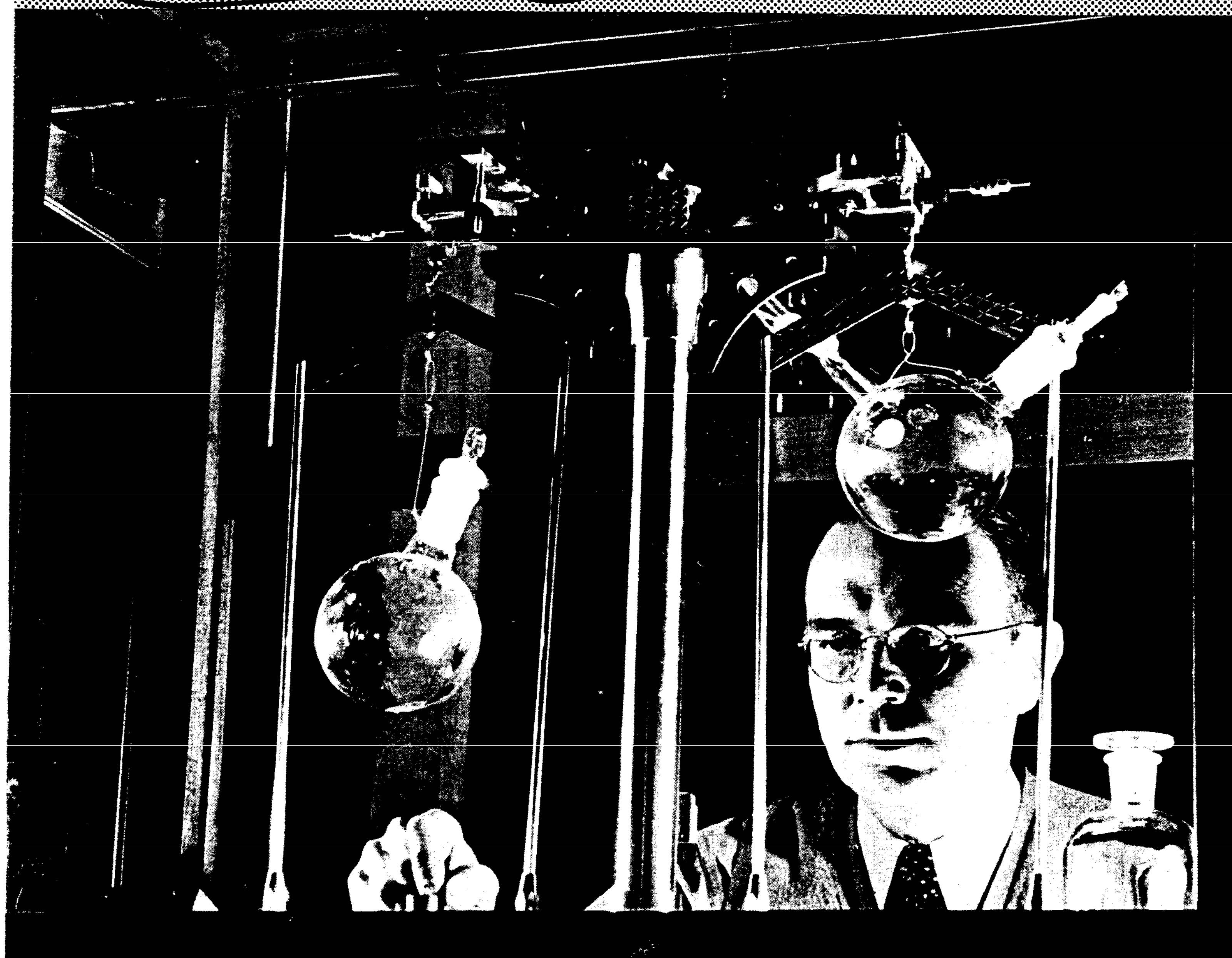
ISOTOPICS



BROOKHAVEN NATIONAL LABORATORY
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ISOTOPICS

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When "Isotopics" was established in June 1947, it became the medium for describing, in non-technical language, the nature and purposes of the Laboratory's plans and program. It also reported the many after-hours interests and activities of the staff. Through individual and group profiles, "Isotopics" has served to familiarize its readers with the great variety of functions carried on by the Brookhaven organization and with the diversity of people needed to perform them.

"The Bulletin Board", a weekly publication sponsored by the Brookhaven Employees' Recreation Association, now carries the news of employee social and recreational activities. The story of the scientific work is carried in various program and progress reports and in the papers that appear in technical journals.

Having served the purpose for which it was originally designed, "Isotopics" will cease publication with this edition.

COVER: Dr. H.C. Thomas using a large capacity balance in the preparation of a solution of radioactive aluminum bromide for use in a study in chemical kinetics.

The Cyclotron

This is the fifth of a series of articles written for the layman explaining some of the technical programs at the Laboratory and the meaning of the various terms used.

