PULSED POWER

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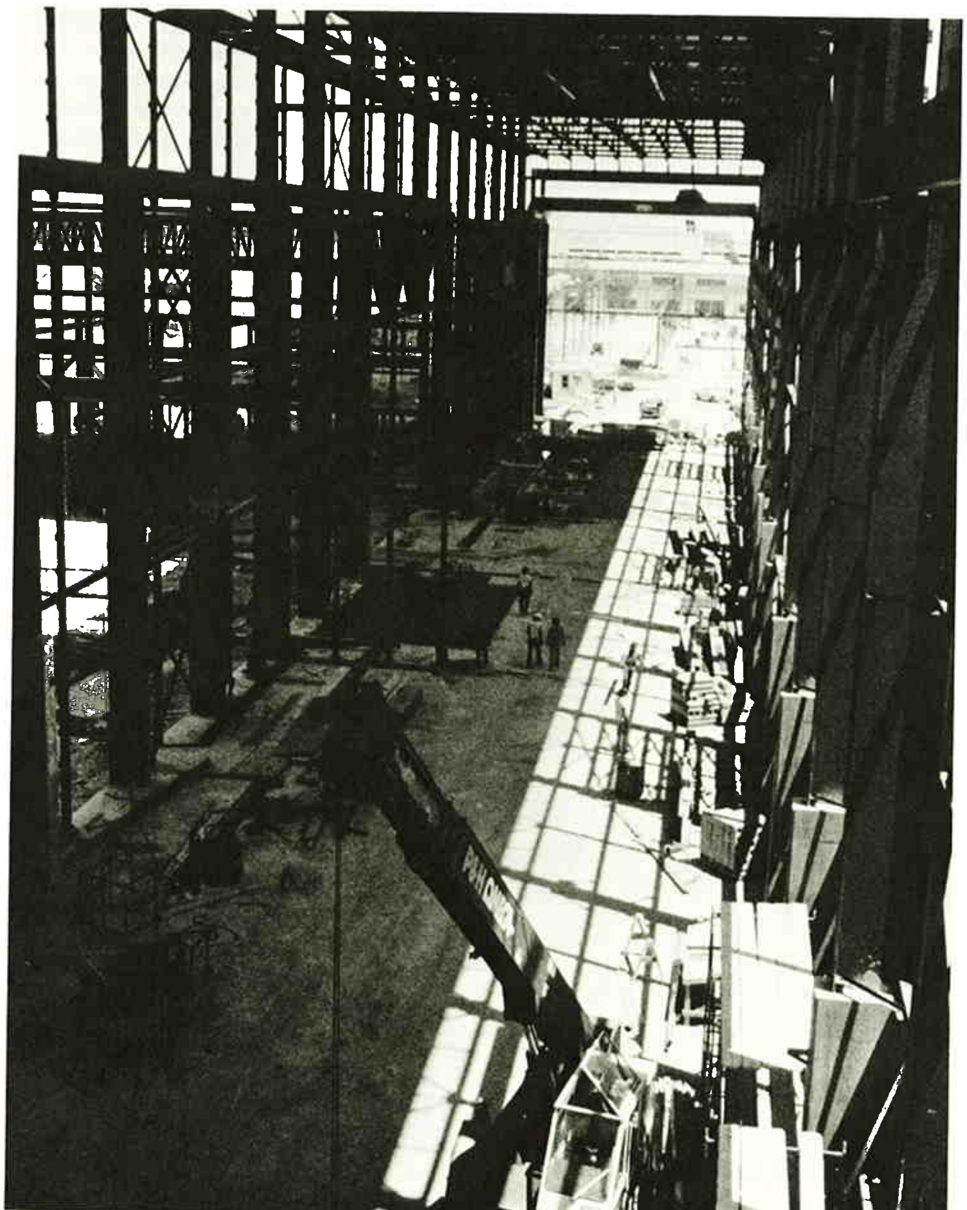
Center for Electromechanics is experimenting with ways to rapidly release an enormous amount of stored power relatively inexpensively



