# edited in retrospect

in this issue

• This issue is mainly devoted to the initial report of Georgia Tech's Nuclear Science Committee. It is a report that should be read by every friend of Georgia Tech. It shows in black and white just how much the teachers and researchers at our school have accomplished with very little in the way of funds. And it points up the even more important fact that if Tech is to carry on the more-advanced nuclear research, more funds must be made available.

Since this report was completed, two happenings have given the Nuclear Science Committee hope that these funds will soon be available: the Governor of the State, Marvin Griffin, indicated that he was interested in nuclear research in Georgia in a speech before a large gathering of Tech alumni on November 25 in Atlanta, and the Lockheed Aircraft Corp. announced plans for a large amount of nuclear work in their Marietta, Georgia plant. We hope that this report will indicate to these two interested representatives of government and industry that Georgia Tech stands ready to carry out what nuclear research and teaching is needed in this state. We have the men with the background to carry out the work. All we need now is the proper financing.

the changing scene

• The change in the appearance of the magazine is due to a change in editors. Odom Fanning, who brought the magazine out of the woods, has left the Engineering Experiment Station to take a position as manager of information services with Midwest Research Institute in Kansas City, Mo. With the new editor comes the new look, it's always that way in the publishing field.

coming in April

• The next issue will feature an article on Trade Marks, a photo story on a Tech research project and Part II of Cobalt 60 Teletherapy by researchers Tolan and Elliott

the research engineer
APR. 1956
Georgia Tech Engineering Experiment Station




from fishing rods to antennas — page 11

the research engineer

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**the station**

Paul K. Calaway, Director
James E. Boyd, Associate Director and Chief, Physics Div.
Harry L. Baker, Jr., Assistant Director
Wyatt C. Whitley, Acting Chief, Chemical Sciences Div.
Thomas W. Jackson, Chief, Mechanical Sciences Div.
Eugene K. Ritter, Chief, Rich Electronic Computer Center

**the staff**

Robert B. Wallace, Jr., Editor
William A. Gresham, Jr., Assistant Editor
Mary Ogden, Editorial Assistant

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**the cover**

Using the Georgia Tech Engineering Experiment Station's special mobile unit, Research Engineer William B. Wrigley, in car, and Assistant Research Engineer Jack Livingston of the Physical Sciences Division are working on Project A-179. In this photo by L. C. Prowse of the Station's photographic staff, the two engineers are checking the radiation efficiency of one of the new fiberglass Wonderod antennas manufactured by the Columbia Products Company of Columbia, S. C. You can follow the work of Project A-179 in the photo and text story beginning on page 11 of this issue.

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# Dr. Blake R. Van Leer and Research

DR. BLAKE R. VAN LEER was a man who believed strongly in the value of an intelligent and progressive research program to the well-being and growth of a modern engineering university. The expansion of research activities and facilities during Dr. Van Leer's years as president of the Institute reflects the enthusiasm he had for this important phase of campus activity.

The year before Dr. Van Leer came to Georgia Tech as president, the total expenditures for campus research (including the Engineering Experiment Station's budget) amounted to a shade over $150,000. During the 1954-55 fiscal year, the total campus research expenditures had reached $1,950,000. Making the 1954-55 figure even more amazing is the fact that only $119,000 of this total came from the State.

Excluding the Engineering Experiment Station's budget from the 1954-55 figure the remaining campus research during that year amounted to $300,000. Research in every school on the campus benefited from Dr. Van Leer's active leadership in research activities. And without this growth in research facilities and activities, the tremendous expansion of Tech's graduate program in recent years would have been impossible.

The expansion of Georgia Tech's facilities for research during this 11½ years was just as phenomenal as the growth of the research budget. Additions to Georgia Tech research facilities during this period included the A-C Network Calculator, the hydraulics laboratory, the Hinman and other research facility additions, the Rich Electronic Computer Center and the highway building. During the same period many of Tech's other research facilities were improved and expanded. Today, Georgia Tech has the largest and most complete facilities for engineering and industrial research in the entire South.

The announcement by Governor Griffin on April 11, that he was making $300,000 available to Georgia Tech to begin the expansion of our nuclear science program was a recent indication that Dr. Blake R. Van Leer's program for the parallel growth of Tech's educational and research facilities and activities is still active.

Paul Weber
*Acting President*




**Photographs, Carolyn Carter**
**The Coca-Cola Company**

*A section of the U. S. Trademark Association 3-D Public Information exhibit, now tourin the country. Sponsored by 12 major Americ corporations, the exhibit was produced by T Coca-Cola Company. Scenes from the exhi are shown on the other pages of this artic*








# Safeguarding of Trademarks

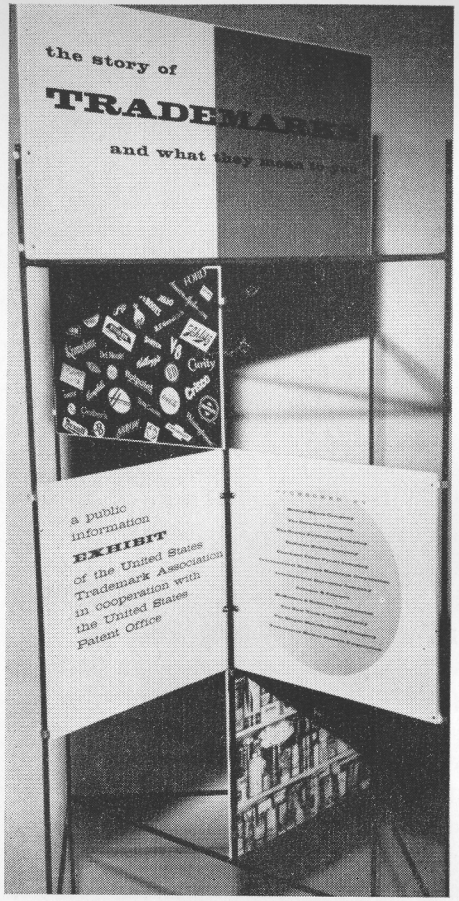
by H. L. McClure, Head, Industrial Technology Department
and Robert Hays, Head, English Department
Southern Technical Institute

PROBABLY YOU HAVE NOTICED many times the phrase "trademark" on labels or in advertisements for goods or merchandise. However, you may not know that behind this phrase lies a story—usually a story of a company's efforts to protect its property; and sometimes a story of theft more intriguing than the plots of many detective stories. For trademark practice in the United States offers an amazing record of loss, abandonment or destruction of property, of carelessness in protecting assets, and of occasional outright larceny.

To understand how property so intangible as a tradmark may be lost or stolen demands first an understanding of the trademark system. From earliest times trademarks have identified the source of products and materials. In ancient Egypt each slave put his own mark on the bricks he produced so that the slavemaster could determine whose work was faulty enough to warrant punishment. As craft guilds developed in medieval times, trademarks were required as a means of placing responsibility for poor work, inferior material, or dishonest weight. In the earliest days, trademarks were primarily a means of detecting fraud or incompetence.

Today's trademarks still help to detect fraud and incompetence. Therein lies part of their value. But more important, trademarks help to prevent substandard imitation and to encourage high standards of workmanship. Any trademark, representing the owner's investment in consistent workmanship and in advertising, is therefore a valuable asset.

