CERN COURIER

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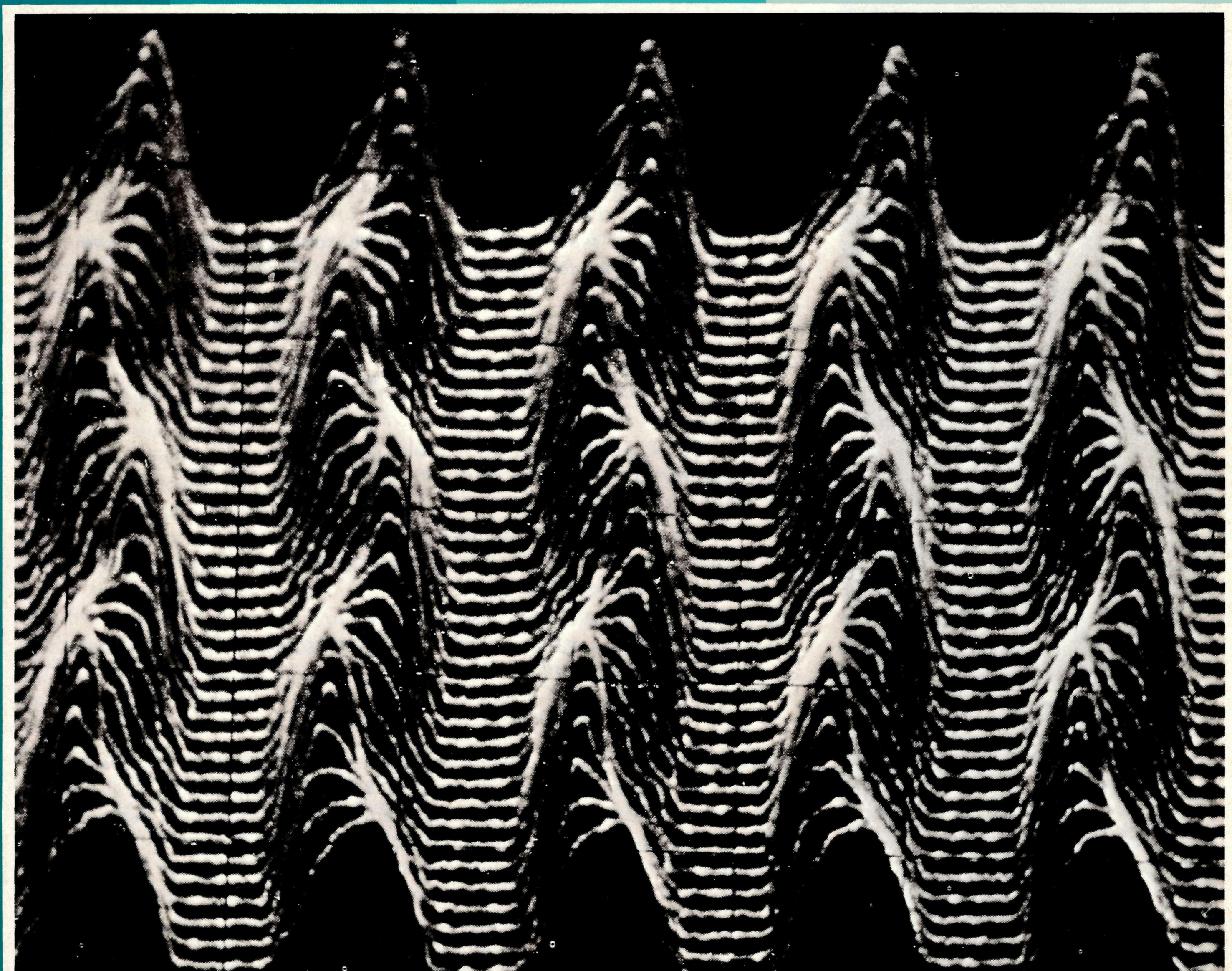

CERN, the European Organization for Nuclear Research, was established in 1954 to '... provide for collaboration among European States in nuclear research of a pure scientific and fundamental character, and in research essentially related thereto'. It acts as a European centre and co-ordinator of research, theoretical and experimental, in the field of sub-nuclear physics. This branch of science is concerned with the fundamental questions of the basic laws governing the structure of matter. The Organization has its seat at Meyrin near Geneva in Switzerland. There are two adjoining Laboratories known as CERN Laboratory I and CERN Laboratory II.

CERN Laboratory I has existed since 1954. Its experimental programme is based on the use of two proton accelerators — a 600 MeV synchro-cyclotron (SC) and a 28 GeV synchrotron (PS). Large intersecting storage rings (ISR), are fed with protons from the PS for experiments with colliding beams. Scientists from many European Universities as well as from CERN itself take part in the experiments and it is estimated that some 1500 physicists draw research material from CERN.

The CERN Laboratory I site covers about 80 hectares almost equally divided on either side of the frontier between France and Switzerland. The staff totals about 3100 people and, in addition, there are about 1100 Fellows and Scientific Associates. Twelve European countries contribute, in proportion to their net national income, to the CERN Laboratory I budget, which totals 382.9 million Swiss francs in 1973.

CERN Laboratory II came into being in 1971. It is supported by eleven countries. A 'super proton synchrotron' (SPS), capable of a peak energy of 400 GeV, is being constructed. CERN Laboratory II also spans the Franco-Swiss frontier with 412 hectares in France and 68 hectares in Switzerland. Its budget for 1973 is 188 million Swiss francs and the staff will total about 370 people by the end of the year.

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Cover photograph: The mountain ranges were produced on an oscilloscope screen by the signals from a wide band pick-up station in the 800 MeV Booster at the proton synchrotron. The pick-up station was watching the behaviour of the five bunches of protons which orbit a Booster ring. Each trace across the screen records five pulses corresponding to the current in the five bunches passing the station. This is repeated every third turn around the ring giving the successive traces going vertically up the screen. This particular photograph records coherent bunch motion—one of the beam instabilities which have been seen in the Booster.

50th Session of CERN Council

The Council met on 20,21 June under the Presidency of Professor W. Gentner

Some physics from the CERN machines

The Director General of CERN Laboratory I, Professor W.K. Jentschke, reported on some of the highlights in the physics programme at the CERN accelerators.

The Intersecting Storage Rings, with the very high energy particle collisions which they make possible, continue to provide completely new, fascinating information on particle behaviour. Results published since the last Council meeting include the measurements on the total cross-section for the proton-proton interaction (see March issue, page 67) which, against general expectation, revealed that the interaction probability at high energies grows with increasing energy. The region of influence of the proton grows as its energy increases and this is a new insight into the nature of the strong force governing the proton behaviour.

A second surprising result, which has been reported to Council before (see January issue, page 3), concerned the number of particles which bounce out at very wide angles from the near head-on collisions in the ISR. About one in a hundred million collisions results in particles emerging with high transverse momentum (over 4 GeV/c). This is about ten thousand times higher than was expected from what had been seen at lower energies. It implies that, whereas a proton colliding with a proton normally results in the two particles brushing through one another with comparatively modest effects, occasionally something hard runs into something hard and particles can then fly off in any direction. Doing the sums reveals that the phenomena observed are probing the structure of the proton at the level of less than 5×10^{-15} cm.

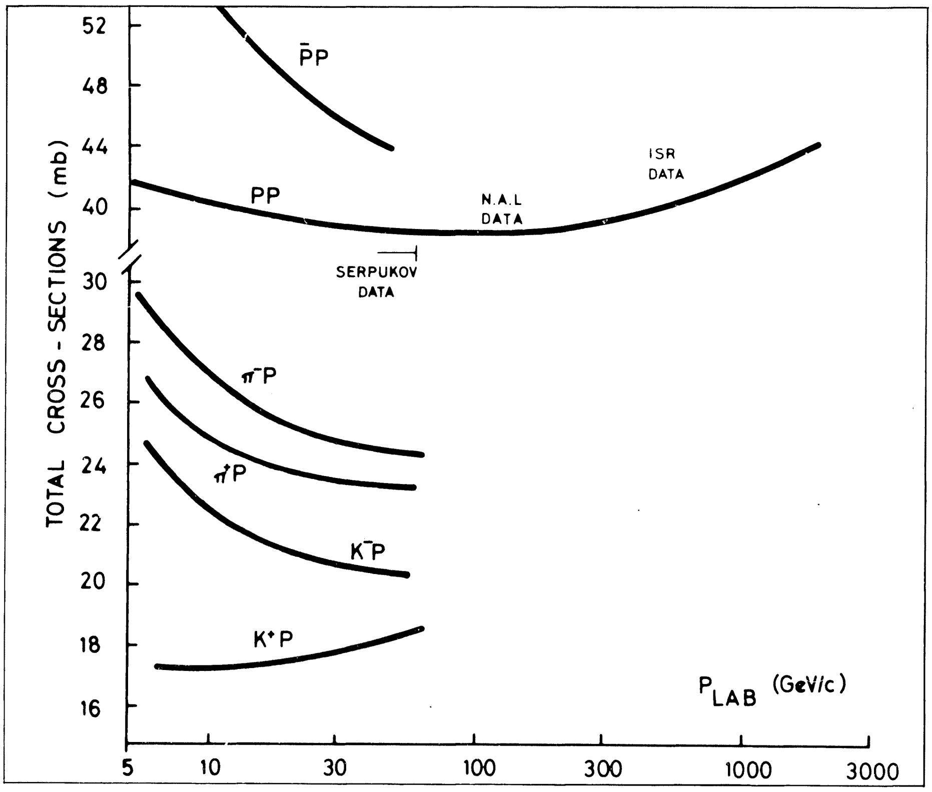
A popular interpretation is that such collisions are occurring between massive, point-like 'partons' — hypothetical constituents of the proton. If this is so, a high transverse momentum particle emerging on one side of the colliding beams should usually be associated with another jet of particles, further produce of the collision, emerging in the opposite direction. The latest results are qualitatively in agreement with this picture. High transverse momentum particles do have these other particles in association with them. The more massive kaons and nucleons are more common than usual in ratio to pions and both jets are predominantly positive in total charge — these properties are predicted by the parton-parton collision model.

Another recent result is the observation of very massive resonances. At lower energies resonances up to about two proton masses are well known; the resonance subsequently decays into a nucleon and a few pions. It was expected that similar phenomena would be seen at the ISR but not out to as far as a resonance of twelve proton masses such as has now been seen. The production and decay of this massive particle will obviously be studied further.

At the 28 GeV proton synchrotron the days of the 'exploratory' experiment are largely over and have been succeeded by the days of the 'high statistics' experiment studying already known phenomena in great detail. One such experiment has now assembled a welter of detail on interactions between pions.

The role of the pion is fundamental in strong interactions; it is by the

The general trend of cross-sections for differents interactions between particles as the energy increases. The probability of the proton-proton interaction taking place (as studied at the high energies available with the Intersecting Storage Rings) increases as the energy goes higher, contrary to expectation.



The 'candidate' for antineutrino-electron scattering recorded on film from the Gargamelle heavy liquid bubble chamber. An antineutrino entering the chamber from the left scatters an electron producing the track apparently starting by itself and travelling across the photograph.

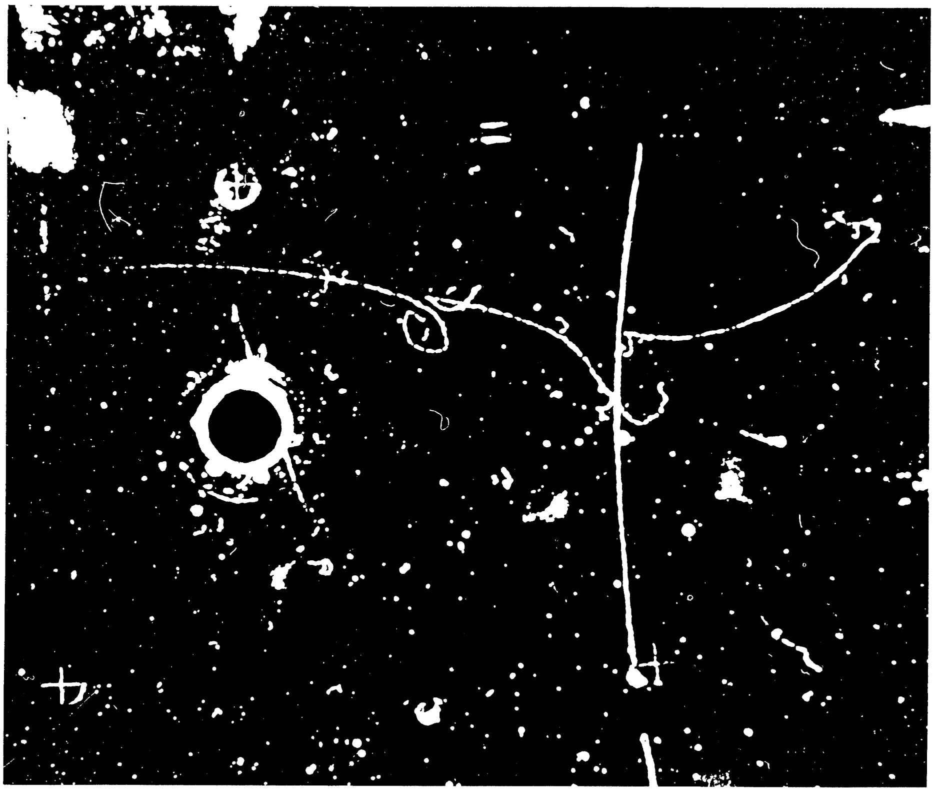
exchange of pions that the strong force is transmitted from one place to another. But sorting out how pions interact among themselves is a difficult task. With their short lifetime (around 2×10^{-8} s) they cannot readily be isolated and brought into interaction in the clean way of the proton-proton collisions in the ISR. Nevertheless, it is possible to produce a beam of pions from a target hit by high energy protons and these pions can be directed onto another target.

