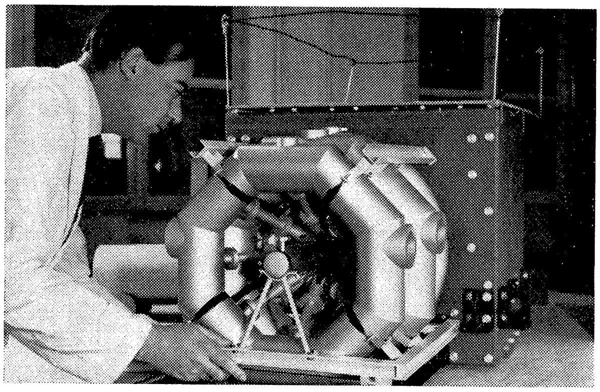
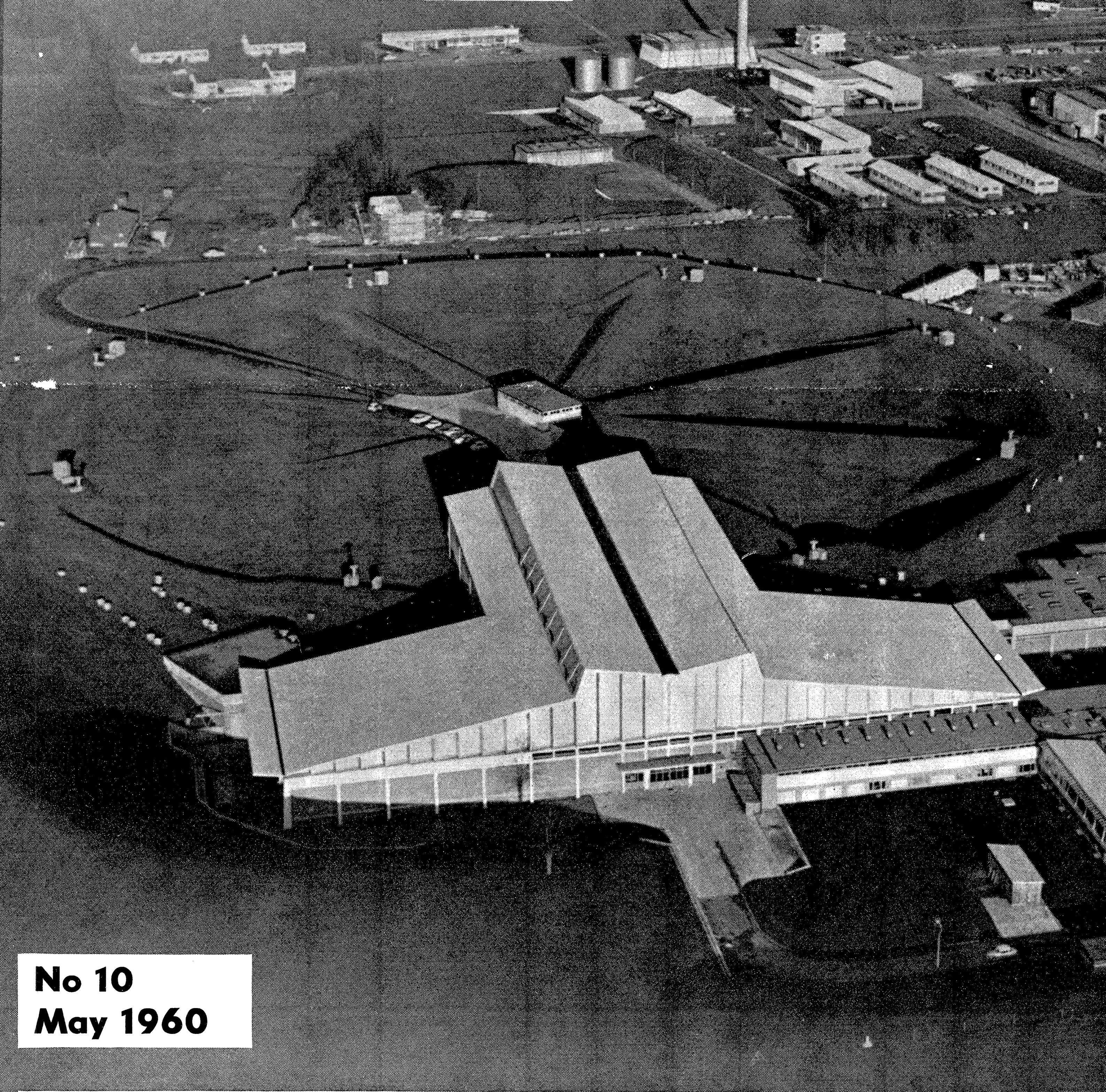
CERN COURIER





No 10
May 1960

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Last Month at CERN

In the course of a few weeks, CERN suffered the loss of two of its staff members. **Albert Fehlmann** died on March 12th after a long illness. Aged 50, Mr. Fehlmann had been a mechanic at the PS workshop since July 1956. **Jack MacCabe** who passed away on April 17th, joined CERN in September 1955. Here, CERN wishes to express once more its sympathy to their families, in their sad loss.

There has been no full operation of the **25 GeV proton synchrotron** (PS) between the end of the 32 cm hydrogen bubble chamber run, on March 24th, and Monday, April 11th.

A new programme of PS operation has been set up. Beginning after Easter the machine has been operating on Mondays, Tuesdays and Fridays, from 08.30 until midnigth. Wednesdays, are reserved for maintenance and experimental set-up, while on Thursdays mainly parts tests are conducted. Each day of operation is divided into three shifts which, on the whole serve for :

— nuclear physics experiments, official or "parasitic";

— starting procedure, training of operators, machine studies and component tests.

Early in May, work began on the ground adjacent to the **PS laboratories.** A **third wing** is being erected there to house more laboratories as well as the PS workshop which will have to vacate its actual floor in the south experimental hall.

Near the water tanks, on the southernmost part of the site, a propane distillation unit is being erected. It will supply the propane bubble chamber group with the indispensable fluid for the operation of its 1 m-diameter apparatus.

The **Site and Buildings** Division has undertaken new borings at Peney, near the Rhône river, and at St-Genis (France) in the hope to double CERN's supply of refrigeration water, the needs of which now reach 7000 litre/minute.

While on the subject of civil engineering it may be worthwhile to mention here the petition circulated early in April among the staff. The hundreds of signatures gathered will help—it is hoped—to accelerate, not particles for once, but the work on the Meyrin road which, for more than 6 months has been a bumpy, car-shattering open trail.

Evaluation of 40 000 pictures recently taken with the 32 cm hydrogen bubble chamber was carried on. So far it led to interesting results on which more may be said later.

