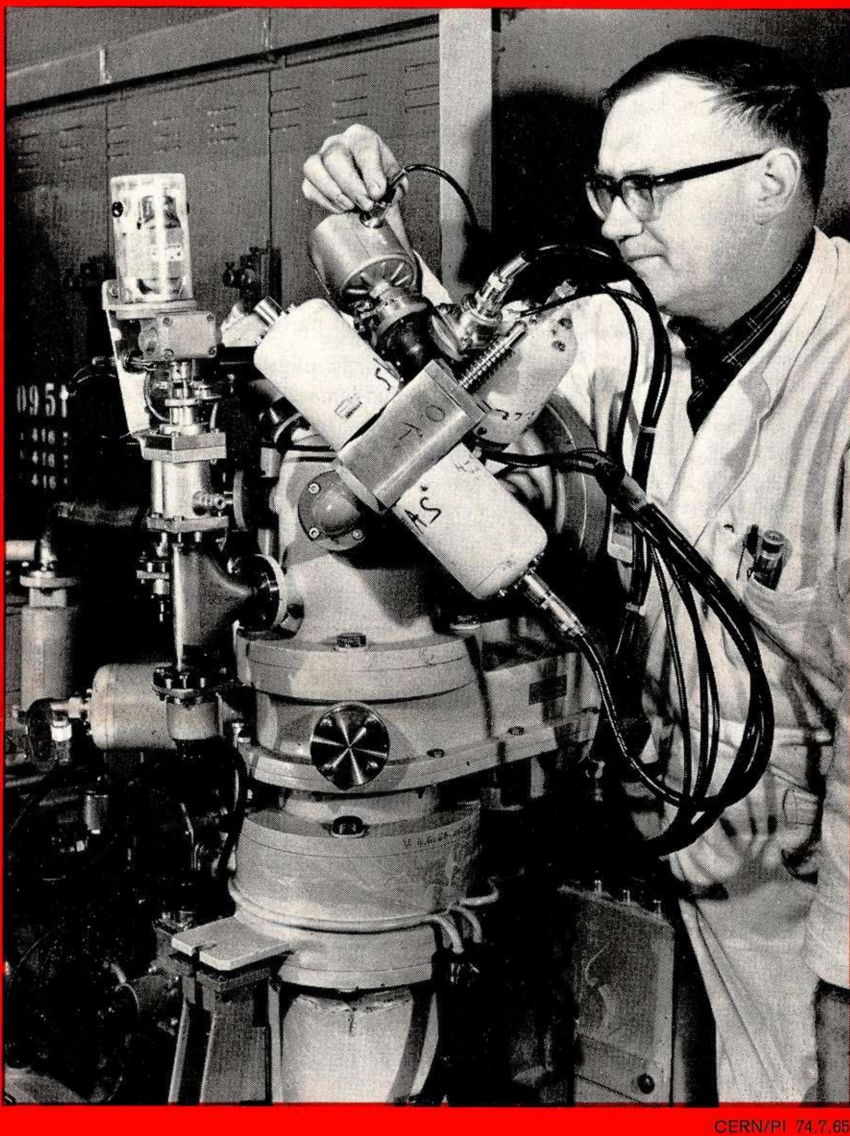
CERN COURIER



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EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

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Contents

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The cover photograph shows part of one of the 80 diffusion-pump units of the CERN proton synchrotron, which together serve to keep a high vacuum in the vacuum chamber of the accelerator. The pressure of the residual air is around 10^{-6} torr, or nearly one thousand millionth of normal atmospheric pressure. Such a high vacuum is necessary to prevent too many collisions with air molecules as the protons travel round and round inside the chamber, going more than 300 000 kilometres in only 1 second, during the acceleration process.

In this picture, Fernand Contant, of the PS Machine Utilization Group, is tightening one of the connexions to the collection of vacuum gauges that are interlocked with pneumatic and electromagnetically operated valves to form the control and safety system for a 60-metre sector of the vacuum system. During the accelerator shut-downs of the past year, work has been carried out to modify the electrical and water connexions of the pump units to facilitate rapid replacement or change of position if necessary, and 14 units were dealt with in the latest shut-down in June and July. Among other work on the pump units during this time were oil changes, replacement of faulty vacuum gauges and a general checking of the electrical circuits.

CERN COURIER

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The European Organization for Nuclear Research, more commonly known as **CERN** (from the initials of the French title or 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 2100 people.

In addition to the scientists on the staff, there are about 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 Observer.

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 twelve states, covers design work on two projects for the future of high-energy physics in Europe — intersecting storage rings for the 28-GeV accelerator at Meyrin and a possible 300-GeV accelerator that would be built elsewhere ●

Last month at CERN

New external beam at the PS

Just over two years after the internal proton beam was first successfully ejected from CERN's 28-GeV proton synchrotron, a second, more complex ejection system has now been installed and successfully tested in the accelerator.

The original system ('fast ejection') gives a very short, intense pulse of protons, lasting about 2 millionths of a second on a target serving the South experimental hall. The new one, the result of intensive design, development and construction work over the past eighteen months, involving practically all the groups in the MPS Division, provides an external proton beam for the East experimental hall, with three widely different possibilities for the pulse duration.

Two of these possibilities arise from operation of the equipment as a 'resonant' ejection system (the principle of which was described in *CERN COURIER*, vol. 3, pp. 110-111, September 1963), when the accelerated protons circulating inside the synchrotron are 'gradually' spilled out into the external beam line to give either a long burst, at more or less constant intensity and lasting up to nearly one fifth of a second, or a much shorter burst of about a thousandth of a second, with each accelerator pulse. The longer, 200-ms, burst (known as 'slow ejection') is mainly suitable for experiments using counter and spark-chamber arrays for particle detection; the 1-ms burst ('quick ejection') will be used for bubble-chamber experiments requiring electrostatically separated beams of secondary particles. The third possibility is given by operation as a fast-ejection system, when the beam is sent out of the accelerator in an even shorter time, giving a 2.1-microsecond target burst suitable for bubble-chamber experiments requiring radiofrequency separators in the beam line. This method of operation is basically the same as that of the existing fast-ejection system, a selected number of bunches of circulating protons being ejected from the accelerator within the time taken for one revolution. At present, also, the two fast-ejection systems utilize the same kicker magnet, originally installed for the external beam in the South area.

