CERN COURIER

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European Organization for Nuclear Research

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 1200 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 3000 people and, in addition, there are about 850 Fellows and Visiting Scientists. Twelve European countries contribute, in proportion to their net national income, to the CERN Laboratory I budget, which totals 371.4 million Swiss francs in 1972.

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 hundreds of 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 1972 is 95 million Swiss francs and the staff will total about 300 people by the end of the year.

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Contents

Cover photograph: Aladdin's cave. There is no Christmas pantomime going on at this location in CERN (at least not intentionally) but the digging out of the tunnel where beams will emerge from the underground accelerator towards the North Experimental Area at the SPS. The tunnel is being dug downwards from the surface and is now into the underlying molasse rock having been excavated through the moraine for over 200 m. (CERN 152.10.72)

Laboratory II Two years on

It is almost two years ago that the CERN Council approved the 'Programme for the Construction and Bringing into Operation of the CERN 300 GeV Laboratory'. The SPS project has now reached the stage where most of the design work on the accelerator components is complete. Many of the big contracts have been placed. The Laboratory buildings are almost ready for occupation. Several of the access shafts to the machine level underground have been dug to their full depth and the boring machine, which will chew its way around the 7 km circumference of the accelerator, is on site ready for action early next year. This article is a brief report on the progress at CERN Laboratory II.

It is rare on a large project that the civil engineering work goes without a hitch and the SPS has been no exception. The early stages of both the tunnelling and the surface building moved slower than had been hoped. Nevertheless construction is now going ahead at a very fast pace. It is not out of line with the overall programme and early next year will see major stages reached.

One of these will be the completion of the first office and laboratory block. Some of the SPS staff will then be able to escape from the rabbit hutches, where they have been housed up to now, and move into the Laboratory II buildings proper. Two other blocks should be ready by about six months later. The huge assembly hall is also virtually complete and will be fitted out in ample time to receive machine components as they start to arrive in the second half of the year.

Temporarily, water and electricity supplies are being drawn via Laboratory I but eventually a power link to the French grid network and a water supply from Lac Leman will serve the Laboratory. Negotiations with Electricité de France have fixed the route of the 380 kV connection to the grid at Genissiat and, after some discussion concerning the capitalization of power losses, the contract for two 380/18 kV transformers has been let. A pumping station, capable of drawing 1500 litres per second from the lake, will be built at Le Vengeron and 1000 litres per second will be piped to the SPS site. Temporary measures will be taken to fill the two reservoirs on the site before March 1975 when the supply from Le Vengeron should be in action. Small cooling towers will bring the temperature of the used water down before feeding it back to the Rhone.

Tunnelling work is also reaching an important stage because 'the mole' is almost ready to set off. The civil engineering shaft, where the spoil bored out by the mole will be taken out, is completed and its heavy duty lift is installed. The nearby access shaft close to 'Long Straight Section 1' is also ready and the tunnel which joins them was cut through on 18 December. It is here that the mole and its long train of concrete lining and spoil removal equipment will be assembled. Near the civil engineering shaft, the concrete factory (which will make the tunnel-lining sections) and the railway marshalling yard (where spoil and concrete sections will be shunted around) are being assembled. Long lines of yellow trucks are ready waiting to be spoiled. The tunnel towards the North experimental area, which is being dug downwards from the surface, is now over 200 m long having cut through the moraine into the molasse rock.

Moving to components of the machine itself : The injection scheme for the SPS has now been fixed. After the successful tests of the continuous ejection scheme at the 28 GeV proton synchrotron during the summer (see

CERN Laboratory II buildings taking shape. (The shape, paradoxically since the buildings are across the border in France, is that of a Swiss cross.) One of these buildings will be ready to receive SPS staff early in 1973 and two others, as well as the large assembly hall, are scheduled for completion during the year.

June issue page 203), this technique has been selected, rather than the bunch by bunch method, since it gives better beam quality. Ejection from the PS will be at 10 GeV and the protons will travel along the existing beam-line towards the ISR for about 200 m before being bent down a tunnel 800 m long to be injected at Long Straight Section 1 of the SPS. In collaboration with the ISR Department the section of beam-line towards the ISR will be adapted so that it can handle (on alternate pulses and at different energies if necessary) protons for filling the ISR and protons for injection into the SPS.

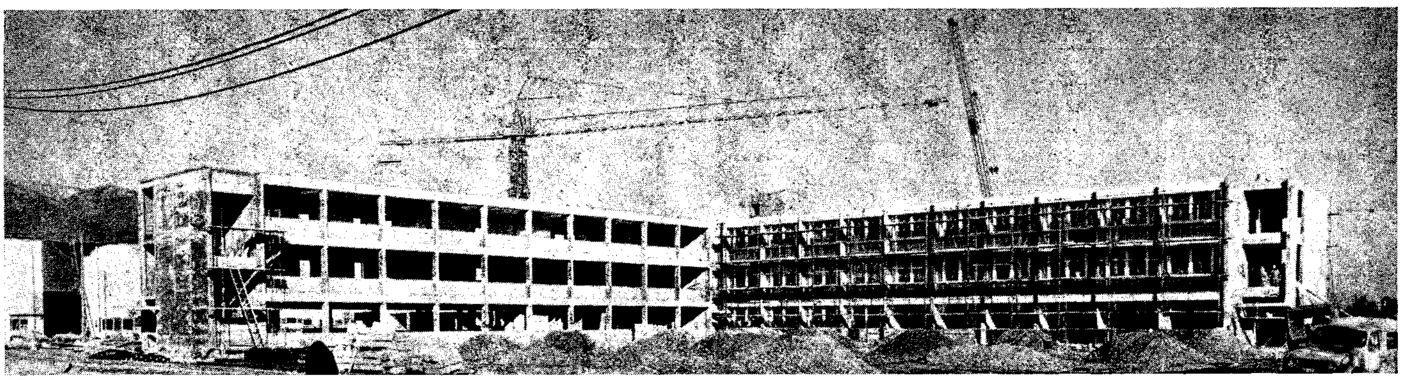
Once a beam has been achieved in the ring, care has to be taken not to let it go astray. This has been an obvious accelerator requirement for some time in order to reduce radiation damage and induced radioactivity problems. However there is an additional reason with very high energy, high intensity beams. Estimates indicate that, for example a 400 GeV 10^{13} proton beam of small cross-section can locally heat a block of metal to temperatures of a thousand degrees. An internal beam dumping system, using fast pulsed magnets which give a constant vertical deflection to the beam over one turn (to catch the full ribbon of beam), has therefore been designed. The diverted beam will be directed onto an absorber block and an additional magnet with a linearly rising field will be available to spread the beam horizontally across the block to prevent overheating of a tiny volume.

This problem also has its implications for the ejected beams. Because of the potential danger to beam-line components the days when ejected beams could be set up by twiddling in front of a scope are over. Computer control of ejection elements will be necessary. Fast and slow ejection schemes have been studied and tests have begun with an electrostatic septum (see last issue page 375). For optimum slow ejection at different energies it will be necessary to be able to change the septum gap by remote control, which adds a complication.

The layout of the ejected proton beam lines to both the West and the North experimental areas has been worked out. Going West, an underground switchyard (a specially enlarged section of tunnel also known as the 'underground cathedral') will house magnets which can deflect protons onto a target providing particles for a r.f. separated beam or onto a target to provide neutrino parent particles. The neutrino parents will be pointed at the BEBC bubble chamber and the neutrinos will travel through earth, which will filter out other particles, before emerging at ground level at BEBC. The r.f. beam-line will climb to the surface in the same tunnel as the ejected proton beam-line. The proton beam-line will be further subdivided into three beams in the West area. Going North, the beam-line geometry to the surface has also been fixed (as indicated above in describing the civil engineering work). Much of the design work on magnet systems etc. has been done and the placing of contracts will be phased so that beam transfer equipment will start to arrive on site in 1974.

On the magnets for the main ring itself delivery has to start much earlier and contracts for the bending magnets and the quadrupoles have been placed. The first 60 tons of steel (a test quantity) have been delivered to the core manufacturer and found to be satisfactory (in fact the coercive force is a factor of two lower than needed according to the specification). A further 1000 tons has been produced and is being checked using an automated version of the permeameter system used by the ISR team. Prototypes from the manufacturers will be at CERN in April 1973 for the bending magnets and June 1973 for the quadrupoles. Production magnets will be at CERN before the end of the year.

The prototypes built at CERN have been subjected to careful measurements to ensure that the required field quality can be achieved. The two full length (6 m) bending magnets



CERN 221.11.72

Inspecting the roof of the tunnel which links the 'civil engineering shaft' to straight section 1. Appropriately this is the injection straight section for it is here that the mole will be injected to start burrowing. The link tunnel from access shaft 1, where the mole will be assembled, was cut all the way through on 18 December.

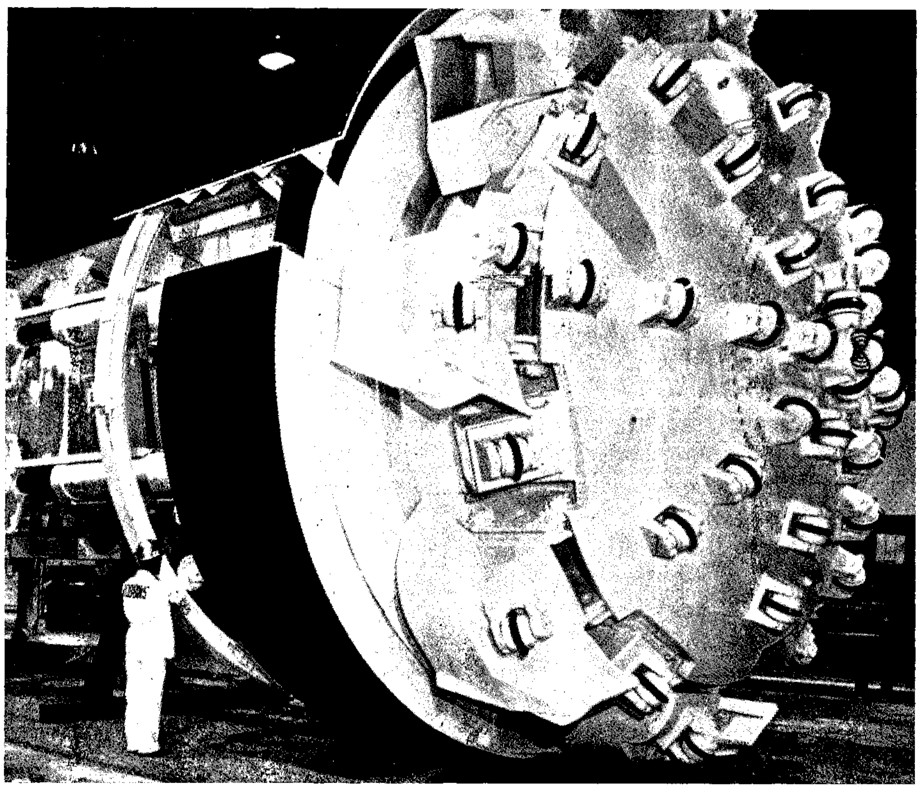
A Robbins rotary tunnelling machine of the type which will bore the tunnel of the SPS. Components of the machine to be used at CERN, known colloquially as 'the mole', have arrived on site and the 7 km journey around the accelerator circumference is scheduled to begin in February.