Careful analysis of what happens in this second target can distinguish the effect of the interaction between an incoming pion and a 'virtual' pion associated with a nucleon in the target. For example a negative pion brushing against a proton can be thought of as brushing against a neutron linked with a positive pion. The two pions can emerge together leaving the neutron.

Studying this at the PS has yielded new information on the pion exchange process and on the pion-pion interaction in the energy range 600 to 1900 MeV. In particular it adds fresh evidence for the existence of the rho prime meson (of mass 1600 MeV) which has already been spotted in a four pion decay mode at electron machines (see March issue page 78).

The hot topic in the PS programme is the search for signs of electron-neutrino scattering in the heavy liquid bubble chamber Gargamelle. Such events are predicted by theories which could unify the interpretation of weak and electromagnetic interactions and thus be of very great importance in bringing together aspects of our understanding of Nature which up to now have been kept in separate compartments.

Since the December Council meeting one candidate for such an event has been picked out from the 800 000 photographs taken last year. The search is being continued in further experiments with Gargamelle.



The 600 MeV synchro-cyclotron finished operation on a high note prior to its long shutdown for implementation of the improvement programme. A fiendishly difficult experiment has started to try to measure transitions in a muonic helium atom (where a negative muon has come under the influence of the positive nucleus). Just before the shutdown it looked as if transitions were being seen and that the adventurous experiment would bear fruit after all.

The aim is to carry out yet another very refined test of the laws of quantum electrodynamics which have so far held good over an enormous range of study. They predict very small corrections to the classical Coulomb force. In particular electron-positron pairs appearing and annihilating in the vicinity of a charge causes what is known as 'vacuum polarization' and slightly alters the energy levels in an atom. With a muonic atom the muon lives much closer to the nucleus in a region of more intense electric field and the effect on the energy levels is more pronounced. It looks as if transitions between levels can be measured and QED put under the microscope again.

Budget problems in Laboratory I

In December of last year, the Council voted on budgets for coming years in accordance with what is known as the Bannier procedure. This involved approving the budget for 1973, a firm estimate for 1974 and a provisional determination for 1975. Normally a provisional determination for 1976 would also have been approved but it was postponed until the June 1973 session to give time for a further look at the long term implications of voting the proposed figure.

To understand where difficulties have arisen it is necessary to go back

The mole appears again. The head of the Robbins boring machine, which set off from straight section 1 of the SPS in February, emerged 1.2 km round the ring at the gallery of straight section 2 on 14 June within 3 cm of its scheduled position — to the joy of the machine builders who can now be more confident that they are not building a separated orbit cyclotron.

a few years to the time when the SPS project in Laboratory II was authorized. Laboratory I became part of the package deal in giving the go-ahead to build the new machine alongside the existing Laboratory. The budgets which had been discussed for the years when all the improved facilities would be in action at Laboratory I were cut back to reduce the extra expenditure falling on the Member States with the construction of the SPS.

At the same time there was concern to ensure sufficient exploitation of the improved facilities to justify the considerable investment they had involved. Therefore a series of budget figures for Laboratory I during the construction years of the PS were drawn up and agreed in discussions with the Council (though each annual budget is not definitive until formally voted by the Council the preceding December). This is often referred to as the 'gentlemen's agreement'.

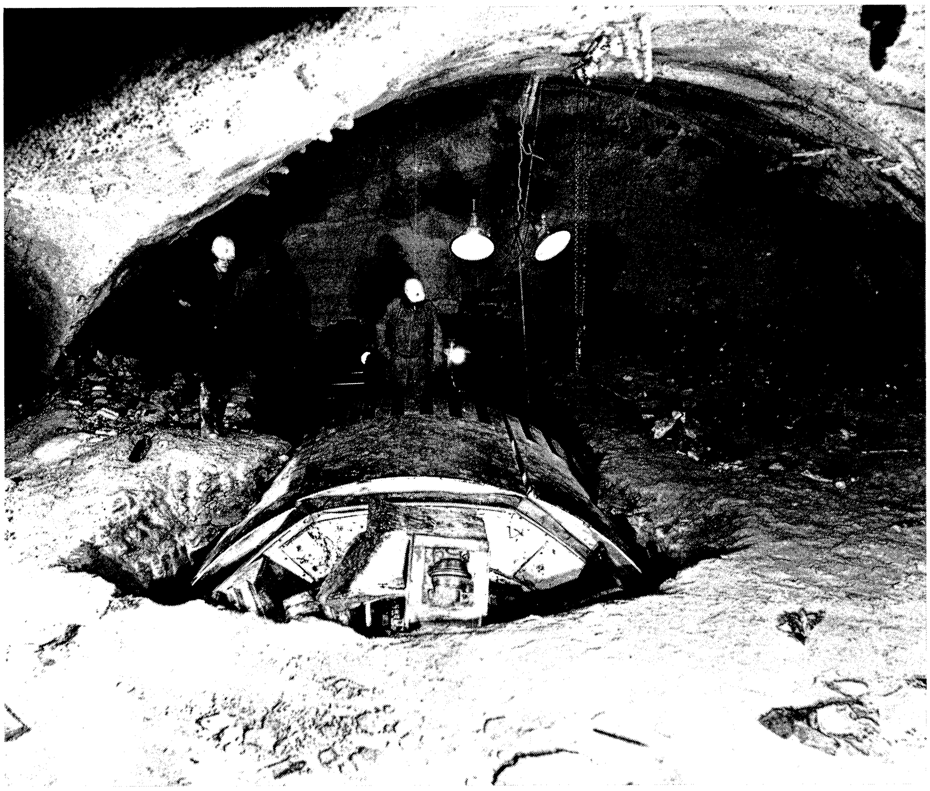
Without loosing their claim to be gentlemen, several delegations have had to call for reductions in the anticipated figures. Soaring inflation in Europe has had its inevitable effect on the CERN expenditure (which moves each year with a 'cost variation index') and the figures now look much higher. When national science budgets do not move so fast, the size of the contribution to CERN can have complicated internal repercussions.

CERN has carried out a long and detailed programme and budget review and the latest information on this was presented at the Council meeting. In addition to the cuts mentioned above, Laboratory I has to find a substantial amount of money to prepare for physics at the SPS (the equipping of beam-lines and experimental areas), so much so that a deficit of about 70 million Swiss francs appeared in the sums for the four years 1974 to 1977.

The knife was brought to bear on Laboratory I. Administrative services were reduced severely, staff numbers were held down, technical development (other than in preparation for SPS physics or, to a modest extent, for the ISR) was stopped. The physics programme was cut back by reducing bubble chamber output, running time of the ISR, exploitation of the West experimental area and use of high intensity Booster beams. Doing the sums after these cuts indicates a deficit of 57 MSF over the four years. The financial difficulty is not evenly spread over the years but grows from early years, when effort is mainly on design, towards the end, as the bills for equipment arrive. To avoid a peak appearing in the budgets, money is being set aside in a Special Fund (19 MSF in 1973) to be used for preparations for SPS physics. But there still remains a lot of money to be found.

The programme was then studied again. Several sections were left untouched — preparations for SPS physics (which implies CERN's future research), the ISR physics (which is unique in the world and giving fascinating results) and the synchro-cyclotron (which for comparatively little outlay provides research material for a large number of physicists who, certainly until the start-up of the SIN accelerator at Villigen, have no equivalent machine in Europe).

This leaves the proton synchrotron and the proposed cuts are — to close the North experimental Hall and to close the South Hall, to close down the heavy liquid bubble chamber Gargamelle (though it may have a future at the SPS), to close the South-East Area when the g-2 experiment is complete, to go slower on building up the computer facilities. If this does not prove to be enough, then the SC, ISR and SPS experimental



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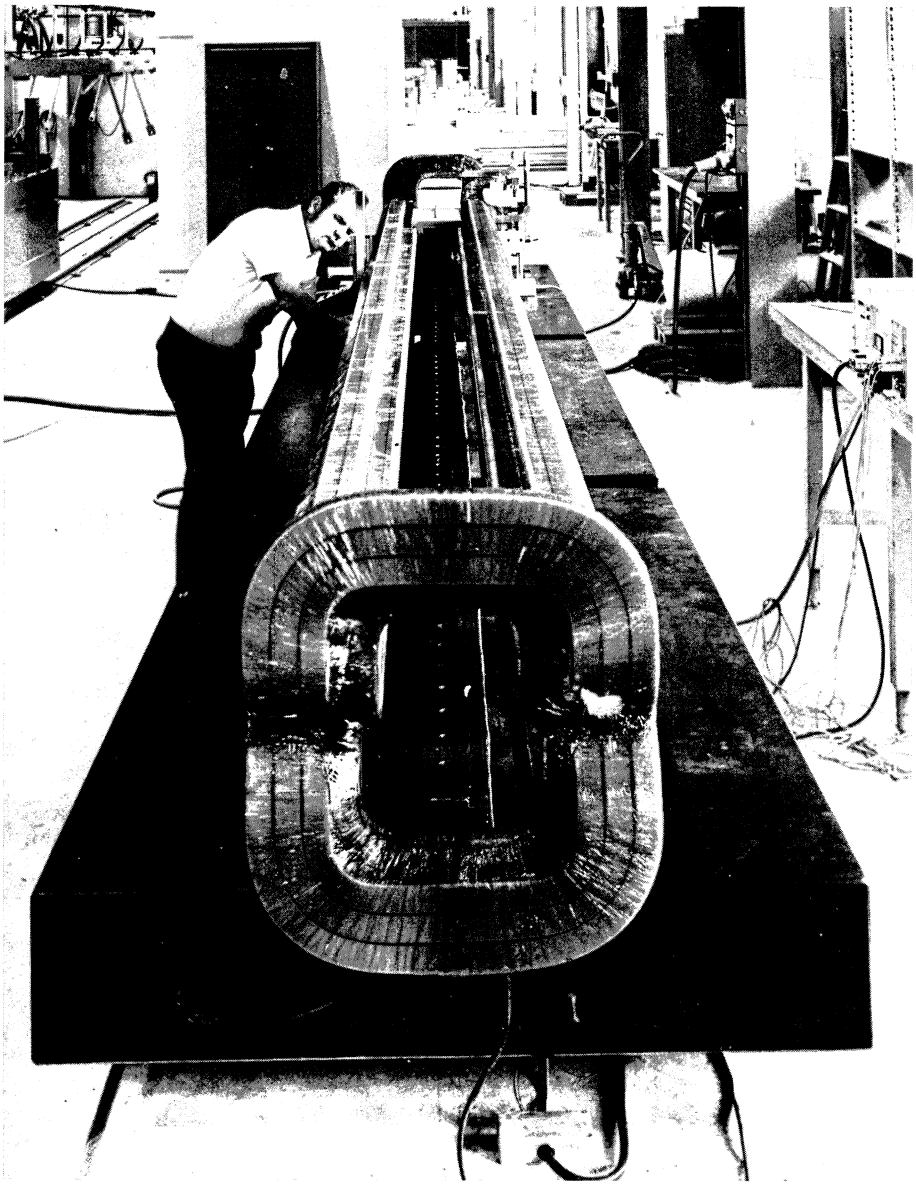


Bending magnet coils for the SPS which have arrived at CERN. These first coils are being severely tested before the magnet production and testing chain gets fully underway later this year.

CERN 440.5.73

programmes will have to come under the axe also.

With the realization that the CERN physics programme will inevitably have to be reduced even with the 'gentlemen's agreement' figures, CERN urged the Council to approve the provisional determination for 1976 (379.2 MSF at 1973 prices). However, to allow still more time for discussion the decision was postponed until December.

Progress in the construction of the SPS

The Director General of CERN Laboratory II, Dr. J.B. Adams, reviewed events in the construction of the new accelerator. The most obvious developments are still in the domain of civil engineering but machine components are beginning to arrive on the site and the emphasis will shift in the next few months.

The huge assembly hall has been made ready to receive components, about half of it being given over to assembly and testing areas for the hundreds of magnets. One of the office and laboratory blocks is fully occupied and a second block is almost ready. (The move of the Laboratory staff to their permanent quarters was completed in July.) A third block, which contains services such as a bank, post-office, etc..., is scheduled for completion later this year.

Meanwhile, deep underground, the mole has been seen again. The large boring machine broke through into the gallery from access shaft 2 on 14 June. The length of tunnel bored out from shaft 1 was 1.2 km and it was very gratifying to see that the survey and alignment techniques were working so well that the mole emerged within 3 cm of its scheduled position.

The boring of the tunnel is behind schedule (though not out of line with the overall machine construction programme). Operation of the mole and its tunnel lining and spoil removal train has been re-scheduled and other measures taken for excavating the long straight sections so as to speed the completion of the tunnel. Boring is going faster now and a maximum rate of 30 m a day has been achieved.

Prototype half-cores for the main magnets have arrived from the manufacturers. The first coils for the two types of bending magnet have also been manufactured and are being submitted to rigorous tests involving thousands of thermal cycles and high voltage tests after immersion in water. The first production magnet has been assembled and the measurement routines using computer control have been checked out. The first of the quadrupole magnets will follow soon.

Two cell's worth of the travelling wave structure to be used in the r.f. accelerating cavities have comfortably exceeded their design requirements in the laboratory. Tests are also under way on units for the injection and ejection systems. The ejection systems in particular involve some of the trickiest components of the machine. Development work on electrostatic septum magnets has gone well and construction techniques for producing a long wire septum are now fixed. A full length prototype (3 m long) is being made.

The first three of the 24 computers which will be used in the machine control system have arrived at CERN and are performing well in their first tests. The planning of the experimental areas is well advanced and has of course been greatly influenced by the various discussions involving the high energy physicists who will be using the accelerator.

Decisions affecting the SPS

When the plans to construct the SPS were laid before Council for decision several years ago, they had several options built into them which could be taken up according to how technical developments and construction progress evolved. In particular there was the possibility of incorporating superconducting magnets in the main ring of the machine. The stage has now been reached where the decisions concerning these options have to be taken.