The first tests on the resonant ejection system were made on 19 July and those with the fast system (carried out in collaboration with staff of the NPA Division) on 29 July, in each case using protons with a momentum of 19.2 GeV/c. Both methods, together with the first section of the external beam line and target system, worked well. Other tests were made at 12 GeV/c and 24.5 GeV/c and were equally successful. When focused on to the external target the fast-ejected beam had a cross-sectional diameter of less than 2 mm. The efficiency of the slow ejected beam was about 70% (that is, 70% of the protons circulating inside the accelerator were transferred to the external beam), which is a high value for a pulse as long as 200 ms.

During the tests a start was made on training the operators for the new beam facilities, in preparation for experiments scheduled for October: slow ejection into the e_2 beam line for proton-proton scattering experiments and fast ejection into the u_1 beam line, incorporating radio-frequency separators, for the 2-m liquid-hydrogen bubble chamber. In fact, one experiment was carried out almost immediately — a target exposure for the NP Division's Nuclear Chemistry Group.

PS shut-down

Installation of the East-area ejected beam was one of the most important of the major jobs carried out during the long shut-down of the synchrotron which lasted from the beginning of June until the middle of July.

In addition, in the East and North experimental halls especially, major changes were made concerning the experiments on the floor, most of the existing beam lines being dismantled and many new ones wholly or partly constructed. In the South hall the beam line for the muon storage ring was installed. Among other things, the CERN heavy-liquid bubble chamber was moved from the South hall to the North hall, following the end of the neutrino run, ready for a new experiment on the decay properties of positive K mesons. In fact, from the point of view of the MU group, responsible for all the beam and equipment changes, the shut-down effectively began last Easter and will go on well into September. Practically all the experiments scheduled from July onwards are completely new, involving new experimental equipment, and even the liquid-hydrogen bubble chambers are using new beam lines.

Unfortunately it has not been possible to compile a full account of the work carried out during the PS shut-down period, but we hope to give further information on at least some aspects of it in subsequent issues of *CERN COURIER*.

May–July at the SC

During the three months May–July, four long experiments were in progress at different times at the synchro-cyclotron, together with a number of shorter ones. In parallel, as usual, various items of equipment and experimental arrangements were tested in preparation for forthcoming experiments.

At the beginning of May a series of experiments was carried out by the Health Physics Group, using the extracted proton beam. This was partly for shielding tests and radiation-dose measurements but also for biological irradiations on behalf of a number of institutes in Europe. The various experiments required a great deal of effort on the construction of the necessary shielding and on the precision alignment of the beam.

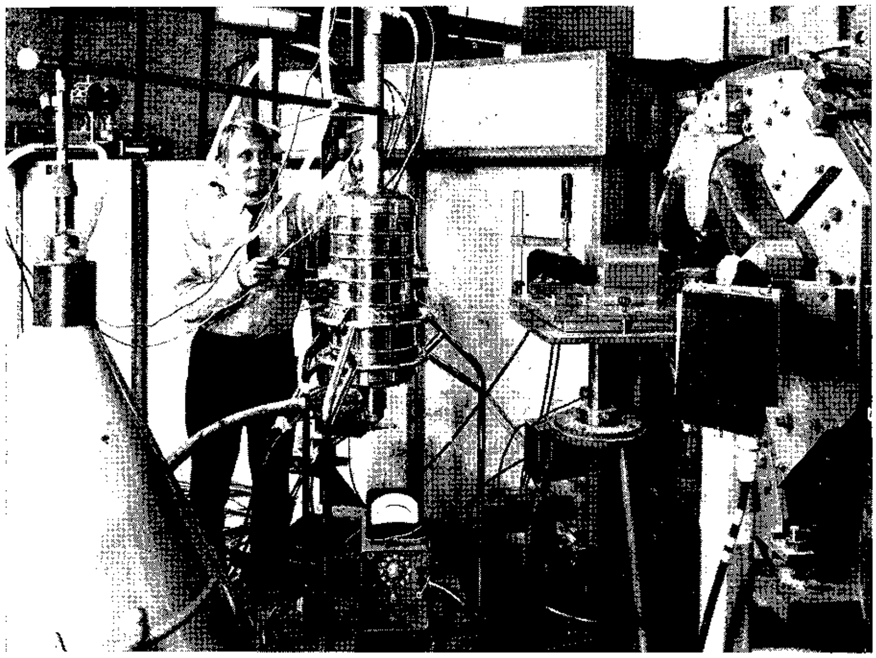
The rest of the month was occupied mainly by three of the long experiments that are continuing at the SC: measurement of the x-rays produced by muon capture in atoms, search for the disintegration of the neutral pion into three gamma rays, and investigation of muon capture in a target of high-pressure hydrogen gas.

During June and July a fourth experiment was begun and completed, the beam line having been set up during the preceding month. This experiment, carried out by a combined team from CERN and the French laboratories at Saclay and Orsay, was on the scattering of 600-MeV polarized protons from a polarized-proton target. The target was the same as that used in previous experiments at the SC and

PS and described in *CERN COURIER* last December (vol. 4, p. 168). It was bombarded by protons polarized by scattering from a small carbon target. The beam line guiding the protons to and from this target and enabling protons of either 'spin up' or 'spin down' to be selected consisted of sixteen independent elements and was the most complex ever used at the SC. A photograph of the detection equipment, together with some information on its mode of operation, appears on p. 121 of this issue.

During May the position of the magnetic extraction channel for the external proton beam was changed, in accordance with prior calculations, to obtain a considerable increase in the extraction efficiency. The beam-measuring system was also recalibrated, to give a more accurate reading. Some 5×10^{11} protons per second can now be obtained in the external beam.

Also in the period under review, many members of the MSC Division moved into their new quarters in the buildings constructed in the area between the SC control room and the Main Workshop. For example, much of the equipment used by the New Projects Group was moved into the newly finished hall where the cyclotron model will be set up. The SC workshop was also among the sections to be transferred.



CERN/PI 86.5.65

This photograph shows the compact nature of the special cryostat containing the superconducting magnet for the emulsion experiment of the Strasbourg group, as mounted in the neutron room of the synchro-cyclotron at CERN. The incident pion beam comes through the quadrupole focusing magnet at the right, is collimated by the pile of lead bricks and is detected by the small plastic scintillation counter immediately to their left. In the left foreground is the liquid-helium container for continuous replenishment of the liquid in the cryostat.

Superconducting magnet used in emulsion experiment at the SC

One of the shorter experiments at the SC in May was of particular interest since it involved the use for the first time at CERN of a superconducting magnet. The aim of the experiment, which was carried out by a group from the Particle Physics Department of the 'Centre de Recherches Nucléaires' at Strasbourg, was to study the mechanism of double charge exchange, π^+ changing to π^-, in light nuclei forming part of nuclear emulsions or added to them. The superconducting magnet, giving a magnetic field of 42 000 gauss yet still very easy to handle, permitted a good distinction to be made between the positive and negative pions of high energy.

