PHYSICS

Most Powerful Accelerator

This summer U. S. scientists will operate an atomic accelerator at 30 billion electron volts, a machine more energetic than the world's highest now smashing atoms at Geneva.

By ANN EWING

TODAY, THE WORLD'S most powerful atom smasher is the 28-billion-electron-volt machine now operating under the CERN organization of 13 European nations at Geneva, Switzerland.

This summer, however, the United States will begin experiments at even higher energies with the 30-billion-electron-volt accelerator at Brookhaven National Laboratory.

With the CERN and Brookhaven particle accelerators, plus many others now under construction, scientists expect to learn new facts about the atom and its nucleus. The protons or electrons, given terrific speeds by the accelerator, are used as "bullets" to crash into atoms. The particles that come flying out tell scientists about atomic structure. To some extent, this can be done by studying the tracks of atomic collisions caused by cosmic rays.

In space, the cosmic rays that continuously bombard the earth's atmosphere are accelerated to much higher energies than those available from any man-made machine now in operation or being built.

However, it is much easier to trace what occurs when atomic cores disintegrate if the collisions are produced in the known conditions of atom smashers.

Accelerators are used as "microscopes" to help scientists "see" inside the atomic nucleus, where distances are measured in fractions of a trillionth of an inch. The greater the energy of accelerated particles, the easier it is for scientists to "see" the detailed structure of the nucleus.

By studying the results of atomic smash-ups in high energy accelerators, scientists have found that the structure of atomic nuclei is not as simple as was once thought. Some 32 "elementary" particles are now known, and about half of these are anti-matter, a state opposite to that of ordinary matter. When an anti-proton and a proton collide, for instance, both particles are annihilated and matter is turned into energy.

Naturally radioactive materials, such as radium, were first used to bombard atoms and thereby learn more about how atoms are constructed. The energies involved in these early studies were only a few thousand electron volts.

The first man-made accelerators gave the particles less energy than that of natural radiation, but paved the way for more powerful ones. The first in the billion-volt range were constructed during the early 1950's in the U. S.

The CERN machine reached energies of some 24 billion electron volts late in 1959, then in 1960 it operated at a power level of 28 billion electron volts, usually abbreviated to Bev. Until late 1959, however, the Russians were operating the world's most powerful machine, a 10-Bev accelerator at Dubna, Russia. The USSR several years ago announced plans for building a 50-Bev proton synchroton, but little definite information on its progress has been released since then.

Basically, all accelerators consist of a source of particles, usually protons or electrons, to be accelerated, and a high vacuum chamber in which the particles can move without colliding too frequently with air molecules. Acceleration is achieved by giving the particles successive electric "kicks," and they are kept in position to receive these jolts by magnetic fields.

Atom smashers are broadly subdivided into two classes, linear and circular. Both the CERN and Brookhaven proton accelerators are circular and use the so-called strong focusing method to keep particles on their assigned paths.

Linear atom smashers are often used as pre-accelerators for the very large synchrotrons, as well as on their own.

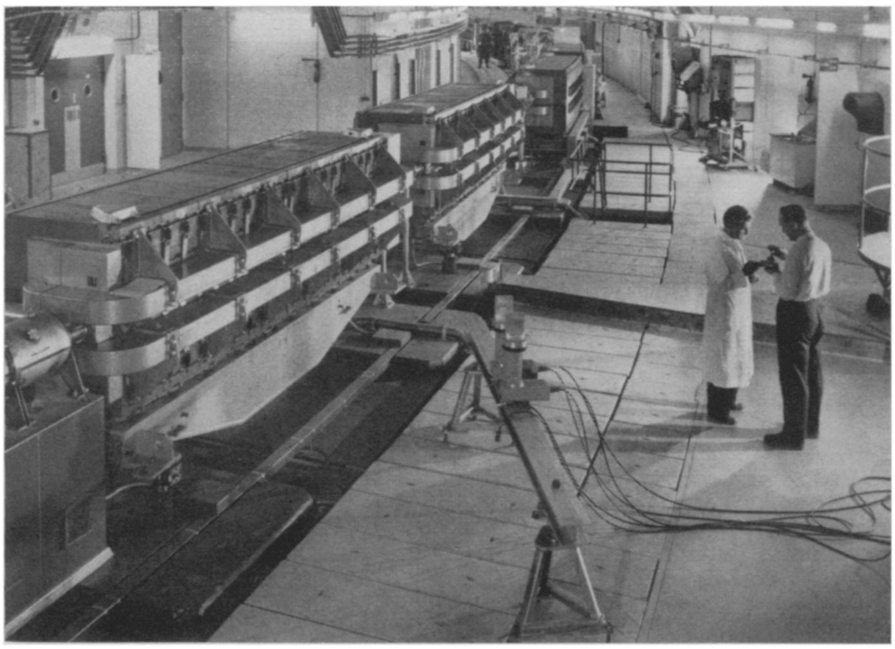
The most ambitious plan for a linear accelerator involves building a machine two miles long at Stanford University in California. Congress has before it a request to authorize design and construction of such a high-energy electron accelerator.