The first magnet contracts for the SPS were placed for conventional magnets but only half-a-ring's worth were ordered. These would have been distributed around the ring according to the 'missing magnet' scheme (see vol. 10, page 109) and would have held a beam accelerated to 200 GeV. Meanwhile the GESSS collaboration (involving Karlsruhe, Saclay and Rutherford) attacked the problems associated with pulsed superconducting magnets. Had these problems all been resolved, superconducting magnets could have been fed into the empty spaces of the ring to cater for a beam accelerated as high as 500 GeV.

The situation with regard to pulsed superconducting magnets was summarized in the April issue, page 117. Essentially, they have been shown to be technically feasible but there has not yet been time to check how reproducibly magnets can be manufactured and how reliable they are in long-term operation (see later in this issue for news of Brookhaven's work on these problems). Also costs and timescales are tentative because industry has not yet been able to get its teeth into mass producing such magnets. As an example of the cost estimates — a magnet of 8 cm aperture could be about 62 000 Swiss francs per metre (magnet about 48 000, plus refrigerator 14 000). The timescale through to commissioning a superconducting accelerator is estimated as 10 years from now. These figures are clearly outside the limits of the '300 GeV programme' approved by the Council.

Incorporation of superconducting magnets in the missing magnet lattice was also seen as a route to considerably higher energies at a later stage. A subsequent substitution of the half ring's worth of conventional magnets by superconducting magnets would give a machine of 1000 GeV potential. However the GESSS committee also looked at this possibility and concluded that if the physics interest and the financial climate ever opened the door to 1000 GeV, the missing magnet lattice was not the best, or cheapest, route. (This also was detailed in the April issue.)

It is proposed therefore to shy away from the incorporation of superconducting magnets in the SPS main ring and to complete the machine with conventional magnets. Within the provisions of the programme authorized by the Council, it is possible to purchase and install enough magnets to fill the ring. This gives the machine the capability of reaching 400 GeV.

Finally, it is proposed to follow what is known as 'Schedule C' in constructing and commissioning the machine. In line with the various options and energy stages, several schedules have been on the table. Schedule C involves installation of all the magnets before commissioning so that the machine will have 400 GeV potential from first operation. Accelerated proton beams will be fed to the West experimental areas by the end of 1976 and the North experimental area by early 1978.

These proposals were approved by the Council.

Schooling of CERN children

The progress of the consultations between the French authorities and CERN concerning the schooling of children of CERN personnel was reported to Council. As described in the May issue (page 146) a Colloquium was held at Sèvres to discuss the pedagogical structure of a schooling system adapted to the needs of both the French families of the region and the CERN community.

The outcome of the Colloquium was considered to be very satisfactory by the Council and several delegations declared the intention of their educational authorities to participate in the schools. Some countries, however, have formal difficulties in finding a mechanism whereby teachers could be sent to the schools and administrative measures to get around these difficulties remain to be found. Many other administrative aspects of the schools are not yet clear.

The French government was asked to make known its programme for implementing the system. At the same time CERN was asked to provide information on the numbers of children likely to frequent the schools. A survey of all parents with children of school age has been conducted within CERN and has revealed virtually unanimous support for the type of schooling system which is proposed. The results of this survey will be used to provide the French authorities with numbers for the children who may go to the schools from September of this year or in later years when the system is really on its feet.

The Council expressed its strong support for the work which is being done to try to find a good solution for the schooling of children of CERN personnel.

Staff Rules and Regulations

The Council approved a variety of changes to the Staff Rules and Regulations which, in effect, spell out the conditions under which people work at CERN. Most of them are of purely internal relevance but some themes have been incorporated which merit wider attention.

The Council relaxed on the evening of 20 June and celebrated the twentieth Anniversary of the founding of CERN. The Convention establishing CERN was signed in Paris on 1 July 1953.

1. Sir Ben Lockspeiser, the first President of the CERN Council, came to CERN for the occasion and is seen here speaking at the dinner with two of his successors, Professor W. Gentner (the present President) and Professor E. Amaldi, on his left.

The opportunity was also taken to pay tribute to three distinguished Council members who from now on will not be so intimately involved in the affairs of CERN:

2. Professor J.K. Boggild of Denmark (with another former Council President, G.W. Funke on his right);

3. Professor F. Perrin of France (with the Director General of CERN Laboratory II, Dr. J.B. Adams, on his left);

4. Sir Brian Flowers of the United Kingdom (with Professor Boggild on his right).

There is more equality in the treatment of all members of the personnel irrespective of their grade within CERN or sex. Thus all grades are now accorded the same annual leave. Married men and women have equal right to various allowances and grants. Certain welfare provisions have been improved — such as increased contributions to schooling expenses, longer maternity leave, help for handicapped personnel. There are also new provisions concerning occupational training, health and safety.

Most of the revised Staff Rules and Regulations came into force on 1 July. They are the outcome of a lot of careful thought and effort by a Working Group, set up by the Finance Committee, which consisted of representatives of the Member States of the CERN Administration and of the Staff Association.

New appointments

A. Bohr and G.H. Stafford have been elected as members of the Scientific Policy Committee for three years. The Council appointed D. Amati as Leader of the Theory Division for three years as from 1 July succeeding B. Zumino. Also to take effect from 1 July for three years are three reappointments — G.R. Macleod as Leader of the Data Handling Division, C. Tièche as Leader of the Finance Division and G. Ullmann as Leader of the Personnel Division.

1. *(CERN 305.6.73)*

2. *(CERN 320.6.73)*

3. *(CERN 339.6.73)*

4. *(CERN 311.6.73)*

CERN News

The delegation of physicists from China photographed during their visit to CERN.

1. During a lecture on the ISR. Professor Chang Wen-Yu, Deputy Director of the Institute of Atomic Energy at the Chinese Academy of Sciences in Peking, who led the delegation can be seen in the middle of the front row.

2. At the Split Field Magnet. L. Resegotti is describing the magnet system installed at intersection region I-4 of the Intersecting Storage Rings.

A visit from China

A delegation of scientists from the People's Republic of China, including twelve specialists in particle physics, visited the CERN Laboratories from 26 June to 3 July. The Group was led by Professor Chang Wen-Yu, Deputy Director of the Institute of Atomic Energy at the Chinese Academy of Sciences in Peking. He was no stranger to CERN since he attended the International Conference on High Energy Physics in 1958.

The scientists were welcomed by members of the CERN Directorate and embarked on an intensive eight day tour during which they showed a keen interest in the various large installations and discussed at length with the leaders of the physics teams and with the machine designers. They heard a series of lectures on the CERN accelerators and ancillary equipment.

Before coming to CERN, the Chinese delegation had visited several research centres in America including Brookhaven, Batavia and Stanford. The reason for this tour was to gather information on the particle physics Laboratories with a view to discussing a similar Laboratory in China. A cosmic ray Observatory has already been built near Kun Ming (Yun Nan province).

At the farewell party held in honour of the Chinese visitors, the possibility of closer co-operation between European and Chinese research workers in particle physics was discussed. Throughout the visit there was a very open and fruitful exchange of views.

1. (CERN 411.6.73)

2. (CERN 453.6.73)

Books on CERN

Mrs. Margaret Gowing, Professor of the History of Science at Oxford University, is preparing the groundwork for a book on the history of CERN. She has already talked with a number of those who were party to the setting up the Organization in the early 1950s.

To provide a direct link with the evolution of CERN, from its beginnings and through the various stages of its development, L. Kowarski, former CERN Director who retired in 1972, is serving as consultant to the author. Amongst other things he will help with the preparation of a file on the 'prehistory' of CERN and with the chapter on the implementation of the scientific programme.

Mrs. Gowing is well-known for her history of nuclear energy in Great Britain, a publication running to several volumes the last two of which are due to appear on the bookstalls shortly.

Another book on CERN's activities is also being prepared. It will describe the SPS project which began in 1971 and will continue through until 1979.

Maurice Goldsmith is compiling this book and is making regular visits to the site to gather information as the project progresses. Mr. Goldsmith is the Director of the Science Policy Foundation in London.

Storm hits CERN

Late in the afternoon of 12 June a freak storm hit the Geneva region and caused serious flooding. A cloudburst lasting an abnormally long time (over an hour) swept down on the CERN Laboratories and left flood damage amounting to millions of Swiss francs in its wake.

Preceded by a violent wind of nearly 50 miles an hour, the storm began with hail which fell for fifteen minutes. The effect of this combination was to choke the drains with hailstones and leaves so that they were no longer able to cope with the subsequent torrent of rain. Hardly a building or installation, surface or underground, went unscathed but three areas in particular were hit very

The sad results of the storm on 12 June:

1. In the building of the Track Chambers Division exposed bubble chamber film stored in the basement was damaged by mud and water. Boxes of film are seen here stacked in the open air while their usual home was cleaned. It will be difficult to save much of the film.

2. In the Main Building the flooding was spectacular but did not cause as severe damage as elsewhere. Nevertheless this indoor swimming pool in the basement illustrates how the unusual volume of water which fell during the freak storm far exceeded the ability of the drainage system to cope with it.

1.

2.

CERN 91.6.73

hard: the installations of Nuclear Physics Division, of Track Chambers Division and of Health Physics Group.

The NP Division suffered its main damage to the equipment in Hall I-1 of the Intersecting Storage Rings and in Laboratory 3. Water and mud inundated Hall I-1 to a depth of a metre and the delicate equipment there — mainly electronic counters and spark chambers — can be considered a write-off. The basement of Lab. 3 was in similar shape with various other items of equipment for the most part destroyed — spark chambers, vacuum pumps, detectors, recorders, stabilized power supplies and the like.

A wave of water passing down the road from the ISR penetrated the electricity substation and thence by underground tunnels reached the basements of Laboratory 13, where there was a large quantity of electronic and mechanical apparatus belonging to the TC Division — counters, scalers, power supplies, spares for measurement tables, etc. Valuable technical documents, as well as the air-conditioning units were almost totally destroyed. In addition many reels of unexposed film were completely submerged, together with 400 km of film which had been exposed and developed and was in the process of being scanned; part of film may be recoverable but the possibility of distortion of the emulsion makes this a faint hope. In the case of film from experiments performed several years ago it will be extremely difficult to recreate the same conditions if the film is lost.

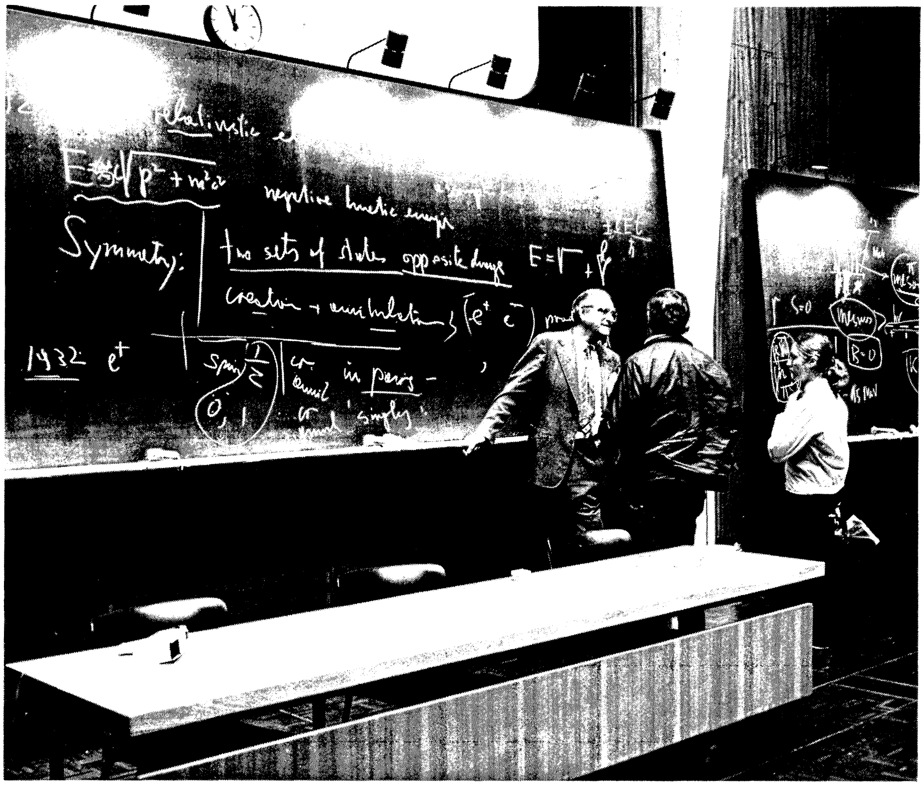
The 2 m hydrogen bubble chamber was the scene of much activity. The operating crew took quick action when, right at the beginning of the storm, water was seen infiltrating under the chamber building in the tunnels housing the 10 kA power supplies and the power, monitoring and safety lines of the entire installation. It was possible to cut the magnet power supply before the water actually rose (it rapidly reached a height of 1.4 m). The refrigeration plant had to be shut down and water was also threatening the pumps providing the vacuum which isolates the chamber thermically. It was therefore decided to evacuate the liquid hydrogen from the chamber. The muddy water was by then no longer coming from the surface but was welling up from the drains — as was the case in most of the flooded areas of the site.

The entire staff of the 2 m chamber was on duty for 48 hours, carrying out safety precautions manually, clearing some two cubic metres of mud and cleaning up the vital circuits in the tunnels. The necessary repairs have meant a considerable interruption in the bubble chamber's experimental programme. Gargamelle, the heavy liquid chamber, and the large European bubble chamber (BEBC) were fortunately only slightly affected.

The most serious damage in the building of the Health Physics Group was the complete destruction of the low level counting laboratory. The laboratory is in the basement to reduce the influence of environmental radiation and its specialized equipment is a total write-off.