*Continued*




The uninitiated might define a trademark as simply "the name of a piece of merchandise." No assumption could be more damaging to the owner of a trademark. Instead, a "trademark," as defined in the Lanham Act, statute relating to registration and protection of trademarks, includes any word, name, symbol, or device, or any combination thereof adopted and used by a manufacturer or merchant to identify his goods and distinguish them from those manufactured or sold by others." The key to this definition lies in the phrase, "to identify his goods"; for the purpose of a trademark is the identification of goods, rather than the naming of goods—and there is a difference. A trademark is an alias (like Kodak) for the name of the maker (Eastman) not the descriptive name for the goods (like camera).

To further illustrate this gap between popular misconception and the true meaning of a trademark, the trademark "Dacron" may be cited. "Dacron" is not the name of a fabric, as some seem to think. Instead, "Dacron" is a coined term used to indicate the particular source (the Du Pont Company) of polyester fibers. The trademark "Dacron" is one of this company's most valuable assets. It will remain an asset so long as the Du Pont Company retains sole rights to use this term to indicate the source of its polyester fibers.

A trademark, not subject to the same protection afforded a piece of real property, must be protected from careless loss and from interlopers. Above all, a trademark must not be allowed to become a common noun; the courts have held that a trademark has been lost when in the public's mind it has become a common noun—*the name of something* rather than an indication of the source of a particular piece of merchandise.

And the sole safeguard for a trademark lies in the consistent usage combined with unrelenting defense. Once a trademark has through careless usage become the generic name of a kind of merchandise, its owner loses his restrictive rights to exclude others from using it. The original owner's property will have passed to any who care to use it, often when the property has become most valuable. Trademarks such as *aspirin, linoleum, cellophane, celluloid, kerosene, milk of magnesia, dry ice* and *shredded wheat* passed into the common domain and may now be used by any manufacturer or merchant. To the original owner of the trademark this meant a costly, often disastrous, loss of a priceless asset.

Protecting a trademark creates problems. The courts have pointed out the consequences of a trademark owner's failure to police the use of his mark. "A trademark owner cannot muzzle 160 million Americans; he wants the public to recognize his trademark. But the owner must continuously make clear to the public that his trademark is not a generic term. His success in establishing his trademark as restricted property depends greatly upon his success in keeping it out of the language as a common noun. According to an article in the January 1, 1949 issue of *The Trade-Mark Reporter*, a court stated in 1936: "It, therefore, makes no difference what efforts or money the Du Pont Company expended in order to persuade the public that 'cellophane' means an article of Du Pont manufacture. So far as it did not succeed in actually converting the world to its gospel it can have no relief."

AN ALERT COMPANY MAY prevent misuse by writers, editors, publishers, or teachers by writing letters of protest to those who misuse a trademark. Correcting improper usage demands a constant vigilance. James J. Winters, legal counsel of the Dictaphone Corporation says, "We subscribe to a clipping service with instructions that they clip and send to us any items in which the word 'Dictaphone' (trademark of the Dictaphone Corporation) is used, whether properly or improperly. In cases of improper usage, we write to the author or publisher, calling attention to the fact that this is a trademark and explaining that, as such it identifies the products of this company, and that it is improper to use it as a descriptive term for dictating machines generally."

G. A. Gillette, Jr., of Eastman Kodak Company's Patent Department reports, "In the course of a year we write several letters requesting correct usage of our trademark 'Kodak'."

As one authority points out, "the phrase (in the Lanham Act) 'including acts of omission as well as commission' may well make it necessary for the owner to take notice when writers, publishers, or competitors use his mark incorrectly. He is justified in taking action against those who misapply his trademark and caution those who use it carelessly."

In addition to letters of protest and definite legal action, many companies take positive steps to ensure proper use of their trademarks. For example, The Coca-Cola Company conducts a continuing program of educational advertising in more than fifty trade publications on the proper use of its trademarks, "Coca-Cola" and "Coke". Equally familiar has been the series of advertisements on "Trademarks of Nature" run by the Ethyl Corporation.

Apparently more corporations need to increase their educational efforts in two directions: first, to inform the public about the status of the trademark and its benefits to consumers; and second, to make certain that their own advertising does not compromise their trademarks.

In accomplishing the first aim, the public must be given a fuller understanding of the significance of trademarks. Many think that a trademark, because it can be registered in a governmental office has the same status as a patent or

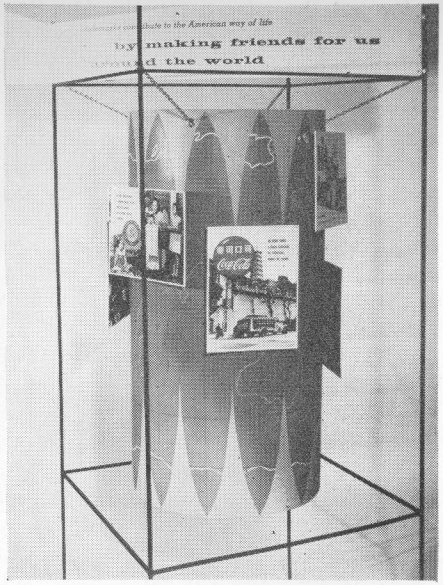


*This section of the 8-panel exhibit is devoted to explaining the contributions trademarks make to the American way of life. The exhibit opened in the lobby of the Department of Commerce Building in Washington and was shown recently in Atlanta. It is now at Grand Central Station in New York City. The exhibit marks the diamond anniversary of the enactment of the very first constitutional trademark law.*










## TRADEMARKS—cont.

copyright. This is not true. Registration provides the evidence of use and the right to try a trademark case in Federal Court. According to the Department of Commerce, registration of a trademark in the Patent Office does not in itself create or establish any exclusive rights but is recognition by the Government of the right of the owner to use the mark in commerce to distinguish his goods from those of others. The burden of prosecution against interlopers still apparently falls on the owners of trademarks.

Educating the public can help defend the trademark against unintentional attacks by writers and speakers, who do almost as much harm as people who are against trademarks as an institution and would like to do away with them entirely.

But cautioning the writers, teachers, editors and publishers against improper usage is only the negative side of educating in proper usage. Hence, some firms have published instructions for the use of trademarks. Some of the best of these instructions are two Du Pont pamphlets, *How To Use the Trade-Mark Dacron* in Print,* and *How To Use the Trade-Mark Orlon* in Print,* and The Coca-Cola Company's booklet *The Case for the Upper Case,* which, with its accompanying sound strip-film has been shown to thousands of businessmen, publishers, and the general public.

**Du Pont registered trademarks*

At least one company, which has requested anonymity, began its educational efforts by cautioning all its personnel to detect any improper use of any of the company's trademarks in any printed literature or on any goods.

INSTRUCTIONS ABOUT USING trademarks include the following rules:

A. *Use a trademark correctly, or do not use the trademark.* Says one company, in discussing its problems with writers, "We would much rather that they use the generic term than misuse our trademark."

B. *Use a trademark as an adjective, not as a noun*: Use Kodak camera or Kodak film, not just kodak; or Thermos vacuum bottle, not just thermos.

C. *Do not use a trademark as a possessive*: Say the remarkable resistance to wrinkling of Dacron polyester fiber, not Dacron's remarkable resistance to wrinkling.

D. *Always designate a trademark as such.* This can usually best be done by following the first mention of the trademark with an asterisk to refer the reader to a footnote. The footnote should explain that the term designated by an asterisk is a trademark, registered or otherwise, as the case may be.

E. *If possible, use a generic term after the trademark,* as "Dacron* polyester fiber." The generic term, i. e. "polyester fiber," should not be capitalized.

F. *Capitalize the first letter of each word in the trademark,* unless the company which uses the trademark does not capitalize its mark.