After preliminary tests at Saclay, using the 3-GeV proton synchrotron 'Saturne', the equipment was brought to CERN and used on 14 and 15 May in a pure beam of 70-MeV positive pions from the SC, at an intensity of about 100 pions per square centimetre. Basically the apparatus consisted of a light cryostat, of original design having a clear space in the middle into which stacks of nuclear emulsions (4 cm x 9 cm x 2 cm) could be placed, in free air, uncooled. Inside the cryostat was the coil of the electromagnet, constructed in two parts, of niobium-zirconium wire, surrounded by liquid helium with no other cooling jacket. The cryostat and coil complete weighed about forty kilogrammes; the d.c. generator, giving a regulated output of 200 A at 6 V, weighed some 150 kg. The whole equipment, in contrast to a conventional magnet and power supply of similar performance, was easily moved and was in fact brought to CERN in a light van.

During the experiment, after the initial cooling down of the coil, the average consumption of liquid helium was between 1 and 2 litres per hour, the vapour being collected for re-use, and the system was in operation for about twelve hours with the magnetic field constant to one part in a thousand.

According to the group that carried out the experiment, the size of such an enclosure for emulsion stacks or other techniques of detection is limited only by the present cost of superconducting wire. The value of the magnetic field is limited by the critical field of the superconducting material, but by using more favourable materials, such as niobium-tantalum alloy or niobium-tin, there is a hope of exceeding 100 000 gauss over quite a large volume in the near future. This would obviously offer a very

Continued on p. 123

PARTICLES AND SELCITRAP

In the December, 1964, issue of CERN COURIER *we published a short contribution in German on the subject of antiparticles. As a result we have received the following comment — from John Sykes, of the Atomic Energy Establishment at Harwell, U.K. — which seems particularly appropriate in view of the recent discovery of 'compound' antiparticles in the form of antideuterons.*

WHAT MATTER ?

Cheer up ! for somewhere, off the map
By many and many a parsec
The stsitneics at their NREC
Are closely studying selcitrap.

After a long noitirutrap
(almost sisenegonehtrap)
They too have reached a pihsrentrap
To do research on selcitrap.

And in their Reiruoc, mayhap,
They're writing gloomy articles
About these awful **particles**
That spoil their world of selcitrap.

30th Session of CERN Council

As briefly reported in the July issue of *CERN COURIER*, delegates from the 13 Member States of CERN met at the laboratory on Wednesday and Thursday, 16 and 17 June, for the 30th Session of the Council of the Organization, held under its President, Mr. J. H. Bannier, of the Netherlands.

News of the two most important decisions taken during this session was also given in last month's issue. As usual, a brief survey of the current state of CERN was given by the Director General, Prof. V. F. Weisskopf, in presenting the Progress Reports of its Divisions (for the period November 1964 to May 1965), and various detailed points concerning the running of the Organization were discussed or given formal approval. Most of the session, however, was devoted to the future of sub-nuclear physics research in Europe, and it was in this context that the decision was taken to support the construction of intersecting storage rings for the CERN proton synchrotron.

Progress Reports

Presenting the half-yearly Progress Reports of the Divisions*, Prof. Weisskopf remarked first of all on the new technical equipment of the laboratory, especially the 2-m liquid-hydrogen bubble chamber and the radio-frequency particle separator, as well as the large new computer, which had been installed and was in use although it still lacked the full time-sharing system necessary for its proper use.

Turning to the research results, Prof. Weisskopf noted that there was a new excitement in this field of physics. New ways of looking at the evidence presented by experiment were beginning to evolve and there seemed to be a better understanding of the facts. The symmetry theory known as SU_6, together with its various developments, was characteristic of this new feeling and the theoretical physicists at CERN had made important contributions. One of the consequences of the new way of looking at things was the possibility that all the many mesons (including 'resonances') discovered in the past few years might in reality be only one, seen, as it were, from different viewpoints.

Experimentally, the discovery at CERN of a new meson resonance having an electric charge of two units and a 'strangeness' of two units provided striking proof that our previous ideas on the nature of 'elementary particles' were insufficiently developed. Another experiment, made possible by the development of new techniques enabling very small angles of scattering to be measured, had shown the existence of diffraction patterns in the scattering of high-energy protons from the nuclei of various atoms. In the study of the so-called 'weak' nuclear interaction, the experiment on antineutrino interactions, for which the accelerator run was carried out in May, practically completed the present phase of CERN's neutrino programme, although preparations were in hand for the next series of experiments under improved conditions. Another CERN experiment on the effects of the weak interaction had lent strong support to the idea that the basic laws governing the interactions of nuclear particles might after all depend on whether time was measured forwards or backwards — requiring a fundamental change in our thinking on these matters —, and a whole new series of experiments was beginning here and in other laboratories.

* CERN/587

Prof. Weisskopf also mentioned the work on the structure of atomic nuclei that was being carried out with the help of the synchro-cyclotron. Since it was decided to do more experiments of this kind, supplementing the sub-nuclear investigations using both the CERN accelerators, much interest had been shown among laboratories in the Member States and there had been many proposals for experiments. Some interesting new developments, such as the measuring of the electric quadrupole moment of various nuclei and the discovery of a new excited state of helium, were coming out of this work.

Internal Organization

The Director General was followed by the Directorate Member for Administration, Mr. G. H. Hampton, who gave a short account of the changes that had been made in the internal organization of CERN over the last year or two, as a result of continued expansion and in the quest for greater efficiency. As an example, incorporation of the Purchasing Office into the Finance Division had meant, among other things, that it was no longer necessary to have two largely overlapping staffs for accounting control. At the same time, purchasing officers were being appointed to serve with the various Divisions, so as to achieve a better co-ordination between individual needs and the benefits of bulk ordering. In the Finance Division as a whole, an overhaul of the 'paperwork' was taking place and an 'organization and methods' officer had been appointed. As well as the new purchasing system, a similar arrangement was being tried with the stores, that is, a large central store supplemented by smaller, more specialist stores where required, and a stores manager had been appointed to co-ordinate the whole. Personnel-record methods were being 'mechanized', and the budget coding system was being changed so as to provide better accounting statistics. In this connexion, the labour cost of jobs carried out in the workshops would now be charged to the Divisions concerned, instead of appearing separately in the Budget, and it was hoped that this would also lead to a better balance between work carried out inside CERN and that outside.