Every building suffered in some way or other. The new computer centre was inundated by mud covering a large area containing the converter units and power supplies of the CDC 7600 computer and its satellite machines. There was also damage to the linac, the booster and the PS itself. The total bill is still being worked out by insurance experts who have no easy task in front of them.

A programme of lectures has been arranged as usual for the Summer students. In the photograph V.F. Weisskopf (former Director General of CERN who is also a summer visitor) continues discussion after one of his, by now traditional, introductory lectures on high energy physics.



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Vacation courses

As in previous years, during the season when many CERN employees are off on holiday, vacation students have arrived to follow a two to four months' course.

Circulars on the programme for these courses, which have been held for eleven years now, are sent out at the end of every year by the Fellows and Associates Service to the Universities in all the Member States. Students reading physics, electrical and electronic engineering, mathematics and information science at these Universities and Technical Colleges are invited to submit their applications before the following March.

A difficult choice then has to be made from among the applicants, taking into account their interests and the available places. CERN defrays travelling and board and lodging expenses.

There were some 350 applicants this year, of whom 148 were invited to follow the courses. They are distributed over the various scientific and technical Divisions — joining groups working on experimental and applied physics, data handling, accelerators, technical services or Health Physics. Taking part as they do in the daily work of the groups, the students should be able to obtain a useful supplement to their education from the people they meet and work with. As well as their work in the groups, the students are offered a series of fifty-three lectures on elementary particle physics, accelerators, detectors and computer science through which they can become familiar with the various facets of particle physics research.

Booster struggles with instabilities

Commissioning of the 800 MeV Booster is at an intensive 'machine physics' stage where the behaviour of

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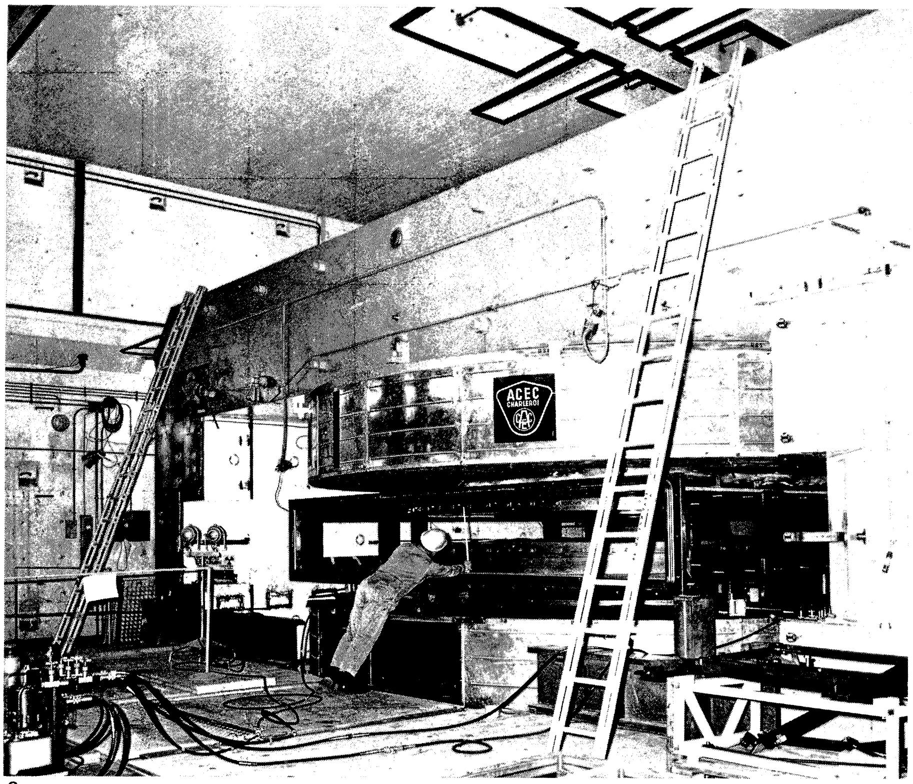

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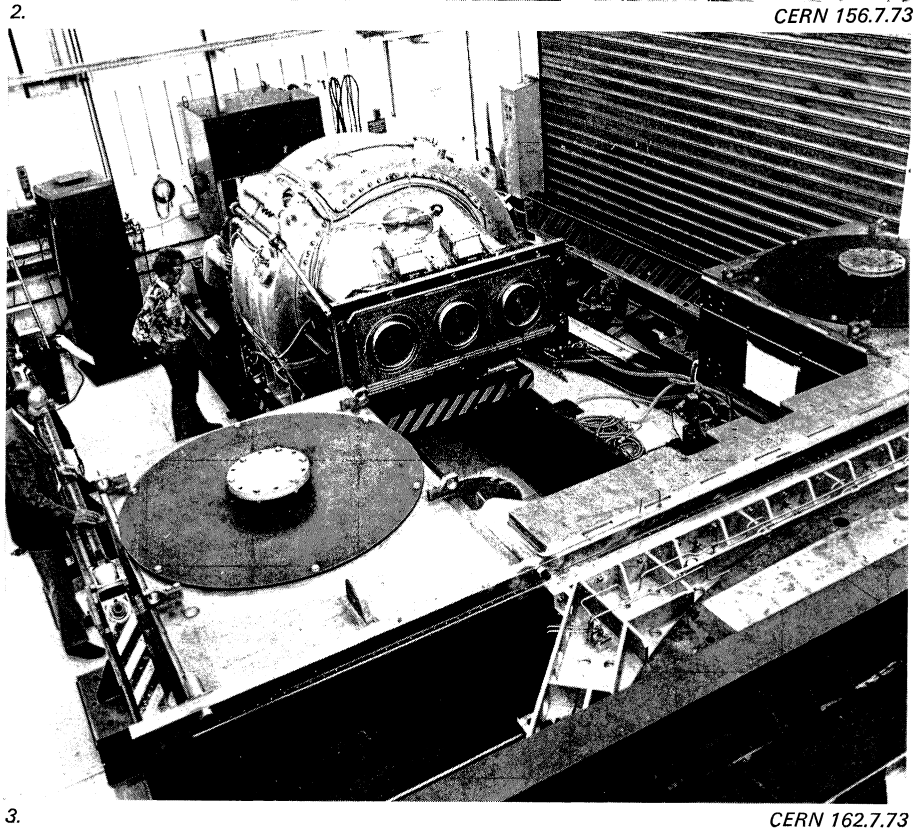


3. CERN 162.7.73

1. Internment of the 'old' 600 MeV synchro-cyclotron on 7 June. The last day of operation of the machine which has been in action at CERN since 1957 was suitably mourned by those who had operated and used it.

2. The machine will rise again from the ashes in about a year's time after extensive modifications to improve its performance. It is shown here being dismantled and the old vacuum chamber can be seen with its big window where the Dee electrode was introduced.

3. The rotary condenser, key element of the synchro-cyclotron improvement programme, is now at CERN. It is photographed here mounted on its rails in the test area.

the proton beams in the machine is being closely studied in order to master the acceleration of intense, good quality beams to the design energy. The Booster consists of four synchrotron rings, stacked vertically one above the other, which receive a 50 MeV beam from the linac and feed it at 800 MeV to the main ring of the proton synchrotron. This higher injection energy should enable the PS ultimately to accelerate beams of 10^{13} protons per pulse.

By the end of last year the Booster had been taken through its paces sufficiently far as to reach most of the design requirements. A beam of intensity 2.55×10^{12} was accelerated to 800 MeV in one ring and protons were fed to the PS. However beam quality was poor and it was not possible to work on this problem in a systematic way because the quality and reliability of the input beam from the linac was not good and because the Booster itself had the usual teething troubles and had not got its full range of beam monitoring equipment.

This situation has now been greatly improved — the linac is providing excellent, stable beams (with intensity reduced to 50 mA) and the Booster is better equipped and operating reliably. The attack on beam quality is being mounted in earnest.

Beam instabilities have been detected. One is a longitudinal instability with coherent oscillations of the protons in each bunch so that the bunch oscillates in phase and length. However the motions of the five bunches are not in synchronism. Reducing intensity and increasing energy spread removed the oscillations. Coherent transverse instabilities (possibly resistive wall instabilities) are seen when a beam is left coasting for a long time. However those that have been observed are very slow effects and should not be troublesome in normal acceleration conditions with a bunched beam.

More difficult are the incoherent transverse instabilities causing blow-up during acceleration of the beam. It occurs in two stages. There is fast blow-up which takes place in the first millisecond of the acceleration cycle followed by a much slower one lasting several hundred milliseconds. Various cures (such as moving the working point around and applying various correction fields) have been tried without success and the reason for the blow-up remains obscure.

Further studies, helped by more instrumentation such as the 'ionization beam scanner', will be carried out during the summer months to pin down the origins of the instabilities and then to counteract them.

Preliminary results of schooling survey

As mentioned in the report of the Council meeting in this issue, a survey was conducted at CERN in June to obtain the reactions of parents to the proposed schooling system in France for children of CERN personnel. In April of this year the outline of a pedagogical structure for the system was worked out in collaboration with the French authorities and representitives of the local schools at a colloquium held in Sèvres (see May issue, page 146). Although the recommendations from Sèvres have not yet been formally approved by the Ministries of Education in France and the Member States, they were put before CERN parents so as to gauge the extent of support and to determine the number of children who might attend the schools.

The survey was necessarily tentative at this stage since the recommendations have not yet been put into effect. Nevertheless the response was favourable to a surprising degree. First of all, although the survey had to be carried out very quickly, 940 replies were received. Of these, 90 % expressed the opinion that the proposed schooling system represents a real advance in the educational conditions available to CERN children. Many replies expressed appreciation of the multi-national nature of the venture and of the parallel concern to help integration into the local community.

Parents were also asked whether they would send their children to the schools. From replies concerning 1840 children, 1170 were in the affirmative. The replies were obviously conditioned by the need to see the Sèvres recommendations being implemented in the spirit in which they were formulated and by concern over local problems such as transport. As many as 350 children were put down as potential pupils for 1973 school year and a further 200 for 1974.

The preliminary information extracted from the survey has been forwarded to the French authorities and the other Member States. It shows that the concern of the CERN personnel for the education of their children, in the unusual environment in which they find themselves, remains as strong as ever. The internationally oriented system emerging from the Sèvres colloquium is almost unanimously considered as a step forward and the potential demand for places in the schools is high.

Around the Laboratories

STANFORD Superconducting surgery

The Low Temperature Materials Research group at Stanford has developed a small superconducting magnet for use in medical surgery. It has been applied successfully in the treatment of cancer tumors and other applications are foreseen.

The development began when a neurosurgeon of University College Los Angeles, R.W. Rand, was brought into contact with the SLAC group (initially led by H. Brechna and now by S.J. St. Lorant) by a SLAC technician W.R. Schulz. The idea was to use the more powerful fields available from superconducting magnets to avoid some major difficulties in the treatment of brain aneurisms.

Aneurisms are weakened sections of blood vessel wall which can balloon, rupture and cause serious hemorrhage. The previous technique used in the treatment of brain aneurisms involved injecting a colloidal solution of iron and using bar magnets (inserted in small holes drilled in the skull) to hold the iron solution near the blood vessel walls. The tiny iron particles serve as centres for blood clotting and thus permanently plug the weakened area. It was an expensive and difficult operation requiring several days of intensive care afterwards. Also most people can do without extra holes in the head.

A superconducting magnet could dispense with holes in the head but no appropriate magnet existed. The existing magnets, with their nitrogen and helium refrigeration systems, vacuum tanks, etc, were far too cumbersome for such use and the difficult task of designing and constructing a simple, manoeuvrable magnet took several years. Finally a magnet, about 20 cm long and 15 cm diameter was produced using niobum-tin superconductor and an iron core. It is cooled only by liquid helium, linked to a helium reservoir by a vacuum insulated 'umbilical cord'. The magnet can produce a peak field of 1 T and gives a field of 0.2 T at a depth of 10 cm in the body which is adequate for the required types of treatment.

In the meantime, Rand had confirmed, in association with a plastic surgeon, that silicone loaded with iron can replace the colloidal suspension of iron and can work much more efficiently. Silicone is not unknown to womankind as a bust booster. It sets quickly to fleshy constituency and thus removes the need for long intensive care after the operation. Ferrosilicone has since been used successfully in the treatment of aneurism.

Dr. Rand had a further idea that the sealing property of ferrosilicone could be used to cut off the supply of blood from cancer tumours. This can be done without damage to the rest of the body if the site of the tumour has its individual blood supply. Tests with animals worked well and the technique has been applied several times using the SLAC superconducting magnet to hold the ferrosilicone in place and prevent it drifting to other parts of the body before it sets.

In the first clinical trial, a malignant tumour of the tongue was removed by injecting ferrosilicone and holding it with the magnet so as to block off the blood supply to the tumorous part of the tongue. After half an hour the ferrosilicone had solidified and the tumour began to atrophy. Within a few weeks it was completely removed. Similar operations have been performed on a tumour of the adrenal gland and for a type of brain tumour with promising results in both cases.

Further improvements to the type of magnet can be foreseen — particularly a further reduction in size and a shortening of the time needed to cool it to superconducting temperature (presently about three hours) — so that it can be used with greater ease in hospital conditions. Unfortunately no resources are available to pursue the development. Applications are feasible in the treatment of a wide range of cancer tumours (kidney, thyroid, lung, liver, etc.), in spleen removal and in the treatment of aneurism.

SPEAR detector coming into action

Meanwhile, back in the Laboratory, the electron-positron storage ring SPEAR (see vol. 11, page 279) has settled to rather steady performance. A typical operating cycle sees the accumulation of 25 mA beams of both electrons and positrons in the ring injected at an energy of 1.5 kV from the electron linear accelerator. The energy is raised by the r.f. system in the ring to 2.6 GeV and the beams are then brought into collision in the two long straight sections. This filling and acceleration process takes about half an hour.