Facilities for vacation students have been announced by the Personnel Office. A limited number—about 30 in all—of vacancies for university and technical high-school students are available for the coming summer vacation period. Students selected will be required to contribute to the work of the group to which they will be assigned. Though they will receive no formal training they will be given every opportunity to learn about the work in their group and about CERN activities in general. The tenure of the appointments will be for periods of one to three months, during which students will be regarded as temporary staff members.

With deep regret, I must convey to the death of one af my close collaborators: staff of the Organization, the news of the J. R. MacCabe, CERN senior Public Information officer. I am certain all staff members, and particularly his many friends in CERN, will wish to join me in expressing the Organization's sympathy to his widow and family.

C. J. Bakker
Director-General

FAREWELL TO A FRIEND

Jack R. MacCabe

Jack R. MacCabe died in the morning of April 17. On this Easter day, when all the trees were in full bloom, none of us knew that we had lost a friend, up in the Rhône valley.

To many of us at CERN and to all at the Public Information Office, Jack MacCabe was more than just the Senior Information Officer. His humane approach to the problems of all kinds he had to deal with in his position, made him more a friend than a colleague.

Jack was born on May 4th, 1914 at Edmonton, Canada, where, in 1930, he entered the University of Alberta. Two years later he went to McGill University, Montreal, where, by 1937, he had taken his degrees of Bachelor of Science and Master of Science (natural sciences), while working as a demonstrator and lecturer in physiology at the University's Faculty of Medicine.

Jack MacCabe came to Europe soon after finishing at McGill and continued medical and biological studies and research at Munich University, up to the outbreak of World War II, in 1939. When he arrived in Switzerland, Jack found a position as a lecturer at the Ecole Internationale and at the Ecole d'Interprètes of the University of Geneva, where he remained until 1944. In the meantime, in 1942, he had been taken on the staff of the well-known aviation magazine "Interavia" where, in 1951, he became executive editor of the daily "Air letter".

Joining CERN in September 1955, Jack MacCabe worked for the Synchro-cyclotron Division until March 1956, when he transfered to the Scientific and Technical Services Division as Public Information Officer. When the Public Information Service was expanded and placed under the immediate supervision of the Director-General, on January 1st 1957, J. MacCabe became Senior Information Officer.

Jack devoted his considerable energy and intelligence to meeting the general desire of the public for further information about the Organization and to bringing CERN's achievements to the notice of all those in the press and in the public, who might not be aware of them.

Already stricken by a serious illness in the Spring of 1959, Jack had made a wonderful recovery. However, his health had recently shown signs of failing again and he had decided to take a short rest. We were all looking forward to seeing him come back in good health after his holiday. Unfortunately, heart failure robbed us of a friend and CERN of one of its most devoted staff members.

Jack is survived by his wife Hertha, also one of our CERN colleagues, to whom in this sad moment we extend our most heartfelt sympathy.

R. A.

Contents

«CERN COURIER»

is published monthly for the staff of the European Organization for Nuclear Research. It is distributed free of charge to members of the Organization, to scientific correspondents and to anyone interested in problems connected with the construction and operation of particle accelerators or in the progress of nuclear physics in general.

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The cover photograph shows, in the foreground, the large 25 GeV proton synchrotron ; the **inset picture** shows S. Minor inspecting the model of the 1 m propane bubble chamber which C. A. Ramm's group is now constructing.

General Services and

THE HOUSING PROBLEM

It is no easy matter to find a flat in the canton of Geneva, as most of our staff members know only too well. In this respect it may be interesting for staff members, visiting scientists, research associates and fellows to hear from the General Services of the Personnel Office (Housing Service) about some of the difficulties experienced daily in this field—as well as the measures envisaged for overcoming them.

Statistics are often despised, but a glance at them can be enlightening. The population of Geneva increases by 18 or 19 every day, taking into account arrivals and departures, births and deaths, but not counting seasonal workers.

The Rent Control Office of the City of Geneva and the Cantonal Housing Office, both run by the State of Geneva, have on file numerous request for accomodation. The exact number is unfortunately not known, but it can be estimated at about 2 500 for each of these offices. This figure, which varies according to different authorities, probably does not give an accurate picture of present requirements.

In spite of this depressing picture, every month, about 20 to 25 staff members and their families find flats through the CERN Housing Service, which would very much like to double this figure.

Where building is concerned, the great difficulty is to find sites at a reasonable price. On account of the growing demand in this sector, most landowners are holding on to their land in the hope of getting a better price. This policy encourages the profiteering fostered by such a situation where ever it arises. Many groups even seem anxious to slow down the building of blocks of flats or villas—which is already very expensive—in the hope that increased demand will maintain the price level and keep rents high.

However, it is hoped that in a few years' time prices will become steadier, in view of the drastic measures planned by the City of Geneva.

Where does CERN's housing service come into the picture to help the staff members ?

The Service collects information to give staff members as much help as possible in obtaining accommodation. The part it plays cannot be compared to that of a housing Agency because, unfortunately, it has no blocks of flats or funds at its disposal. Consequently it is rather difficult to get the desired results. In practice priority is given to new arrivals, but this does not mean that the Service neglegts the others. A factor which still complicates the situation is the fact that most staff members prefer accommodation on the right bank (on the Jura side of the Lake of Geneva), which reduces their chances by about 50 %.

It should be noted that CERN is the only international organization in Geneva which has had a Housing Service in operation for several years.

In an attempt to overcome the increasing difficulties, the Housing Service has explored every avenue likely to lead to the solution of these problems. As a result of contacts with personalities connected with the City of Geneva and representatives of building societies, various projects have been envisaged for the near or more distant future, including building blocks of flats at Versoix, Châtelaine, Meyrin, Grand-Saconnex and possibly Petit-Saconnex, and in France. CERN would then have considerable accommodation available for its staff.

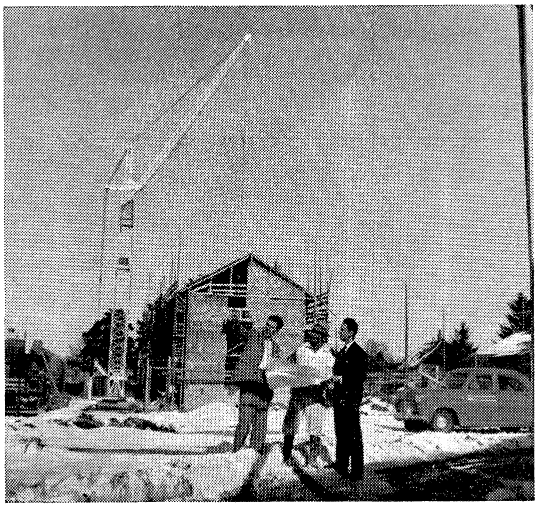
Percentage of vacant flats

Period	Total accomodation available in Geneva	% vacant
January 1958	68 845	0,0044
July 1958	69 764	0,028
December 1958	71 000	0,017
January 1959	71 452	0,016
July 1959	71 478	0,015
January 1960	72 204	0,017

However, neither these contacts nor the expansion of the Housing Service—which is, in any event, ruled out by the CERN budget—could entirely solve the housing problem for CERN staff members. Therefore it is encouraging to learn that during the last few weeks the Geneva authorities have been holding a serious enquiry, with special regard to the difficulties experienced by the staff of international organizations. Meetings have been held to decide upon emergency measures. At the first of these meetings Mr. Max Petitpierre, President of the Swiss Confederation, and the Directors-General of the main international organizations (including CERN) were present. Practical building schemes are being planned both in Geneva and in the frontier region.