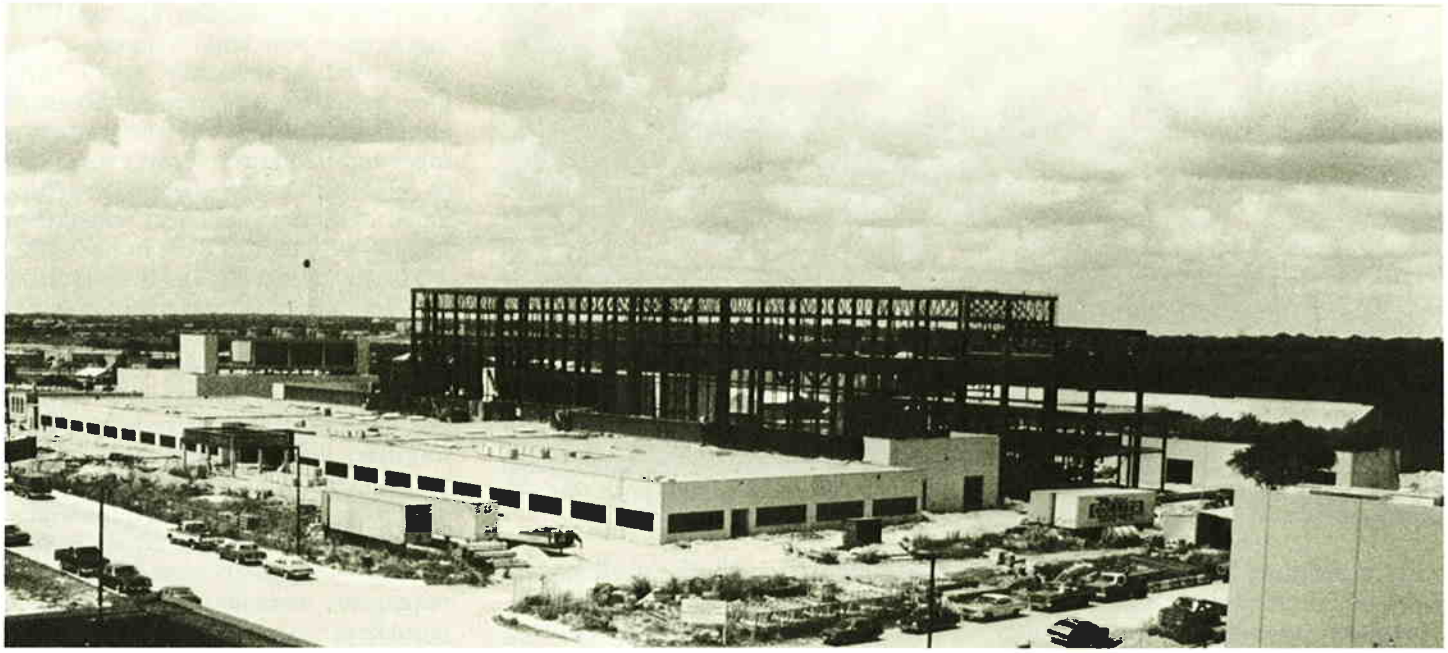
View of the seventy-six-foot high bay, taken at the elevation of the fifty-ton bridge crane. This unique facility is shared by the Center for Electromechanics and the Center for Energy Studies for their research testing. The machine shop bay extends to the left.

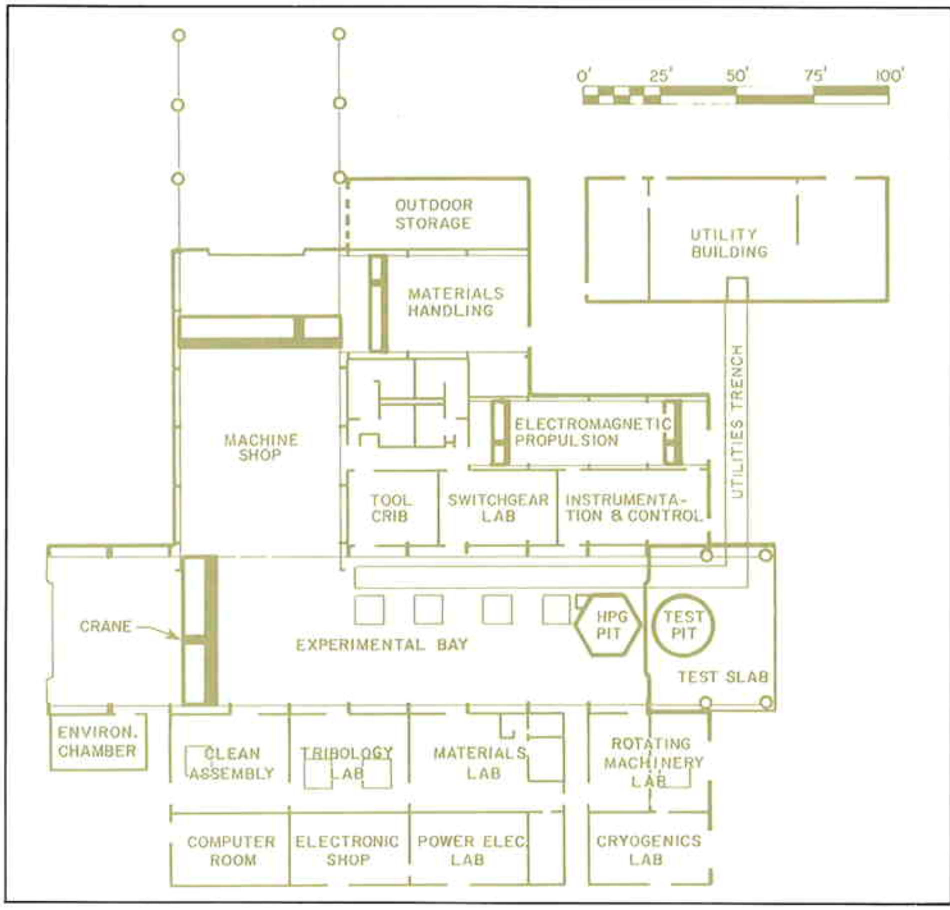
Controlled bursts of energy released in short time periods have become the major research thrust of the Center for Electromechanics at The University of Texas at Austin. Many refer to this type of energy as "pulsed power" even though only one pulse may be all that is desired. In a general sense, any form of energy can supply the desired pulse, but most practical applications require a rapid release of stored energy at enormous power levels up to gigawatts. Energy storage devices are thus desirable and necessary in order to produce a high level pulse with relatively low charging rates.