The initial luminosity is usually about 4×10^{30} cm^{-2} s^{-1}. After two to three hours, the luminosity falls to about 1×10^{30}, the beams are dumped and the injection process starts again.

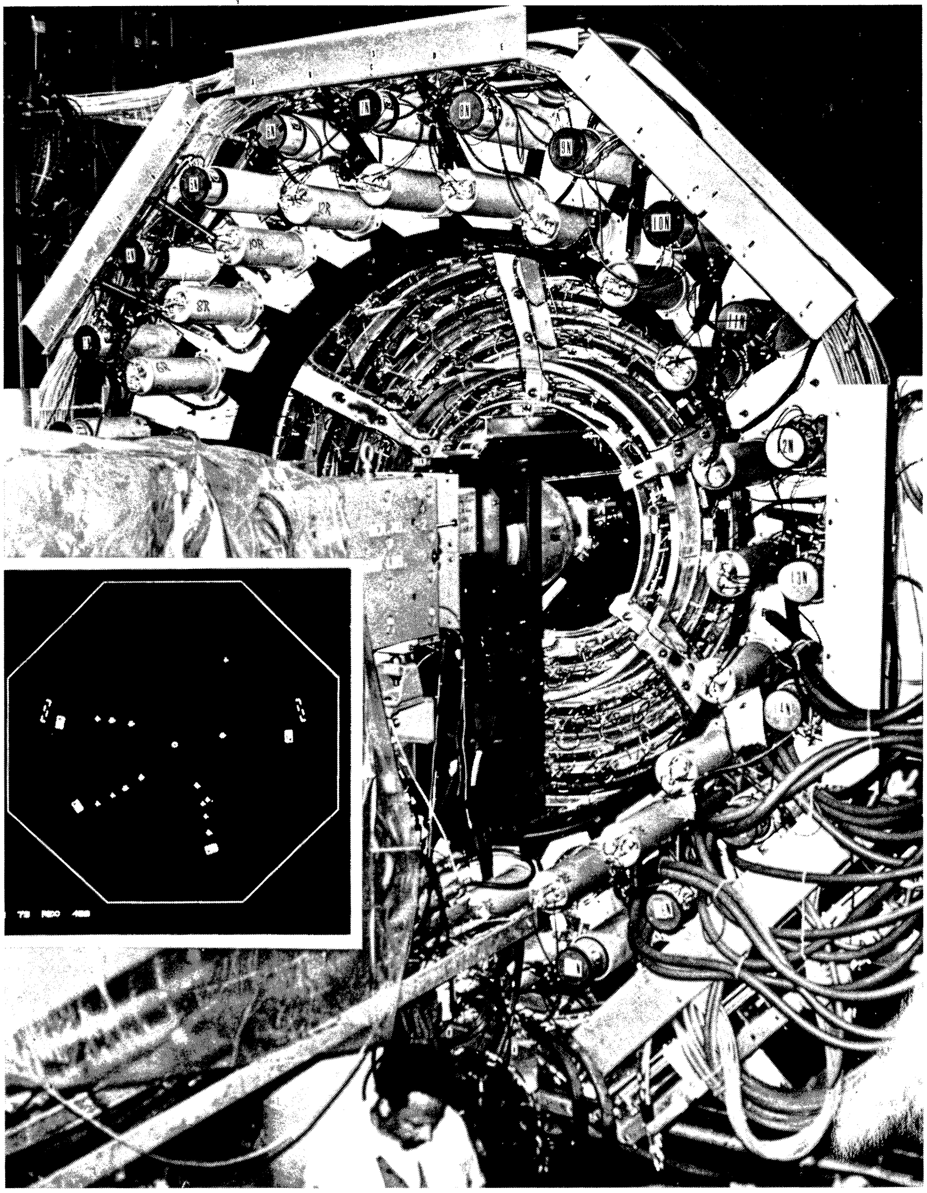
The large multipurpose magnetic detector installed at one of the collision regions (the West pit) is being tested. It consists of a large solenoid magnet enclosing sixteen cylindrical wire spark chambers, with over 100 000 wires, and scintillation counters surrounding the interaction region (extending out over a radius of about 1.5 m) and further shower detectors outside the magnet. The whole assembly is about 4.5 m long.

The detector magnetic field was measured and proved to be highly uniform. It had no adverse effect on the operation of the magnetostrictive

The special superconducting magnet, developed at Stanford, being used in a 'knifeless operation' for the treatment of a malignant tumour of the tongue. The magnet, positioned near the patient's cheek, holds ferrosilicone in position until it sets to block off the blood supply to the tumour. The operation was completely successful.

The multipurpose detector installed at one of the two collision regions of the electron-positron storage ring, SPEAR, at Stanford. It comprises a solenoid magnet, within which can be seen cylindrical wire chambers and trigger scintillation counters. Shower counters give the octagonal shape outside the magnet. Inset is a photograph of the tracks associated with a particle interaction which has been recorded in the detector and recomposed via an on-line computer.

(Photo SLAC)



readout system when the 0.4 T field was switched on (in fact the system worked more efficiently). Also there was very little disturbance of the orbiting beams due to the magnetic field. It proved comparatively easy to distinguish the desired particle interactions from the background events during tests with an electron beam but much higher background was encountered with positrons. This has not yet been studied and corrected.

The detector will be used initially in a survey experiment studying electron-positron annihilation into many particles over the centre of mass energy range from 2 to 5 GeV.

In the other interaction region, electron-positron annihilation into two gammas and the Compton reaction giving an electron, a positron and a gamma are under study using sodium-iodide detectors and multiwire proportional chambers in a spectrometer. A synchrotron radiation facility is also being added in the north portion of the ring.

BROOKHAVEN Superconducting dipoles tested

The programme of work at Brookhaven to produce pulsed superconducting magnets has reached the stage where a series of tests have been carried out on two 'identical' magnets. Several differences were, in fact, fed into the second magnet to be built so the word identical correctly appears in inverted commas. Most of the results were very encouraging but a few puzzling differences in the behaviour of the respective magnets were observed and are being studied again.

Some of the important design parameters of the two magnets are as follows: Peak field 4 T, peak current 3.5 kA (27 kA/cm^2 current density), stored energy at peak field 60 kJ, magnet aperture 8 cm (inner diameter of dipole windings — correction coils of diameter 7.7 cm sit inside this), magnet length 92 cm, outside diameter of iron core 30 cm. The magnets are known as ISA-1 and ISA-2, drawing their initials from 'Intersecting Storage Accelerators', the Brookhaven 200 GeV colliding beam project, ISABELLE, which requires the used of pulsed superconducting magnets.

ISA-1 was powered for the first time in March. At the first attempt it reached short sample current of 3.6 kA corresponding to a field of 4.1 T. Subsequent quenches revealed a little 'training' taking the magnet into the resistive region to a field of 4.4 T in the magnet aperture at a current of 3.9 kA (30 kA/cm^2 in the magnet coil). The magnet stayed at this performance during the subsequent tests and was pulsed at different rates down to a rise time of 15 s.

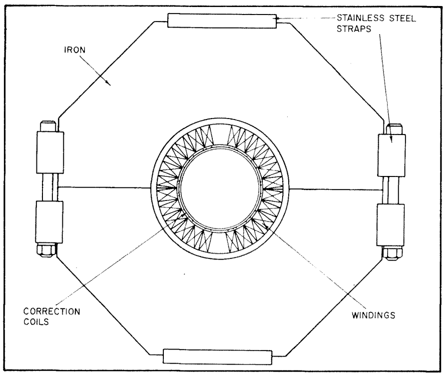
ISA-2 was built using different size wedges holding the coils (due to a problem arising unintentially during the construction) and, combined with the differential contraction of the epoxy components, this is a source of most of the observed systematic error. Also, poorer conductor had to be used to build the coils which again did not help to yield an identical magnet. Nevertheless when tests on ISA-2 began at the end of May the same behaviour as with ISA-1 was experienced. The magnet went straight to short sample current, 3.26 kA and a field of 3.8 T. Subsequent quenches trained the magnet to 3.65 kA and 4.15 T.

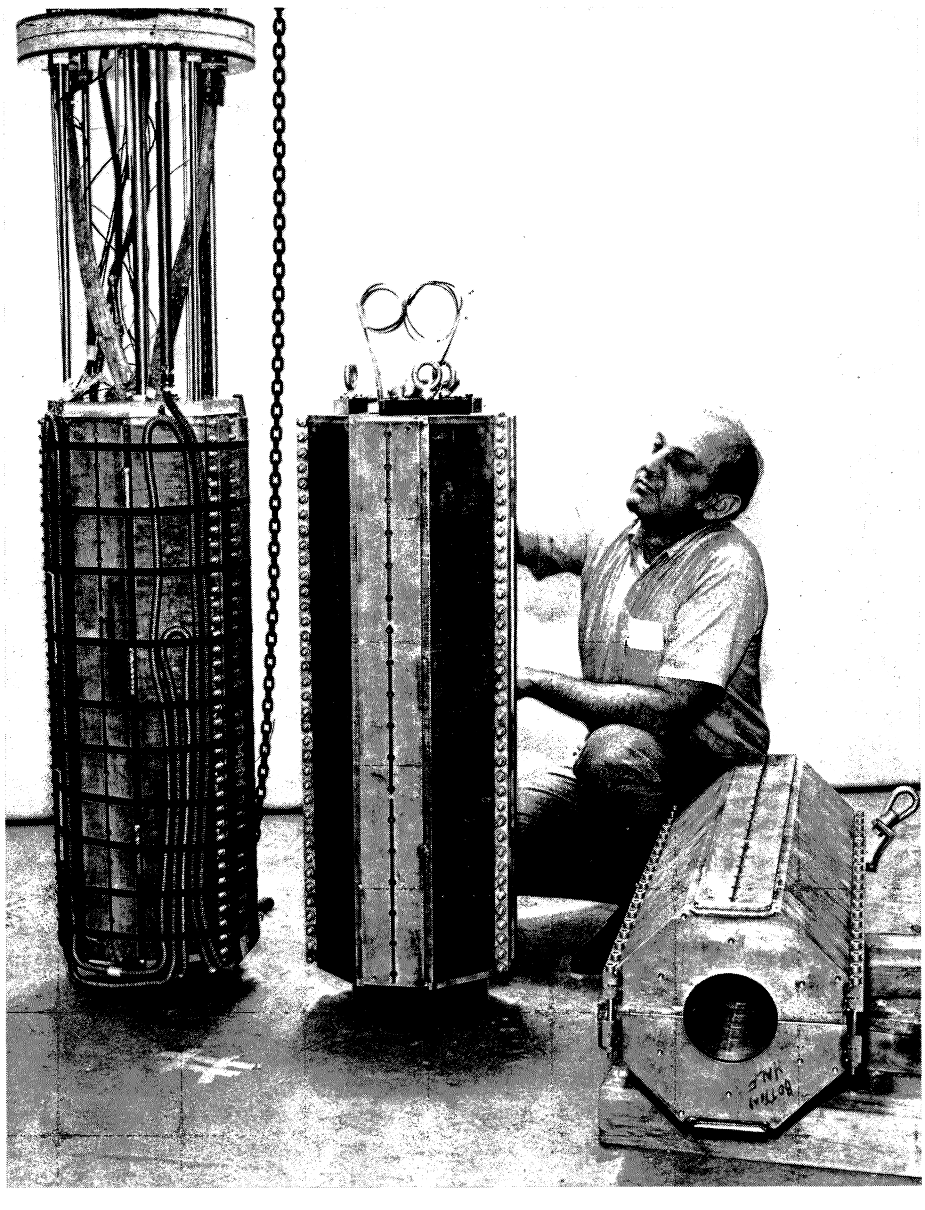
There was good agreement in other aspects of performance — for example, the sextupole field compared with the dipole field for both magnets agree to a few parts in 10^4. The unexplained differences came in the measurement of the residual fields after the magnets

Cross-section of an ISA pulsed superconducting magnet. Two magnets of this type, 30 cm across and almost 1 m long, have been built and tested at Brookhaven. Both reached short sample performance the first time they were powered.

ISA magnets ready for testing. ISA-2 is installed on the vertical stand, ISA-1 is in the centre and lying horizontal is a third core made of vitrenamal low carbon steel which will be used later and compared with the M-36 steel used in the two others.

(Photo Brookhaven)





had been cycled to 4 T. The dipoel remanent fields were 6.9 gauss in ISA-1 and 0.1 gauss in ISA-2, the quadrupole fields were 1.3 and 3.2 gauss, the sextupole fields were 22.5 and 14.6 gauss. There may be some dynamic effect since the ISA-1 measurements followed immediately on turning the magnet off whereas ISA-2 was measured 12 hours after turning off. This will be looked at again during a long term test.

The aim of the long term test is to check reliability over the sort of life time required of magnets for ISABELLE. If the storage rings have a life over 10 years and are filled twice a day the magnets will be called upon to sustain of least 10^4 cycles. This will be simulated by pulsing with 5 minute cycles for two months and running them d.c. during the night as required for long storage times.

It was mentioned in the June issue that the 33 GeV Alternating Gradient Synchrotron at Brookhaven has accelerated a proton beam of record intensity. An intensity of over 9×10^{12} protons per pulse has been reached putting the AGS comfortably ahead of all other proton synchrotrons.

Component reliability had improved considerably and the machine team were able to tune the 200 MeV linac and the synchrotron ring with greater precision than in previous runs. The most encouraging result was that even at 9×10^{12} there was no sign of any effects which could limit the ultimate intensity and, when the quality of the beam from the linac is tidied up still more, it is expected that the 10^{13} barrier will fall.

