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Contents

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The cover photograph shows Roland Frachet, of CERN's Track Chambers Division, engaged in tightening the flanges that seal the windows on the camera side of the safety cold tank of the new 2-metre liquid-hydrogen bubble chamber. The picture was taken during the last stages of assembly prior to the first cool-down of the chamber last December. Around the edge of the vacuum tank are the large studs on to which the cover plate is fixed; the latter also contains six double windows through which the cameras can view the inside of the bubble chamber.
Further pictures, taken during the critical first run of the chamber, can be seen on pp. 24 and 25 of this issue.

CERN COURIER

is published monthly in English and in French. It is distributed free of charge to CERN employees, and others interested in the construction and use of particle accelerators or in the progress of nuclear physics in general.

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The European Organization for Nuclear Research, more commonly known as **CERN** (from the initials of the French title of the original body, 'Le Conseil européen pour la Recherche nucléaire', formed by an Agreement dated 15 February 1952), was created when the Convention establishing the permanent Organization came into force on 29 September 1954.

In this Convention, the aims of the Organization are defined as follows:

> **'The Organization shall provide for collaboration among European States in nuclear research of a pure scientific and fundamental character, and in research essentially related thereto. The Organization shall have no concern with work for military requirements and the results of its experimental and theoretical work shall be published or otherwise made generally available.'**

Conceived as a co-operative enterprise in order to regain for Europe a first-rank position in fundamental nuclear science, CERN is now one of the world's leading laboratories in this field. It acts as a European centre and co-ordinator of research, theoretical and experimental, in the field of **high-energy physics,** often known as **sub-nuclear physics** or the **physics of fundamental particles.**

High-energy physics is that front of science which aims directly at the most fundamental questions of the basic laws governing the structure of matter and the universe. It is not directed towards specific applications – in particular, it plays no part in the development of the practical uses of nuclear energy – though it plays an important role in the education of the new generation of scientists. Only the future can show what use may be made of the knowledge now being gained.

The laboratory occupies an area of 41 hA (100 acres) at Meyrin, Canton of Geneva, Switzerland, next to the frontier with France. A similar area on adjacent French territory is expected to be taken over shortly.

Its main experimental equipment consists of two large particle accelerators:
– a 600-MeV synchro-cyclotron,
– a 28 000-MeV (or 28-GeV) proton synchrotron,
the latter being one of the two most powerful in the world.

The CERN staff totals some 2000 people.

In addition to the scientists on the staff, there are nearly 300 Fellows and Visiting Scientists, who stay at CERN, either individually or as members of visiting teams, for periods ranging from two months to two years. Although these Fellows and Visitors come mainly from universities and research institutes in the CERN Member States, they also include scientists from other countries.

Thirteen Member States contribute to the cost of the Organization, in proportion to their net national income:

Austria (1.95%)	Italy (10.78%)
Belgium (3.83%)	Netherlands (3.92%)
Denmark (2.07%)	Norway (1.47%)
Federal Republic of Germany (22.74%)	Spain (2.18%)
	Sweden (4.23%)
France (18.57%)	Switzerland (3.19%)
Greece (0.60%)	United Kingdom (24.47%)

Poland, Turkey and Yugoslavia have the status of Observers.

The budget for 1965 amounts to 128 760 000 Swiss francs (= $29 800 000), calling for contributions from Member States totalling 126 400 000 Swiss francs (= $29 300 000).

A supplementary programme, financed by eleven states, covers design work on two possible future European projects in high-energy physics – intersecting storage rings for the 28-GeV accelerator at Meyrin and a 300-GeV accelerator to be built elsewhere ●

Last month at CERN

CERN/PI 155.1.65

Neutrino Conference

From 20-22 January, 1965, CERN was once again the centre for an international gathering of scientists, on the occasion of an 'Informal conference on experimental neutrino physics'. For the historically minded, this was said to be the first international neutrino conference ever to be held; at all events it enabled scientists working in a number of different fields to meet and compare notes at first hand. The conference was a small one, and informal both in the sense that participants were mostly invited on a personal basis and because rather more time than usual was allowed for discussion, even during presentation of the papers. About forty participants came from outside CERN, from universities and research institutes in Belgium, Federal Republic of Germany, France, India, Italy, the United Kingdom, the U.S.A. and the U.S.S.R., the largest number coming from the U.S.A. The great interest that the conference aroused among physicists at CERN, however, brought the attendance up to over 100 at most sessions.

One of the most interesting aspects of the conference was that it brought together scientists working in three distinct fields of neutrino physics — those endeavouring to detect neutrinos of extraterrestrial origin, or produced by the interactions of cosmic rays in the upper atmosphere, those utilizing the neutrinos emitted by nuclear reactors and those (as at CERN) who experiment with high-energy neutrinos obtained with the help of particle accelerators. A report on the conference will be included in the March issue of *CERN COURIER*.

PS operations

Starting up again after the Christmas and New Year holidays, the proton synchrotron began operation one day earlier than usual ('Machine Development' on Tuesday instead of Wednesday), in order to allow time for a more comprehensive set of measurements of the muon flux (number per square centimetre per second) in the neutrino shielding. Some measurements last September had been found difficult to reconcile with those expected on theoretical grounds, and

CERN's new CDC 6600 computer arrived by air from the U.S.A. late in the afternoon of Thursday 14 January. In this photograph, some of the units are seen being unloaded from the aircraft at Cointrin Airport, before beginning the last stage of their journey to Meyrin. Re-assembly of the equipment in its new building began on the Friday morning and power was switched on on the following Monday. At the end of January, Fortran test programmes were being run on the computer.

the new results have now confirmed that the shield could be shortened by approximately three metres without decreasing its effectiveness. This would allow the neutrino detectors to be brought that much closer to the target, thereby increasing the neutrino flux passing through them. Possible improvements in the design of the shielding were also suggested by the results.

Apart from the usual nuclear chemistry exposures, the rest of this fortnight was devoted mainly to six counter experiments working in the different beams. Among these, the 'Paplep' group carried out a check on the stability of their new electron detectors and set up all the electronics for the latest version of their equipment. This is intended to detect and distinguish between pairs of muons, electrons or gamma rays, from the annihilation of antiprotons, all in the same run, whereas previously the results for electrons and muons were obtained separately. The CERN/ETH group took about 100 000 pictures in the d_{18} beam and the CERN/Ivry group an equal number in the a_7 beam. In the c_8 beam, the sonic spark chambers coupled to the SDS 920 computer recorded about 650 000 'triggers' (corresponding to probable useful events) for proton-proton scattering at small angles and another 100 000 for proton-copper and proton-lead scattering. Using the b_7 beam in the South hall, the group investigating the decay of the neutral kaon continued to collect data (see summary of early results on pp. 20-21 of this issue). A new counter set-up was tested in the q_3 beam, as well as a system of current-measuring spark chambers of the Charpak type (mentioned in connexion with the cover photograph of the September *CERN COURIER*, 1964). This beam could only be operated for part of the time, however, because it was also desired to make flux and background measurements with the k_4 beam and there are insufficient generators in the South target area to power all six beam lines at the same time.

