



*Dr. Gwilym S. Lodwick (right) and Dr. Theodore E. Keats adjusting powerful Van de Graaff generator at Medical Center as a member of the staff takes role of a patient.*

## Supervoltage X-ray generator

Supervoltage X-ray treatment for deep-seated cancer is now available at the University of Missouri Medical Center with the University's new 2,000,000-volt Van de Graaff X-ray generator.

Installation of the highly penetrating-ray machine in its underground laboratory has been completed and an average of about ten patients daily are receiving cancer treatment under the supervision of the Department of Radiology. The equipment also is being used for the Medical School's teaching program in radiology, a program that has been approved by the American Board of Radiology and the Association of American Medical Colleges.

The generator is a gift from the Donner Foundation of Philadelphia, which awarded twelve such machines to hospitals and clinics over the country that were selected as key centers for the treatment of deep-seated cancer. It is the only one of that voltage in Missouri. By contrast, the conventional therapy machine used by the University generates 280,000 volts.

In conjunction with the modern cobalt machine for treatment of cancer at Ellis Fischel State Cancer Hospital, the 2,000,000-volt generator makes Columbia a major Missouri center for cancer therapy.

With the installation of the supervoltage generator, far more effective treatment of deep-seated cancers has been made available to residents of Missouri, accord-

ing to Dr. Roscoe L. Pullen, dean of the School of Medicine and director of the Medical Center. He pointed out that the establishment of the generator will be an especial asset in the fight on cancer because the central location in the State will make it readily accessible for patients from all parts of Missouri.

Treatment of cancer with the supervoltage machine is provided at the Medical Center on a non-profit basis. It is available to both paying and indigent patients; however, all patients who need or apparently need radiotherapy must first be referred to the Center by their personal physicians. All cases referred to the Center are re-evaluated by specialists there to determine beyond doubt the patient's condition, and the necessity, type, extent, and other factors relating to treatment.

Operation of the Van de Graaff generator is under the direction of Gwilym S. Lodwick, M.D., professor of radiology and chairman of the department, who is a diplomate of the American Board of Radiology and of the National Board of Medical Examiners. Associated with Dr. Lodwick is Theodore E. Keats, M.D., associate professor of radiology and also a diplomate of the American Board of Radiology and the National Board of Medical Examiners.

Dr. Lodwick and Dr. Keats are assisted by Dr. Robert M. Jamison, assistant instructor in radiology

and resident in X-ray therapy. Other members of the staff are George F. Koenig, instructor in radiologic technology, who is chief technician, and Miss Marilyn Gerber, technician.

"Radiation treatment has proved to be the treatment of choice for many cancers, and is the only definitive form of treatment for the cancer patient who cannot be surgically treated," Dr. Lodwick said in discussing the medical importance of the new machine. "The supervoltage generator greatly broadens the scope and effectiveness of X-ray treatment at the Center, compared with conventional equipment.

"It also has advantages over cobalt supervoltage therapy. The beam of this generator can be quite closely restricted to the cancerous area to be treated, while cobalt radiation is more diffused. More rapid treatment than with cobalt is possible."

Among the advantages of supervoltage therapy over conventional therapy are:

It permits treatment of cancers that otherwise could not be treated satisfactorily.

There is a considerable decrease in radiation sickness, which can be a serious problem with less penetrating rays.

A speedup in treatment time, both for individual dosages and the overall treatment in number of days.

The possibility of obtaining higher dosage levels of X-rays in the cancerous area, since the rays are more penetrating and closely focused, with a minimum possibility of overdosage for adjacent healthy tissue.

A minimum of damage to the skin by back-scattering of rays, because the sharp focus cuts down such scattering, and the character of the beam causes maximum absorption of the rays below the skin.

The Van de Graaff machine permits attempts at cure in patients who otherwise could receive only palliative treatment.

One of the big advantages of the generator in treating deep-seated cancers, Dr. Lodwick said, is that it can be used for rotational therapy; that is, the patient can be placed on a rotating stand and kept turning slowly around while the beam is focused on the cancer. The patient is positioned on the stand so that the cancer area is always in the center and in effect is stationary in relation to the beam. The surrounding tissue, on the other hand, comes under the beam only at intervals, one time each turn, and receives a small fraction of the total dose.

In some cases, the generator permits more extensive therapy with greater safety to the patient than is possible with less penetrating rays.