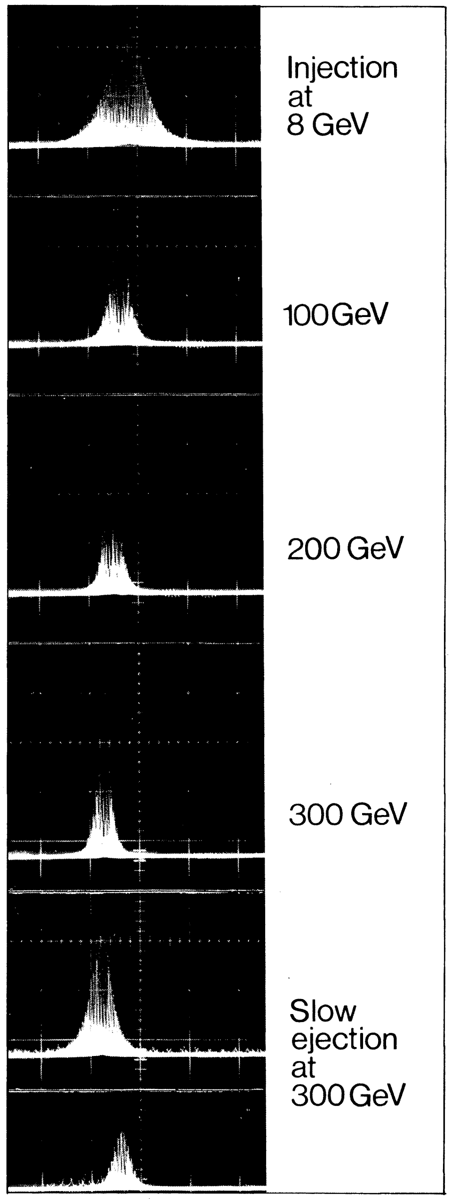
Another machine physics achievement in May was to operate a new ejection system. The system uses the shaving technique (similar to the 'continuous transfer' method developped at CERN for ejecting beam from the PS to feed the SPS — see vol. 12, page 203).

The AGS orbiting beam is given a rapid deflection by full aperture kicker magnets to take it across a very thin septum (0.25 mm) powered with a 200 μs, 3 kA peak, half sinusoidal current waveform. The power supply can provide a variety of waveforms so that the full aperture kickers can respond to many requirements of the ejection system. Operation and control

Celebrating successful performance of the new ejection system at Brookhaven. It uses the 'shaving' technique similar to that tested at the CERN PS ready for ejection towards the SPS. Ejected beams of 4×10^{12} protons per pulse crowned over two years of design and development of the ejection system at the AGS.

(Photo Brookhaven)

Observing the beam in the main ring of the accelerator at NAL, Batavia in July. An ionization beam scanner (IBS) is picking out the horizontal profile of the orbiting beam during the acceleration cycle (horizontal scale: one division is one centimetre in the vacuum tube). Fine structure is seen in the profile since only one set of bunches from the Booster were fed in and the rest of the ring was left empty. On 8 August a new intensity record of 5.22×10^{12} was achieved at 300 GeV and this was with the operating conditions not at their best.



of all power supplies is via a PDP 10 control computer. This septum bends the protons across another thicker septum (2 mm), operating with a 1 ms, 21 kA half sinusoidal current waveform, and they are there bent out of the ring. An electrostatic septum (0.05 mm) to give fields of over 100 kV per cm has also been developed to precede the first magnetic septum reducing beam losses further.

Tests began using an ejection mode in which a fraction of the AGS beam was sent to an external target to produce secondary particles for experiments in the 80 inch hydrogen bubble chamber. The duty cycle of the r.f. separators in this beam-line requires a particle pulse of 1.5 μs. Using the shaving technique a fraction of seven AGS bunches was trimmed from the accelerated beam. This required the kickers to be powered for 2.4 μs with 5 kA peak. It was confirmed that the shaving technique works well also with the accelerated beam debunched.

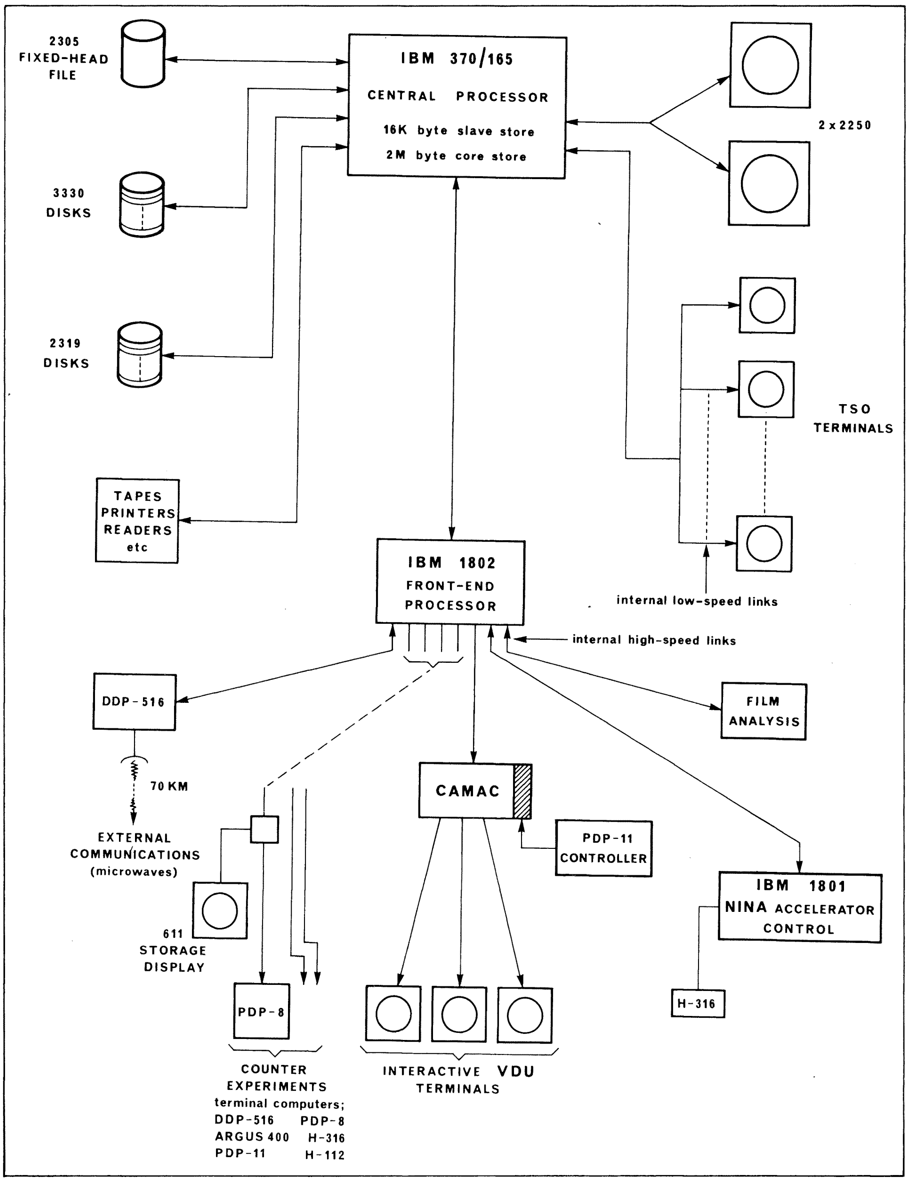
Another mode of ejection is scheduled for sending the full accelerated beam to the 7 foot bubble chamber, which is being reassembled in the North Area, for neutrino experiments. The kicker is then powered with a 0.75 μs rise time and a 3 μs, 8 kA flat top. The beam was ejected over 2.9 μs and an ejected intensity of 4×10^{12} protons per pulse has been recorded.

DARESBURY
Integrated computer network

The demands for data collection and computing in high energy physics are large scale and often complex (see last issue, page 181). Though there are many themes in common, each

Laboratory has tended to have its own individual response to these demands. Daresbury is one of those which has gone for a completely integrated computer network where all the computers tap into a large central computer (an IBM 370/165 in Daresbury's case). The information is drawn from a talk by B. Zacharov at the Frascati Instrumentation Conference.

An important reason for adopting this philosophy was to avoid building up extensive local computing systems, each special to a particular experiment and thus usually expensive in terms of equipment and of man hours for the development of the system. An additional saving, with all the Laboratory computers linked together, comes from the ability to pump data directly into the main computer so that the stage of local data collection on tape, which is later wheeled to the central computer, is not necessary.



Schematic diagram of the integrated computer network at Daresbury. All 'local' computers (connected with individual experiments, accelerator control, film analysis, etc.) are linked to the large central computer at the Laboratory.

This is more economical and more reliable.

Common access to the central computer brings other advantages also. It can make stored data available to all experiments and when several experiments require access to the same information there is no necessity to duplicate the data. It is also possible to provide more facilities to the individual user; since these facilities are not unique to the individual user, they can be more extensive than it would be reasonable to provide for a series of different local systems.

The network at Daresbury is shown schematically in the diagram. It can cope with many users simultaneously without interference between them. It has aimed to keep down the complexity of local computers and to minimize the amount of associated software development. There is no local data storage. Users communicate with high level language modules and are unaware of the manoeuvres within the network which connect them to the central computer. Processed data is fed back to the local stations (in graphical form if required).

The main properties of the central computer were listed in the March issue. The local stations are brought in via twelve high speed links (up to 12 bits per μs) which are multiplexed by a 'front end' computer (IBM 1802). The number of links could be stepped up by adding another front end machine. One or two small computers sit at each local station and they are of many types (PDP, ARGUS, IBM, etc.). CAMAC units (see vol. 8, page 314) are used throughout, bringing invaluable benefits of modularity and standardization.

The network at Daresbury has been in operation for five years and, except for some initial difficulties following the installation of the new central computer, the fault time on the whole network from any cause is about

4 hours per month (about 0.5 % down time). With so many users leaning on an integrated system, reliability is obviously a vital feature and, if necessary, other computer abilities must be sacrified for this.

At the Frascati Conference there was discussion as to whether such a system could be extended to cope with the computing needs of a much larger Laboratory. There are worries concerning reliability, availability (given a larger number of users) and the dangers of users stepping on one anothers computational toes. Nevertheless a Daresbury type network seems capable of extension without introducing new features and has demonstrated its abilities impressively.

ARGONNE
ZGS accelerates polarized protons

On 11 July the Zero Gradient Synchrotron at Argonne became the world's first accelerator to give a polarized proton beam of GeV energies. The first polarized beams were taken to 3 GeV and a few days later the energy climbed to 6 GeV. The measured polarization was about 50 %.

Work towards polarized beams at the ZGS began about two years ago in the Accelerator Division led by R.L. Martin. An experimental team from Argonne, Michigan and St. Louis, led by A.D. Krisch, has also been involved and will be the first to use the polarized beam. A polarized proton source arrived from New Zealand in May and tests began when the ZGS started up again in July after a long shutdown.

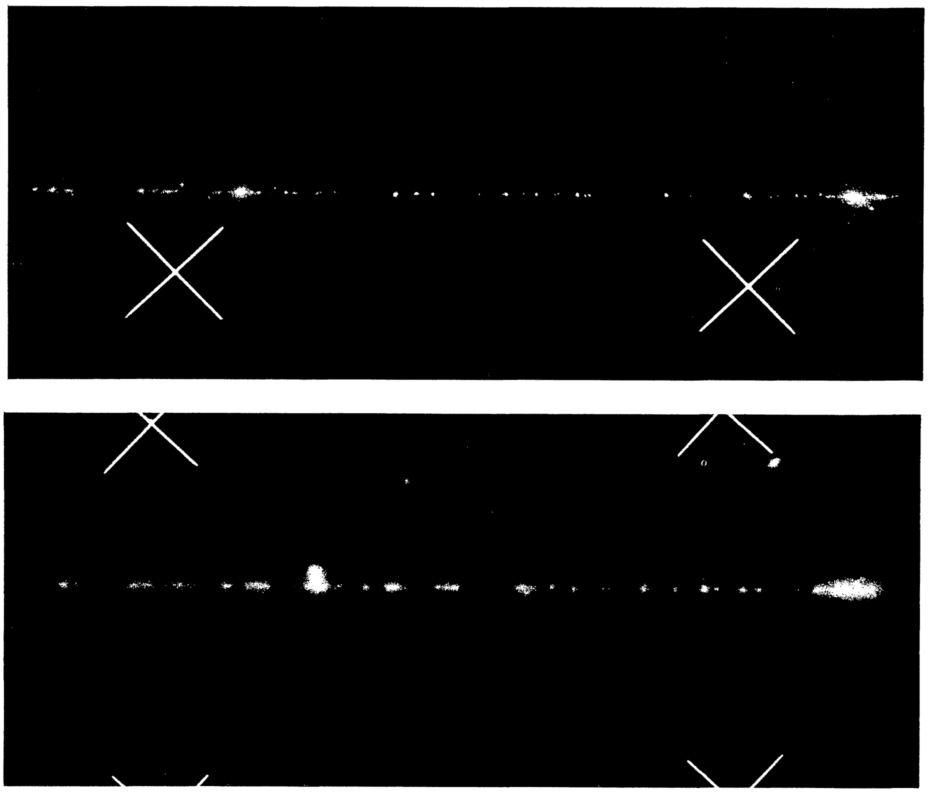
The first experiment will also use a polarized proton target thus specifying the spin conditions of the interacting particles more completely than has ever been possible before at high energies. Some preliminary data has already been taken at 3.5 GeV/c and the 'serious' run to measure total cross-sections is scheduled in October. (More on polarized beams next month.)

The ZGS has been running very reliably since the installation of the new titanium vacuum chamber (see vol. 12, page 332). No spectacular gain in peak accelerated intensity resulted (peak intensity stands at 3.63×10^{12} protons per pulse and 2.5×10^{12} can be turned on rapidly even after a long shutdown) but there have been great benefits in tuning flexibility and in the improved beam diagnostic systems.