The cyclotron, one of the earliest atom smashers, is a machine for speeding up sub-atomic particles by giving them a series of electrical pushes as they whirl around in ever-widening circles. This is done by placing an acceleration chamber between the poles of a magnet and maintaining a high vacuum within the chamber to prevent air from retarding the tiny particles. The magnetic field causes the particles to follow a curved path. When they have gained their maximum energy they are deflected from their circular path and used as bullets against the atoms of whatever substance has been chosen as a target.

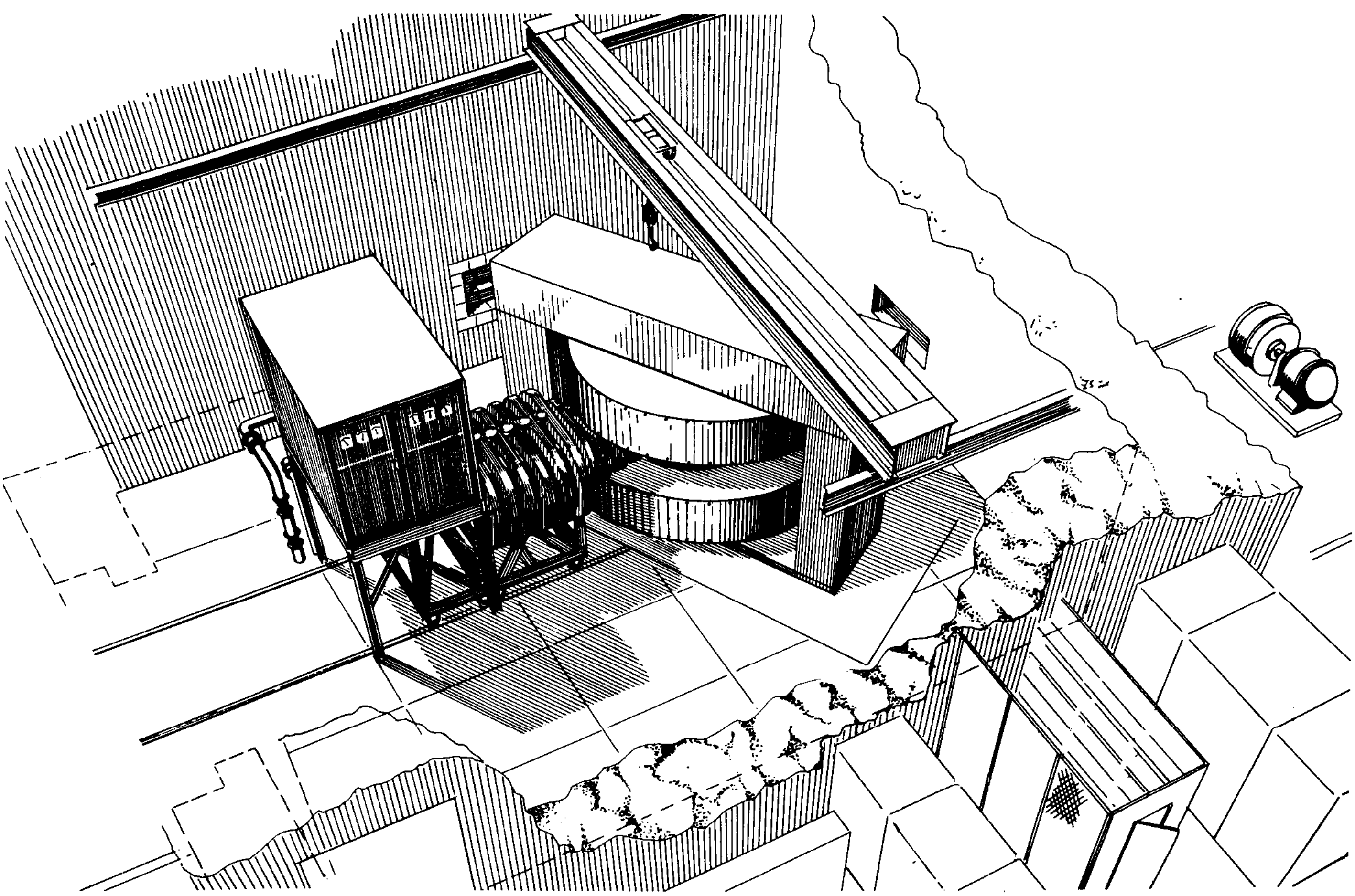
Brookhaven's 60-inch cyclotron, which will be placed in operation next year and which is the first commercially-built cyclotron in the United States, was designed by the Research Department of the Collins Radio Company of Cedar Rapids, Iowa. The Collins Company numbers several eminent cyclotron physicists and engineers on their staff who did the final engineering of the basic specification as prepared under Dr. M. Stanley Livingston's guidance. The cyclotron will be installed in the building being constructed on Cornell Avenue south of the Pile Building. The size of 60 inches is determined by the diameter of the iron top and bottom pieces of the large vacuum chamber placed between the poles of a magnet weighing about 505,000 pounds. Inside the vacuum chamber a pair of electrodes, known as "D's" because of their shape (like half a pie crust with no filling), are electrically excited by a high frequency oscillator.