(Photo Robbins)

were measured using a special matrix of nine 7 m long search coils and were found to meet the tight field tolerances (a few parts in 10^4). Taking readings along the length of the magnets revealed a few dips in the field level which were related with slight gaps between the half cores. The procedure for welding the tie plates holding the half cores together has been modified to cure this. Another important check was to pulse both magnets simultaneously and to measure how well the fields 'tracked' together. A one per thousand deviation here would correspond to a loss of about 3 mm of aperture. The tests indicated that the magnets will track together to better than one per thousand. Measurements are currently under way on the quadrupoles to fix the end shape so as to keep the integrated focusing gradients constant across the aperture to a few parts in a thousand.

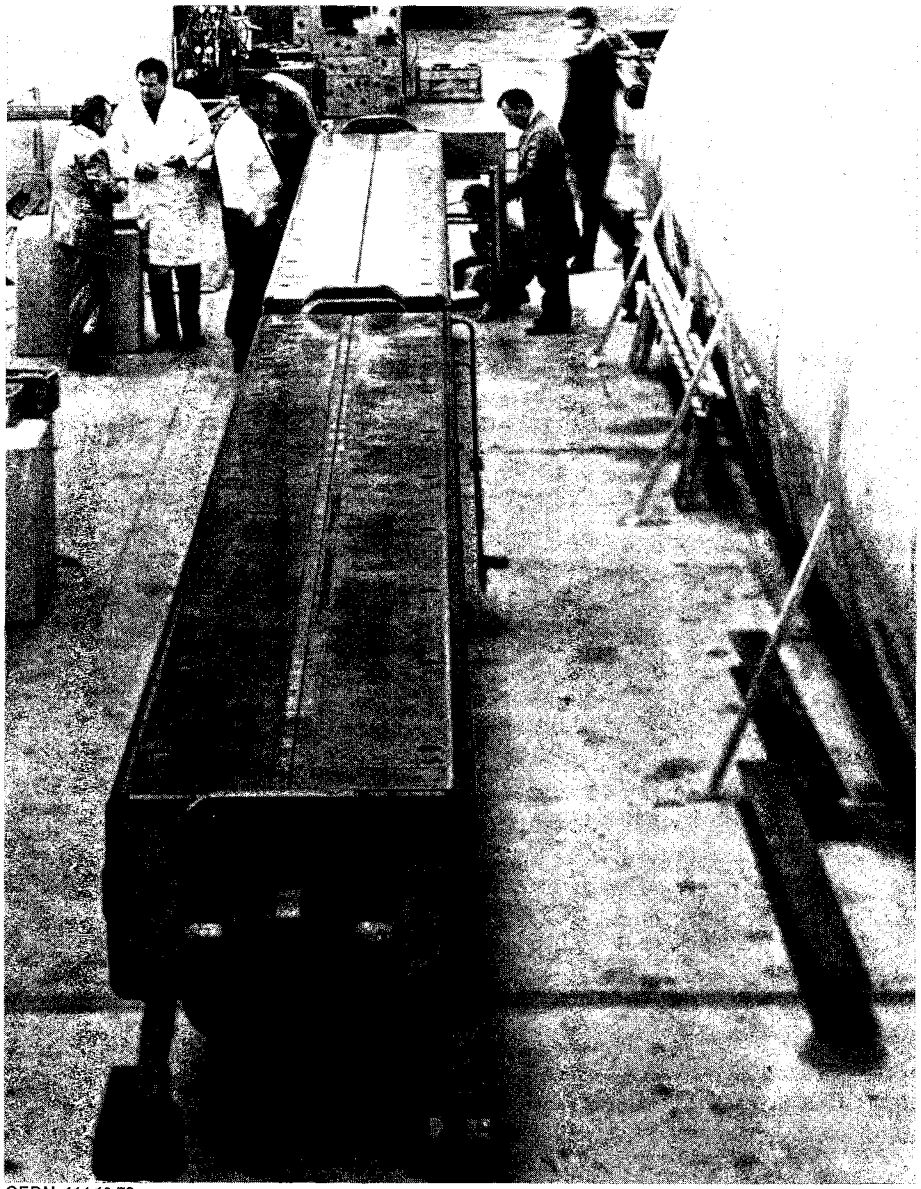
CERN 356.11.72

The dipoles for orbit correction and for sextupoles have been designed and the design of the octupoles has started. The specifications are also being drawn up for the special quadrupoles needed in the two beam ejection regions. To give room for manoeuvring the beam, larger apertures are needed and the standard components are being scaled up by a factor of 11/9. Since only twelve are needed they will be assembled at CERN.



In twelve months time, a veritable magnet factory will be in full swing. Dipoles will be assembled on site and a series of tests on each magnet (mechanical checks, hydraulic tests electrical connections, and magnetic measurements using the search coil matrix) will be carried out before the magnet is liberated for installation in the ring. When the pressure builds up to its peak, ten magnets per week will go through the mill.

Two full length prototype bending magnets lined up for tests in the West Hall. (On the right can be seen the outside of the model SPS tunnel.) The main measurements on the prototypes are complete and have confirmed that the required field quality can be achieved.



CERN 114.10.72

Components for the power supplies of the main ring magnets (the rectifier transformers, thyristor modules and passive filters) have been ordered from industry. The supplies are designed to provide the pulsed wave form required by the magnet to a voltage accuracy of one part in 10^{-4} with a ripple of less than 10^{-4}. The low-level electronics and control circuitry are being developed at CERN and some prototype units have been tested.

The other major part of the power supply system is the static compensator which smooths out the effect of the great surges of power taken by the accelerator (120 MW peak) on the EDF grid system. Tests have confirmed that the effect of the accelerator pulsing will not perturb the grid above acceptable limits. Specifications for the compensator and filter have been drawn up and the contract will be placed early next year. The compensator will arrive at CERN as a complete unit. The magnet power supplies, on the other hand, will arrive in sections and will be assembled on site ; the first components are expected towards the end of 1973.

The form of the radio-frequency cavities for the acceleration system has been carefully studied during the year and has now been fixed in its most important aspects. Travelling-wave cavities are to be used, as discussed before, and they will operate in the $\pi/2$ mode. During the year, reduced-scale models of cavity sections have been tested and a design having an inner tank diameter of 0.75 m with drift tubes supported by stems on either side has been selected. It results in a comparatively simple mechanical structure and gives a high, unloaded, Q factor (17 000).

A full-scale model of this structure with two cells was then built and checked in the laboratory. Tolerances, cooling effects, etc. were all in order and furthermore power tests were also successfully carried out with current and voltage levels each five times those which will be experienced in the accelerator itself. The contract for manufacture of two cavities is likely to be placed around the middle of 1973 and the cavities are scheduled to be on site in 1974. Each cavity will have five sections with eleven drift tubes per section — a total of 112 accelerating gaps in all.

The amplifiers to power the cavities needed to be newly developed since models are not available commercially to cover the frequency range (around 200 MHz) at the power levels (500 kW) required. A major concern in the design has been to ensure high reliability and this led to a division of the r.f. power amplifier system into smaller power units linked together.

Three amplifiers are to be built, each to provide 500 kW of r.f. power. Two of them will be needed at any one time to feed the two cavities and the third will be available as a standby. It could also be used eventually to feed an additional cavity should operational experience indicate that a third cavity would be an advantage. The contract for the amplifiers, based on the use of tetrodes, was placed in September and a prototype tube cavity and dummy tube are already available at the manufacturers for tests. The completed units are required on site in 1974.

The control system for the SPS is one of the most novel and challenging features of the project. It has problems of shear scale to confront since the accelerator plus its injection and ejection lines are distributed in some ten kilometres of tunnel and there are six service buildings (at the top of the access shafts to the six long straight sections) with major concentrations of equipment. In setting up the machine, for example, information on beam behaviour has to be gathered from the whole accelerator brought together for analysis at a central point (or points) and the corresponding instructions sent out to the service buildings. The ability to adjust rapidly to a variety of machine operating conditions and good reliability are other important requirements.

The use of computers is obviously essential and during the year the specification for the computer control system has been drawn up. It has been decided to go for a number of small computers, each of which can be assigned specific tasks, rather than to put all the eggs in one large computer.

About 90 firms were invited to tender for the control system but none proved able to supply both the computers and the extensive data distribution system in line with CERN's requirements. The system was therefore split and a contract for the supply of 24 computers and peripheral equipment is now being negotiated. The first three of these computers are scheduled to reach CERN in May 1973. Decisions concerning the provision of the data distribution system have not yet been taken and some design work has started at CERN itself in case commercially available equipment does not meet the requirements.

The interfacing between the computer and the accelerator components will use CAMAC units. This is in line with the standardization of electronic equipment and a great deal of CAMAC equipment is available to select appropriate units for the needs of the SPS. This decision also enabled work on the interfacing to go ahead without waiting for the type of control computer to be selected (since CAMAC does not mind which computer it hangs onto).

Some experience in applying the ideas behind the control system (particularly concerned with the use of the 'high-level' computer language called BASIC) is being gathered in developing the control system for the automatic measuring equipment which will be used to check the magnets, as mentioned above, and the control system for measurements on the r.f. cavities.

The Controls Group is also looking after most of the beam monitoring instrumentation in the accelerator and its input and output beam-lines. In order to pull in expertise from other Laboratories on this topic, a Study Meeting on beam measurement techniques was held in the summer. (Like the Spring Study Session on theoretical problems, this Meeting was at the instigation of the 300 GeV Advisory Machine Committee.)

There are some new features which make the development of this instrumentation interesting. For example, the beam monitors have to be sensitive both to the PS type beam frequencies prior to switching on the r.f. accelerating cavities and then to the very high (200 MHz) SPS frequencies. Prototypes of electrostatic pickups are being tested together with associated electronics.

Electronic units have been sprayed with radiation in a reactor and their ability to withstand even comparatively low doses without changing their characteristics proved to be poor. This was true even for special 'radiation-hardened' devices. It will result in rather more wires being strewn around the machine than had been hoped in order to get the electronics out of the high radiation regions.

There is obviously a great deal of other work in progress which we will not cover in detail in this short article. For the vacuum system, the contract for the chambers to be installed in the bending and quadrupole magnets has been let and the pumping system has been designed. For the radiation control system, methods of regulating personnel access to radiation areas, shielding requirements and ways of coping with radiation effects on accelerator components are all receiving attention. The survey system has to achieve millimetre accuracies over kilometre distances and already the junctions near straight section 1 have been made with an accuracy of better than 2 mm. We shall be describing in the near future (at the time when the mole starts its journey) the techniques they use. Planning of the experimental areas is also underway and some major features were reported in the October issue when reviewing the Tirrenia meeting.

Finally, a lot of effort has gone into working out the administrative arrangements both within the Laboratories and in association with the French and Swiss authorities. This type of work requires great care and foresight because from it emerges the framework within which the Laboratories must function. The agreements reached must be clear and obviously be acceptable to all parties involved and yet be sufficiently flexible to allow CERN's activities to develop and adapt to changing situations. We often neglect to underline that CERN's success on the administrative/political front is every bit as impressive as its scientific success. The recent signature of the lease by the French government of 412 hectares for Laboratory II is reported later in this issue and speaks for itself as a tribute to CERN's unique position as an international organization.