During the second fortnight, the main experiments were with bubble chambers: the 81-cm Saclay/Ecole Polytechnique chamber in the k_4 beam and the 152-cm British chamber in the o_2 beam. As usual, some of the counter experiments continued to collect data or test equipment, using part of the accelerated proton beam on the targets supplying their secondary beams. The first few days of operation with the o_2 beam were devoted to tests of the radiofrequency-separator system, with the success already announced.

Among other work in the PS Division, life tests were begun on the two septum magnets for the ejected beams to be installed in the East experimental area. It is hoped to install one of the magnets during a shut-down in June/July and the other probably at

No fifth force?

Early in February the preliminary results were made known of the CERN experiment to investigate the decay of the K^0_2 meson into two pions*. The experiment, which was proposed last September and began its first run at the synchrotron three months later, was designed to discover more about this highly unexpected mode of decay, found at Brookhaven last year, and in particular to see whether it could be explained by the existence of a new force of nature, much weaker than gravity (see *CERN COURIER*, vol. 4, p. 118, September 1964).

The K^0 meson, in effect, provides an extremely sensitive 'natural' detector of such a force, because of the 'interference' effects that would be produced if it existed. When a piano tuner uses a tuning fork to get a perfect result, he listens for the 'beats' — a periodic rising and falling of the sound — that occur when the fork and the piano string are sounded together. Their presence shows that the fork and string do not have exactly the same frequency of vibration, and the frequency of the beats tells the tuner by how much the two differ. The tuning fork could also produce beats by itself, if both its prongs did not vibrate at exactly the same frequency, and the presence of such beats would be an accurate indication of some difference between the two prongs — a difference of mass, perhaps. In an analogous way** the K^0_2 meson might be considered as a tuning fork in which one prong was the K^0 particle, the other the $\overline{K^0}$ antiparticle. If particle and antiparticle had exactly the same mass, then the 'sound' produced by combining the particle and antiparticle waves would be detected as K^0_2 mesons. If there was the slightest difference in mass, 'beats' would be detected as K^0_1 mesons. Such a difference in mass could be caused by a force that acted differently on particles and antiparticles, and the laboratory detection of K^0_1 mesons in a beam of K^0_2 mesons in fact provides an extremely sensitive method of searching for such a force. In fact, it was shown in this way rather more than four years ago (M. L. Good; *Physical Review*, vol. 121, p. 311, 1 January 1961) that antiparticles could not have negative mass, that is they were not subject to 'antigravity'.

The existence of antigravity would have meant that the K^0_2 could scarcely exist; the effect would have been very great. The discovery that the K^0_2 could sometimes decay into two pions was puzzling because it did not happen very often. If the so-called CP conservation was a false assumption in the theory, why was it disproved only a few times in every 1000 decays? To many physicists, a more acceptable explanation was that some unknown force, hitherto undetected, was acting on the K^0_2 system in such a way as to produce 'beats' of K^0_1 mesons, the observed pairs of pions then being due to the normal decay of the K^0_1. This idea was first put forward by J. S. Bell and J. K. Perring, and independantly by J. Bernstein, N. Cabibbo and T. D. Lee. They showed that if there was a universal, long-range force, analogous to the electromagnetic force but acting on the 'hypercharge' rather than the charge, then its action on particles would be opposite to that on antiparticles — in effect the mass of one would be increased and that of the other decreased. Such a force had to be a vector force, propagated by 'hyperphotons', analogous to the well-known photons of the electromagnetic field, particles with one unit of spin. Most interesting experimentally was the fact that its effects would be proportional to the square of the energy of the K^0_2.

* X. de Bouard, D. Dekkers, B. Jordan, R. Mermod, T. R. Willitts and K. Winter; P. Scharff, L. Valentin and M. Vivargent; M. Bott-Bodenhausen: Two-pion decay of K^0_2 at 10 GeV/c, **Physics Letters**, vol. 15, no. 1, 1 March 1965.

**This analogy comes from Prof. T. D. Lee.

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the end of the year. The fast-ejected beam in this area will initially use the same kicker magnet as the beam in the South hall, but a powerful new one is being developed and orders have recently been placed for its power supply. This new magnet will have an aperture sufficiently large for it to be left permanently in position inside the vacuum chamber, instead of having to be moved into place at the correct instant in each acceleration cycle. Power will be supplied to it in two ways, one providing for repeated ejection of one bunch of protons every 30 milliseconds, the other causing the whole circulating beam (20 bunches) to be ejected in the time of one revolution, that is, in just over 2 microseconds.

The magnet of the new CERN 2-metre liquid-hydrogen bubble chamber was also given its final test during this time. It needs an electricity supply capable of providing 6 MW (10 000 A at 600 V) and uses 140 000 litres per hour of cooling water to limit the temperature rise to 30° C.

Shut-down at the SC

After a successful year, during which the synchro-cyclotron was not only available for physics experiments for about 96% of the scheduled time but also supplied beams to several experiments in parallel for a large fraction of this time, the machine was shut down for a major overhaul at Christmas. Included in the work carried out then was the installation of a new secondary radiofrequency system for slow ejection of the accelerated proton beam, an injector magnet for the muon channel, and extensive tests and repairs of the main field coils. At the same time, improvements were made to the vacuum system and to the ion source.

The shut-down, which was planned to end in mid-February, was expected to be followed by two weeks of testing and running-in of the new installations, before embarking on a demanding programme of major experiments in the field of meson physics and the physics of nuclear structure.

New welfare office

An enquiries and staff-welcome office was added in January to the services provided by the CERN Welfare Section. Its main purpose is to give information to all those working at CERN, particularly newcomers, and their families, on such matters as: doctors, lawyers, tradesmen, etc., speaking various foreign languages; educational facilities and vocational guidance; nurses and family helps in cases of emergency; baby sitters; language courses, clubs, use-

The experiment at CERN is being carried out by a group with members from CERN and the 'Institut du Radium' at Orsay (France). Their apparatus is similar to that used by Christenson *et al.* at Brookhaven, but more adapted to the accurate identification of the decay products of the K^0_2 meson. The principal aims are:

1. To resolve any doubt about possible regeneration of K^0_1 mesons by matter in the beam, by recording the decays that occur in a region in vacuum rather than in helium (which was used at Brookhaven), and to identify the decay particles.
2. To search for an energy-dependence of the two-pion decay rate, by measuring the rate for kaons with an average momentum of about 10 GeV/c and comparing it to the Brookhaven result at 1.1 GeV/c.
3. To search for any other unknown weak forces that might show themselves.