Pole face windings in the new chamber are designed to enable simultaneous slow ejection into the two ejected beam-lines at the accelerator. Before this is accomplished it will be necessary to move two sextupoles in the machine and, to avoid breaking into the experimental schedule, this is planned for the beginning of next year. Also some attention is needed to the 'ripple' from the magnet power supply which damages the beam during ejection. It is hoped to clear this by next July.

Tests of the booster, which accelerates negative hydrogen ions (see vol. 9, page 239), are continuing and look encouraging. Ions have been accelerated to 200 MeV and ejected from the booster with about 90 % efficiency. Another run is scheduled for October and will involve a new 30 Hz ion source. Work remains to be done on the injection system from the booster to the ZGS where a rather sophisticated kicker magnet is being designed. Operation of the ZGS fed by the booster is planned in a year's time. Meanwhile 'Phase II' of the booster programme — the design of a 500 MeV ring for ZGS injection — has started.

The physics programme is hamper-



Photographs of cosmic ray tracks taken in the 1.5 m streamer chamber at Argonne; the chamber was being tested with a helium filling. The top photograph was with the chamber filled with pure helium when a voltage gradient of 27 kV per cm was need to achieve good tracks. The lower photograph was with the addition of 0.2 % isobutane which made it possible to reduce the voltage gradient to 25.2 kV per cm but gave poorer quality tracks.

ed, as in almost all the Laboratories in the USA, by budget cuts. Argonne is at $ 14.4 million for the present fiscal year (started on 1 July) which is a cut of $ 1.3 million. Lengthy machine shutdowns, known sardonically as fiscal shutdowns, are inevitable. During the next twelve months the operating programme is — six months of running with conventional beams, two months with the new polarized beam and one month with a neutrino beam to the 12 foot bubble chamber. The machine will be off for three months.

The 12 foot chamber has had some very successful runs in recent months. About 260 000 pictures, with proton beams of 7, 8.7 and 11 GeV/c, were taken for Tohuko University with the chamber double pulsing for most of the experiment. Another neutrino run with the chamber filled with deuterium gathered 325 000 pictures (bringing the total in deuterium to 650 000 out of a scheduled million). Also, the first physics run with a beam-line incorporating r.f. separators gave 35 000 pictures with 6.5 GeV/c negative kaons into the chamber.

Streamer chamber runs with helium

The 1.5 m Streamer Chamber Facility at Argonne successfully completed feasibility tests in May with the chamber filled with pure helium gas. The tests were prompted by a proposal by groups from Strasbourg and Orsay to study coherent production off helium using 9 GeV/c protons.

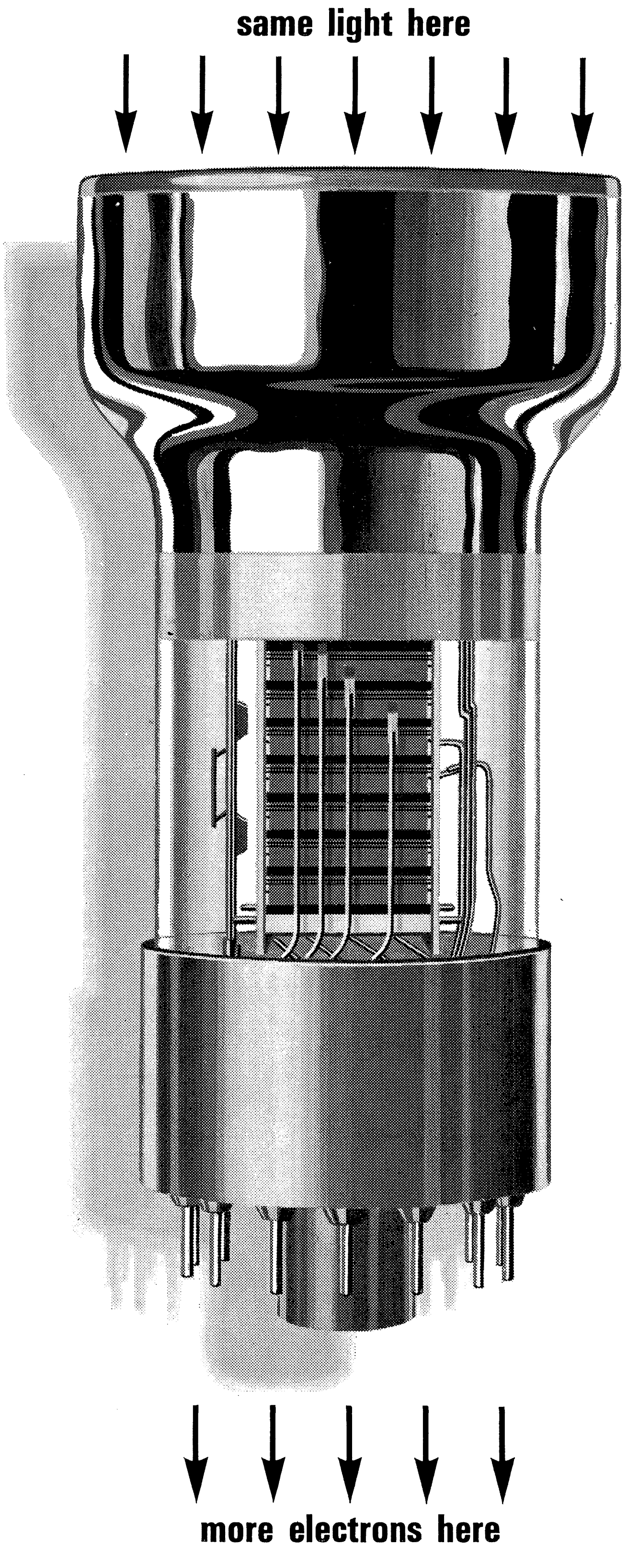
Prior to the tests there was concern that the high voltage pulsing system would not be adequate to achieve streamers in helium using the present chamber ($1.5 \times 1.0 \times 0.6$ m^3). The system consists of a 34-stage Marx generator and a continuously variable-length Blumlein line. Under normal operating conditions, with a 90 % neon-10 % helium gas mixture, the chamber is pulsed at approximately

700 kV for 10 ns to achieve streamers 1 cm in length.

The problem is to achieve sufficient brightness and density when pure helium is used and this has been solved by increasing the voltage amplitude by 17 % and the pulse length by 40 %. Without a variable-length Blumlein line, the pulse required would probably have been close to 1 MV and a chamber with gaps smaller than the present 30 cm would have been required to achieve the higher field in the sensitive volume.

Tracks have been recorded (see photographs) with the chamber filled with pure helium and with helium supplemented by 0.2 % isobutane (C_4H_{10}). The small concentration of hydrocarbon lowered the necessary operating voltage by 7 % but the streamers became more diffuse. There was no magnetic field used, when the photographs were taken, to help brighten the streamers and retard electron diffusion. This makes the Argonne Illinois chamber the largest operational helium streamer chamber. It will be a considerable asset in the experiments at the ZGS which are studying interactions in helium.

The chamber is now being used for a University of Illinois experiment studying baryon exchange in the reaction $\pi^+p \rightarrow nX^\circ$ (180°) at 8 GeV/c. The trigger is primarily the detection of the emerging high momentum neutron in a set of heavy plate spark chambers located downstream of the streamer chamber. This will be followed by an experiment searching for exotic resonances in the reaction $\pi^+p \rightarrow nX^{++}$ (180°) at 8 GeV/c again by the Illinois group and a study of $\pi^-p \rightarrow \overline{K_1^0}\, K_1^0 n$ at 6 GeV/c by a University of Notre Dame group.



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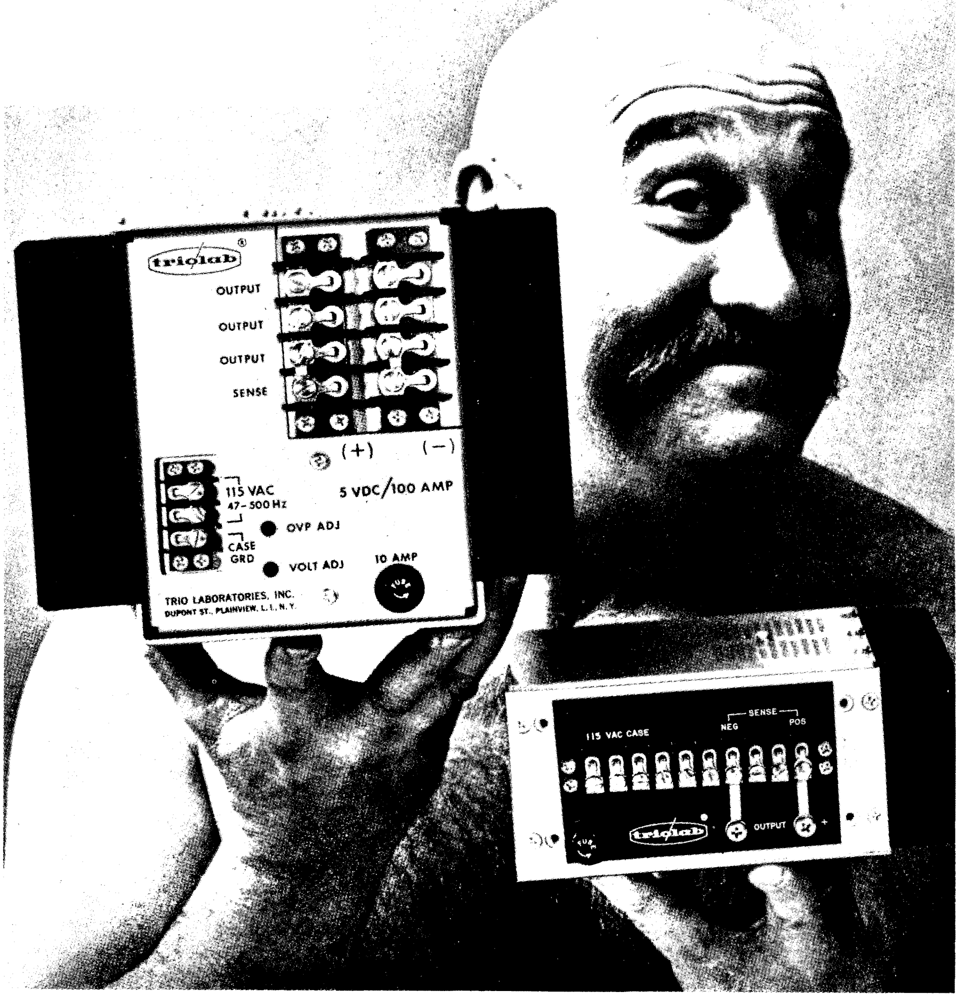

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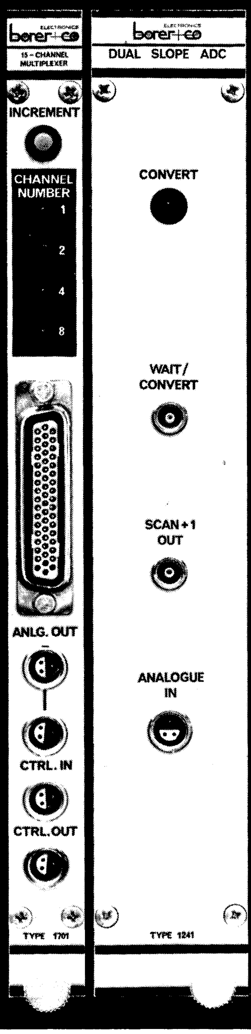

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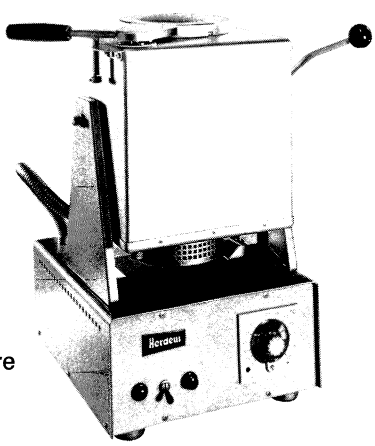

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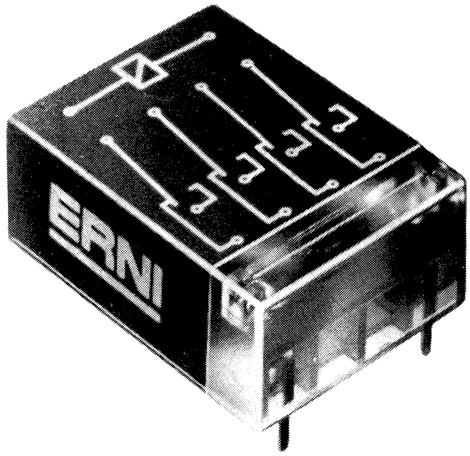