Accordingly, it is hoped that things will improve during 1961 and that CERN staff members will no longer have the worries they have experienced in former years.

Until that time J. van der Meerschen and J.P. Chambon will do their very best ; all they ask is not to be expected to do the impossible.



To supply adequate housing for new staff members requires many special dispositions. Here, J. van der Meerschen (left) and J.P. Chambon discuss with a foreman the particulars of a building where several appartments are reserved for CERN staff.

The study of the components of the atomic nucleus, the elementary particles mentioned in the article "Fundamental Nuclear Research" (*), calls for equipment which is often cumbersome and always intricate. It is something of a paradox that the quest for knowledge of the infinitely small calls for increasingly large equipment.

Some of the equipment produce high energy particles, while the rest measures particles moving at the velocity of light or detects the events brought about in matter by the sudden irruption of these minute projectiles. To construct, test and exploit all these instruments, a host of experts in all branches of modern technique is necessary.

Such are the needs of a modern fundamental research laboratory.

The difficulty of exploring matter

The difficulty of exploring the innermost structure of matter, of defining the forces involved and the interactions between its fundamental particles, lies in the submicroscopic dimensions of the latter. The human eye can see nothing smaller than about seven thousandth of a millimetre. Even the most highly developed optical instruments are still limited on account of the wave nature of visible light. Nothing smaller than its wavelength (about 0.5 thousandth of a millimetre) can be perceived, and this is about five thousand times the diameter of an atom..., five hundred million times that of the nucleus.

Atoms and nuclei can be detected by beams of light with a wave-length shorter than that of visible light. Such short-wave-length forms of light, e.g. X-rays or gamma rays, can be emitted by high energy electrons hitting a target. The higher the energy, the shorter will be the wave-length of the rays. One example of the application of this technique is X-ray apparatus.

The light beam can also be replaced by a particle beam, since particles possess wave-like properties and a beam of light can be regarded as a particle beam. (*) Therefore, the wave-length of particle beams, which is in inverse ratio to their energy, enables us to examine infinitesimal details. The electron microscope resolves more detail than its optical equivalent because it uses an electron beam with a smaller wave-length than that of light to which our senses are accustomed. The image produced by an electron beam, or by a proton beam, differs from that given by visible light, because electron or proton radiation is invisible. Accordingly the electron image is projected on to a fluorescent screen or recorded on photographic plates.

However, a high energy particle beam probing the atom, or even the nucleus if its energy is sufficiently high, disturbs to some extent the system under observation. Therefore, while a partial view is obtained of the interior of the target, particles are freed or even created as a result of the impact of the beam. How do particles come to be created ? According to Einstein's equation, $E = m.c^2$, whereby the energy produced equals the particle mass multiplied by the square of the velocity of light, it is perfectly feasible to convert the mass of a particle into energy and vice versa.

The above remarks give an explanation of the creation of unstable particles, such as hyperons produced by the big CERN accelerator, or the pi mesons produced by its synchro-cyclotron. Channelled into secondary beams, these mesons can in turn be used to explore matter in the same way as primary beams of electro-magnetic waves, electrons or protons, or like secondary neutron beams.

Nuclear physicists thus have a basic means of studying the secrets of matter : the high energy particle beam. How is this beam obtained ?

How particle beams are produced

The first particle bombardment was carried out with alpha particles naturally emitted by radium. This discovery was the starting point of nuclear research and led to the discovery of artificial radioactivity and of nuclear energy which incidentally belongs to a field completely apart from that of CERN's activities.

The energy involved in alpha radioactivity—about 4 MeV—is much smaller than that of cosmic rays, which reach 10^{17} eV. But cosmic rays of such high energy are not frequent and therefore not freely available for specific experiments. The need for a high energy particle beam led the physicists to construct accelerating machines of increasingly high kinetic energy.

For several reasons, **accelerators** have developed as machines imparting increasingly higher energies to increasingly smaller quantities of particles. As charged particle movement constitutes an electric current, the current, or intensity, of the beam tends to decrease when the energy of the particle stream increases. To overcome this drawback, accelerators of relatively old design and comparatively low energy are still being constructed to obtain high intensity beams.

All accelerators consist basically of a source of particles to be accelerated and a high vacuum chamber in which the particles can move without too much risks of colliding with air molecules. Acceleration is achieved by giving the particles successive electric "kicks". The particles in the vacuum chamber are therefore kicked by electric accelerating fields and focused or kept on a given trajectory by magnetic fields.

Accelerators can broadly be subdivided into "linear" and "circular" machines.

Linear accelerators are themselves divided into high voltage and high frequency machines.

The first accelerator was of a high voltage type. **Cockcroft and Walton** used a Greinacher assembly to apply a high electric voltage to protons and accelerate them in a straight tube. Even though the energy given to the particles by this ingenious electrodynamic device was less than that of natural alpha radiation, it paved the way for more powerful accelerators based on the same principle and on others.

Another high voltage generator, the **Van de Graaff**, uses an electrostatic phenomenon. A belt of insulating material carries the electric charges and supplies the voltage used for the acceleration.

For technological reasons, the energy ceiling of these machines is about 1.5 MeV for the first and 6 MeV for the second.

In another type of linear accelerator, very high frequency waves accelerate electrons or protons. Such is the **linear accelerator** of the type used at CERN as a 50 MeV pre-accelerator for the big proton synchrotron. The maximum energy which is now reached with this kind of machine is about 1 GeV.

In circular accelerators, the shape of the vacuum chamber is determined by the particle trajectory. If its radius varies slowly, as in the cyclotron or the synchro-cyclotron, the chamber will have the form of a flat cylinder. If the radius of the trajectory is more or less constant, as in the betatron or the synchrotron, the vacuum chamber will be doughnut-shaped.

The **cyclotron** designed by Lawrence was the first circular accelerator. It includes a magnet between the poles of which is the vacuum chamber. This contains an ion source in the centre and two D-shaped accelerating electrodes called "dees" or Ds.

The particles emitted between these by the source subsequently come under two influences : the constant magnetic field and the alternating electric voltage fed to the dees. Positively charged particles—in the case of protons—are attracted to the negatively charged D, where the magnetic field gives them a semi-circular trajectory. When the particles are about to re-emerge from the D, the alternating voltage is reversed, the particles are repelled by the D which is now positive, and attracted by the other D which has become negative. The repetition of this process accelerates the particles. Their growing velocity makes them travel in circles

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(*) "CERN COURRIER" N° 4, November 1959.