Concrete walls, five feet thick, will surround the cyclotron on three sides and the wall on the north side, which is built against the base of Rutherford Hill, will be four feet thick. The roof will be a three-foot concrete cover. Huge elevator-type doors will be installed in the wall and indirect service openings are planned to prevent leakage of any radiation outside the cyclotron room.

In theory, Brookhaven's cyclotron will operate as follows: Vacuum pumps will remove the air from the acceleration chamber (unless nearly all molecules of air are removed, the atomic projectiles cannot be whirled around freely in the chamber). An electron stream injected into the chamber will strike molecules of deuterium gas, producing positive ions (deuterons). The deuterons will be accelerated into one of the electrodes by a radio-frequency field and deflected in a circular path by the magnetic field. A resonant condition is established by adjustment of the magnetic field and radio-frequency so that the time of reversal of the current is the same as the time for the deuteron to make the semi-circular trip. In this resonant condition, deuterons gain additional energy through an electrical push each time they pass the gap between the "D's" and travel an ever-widening circular path until they attain a speed of approximately 25,000 miles per second when they are deflected outward to an external target.

The cyclotron will be a source of high-energy deuterons serving for isotopes production for chemistry, biology and medical research and for basic physics research as a deuteron and neutron source. Deuterons of 20 million electron volts at an intensity of 25 microamperes on an outside target, or 200 microamperes on an inside target, are expected in the first year of operation, and the machine will have a capacity of increase to a maximum of 25% higher. (For purposes of comparison, an atom of lead traveling at 2000 m.p.h. has the energy of one electron volt.)

Atom smashing to date has not resulted in the smashing of atoms in the sense that an eggshell or a piece of crockery is smashed. It has involved making changes in the atomic nuclei by adding or substracting basic particles. Through the operation of cyclotrons and other high-energy machines such as Brookhaven's new Cosmotron, which was described in the May-June edition, scientists hope to be able to make the atom disintegrate completely.



Cut-away sketch of cyclotron building showing cyclotron in operating position.

STAFF PROFILE

Nelson M. Blachman

One of Dr. Nelson M. Blachman's hobbies is square dancing and he may be observed wherever Laboratory groups gather to practice this terpsichorean art.

Nelson was born in Cleveland, Ohio, and graduated from Case School of Applied Science with a B.S. in Physics. He was first employed at the Harvard Underwater Sound Laboratory in Cambridge as a physicist in a theoretical group developing Sonar apparatus for submarine detection. After that he joined the Central Communications Research at Cruft Laboratory, Harvard University. While there he began part-time graduate work at Harvard, which soon took up all of his time. As a result of his studies and his thesis on noise in F-M radio reception, he was awarded an A.M. and Ph.D. in Engineering Sciences and Applied Physics.

Entering the employ of the Laboratory in July, 1947, he spent three months in the Physics Department before being transferred to the Accelerator Project as a physicist in the theoretical group.

Nelson lives on the Site and occasionally visits his parents at their home in Cleveland. He is a licensed amateur radio operator and is also interested in cooking. In fact, in order that men and women who live on the Site may have what they want to eat when they want it, he is promoting the organization of a cooperative eating group.

STAFF PROFILE

Cora L. Gray

Miss Cora L. Gray, files control supervisor, has had many types of employment--secretarial work, purchasing, supervision of steno pools and filing, as well as religious education work for an Episcopal bishop. In addition, she has done quite a lot of volunteer work for the Montclair Hospital, even helping to operate their soda fountain.

Miss Gray was born in Pittsburgh, Pennsylvania. Her family moved to Montclair, New Jersey, and she graduated from the Montclair High School and the Montclair Secretarial School. She also spent a year in the Emma Willard School at Troy, New York, one of the oldest girls' schools in the country.

After working for several years she took a vacation of six months and toured France and England. During World War II she was employed by the Sperry Gyroscope Company and watched that organization grow from 3,000 to 30,000 employees. Her duties with Sperry included the supervision of typing work and the distribution of the house magazine. In 1947 she was employed by the Laboratory and has the responsibility of keeping the files in order.

Miss Gray lives in Patchogue during the week and spends the week-ends with her father and mother in Montclair. Her hobby is bicycle riding and she rides around Patchogue in the evening on many of the roads that are not heavily congested with traffic.

STAFF PROFILE

Working on the Laboratory Site is no novelty for Edward J. Bergin, leader of the Transportation Group, as he has been here in various capacities since 1942.

"Ed" was born in New Rochelle, New York, and graduated from the George Washington High School in New York City and the New York Institute of Finance. He was employed by DeCoppet and Doremus in Wall Street for 13 years. In 1941 he joined the Army and was assigned to the First Armored Division at Fort Knox. After a short period he was commissioned a Second Lieutenant in the Quartermaster Corps and sent to Camp Upton.