Finally, Mr. Hampton mentioned the efforts being made in the field of social welfare, especially in respect of housing and other facilities for the very large number of transient staff. CERN was also taking the initiative in helping to solve, or at least ameliorate, the various local problems that had begun to take on a more acute form.

Future Programme

Once again at this session, the delegates devoted special attention to a discussion of the proposals for Europe's future activities in the field of sub-nuclear physics research. These proposals, it will be recalled, are in the form of a three-point programme comprising two major new projects — intersecting storage rings as an extension to the present CERN synchrotron and a new 300-GeV accelerator — as well as a series of improvements to the present CERN facilities.

Intersecting storage rings

The first part of the programme to be discussed by the Council was that concerning the storage rings. After an introduction by Mr. Bannier, Dr. Schulte-Meermann (Federal Republic of Germany), Chairman of the Finance Committee, reported on the progress that had been made in defining the procedure to be followed for the establishment and control of the supplementary programme needed for the construction of this major addition to the CERN facilities, particularly as it affected cost control and the relationship with the normal activities and budget. Although final agreement had still not been reached on some points, it was felt that this was only a matter of time and should not act as a deterrent to any decision of principle.

Sir Harry Melville, speaking for the British Delegation, then said that he was glad to be able to announce that the United Kingdom would be pleased to participate in the project and to have this further opportunity of co-operating with its partners in CERN. After Dr. Funke had added Sweden's support, the proposal for the approval in principle of the undertaking was adopted without dissent by the Council*.

This decision, according to Mr. Bannier, will assure the future of CERN-Meyrin, for many years to come. He thanked all those in CERN who had worked on the design and also those in the Council and its Committees, the Government authorities concerned, and others, who had made the decision possible.

Prof. Weisskopf also thanked the Council for their demonstration of confidence, interpreting the decision not only as one of confidence in the intersecting storage rings as such but also in the future of high-energy physics in Europe.

As previously indicated, it is expected that the number of Member States that will actually participate, as well as the first year's budget and the start of construction, will be decided at the next meeting of the Council, in December.

* For more information, see CERN COURIER, vol. 5, p. 99, July 1965.

RESOLUTION ON THE ISR PROJECT

THE COUNCIL,
having examined document CERN/542 (Report on the design study of intersecting storage rings (ISR) for the CERN proton synchrotron);

understanding, at its Thirtieth Session, that many Member States wish in principle to undertake such a project;

being of the opinion that the project proposed in document CERN/542 is a supplementary programme in accordance with the terms of the Convention;

considering that any supplementary programme shall require approval by a two-thirds majority of all the Member States of the Organization;

APPROVES in principle the undertaking, by the Member States who wish to participate, of such a supplementary programme for the construction of intersecting storage rings;

AND SUBMITS this programme to Member States for consideration and for appropriate decision in Council at its Thirty-first Session by those Member States agreeing to contribute financially.

300-GeV accelerator

Turning to the new large proton synchrotron that it is hoped will be built in Europe within the next ten years, the Council received the report on the official offers of sites that had been made by Member States up to the closing date. The response to the request for offers had turned out to be greater than expected, and altogether seventeen proposals, coming from all the Member States except Denmark, Holland, Greece and Switzerland, were available for evaluation (see map on p. 119).

In the course of a preliminary discussion on ways in which criteria for evaluating the sites could be laid down, it was brought out very clearly that this is a European project and not one of CERN alone. In fact it is probable that if European Governments decide to build the accelerator, a new organization, (perhaps covering both the new Laboratory and CERN-Meyrin) will be set up for the purpose. Mr. Bannier pointed out in the discussion that the CERN Council could study the many problems of site selection but could not make any decisions that would be binding on any new body. It was agreed that a comprehensive report on the site offers, from a purely technical point of view, should be submitted to the Council and that the Steering Committee for the 300-GeV project should consider further the question of the way in which a final choice could be approached.

The map opposite shows the location of the sites proposed by the Member States of CERN for a 300-GeV accelerator.
(Ref. : CERN/SIS/R/10899)

0
100
500
1000 km
ASK
OSLO
KONGSVINGER
UPPSALA
STOCKHOLM
COPENHAGUE
Cambridge
MUNDFORD
LONDRES
AMSTERDAM
DRENSTEINFURT
Hamm
BRUXELLES
BONN
FOCANT
MAISSIN-JEHONVILLE
BERTRIX
SARRELOUIS
PARIS
GOPFRITZ
Munich
EBERSBERG
VIENNE
BERNE
CERN
DOBERDO
Trieste
VITORIA
Nice
Marseille
LE LUC
EL ESCORIAL
MADRID
ROME
Bari
Brindisi
NARDO
ATHENES

Basic programme of CERN

The third part of the future programme concerns the development of the existing CERN facilities. On this point, the Director General put forward detailed scientific proposals and analysed their financial implications. The proposals, which were first worked out during 1964, call for improvements in two stages. In the first of these, scheduled to be completed before 1969, the intensity of the proton synchrotron would be effectively improved by increasing the pulse repetition rate, the instrumentation for normal experiments and for neutrino research would be increased (the additional equipment including the proposed new bubble chamber, 'Gargamelle', to be built by France), and the experimental areas would be slightly enlarged. The second phase would involve a new injector for the synchrotron, bringing the overall increase of intensity up to a factor of ten, and a 5-m liquid-hydrogen bubble chamber. If carried through, the improvements included in the first phase, in particular, would put the laboratory in a very strong position, technically, compared to similar laboratories elsewhere, at a time when comparable or more ambitious improvements to other accelerators would still be uncompleted.

Unfortunately, such plans cost money. Together with the expected small growth in utilization, and hence cost, of the present facilities, they would lead to an average growth in CERN budgets (excluding those for the storage rings) of about 11 % per annum, up to 1971. However, in order to keep to the proposed time scale the increases in the first few years would need to be rather higher, and although most Member States appeared to be ready to consider supporting the whole programme, several of them would find it more difficult to approve the growth rates in their contributions that would be needed to get the programme started quickly.