CERN News

ISR reaches design luminosity

The ISR team celebrated Christmas by achieving the design luminosity of 4×10^{30} per cm^2 per s during the night of 20-21 December. This was really the moment that the ISR reached the level of performance for which it was designed. The luminosity is the crucial machine parameter for the physics experiments since it determines the number of interactions which will take place when the beams collide.

The success of the December run followed further improvements in the vacuum and the selection of a working line with more Q spread. The peak recorded luminosity was 4.35×10^{30} per cm^2 per s with currents of 12.2 A and 11.3 A stored in the rings. The beam currents fell only slowly. The beams were left circulating until the morning and the luminosity was over 3×10^{30} even then.

What was additionally pleasing was that physicists were able to use these high luminosities immediately. The beams were sufficiently well behaved for data to be collected at intersection regions I-2 and I-5.

The design luminosity has thus been exceeded by a comfortable margin. Rather than resting on their laurels, the ISR team have now raised their sights and 10^{31} per cm^2 per s is their next major goal. A lot of attention is also being given to the possibility of inserting a low beta section at one of the collision regions and even the 10^{31} figure may be surpassed.

The big detectors

BEBC tests imminent

In the next few weeks a second series of tests with the 3.7 m European bubble chamber BEBC is scheduled to begin. During the first tests last summer, though most components performed well (see July issue page 231), some problems were encountered. It was however difficult at the time to judge how serious they were. Leaks appeared in the pipework of the magnet cryostats but their precise location and their nature were not known.

The upper part of the chamber assembly had to be dismantled to get at the faulty regions and the taking apart went on until early September. Several leaks were found in a section of pipework which connected four collectors at the bottom of the cryostats. The pipework was obviously too weak to withstand the mechanical forces it was experiencing.

A careful look was also taken at the collectors and at the pipework on top of the chamber. When the repairs had been completed, vacuum tests were carried out and everything appears to be in good shape.

Reassembly began mid-October and was completed without problem at the beginning of December. At the same time major repairs on the refrigerator installed in an adjoining building were carried out. Each of the four compressors has several water cooling circuits connected to cooling towers. Previously the circuits passed 'normal' water but this resulted in corrosion problems and even the penetration of water into the hydrogen and helium circuits. The refurbished refrigerator came back into action in December.

During January cool down of the magnet to superconducting temperatures will begin again. The magnet will then be powered to achieve the design field of 3.5 T at the centre of the bubble chamber volume. Full tests with hydrogen in the chamber are scheduled in February. It is hoped that the results will be sufficiently good to allow the first photographs for physics to be taken after cool down number 3 about the middle of the year.

Vibrations at Gargamelle

BEBC is not the only chamber to have trouble with leaks in pipework. The heavy liquid bubble chamber, Gargamelle, was scheduled to complete a neutrino physics run while filled with freon from 6 to 13 December. The run had to be cancelled for safety reasons because, during the preceding run, leaks in some connecting tubes in the pressure system were detected.

The leaks appear to result from the severe vibrations which occur during the pressure pulsing of the chamber. Repairs are under way together with a careful analysis of the problem so as to eliminate the cause of the fracturing of the pipework. It is intended to replace two tanks in the pressure system, to reinforce the supports of all the tanks and to modify some of the connections between the tanks and the chamber magnet.

When the repairs are complete the chamber will be tested again. Fortunately, this can go on during the long annual shutdown of the 28 GeV proton synchrotron in January and February. It is hoped that Gargamelle will be ready to take up its experimental programme again as scheduled at the end of April.

Two-coiled Omega

A third major detector, the Omega spectrometer, has also been a scene of change during the past month. Omega came into action this year with just one of the coils of its superconducting magnet in action (see September issue, page 286). Manufacturing problems delayed the installation of the second coil.

At the beginning of December both coils were in place and cooling to

A contract concerning the use by CERN of 412 hectares of land in France was signed at Gex on 9 December. In the photograph, A. Alline (Ministère des Affaires Etrangères) signs on behalf of the French government. Behind him on the right are the two other signatories, the Directors General of CERN, W.K. Jentschke and J.B. Adams.

superconducting temperatures gingerly commenced. As the temperature crawls down, a careful check is being made for leaks in the helium cooling circuit. So far all has gone well and it is hoped to be able to check the fields at design level before the end of the year.

SFM tests going well

The magnet for yet another big detector was successfully taken to its design field for the first time early in December. It is the so called Split Field Magnet which will be part of a general purpose detection system surrounding interaction region I-4 in the Intersecting Storage Rings. (For details of the design see the July issue, page 236.)

Tests began at the end of October and current to the magnet coils was gradually taken higher in the subsequent weeks while the safe performance of components was successively checked. This included both mechanical safety and electrical safety. Strain gauges monitored the strain experienced at crucial points in the magnet structure and thermocouples kept an eye on the temperatures in the water cooling circuits and on bolts where eddy currents could produce heating when the magnet was abruptly switched off. Vibrations were also measured since various resonant frequencies in the structure are close to possible harmonics in the excitation current.

The electric safety of the circuitry involved in powering the magnets was also up to the mark. The actual acceptance tests on the power supplies are scheduled before the end of December.

The design field of 1.14 T was reached on 7 December with a current of 5700 A fed to the magnet coils. This is below the anticipated figure and involves less power to the SFM. It will give a healthy saving in power costs over several years of operation.

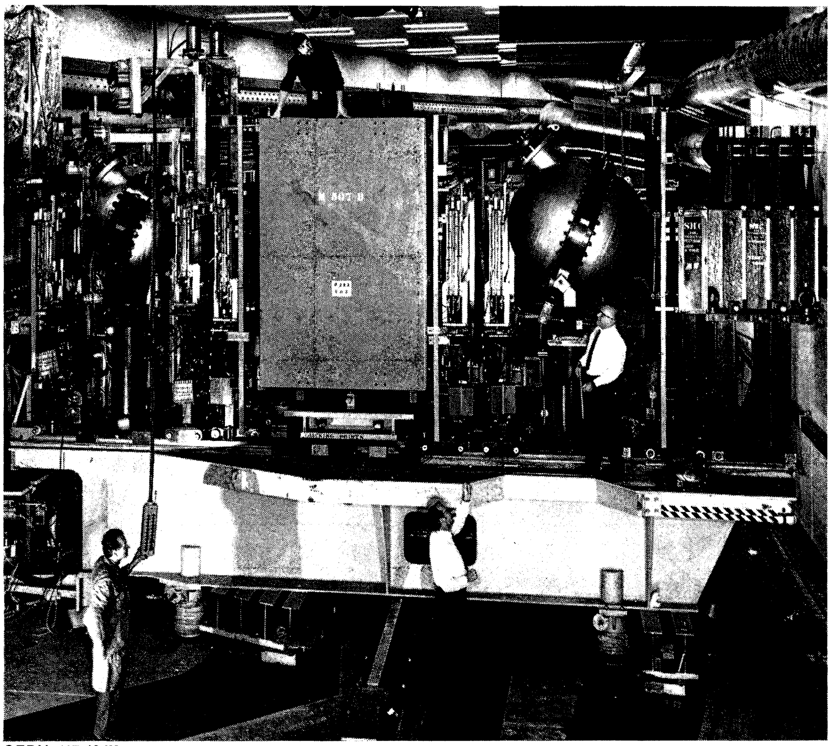
The compensator magnets which go with the SFM are now being installed and, when they are in place together with the magnetic channels, a careful series of magnetic measurements will be taken at several field levels so as to have good maps of the field configuration. The date when the SFM will be wheeled into I-4 has not yet been decided. The installation will require several weeks of work and will therefore be aligned as best possible with the ISR experimental programme.

CERN-France contract signed

On 9 December the signatures of the CERN Directors General and of representatives of the French government found their way again onto a formal piece of paper after many months of careful preparation. In June this happened with the signature of an Agreement concerning the legal status of the Organization in France — it had become necessary to define the status more fully with the extension of CERN's activities in France. In the Agreement there is reference to a contract concerning the land made available to CERN for the development of Laboratory II. It is this contract which was signed at the beginning of December.

A ceremony took place at the Sous-prefecture at Gex in the presence of representatives of the government, of the local authorities and of CERN itself. The Directors General of CERN thanked the French authorities and spoke about CERN's policy in the region. It is hoped to avoid becoming a foreign enclave and, on the contrary, to become integrated in the life of the region. An aspect of this can be seen

Intersection I-2 at the Intersecting Storage Rings. On either side of the congested collision region are spherical Cherenkov detectors looking like overgrown Christmas decorations. They have been installed by the British, Scandinavian group and will be used for particle identification, being particularly concerned with the high momentum particles emerging at wide angles which are among the most surprising observations at the ISR.



CERN 127.12.72

in that the Laboratory II site is largely an open one where the existing farming and forestry activities can continue.

A scheme has been worked out together with the French authorities for management of the site. It will involve regular contact with the representatives of the local community and a liaison committee has been set up to ensure this. The committee will determine, for example, the conditions under which the farming on the CERN site will be carried out. Care will be taken particularly to preserve the forests with the help of the Office des Forêts.

The agricultural land not needed for the Laboratory installations will be sub-let and the income from this source will be used for the preservation, or improvement, of the environment on the site. As an indication of the seriousness of the concern in this direction, the tenants (who are in fact the previous owners of the land) would have to have authorization before they could cut down a single tree.

Another section of the contract concerns the linking of the two Laboratories without passing via the customs posts. A tunnel will be dug underneath the route N 84 and a road in the tunnel will be used by CERN personnel and for the transport of CERN equipment.

The contract makes available to CERN an area of 412 hectares at a nominal rent of 100 French francs per year for 92 years. It is linked to that concerning the use of the ISR site which came in effect in 1965 and runs for a hundred years.

Just looking around

To investigate the production of high momentum particles at wide angles in collisions at the ISR, a matching pair of Cherenkov detectors have been sent into I-2 to take a good look around. Reports from the CERN, Columbia, Rockfeller group concerning neutral pions and from the Saclay, Strasbourg group concerning charged pions, indicate that such particles are in plentiful supply and these results are among the most surprising to emerge so far from the experiments at the ISR.

The Cherenkov detectors for I-2 will sit on the large movable platform installed for the experiment of the British, Scandinavian group. They will provide particle identification over a momentum range from 1.5 GeV/c to 5.0 GeV/c.

The larger of the two spherical detectors has a diameter of 1.5 m and a working pressure of 7 atmospheres. When filled with the gas Freon 13B1 the detector can distinguish pions from kaons and protons. The kaon-proton separation is provided by the 1 m diameter sphere filled with Freon 13 to a working pressure of 45 atmospheres. To prevent liquefaction of the gas at this pressure, the sphere will be wrapped in a heating jacket and maintained at 35°C. The use of stainless steel only 6 mm thick in the construction of these spheres initially caused some raised eyebrows in view of the safety requirements but the spheres successfully withstood stringent pressure tests and were installed in the intersection region in early December.

In each detector, the light produced in the gas is reflected from a spherical mirror and focused through a quartz window 85 mm thick onto 125 mm photomultiplier tubes. The larger detector employs a 1 m wide mirror and two tubes and the smaller detector has a 0.5 m mirror and one tube.

Both detectors were designed and constructed by Liverpool University with financial support from the Rutherford Laboratory where they have been tested on an extracted beam from Nimrod. These tests indicated that the detection efficiency is greater than 99 % over a wide angular aperture.