From 1942 to 1946 he was Post Quartermaster and in 1946 was made Director of Supply. "Ed" says it is not true that soldiers were sometimes given two left shoes. He says that they made sure the soldiers' equipment was right, even to the extent of sometimes giving them two right shoes. In 1947 he was released from the Army with the rank of Captain and was immediately employed by the Laboratory.

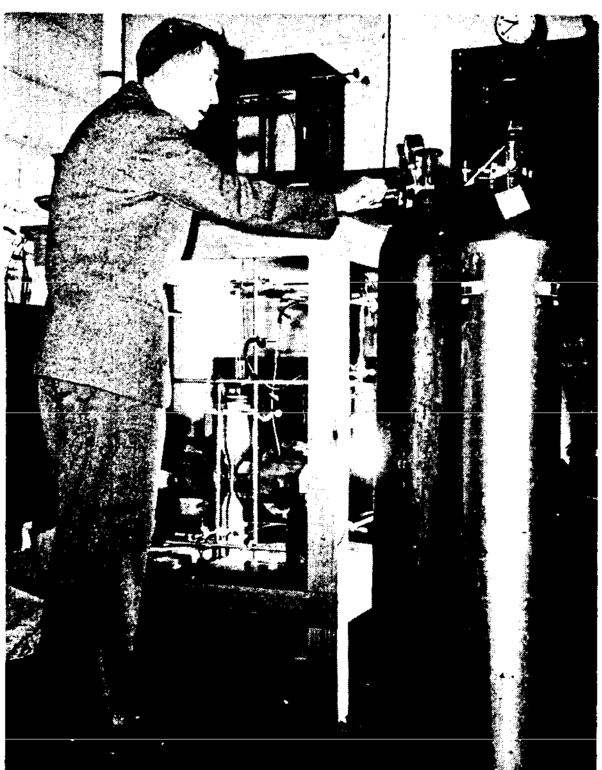
"Ed" is married and lives in Patchogue with his wife and two children, Kathy, age 3 years and Elizabeth, age 2 months. He has no particular hobbies, he says, since family matters and taking care of the house he owns occupy all of his time.

Edward J. Bergin

The cast of the Dramatic Club's forthcoming production, 'Life and Half-Life", rehearsing a scene under the direction of Leonard D. Heyman.

Dr. Julius Hastings and Dr. Oliver Schaeffer operating a mass spectrometer to study the forces which hold molecules together.

Dr. Norman Elliott with apparatus for studying the magnetism of uranium and plutonium.



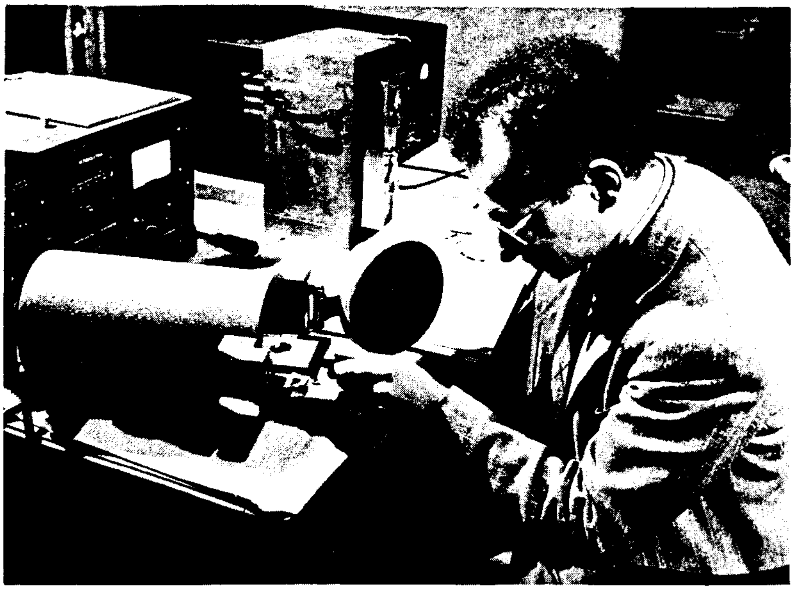
Chemistry Department Group Profile

How may radioactive substances be used to increase our understanding of chemical reactions? How may experiments with radioactive atoms increase our knowledge of nuclear disintegrations which are the basis of atomic energy? Will certain molecules, subjected to various intensities of radiation, fly apart, rearrange into different shapes or build still larger molecules? Can any one of the atoms in the molecule be changed without disrupting the whole molecule? Why are certain substances catalysts?

These are a few of the many questions that the Chemistry Department is trying to answer. The equipment that will be available for their use and the extraordinarily large amounts of radioactive materials that will be produced by the pile and the various particle accelerators will enable them to proceed with their investigations on a hitherto unprecedented scale.