A neutral beam is obtained from one of the internal targets in the proton synchrotron, by deflecting all charged particles out of the path by means of a magnet. Gamma rays are also largely eliminated by converting them into electron/positron pairs. The beam travels some 50 metres to the detection apparatus, the last 30 metres of the path being in a vacuum tank, and this distance is more than sufficient to ensure that all K^0_1 mesons present in the original beam have decayed, leaving a pure beam of K^0_2 (apart from other neutral particles which are either undetected or whose effects have to be eliminated during analysis of the experimental data). The detection system, which accepts decay particles from a certain specified volume of the beam, consists of an array of spark chambers, scintillation counters, a bending magnet, a threshold gas Cherenkov counter and an iron absorber 1-m thick. By this means electrons and muons from the normal decay of the K^0_2 into three particles can be identified.

The spark-chamber films are measured by an automatic machine installed at Orsay and the readings from the films, together with the records given by other counters in the detection system, are analysed by computer. The calculations are quite complicated, partly because the energy of the incoming K^0_2 mesons is not known, so that identification of each K^0_2, as well as its momentum, has to be obtained from measurements on the decay products.

Only the results from the first runs are available so far, and the experiment is still running at the PS during February, but they are sufficient to show that the proposed vector force cannot exist. If this force had the properties predicted for it, the number of two-pion decays detected in the CERN experiment would have been about 80 times higher than that actually obtained. The preliminary value for the fraction of two-pion decays, compared to all other decays into charged particles, is $(3.5 \pm 1.4) \times 10^{-3}$, which in fact is about the same as the value $2.0 \pm 0.4) \times 10^{-3}$ found at Brookhaven.

Thus the K^0_2 clearly decays into two pions, either directly or because of something that changes it first into a K^0_1. One possible explanation has been ruled out, but others have been put forward and remain to be explored, both in the current experiment and in future ones.

Certainly any other kind of 'fifth force' would be extremely feeble. Even these preliminary results show that if there is a difference between the mass of the K^0 particle and that of the $\overline{K^0}$ antiparticle it is less than 2 million million millionths (2×10^{-18}) of the kaon mass. It follows that the 'gravitational' mass and the 'inertial' mass of any body are also equal, to this order of magnitude, giving an extremely accurate proof of the equivalence principle of Einstein's general relativity theory ●

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ful institutions, etc.; and public services. An additional service, that will no doubt be appreciated by the many people who arrive at CERN with little knowledge of the French language, will be provided by the drafting of letters in the accepted form to any official or other organizations with whom the newcomer might have to deal.

Visitors to CERN

On Tuesday 5 January, CERN was visited by the new British Government's Minister of State for Education and Science, **Lord Bowden.** He was accompanied by his daughter, Miss Virginia Bowden, and by two Members of the CERN Council, Dr. J. B. Adams and Mr. R. St. J. Walker. Lord Bowden is better known in the U.K. as the Principal of Manchester College of Science and Technology. Earlier in his career he studied physics under Rutherford and afterwards worked successively on radar and computers, so that he found much to see of particular interest at CERN. The visit in fact lasted much longer than originally planned, with a great deal of time being spent in detailed discussion of the designs for intersecting storage rings and a 300-GeV accelerator.

Later in the month, on Monday 18 January, CERN received the Head of the Permanent Delegation of the U.S.S.R. to the United Nations Organization in Geneva, **Mr. N. Moliakov,** together with Mr. E. Pavlov, second Secretary, and Mr. G. A. Smirnov. One of their guides was Dr. V. Kaftanov, from the Institute of Theoretical and Experimental Physics in Moscow, who left CERN at the end of January after spending about 18 months with the spark-chamber group on the neutrino experiment.

The visits of Lord Bowden and Mr. Maliakov are typical of many others by people who are particularly involved in the affairs of International Organizations. Last November, for instance, CERN received **Mr. F. T. Wahlen,** head of the Swiss 'Departement politique fédéral' and the **Foreign Affairs Committee** of the Federal Parliament (Thursday, 26) as well as **Mr. R. Isaacson,** British Ambassador at Bern, and Mr. Wiltshire, Consul General in Geneva, with their wives (Wednesday, 4) and Mr. M. Barthour, Israeli Ambassador at Bern (Friday, 27). On 12 September, 1964, CERN was visited by the **Finance Committee of the Norwegian Parliament,** whilst earlier that month, one of the many visitors welcomed during the U.N. Conference on the peaceful uses of atomic energy was **Dr. H. Lenz,** Minister for Scientific Research in the Federal Republic of Germany, together with his wife, Prof. and Mrs. Brandt, and Dr. Pretsch ●

28th Session of CERN Council

The customary end-of-year meeting of the CERN Council was held on 15 and 16 December 1964, in the Council Chamber at Meyrin, under its President Mr. J. H. Bannier, of the Netherlands.

HOMAGE TO FORMER GREEK DELEGATE

Before beginning their formal business, the delegates stood in tribute to Prof. N. Embiricos, who had died suddenly on 15 November. Prof. Embiricos was for many years one of the Greek delegates to Council and his signature appears on the Convention establishing the Organization.

Six months of progress

An early item on the agenda was the presentation by the Director General of the Progress Reports of the Divisions for the preceding six months*. Notable advances had been made on the instrumentation side of the Laboratory since the previous Council Session, and, in particular, Prof. Weisskopf was able to announce the successful operation of the CERN 2-metre bubble chamber. The proton synchrotron had reached a beam intensity of 10^{12} protons per pulse in July, and had been operated for long periods at around this intensity many times since. The accelerator was more reliable and had fewer breakdowns than others and was undoubtedly, at the present time, the best in the world. Another field where CERN was leading was that of radiofrequency particle separators. In the field of data evaluation the HPD (Hough-Powell Device) was being used for the automatic evaluation of photographs from a bubble-chamber experiment, in addition to its earlier use for spark-chamber photographs. Luciole, the other automatic device for analysing spark-chamber photographs, was also in operation.

Among the scientific achievements of the Laboratory, Prof. Weisskopf drew attention to the results of the first stage of the neutrino experiment, pointing out that it was almost as important to know that the so-called W particle, even if it exists, could not be produced with present-day equipment as it would have been to have discovered the particle itself. CERN was now a leading centre in the discovery and investigation of new 'resonances' and similar phenomena, according to Prof. Weisskopf. The team investigating high-energy proton-proton scattering had discovered, in common with other laboratories, the very interesting phenomenon of a 'real scattering amplitude'. Results from the experiment to investigate the electron decay of the lambda particle showed that this process was most probably identical with that of ordinary radioactive beta decay.

More generally, the ties between CERN and other high-energy laboratories throughout Europe were being strengthened. The 152-cm British bubble chamber, for instance, had taken several hundred thousand pictures already (again since the last meeting of the Council), and a team from the French Laboratory at Saclay had constructed their own apparatus to investigate the charge exchange of pions and protons, bringing the equipment to CERN for the actual experiment.