G. *Spell the trademark the way its owner prefers it spelled.* Trademarks, like other proper names, are not subject to the basic rules of English spelling. First, many trademarks are coined (e.g. "Photostat" and "Kodak"), and hence they are entirely new words. Second, many trademarks are created by grossly mispelling a common English word or several words (e.g. "Uneeda" and "My-T-Fine"); and, finally, the owner of a trademark has just as much right to spell "Plexiglas" with one "s" as a man named Smyth has to spell his name with or without an "e".

WITH TRADEMARKS being used so widely and with many advertising experts unfamiliar with the implications of trademark usage, many improper usages will naturally occur, even in the advertising purchased by the owners of trademarks. For example, a check of a recent issue of one of the best-known business magazines showed advertisements containing 42 different trademarks. These were rated with five evaluations: "++" to mean that the advertisement clearly protected the owner's rights; "+" to mean that the advertisement established that the merchandise was covered by a trademark; "?" to mean that the use of the trademark was doubtful; "−" to mean that the advertiser was endangering his own trademark by grammatical usage or improper identification; and "+ or −" to indicate that in his advertisement a trademark owner established his claim to a trademark but tended to compromise it with usage. The results of this survey were as follows:

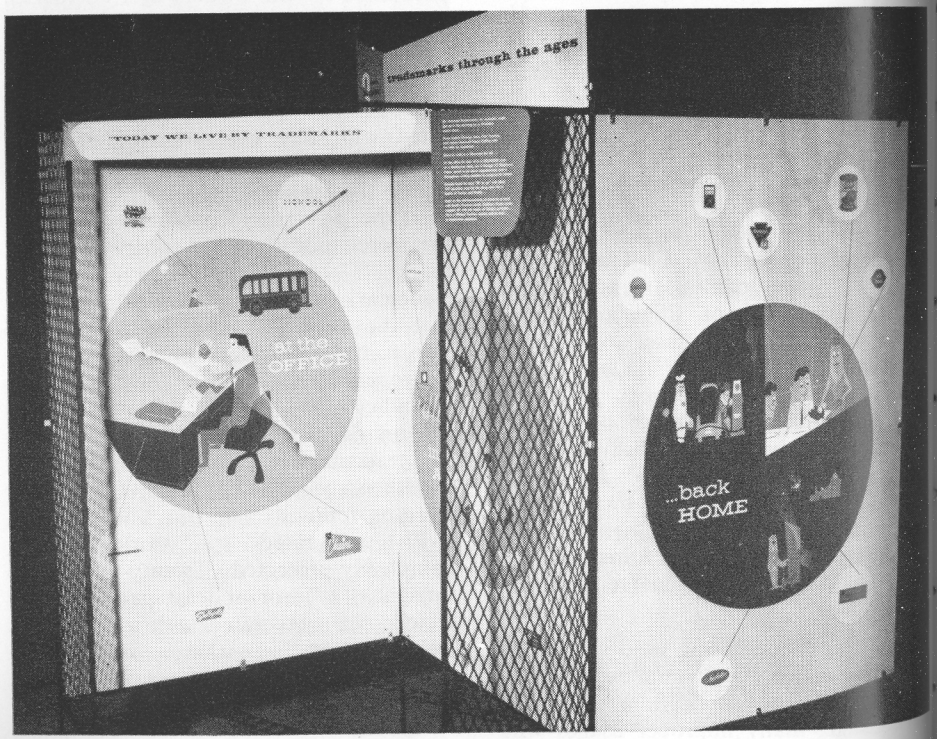
Five were rated "++"—or apparently completely protected. Twenty-three were rated as "+"—or at least partially protected. Six were rated with a "?". Five were rated as "−"—that is, as definitely tending to compromise the owner's rights to a trademark. Three were rated as "+ or −."

*Continued*

Two of the advertisers, the Du Pont Company and the Dictaphone Corporation, had answered queries about trademarks submitted in preparation for this article. Both of these advertisers rated a "++" in their advertising; in their advertising, they made clear their trademark claims. A rating in any of the last three categories indicated an advertising practice which might lead to the loss of a trademark. It is ironical that one-third of the 42 advertisers purchased obviously costly advertising, only to create evidence which might be introduced against them by the defendant in a suit for violation of trademark rights.

BUT THE MOST IRONIC FEATURE of trademark usage is the almost complete lack of instruction in schools about the spelling of trademarks. Few books about grammar so much as mention the rules for capitalization. The student (on the college level) learns that among other proper nouns, he must capitalize the first letters of "Miltonic" and the "New Stone Age." But not a syllable does the student read about capitalizing and spelling of trademarks. The student might reflect that should he write "Miltonic" with a lower-case "m," he would at worst be thought ignorant of the works of John Milton; more likely, the college student, who after graduation enters business or industry, will never use the word "Miltonic." But if he should spell his company's trademark incorrectly in business correspondence, he would at least be reprimanded by his employers and he might possibly lose his job.

In short, using a trademark as a generic term is a technical inaccuracy as well as a violation of proper usage. Conversely, using a trademark accurately is a debt due the owners of property. Spelling and capitalizing a trademark correctly mean following the properties of grammar and English usage as well as helping protect the buying guides of consumers.







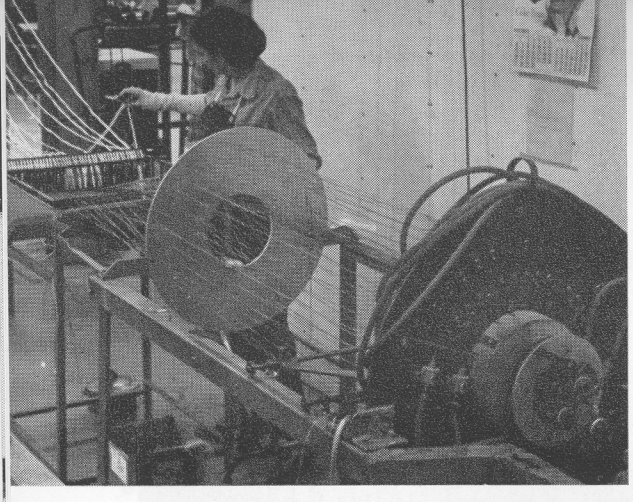

*PART OF THE COLUMBIA PLANT, IN FOREGROUND THE ANTENNAS ARE MADE.*

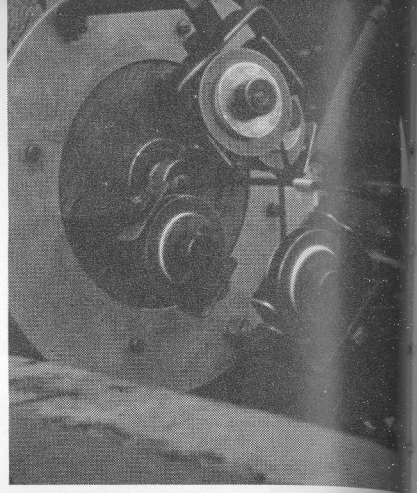
# FROM FISHING RODS TO ANTENNAS

## Georgia Tech research helps a South Carolina manufacturer to develop a brand-new product

THE COLUMBIA PRODUCTS COMPANY of Columbia, S. C., is a manufacturing division of the Shakespeare Company, producers of fishing tackle for over fifty years. Columbia's principal assignment is to turn out all of Shakespeare's famed fiberglass "Wonderod" fishing rods for the enormous present-day fishing-tackle market. But for the past three years, Columbia has been turning out another product using the same process that has made the "Wonderod" so popular with today's fishermen. The new product, the "Wonderod" antenna, is the brainchild of Columbia's vice president and general manager, Arthur L. Scott, an engineer and radio enthusiast, who conceived the idea early in the Korean crisis when it appeared that the production of such luxury items as fishing rods might be curtailed. On the following pages, through photos and text, we bring you this story.