To aid the particle identification, a shower detector sensitive to electrons and positrons and a muon range detector have been added at the rear of the platform. Momentum measurements will be done using the 50 ton magnet with the spark chambers and the counter hodoscope arrays which are being used by the same groups to search for new high mass particles.

An angular survey over the whole momentum range will be performed during the first half of 1973. High momentum particles will no longer be able to escape incognito.

LOS ALAMOS Linac Conference

The people who think straight got together again at Los Alamos from 10-13 October for the 1972 Proton Linear Accelerator Conference. These conferences are held every other year and, in fact, are not too particular about the particle involved — electrons and heavy ions were featured at Los Alamos also. About 150 specialists met to exchange their latest plans/ideas/experience and there was also useful contact concerning common approaches to component manufacturers.

The coming into action of the 800 MeV proton linac, LAMPF, at Los Alamos was obviously a major source of papers at the conference. After a promising start they are beginning the long haul to achieve the high design intensity of 1 mA. It will be well into 1973 before the full experimental programme is launched but there has nevertheless been some physics at the machine already. Many aspects of component design and performance and of the machine commissioning procedures were of great interest. However since we intend to have a rather full report from LAMPF in the February issue we will move onto other topics.

Two other linacs to achieve design energy since the previous conference are the related proton injectors at Brookhaven and Batavia. Both had 200 MeV protons over a year ago but neither has yet settled to completely satisfactory operation at their high design intensities. Radiofrequency component problems on these two machines were discussed at length, both formally and informally, at the conference. An injector which has been upgraded to give unusually high intensity is the 24 MeV proton linac feeding the 7 GeV synchrotron at ITEP Moscow. By the standard trick of increasing apertures at the low energy end of the machine and by careful tuning of the focusing quadrupoles, 24 MeV pulses in excess of 200 mA are achieved. They plan a beam at this energy, at the output end of the linac, for some nuclear physics work.

Work on linac structures, which led to the side-coupled, post-coupled and multistem schemes in the tanks at Los Alamos, NAL and Brookhaven, etc., has continued with axial (rather than off axis as at LAMPF) coupling schemes promoted at Chalk River and in the Soviet Union. In the wake of the ING project some experimental work on c.w. linacs still flourishes at Chalk River.

Several sessions were given to the applications of superconductivity in linacs (and in r.f. particle separators where many of the problems are the same). The promise of high field gradients and long duty cycles which superconducting cavities held out has still a long way to go to realization. Nevertheless, a review of the subject by P.B. Wilson listed about twenty Laboratories where some practical work on these problems is under way. For example, r.f. separators are under attack at Brookhaven, Karlsruhe, Rutherford and the Weizmann Institute ; electron linacs at Cornell, Illinois, Stanford and Orsay ; proton linacs at Karlsruhe ; applications in heavy ion acceleration at Argonne, Caltech, Oak Ridge and Stanford...

Higher gradients and higher duty cycles than in conventional cavities are already possible but they are some way from what was anticipated with superconducting cavities. The problems seem to lie in the quality of the cavity surfaces. Microscopic imperfections in geometry prevent high fields being achieved. Surface quality seems to be degraded badly by exposure to particular gases (such as carbon dioxide or methane).

Among the experimental results achieved in large structures, Karlsruhe is reaching accelerating rates of 1.2 MeV/m without difficulty. With their helix-type cavities they operate at present in a self-oscillator mode but in the future, when they have multiple section operation, they will need to solve the additional problem of fast servo-tuning. The interaction between the mechanical energy and the electromagnetic energy in a helix (mechanical Q about 10^4) makes this especially tricky.

Stanford have seen X rays corresponding to electron energies three times the gap energy in their cavity test experiments. This is not understood yet. It appears to be a new phenomenon involving multiple gap crossing which certainly differs from multipactoring where there is current build up but no energies in excess of the gap energy. Nevertheless, as reported in the April issue, the Stanford HEPL group are methodically solving other novel problems with their full-scale electron linear accelerator. These concern, for example, the operation of the 8 MeV injection section with fine output beam quality and the suppression of beam break-up modes in the main accelerating structure.

Superconducting cavities ought to yield under the multi-Laboratory onslaught which has been launched.

The recirculating linear accelerator (RLA) project, now being promoted hard by SLAC, received some attention. It is designed to increase the peak energies and the duty cycle available from the SLAC electron machine which now operates at just over 20 GeV. It looks the most likely project (if any) to go ahead in the near future in the USA. We will come back to it next month with a fairly detailed description of the plans which are now on the table.

Another subject we will return to is that of heavy ion linear accelerators. There were reports from Berkeley on the revamped HILAC (Super-Hilac, mentioned in the last issue page 381) and from Darmstadt on the multistage UNILAC. Most UNILAC components are now ordered and it is hoped to have the first heavy ion beams by the end of 1974.

Under the miscellaneous heading there are a couple of topics worth mentioning. Brookhaven and Batavia have looked at deuteron acceleration in their linacs. Both have found that above about 40 MeV things become difficult as structures and r.f. power sources are not right. A development in ion source technology might have interesting repercussions in the years to come. Negative hydrogen ions can now be produced with beam intensities of tens of milliamperes. The schemes, such as that being tried at Argonne, using negative ion injection into a synchrotron and then stripping to yield protons (sliding around Liouville's theorem which limits normal injection capabilities) become much more interesting with negative ion currents at this level.

BATAVIA News on accelerator and programme

Towards the end of November the beam intensity in the NAL synchrotron topped 10^{12} protons per pulse for the first time. This was achieved with eight pulses fed to the main ring from the fast cycling 8 GeV Booster. It is hoped to bring the number of Booster pulses per cycle up to the design level of 13 by the end of the year which should push the intensity to a few times 10^{12}. Further intensity improvements await the bringing in of multi-turn injection from the linac to the Booster and a further diminution of the beam losses early in the main ring acceleration cycle.

For some time the peak energy has been held at 200 GeV while effort has been concentrated on improving the pulse repetition rate. (This is so that higher energy operation can be implemented with acceptable repetition rates.) The design figure for the rate of energy rise, 125 GeV/s, has now been achieved and it is hoped to have an extended run at 300 GeV in December.

Development of the machine has now reached the stage where a schedule for the experimental programme can be prepared. Components have been sufficiently tamed to be confident of providing beam to experiments with good efficiency as planned in advance. For example, the main ring magnet problems seem to be mastered — the replacement of magnets is down to about one per week. A two week schedule is being applied, nine days of which go to the experimental programme (including time given to the tuning of beams).

The active experimental programme is concentrated in two regions. One involves internal targets. Recently the polyethylene targets have been replaced by the supersonic gas jet target built at Dubna and previously used at Serpukhov. It is being used by a USA/USSR collaboration to extend the proton-proton scattering measurements where a lot of data has already been collected. The target has also been shown to work with deuterium and proton-neutron measurements will be done later.

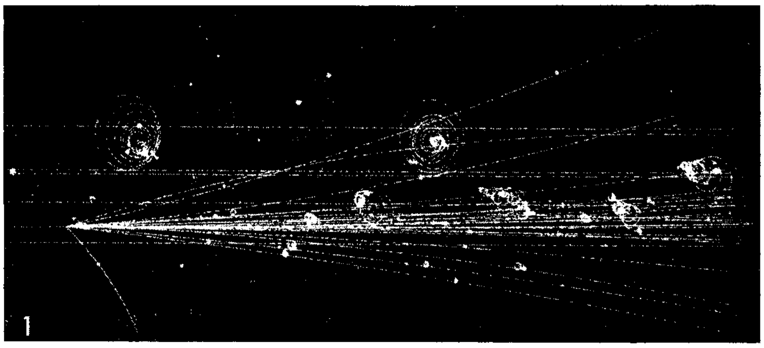
Other experiments with the internal target include gamma detection (and thus neutral pion detection) in the backward direction (where a lot of data, which seems in line with scaling, has been collected) and at 90° (where

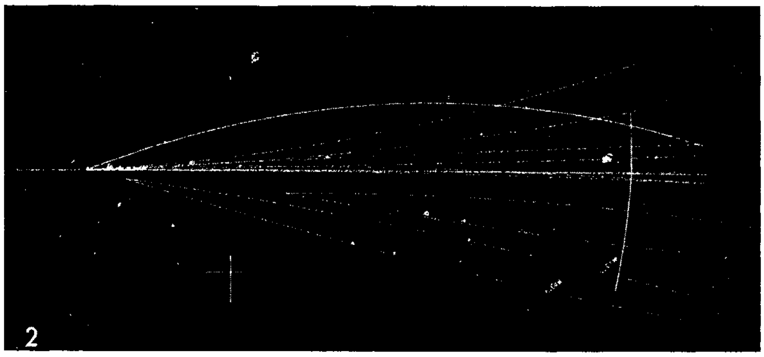
Photographs taken in the 30 inch bubble chamber at NAL with an incoming proton beam of 300 GeV :

1. A high multiplicity event — 24 particles emerge from the interaction.

2. Strange particle production.

3. A 25 prong event initiated by a high energy neutral particle.





the experiment is just beginning). Finally, a missing mass experiment using the Jacobian peak method is gathering its first data from proton-proton interactions.

The second active region is the 30 inch bubble chamber brought to NAL from Argonne. The chamber has been used for several experiments and, in particular, has yielded good data on multiplicities up to 300 GeV.

The chamber is located in the Neutrino Laboratory which is also the site of the 15 foot chamber. Repairs are now under way on the piston of the chamber and if they are successful, operation of the chamber will be attempted again very shortly. (As reported last month the chamber's large superconducting magnet is in action and has achieved its design figures.) If the repairs do not succeed, several months will be required to obtain a replacement piston. The approved programme for the chamber is exclusively neutrino physics with something like two years' worth of neutrino experiments lined up.

The Neutrino Laboratory also has a muon experimental area where two experiments studying the deep inelastic region are being prepared. In another area a narrow band neutrino beam will be used to study the variation of neutrino cross-sections with energy.

Construction of the Meson Laboratory is also well advanced and six beams — two of them neutral beams (kaons and neutrons) running one above the other — will be available. 200 GeV protons were first fed to the Meson Target Hall early in September and tuning of the beam is continuing. Less far advanced is the construction of the Proton Laboratory where three beam branches will be available. Protons were fed to the Laboratory for the first time also in September.

With the continuing improvements in machine performance and reliability the extensive programme scheduled for all three experimental Laboratories should be well launched during the coming year.

As we go to press, news has reached us that, on 14 December, the synchrotron has accelerated protons for the first time to 400 GeV. No further details are available for the moment but we may have more to report in the next issue.

RUTHERFORD
Computing by telephone

At the end of last year (vol. 11, page 330) we reported the 'instant commissioning' of the Rutherford Laboratory's large new computer — an IBM 360/195. The machine has continued to operate very reliably and there has been the additional advantage that it is completely compatible with the previous

The superconducting quadrupole doublet OGA (the white cylindrical unit to the rear) operating in a pion beam-line on the 3 GeV proton synchrotron, Saturne. Use of the quadrupoles more than doubled the pion flux and they performed without problem during their first run.

(Photo Saclay)

central computer (IBM 360/75). Most of the software was taken direct from IBM, the Laboratory adding a message transfer system and an interactive terminal file handling system. The only difference that users are aware of is that their computing goes through about five times as fast.