Mention ought also to be made specifically of the increased number of experiments on nuclear structure — more truly 'nuclear research' than most of the work at CERN —, and it had been proposed that a large part of the synchro-cyclotron operating time would be devoted to such experiments in the future.

'Europe' equivalent to 'CERN'

Summing up these results, Prof. Weisskopf referred to the 'Rochester' conference, held at Dubna in August 1964, where it was clearer than ever that the contributions of Europe to high-energy physics were becoming more and more important with respect to those of the U.S.A. and U.S.S.R. Moreover, in this context it was impossible to distinguish between 'Europe' and 'CERN'.

As for the future, he hoped that this advance would be maintained, and that Europe would be able to keep pace or even improve its position. Much thought was being given to long-term plans, and an enormous effort had been put in by those concerned to produce the report that was being presented to Council (in two languages) on the design study of a 300-GeV accelerator. CERN could not stand still; by 1970 there would be machines of higher energy than the CERN proton-synchrotron in operation at Stanford and Serpukhov, and more powerful machines were also foreseen for Brookhaven and Berkeley.

Of more immediate concern, Prof. Weisskopf mentioned that the successful trials with the 2-metre bubble chamber had accentuated the problems of the electricity supply to the site. The necessary consumption was approaching a rate of 20 MVA and although the increased need had been foreseen over four years ago, difficulties outside CERN's control were considerably delaying the installation of the planned new supply. He hoped that these could soon be resolved.

In thanking Prof. Weisskopf for his report, and congratulating Prof. Peyrou and the whole of the TC Division on their new bubble chamber, Mr. Bannier recalled that when the decision was taken to build this instrument the Council Chamber did not exist, and few of the delegates, meeting at that time in the conference room of the International Labour Office, had realized how far CERN was going to develop in the meantime.

Among other speakers, Prof. Trumpy (Norway) remarked on the inspiring effect of CERN on the number of advanced students of physics in Norway, where active schools now existed at the Universities of Oslo and Bergen and the Technical University of Trondheim.

* Document CERN/560. See also last month's CERN COURIER.

More to spend in 1965, but costs higher

At the meeting in December 1963, Council approved a budget total for 1965 of 116 million Swiss francs, at 1963 prices. Taking into account the subsequent increases in the cost of buildings and equipment, as well as salaries, the corresponding total has become 128 760 000 Swiss francs*, and the draft budget for this amount was approved at the December 1964 session. Since a small part of the money required comes from miscellaneous other sources, a total of 126 400 000 Swiss francs** is to be provided by the contributions of Member States. The amount approved represents a 'real' increase of some 11% over the expenditure in 1964, conforming to the recommendations of the 1962 'Bannier report'.

Later in the session a firm estimate for the 1966 budget of 135 million Swiss francs (at 1964 prices) was also agreed upon.

Symphony in three movements

Opening a discussion on general scientific policy, Prof. L. Leprince-Ringuet presented the recommendations of the Scientific Policy Committee, of which he is Chairman. Broadly speaking these were the same as those presented at the June session of Council, but further discussions — and particularly a special meeting of the European Committee on Future Accelerators in October — had enabled further developments to be taken into consideration. Prof. Leprince-Ringuet likened the three parts of the programme to a symphony composed of three movements. The prelude would be the improvements to the present facilities at CERN, taking the Laboratory as far as 1971-1972, the andante would be the intersecting storage rings, and the finale the 300-GeV accelerator, which would not be in operation before 1976. Like the symphony, this programme formed a coherent whole. If the first movement were not followed by the second, to take one example, the audience might leave before the finale — if the proposed storage-ring operation were to be left out there might not be sufficient qualified physicists of the right calibre left in Europe to run the 300-GeV machine.

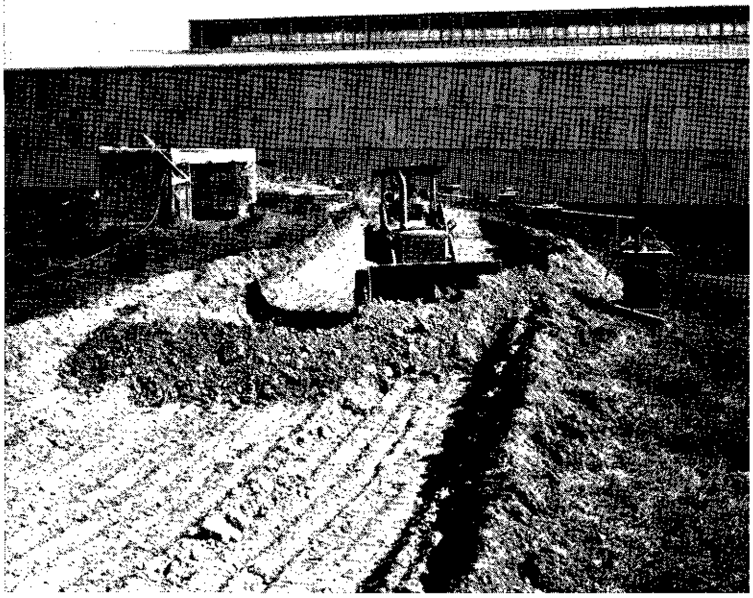
Mr. Bannier, reporting on a meeting held in Vienna between representatives of European countries, the U.S.A. and the U.S.S.R., said that it was quite clear that no collaboration was possible on an accelerator with an energy as low as 300 GeV. In addition, talks between representatives of the CERN Member States and of the U.S.A had shown that joint construction of a machine of the order of 200-300 GeV was also impracticable. However, the idea of future collaboration between Europe, the U.S.A. and the U.S.S.R. should not be abandoned and CERN should continue to explore all possibilities in this direction.

Prelude

Later in the session, CERN's Director General, Prof. V. F. Weisskopf, outlined the present status of the improvement programme for the 28-GeV proton synchrotron. Although, as he pointed out, from a physics point of view the storage rings should be included in such a programme, from a budgetary point of view they were separate. During consideration of the normal budgets of CERN for the next few years, therefore, only the other improvements had to be discussed.

* Equivalent to 29 800 000 dollars. ** Equivalent to 29 300 000 dollars.

CERN/PI 52.9.64



Many people were surprised last September when it appeared that preparations were being made for yet another new building, this time on top of the proton synchrotron ring! However, the bulldozer was only 'on loan', to remove a layer of earth temporarily in an experiment designed to gain more exact information on the shielding properties of this useful material. The experiment formed part of a study made jointly by AR Division, MPS Division and the Health Physics Group, to enable estimates to be made both of the extra thickness required if the PS intensity is further increased and of the needs of possible future machines such as the intersecting storage rings or the 300-GeV accelerator.