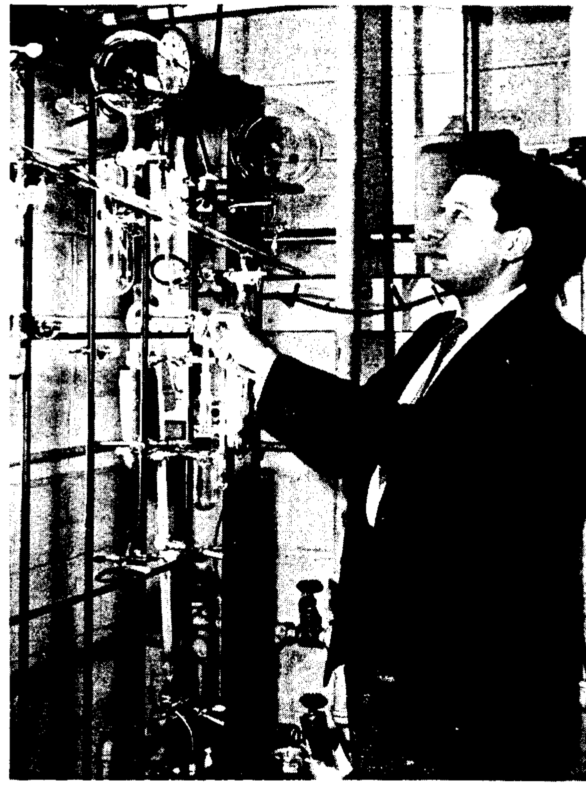
When alterations are completed, the Chemistry Department will occupy the six former Army classroom buildings on Rochester Street. Each building will contain complete office and laboratory facilities. One building will have a "hot" laboratory where investigations involving the use of materials of intense radioactivity will be conducted.

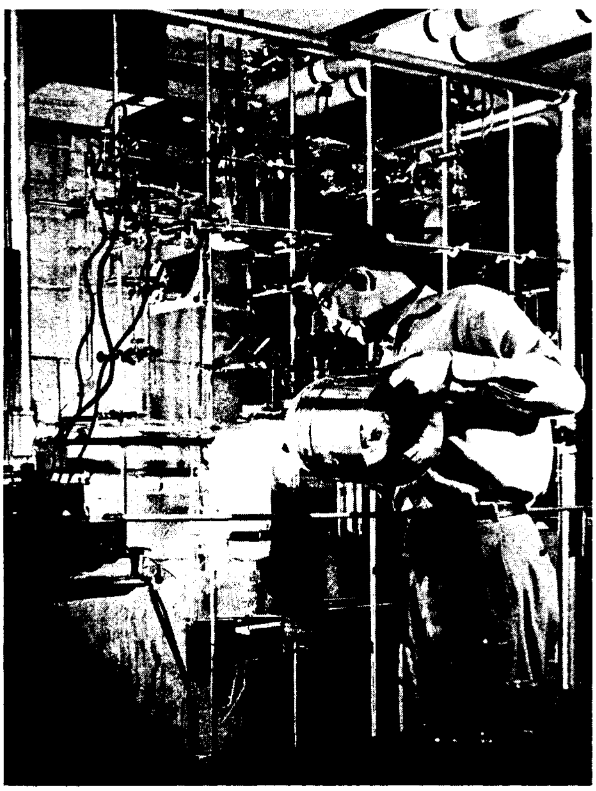
It is, of course, impossible to state that the investigations underway and planned for the future will bring specific benefits to mankind; like all scientific research the practical application of the results of the work of the Chemistry Department may not be immediate. It is safe to say, however, that a better understanding of chemical problems will be gained through the use of nuclear science.



Dr. G. Friedlander placing a sample of radioactive nickel under a Geiger counter enclosed in a lead shield to measure its radioactivity. The box behind the lead shield contains the power supply and the scaling circuit for the Geiger counter.

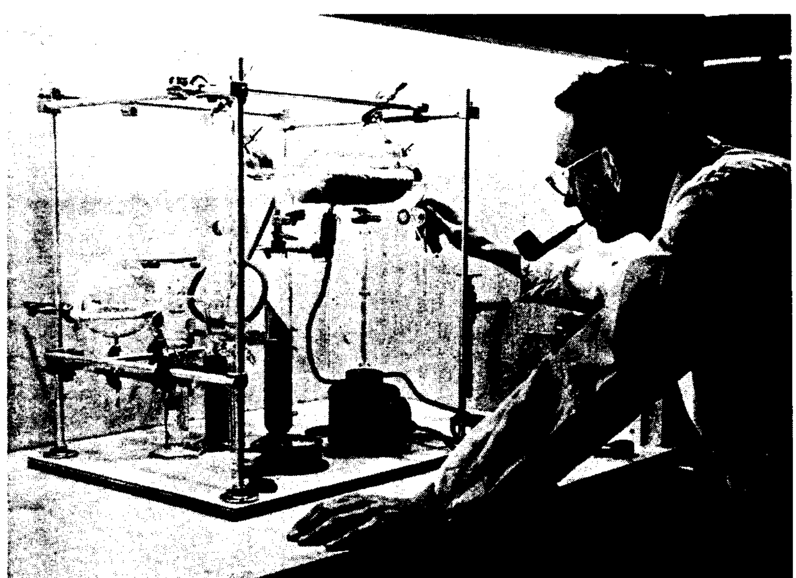
Dr. Lewis Friedman with apparatus used for the synthesis of tracer containing compound.