The tools of the nuclear physicists

of ever increasing radius, until they are extracted, by means of a deflector, in the form of a beam of "projectiles".

The cyclotron pushes the energy up to about 100 MeV. This limit is due to the fact that the mass of the accelerated particles increases as a function of their energy. Accordingly the particles become dephased with respect to the rate of change-over of polarity of the accelerating Dees.

In the **synchro-cyclotron,** the oscillating frequency of the accelerating voltage decreases as the velocity of the particles increases. For the CERN synchro-cyclotron, the accelerating frequency thus decreases from 29.3 to 16.4 Mc/s (millions of cycles per second), and the maximum energy which can be given to the protons in this case is 600 MeV. The energy limit for this type of machine is about 1 GeV.

The **betatron** was the first accelerator with a variable magnetic field. In addition, the particles—always electrons in this case—are accelerated by the magnetic field on an orbit with a constant radius. The energy which this machine can impart to the particles reaches about 500 MeV.

The **synchrotron** has a circular vacuum chamber in which the particles move on a constant radius under the influence of a bending magnetic field, which rises as a function of the particles velocity. The frequency of the accelerating voltage can either be constant or variable. In the case of the big CERN **proton synchrotron,** the diameter of the vacuum chamber is 200 m and its cross-section 7 x 14 cm. In one second, the magnetic field varies from 147 to 12 000 gauss and the frequency from 2.9 to 9.55 Mc/s. The energy of the accelerated protons can thus reach 24.3 GeV ; it goes up to 28.3 GeV when a magnetic field of 14 000 gauss is available.

The CERN proton synchrotron is a "strong focusing" machine where the magnetic field has an alternating gradient that focuses the particles successively in the radial and vertical planes.

Other types of synchrotron exist : the electron synchrotron, which is a betatron with an accelerating cavity, and the weak focusing proton synchrotron.

The observation of nuclear events

A second group of apparatus for the nuclear physicists consists of **detectors,** without which it would be impossible to record or evaluate the movement and the interaction of the infinitesimal nuclear particles.

Most of the detectors are based on the principle of ionization. Ionization takes place when a neutral atom acquires an electric charge, for instance when an incident particle removes one of the peripheral electrons of an atom, which thus becomes an ion.

Proportional counters, like Geiger-Müller counters, consist of a gas filled tube with a positively charged wire running from end to end. If a particle goes through the counter, it ionizes the gas and causes an electric discharge between the electrodes. The pulse thus produced can be amplified and recorded on a mechanical counter. It then becomes possible to count the particles—e.g. with a Geiger counter—or to discriminate between them—e.g. with a proportional counter. In the **ionization chamber,** radiation intensity can be evaluated by measuring the current it induces. Proportional counters, Geiger counters and ionization chambers are therefore the means of determining the type, intensity and quantity of radiation emitted by a source.

Highly sensitive **photographic emulsions,** arranged so as to record in three dimensions the passage of an ionizing particle, can be developed and studied under the microscope. The photographs are mounted to show the trajectories on two planes. The traces thus obtained enable the physicists to study the mass and energy of the particles. When one of these strikes an atom of the photographic emulsion, it often produces a "star" or explosion of a nucleus of the emulsion, which can be studied to add to our knowledge of particles.

The scintillation counter combines the effects of luminescent phosphors with that of a photomultiplier tube. It detects ionizing particles through the emission of light as result of the absorption of the radiation by the phosphors. CERN uses many counters based on this principle.

The **Cerenkov counter** can discriminate between events happening within one thousand millionth of a second of each other. Its basic principle is that a charged particle crossing a material faster than light would do it in the same material, gives rise to a sort of shock light wave. Although scarcely perceptible, this radiation can be picked up, amplified by photomultipliers and used for fundamental research.

The **cloud chamber** shows particle tracks which can be compared in a way with the vapour trails left by aircrafts flying at high altitudes. Both aircrafts and particles are invisible but leave a tell-tale trail behind them. The gas in the cloud chamber is suddenly expanded and this produces a supersaturated vapour. Any charged particle crossing the chamber at that moment generates ions all the way along its track. Vapour droplets condense on these ions and indicate the track of the particle. Photographs taken under these circumstances reveal the nature of the nuclear projectile, its energy and the effect of any collision with atoms. When a magnetic field is applied to the chamber, as it is the case for the large chamber now constructed at CERN, the curvature of the tracks gives additional data on the energy of the particles.

The **bubble chamber** differs from the foregoing apparatus by its content, a liquid kept at appropriate temperature and pressure levels. When a charged particle crosses this, it leaves a trail of gas bubbles which can be photographed and interpreted, as in the case of the cloud chamber.

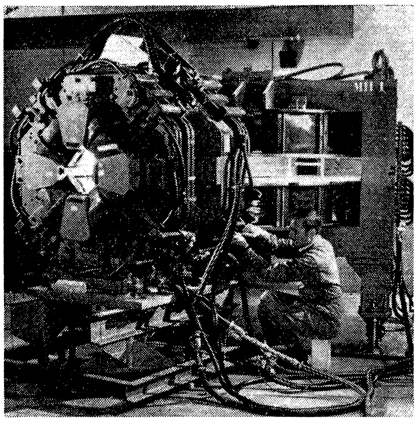
The liquid used is generally propane or liquid hydrogen. CERN has large chambers under construction or being designed, which will incorporate these two substances. These chambers, like the cloud chambers, will be placed in beams ejected from the accelerators.

Evaluation of data

Thousands of photographs are supplied by the bubble or cloud chambers during experiments.

Automatic apparatus, such as the CERN *"IEPs"*, help to evaluate them. The mass of information collected is then processed by electronic computers.

Discoveries come to light through this chain of intricate apparatus, and their importance is not always immediately apparent, even to those in the know. Spectacular or unimpressive, astounding or unexciting, these results help to swell the sum of knowledge which satisfies man's curiosity and improves his position in the universe ●



The b
enlarg

by R. S

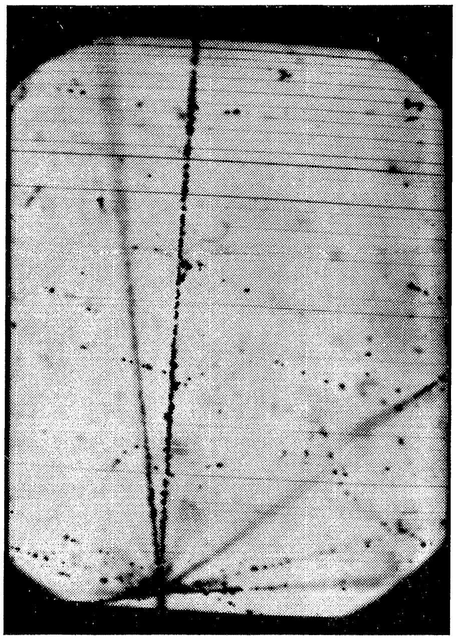
CERN Nuclear

The work at CERN deals with the smallest quantities of matter known, using the largest accelerating machine in the world. Speaking purely from a photographic point of view the enlargement which was used as a backcloth to the proton synchrotron inaugural ceremony typifies to a certain extent the extremes in size which are encountered at CERN.