The first of the projects included a new power supply and Linac injector for the PS, which together would increase the beam intensity (protons per second) by a factor of ten. The second item to be considered was new instrumentation — a long-pulse radiofrequency separator, a large magnetic spark chamber, wire spark chambers working on-line to computers, etc., and other techniques as yet unknown.

An instrument that would certainly be needed was a large new bubble chamber. It might seem strange to talk about this on the same day that operation of the 2-m chamber was announced, but these things took many years to plan and build, and recent technical progress, in photography and cryogenics, now made it possible to consider building a much larger chamber at proportionally less cost. A cylindrical chamber, with a diameter of 5 metres and containing around 25 000 litres of liquid hydrogen would enable many experiments to be carried out that were impossible with present techniques, and such designs were currently under study in the United States, United Kingdom and elsewhere, as well as at CERN. The cost of a chamber of this size might be about 40 million Swiss francs, but the suggestion had been made that this instrument could perhaps be constructed by some of the Member States, following the 'tradition' established by the Ecole Polytechnique, Saclay, British and other chambers used at CERN, and thus not fall on the CERN budget.

Continued on p. 26

First run of the CERN 2-metre

As noted in our January issue, CERN's 2-met
the Track Chambers Division, successfully unc
months after the delivery of the chamber body
on Tuesday, 8 December, a start was made c
was being tended day and night by three shifts
and engineers were on duty almost continuous
night on the night of 12/13 December, when th
in the chamber. The time of 102 hours betv
first tracks is certainly a record in the history c

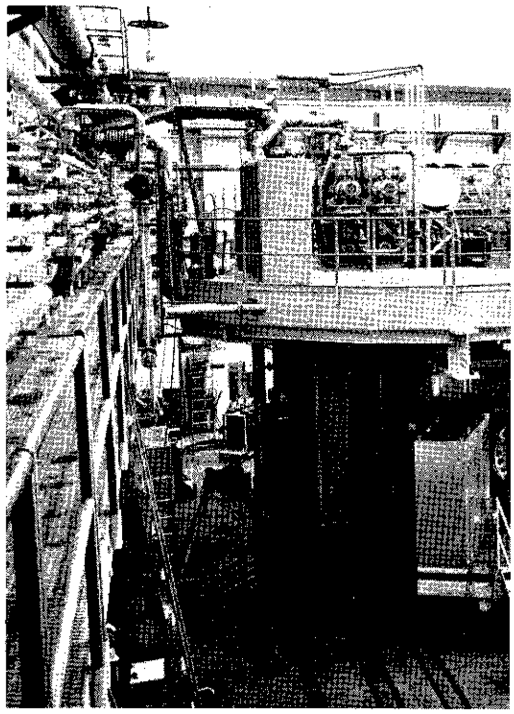
The photographs reproduced here, mostly tal
the chamber, show a few of the people invo
and tension, at that time.

CERN/PI 149.12.64

Captain on the bridge!
Prof. Ch. Peyrou, leader of the Track Chambers Division, regards with an anxious eye the vacuum gauges mounted on the 'platform' from which the chamber body is suspended, and wonders if the vacuum will really be maintained during the cool-down.

CERN/PI 148.12.64

Last minute checks in the control room.
On the left, L. Naumann talks to J. Zoll while J. Cavalli works on the control panel of the expansion system for the chamber and E. Mande does some calculations at the desk.



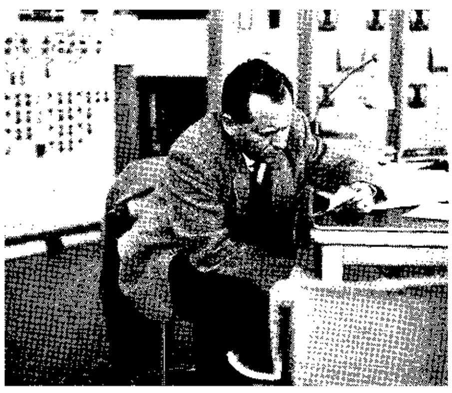
One of the two largest bubble chambers in the world.
chamber, some idea can be gained of the complexity of
on the magnet armature, carries the fore-vacuum pumps,
liquid hydrogen, the temperature-control panel, gas
is provided to the four cameras that provide eoscop

CERN/PI 155.12.64

It seems to be working.
J. Cavalli and R. Daneyrolle (white coat) watch the operation of the expansion system, as shown by the curves of piston displacement and pressure, with respect to time, displayed on the 10-channel oscilloscope specially built for this purpose in the TC electronic workshop.
J. C. Lambert (check shirt) and G. Amato examine closely another oscilloscope that shows the pressure/volume diagram of the chamber.

CERN/PI 180.12.64

Are the conditions right yet?
J. Trembley and G. Amato (right) wait anxiously by the intercommunication system to request the next variation of the expansion ratio to the operators on the bridge, during regulation of the chamber to produce the first tracks. On the left H. Schultes makes some notes.



CERN/PI 170.12.64

Can these really be tracks?
A. Burger suspiciously inspects one of the first Polaroid photographs.

How good are they?
Ch. Peyrou takes a ma
the first photographs,
(left), A. Burger and H.

liquid-hydrogen bubble chamber

bubble chamber, designed and assembled in ;rwent its first tests in December. Only eight all was finished and in place, and at 6.30 p.m. the first cool-down. Already, the chamber of operators, and many of the senior physicists y. Their efforts were rewarded just after mid- : first pictures were obtained of particle tracks ;en starting the cool-down and obtaining the large bubble chambers.

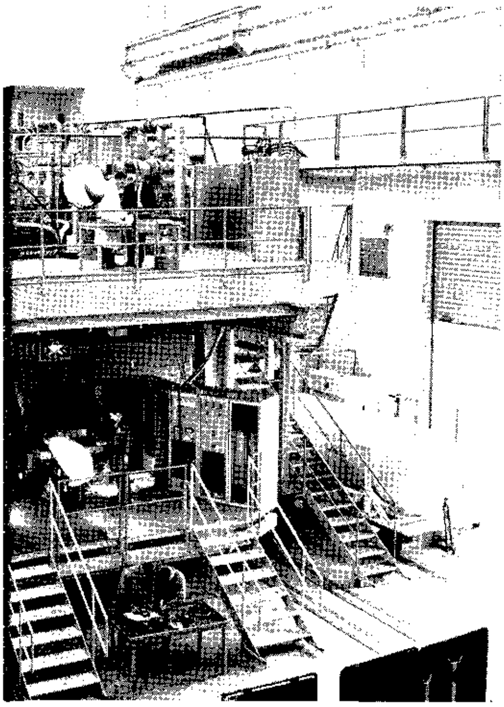
ɪn in the control room during this first run of ·ed and perhaps give some idea of the activity,

CERN/PI 218.12.64F

Refrigerator checks.
F. Schmeissner (left) joins A. Therond and B. Chamdru on the platform of the hydrogen refrigerator, to check on the valve operation.

