PHYSICS

Two Giant Atom Smashers

Both promise to operate in the energy range of cosmic rays. They will be built within the next few years with $11,000,000 of A. E. C. Funds.

See Front Cover

➤ TWO new gigantic "atom smashers" or electronuclear machines, both of which promise to operate at billions of electron volts in the energy range of the cosmic rays, will be built in the next few years with $11,000,000 of Atomic Energy Commission funds. The largest, a 110-foot cyclotron, will be at the University of California's Radiation Laboratory at Berkeley. The other, a 30-foot synchrotron, will be built at the Brookhaven National Laboratory, Upton, Long Island, N. Y.

California Cyclotron

About ten billion electron volts, enough energy to exceed the most powerful cosmic rays from the depths of the universe, will be produced by the $9,000,000 Berkeley cyclotron.

This will multiply about 20 times the power of the largest cyclotron now operating, the 184-inch atom smasher also at Berkeley, which only a few weeks ago produced man-made mesons for the first time by bombardment with 400,000,000 electron-volt particles.

The new machine will be a gigantic affair 110 feet in diameter with a circular housing around the rim. Atomic particles will speed around it under the influence of 10,000-tons of magnet, like an immense merry-go-round. Protons, the hearts of hydrogen atoms, will be fed into the machine. Mere men operating it will be dwarfed by the apparatus.

The planning for the new giant among atom smashers was under way many months ago. W. M. Brobeck, who did the engineering design of the present world's largest cyclotron, determined that it would be feasible to build and operate a great proton accelerator at ten billion electron volt level.

Dr. Ernest O. Lawrence, whose invention and operation of the cyclotron won him the Nobel Prize, will direct the new one, which will take five years to build. He first announced the possibility of the ten billion electron volt machine at a lecture at Yale's Centennial Celebration of the Sheffield Scientific School last October (*See SNL,* Oct. 25).

Plutonium, the atomic bomb element, was first created in one of the smaller cyclotrons, and so were the other three elements heavier than uranium.

The magnet will be divided into four segments, the four gaps providing access to the accelerating chamber for such equipment as vacuum pumps and the high frequency equipment which accelerates the protons.

As protons pass the accelerating electrode point on each trip around the magnet, they will be struck by a high frequency charge of either 2500 or 5000 volts. With 5000 volts on the accelerating electrode, each particle would make more than one million trips around the chamber before reaching six billion electron volts.

Operation of the great atom smasher will be pulsed; that is, it will operate for about two seconds at a time, then will be turned off for a few minutes.

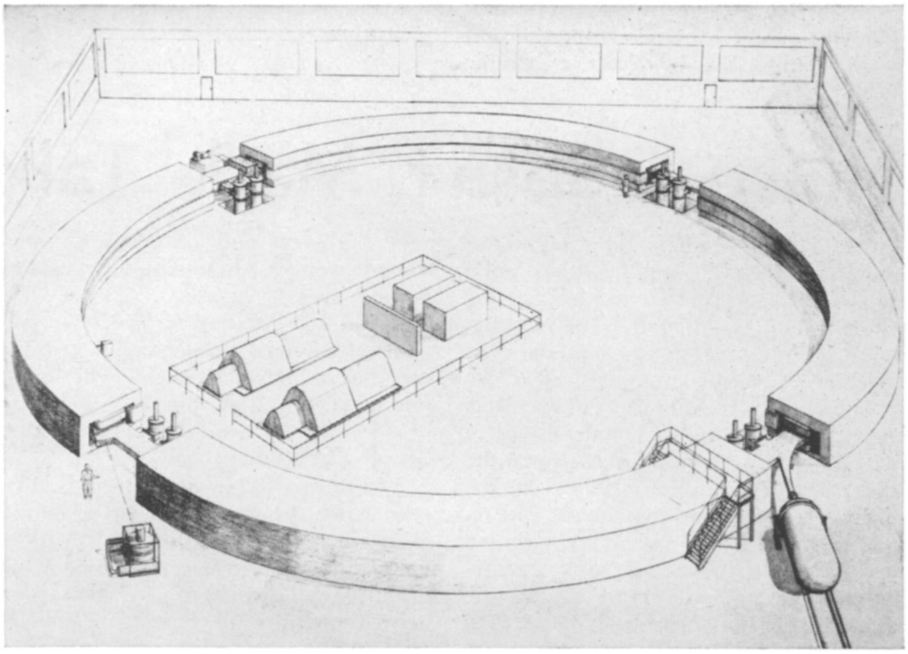
Brookhaven Machine

Three billion electron volts will be the energy of the protons to be accelerated in the 30-foot machine to be built at Brookhaven National Laboratory in about three years at a cost of $3,000,000.

