgia Tech and the University System.

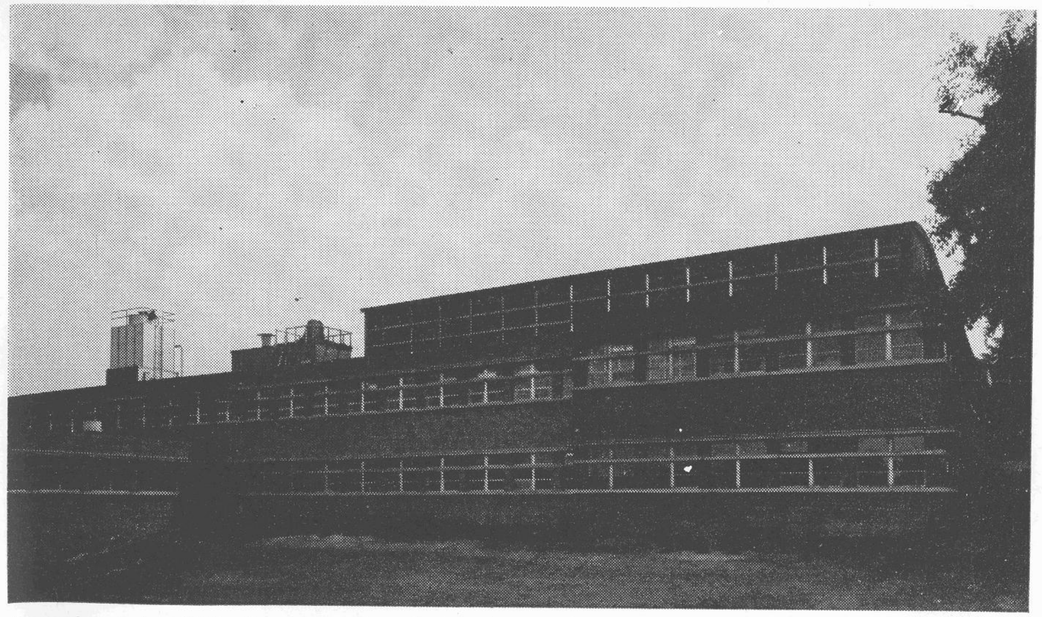
THE PHOTOGRAPHIC AND REPRODUCTION SERVICES

The Photographic and Reproduction Services have not only kept pace with the heavy demand for reproduction of project reports resulting from a marked increase in the Station's research activities but have also rendered valuable photographic services to the various projects, to those persons responsible for Station news releases and publications, to students and to the Faculty of the Georgia Institute of Technology. In addition, the Services have cooperated with Southern Technical Institute and the R.O.T.C. units in providing two motion pictures designed to inform high school students of the opportunities available at Georgia Tech.

In the field of photography, the "Photo Lab's" services include preparation of still and motion pictures, high-speed motion picture photography, developing, printing, enlarging, photostating and offset plate preparation. For duplication of reports it offers Ozalid reproduction, Vari-typing, Multilith printing, mounting, layout and art work. These services are made available not only to the Station but to all of the schools, departments, organizations and individuals at Georgia Tech who have need of them in their research and educational activities.



Satisfying the photographic needs of the various Station projects is one of the Photo Lab's services.



Completed in 1952, the new wing shown here doubled the Hinman Building's floor area.