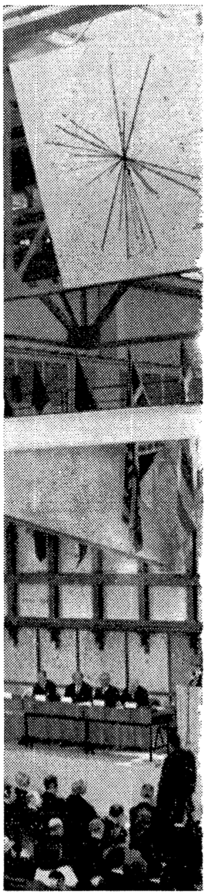
The photographic enlargement shows the interaction of an artificially produced 25 GeV particle from the PS, interacting with a bromine or silver nucleus. The size of the original interaction or "star" as seen through a microscope measures only some 200-300 μ (μ = micron ; 1000 micron = 1 mm). The size of the final enlargement, i.e. 3.5 x 3.7 meter, corresponds to a 14 000x enlargement of the original. This can be claimed to be the largest enlargement ever made of a photograph of an event in a nuclear emulsion.

The latent image of the star was produced in a 200 μ Ilford G5 nuclear emulsion which was exposed to a particle beam from the proton synchrotron on December 3, 1959. After processing, the emulsion was searched under a high power microscope and the event under discussion was found. In the field of view in the microscope the event is seen only in two dimensions for the depth of focus of a high power oil objective is only one or two micron. Thus to follow tracks which go up or down in the emulsion, it is necessary to move the objective up and down by means of the fine focusing screw. Similarly to photograph a dipping track it is necessary to photograph each part that is in focus at any one time. This is accomplished by placing a slit before the plate of the casette so that only the grains of the track actually in focus are recorded. Then the focus is changed, the position of the slit is altered so that the next part of the track is in focus, and so on.

Microplate photograph showing a two dimensional view of a particle track made up of 47 individual exposures on the same plate.
Other tracks can be observed disappearing, out of focus, into the emulsion (micro-exposures by A. Roberts).



A single track may be composed out of some 30 or 40 individual exposures according to the angle of dip into the emulsion. One of the adjacent figures shows a complete track on one negative made up of some 47 exposures, other tracks can be seen in focus at the centre of the star and gradually going out of focus. A. Roberts, who carried out the microphotography thus obtained some 26 plates, each showing one track in focus from start to finish.



Partial view of the
mony on February 5 1

An enlargement of about 1.5 time was then made of each plate. The next step was the construction of the mosaic. Each individually enlarged track was cut

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OTHER PEOPLES' ATOMS

U. S. High Energy Physics in 1959

In the United States the construction of particle accelerators is largely sponsored by the Federal Government, through the U. S. Atomic Energy Commission. The latest report (*) published by this organization gives interesting facts on the high energy physics situation in the United States. This report was the main source from which the information gathered in the following article was obtained. Further data on high energy accelerators will be found in a recent publication of CERN : "Data sheets and status reports on accelerating machines in the energy range of 1 GeV and above" (**), as presented at the International Conference on high energy accelerators and instrumentation at CERN, Geneva, 14 to 19th September 1959.

Ed.

In the foreseeable future, the U.S. Atomic Energy Commission's efforts in high energy physics will emphasize development and construction of additional and novel type accelerators, toward modifications, and improvement of existing machines in order to realize their research potential more fully, toward establishment of higher beam intensities as well as higher energies, and toward development of new experimental devices and techniques and the construction of better ancillary facilities.

The first accelerators in the billion electronvolt (BeV or GeV) range were constructed during the early 1950's, and by 1956 the United States had four synchrotrons in operation capable of accelerating electrons or protons to 1 BeV or higher, the most powerful being the Bevatron - a 6.2 BeV proton synchrotron

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(*) "Major activities in the Atomic energy programs" January-December 1959 - Published by the U.S. Atomic Energy Commission in January 1960 - Price $ 2.

(**) Available from CERN's Scientific Information Service, under the reference number CERN 60-4.

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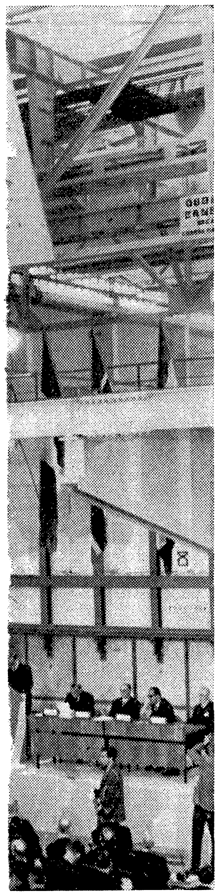
TERCHI

Emulsion Group

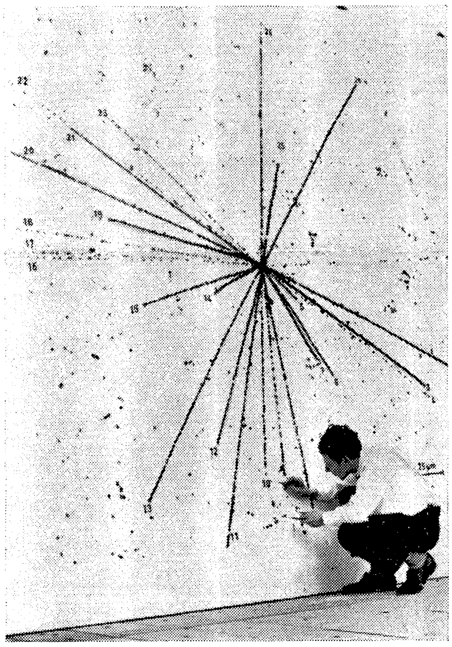
out and dry mounted on a sheet of white cardboard; great care was taken to reproduce the exact angles of the individual tracks. The final mosaic was then a two dimensional representation of the original three dimensional event in the emulsion. After the mosaic had been mounted it was rephotographed. The size of the new negative was then approximatively 40 x 40 mm, corresponding to a reduction in size of the mosaic by a factor of 10.