The computer has been operating up to now on a 24 hour, 5 days a week schedule with two 8 hour periods at the weekend. About 20 % of the computing time is assigned to the Atlas Computer Laboratory and is thus used by other than high energy physicists (work in theoretical chemistry, for example, taking a sizable part of this time). The computing load is climbing, however, and round the clock operation seven days a week is about to start. Out of this time, 6 to 8 hours usually goes to system development and about 4 hours to maintenance. Unscheduled shutdowns generally involve 1 to 2 hours per week.

Five satellite computers (a DDP224, two DDP516's, two IBM 1130's) control a variety of automatic measuring machines, graphics terminals and typewriters and are connected through IBM 2701 interfaces by fast data links. In addition remote workstations (small computer, card reader, line printer) are connected via 2400 baud Post Office leased telephone lines to a Memorex interface. The Memorex can handle 24 bisynchronous lines and 72 asynchronous lines. The latter are used for local typewriters and VDUs and can also be accessed through the PO switched public telephone network. In this way the Laboratory's computing facilities are accessible to other research centres (particularly Universities).

Centres which are now connected are Glasgow (360/44), Birmingham (360/44), Oxford (IBM 2780), Imperial College London (IBM 2780), Durham (IBM 1130), Westfield College (CTL Modular-I), CERN (IBM 278), RSRS Slough (IBM 2780), ATLAS Laboratory (IBM 130) and the Institute of Computer Science London (PDP9). The latter has been in operation since 1968 but use of the telephone network on this scale for the others is a new venture for the Rutherford Laboratory though such a system has been implemented before — the London University CDC 6600 and 7600 central computers have about twenty lines already in action.

Leased lines within the United Kingdom at 2400 bits per second cost between £1400 and £3250 per year. The CERN link which can be used by UK teams who are involved in experiments at the PS and ISR is obviously more costly being of the order of £14 000 per year.

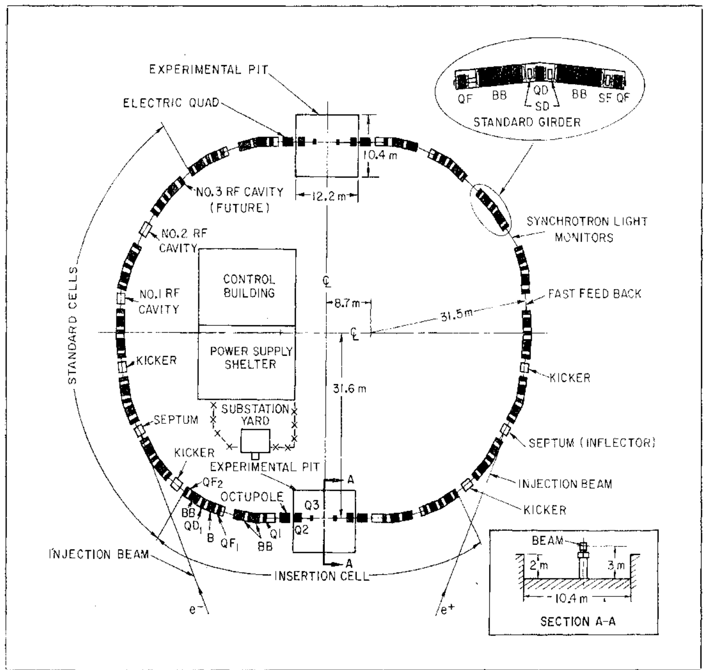
Many of the present workstations are rented and will be replaced next year by thirteen stations based on the GEC 2050 computer (including five for the Atlas Laboratory). These small systems have a central processor of 16 Kbytes core, card reader, line printer and teletype console. Later it is intended to add further consoles and VDUs.

The existing workstations came into action fairly smoothly after the initial teething troubles were cleared. For example, the Imperial College, London station took about a month to tidy up while the Durham station was doing work after only three hours.

'Dial a computer' seems to be with us.

SACLAY
OGA doubles pion flux

The superconducting quadrupole doublet OGA has been brought into action for a physics experiment on the 3 GeV proton synchrotron, Saturne, *Diagram of the layout of components in the electron-positron storage ring SPEAR at Stanford. Beam input lines are at the bottom of the ring on the diagram. The two experimental regions are located symmetrically in the ring, top and bottom. Control and power supply buildings are inside the ring. On the right is picked out the components sequence on a 'standard girder' and an indication of the space available for the installation of detectors around the colliding beam zone.*



at Saclay. The experiment is studying the interaction $\pi^- + p \rightarrow \pi^+ + \pi^- + N$ in order to gain insight, via the so-called Chew and Low approximation, into the interaction between a negative and positive pion.

The approximation only applies for incident pion momenta in excess of 2 GeV/c and, since Saturne is a low energy machine, the flux of higher momenta pions falls off rapidly above 2 GeV/c. It is in order to catch as many of these pions as possible that OGA has been used.

The number of pions which can be captured in the beam is proportional to the peak quadrupole focusing field which can be applied to the beam (presuming constant quadrupole apertures). Hence the interest in bringing OGA to bear with the higher fields that superconductivity makes possible.

The doublet was described in the May issue page 171. The useful apertures are 20 cm for the first quadrupole and 30 cm for the second. Peak focusing gradients are 35 T/m and 23 T/m respectively. It is positioned close to the target bombarded by the Saturne beam (the photograph shows the last element, a conventional quadrupole, of this beam which is followed by the target and then OGA). Pion fluxes were up by a factor of 2.6 with the help of OGA.

This makes it possible to study the pion interaction with higher pion energies than was feasible previously. This is an important ability since the Chew and Low approximation is more exact the higher the incident pion momentum.

During a ten day run, the quadrupole doublet performed as required without any need for intervention. Particularly successful were the automatic systems for nitrogen and helium refillings. This enabled the experiment to be carried out without interruption just as with conventional beam elements.

STANFORD SPEAR progress

Some news from the electron-positron storage ring SPEAR. By the time this is read, the performance figures may well have changed because the SPEAR team has not displayed much ability to stand still.

To recall briefly some of the major features of the ring : The peak energy is at present 2.8 GeV (limited by available r.f. power) though ring components are built to handle beams of up to 4.5 GeV. The layout of the ring is shown in the diagram. In the two experimental regions, low beta sections are installed to produce a maximum luminosity of 10^{32} per cm^2 per s at 2.3 GeV. A figure of 2×10^{30} has been achieved at 1.5 GeV (which is the injection energy).

Studies on the beams have revealed phenomena which can be readily interpreted such as the head-tail effect controllable with sextupoles and feedback systems. However, above about 40 mA there can be abrupt loss of particles which is not yet understood. Bunch lengthening with increasing bunch current also follows predictions but there is a related bunch widening, seeming consistent with a change in energy spread which is also not yet understood. Most importantly, however, the observed luminosities have followed predictions closely and the low beta insertions seem to perform as designed.

The luminosity which has been achieved is already healthy enough to support a vigorous experimental programme.

Experiments are about ready to go to study questions in quantum electrodynamics (limits of QED, electron-muon universality, search for heavy muons), form factors (ee→pp, $\Lambda\bar{\Lambda}$ etc., measuring q^2 dependence), inelastic scattering ($ee \rightarrow pX$, ΛX, etc...). One beam collision region will have a large multipurpose detector installed. It involves a large solenoid magnet with smaller solenoid compensators at each end to ensure that the overall effect of the detector's magnetic fields on the orbiting beams is zero. The central solenoid is 3 m in diameter, 3 m long and is designed to produce a 0.4 T field on its axis. Detection will involve a multiwire proportional chamber, a series of cylindrical wire spark chambers (the largest being 2.5 m diameter) and scintillation counters. The solenoid has an aluminium coil which is further surrounded by lead scintillator shower counters, a 20 cm thick iron return yoke and a muon detector. A Sigma 5 computer will be on-line. Many components of the detector are already tested and it is hoped that it will be in action, initially for a survey experiment, early in 1973.

Moves have already started on an improvement programme for SPEAR. The most obvious next step is to install more r.f. so as to be able to push the peak energy to 4.5 GeV. The r.f. frequency will be taken higher to 358 MHz and a set of Los Alamos type cavities will be used possibly with slot-coupling rather than side-coupling. About 2.5 MW of d.c. power will also be added to take the magnets to the 4.5 GeV level. It is hoped to complete this programme by July 1974.

DARESBURY SRF successful start

The Synchrotron Radiation Facility at the Daresbury Laboratory is now in operation. The Laboratory's 5 GeV electron synchrotron, whilst providing beams for the high energy physics programme, is also a powerful source of synchrotron radiation (see April issue, page 130) and a wide range of experiments are possible using this radiation in fields such as molecular biology, solid state physics, astrophysics, atomic and molecular physics and photo-electron spectroscopy.

With the electron synchrotron operating optimally for high energy physics experiments, its synchrotron radiation, emitted by the relativistic electrons as they are forced to follow curved trajectories within the accelerator, provides a light source extending continuously from the X-ray to the visible regions of the spectrum. It is a powerful source of highly polarized light. The angular divergence of the light from the horizontal plane is approximately one milliradian and this degree of parallelism is comparable with that obtained using lasers.

Comparison of the properties of synchrotron radiation with those of other light sources is revealing. Conventional sources in the vacuum ultraviolet are unpolarized, comparatively weak, and usually yield a line spectrum. Variable wavelength lasers currently cover only a very limited region in the visible and ultra-violet. Radiation from a synchrotron, such as that at Daresbury, has an r.f. structure which can be used to give time resolved information. These and other factors make synchrotron radiation a light source with unique properties.

The typical purpose of many of the experiments is to find the photon energy required to excite a system from the ground state to another state. The usual way of obtaining such information is to measure the absorption of a sample as a function of wavelength. When the photon energy is such that it causes transitions, an absorption dip in the spectrum is observed. The basic component of instruments for making such measurements is the monochromator. A selection rule for dipole transitions depends upon the relative orientation of the plane of polarization of the incident light and, for example, a symmetry direction within a molecule. Since molecular alignment occurs in certain crystals, it is clear that the high polarization of synchrotron radiation can be used to investigate this aspect of transitions.

Three monochromators have been installed in the SRF at Daresbury by groups from Cambridge, Manchester, Oxford and Reading Universities. They are horizontal dispersion and vertical dispersion Wadsworth monochromators and a grazing incidence monochromator. Studies of the absorption of thin film alkali halides, metallic vapours and organic materials are underway.