***Photographed for the Research Engineer by L. C. Prowse***

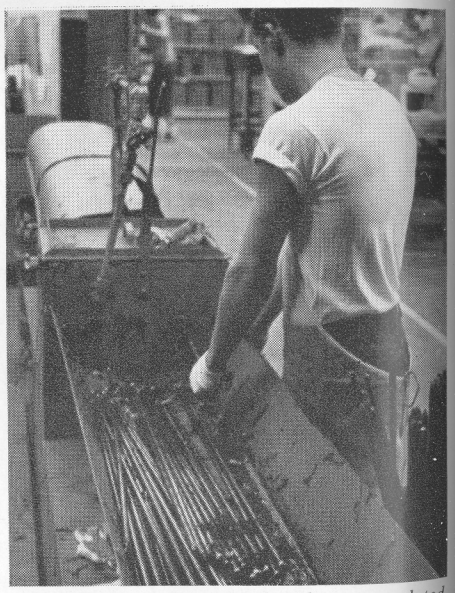




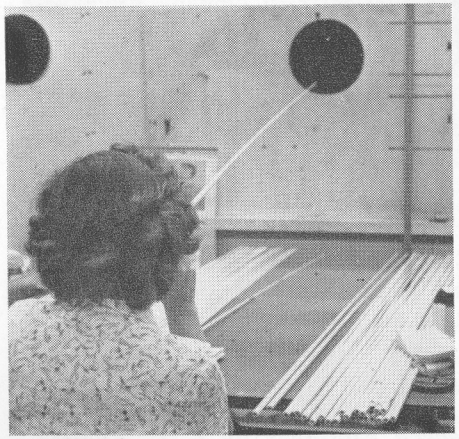
*The production line for the antennas is almost exactly like the one for the fishing rods. The fiberglass and the wire go into the extrusion machine and are formed, tapered, impregnated with polyester resin, wrapped with cellophane tape, and cut (above), into desired lengths.*

## FROM FISHING RODS—cont.

WONDEROD FIBERGLASS ANTENNAS are constructed by embedding a metallic conductor lengthwise in a rod of fiberglass reinforced polyester plastic. Produced by the same Howald Process used for the Wonderod, the antenna differs from the fishing rods primarily in the addition of the conductor and the change in fittings. The antennas—used by aircraft, armed forces vehicles, police cars, submarines and others—now constitute 8% of Columbia's present-day production.

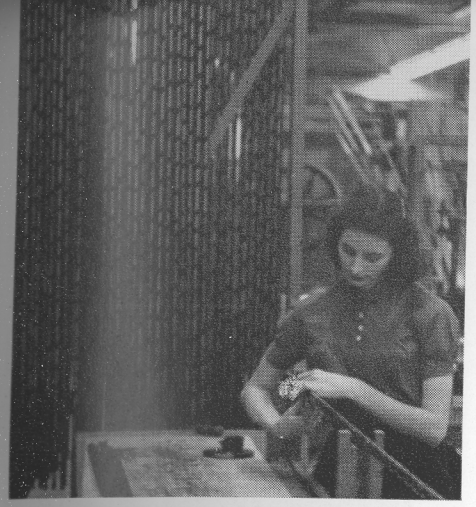


*After the curing process has been completed, the antenna rods are removed from the iron bars and inserted in this machine, which removes the original cellophane wrapping through the use of several jets of high pressure water.*

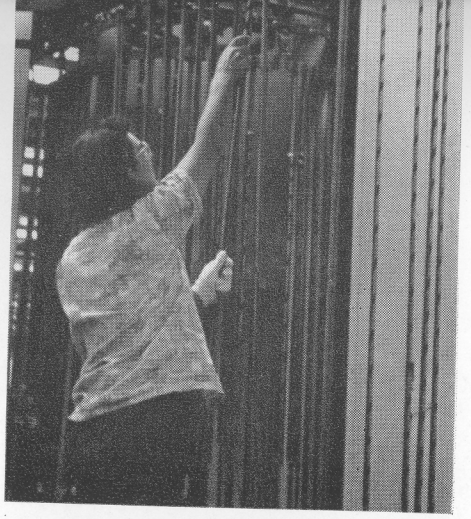


*After the tape is removed, the antenna rods are checked for straightness and strength.*





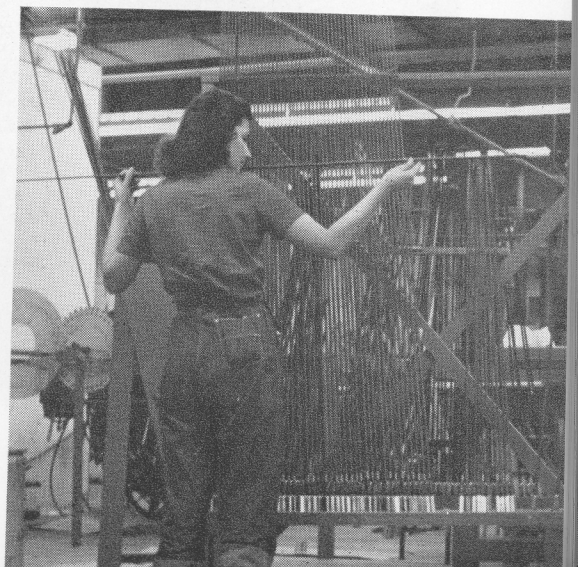
*The antennas are then bound to iron bars with cellophane tape and hung on racks like those shown in the background. From here, they are moved to the conveyer belt, (above), on which they travel through the oven for the curing process which hardens the polyester resin.*





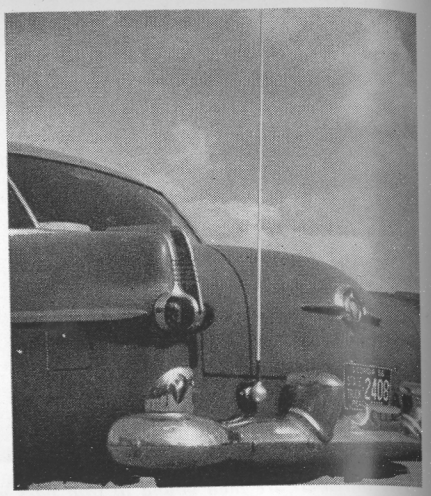
*From the initial checking station, the rods go to the fitting tables where they are marked for length and furnished with electrical fittings. At this station, the wires are also exposed and a spiral layer of fiberglass is added to the upper portion to improve impact resistance. Conductors are soldered to fittings.*

*Final stop for the antennas is this station where all antennas are completely inspected.*



## FROM FISHING RODS—cont.

SOON AFTER THE Wonderod antennas appeared on the market, Columbia Products began to receive questions about the electrical properties of their antennas. Realizing that the company was not equipped to ascertain the answer to these problems, General Manager Scott called on Tech's Engineering Experiment Station to conduct a research study on the new product. Tech engineers obliged and after completing the basic study on the original design, they went further into the problem. As a result of these studies, changes have been made in the composition resins, and a brand-new concept of antenna design is now in the making.