The enlargement displayed on inauguration day was made in the following way. The Council Chamber itself was converted into an "enlarger", the negative being projected from the back of the room on to a light sensitive screen mounted on a wooden frame measuring 4 x 4 m. This large composite sheet of enlarging paper was placed in front of the blackboard. Four strips each 1 meter wide and 4 meter long were joined into one large sheet. An exposure of 4 second was chosen so that the joins of the mosaic were not reproduced. The 16 m² sheet of photographic paper was then cut into eight individual sheets and processed separately. The processing had to be carried out in an extremely primitive manner. No large sinks were available while the "rolling" technique could not be used because certain parts of the exposed paper had to be "forced" or held back during the actual developing time. Sheets of hardboard with a 4 cm border and Scotch tape water proofing served as trays to hold the solutions; sponges, buckets and high pressure water jets were used as auxiliary apparatus. The entire processing looked very unprofessionnal; the scene resembled a dimly orange-lit laundry with several technicians walking around enveloped by 2 meter-long dripping wet "sheets" covered with black spots. The processed strips were laid out on the floor over-night to dry. The mounting on hardboard was done by a specialized firm in Geneva. The eight panels were then tacked to the stout wooden frame. Then began the painstaking work of retouching, requiring several days. Joints were filled with a special Araldite paste while the actual retouching was done with relatively large brushes using black and white water-soluble paint. After that came an extremely tricky hauling up onto the 30-ton travelling crane by the acrobatic team of SB firemen. Final retouching on the enlargement in its definitive setting was then done, this writer being perched on a swaying "beanstalk" some 40 feet above the floor of the PS south experimental hall.



PS Inauguration cere-
'60. (photo by the author).

Retouching the final enlargement (photo B. Sagnell).



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at the University of California Lawrence Radiation Laboratory, Berkeley. During the latter part of the 1950's design and construction of additional high energy accelerators progressed, and by 1962, one linear accelerator and four additional synchrotrons are scheduled to be in operation in the BeV range.

Stanford University

Mark III linear accelerator

Work is under way to extend the 220-foot long Mark III linear electron accelerator at Stanford University to 310 feet to allow operation at about 1.2 BeV. Built and operated for the Office of Naval Research (ONR) under the ONR-AEC joint programme of research in nuclear physics, this machine first went into operation at 350 MeV (million electronvolt) in December 1952 and at present produces electrons with energies up to 730 MeV.

Two-mile linear accelerator

Congress has before it for consideration a request for authorization to proceed with design and construction of a new high-energy electron accelerator at Stanford University. The machine would be of linear design, approximately 2 miles in length and in the initial stages would achieve an energy of 10-15 BeV. Design and construction would require about 6 years.

The average current delivered to the target would be approximately 30 microampere. The accelerator will be powered by 240 klystron tubes operating at a frequency of 2,856 megacycle per second. The accelerating tube is to be housed in a horizontal 10-foot wide tunnel which will be deep enough underground to provide the necessary shielding. A parallel tunnel, 24 feet in width, would contain the radiofrequency equipment and wiring. The two tunnels would be separated by 35 feet of earth so that personnel can service the equipment during accelerator operation.

The proposed accelerator would not require development of new basic components. The present Mark III linear machine at Stanford has been successfully operated for several years with energies as high as 730 MeV. To achieve a higher energy, a longer machine of the type already in operation is required. Previous performance indicates that 24-hour operation should be possible. It is planned to divide the 2-mile accelerator into 40 250-foot sections, which can be aligned and tuned individually during startup operations.

(Please turn over)

OTHER PEOPLES' ATOMS

(Continued from pages 6 and 7)

U.S. High energy accelerators presently in operation

Machine	Particle	Energy Bev	Location
Synchrocyclotron	Proton	0.240	Univ. of Rochester
Synchrotron	Electron	.300	Univ. of California
»	»	.300	General Electric Co.
»	»	.300	Mass. Institute of Tech.
»	»	.300	Purdue University
Betatron	»	.300	Univ. of Illinois
Synchrocyclotron	Proton	.400	Columbia University
»	»	.440	Carnegie Inst. of Tech.
»	»	.450	Univ. of Chicago
»	»	.740	Univ. of California
Linear Accelerator	Electron	.7	Stanford University
Synchrotron	»	1.5	Cornell University
»	»	1.2 - 1.4	Calif. Inst. of Tech.
» (Cosmotron)	Proton	3.0	Brookhaven Natl. Lab.
» (Bevatron)	»	6.2	Univ. of California

U.S. High energy accelerators presently under construction

Machine	Particle	Energy Bev	Location	Completion expected
Synchrotron (PPA)	Proton	3	Princeton-Penn (N.J.)	1960
Synchrotron (ZGS)	Proton	12.5	Argonne Natl. Lab	1962
Alternating-gradient synchrotron (AGS)	Proton	25-30	Brookhaven Natl. Lab	1960
Synchrotron (CEA)	Electron	6	Harvard-MIT,Cambridge	1960

Several sections can be inoperative (by klystron failure, for example) without affecting operations of the accelerator as a whole.

Initial operation of the klystrons is planned at a level of 6 megawatt, which would give a beam of 10 BeV electrons. With present day techniques, klystron power can be increased to give a beam of 15 BeV. The tunnels, waveguides, accelerator tube, and power facilities are being planned so that at a later date the beam energy can be increased further to 45 BeV, if developments in high energy physics then make a higher energy electron beam desirable.

The proposed linear electron accelerator would provide at 10 BeV the highest energy electron beam in the world. Its average current of 30 microampere is approximately 50 times greater in intensity than can be attained with a circular electron machine.

Brookhaven National Laboratory

Progress in the Cosmotron repair

The 3 BeV Cosmotron at BNL was brought back into test operation after having been under repair for more than a year. Pulsing test started in February, and the experimental programme has been resumed with a full series of experiments in early 1960. The newly designed shielding has been completed.

Total shutdown time was minimized by the fact that the repair work was carried out concurrently with previously authorized extensive construction activities designed to expand and improve the auxiliary equipment and other experimental facilities and areas centred around the accelerator.

The improvements are designed to permit a major portion of future experiments with high intensity external proton beams (as many as 10^{12} protons per pulse), since past experience has shown that external beams have many advantages over internal beams, and make possible some additional types of experiments.

Brookhaven's AGS

Progress on construction of the 25 to 30 BeV Alternating Gradient Synchrotron (AGS) at Brookhaven National Laboratory continued approximately on schedule with plans for systems testing by early 1960. The AGS is estimated to cost about $ 31 million (about 145 million Swiss francs).

All 240 magnet sections have been positioned radially around the ring, having undergone the necessary magnetic testing. The main magnet power supply, which required six railroad flatcars to deliver, now is installed and is' undergoing tests. Initial pulsing of the synchrotron magnets at one-quarter voltage (1 500 volt) has been conducted, and no undesirable performance characteristics, such as high transient voltages, have been observed.

Progress continued on the linear accelerator particle injector. All 124 drift tubes have been machined to the final contour, and now are being installed in the linac tank and undergoing precision alignment. The Cockcroft-Walton pre-injector for the linac has been completed, and in its first acceleration a one milliampere, 750 KeV ion beam was obtained. Subsequent system modifications resulted in a beam output of up to four milliampere.