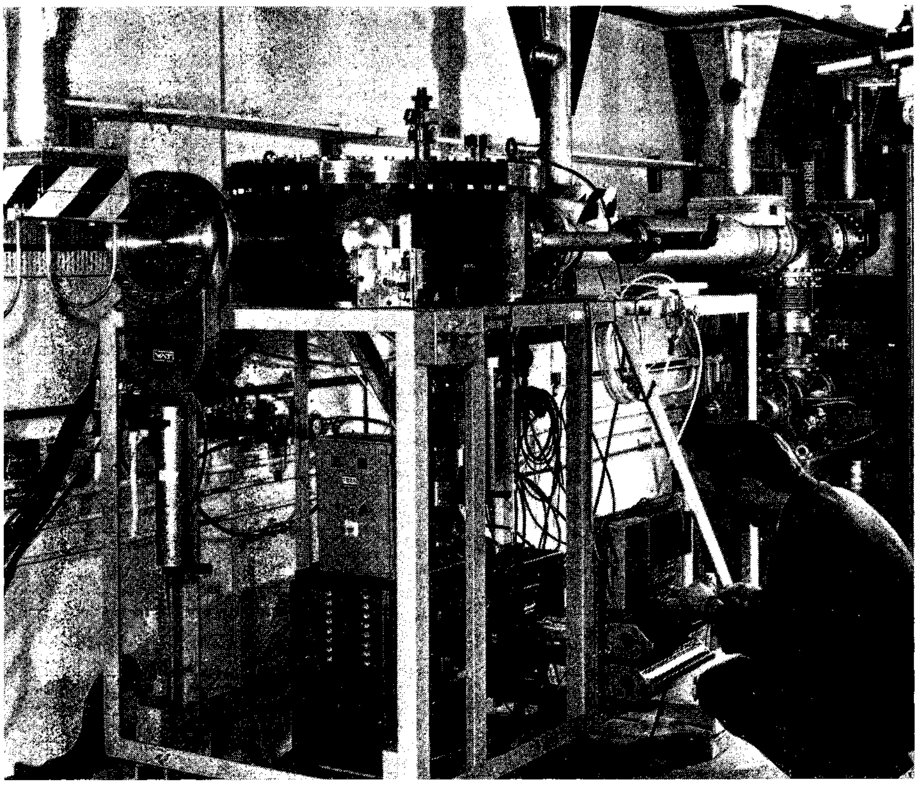
Early in 1973 a preliminary experiment to measure and use 1.5 angstrom X-rays in the facility will be installed jointly by the Muscle Group from the MRC Laboratory of Molecular Biology, Cambridge and the Membrane Structure Group from King's College, London. It is hoped that this work will enable the group to study changes in the weaker parts of the diffraction pattern when muscles contract and to follow the detailed time course of the structural changes associated with activity. In addition, it is hoped that the X-ray equipment will provide many possibilities for following structural changes in membranes associated with their function.

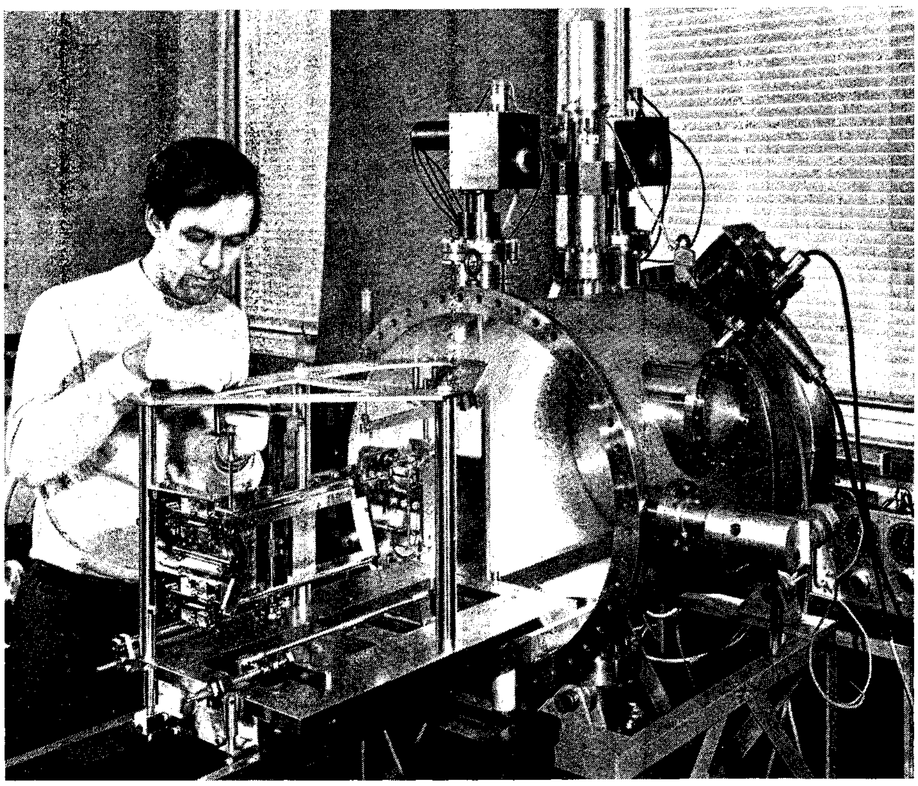
An electronics and data collection system has been designed for the SRF providing each monochromator with an identical set of basic equipment. This comprises stepping motor, shaft digitizer, input registers and counters. Each monochromator has a separate CAMAC crate through which all data logging and control operations are carried out. Each crate has a Vista television monitor with a keyboard for interaction between the user and the system and to provide a certain degree of data monitoring. Additional monitoring is provided by a spectrum plot on

Beam tube in the Daresbury Synchrotron Radiation Facility. About a third of the beam is intercepted by the Wadsworth normal incidence monochromator which can be seen in the photograph and the monchromatic light so produced is used for spectroscopic experiments in the 400 to 3500 angstrom region.

Interior of the grazing incidence monochomator used for absorption spectroscopy in the 40 to 360 angstrom region at the SRF. Monochromatic radiation emerges from either of the two slits visible on the left hand side of the instrument. A resolution of 0.2 angstroms at 170 angstroms has been achieved so far.

(Photos Daresbury)





a storage oscilloscope. The whole system is permanently under the control of a program in a H316 computer.

The system accepts information typed in by the user specifying a set of spectrometer operations and then automatically executes the operations and displays and stores the data accumulated. The user may interrupt the program using the keyboard at any time to specify changes in the sequence of operations. Like the on-line computers used in high energy physics experiments, the H316 computer is connected by a fast data link to the Daresbury central computer, an IBM 360/65. This makes available all the powerful facilities of the central computer system.

To consider developments in the field of synchrotron radiation spectroscopy, a study group has been set up at Daresbury to look at possible improvements which could enhance the long term usefulness of the facility.

In January 1973 the Laboratory will be host to approximately 100 guests from all over the world at an International Symposium for Synchrotron Radiation Users. It is expected that the advantages to the physicists of collaborating within national laboratories (that have long been apparent in high energy physics) will be evident at the Symposium.

BERKELEY/DUBNA Recalcitrant ERAs

A few notes on the development work on electron ring accelerators at Berkeley and at Dubna.

Berkeley have had their new injector in operation at 4 MeV for a year and a half and research can now go ahead methodically without interference from other injector users. Runs take place for about 3½ days per week and with a pulse repetition rate of 1 per 3 s a lot of data is being collected.

The studies are still concentrated on what happens to the injected electrons after they have formed rings and during the first few turns at the start of compression to give smaller rings. Improved instrumentation is giving good knowledge of the ring behaviour but it is still difficult to understand what is happening. When the circulating intensity is increased, the momentum spread goes up seemingly due to some instability and at about 10^{13} electron levels the ring quality is poor. Only when these phenomena are understood and mastered will attention move to compression, injection of ions and acceleration of the loaded rings.

At Dubna, where alpha particles were accelerated in electron rings about two years ago, no more spectacular results have been announced. They are using the same compressor but with a new coil configuration and an electrostatic septum for injection. A new injector designed to provide 2 kA pulses of 20 ns duration is being tested. It has provided 1.5 kA pulses of 20 ns at 3.5 MeV.

A new compressor chamber is being built and an acceleration section of the r.f. type (rather than the ring expansion type used up to now) is ready for installation. Work on a superconducting r.f. section continues.

On the theoretical side, calculations of longitudinal stability indicate that the holding power of the rings is lower than the initial calculations suggested. The holding power is proportional to the peak compressing field and therefore if it proves possible to compress in higher fields the holding power would become healthy again. For the moment, however, the multi-GeV proton acceleration ideas are not discussed and all the emphasis is on heavy ions. At Dubna, for example, the very successful nuclear physics group of G.N. Flerov is very keen to accelerate xenon ions to high energies in an attempt to produce the comparatively stable superheavy elements predicted to exist around element 114.

UPPSALA Conference

The Fifth International Conference on High Energy Physics and Nuclear Structure will be held at Uppsala, Sweden from 18-22 June 1973. It is sponsored by IUPAP with the Gustav Werner Institute as the main organizer.

This series of conferences started at CERN in 1963 with the intention of bringing the diverging fields of high energy and nuclear physics together. Since then there have been meetings at Rehovot (1967), Columbia (1969) and Dubna (1971). The conferences are meeting grounds where particle physicists and nuclear physicists discuss the use of elementary particles in the study of the nucleus and also the nucleus as a tool in analyzing high energy phenomena.

The Uppsala Conference will change the approach somewhat in dividing topics according to the physical phenomena being studied rather than according to the methods or projectiles used. The draft programme has six headings: Elementary particles as nuclear probes (their properties and elementary interactions), Elementary and composite particle interactions with nuclei (nuclear scattering production processes, capture processes), Nuclear structure (gross features, microscopic features), Nuclei as tools in elementary particle physics, New instruments and future trends, Applications to other fields.

Attendance is by invitation and between 300 and 400 participants are anticipated. Further information may be obtained from G. Tibell, The Gustaf Werner Institute, University of Uppsala, Box 531 751 21, Uppsala 1, Sweden.

CC Correspondents

We close this volume of CERN COURIER recording our appreciation of the help we have received during the year from our correspondents in other Laboratories. Their participation in pulling information together for the journal is very valuable.

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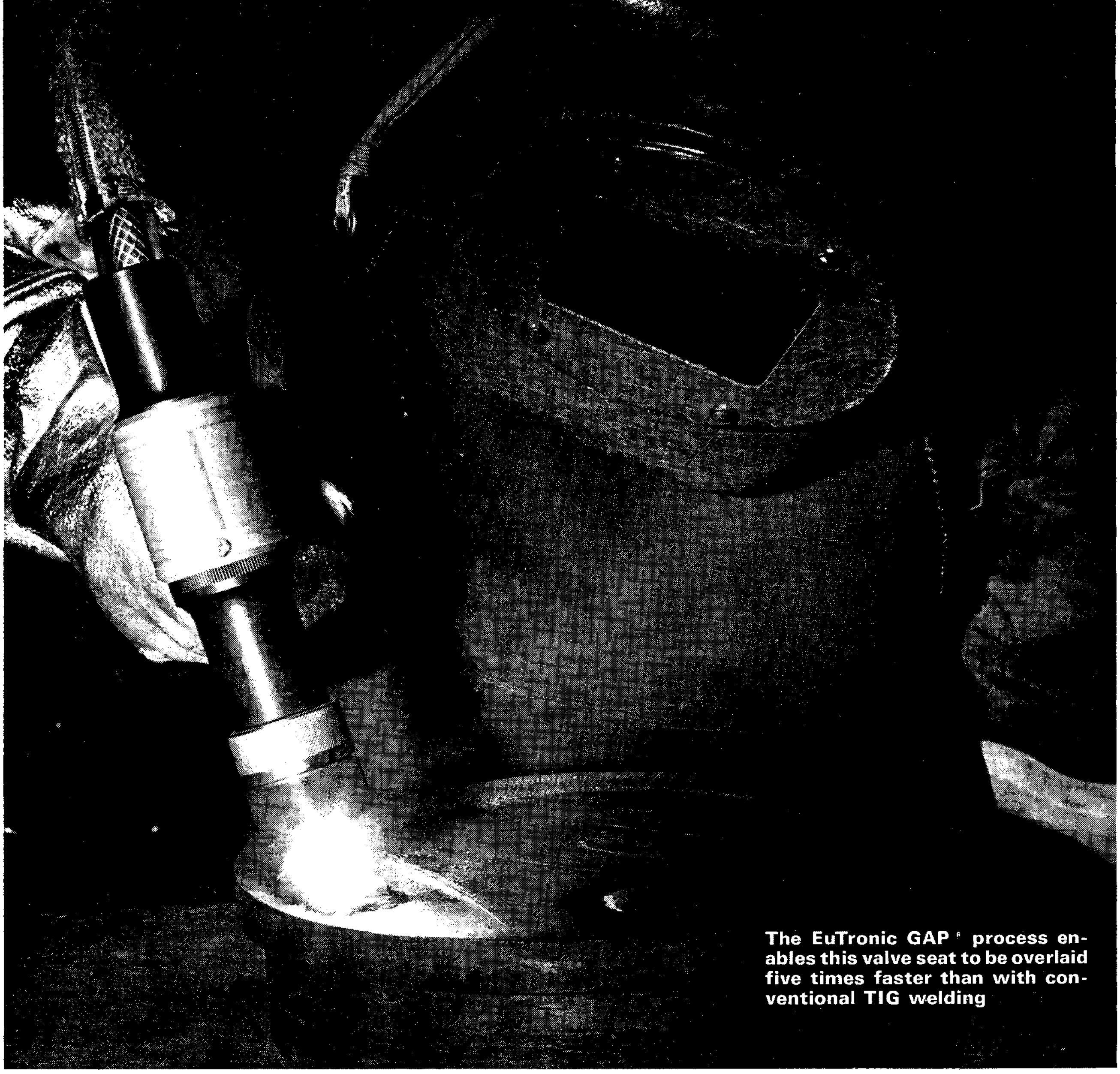