Chemical explosives are perhaps the most used form of energy for pulsed power devices; however, compressed gas, elevated water storage, mechanical springs, batteries, capacitors, inductors, and flywheels are also used. Each of these devices uses energy stored in a form that can be released quickly. Upon examination of the uses of pulsed power one quickly determines that the most wanted form of energy is electrical. An analysis of the cost of delivering electrical energy to a specified load revealed that kinetic energy stored in a flywheel coupled to an electrical generator would produce the desired minimum-cost pulsed power.

First efforts to achieve a relatively inexpensive pulsed power source were initiated in 1972 by myself and Herbert H. Woodson of the UT Electrical Engineering Department. The resulting homopolar generator was designed, and a small unit was constructed to test a principle invented by Michael Faraday in 1831. Other designs by William Weldon followed, and the Center for Electromechanics was formed in March 1977. Almost all of the work done by the Center has been conducted in Taylor Hall on the UT campus, but that will change when the Center moves to the Balcones Research Center next year.

For the first time the Center for Electromechanics will have a facility specifically designed for research in this field of growing interest. Central focus of the laboratory will be on the 60 MJ Homopolar Generator that will provide a source of power for experiments using up to five million amperes of direct current. From this central power source inductors can be charged to obtain even higher current levels for short time periods, and the modular de-





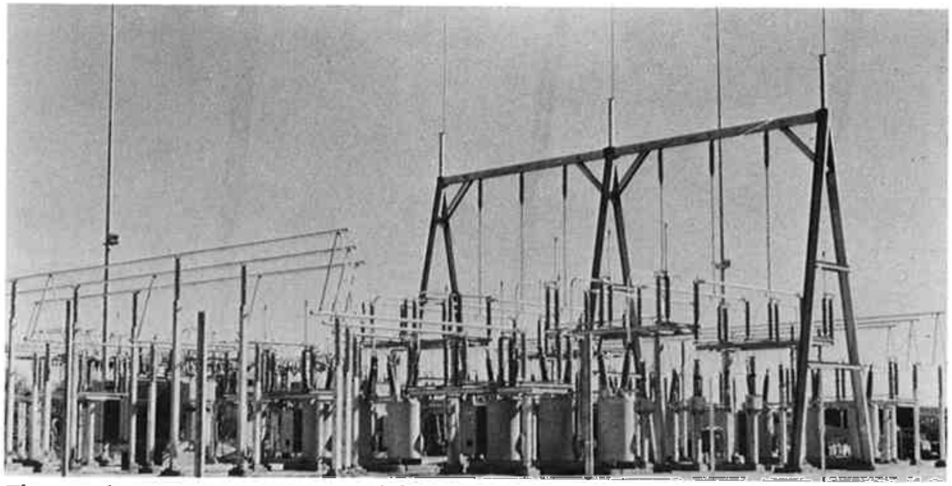
The Center for Electromechanics/Center for Energy Studies building at Balcones Research Center, photographed while under construction. The front part of the building contains offices and administrative areas. The building also includes twenty-four low research laboratories, an experimental high bay, and a machine shop high bay. Also shown (left) are the chilling plant and microwave communications station and (right) the utilities building containing electric, steam, air, and hydraulic power.

sign approach using six generators will enable separate smaller experimental research using one or more power modules. This power source will be the finest low impedance direct current facility in the world, thereby enabling University of Texas engineers and scientists to explore many new and exciting fields that are now out of experimental reach. Truly world-class experiments will be made in this laboratory at Balcones Research Center.