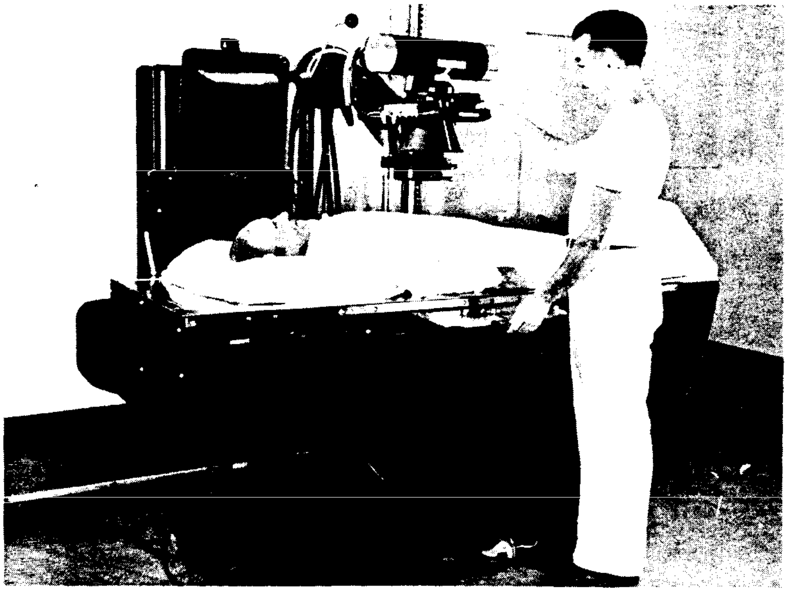


Dr. R. Davis pouring liquid nitrogen into an apparatus designed to measure recoil energy from nuclear disintegration.

Dr. R. C. Anderson investigating a new synthetic method for introducing Carbon 14 into complex organic molecules.



Medical Group



X-ray Equipment in Use in the Hospital.

Fluoroscopy in Out-Patient Clinic.

The addition of Laboratory staff members to the population of surrounding towns placed a burden on the already over-taxed local hospital facilities. Because of this condition, the aim of the Medical Department has been to provide first-class medical care for staff members and for their dependents when it can be shown that the facilities of the surrounding region are not available or adequate.

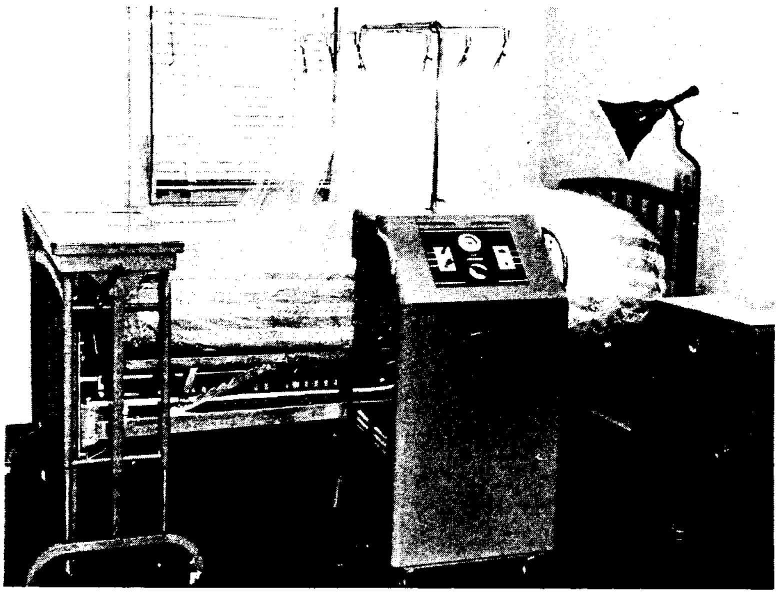
The Atomic Energy Commission recently approved the opening of a 42-bed hospital, which is now ready to receive patients. An X-ray unit is in operation. A surgical unit, which includes two operating rooms, will be in service as soon as equipment is received and building alterations completed. The hospital will also include an isolation ward for communicable diseases.

The clinic, which has been in operation for some time, is now part of the hospital complex. Out-patient care is provided here. Annual routine and pre-employment physical examinations are also given at the clinic.

Medical research will, of course, be a prime objective of the Medical Department, under the Chairmanship of Dr. Lee Farr, when the program is advanced; but the welfare of the Laboratory staff members has been, and remains, an essential consideration.