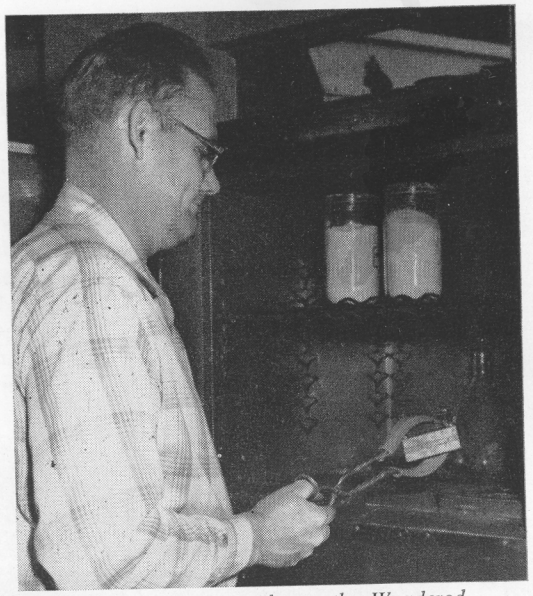


*Mobile lab interior showing Engineer Wrigley making impedance measurements, which indicate electrical characteristics of various test model antennas.*



← *A view of a Wonderod antenna mounted on the Station's mobile research unit which acts as a lab.*

*Field strength measurements, indicating the efficiency of the antennas, are also made through the use of Tech's mobile unit.*



*Among the first tests made on the Wonderod antennas at Tech were those by the Station's coatings laboratory. Picture shows a dielectric sample being removed from the curing oven in preparation for the studies of the electrical properties of resin-bonded fiberglass.*





# DOSIMETRY AND INSTRUMENTATION

By John H. Tolan, Research Physicist

ALL DOSIMETRY PRESENTLY USED in radiation therapy is based on the unit named after the discoverer of the X-ray. This unit is called the roentgen (abbreviated r) and is defined as follows:

*The Roentgen shall be the quantity of X- or gamma radiation such that the associated corpuscular emission per 0.001293 grams of air produces, in air, ions carrying one electrostatic unit (esu) of quantity of electricity of either sign* (one cubic centimeter of air at 0° C and 760 mm Hg pressure has a mass of 0.001293 grams).

This unit has found wide acceptance in radiation dosimetry because it uses an easily reproducible medium (air), the radiation is measured by its secondary effect (ionization produced) which simplifies the measurement, and the effective atomic number of the medium is nearly the same as that for body tissue. The acceptance of this unit, superceding the use of many unsatisfactory units, was a great forward step in the science of radiation therapy. As might be expected, however, this unit does not satisfy all of the requirements for dosimetry, and its use will no doubt be curtailed in the future. The chief difficulty is that it does not relate the actual exposure within the body. It gives indirectly the energy absorbed per unit mass of air, but it does not give the energy absorbed per unit mass of tissue. Present-day difficulties in establishing the true radiation exposure or dose delivered to an element of body tissue are the result of this inconsistency.

The International Commission on Radiological Protection has recommended acceptance of a new unit called the *rad* which is defined in terms of energy absorbed by a unit mass of material (100 ergs/gram) rather than by the ionization produced in that material. Furthermore, unlike the roentgen, its use is not restricted as to type of radiation. For example, the roentgen cannot be used as a measure of exposure from beta, alpha, or other particle radiation.

Dosimetry associated with radiation therapy can be separated into three major groups. The first general type of measurement establishes the output or intensity of radiation from the therapy device. This measurement is made with a secondary standard instrument in air at a distance from the radiation source equivalent to that used in therapy. The result then is a measurement of the quantity of radiation received in air per unit time. The accuracy of this measurement is not only dependent on the inherent accuracy of the secondary standard chamber, but is also dependent on the presence or absence of scattering objects in the vicinity which might influence the total quantity of radiation detected by the chamber. The second group of measurements is concerned with the quantity of radiation that is scattered by the patient and other objects in the beam to areas outside of the therapy room. This type of measurement is performed with a survey meter which indicates the rate or intensity of radiation directly. It is necessary that this survey meter have the same characteristics in its response to different energies of X- or gamma radiation as does the secondary standard. In the third type of measurement, an attempt is made to convert the measurement made in air at a given treatment distance to the exposure received at a point within the body. To perform this conversion it is necessary to know what the distribution of radiation will be within the body. To make this measurement, a phantom or simulated body section is set up so that a detector can be positioned within its volume and intensity measurements made as a function of this position. The information derived from this measurement is plotted on a series of curves, known as isointensity or isodose curves, each of which represents a fixed percentage of the radiation incident on the surface.





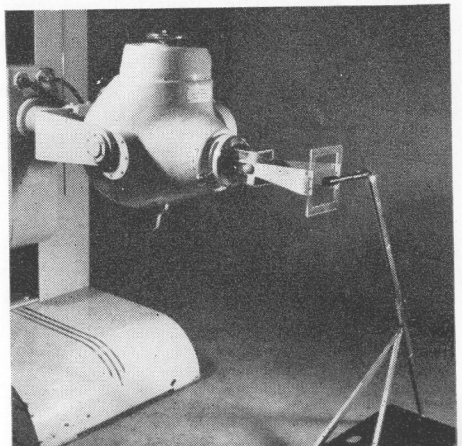
## intensity measurements

Intensity measurements of X- or gamma radiation used in radiation therapy are conventionally made with a secondary standard instrument manufactured by the Victoreen Instrument Co., Cleveland, Ohio. This instrument consists of an electrometer unit and a separate capacitor and ionization chamber assembly. The capacitor, ionization chamber, and electrometer unit are joined and simultaneously charged to a voltage sufficient to produce saturation in the ionization chamber. The capacitor and chamber assembly is then separated from the electrometer and placed in the appropriate position of the radiation beam. After a predetermined-time exposure, the capacitor and chamber assembly is returned to the electrometer unit for reading. Ionization produced by the radiation beam in the sensitive volume of the chamber partially discharges the capacitor associated with it. Consequently, when the capacitor and chamber assembly is returned to the electrometer, the electrometer will indicate the charge remaining on the combined capacity of the entire system, and the reduced voltage will indicate the quantity of the exposure.

One difficulty in making a measurement in this way is that, for the chamber to conform to the definition of the roentgen, the ionization collected by the chamber must have been produced entirely within the sensitive volume of the chamber. Ionization produced within the volume by energetic electrons produced outside of the wall but penetrating the wall must not be counted. Thus, it is necessary that the wall have sufficient thickness to prevent penetration of energetic electrons produced by either the Compton or photo-called equilibrium wall for a chamber designed to measure radiation from cobalt 60 (1.25 Mev) is 4-5 millimeters of bakelite or nylon. An experimental arrangement of the capacitor and chamber, support stand which removes the chamber from scattering objects, and cobalt unit is shown in Figure 1. Since the cobalt 60 radioisotope follows an exponential decay, it is only necessary to know the initial intensity for the unit to establish the intensity at any time.