Equally impressive will be the air-conditioned five-story experimental bay extending the full length of the building. Sliding doors (thirty-two feet by sixty feet) will provide access at the ends of the building, and they will separate experiments in the adjoining Center for Energy Studies from the Center for Electromechanics. Raising the central door will permit movement of large equipment through the high bay and provides the possibility of combining all of the large experimental area for apparatus up to 300 feet long.

Many experiments in electromechanics require variable speed drives with accurate controls and safety features including runaway speed protection. Such a power system is provided by a 2,400 horsepower hydraulic system that is remotely powered and piped throughout the building. This system will drive the 60 MJ d.c. generators, dynamometer, and other apparatus. Where large power experiments are conducted, cooling must be provided. A 1,400 ton chilled water station is adjacent to this facility providing the necessary cooling for the facility. Modern loading docks and fifty ton cranes will greatly assist transport of equipment in and out of this facility that is intended to handle research using equipment too large for the central campus.

Two adjacent underground pits are provided to facilitate the interconnection of large electrical apparatus



The new thirty megawatt, sixty-nine kilovolt substation at Balcones Research Center that will provide power for the Center for Electromechanics and other new Balcones facilities.

with minimum lengths of bassbar. The twelve feet deep inside pit is hexagonal (twenty feet on one side) in cross-section with supports for six homopolar generators (one for each side). This configuration provides an optimum arrangement for interconnecting generators to the load on the test floor immediately above the pit.

The outside pit, twenty feet in diameter and twenty feet deep, enables side-by-side interconnects for high speed electrical machinery while providing the safety of underground testing for exploding rotors. Very large equipment can be assembled on the forty-by-sixty foot outdoor assembly pad that is accessed by an overhead crane.

Support facilities include a modern machine shop, drafting room, library, and computer with an ultramodern data acquisition system interconnecting all laboratories by a tunnel. Accurate and clean high speed data management coupled with digital control is an essential element of the new laboratory.

Laboratories will be provided for experimental research in all phases of electromechanics. Specific laboratories include the Power Electronics Lab where experiments on electronic equipment for the power industry will be conducted. The Rotating Machinery Lab, with a 600 horsepower hydraulic drive, will provide dynamometer measurements and electronic test instrumentation for evaluating rotor dynamics and machine efficiency under controlled operating conditions. A Tribology Lab will investigate friction and wear properties of brush and bearing materials as well as evaluate lubricants, seals, and bearing systems.

Many of the new electromechanical devices will operate at low temperatures because of the enhancement of material properties such as reduced electrical resistance. Low temperature facilities in the Cryogenics Lab will be equipped for temperatures from liquid helium (3° to 15°K) up to room temperature. This laboratory will be used to investigate superconducting materials for the high magnetic fields needed for machines of the future. The Switchgear and High Voltage Lab is to be used for designing and testing new switches and circuit breakers along with high voltage transformers and insulators. Power levels up to eighty-five megawatts are provided by a new electrical substation located at Balcones Research Center.

Future research in this facility will include many startling new designs for the use by generations to come. The use of power levels in the gigawatt range is anticipated to heat and confine plasma, fire lasers, heat forgings, weld, surface coat, sinter granular material, cut and form parts, and power electromagnetic devices. Studies already completed show substantial savings in cost by electromagnetic, instead of rocket, space launches.

New electromechanical devices such as generators will be tested to determine design limitations and explore the limits of engineering technology for design parameters such as minimum discharge time, flux compression, rotor stability, ultra high magnetic fields, brush materials, and eddy current losses.

Electromagnetic guns will fire projectiles and plasma at speeds more than ten times the speed of present gas guns. Many new fields of application are anticipated for these open-breech devices since they can easily propel mass at velocities exceeding the escape velocity of the earth. Revolutionary methods of surface coating and alloying now being explored will provide new materials, such as amorphous iron and tungston alloys, at reduced cost.

Intelligent machines and machine components will be developed to take the monotony out of factory and field work. Already intelligent machines can outperform human beings with their super memory and extreme precision. Product quality control using computers, hard automation, and robots can substantially increase the productivity of many fabrication and assembly plants.

The new Center for Electromechanics at Balcones Research Center is truly a dream come true. Research is funded that depends upon this unique building and associated equipment. Most importantly, the facility is suitable for several decades of research at levels not now attainable.

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Dr. H. Grady Rylander is director of the Center for Electromechanics and chairman of the Department of Mechanical Engineering at The University of Texas at Austin. A nationally recognized authority on bearings and lubrication, he has conducted or directed several research projects in the electromechanics field. He received his bachelor's and master's degrees from UT Austin and earned a Ph.D. in mechanical engineering from the Georgia Institute of Technology.