Very precise treatment fields are attainable with the generator by means of beam-shaping accessories that enable the radiologist to get every field size and shape commonly used in present day therapy. The beam opening can be made square, round, rectangular, or irregular, so that the beam can be blocked off from normal tissue, and focused just on cancerous tissue. The adaptability of the beam-shape to treat-

ment needs is another important factor in permitting a maximum X-ray dosage to be given the cancer area with the machine, while the healthy tissue is spared.

Dr. Lodwick explained that among the types of cancer which the generator is especially suited for treating are those of the cervix; breast; lungs; head, including brain tumors; neck, including the tonsils and larynx; esophagus; lymphomas; leukemia, and other deep-seated sarcomas. A sarcoma is a malignant growth derived from connective tissue, cartilage, bone, and similar tissue.

He said that for curative attempts the Van de Graaff machine is best for cancer of the cervix, and head and neck; it achieves fair results on breast cancers, on which a combination of X-ray and surgical treatment is frequently used. X-rays are sometimes used after surgery, sometimes are the primary or pre-operative treatment.

The value of X-rays in treating cancer lies in the fact that cancer cells are more easily killed by X-rays than are most normal or healthy cells. Therefore it is possible with some tumors to subject the cancerous cells to a dose of rays that will be deadly to them, but will permit the normal cells to recover. In some cases, however, Dr. Lodwick said, the cancer appears to have a tolerance of X-rays nearly equal to the tolerance of surrounding normal tissues, so that the cancer cannot be killed without harm to the healthy tissue. Any cancer can be killed by X-rays, he said, but treatment is limited by the danger to surrounding tissue.

The X-ray machine's voltage generator, vacuum tube system, tungsten target and other "working" parts are housed in a cylindrical steel pressure tank 36 inches in diameter and 106 inches in overall length, and shaped slightly like an immense vacuum bottle. The tank is filled with 80 per cent nitrogen and 20 per cent carbon dioxide, under 360 pounds pressure per square inch, to insulate the very high voltages within the generator.

The entire instrument is suspended between the ends of two vertical, telescoping steel arms, or columns, attached to a pneumatically-operated ceiling mount. The mount, supported by I-beams in the ceiling, moves backward or forward, the generator moving with it. The generator can be raised or lowered on the telescoping arms. It also tilts under pneumatic control between the arms, and the beam opening can be moved through an up and down arc of 110 degrees that has its highest point 10 degrees above the level of the axis on which the generator tilts. The machine does not swing from side to side.

A simple, small control panel suspended on a cord from the machine—not unlike the remote control apparatus for a radio—has five buttons that control all movements of the mount.

The generator weighs 5,000 pounds; the mount weighs 3,000 pounds.

While the generator is a highly complex electronic device, its fundamental principle is that of bombard-

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Laura Jane Pace, AB, and Thomas Eugene Crane, BS BA '54, both of Columbia, on June 29 in Columbia. They are living at 99 Willis Ave., Columbia, Mo.

Beverly Howlett, BS Ed., of Bonne Terre, Mo., and William Muckler, AB, St. Louis, on June 14 in St. Louis. Lt. and Mrs. Muckler are living at 54 Power Road, Thomason Park, Triangle, Va. where he is stationed with the U. S. Marine Corps.

Donna Lou Harris, BS Ed., and Paul H. Kniep, BS Agr., both of the St. Louis area, on June 27 in St. Louis. They are living in Amarillo, Texas, until Lt. Kniep completes his training with the Air National Guard.

Lois Fay Eberhart, of California, Mo., and Ludwig Adam Gritzko, BS ChE, on June 21 in St. Louis. Mr. and Mrs. Gritzko are living in Los Alamos, N. Mex., where he is doing research for the Los Alamos national laboratories.

Patricia Olivia Becker of Columbia and Richard Holmes Hawkins, BSF, Webster Groves, on September 6 in Columbia. Mr. and Mrs. Hawkins are living at 109 Frederick Apartments while Mrs. Hawkins completes her senior year at the University and he continues his work toward a degree in the College of Engineering.

Suzann Carey, BS Ed., and Homer Daniel Martin of Columbia on August 17 in Macon, Mo. Mrs. Swanson taught in the kindergarten of the Sullivan, Mo., schools last year and is with the Jefferson City schools at present.