Department Profile

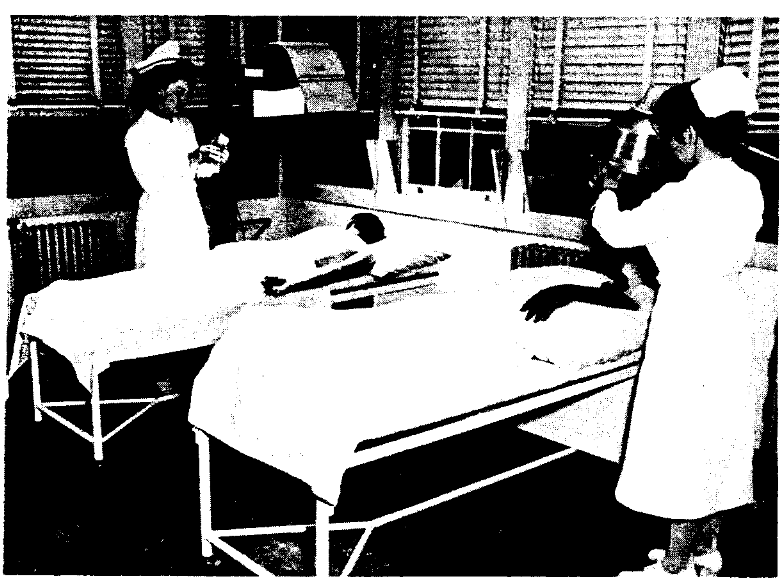
A Corner of Out-Patient Treatment Room in the Clinic.



A Private Room With Oxygen Tent.

A Section of the Clinical Laboratory.

Physiotherapy in Out-Patient Clinic.



STAFF PROFILE

Pietro Agnetti

Skiing might be the hobby of Pietro Agnetti, laborer in the Ground Maintenance Group, if there were any real hills on Long Island, but after several years spent with the ski troops in the Italian Army in World War I, he is not interested in mere bumps.

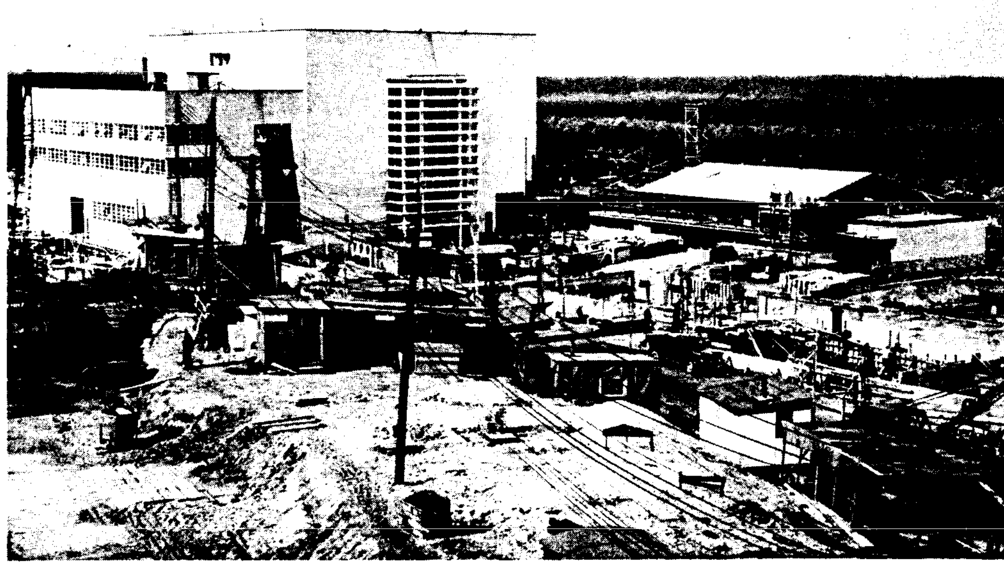
Pietro was born in Parma, Italy, and when World War I began he was a Ski Trooper. Captured by the Germans near Turin, Italy, he was sent to Germany and placed in a concentration camp where little food was given to the prisoners. In fact, Pietro says that in a few months he lost half of his weight and was so weak that it was an effort just to stand up. One morning at roll call an Italian Army officer, who was acting as an interpreter, recognized Pietro's name and looked him up later in the day. Realizing that Pietro was slowly starving to death, the officer told him of a method by which he could get in and out of the Camp and Pietro and one of his companions were able to slip out at night and forage for food, freely given them by neighboring farmers.

This night ranging went on for some time, until one night they were caught returning later than usual with several dozen eggs. They were brought before the German camp officer who smashed the eggs and ordered the two men confined in punishment cells (coffin-like boxes just large enough for a man to stand in, allowing no room for him to turn around or relax in any way). For eleven days Pietro was confined in this cell with only an occasional drink of water and no food. Finally, when he had given up hope of getting out alive, and says he would gladly have strangled himself if there had been space enough to get his hands up to his neck, he was released and turned over to an Austrian farmer as a prison laborer. From that day on he was well supplied with food and when the war ended a few months later, he returned to his home in Parma, walking the last 100 miles.

Pietro came to the United States in 1922 and farmed with his brother on land rented from the Army just east of Camp Upton. He was employed as a fireman at Camp Upton before the Laboratory took over and in April, 1947, entered the Laboratory employ as a laborer.

After his experience as a prisoner-of-war, Pietro might be pardoned if he thought only of food, but he says his memory of extreme hunger has worn off and, despite promises made to himself during the time he was in concentration camp, he does occasionally throw away a piece of bread.