Strong support for the Director General's proposals by the Scientific Policy Committee was expressed by its Chairman, Prof. L. Leprince-Ringuet, who also underlined the specific cuts and delays that would be needed if the money could not be provided. However, to allow more time for consideration of the various points that had been raised, a decision on the provisional budget figures for 1967 and 1968 was deferred until the next meeting of Council. The overall budget total for 1966, amounting to 142 million Swiss francs at 1965 prices. was fixed previously by the Council at its session in December 1964 ●

NEW APPOINTMENTS

Apart from the appointment, as from 1st January 1966, of **Prof. B. P. GREGORY** as Director General of CERN in succession to Prof. V. F. Weisskopf, the Council also approved the following:

– **Dr. G. Ross MACLEOD** as Leader of CERN's Data Handling Division;

– **Dr. Kjell JOHNSEN** as Leader of the new Division that will be set up to carry out the project for intersecting storage rings.

Dr. Macleod is of British nationality and has already occupied the post *ad interim* since September 1963, in the absence of Prof. L. Kowarski, who has been on leave as Visiting Professor at Purdue University, U.S.A. Dr. Johnsen, a Norwegian, has been one of the Leaders of the Accelerator Research Division (see *CERN COURIER*, vol. 3, p. 52, April 1963) and is presently Head of its Study Group on New Accelerator Projects.

– **Prof. L. KOWARSKI,** who returned to CERN in June, has been given responsibility for the performance and guidance of studies, in a longer-term perspective, on data processing as well as on the related problems of communication and collaboration between central laboratories like CERN and the outside groups that use their facilities. Since the scope of these problems is wider than can be handled within the framework of a single CERN Division, Prof. Kowarski will belong administratively to the Directorate staff.

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Prof. L. Leprince-Ringuet

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Mr. E. K. Williams[2]

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Mr. K. Vidas **(Yugoslavia)**

* Adviser ** Substitute
[1] First day [2] Second day

BOOKS

The boundaries of science, by Magnus Pyke (Harmondsworth, Pelican Books Ltd., 1963; 4s. 6d.), is an essay in the philosophy of science rather than a 'popular science' book of the usual kind. Instead of explaining a particular scientific topic it sets out to show something of what science itself is, using examples drawn mainly from the fields of chemistry, physics, biology and astronomy. On the whole, it fulfils this task extremely well, and the book can be read with profit not only by the 'layman' but by many scientists and engineers who have become a little lost in the day-to-day progress of their own speciality.

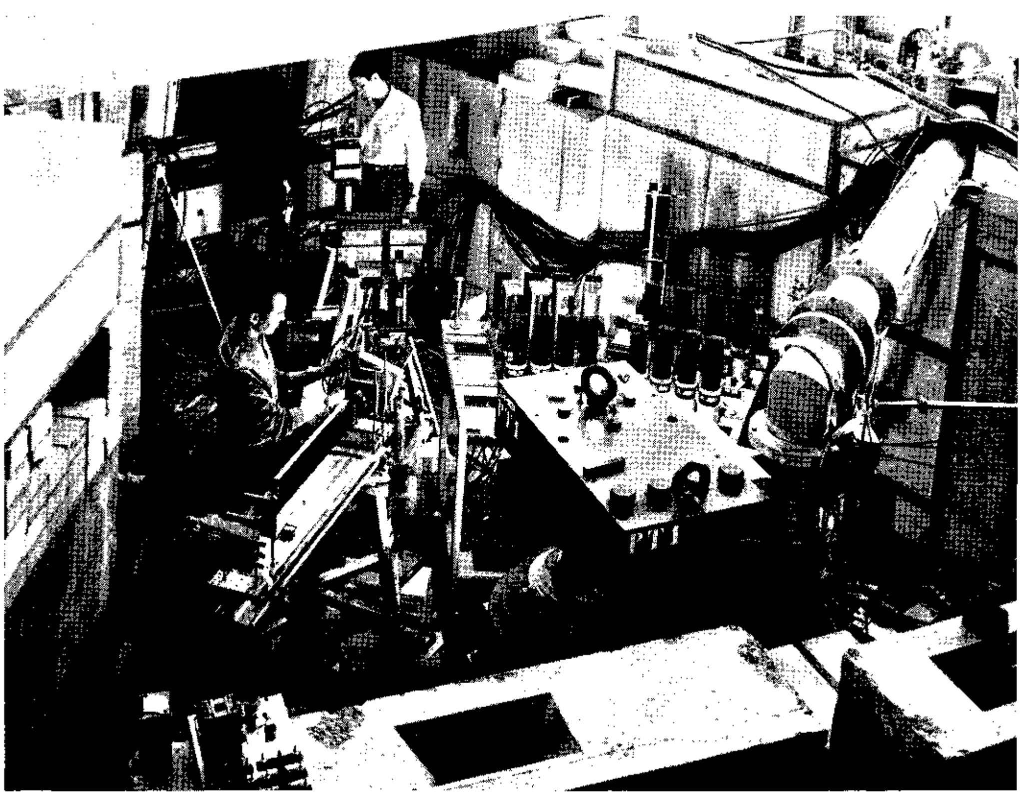
The author, a biochemist and director of a large industrial research station, begins by denying the short dictionary definition of science as 'ordered knowledge' and substituing for it 'a way of thinking'. Science, he believes, comprises two main tenets; the first has three parts — the collection of facts, the construction of hypotheses, and the selection of further observations to test the hypotheses; the second is the assumption that the universe is a systematic and ordered place and that every observation is eventually capable of rational explanation.

One of the legacies of the former view of science has been its sub-division into the branches of physics, chemistry, biology, etc., but more than sufficient evidence is given in the first chapter of this book to show that such sub-divisions are no longer tenable. Even professional specializations, although usually narrower in scope, cut across the former boundaries.

In the second chapter, the author shows how modern chemistry falls much more naturally under the old heading of physics, even if the chemist still has to learn his own particular trade, and physics itself is taken up in the following pages. Is biology chemistry ?, the author then asks, and proceeds to prove that in many respects it is — but as chemistry it is therefore physics ! A common link in all three subjects is the concept of energy, and the next chapter deals with this in its various forms.

If this first half of the book is concerned more with a much needed re-interpretation of established ideas, the second part goes further into the realms of philosophy. The chapter on 'evolution: animate and inanimate' introduces the idea that our present way of thinking about science represents an evolutionary advance, compared with the attitude of Galileo's time, for instance, and goes further to suggest that higher evolutionary steps may be in store. This leads the way to a discussion of the brain as an electronic machine, in the course of which an important distinction is made between 'reflex' actions, which can also be done by electronic computers, and the seeing of new and unexpected purposes, of which only brains are capable. This kind of distinction, between the careful routine of applied science for instance, and the flash of intuition of a Newton, an Einstein or a Heisenberg, is brought more than once into the book.