CERN/PI 140.12.64

Cooling down.
On the platform, P. Dow casts an eye over some of the gauges in the temperature-control panel while H. Demo notes the readings in the log book.



CERN/PI 151.12.64

this view of the CERN 2-m liquid-hydrogen bubble e installation. The upper platform, or bridge, which rests ,e expansion system, the valve box for the distribution of stributi ɪcks and so on. On the lower platform, access · photo hs of the liquid hydrogen in the inner tank.

Progress report.
M. Schmitt telephones from the control desk, watched by L. Naumann and a visitor to the control room.

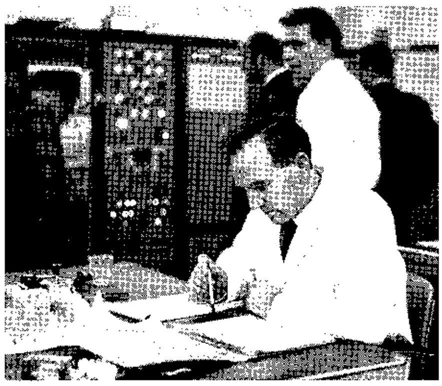
CERN/PI 142.12.64

CERN/PI 160.12.64

nifying glass to inspect ·atched by P. Lazeyras :hultes.

CERN/PI 159.12.64

Tracks! – trails of little bubbles!
L. Naumann and A. Burger muse over a photograph that marks the success of five years' work. Behind them, G. Amato keeps an eye on the racks controlling the timing and synchronization of the expansion cycle.



CERN/PI 172.12.64

Who's on duty tomorrow?
T. Ball takes advantage of a quiet moment to check the shift rota. The glasses are still for utilitarian purposes; celebrations will come afterwards, sleep first.

Track Chambers Division's Christmas party on 22 December was also the occasion to celebrate the successful completion of the 2-m bubble chamber, and many other people from CERN were invited to join in the festivities. The party also inaugurated the Division's new apparatus assembly hall, then nearing completion as part of the new laboratory 13.

With the growing importance of neutrino physics, better beams and new experimental halls, ejection systems and detectors would no doubt be needed.

Balanced ensemble

It was hoped to carry out these projects during the years 1966-1971 inclusive. If this were done the PS would still be able to hold its own, after that time, with respect to the Brookhaven AGS, where even more ambitious improvements were expected to be carried out. The total cost would come to rather more than 20 million Swiss francs a year, on average; with the slower increase anticipated in the 'basic' CERN budget after 1966, the total annual expenditure could be expected to reach rather more than 210 million Swiss francs in 1971. If the programme as suggested could not be financed, it would have to be cut down or extended in time. The first alternative was undesirable, because CERN would then find itself with facilities far below those of Brookhaven. The second would be uneconomic in the long run; experience at CERN had already confirmed the rule that *ad hoc* improvements, compromises, and efforts to make do with existing equipment instead of what is really necessary, rarely use money in the most efficient way.

Referring to Prof. Leprince-Ringuet's analogy, Prof. Weisskopf said that he disagreed slightly. He felt that the improvement programme and the intersecting storage rings were more like the strings and the brass in a single movement. The two together formed a balanced whole that would serve CERN-Meyrin for the next 10-15 years and bring European physicists to the state where they could exploit to its full extent the 300-GeV accelerator — the key to the future of high-energy physics in Europe — which they all hoped would be producing results long before 1980.

ISR decision deferred, but studies continue

Although delegates from a number of Member States were able to announce that their Governments were in favour of constructing the intersecting storage rings (ISR), intended as an addition to the CERN proton synchrotron, others were still not in a position to vote definitely for the project. It was accordingly decided to postpone the decision in the hope that it could be made at a special meeting of Council, called for 25 March. Later in the session, the continuation in 1965 of the supplementary programme, which covers work both on the storage rings and the 300-GeV accelerator, was agreed upon. Spain joined the Member States financing these studies, but Italy had to withdraw for the time being. All the other Member States except Greece are involved and expenditure this year of up to 5.7 million Swiss francs was authorized, pending a final decision on the budget and contributions at a later date.

450 pages on 300 GeV

The current state of the design studies on the proposed 300-GeV accelerator was shown by the presentation of a two-volume report by the Study Group on New Accelerators. In some 450 pages, accompanied by over 100 drawings, the main parameters of the complete project were given, including detailed time and cost estimates for construction.

As envisaged in this report, the accelerator itself, its booster synchrotron and injection linac, and the ejected beams would all be situated in tunnels some 10 metres underground. The accelerator tunnel would form a ring some 2.4 km in diameter, followed on the surface by a road with suitably positioned access points all round the ring; ejected beams from a number of points would follow inclined tunnels to reach the surface

COUNCIL OFFICERS FOR 1965

At the 28th Session of Council the following officers were elected, or re-elected, for the coming year:

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Chairman of the Scientific Policy Committee
– **Prof. L. LEPRINCE-RINGUET** (France).

In addition to the above, the Committee of Council includes the following members:

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- **Prof. W. JENTSCHKE** (Federal Republic of Germany),
- **Mr. J. MARTIN** (France),
- **Mr. J. WILLEMS** (Belgium), representing Belgium and the Netherlands,
- **Prof. B. TRUMPY** (Norway), for the Scandinavian countries,
- One representative of **Spain**, for Spain and Greece,
- One representative of **Switzerland**, for Switzerland and Austria.

several hundred metres away from the ring; a bubble-chamber area is envisaged at a distance of 3 km. Apart from roads, and small buildings at the access points, most of the surface constructions would be concentrated in two areas, one around the main control centre and a smaller one in the so-called 'experimental area A'. By using buildings of several storeys, it is planned to keep the area of the central complex less than that of the present CERN site.

The report, as presented, would enable a decision of principle to be taken now on the construction of the accelerator. In fact it was stated in the foreword that the design is at a much more advanced state than was that of the CERN PS when approved by Council at the end of 1953.

According to the construction schedule, if a decision to build the accelerator could be made at the end of 1966 the machine could be finished before 1975. However, before work could begin, a site would have to be decided and agreement would have to be obtained on the convention governing the new laboratory and its relations with the host country. Both steps would involve a considerable amount of technical and administrative work, and it was for this reason that the request for offers of sites had been sent to Member States after the June Session of Council. At the December Session, offers from four Member States were made known, and others were expected. A closing date of 1 May was fixed, so that a start could be made after then on a comparative evaluation.