Instruments other than the Victoreen r-meter can be used as secondary standard measurement devices. Most of these, however, have been of more recent design and manufacture and to date have not found wide acceptance. Figure 2 shows the Victoreen r-meter with its associated chambers. It is to be noticed in this figure that the range of radiation exposure for each chamber is established by the volume of the chamber. The least range of exposure (0.25r) is represented by the chamber having the largest volume and the greatest range of exposure (250r) by the chamber having the smallest volume. The capacitor associated with each chamber is essentially identical in each case. The thick-wall chambers used for cobalt 60 radiation are those identified by the arrows. The response of photon energy is not constant throughout the portion of the electromagnetic spectrum used in radiation therapy. It is necessary in use, therefore, that correction factors be obtained for each chamber for a specific photon energy. These correction factors

*FIG. 1—capacitor and chamber assembly.*



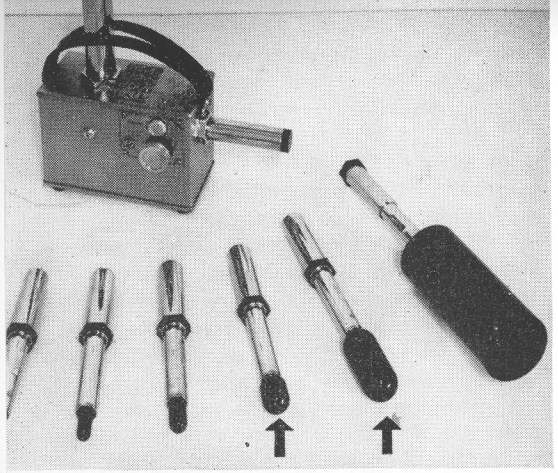


*FIG. 2—Victoreen r-meter and chambers.*

are obtained from the National Bureau of Standards by a direct comparison with a free-air ionization chamber. This free-air ionization chamber is a primary standard instrument developed especially for the measurement of X- and gamma radiation according to the definition of the roentgen. Such a primary standard is the basis for practically all dosimetry of radiation beams used in radiation therapy up to a photon energy of 3 Mev. The primary-standard and the secondary-standard instruments like the Victoreen r-meter cannot be used for photon energies in excess of 3 Mev because the range of secondary electrons produced becomes excessively large and a third absorption process called pair production becomes predominant at energies above 3 Mev. As a consequence of this practical consideration, the roentgen is not usable for the measurement of radiation quantity for radiation beams having photon energies above 3 Mev. The suggested new unit, the *rad,* not being dependent upon energy or on type of radiation, can be used beyond 3 Mev. This unit is not simple to use, however, as it depends on a measurement of energy absorbed, and calorimetric detecting devices are not sufficiently sensitive.

## radiation survey measurements

The successful installation of a radiation therapy device requires that the exposure to the personnel operating the equipment be kept below recommended maximum permissible exposure levels. The maximum permissible exposure level as recommended by the International Commission on Radiological Protection is 0.3 r per week of whole body X- or gamma radiation. This is considered to be an external exposure. Other permissible exposure levels for internal radiation sources have also been formulated but are not reported in this paper. On a forty-hour week operating basis, the 0.3 r per week exposure is equivalent to 7.5 mr per hour (milliroentgens per hour). To establish that this exposure level is not exceeded in the area surrounding the radiation therapy device in all space occupied by personnel, the radiation survey is required. This survey is normally performed with an instrument utilizing the ionization principle but one which converts the ionization produced per unit time to a measure of radiation exposure per unit time. It is necessary that the ionization chamber used in this survey meter have the same wall characteristics that are required for the secondary standard ionization chamber. To increase the senstivity of such a device, the ionization chamber survey meter normally has a considerably greater volume and hence a greater collection of ionization than does the secondary standard ionization chamber. An ionization chamber survey meter of this type is shown in Figure 3. This particular instrument has a range of 0 to 5000 mr per hour in three decade steps. The least significant reading obtainable with this instrument is about 2 mr per hour. For a measurement of intensities less than 2 mr per hour, it is necessary to utilize a more sensitive detection instrument like, for example, the Geiger-Mueller survey meter. The G-M survey meter, while being more sensitive, has the inherent disadvantage of having a different response for different portions of the electromagnetic spectrum.

Since the ionization chamber survey meter is normally hand carried, the person carrying it represents a scattering object or has a shielding effect on the measurement made; consequently, an accurate spatial distribution of the radiation is not always obtained with such an instrument. To remove such a shielding effect, one can use a fixed-range ionization chamber in somewhat the same way that the r-meter is used. Since the radiation levels to be measured are quite low, the range of exposure of this chamber must be quite small. And as several of these instruments will be required for a given measurement, the expense involved in performing the measurement with instruments like the r-meter would be prohibitive. However, there are fixed-range ionization chamber instruments available which are not too costly to use in quantity. These require a separate electrometer charging-unit like the one required for the Victoreen instrument. One such unit manufactured by the Landsverk Electrometer Co. with several 0-200 mr chambers is shown in Figure 3 together with the ionization chamber survey instrument.

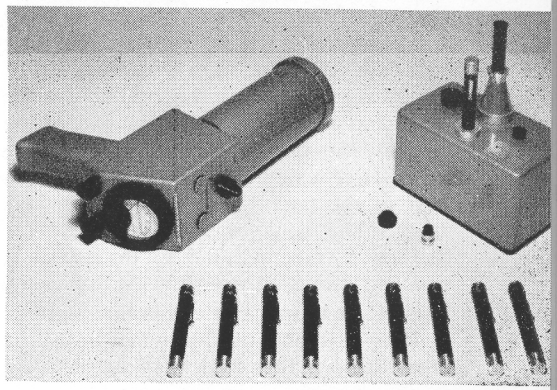
The spatial distribution of the radiation penetrating the shielding walls and scattered from the patients and other objects in the room to the outside can be determined by a series of separate measurements utilizing this fixed-range ionization chamber. Since the quantity of radiation in the space outside the therapy room is a function of orientation of the beam, the measurements will show a different location for each of the isointensity lines for each of the beam angulations. The Atomic Energy Commission, which controls the use of radioactive materials in this country, requires that such a radiation survey be performed in any installation of this type.

## phantom measurements

The preferred detecting element for any radiation measurement based on the roentgen is the ionization chamber. The ionization chamber, however, is a relatively insensitive detection device. If the measurement requires that the detecting volume be quite small, the use of the ionization chamber technique becomes extremely difficult. A G-M detector cannot be used even though it is more sensitive because of its dependence on energy. The only other detection medium which offers sufficient sensitivity without a dependence on energy is the scintillation detector. In this case, it is only necessary that the scintillation crystal employed have the same response to the radiation as tissue. Any of the organic scintillation crystals such as anthracene or stilbene are satisfactory for this purpose. Sodium iodide is much more sensitive than either of these but is energy-dependent. Thus, a detecting system can be fabricated from a small volume of antracene with a hollow tube to transmit the light from the crystal to an amplifying device called the photomultiplier tube. The photomultiplier tube converts the light signal to an amplified electrical signal. The amplified signal can be used either in the form of a voltage pulse proportional to the light flash resulting from the scintillation in the crystal, or it can be used as a continuous current proportional to the total light emitted by the crystal. In this particular application the continuous current proportional to the light output of the crystal is used. This current passes through a calibrated resistor, and the resultant voltage-drop across this resistor, is measured by a vacuum-tube voltmeter circuit. The vacuum-tube voltmeter output is then used to drive the galvanometer movement in a recording ammeter.