The traditional 'layman's' idea of science as something exact, with predictable applications, is further undermined in the next chapter, which deals with the lack of precision inherent in words, or even in numbers, the difficulties of ascribing an exact cause to a particular event, the corresponding ease of drawing wrong conclusions because of preconceived notions, and the ideas of statistics. The subject of astronomy is then used as an example to carry the argument forward, concluding with an interesting commentary on the true nature of science: 'Astronomers are not



CERN/PI 97.7.65

This photograph gives a general idea of the scintillation-counter lay-out for the SC experiment on the scattering of polarized protons reported on p. 116. The polarized-proton target is hidden by its magnet (marked PT 1) ; incident protons reach the target through apertures in the concrete shielding (foreground) and the magnet yoke. Protons scattered to the right at any one of eight chosen angles are detected by means of coincidences between the signals from the corresponding pair (one behind the other) of plastic scintillation counters, clearly visible ; absorbers between some of the pairs are for energy measurements. To the left of the target can be seen a long plastic scintillation counter, with two photomultipliers, of the type mentioned by Prof. Cocconi in last month's CERN COURIER (p. 105). Protons recoiling from the target travel in this direction and the position of each one as it strikes the counter is measured, thus defining its direction of travel. In this way each scattered proton can be associated with its corresponding recoil proton, separated from the general background. Other counters in the background are used in lining up the beam. G. Goignet is adjusting the counter on the left and J. Monmejat is at the back.

really interested in firing ironmongery round the moon, what excites them is the fact that they feel themselves to be on the verge of learning something fundamental about form, order, and change in the world at large'. It would be easy to substitute 'high-energy physicists' for 'astronomers' in this statement.

The boundaries of science are reached in the last chapter, which summarizes many of the foregoing arguments and introduces Gödel's 'incompleteness theorem' to show that there is an absolute philosophical limit to physical thought — human reason is incapable of achieving a watertight proof of its own rationality. One of the boundaries of science is thus the mind of the scientist; the simplicity of the final atomic particle (assuming it to exist) is the end and the uprovable mathematical principles by which it is governed is the boundary. On the other side, the frontier is the complexity of biological chemistry. 'It is inconceivable that anyone ever will be able to make a shearwater', says the author, and who will disagree with him ? The third boundary is of a different nature, but just as real : 'Purpose, aesthetics, impulsiveness, ethics — these are outside the boundaries of science', is the last sentence in a well-written, intelligent and thought-provoking book which, with 200 closely printed pages, 'pocket' format, for 4/6, is very good value for money. There are a few errors of fact, and the discussion of elementary particles is now out of date, but in this context such things are not so very important.

A.G.H.

Plutonium, by M. Taube (Oxford, Pergamon Press Ltd., 1964; 60 s.).

Only twenty years ago, in the course of a piece of pure scientific research, the first man-made elements, with atomic numbers 93 and 94, were produced. Now we have a book surveying the tremendous wealth of detailed knowledge that has been accumulated concerning the physics, chemistry and metallurgy of the element plutonium, an element which is now produced in a few countries in ton quantities annually and whose appearance has meant multiplying by a large factor the world's known reserves of energy, both those for peaceful purposes and those for self-destruction. Until the last few years all of this knowledge was a matter of tightly held secrets for these few countries, but at the 1958 U.N. Conference on the Peaceful Uses of Atomic Energy there was a sudden rush to release this information.

The present book unfortunately contains no references later than 1961, but nevertheless provides a useful broad outline of the subject and a very large list of references for those who wish to know more. The opening chapter describes the physical properties of plutonium and, in particular, the characteristics of the neutron interactions with the various isotopes. The author is a chemist, however, and it is on the chemistry of plutonium that he is at his best and goes into the greatest detail. Many block diagrams and tables are used to describe the various processes for the separation of plutonium from uranium and fission products, its analysis, and general chemistry. Plutonium is one of the most toxic substances known and a special chapter is devoted to the physiological effects of plutonium, and its health physics. The later chapters deal in detail with the metallurgy of plutonium, its preparation into fuel elements for nuclear reactors, and its influence on the economics of nuclear power.

This edition is a translation from the original Polish one. The result of the translation is a quite readable work and only one serious error was noticed — the confusion between the use of 'delayed' as applied to neutrons resulting from the time-delayed radioactive decay of fission products and its wrong use when applied to neutrons which are really 'slowed' (on a velocity scale) by collision. In his efforts to be as complete as possible, the author has unfortunately dragged in a variety of irrelevant pieces of information, such as the photograph of a large white building with a chimney which is supposedly a plutonium factory but could equally well be a gas work. This is a minor criticism, however. The book is a useful work.

C. R. Symons

The structure of atoms and molecules, by V. Kondratyev (Groningen, P. Noordhoff N.V. ; Dfl. 30).

This book, translated from the Russian into English by G. Yankovsky, covers a great deal of ground : experimental methods, numerical results, models that explain the results, and quantum theory for the derivation of the models. Such a method of presenting experiment and theory at the same time emphasizes the physical concepts and makes the book easy to read.

The main topic of the book is, as might be expected, atomic and molecular spectroscopy, and the chapter headings are : electrons and quanta, atomic nucleus, electronic structure of atoms, the quantum-mechanical theory of the atom, the spectroscopy of atoms, the atom in a force field, the nature of chemical forces, molecular spectra, electrical and magnetic properties of atoms and molecules, molecular constants. An idea of the level at which the book is written can be gained from the fact that the second chapter, covering the whole range of nuclear physics, does not include any quantum mechanics. Bohr's quantum condition comes in the middle of chapter 3.

A theoretical physicist may be slightly disappointed : Dirac's equation, the Hartree-Fock method, and the theory of radiative transitions, for example, are omitted ; the method of adding angular momenta is not properly derived. Such things as the periodic system of the elements, on the other hand, are nicely explained. The book contains numerous figures and tables, but unfortunately there is no author index and the subject index is very short.

H.P.

Radiation sources, edited by A. Charlesby (Oxford, Pergamon Press Ltd., 1964 ; 80 s.).

This volume (which includes the work of several authors) describes the sources of ionizing radiation that are used particularly in the field of applied radiation and in industry, either for chemical, biological, medical or agricultural research, or for sterilizing food.

The various chapters deal briefly but clearly with the following subjects: nuclear reactors (with the exception of very powerful ones or those used for military purposes); high-intensity isotopic radiation sources; Van de Graaff accelerators; electrostatic-cylinder generators; resonant-transformer electron-beam generators; powerful sources for industrial irradiation; and linear accelerators. Technical details concerning installation in a laboratory, as well as capital and operating costs of the equipment, are given for each type.