Information presented to the Council showed that over a hundred technically possible sites had been considered by the Study Group since the start of the project, although many of them had quickly been found to have obvious disadvantages. Fourteen were still on the list as possibilities and the results of the eliminating examinations had been used to advise experts in the Member States so that only the most suitable sites would be included among the formal offers ●

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BOOKS

Progress in nuclear physics, vol. 9, edited by O. R. Frisch (Oxford Pergamon Press Ltd., 1964; £4.10.0).

Even the casual reader, on leafing through this book to page 295, where the contents of previous volumes in the series are listed, will notice that those eight books contain the quintessence of nuclear physics. In fact, one is almost tempted to claim that the presence on one's bookshelf of the complete series makes the ownership of other textbooks on nuclear physics a luxury. To what extent, then, does the present volume follow the example set by its illustrious predecessors?

All but the most critical (and they are never satisfied, anyway) will have to agree that the high standard has been fully maintained. The contents have undergone the usual careful selection and the result is six articles of topical interest, covering spark chambres (J. G. Rutherglen), semiconductor counters (G. Dearnaley), beam design (N. M. King), analysis of collision amplitudes (R. J. Eden), interactions of strange particles with nuclei (E. H. S. Burhop, D. H. Davis and J. Zakrzewski), and the electromagnetic properties of the muon (F. J. M. Farley). In other words, three articles on applied physics and three articles concerned with results or with theory; a well-balanced diet.

The quality of presentation is so high that it would be invidious to single out any one paper for praise. However, if laurels must be given, then let them go to Eden's exposé of an elegant technique in the domain of theory and to the review of the strange-particle interactions; to the former for its lucid explanation of a difficult and controversial subject, to the latter for the model ease with which a large body of experimental results, often not too well correlated, have been assembled and knit together to make a very readable (and very useful) survey. Needless to say that, as both articles are of interest to the reviewer, he is an unfairly biased judge.

Dare we, after all this praise, ask one embarassing question? Assuming that *Progress in Nuclear Physics* is intended to present the latest knowledge in an easily assimilable and, at the same time, condensed form, why the long delay between the reception of the manuscript by the publisher and the appearance of the book on the market? With the book dated 1964, the bibliography finishes in 1962 (all references to publications in 1963 are marked 'In press'). Nuclear physics is a progressing field: the results of yesterday are still true today, but their interpretation has more likely than not changed.

But, when all is said and done, signs of maturity may be but a very small disadvantage when one reflects that to produce books of such a calibre must inevitably take a considerable time. It is, I suppose, part of the price we must pay in order to be able to enjoy such a well-edited, clearly written and informative book.

St. L.

Introduction to neutron distribution theory, by L. C. Woods (London, Methuen and Co. Ltd., 1964; 28 s.).

It has always been a source of wonder to me how Messrs. Methuen manage to provide, in their series of *Monographs on Physical Subjects*, such excellent books at such a reasonable price. Lately, however, this wonder has begun to cloud slightly: not on account of the quality and contents of the books, which have maintained their accustomed high standard, but more due to the expense. Here, for instance, we have a volume costing five or six times the usual price of a few years ago. Since the aim of the series is surely to provide brief, inexpensive introductions to topics of current interest in the physical fields for a wider class of reader and not only for the specialist, are the hard covers and the dust jacket really necessary? Judging by a number of opinions I have heard on this subject in the past, a paperback without frills, but at half the price, would be more welcome.

To deal with the book in question: neutron distribution theory is the backbone of the theory of nuclear reactors. Nuclear-reactor technology has been developing with such speed in recent years that its devotees, one has the impression, have had very little time to pause for reflection and to put down on paper a few systematically ordered thoughts. There is a staggering amount of technical literature and a remarkable dearth of good, general books on the subject. We at the fringe should therefore welcome this brave attempt at collecting under one cover a systematic derivation of the basic equations of neutron theory, at a reasonably advanced level, with illustrations of their working when applied to reactor theory. Since the fundamental relations are the Boltzmann transport equations, I am probably not far wrong in saying that this book can be of considerable utility even to those not immediately connected with reactor design and analysis. Again, while the beauty and power of the Boltzmann equations were first demonstrated in the case of gas kinetic theory, their application to neutron physics has led to results which in one way or another seem to involve all of us.

In spite of considerable and necessary compression, the book is very clearly written. However, I do not quite share the author's enthusiasm for presenting the material in this form to honours classes in physics and mathematics. I feel that in order to be able to appreciate best the elegance of the whole technique, one must have passed through the fire that is practice.

Incidentally, what would Boltzmann say to all this? Would he just accept meekly, or would he, beard bristling in support, propound some even more elegant and revolutionary theories? I wonder.

St.L.

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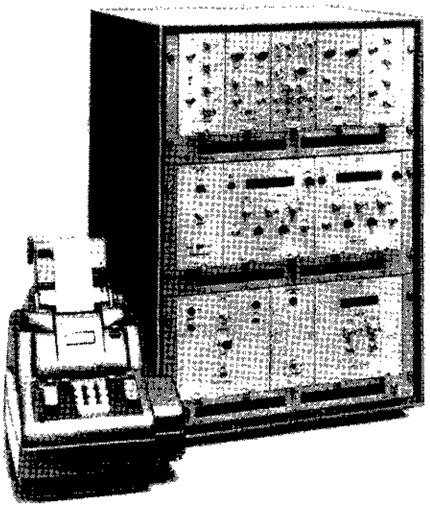

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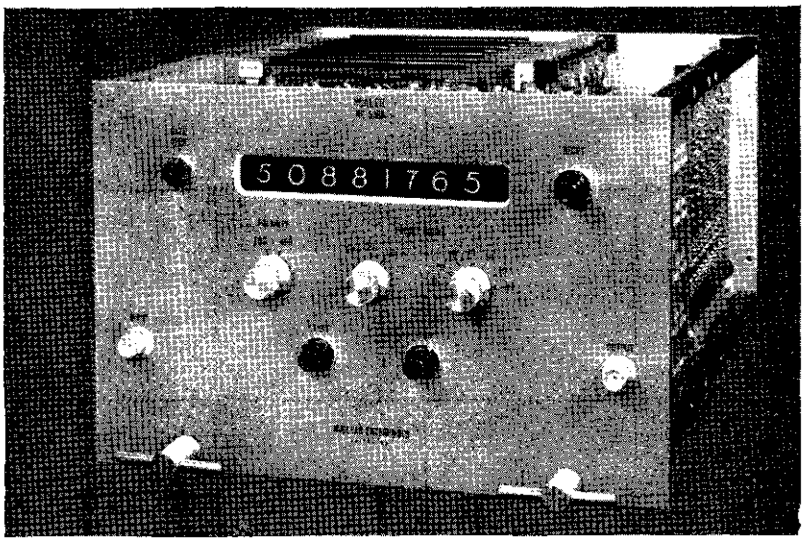