In the Emory University program, it was necessary to develop a special instru-

*FIG. 3—ionization chamber survey meter.*



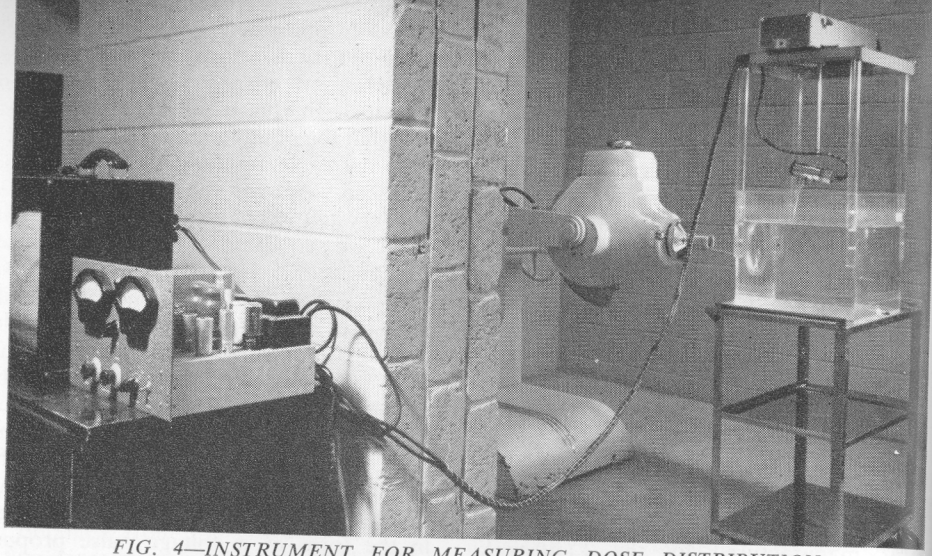


*FIG. 4—INSTRUMENT FOR MEASURING DOSE DISTRIBUTION.*

ment for the measurement of dose distribution. As is often the case with developments of this type, the first unit was not entirely satisfactory. In the material to follow, some of the operational shortcomings of this device will be discussed along with the anticipated changes to be made. The instrument, as originally used, was fabricated by Scientific Associates, Inc. of Atlanta, Georgia, to specifications supplied by the author. This instrument is shown in its operating position in Figure 4. The detector element is mounted at the end of a polished aluminum tube which connects it to the photomultiplier tube. The detector is driven through the water tank by the drive system shown at the top of the tank assembly. The trace followed by the detector is 10 inches long in a direction parallel to the front face of the tank, parallel to the bottom of the tank, and at right angles to the axis of the beam. The detector then returns along a diagonal which displaces it toward the rear of the tank 1 cm from its previous trace. The detector is again ready for an active trace parallel to the previous one and displaced from it 1 cm along the axis of the beam. For one complete trace a total distance of 20 inches must be travelled by the detector. At a trace speed of 3 inches per minute, this requires nearly 7 minutes per active trace. Eighteen such active traces, covering a depth along the axis of the beam of 18 cm, would then require more than two hours to complete. This drive system was one of the major difficulties with the original device. A revision will be incorporated which will permit a variation in the length of the active trace and a faster return time. Also, the depth of the tank, front to back, prevented making more than 18 traces or obtaining dose distribution at depths greater than 18 cm. This shortcoming will also be eliminated in the revised model so that a depth of at least 30 cm may be traversed. It should be noted here that dose distribution information is of little value at depths greater than the maximum body cross-section which is rarely more than 30 cm or 12 inches front to back.

The detector element is exposed to the radiation as it enters the beam area. The response of the amplifier in the recording system must necessarily be fast enough so that there will be no hysterisis loss as the detector traverses the beam. This system indicates no hysterisis loss at trace speeds of 3 inches per minute. As the detector traverses the beam the light output of the detector increases to a maximum, and the output current of the photomultiplier tube increases proportionately. This increase is then indicated on the recording ammeter. The chart speed for the recording ammeter was selected for convenience to be the same as the trace speed of the detector, 3 inches per minute. This permits a direct conversion of displacement along the chart record to that of the detector in the tank. Then, reading off the intensities from the chart record as a function of this displacement, the intensity distribution can be plotted. The sensitivity of the amplifier is adjusted at the beginning to normalize the intensity values recorded on the chart paper. Since the detector starts at a depth of 1 cm and not at the surface of the tank, one must know what fraction of the surface exposure to expect at a depth of 1 cm. Some of the work done at Oak Ridge by J. E. Richardson[1] gives us the required distribution across this first centimeter of phantom. For this type of cone arrangement using an electron filter on the end of the cone, the intensity at a depth of 1 cm is 95% of the intensity measured in air at a distance corresponding to the surface of the phantom. Thus, the sensitivity of the amplifier can be adjusted so that the intensity shown on the chart paper for the first trace will be 95%. If, for another cone condition, the normalized intensity at 1 cm depth is different from 95%, the intensity can be normalized for this different value. After the entire sequence of active traces is completed, the resultant strip of paper may be analyzed to obtain the distribution of the radiation for this particular condition. To reach the final form required for use in therapy, several intermediate steps are necessary. These intermediate steps will not be described here. But the final step, the plot of the distribution in terms of isointensity or isodose lines, is shown in Figure 5 for one field size and one treatment distance. A separate series of curves is required for each field size and treatment distance.

These curves serve a very useful purpose in programming radiation therapy for each patient. The curves are reproduced on X-ray film or heavy transparent paper with at least three copies of each. A body outline of the patient is then made with heavy lead wire. This body outline is traced on transparent paper; and the isodose curves previously prepared, each representing one treatment direction, are arranged at the periphery of the body outline. The dose distribution from two or more separate beams can then be evaluated by summing up the contributions from each of the beams at a specific point.

One inherent difficulty in attempting to evaluate the dose delivered to a point within the body by this technique is that the measurements were originally made in a homogeneous phantom object, and the tissue in the human body to which these results have been extrapolated is not homogeneous. Some corrections to reduce the error introduced can be made in special cases if the attenuation of body elements such as bone is known for the specific energy of radiation. The attenuation of different constituents of the body to cobalt 60 gamma radiation is more

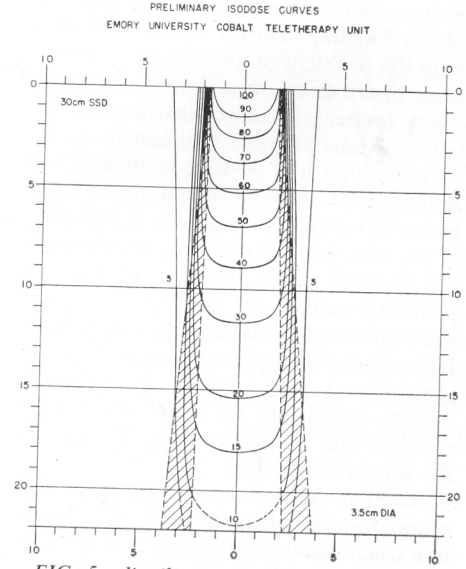



*FIG. 5—distribution plot of isodose curves.*

1. *Jasper E. Richardson, et al, "Skin Dose from a Cobalt 60 Teletherapy Unit," Radiology, Vol. 63, No. 1, July, 1954.*

nearly uniform than the attenuation of these same constituents to the radiation produced by conventional X-ray generators. Therefore, the corrections which might be applied would be rather small. This effect, by the way, leads to one of the chief advantages of using cobalt 60 gamma radiation. In conventional X-ray therapy, the attenuation and hence the energy absorbed by bone is much greater than the attenuation offered by soft tissue or muscle. Consequently, bone involved in exposures to nearby malignant tissue sometimes receives quite large, but unavoidable, exposures. Sometimes these exposures produce bone damage. With cobalt 60 gamma radiation, this secondary bone damage is substantially reduced.

## special problems

In many cases, there is an advantage to be gained by shaping the beam before it enters the body. Special filters can be devised that would be placed in the beam diaphragm changing the shape of the isodose lines. The successful design of such special filters requires that a device be available which would satisfactorily evaluate their effect. The only way in which this can be done is to provide an instrument like the one described above to measure distribution of the exposure within a tissue-equivalent phantom object. Again, however, one is confronted with the problem of attempting to convert dose distribution in a homogenous medium (water) to dose distribution in a hetrogeneous medium (human tissue).