The 13 (12 operating and 1 spare) radiofrequency power amplifiers for the AGS have been delivered. The ferrite-loaded accelerating cavities have been assembled and positioned around the ring. All vacuum pumps have been received, tested and accepted.

Princeton-Pennsylvania Proton Accelerator (PPA)

The Commission is supporting construction of a 3 BeV proton synchrotron at Princeton N.J. as a joint venture of Princeton University and the University of Pennsylvania. The Princeton-Pennsylvania Proton Accelerator, scheduled for completion by the end of 1960, will be similar to the Cosmotron at Brookhaven National Laboratory, but is designed to provide a much higher number of protons per second in its beam, largely because of its higher pulse rate. It is hoped to achieve a total increase in current by a factor of a least 100 as compared with the Cosmotron. The higher intensity beam will make possible experiments on nuclear events that occur too rarely for successful study in the lower intensity machine.

The completely shielded building for the accelerator is finished. Prototypes of the radiofrequency cavities, magnets, and magnet power supply have been operated successfully. The design of all components has proceeded satisfactorily and is virtually complete. All major components are on order and many have been delivered.

Cambridge Electron Accelerator (CEA)

A 6 BeV electron synchrotron scheduled for completion in the spring of 1961, is being built with Commission support at Cambridge, Mass., as a joint effort between Massachusetts Institute of Technology and Havard University.

This accelerator will provide one of the highest energy electron beams in the world. Since energy loss by electrons in circular orbits increases rapidly with energy, CEA is believed to be close to the ultimate that can be economically achieved with circular electron acceleration. The interactions of electrons with nuclear matter and strange particles are weaker than those of the protons, but high energy electrons have the advantage that by using them as probes, pure electromagnetic interactions can be studied at short distances.

The energy available for reactions with 6 BeV electrons is the same as for 9.5 BeV protons. The average beam current in CEA will be considerably higher than that in the Bevatron at Lawrence Radiation Laboratory; hence it is expected that comparatively large numbers of strange particles will be produced despite the weaker interaction of electrons as compared to protons.

Because of the rapid energy loss of energetic electrons, the radio-frequency system must provide very high accelerating voltages. Various cavity designs have been tested and the problems are being solved. The CEA linac injector is under construction.

Annual high energy physics support by various U.S. Government Agencies based on existing or authorized Accelerators

(In thousands of dollars)

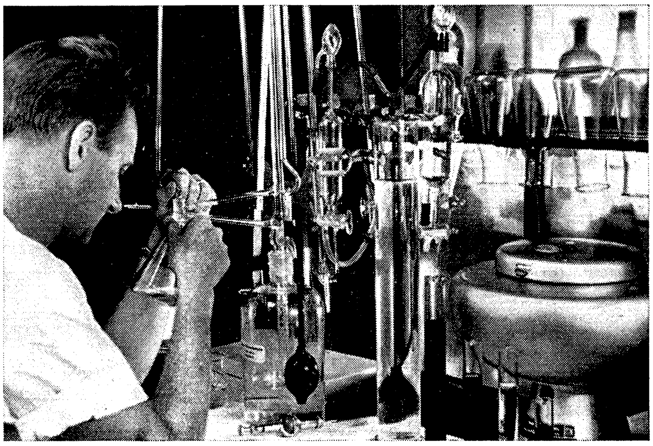
Fiscal year	Atomic Energy Commission		Office of Naval Research	Office of Scientific Research	National Science Foundation	Total
	Operating	Construction				
1946	—	—	3 900	—	—	3 900
1947	—	500	4 000	—	—	4 500
1948	3 400	600	2 400	—	—	6 400
1949	4 800	1 600	2 200	—	—	8 600
1950	3 400	7 500	1 600	—	—	12 500
1951	5 900	4 100	3 300	—	—	13 300
1952	6 300	1 700	1 600	—	—	9 600
1953	7 600	2 300	2 400	—	—	12 300
1954	7 400	1 900	1 800	270	80	11 400
1955	8 300	1 600	1 500	320	280	12 000
1956	10 200	3 200	1 600	610	220	15 800
1957	16 200	7 000	2 000	930	180	26 100
1958	19 100	12 900	3 300	1 000	210	36 500
1959*	27 700	26 300	3 300	865	400	58 600
1960*	36 600	20 500	3 600	950	700	62 400
1961*	45 900	19 000	4 000	1 150	1 000	71 100
1962*	53 700	18 800	4 400	1 250	1 500	79 700
1963*	60 500	9 000	4 800	1 550	2 000	77 900

* Estimated.

Argonne's Zero Gradient Synchrotron

Design work on the 12.5 BeV Zero Gradient Synchrotron (ZGS) at Argonne National Laboratory, scheduled for initial operation in 1962, proceeded satisfactorily.

Groundbreaking ceremonies on June 27, 1959, signaled the start of construction. The foundations for the synchrotron ring magnet and the 50 MeV linear accelerator that will inject protons into the synchrotron, are scheduled for completion in the spring of 1960. The shop and assembly building and the laboratory and office building are scheduled for completion in the summer of 1960. Contracts for the major components of the injector system have been let; bids for the ring magnet power supply have been received and are being evaluated. Final prototypes of the ring magnet coil and vacuum chamber were nearing completion at the end of the year, and fabrication is expected to start early in 1960. The water-cooling systems for main components are in the design stage, with construction to start in 1960.



Below is a view showing the inside of the tunnel housing the alternating gradient synchrotron at Brookhaven National Laboratory. A few of the 240 units of the electro-magnet can be seen. The picture was taken during the early radial positioning of the magnet units. On the right is one of the 24 survey monuments installed by the "U.S. Coast Guard and Geodesic Survey". Two members of CERN's PS Division, M. J. B. Adams and Dr. P. M. Lapostolle, visited Brookhaven in March—April. At that time the constructors of the AGS were finishing positioning the magnet units, while tests were being conducted to apply the high frequency power to the linear accelerator. It is expected the machine may accelerate its first beam about August or September.