It would be a "big brother" to the Mark III linear machine that has been successfully operated at Stanford with energies as high as 730 thousand electron volts. The Mark III is now being extended from 220 feet to 310 feet to allow operation at about 1.2 Bev.

The proposed two-mile accelerator would provide a ten-Bev electron beam, with an intensity some 50 times greater than that available from a circular electron machine.

Two U. S. circular accelerators currently in operation at Cornell University, Ithaca, N. Y., and California Institute of Technology impart to electrons energies of up to 1.5 Bev. The Russian newspaper Pravda recently announced that a four-Bev linear accelerator for electrons was under construction at Kharkov. A one-Bev circular machine is in the design stage in Russia.

When it is completed later this year, the six-Bev synchrotron being built jointly by Harvard University and Massachusetts Institute of Technology will be the most powerful electron accelerator in the world. The energy available for reactions with six-Bev electrons is the same as for 9.5 Bev protons, so that large numbers of the strange particles inhabiting atomic nuclei are expected to be produced in this machine, despite the fact that electrons are



MOST POWERFUL ATOM SMASHER—The most advanced tool of nuclear research in the world is the 28-billion-electron-volt particle accelerator now operating in Geneva under the direction of CERN. The interior view here shows a few of the 100 units of the 3,800-ton magnet that provides the field guiding the particles during acceleration.

much weaker in their interactions with matter than are protons.

For accelerating protons, the U. S. now has two large machines in operation, a three-Bev synchrotron known as the cosmotron at Brookhaven National Laboratory and a 6.2-Bev synchrotron called the bevatron at the University of California's Lawrence Radiation Laboratory in Berkeley.

Besides the 30-Bev Brookhaven machine, two other large ones are under construction in the U. S.

One, a joint venture of Princeton University and the University of Pennsylvania, will be a three-Bev proton synchrotron. It is scheduled for completion by the end of 1960. Although similar to the cosmotron, it is designed to provide a much higher number of protons per second in its beam, thus making possible experiments on nuclear events that otherwise occur too rarely for successful study.

The second is a 12.5-Bev proton accelerator under construction at Argonne National Laboratory, Lemont, Ill. It is scheduled for completion in 1962.

The Soviet Union has scheduled a seven-Bev proton synchrotron for operation in 1960.

From this summary it can be seen that, excepting the 50-Bev machine proposed by the Russians about which little is known, the U. S. will have the largest and most sophisticated atom smashers of the world in operation by the end of this year.

It is noteworthy, however, that the 13 nations forming CERN are also building rather large machines on their own. The 13 nations are Austria, Belgium, Denmark, France, West Germany, Greece, Italy, the Netherlands, Norway, Sweden, Switzerland, the United Kingdom and Yugoslavia.

In the United Kingdom, a seven-Bev proton synchrotron is under construction by several British universities. In France, a three-Bev proton accelerator was placed in operation in 1958 and a one-Bev linear accelerator is nearing completion. In Italy, a 1.2-Bev electron accelerator began operation in 1959. In the Netherlands, a proton synchrotron is being built. Electron accelerators are under construction in West Germany and Sweden.