Sometimes it is possible to measure the influence on dose distribution by some body elements. For example, if the pelvis of an adult human could be simulated by the skeletal pelvic bone, a scan of the phantom behind the pelvic bone would show the change in distribution resulting from bone absorption. Similarly, other specially prepared body elements can be introduced into the water phantom to measure the influence made by each on the dose distribution.

Another sometimes acceptable technique for establishing dose distribution in a tissue-equivalent phantom is to sandwich a piece of X-ray film between layers of masonite parallel to the axis of the beam. If the film density can be properly calibrated as a function of exposure in roentgens, the distribution of radiation exposure can be determined by measuring the density distribution on the film. This technique depends on the response of the film being linear to exposure which is true only under carefully controlled conditions. Furthermore, X-ray film, like all other film, exhibits an extreme dependence on incident photon energy. Thus, film used as the detecting element can be used only in a situation in which the photon energies lie within a narrow band. For an essentially monoenergetic source such as cobalt 60, such a narrow band of energies exists and film dosimetry can be used. In the Emory program film dosimetry has not been attempted yet because of the time and apparatus limitations.

The control of radiation exposure to personnel involved in the operation of the cobalt machine is maintained by restricting access to areas of high radiation intensity and by maintaining a regular, permanent record of individual exposure. The permanent record of individual exposure is obtained by the use of a commercial film-badge service. This commercial service provides a sufficient number of individually worn film-badge dosimeters for all of the personnel associated with the operation of the machine. By means of these controls, a safety factor of at least 10 below the maximum permissable exposure levels has been maintained for all operating personnel.

## conclusions

The dosimetry and instrumentation for a cobalt teletherapy unit, and for other radiation therapy devices as well, represents a many-sided problem involving elements of electronics, mechanical engineering, physics, and biology. Chiefly because of this diversity, the problems are always stimulating. A single task is never repeated with such regularity that it becomes boring, and new ideas and techniques create an ever-present challenge.





*Ingols, Robert S., and George M. Jacobs, "Variations in the Chemical Character of Small Streams." Reprinted from the Bulletin of the Georgia Academy of Science, Vol. XIII, pp. 94-100. Reprint 95. Twenty-five cents.*

Because the U. S. Geological Survey has shown extreme interest in the quantity of water produced by a large number of streams during a very dry spell, the Engineering Experiment Station has been conducting a survey of two small streams in the Yellow River Basin. This paper discusses the study of the quality of these streams and notes the variations which occur on a diurnal basis. Because of the large draft of transporation, the water in a flowing stream may be reduced to a trickle at the period of maximum activity; whereas, the same stream may have a three- or four-fold increase in flow at night causing variations in chemical character. It is the purpose of the paper to indicate these variations and show the basis for a continuing study which may determine the cause of the variations of the quality of the water.

*Cooksey, Marshall, "High-speed Cinematography." Reprinted from Industrial Photography. September-October, 1955. Reprint 96. Twenty-five cents.*

This paper covers the techniques of underwater high-speed cinematography employed by the Engineering Experiment Station in studies of explosions, action of aerosols and other underwater phenomena.

*Walton, J. D., Jr., "New Method of Preparing Cloy Samples for Differential Thermal Analysis." Reprinted from The Journal of The American Ceramic Society, Vol. 38, No. 12, December 1955. Reprint 98. Twenty-five cents.*

A method of preparing clay samples for differential thermal analysis which permits the analysis to be made with the test and reference samples freely exposed to the furnace atmosphere is described. The data obtained when samples were thus heated are presented, together with those obtained when an Inconel block was used to contain the clay. The sensitivity of the two methods is compared, with particular emphasis on the increased sensitivity in the low-temperature range which resulted from the use of the new method.

*Tooke, Raymond, Jr., "Physical Studies of Paint Systems Applied to Southern Yellow Pine." Reprinted from Official Digest, Vol. 22, No. 370, November 1955. Reprint 99. Twenty-five cents.*

This paper received the American Paint Journal award as the best constituent club paper at the 1955 annual convention of the Federation of Paint and Varnish Production Clubs.

The exterior-house-paint exposure studies described in this paper represent a second series of investigations on this subject conducted at the Georgia Tech Engineering Experiment Station. The Station, as well as southern paint manufacturers, has been interested in the painting of southern yellow pine because this wood is one of the most difficult building materials to paint satisfactorily, and because it is extensively used for construction in the South. Emphasis has been directed toward a study of two-coat paint systems since this procedure has become predominant in current exterior-house-painting practice. The initial investigation reported in 1947 was directed toward a study of primers. The present work is intended to encompass the original findings with respect to primers into a comparative evaluation of a number of well-known primer and top-coat formulations together with selected variations.

*Belser, Richard B., and James W. Johnson, "A Versatile High-temperature Infrared Oven." Reprinted from Ceramic Age, December 1955. Reprint 101. Twenty-five cents.*

An economical, high-temperature, infrared oven was constructed from a one-liter beaker, lined with a reflecting material and a single 250-watt, infrared bulb. By operation of the oven, with the beaker inverted over the lamp, the placing of samples to be heated is facilitated. The oven may be powered by a photoflood lamp, an ultraviolet sun lamp. or one of the newer 1500-watt infrared lamps with a Vycor face. By using a lamp with a hole drilled in its face, the oven may be operated within a vacuum chamber. The heating efficiency is greater within the vacuum. A temperature of 750°C was reached within the oven with 135 volts across the lamp's filament. The oven has proven itself to be a useful laboratory tool by three year's active use.

**These and other technical publications may be obtained, and the complete publications list requested, by writing Publications Services, Engineering Experiment Station, Georgia Institute of Technology, Atlanta 13, Georgia.**

# edited in retrospect

**the changing scene**

• Since the January issue reached you, a great deal has happened on the Georgia Tech campus. Almost all of this flurry in activity stemmed from one tragic incident, the sudden death on January 23 of Dr. Blake R. Van Leer, the Institute's fifth president.

Appointed as acting president on February 8 by the Board of Regents of the Georgia University System was Dean of Faculties Paul Weber, who under the Tech statutes had headed Tech in the period between the death of Dr. Blake Van Leer and the action by the Regents. Dr. Weber, a former assistant director of the Engineering Experiment Station, has been associate editor of this magazine for over six years. Because of the press of his new duties, he has resigned from his editorial work. But Dr. Weber hasn't completely left the magazine. On page four of this issue he discusses Dr. Van Leer's contributions to research at Georgia Tech. He also mentions the fact that Governor Griffin has made $300,000 available to Georgia Tech at the suggestion of the Board of Regents. The money is for an expansion of Tech's nuclear science program including starting a graduate level program in nuclear science and building the proposed radioisotopes laboratory.

**the cautious search**

• Selecting a new president for Georgia Tech is the responsibility of the Board of Regents. From all indications they will be cautious and conservative in their search. Tech's faculty and alumni have been asked by the Regents to aid in this task. At the Regent's invitation, a three-man faculty-alumni committee has been set up to consider prospective appointees for the presidency, as well as to cooperate with the Board's educational committee in the selection of Tech's new president. Selected by the faculty as their representative on the committee was Dean of Engineering Jesse W. Mason. President Walter M. Mitchell of the Georgia Tech foundation and President Frederick G. Storey of the Georgia Tech Alumni Association are the alumni members of the committee. Any recommendations for the presidency of Georgia Tech should be forwarded to the Committee secretary, Mr. Roane Beard, executive secretary of the Georgia Tech National Alumni Association.

the research engineer JULY, 1956
Georgia Tech Engineering Experiment Station



selecting basic research problems – page 4