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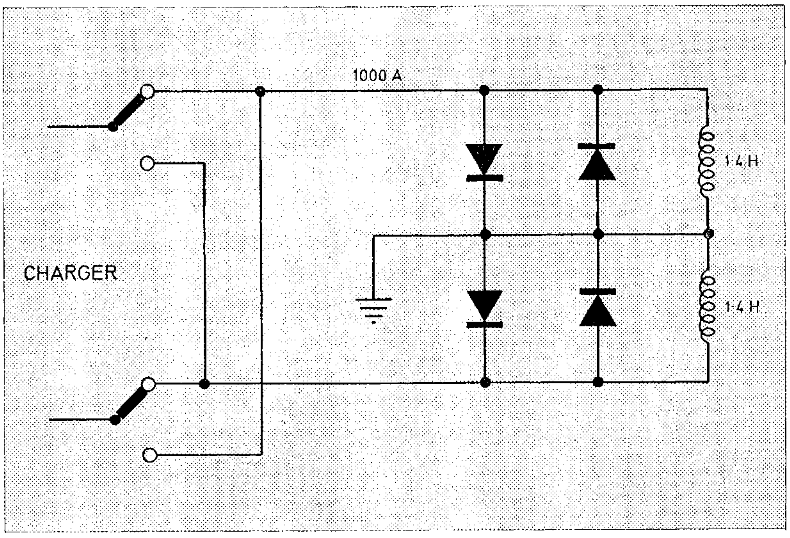

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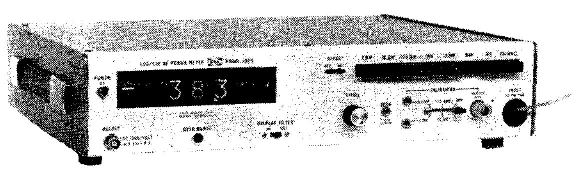

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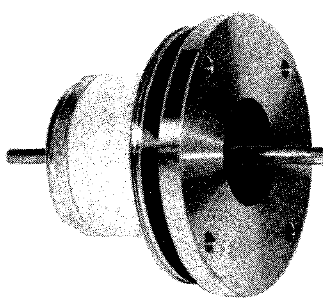
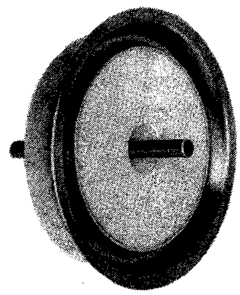
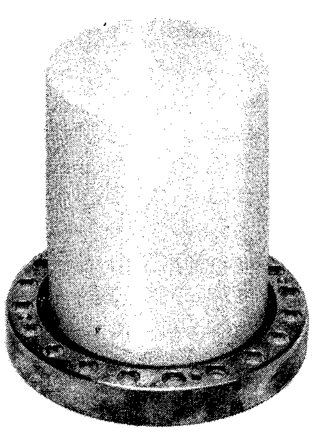
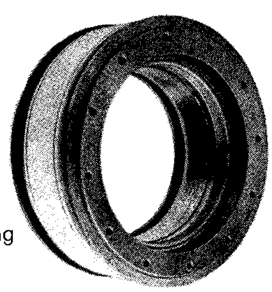




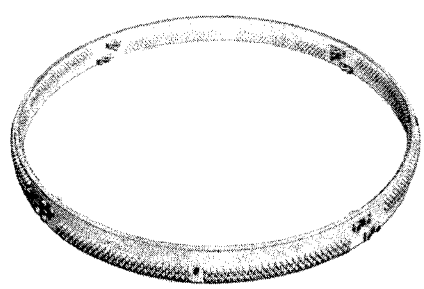
High voltage bushings

High accuracy interaction gap





Rf coupling element



Ceramic ring with hundreds of bushings

Special features

- Vacuum sealed
- High breakdown voltage
- High rf properties
- High resistance to mechanical and thermal shock
- Increased corrosion resistance (optional)
- Ceramic surface specially treated for low lossfactor (optional)
- High bake-out temperatures up to 1200 °C for no outgassing

This represents only a fraction of our product line. You can also obtain from us complete rf generators, electron tube cavities, particle accelerator cavities, drift tubes etc. Our capabilities especially in the area of high quality metal-ceramic seals result from many years of experience in manufacturing many types of electron tubes.

Just contact us with your problems, we can assist you in the development of new systems and prototypes.

For more details please contact:

Siemens Aktiengesellschaft,
Bereich Röhren,
D-8000 München 80, St.-Martin-Str. 76

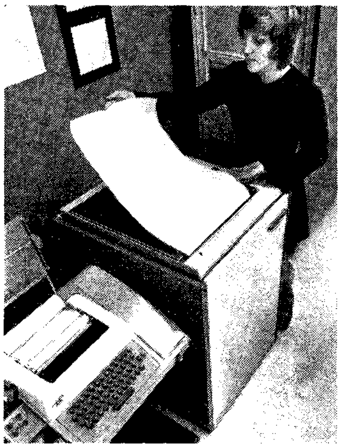
System Engineering from Siemens

B 32/7301.101

varian

STATOS 31™

Electrostatic Printer/Plotter

New  **New**

- 132 or 140 characters per line
- 38.1 cm paperwidth
- Simplified programming through autostep (DMA-operation)
- On-line and off-line software available
- Interfaces for most computers available

Please ask for detailed documentation or a demonstration.

(7013 EE)

Industrievertretungen
Junkholz 333 – CH-8968 Mutschellen

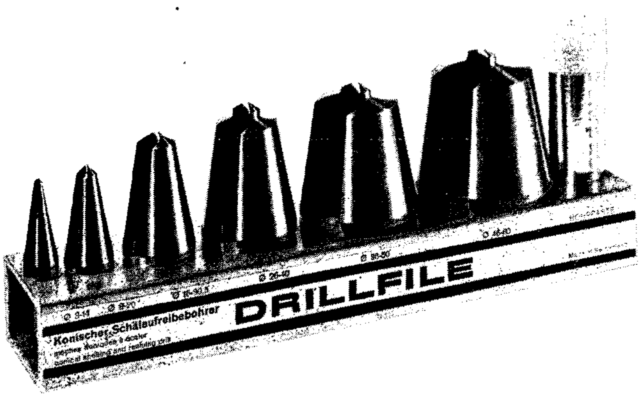
STOLZ AG

Tel. 057 5 46 55

The tapered slabbing and reaming drill is economical and very useful

DRILLFILE

special drill



for the economical mounting of car aerials and car radios, car calling units as well as telecommunication devices **DRILLFILE** is recommended by leading firms all over the world. In its measurements **DRILLFILE** accommodates all requirements.

TIPSWITOOL
1564 DOMDIDIER / Switzerland

Sintox®

alumina ceramics
hard facts about Sintox

Hardness (rockwell)	45 N Scale	80–85
Specific Gravity	g/cm³	3.65–3.83
Compressive Strength	kp/mm²	160–168
Tensile Strength	kp/mm²	19
Transverse Breaking Strength	kp/mm²	28–32
Neutron Absorption Cross Section	cm³/gram.	FF Grade: .0060 EH Grade: .0029
Deformation Temperature (CVD)	°C	1450–1650
Dielectric Constant		1 Mc: 8.9–9.2 70 Mc: 8.9–9.2
Dielectric Strength	kV/mm (peak)	FA and FF Grade: 20

Based on the above mentioned and other excellent properties, SINTOX is used increasingly in the following industries:

Nuclear, Machines, Pumps, Electrical and Electronic, Chemistry, Textile, etc. etc.

More information through the Swiss-Agent for Sintox:

FIBAG

Industrial Division
Kernstrasse 57, 8026 Zürich
Tel. 01 39 48 88, Telex 53347

2/72/Fl

ifélec S 200

Table traçante XY
grand format 30x40cm
fabrication française

Précision-Stabilité-Fidélité
< au 1/1000ᵉ
garantissant une excellente reproductibilité des tracés

Conception modulaire
Nombreuses extensions
Lecteur de tracé pour numérisation
Commutateur de voies (2 à 6)
Tracé automatique à partir d'un ruban perforé
Dérouleur de papier y = f (t)

La table S 200 dispose également de modules base de temps ; préamplificateur, décalage d'origine, convertisseur logarithmique, détecteur d'équilibre pour analyseur multicanaux, etc.
Sa haute sensibilité : 50 ou 200 µV/cm, ainsi que sa vitesse d'inscription : 60 cm/s atteinte en 50 ms sur les 2 axes, assurent un faible déphasage entre les deux voies.