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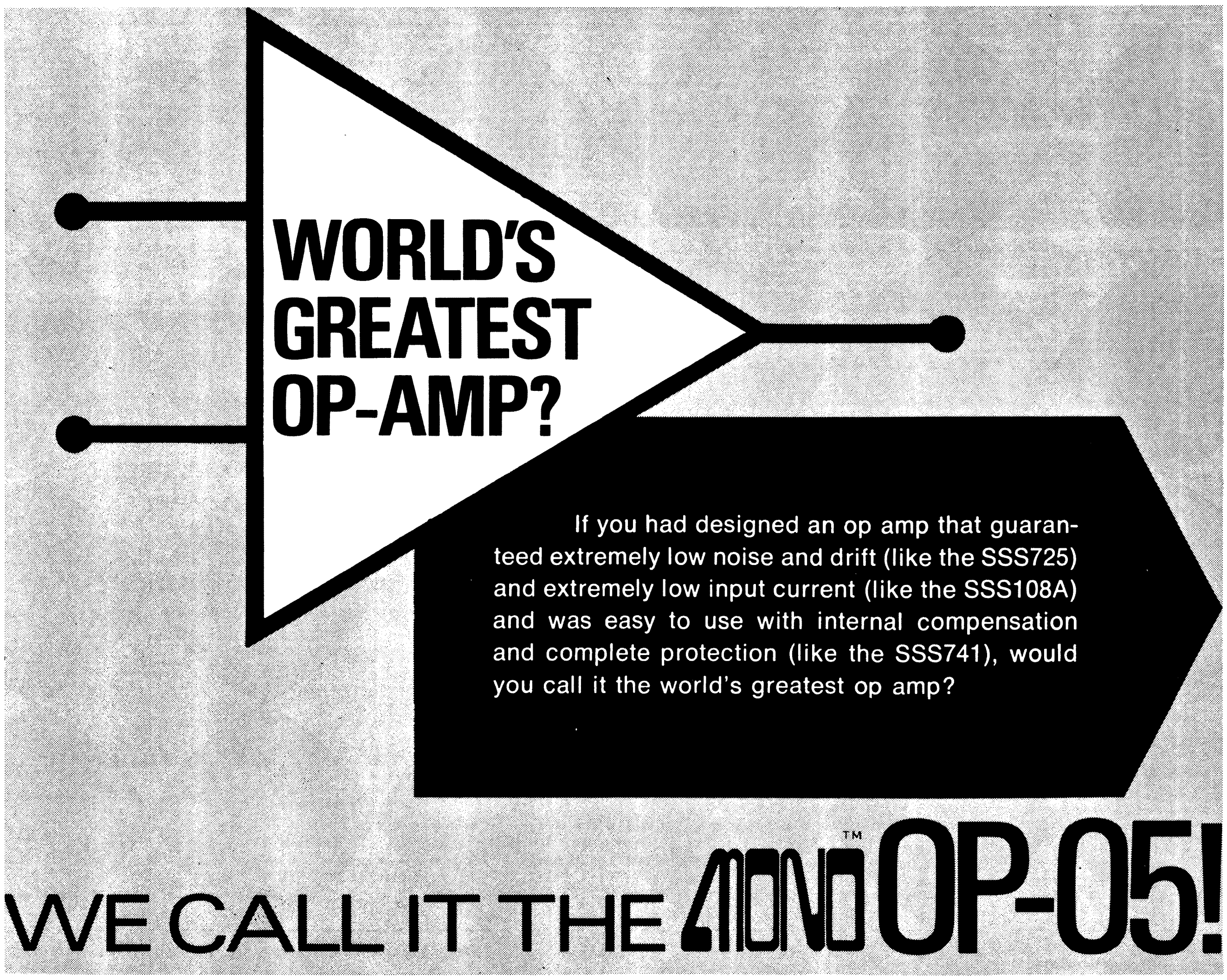

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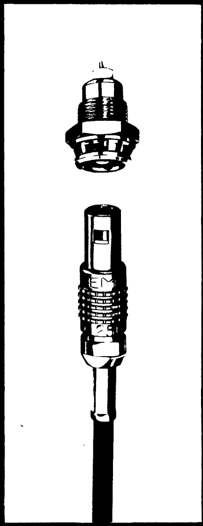

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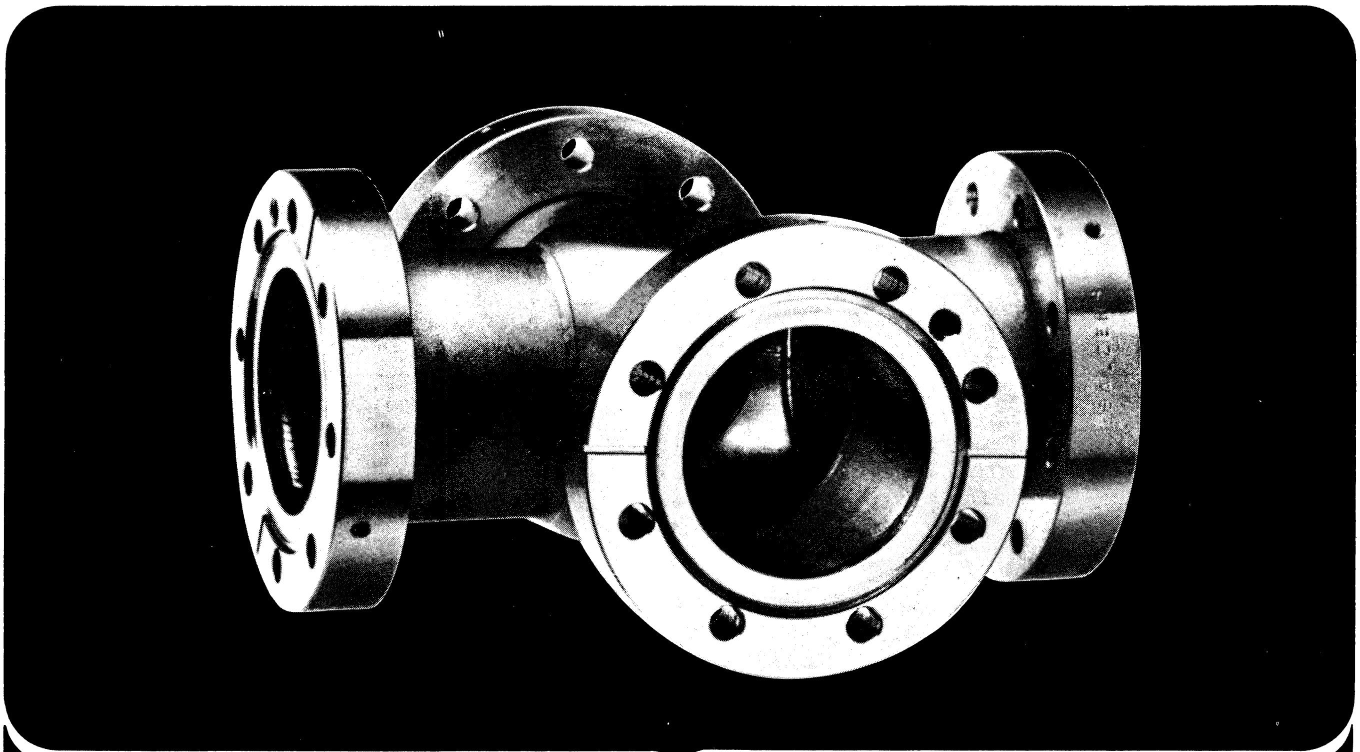

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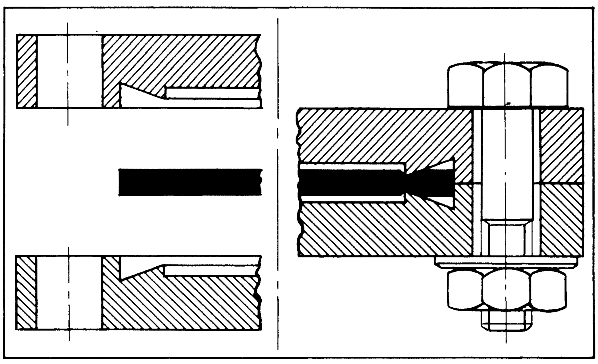

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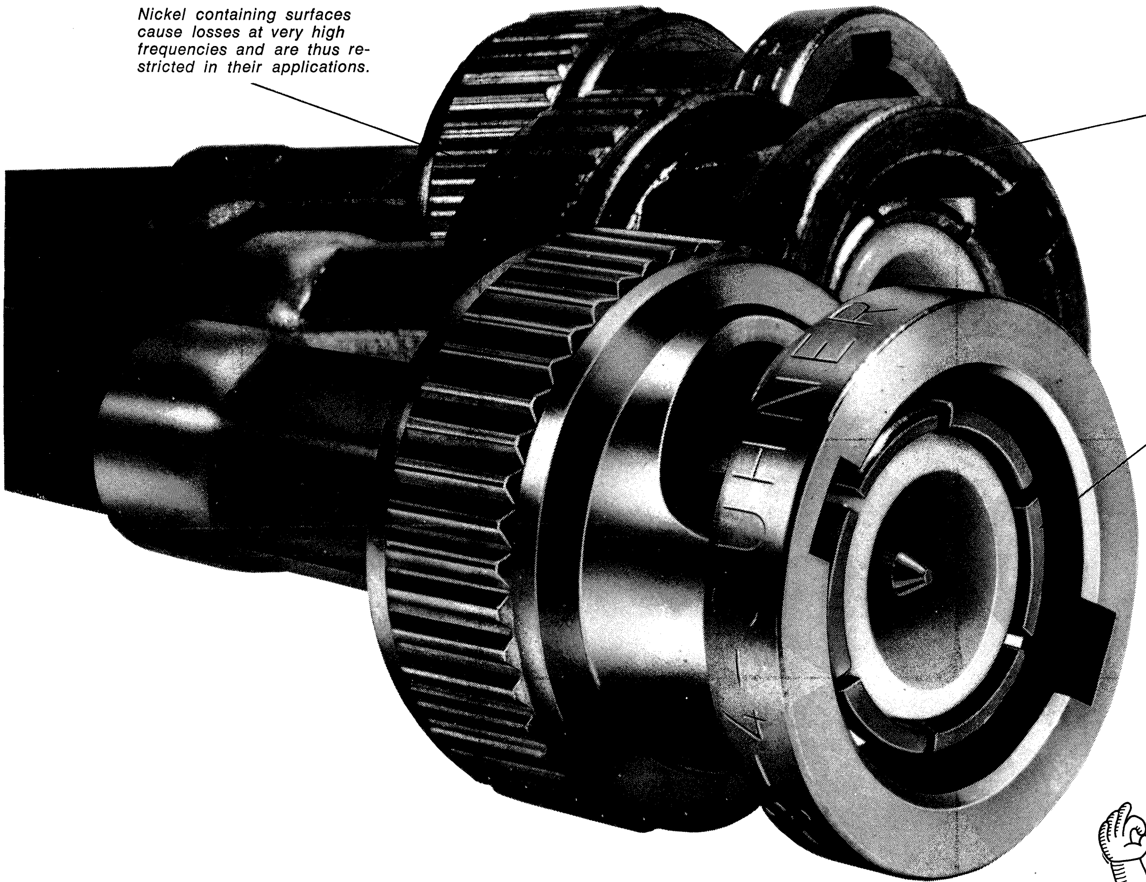

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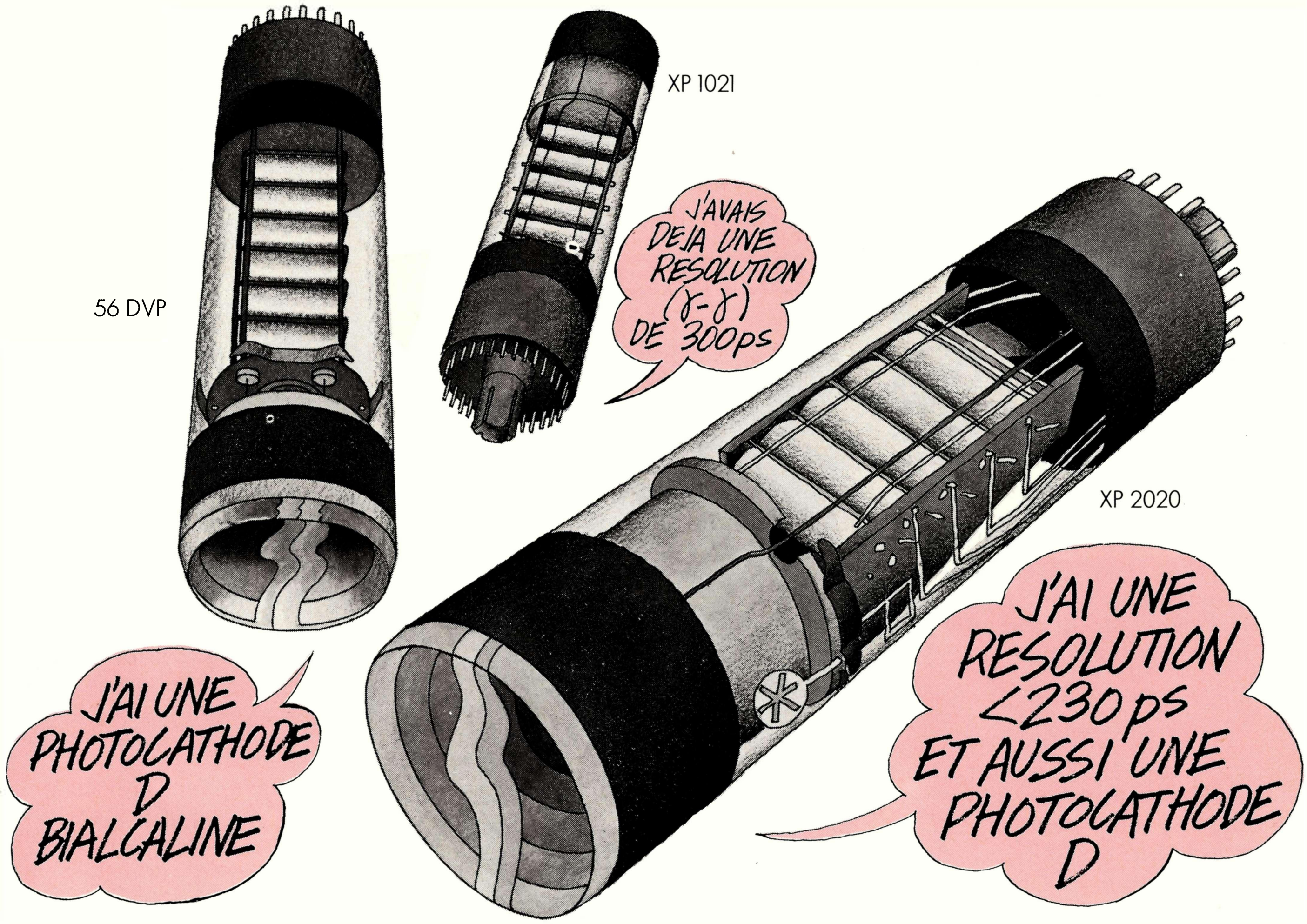

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