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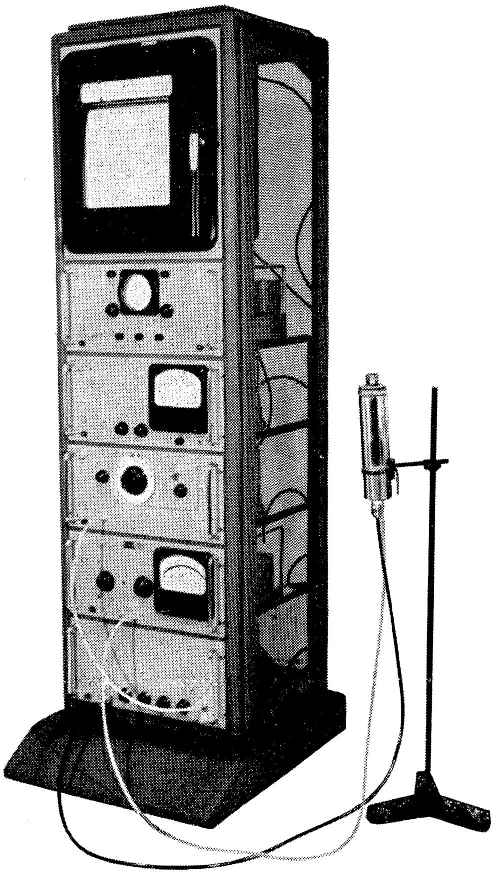
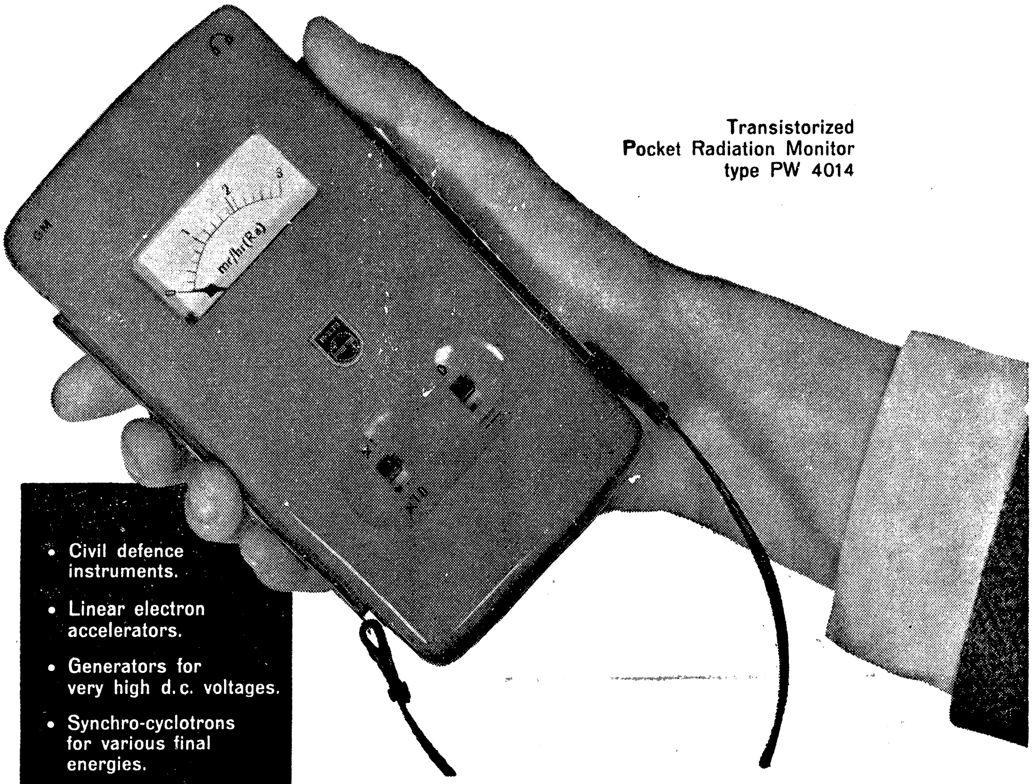


Recording Spectrometer - SPI 3

- Completely automatic scanning and recording of gamma ray energy spectra.
- Alpha, beta, gamma interchangeable scintillators.
- Triggered sweep control oscilloscope.
- Independent functional elements.
- Great stability.
- Strip chart recording.
- Resolution 8 to 10 % at 0,661 MeV.
- Threshold from 2 KeV to 6 KeV.

Other Activities

- 60 channel pulse height analyser with magnetic core memory - SAM 60.
- Amplifiers.
- Ratemeters.
- Fast neutron detectors.
- Proportionnal counters.
- Transistorized scalers.
- 2 π and 4 π counters.



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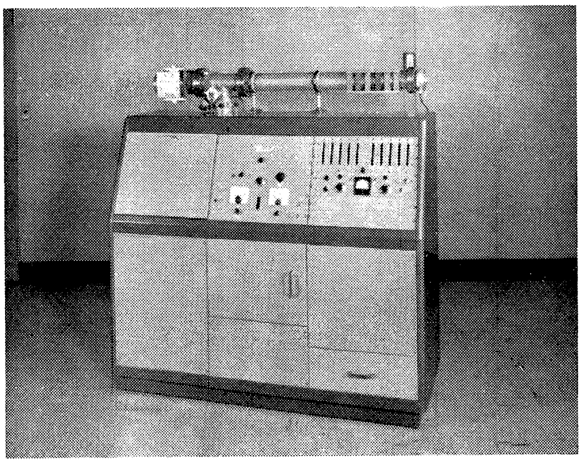

Bendix

Time-of-Flight Mass Spectrometer

● The direct combination of a time-of-flight mass spectrometer, which scans a mass range from m/e = 1 to m/e = 6000 at the rate of 2000 times per second, with a gas-liquid partition chromatographic apparatus results in an instrument capable of rapidly and completely characterizing organic chemical mixtures boiling below 350 ° C.

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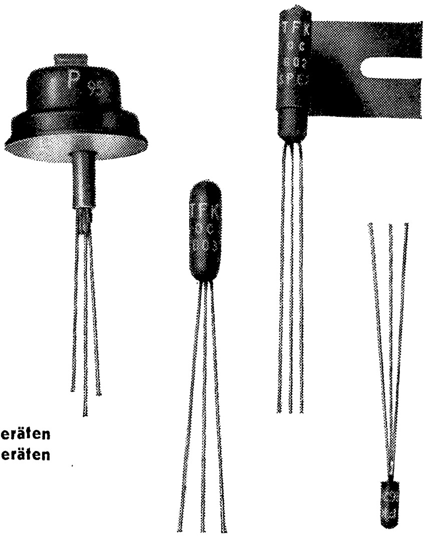
Telefunken-Halbleiter
P-N-P-Flächentransistoren



OC 602	NF-Transistoren mit 50 mW Verlustleistung
OC 603	Kennzeichnung des Verstärkungsfaktors durch
OC 604	Farbpunkte
OC 602 spez.	Schaltransistor
OC 604 spez.	NF-Transistor für Gegentakt-B-Stufen (Sprechleistung 700 mW)
OC 612	HF-Transistor für ZF-Stufen (470 kHz)
OC 613	HF-Transistor für Mischstufen in Mittelwellengeräten
AC 105	HF-Transistor für ZF-Verstärker (10,7 MHz)
OC 614	HF-Flächentransistor für Vor- und Mischstufe in KW-Geräten
OC 615	HF-Fläshentransistor für Vor- u. Mischstufe in UKW-Geräten
OC 622	NF-Subminiatur-Transistoren mit 30 mW
OC 623	Verlustleistung für Kleinstgeräte
OC 624	Kennzeichnung des Verstärkungsfaktors durch Farbpunkte
OD 603	Leistungstransistor, Verlustleistung 4 W

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