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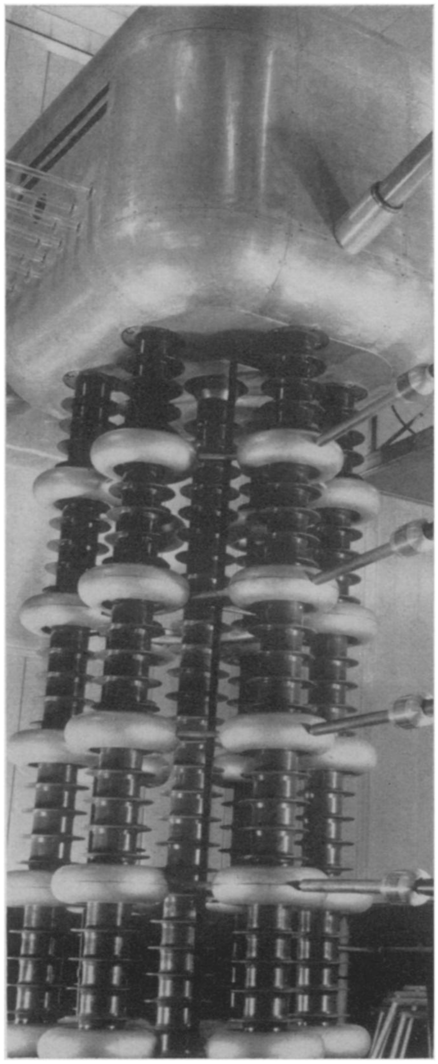

INITIAL ACCELERATION—This Cockroft-Walton generator provides the initial acceleration of 750,000 electron volts to protons that are shot into a 50-million-electron volt linear accelerator. The protons then enter the orbit of the Brookhaven 30 Bev alternating gradient synchrotron.

METEOROLOGY

Natural Air-Conditioning

SAN FRANCISCO has a completely automatic, built-in air conditioning system that not only gives it cool summers and mild winters but also results in substantial economic advantages to commercial jet aircraft operators.

San Francisco has mean summer temperatures lower than those of any other large city in the United States.

In July, the average maximum temperature is a cool 64 degrees. In September, the warmest month, highest temperatures average a comfortable 68 degrees, Halbert E. Root of the U. S. Weather Bureau at the San Francisco International Airport reported.

Mild weather in the San Francisco Bay area is due to its particular location on the eastern shores of the Pacific Ocean and to its topography. These combine to provide what amounts to a natural air-conditioning system, Mr. Root reported in the current issue of Weatherwise, 13:47, 1960, published for the American Meteorological Society in Boston.

In the present age of jet-powered aircraft, the cool temperatures and brisk winds of this air-conditioned region provide great advantages for air travel. These result from the fact that the thrust of a jet engine depends directly on the density of the air, the density being greater at lower temperatures, and that each mile per hour of headwind on take-off means less speed need be provided by the plane's engines in order to reach flying speed.

When compared to a nearly inland location, jet planes departing from San Francisco International Airport could carry an average of as much as 12,000 pounds more per flight, Mr. Root reported.

San Francisco's air-conditioning system also supplies sailing enthusiasts with exciting sport to test their skill. At the peak of flow on a normal ebb tide, the water is rushing out under Golden Gate Bridge at a rate of about 4,600,000 cubic feet per second, about seven times the flow of the Mississippi River.

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PHYSICS

Strained Metal Foil Shows Structure

USING AN ELECTRON transmission microscope and motion picture techniques, research workers at the University of Cambridge, England, are now able to watch what actually happens to metal foils when they are strained to breaking point.

Dr. P. B. Hirsch and Prof. A. H. Cottrell, both of Cambridge, have found that structures "virtually down to the atomic scale can be seen for the first time."

They hope the method will enable scientists to understand thoroughly how the engineering properties of solids result from atomic structures.

The new technique has been used, for example, to watch what happens when a pure metal is suddenly cooled from high temperatures, to find out how nuclear radiation damages metallic crystal structures, and to follow the arrangements and dislocations that occur when a metal foil is gradually strained to its breaking point.

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MILITARY SCIENCE

Device to Stage Battles With Nuclear Subs

THE NAVY'S Submarine School in New London, Conn., is getting a $3,600,000 nuclear submarine training center that will provide realism in waging mock sea battles. To be built by Minneapolis-Honeywell Regulator Company, the new training facility will utilize a giant computer and electronic techniques to duplicate, in color, the attack centers of three nuclear submarines.

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TECHNOLOGY

Largest Nuclear Power Reactor Operating Well

THE NATION'S largest operating nuclear power reactor has performed "outstandingly well" during its initial test run, the General Electric Company and Commonwealth Edison Company have reported.

The reactor forms the heart of the huge Dresden Nuclear Power Station at San Jose, Calif. It produced nearly 25,000,000 kilowatt hours of electricity while operating at power levels up to 90,000 kilowatts for its two-week test.

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