PILE PROGRESS - Photograph taken November 23, 1948 showing pile building and east laboratory wing.



Not a night club, but just as crowded. Section of the floor in the Research Lounge showing a few of the more than 500 staff members who attended the Harvest Dance on November 5, 1948.

Dr. Abraham Edelmann directing a rehearsal of the Laboratory Choral Group. Less than half of the total membership was present when this photograph was taken.

YOU CAN UNDERSTAND THE ATOM

This is the sixth of a series of articles on atomic energy, written by R. J. Blakely, which were printed on the editorial page of the Des Moines Sunday Register.

Scientists bombarded various elements with alpha particles, protons and neutrons. They had three kinds of results.

The first kind of result was the breaking of some nuclei into parts. This can be illustrated with lithium and a proton. The lithium nucleus has three protons and four neutrons. When it is hit with a proton it then contains four protons and four neutrons. This is unstable, having too many positive charges, and it flies apart into two nuclei, each of which contains two protons and two neutrons. In the process considerable energy is released. The amount of energy checks with Einstein's formula, "E" equals mass times "C" squared.

In biology when a cell divides, the process is called **FISSION**. This word was applied also to the breaking of nuclei.

Man can perform fission upon atoms at will. With most atoms it is inefficient in terms of the energy released, however, because the energy which it takes is greater than the energy released. This is so with most materials because the only particles which split nuclei have to be shot by man. There are hundreds of chances that a particle will go through the empty space of the atoms for each chance that it will hit a nucleus. When a particle does happen to hit a nucleus and splits it, the action then dies out, for no particles fly out to continue the process.

The second kind of result from bombarding various elements with particles was the production of isotopes which are not found naturally and which are radioactive--that is, which emit particles and rays.

Take, for example, aluminum. Its nucleus has 13 protons and 14 neutrons. When it is hit by an alpha particle (which is two protons and two neutrons) a neutron is emitted and another nucleus is formed which has 15 protons and 15 neutrons. This is a light isotope of phosphorus. It is unstable. It gives off gamma rays and a positron and very shortly becomes a nucleus with 14 protons and 16 neutrons. This is the nucleus of silicon. Apparently one of the protons loses its positive charge--its positron--to become a neutron.

By bombardment most elements can be made into radioactive isotopes of other elements.

This has the greatest significance. Remember that one value of deuterium was that when compounded into heavy water its weight makes it possible to trace it through the bodies of humans and animals, thus increasing our knowledge of physiology. Deuterium has disadvantages as a tracer. It is difficult to separate deuterium from ordinary hydrogen. And sometimes it cannot be detected in the muscles of animals without killing the animals.

Radioactive substances overcome both these difficulties. Almost all elements can be made radioactive. This can be done without separating isotopes. And even small particles can be detected easily throughout a body.

One application of radioactive isotopes holds great promise but as yet is still only a promise. This is in the cure for cancer. Certain materials concentrate in certain parts of the body--for example, iodine in the thyroid gland and phosphorus in the bones. Gamma rays destroy living cells, but destroy cancer cells more quickly than normal cells.

The hope is that cancer in certain parts of the body can be killed by making the materials which concentrate in those parts radioactive. It still remains to be proved that most organs have their "specifics", that is, materials which concentrate in them. But the ability to trace substances through the body which radioactive isotopes give us will teach us much about physiology.

Until the development of atomic "furnaces" in the making of the atomic bomb, radioactive isotopes were available in only small amounts and at great cost.

The third kind of result from bombarding elements with particles was anticipated in theory before it was achieved in practice. This was the making of elements heavier than the heaviest element found in nature, number 92, uranium. For this purpose the neutron is the most effective "bullet".

The particles used in bombardment are (1) the proton (the nucleus of hydrogen), (2) the deuteron (the nucleus of deuterium, alias heavy hydrogen), (3) the alpha particle (the nucleus of helium), and (4) the neutron (the particle in the nuclei of all atoms which is neutral in electrical charge).

The advantage of the proton, the deuteron and the alpha particle is that since they are positively charged they can be speeded up and slowed down in an electrical current. Their disadvantage is that, being positive, they are repelled by the nuclei of other atoms, which are positive also. Thus, in order to enter the nuclei of other atoms they have to be shot at high speed.

The neutron has the same mass as the proton but is neutral. Thus it is not repelled by positive nuclei. For some time, because of experience with high speed positive particles, scientists sent neutrons against nuclei at high speed. Then they discovered that slow neutrons have a better chance of hitting some nuclei than high speed neutrons. But neutrons, not being charged electrically, cannot be slowed down by means of electricity. The only way to slow them down is to pass them through substances which have stable nuclei and which do not capture the neutrons. The neutrons bounce against these stable nuclei and are slowed down. These slowing down substances are called **MODERATORS**.

When a neutron penetrates a nucleus, the new combination is either unstable or stable. If the new combination is unstable, it breaks up to become a radioactive isotope. If the new combination is stable, a new and heavier isotope is created. Enrico Fermi predicted that in this way elements heavier than uranium could be created.