A chapter is included on radiation protection in the laboratory and in industrial plants, and another (very short) on measuring energy and neutron fluxes.

The book is obviously a practical one, intended to serve as a guide for those wishing to instal radiation sources of a certain power for research, clinical or industrial purposes. It consists of 268 richly illustrated pages covering the various types of equipment and their installation, and there is a wealth of diagrams and tables. The bibliography, which is given separately for each chapter, has been brought up to about 1961.

Antonio Pasinetti

Last month at CERN (cont.)

promising technique for experimental physicists, from the points of view of both ease of transport and ease of operation.

Annual General Meeting of CERN Staff Association

On Wednesday 2 June the Main Auditorium at CERN was well filled for this year's Annual General Meeting of the Staff Association. Representatives from the Staff Council of the United Nations were also present and messages were received from the Staff Associations of the World Health Organization and the International Telecommunications Union, who were unable to send observers.

A summary of the activities of the previous year was given by Dr. G. Vanderhaeghe, the retiring Chairman of the Association, and both this report and the financial report were unanimously approved by the meeting. An important task of the Committee had been to make a careful examination of the **Statutes of the Association,** in the light of experience since it was set up and of the growth and consequent changes that have taken place in CERN as a whole. As a result, a completely revised set of Statutes had been produced and circulated before the meeting. These were adopted in principal, but a committee is to be charged with their final drafting, in the two official languages of the Organization, before final submission to the members of the Staff Association for approval.

An important organizational change adopted in the new Statutes was that in future, instead of the separately elected Committee and Chairman, there will be an elected Staff Council, which will itself elect an Executive Committee, including a Chairman, from among its own members. Moreover, to provide continuity, only half the Council will retire each year, each member being elected for a 2-year period. Among other things discussed at the meeting, the previous Committee's proposals for new electoral groups for the election of the Council were approved unanimously. The proposal to maintain annual subscriptions on a voluntary basis and at the previous levels (Fr. 5.– for grades 2 to 5, Fr. 10.– for grades 6 to 9 and Fr. 15.– for grades 10 to 14) was also approved, after various other suggestions had been put forward.

In the **elections** that took place later in the month, 44 members were appointed to the Council, with 32 deputies. The **Executive Committee** has been appointed as follows:

Pierre Lazeyras	President
Jacques Gioria	Vice-president
Aldo Michelini	Vice-president
Joan Rice	Secretary
Claude Degrange	Treasurer
Eugénie Iseli	Journal ●

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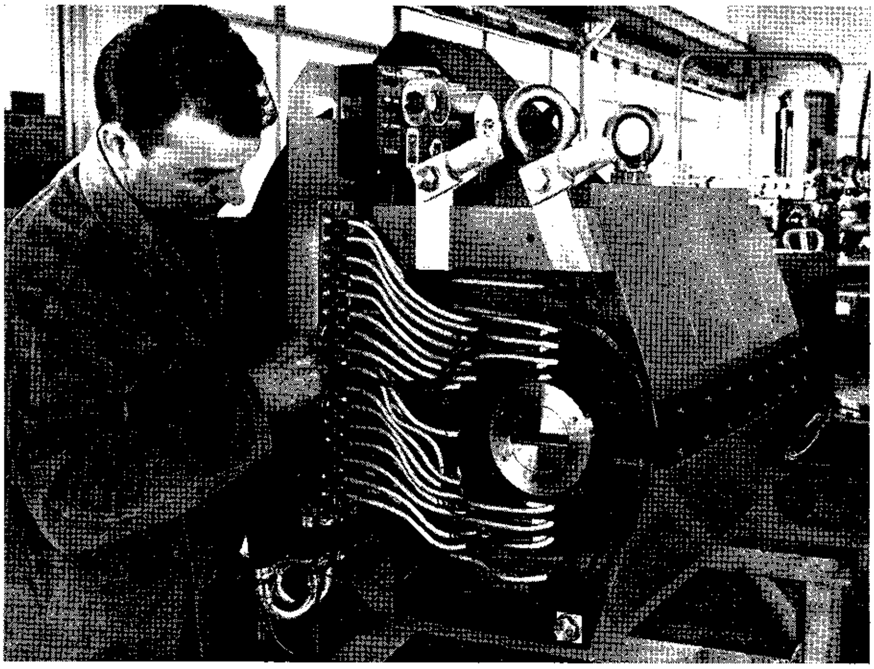

Because particles such as protons, pions and kaons can be guided from one place to another and 'sorted' in momentum by magnetic fields, in much the same way as light can be sent from place to place (and 'sorted' into different colours) by means of prisms and lenses, the design and construction of suitable electromagnets plays a large part in the technology of sub-nuclear physics. In this photograph, Antoine Magouriotis, of CERN's TC Division, is seen with a new magnet (TC 15) developed in the Division and now installed at the beginning of the m_5 beam line which provides antiprotons, pions or kaons for the 81-cm Saclay/Ecole Polytechnique (Paris) hydrogen bubble chamber. It is this magnet which directs the particles away from the synchrotron towards the next magnet in the beam line. It is small, so that it can be fitted close in to the target, and powerful since it has to bend the particles as soon as possible in the direction of the bubble chamber. The distance between the poles is 21 mm and the pole length 840 mm (effective length 870 mm). A field of 21 300 gauss is produced, using a total current through the coils of 800A with a current density of $50 A/mm^2$. This exceptionally high value is obtained by using an advanced system of cooling for the coils, and the connecting pipes for the many parallel circuits are clearly seen in the photograph ; it is of interest to compare the thickness of the bus bars carrying the current to and from the coils with the thickness of the coil conductor itself.