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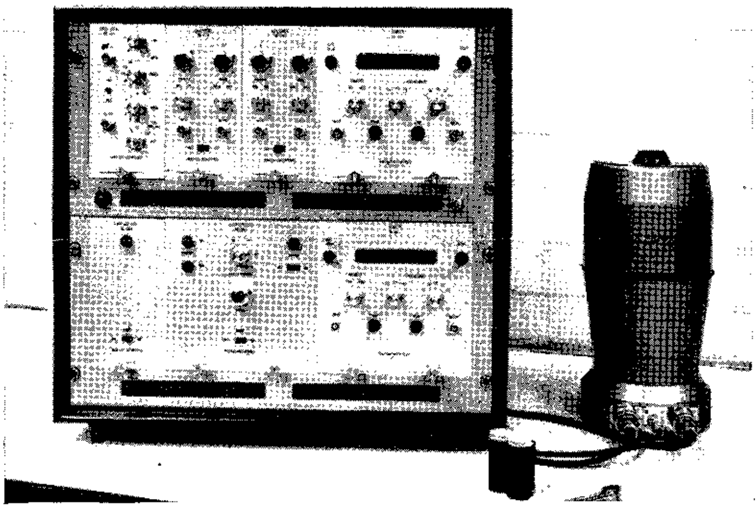

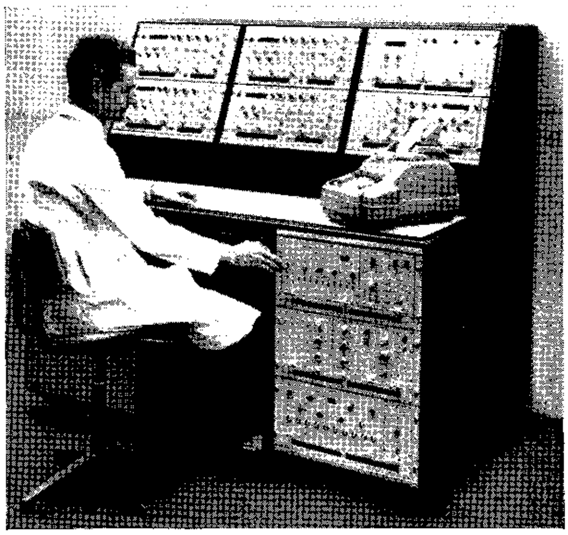

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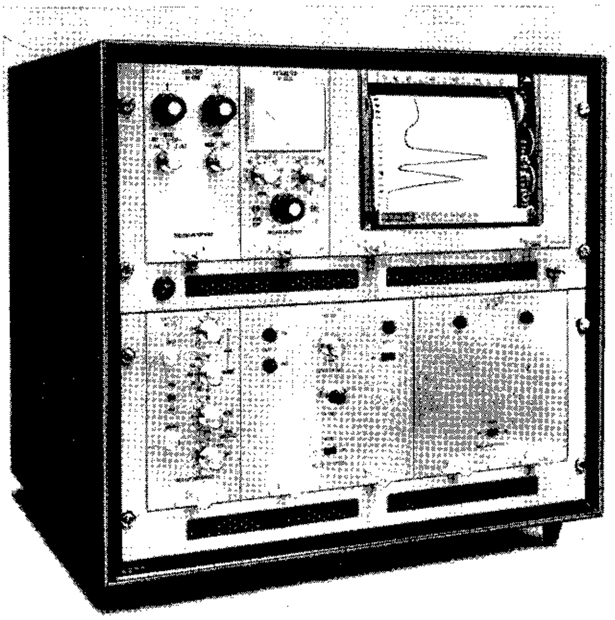

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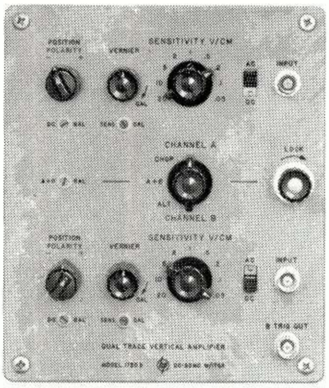

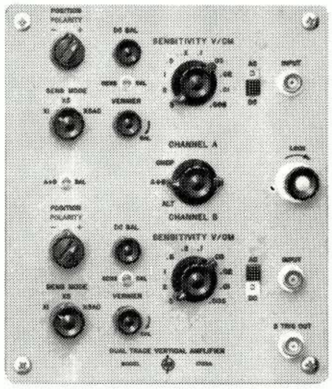

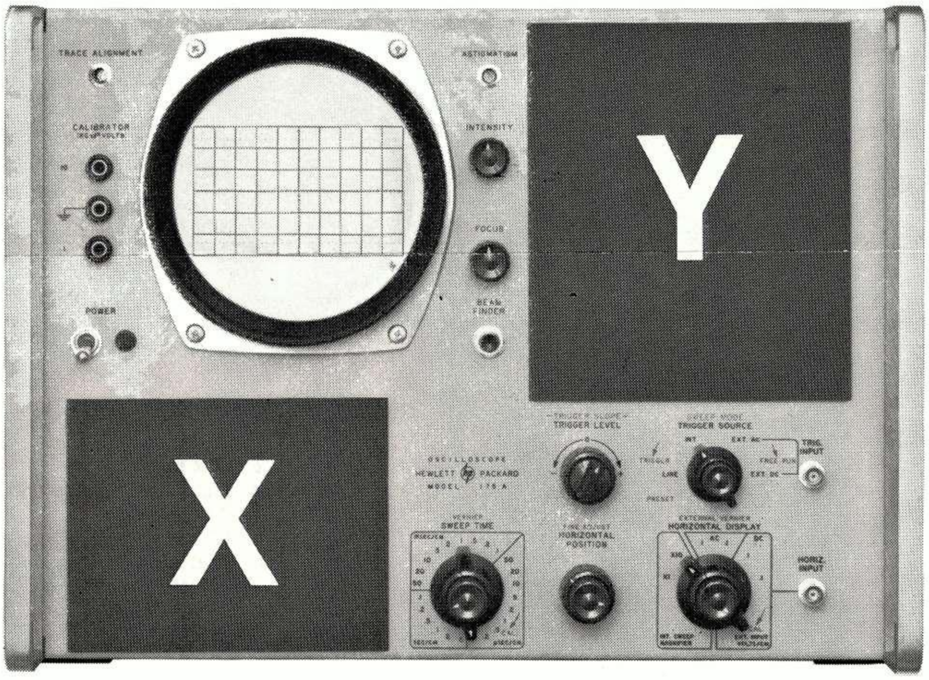

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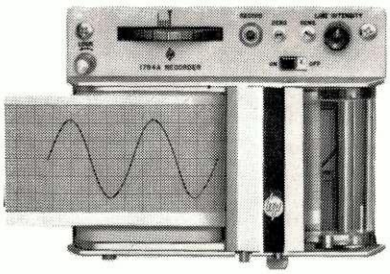

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