Mr. Martin served three years in the Naval Air Force and is presently enrolled at the University. They are living at 316 A. Broadway in Jefferson City, Mo.

Miss Shirley Joan Teschner and Ralph A. Eckles Jr., BS BA, on September 7 in Decatur, Ill. Mrs. Eckles is secretary in the farm department of Millikin Trust Company and Mr. Eckles is with the Soy Capital Bank, both in Decatur. They are living at 61 Wicker Drive there.

Frances Marlene Wotawa, BS Ed., of 339 South Marguerita Ave., Ferguson, Mo., and Robert Ray Kaempfer, Kirkwood, on August 9 in Kirkwood. They are living in the St. Louis area.

Judith Bach and James Franklin Hughes, BS Agr. of Greenville, Mo., on August 24 in Bloomington, Ill. Mrs. Hughes is continuing her work toward a degree at the University and Mr. Hughes, after completing his basic Army training, is stationed at Fort Leonard Wood.

Marilyn Gatterman, BS Ed. of Salisbury, Mo., and Fred Lewis Lineberry, Mendon, on August 16 at Prairie Hill, Mo. They are living at Rainbow Village Trailer Court in Columbia while Mr. Lineberry finishes his work for a degree in food technology. Mrs. Lineberry is teaching home economics and science at Renick, Mo.

Sara Kathryn Sappington, BS Ed., of Kansas City, and Glennon Kirby Forristall, Fredericktown, on August 17 in Lee's Summit, Mo. Mrs.

Forristall is speech correctionist at the Columbia elementary schools this year. Mr. Forristall is a pre-law student at the University. They are living at 1607 East Broadway in Columbia.

Donna Jean Harbert, BS BA, and John H. Cottey, Lancaster, Mo., on August 2 in Unionville, Mo. Mr. Cottey is a junior in the University School of Medicine and they are living at 505 Stewart Road in Columbia.

Suzanne Burch, BS Ed., and Lee Myers Keefer, BS Ed., both of Webster Groves, Mo., on August 11 in Webster Groves. They are living in Audubon Park, Brentwood, Mo.

Miss Kathleen Ellen Murray of Hamilton, Ohio, and James Joseph Buchanan, Columbia, on September 6 in Hamilton. Mrs. Buchanan is a graduate of Stephens College in Columbia. Mr. Buchanan is employed by the Gwynne Company in Camden, Ohio. They are living at 82 Brookwood Avenue, Hamilton.

Frances Holt, BS Ed., and Wallace J. Austin, Chillicothe, Mo., on August 3 in Kansas City, Mo. They are living in Columbia while Mr. Austin completes work for a degree in the College of Engineering.

Margaret Landau Anderson, BS Ed., Corpus Christi, Texas, and Charles Edward Nichols, BS Agr. '56, Kahoka, on August 10 in Columbia, Mo. Mr. Nichols is a senior in Law School at the University and they are living at 610 College Avenue.

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## Supervoltage X-ray generator *from page 6*

ing atoms with electrons and generating Roentgen rays, usually called X-rays. The principle of operation is that a continuous charge from the power supply is sprayed onto a rapidly-moving plastic belt inside the pressure tank. The belt carries the charge to the high-voltage terminal, a highly polished aluminum dome. There an electrostatic charge of 2,000,000 volts is built up. The charge, which is automatically kept constant, passes into a hot cathode that discharges a stream of electrons down the X-ray tube, in which they are accelerated by electrodes and focused to hit a tungsten target at the "muzzle" or beam end of the machine. The electrons hit the tungsten nuclei, generating X-rays that form the X-ray beam.

An underground laboratory designed to afford the maximum protection against radiation has been constructed adjacent to the Teaching Hospital, to house

the huge generator. The radiotherapy laboratory is entered from the north side of the tunnel between the hospital and the Nurses Residence Hall, and has no outside entrance. Approximately 28 by 44 feet in overall dimensions, the laboratory includes the deep therapy room in which the X-ray machine is set up; a control room separated from the therapy room by a 16-inch concrete wall, which absorbs all radiation; an office; a storage room; and toilet facilities.

Outer walls are 12 inches thick and backed by soil, so that no radiation penetrates beyond the therapy room. The window between the control and therapy rooms, through which patients under treatment can be observed by the control operator and radiologist, is of radiation-absorbing leaded glass. The generator cannot be turned on unless the heavily-leaded door is closed.