In the operation of the machine, the protons will travel repeatedly around a fixed orbit consisting of four quadrants of a circle 30 feet in radius, alternating with four straight lines about 10 feet in length. The path the protons will follow will have the appearance of a circle flattened at four equally spaced points around its circumference. The total distance travelled in one revolution will be about 230 feet and a proton reaching its peak energy will make about 3.5 million revolutions, a distance of about 150,000 miles. It will travel this distance in less than a second.

The scale model of the three billion volt proton accelerator to be built at Brookhaven is shown on the cover. At top is model of motor generator set which will supply power to the magnet. The magnet is the ring (60 feet across left to right), inside which the particles are accelerated in a vacuum in a "doughnut" shaped course made of a ceramic. Particles are launched at four million volts from the Van de Graaff generator represented at the lower part of the picture.

Design of the Brookhaven machine was by a group headed by Dr. M. Stanley Livingston, on leave of absence from Massachusetts Institute of Technology.



ATOM-SMASHER—Plans for building this gigantic machine are now under way at Berkeley. It will accelerate protons, the nuclei of hydrogen atoms, to 10 billion electron volts. (From SNL, Nov. 1.)

What Machines Will Do

A continuing attack on the fundamental structure of the heart or nucleus of the atom, the prime problem in physical science, is the objective of the new cyclotrons. There is still much to be learned and enticing theories to be tested.

Both equipments will mobilize the most advanced developments in atom smashers in recent years. Particularly important to operation are the concepts proposed in 1945 by Dr. E. M. McMillan, professor of physics in the University of California's Radiation Laboratory, which made possible the synchrotron and synchro-cyclotrons.

In the giant cyclotron, which is sometimes called a synchro-cyclotron, the frequency of the electrical charge used to accelerate particles is slowed down because the speeding particles tend to lag a little at higher energies. Thus the acceleration is synchronized to accommodate the laggard particles.

In the synchrotron, which accelerates electrons, the synchronization is accomplished by increasing the strength of the magnetic field of the ring-shaped magnet. This jerks the lagging electrons up to the accelerating point in time to receive regularly spaced jolts of high energy power.

One possibility of the new giant cyclotrons will be the production of large number of mesons, in pairs, with which it might be possible to fission chemical elements other than uranium, thorium and plutonium with release of atomic energy. This is a theory that scientists are anxious to test. It may possibly give rise to new kinds of atomic bombs or other applications of atomic energy.

Dr. Philip M. Morse, director of Brookhaven, explained:

"Nuclear physics today is in a position of development which can be compared to that of chemistry 50 years ago. At that time chemists knew a great deal about valences and combining weights of elements, but did not know how the forces acted which made molecular bonds. In the last 50 years this has come to be well understood. In nuclear physics today we know that atomic nuclei are held together by some new force—we call it nuclear force—and we know it is not an electrical, chemical or gravitational force, and that it is specifically a nuclear phenomenon. To study and understand this new force we must have instruments which will make or break this force at will under controlled laboratory conditions.

"The best theories concerning this force find it necessary to talk of inter-change of charge between particles in the nucleus. This inter-change of charge is supposed to be accomplished by means of a meson which is shared alternately by different particles within the nucleus. With new and higher energy accelerators we hope to be able to gain experimental evidence which will clarify or substantiate these theories, and lead to broad extensions of our present knowledge of the nucleus."

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PSYCHOLOGY

Noise Doesn't Mask Talk

➤ ALTHOUGH a loud continuous noise will "drown out" another noise and make conversation impossible, the effect is entirely different if the masking noise is intermittent, as in a burst of machine-gun fire.

Interrupting the noise cuts down on its effectiveness as a mask, but the extent to which it is cut down depends also on the frequency of the interruption, on the pitch of the drowned-out sound and on the loudness of the noise. This is shown by research at the Harvard Psycho-Acoustic Laboratory reported at the meeting of the Acoustical Society of America in Washington.

If the noise is on and off only once in ten seconds, the conversation can be heard without too much difficulty. But, on the other hand, if the interruption is very high—on and off 5,000 times a second—you can hear almost as well as if there were no noise.

If you are listening to speech accompanied by a noise that is interrupted 300 times a second, the speech will sound intermittent to you, but you will hear practically every word just as if you were listening in a quiet room.

A curious effect was discovered, however, when the investigators tried filling in the intervals between words with a noise. For this purpose they used what scientists call "white noise," that is, a noise containing all the frequencies at random.

Now the speech no longer sounded intermittent. The words were understood just as well as when there was no "masking" noise.

This illusion is like that noticed when you drive past a picket fence. If you are standing still, the pickets block your view so that you cannot see what is behind the fence. But if you are moving at the right speed, and the pickets are not too close together, you will get a view of what is behind the fence and the pickets, if you see them, will appear no more than a vague blur.

The intelligibility of conversation is less, if it comes in abruptly and is chopped off suddenly. You can make out more in the same length of time if it comes in and fades out more gradually.

These investigations were reported to the meeting by Drs. George A. Miller and J. C. R. Licklider of Harvard and Dr. W. R. Garner of the Johns Hopkins University.

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