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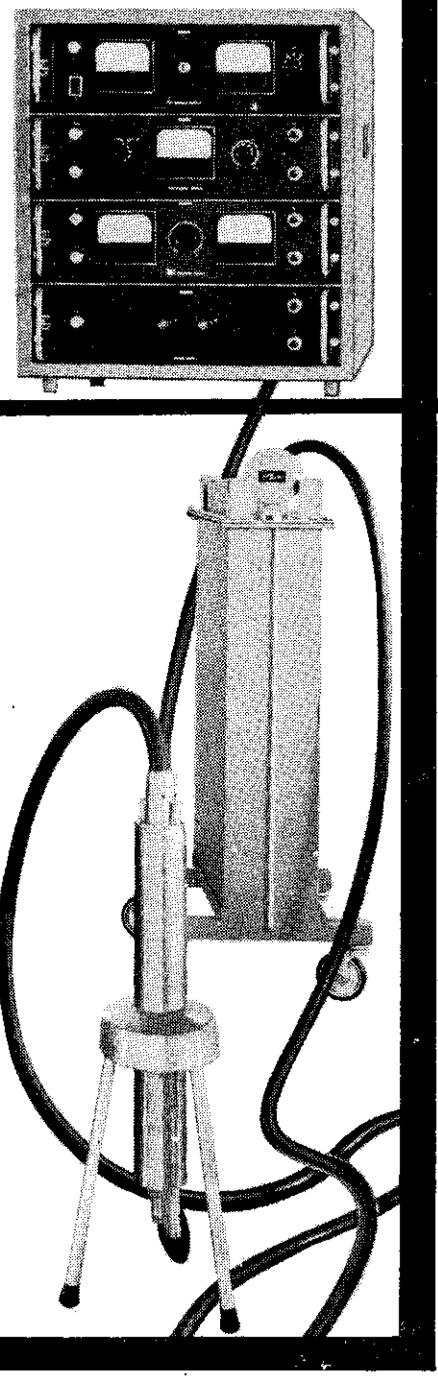

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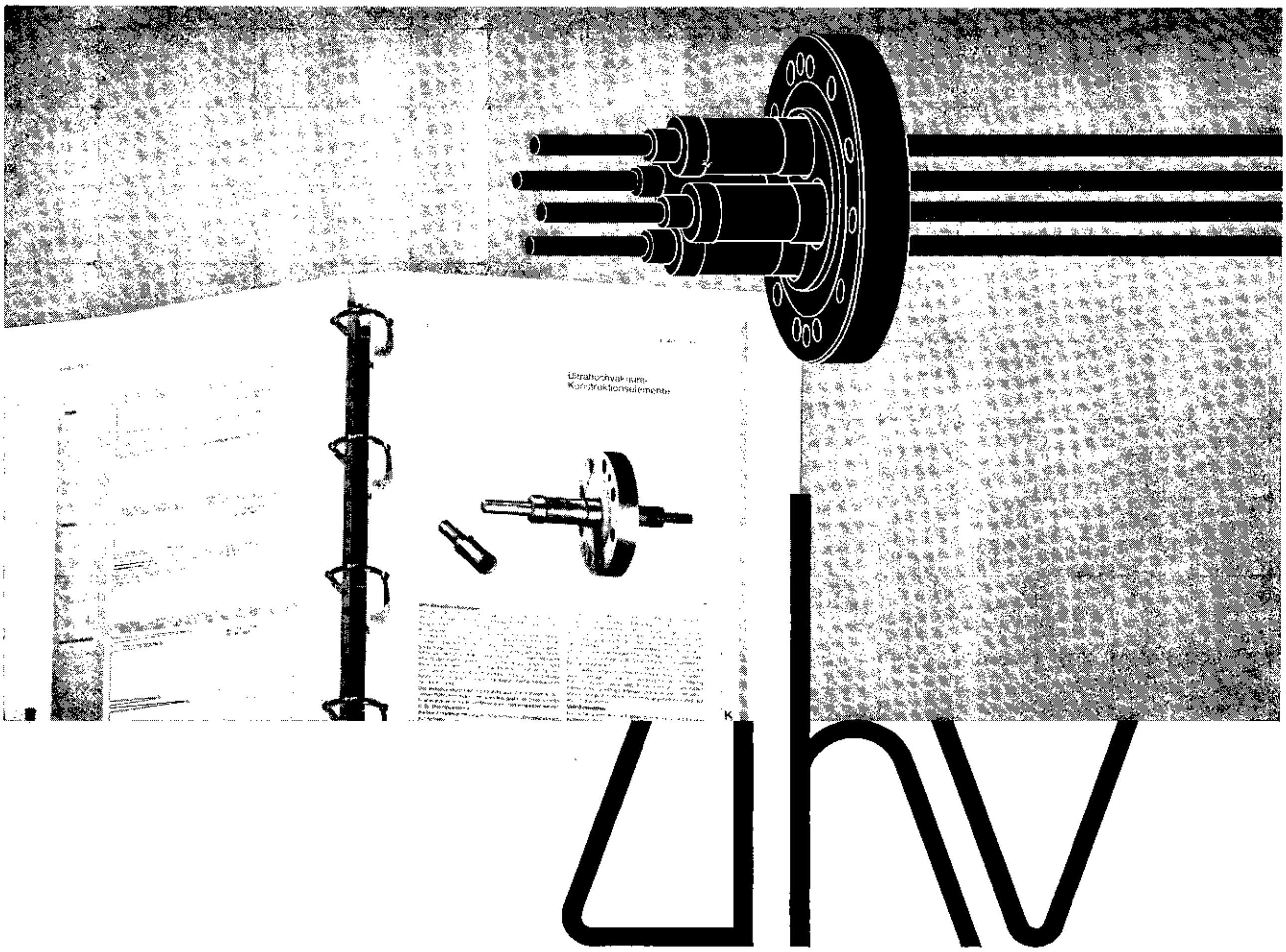

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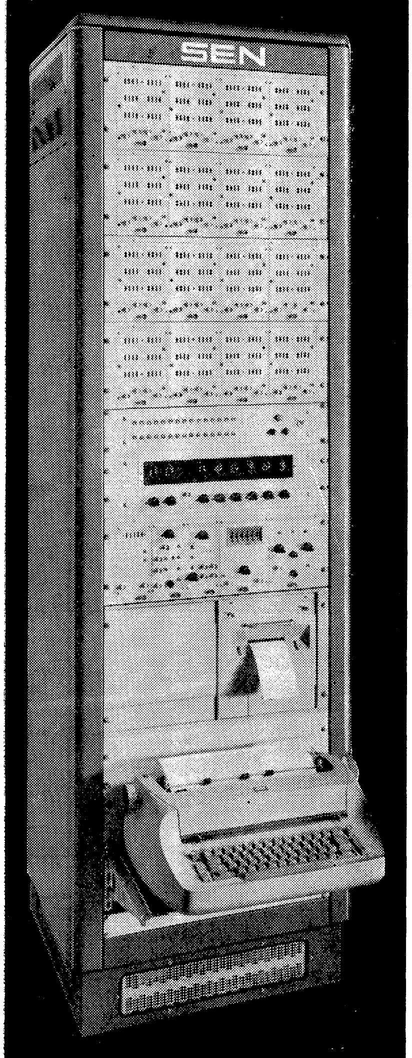

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