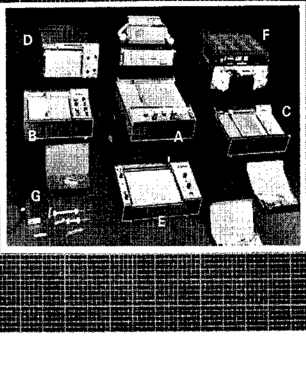
Présentation : modèle de table ou rack

Température d'utilisation : 0 + 55°

Pour tous renseignements, veuillez retourner le bon-réponse ci-dessous à :

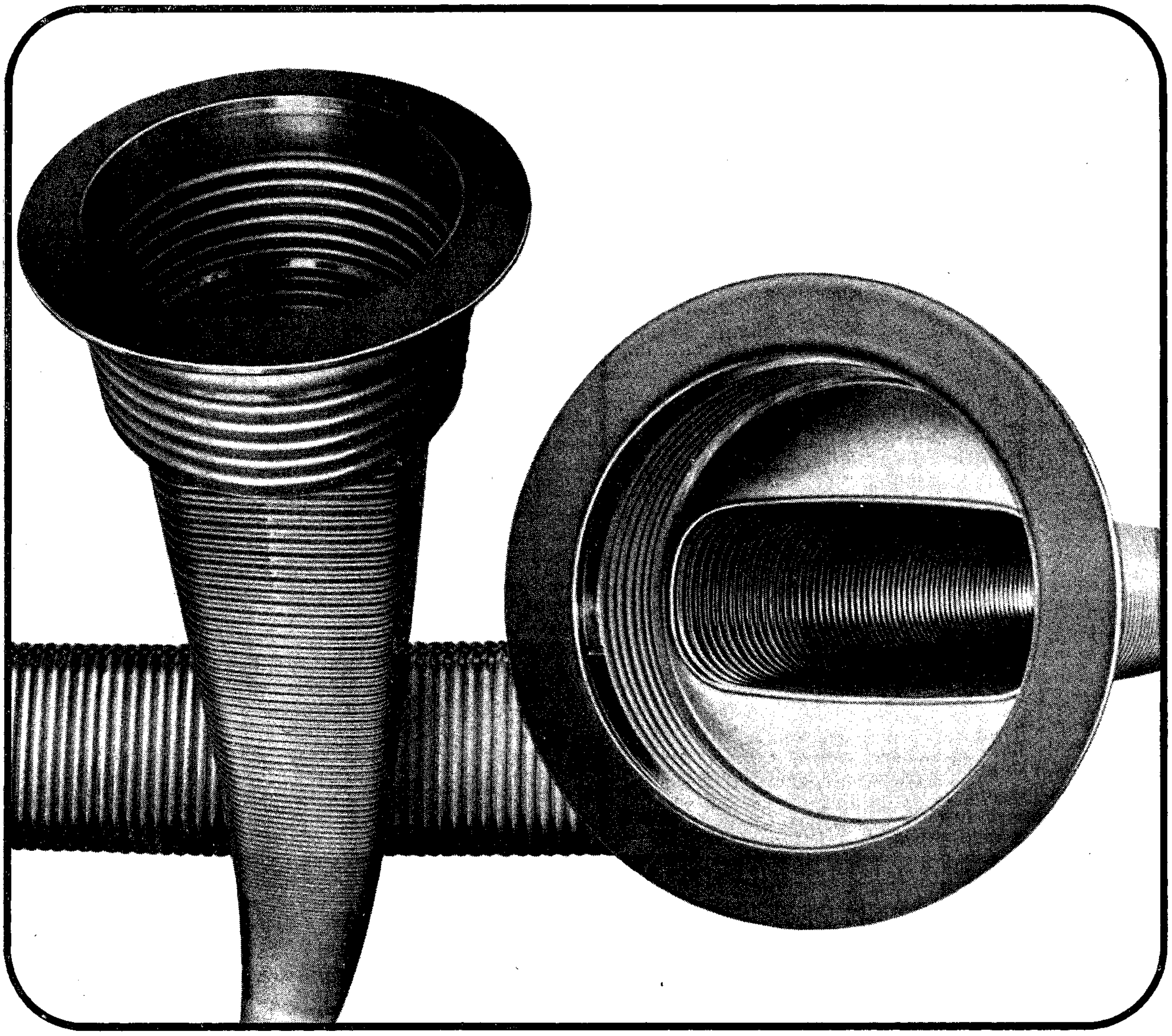
ifélec 1ᵉʳ CONSTRUCTEUR FRANÇAIS DE TABLES TRAÇANTES XY

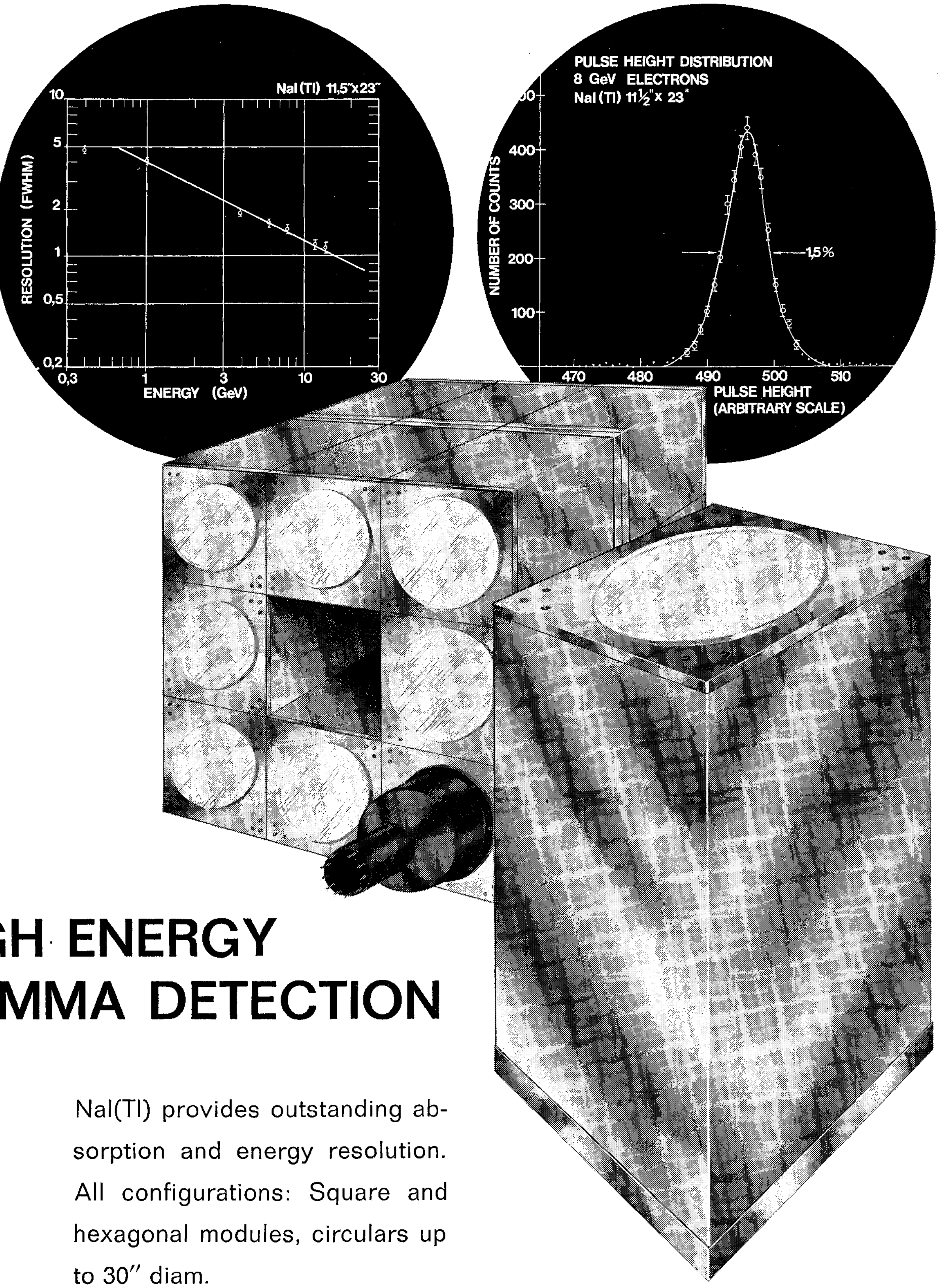
Distribué par la Sté Commerciale CHAUVIN-ARNOUX
188, rue Championnet - PARIS 18ᵉ - Tél. : 627 41-42

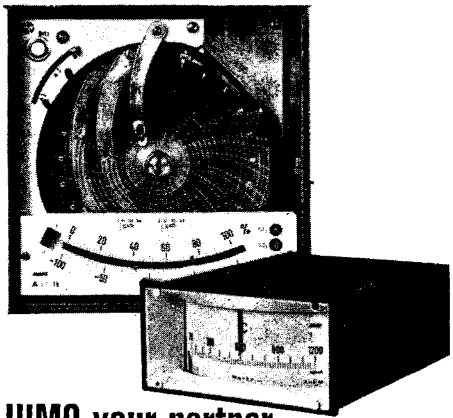


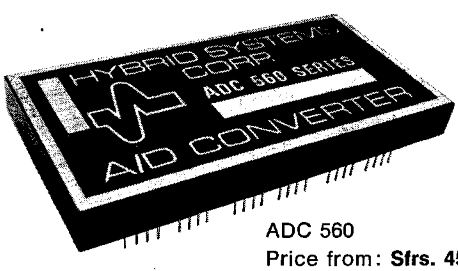
	documentation	proposition	démonstration
A - S 200			
B - Table XY 2025			
C - Table XY 2025 S à cde numérique			
D - Enregistreur bicourbe XD			
E - T5 SM - Analyseur de spectre			
F - Centrale de mesure évolutive EBP 50			
G - Capteurs de déplacement			

M ....
Fonction ....
Société ....
Rue .... N° ....
Ville ....
Département ....

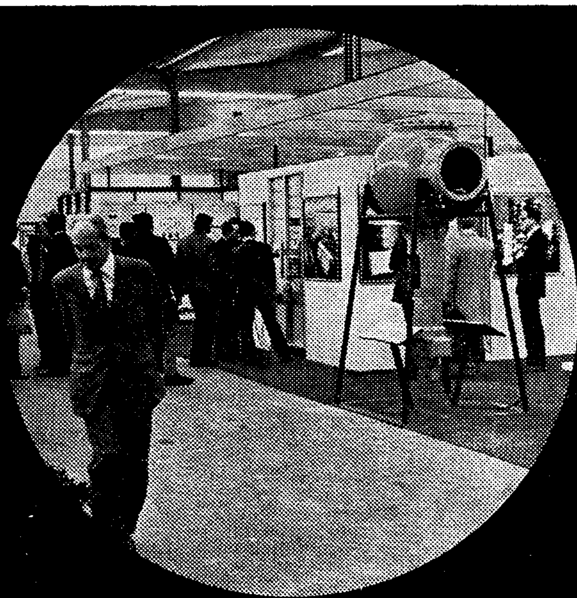



NaI(Tl) 11,5"x23"
RESOLUTION (FWHM)
ENERGY (GeV)
10
5
2
1
0,5
0,2
0,3
1
3
10
30
PULSE HEIGHT DISTRIBUTION
8 GeV ELECTRONS
NaI(Tl) 11½"x 23"
NUMBER OF COUNTS
400
300
200
100
1,5%
470
480
490
500
510
PULSE HEIGHT
(ARBITRARY SCALE)





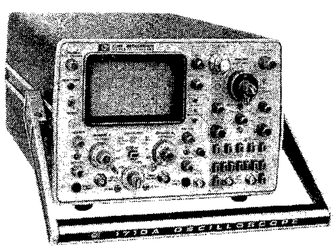
HYBRID SYSTEMS CORP.
ADC 560 SERIES
A/D CONVERTER



Le cas Hewlett-Packard

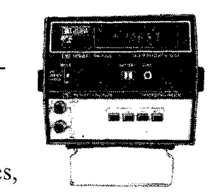
L'oscilloscope portatif

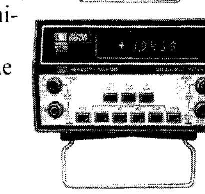
Le modèle 1710 A est venu se joindre à la grande famille des oscilloscopes portatifs Hewlett-Packard. C'est un appareil robuste, à double canal, 150 MHz. Conçu comme instrument de laboratoire, il peut être utilisé également en service externe, même dans des conditions particulièrement délicates.
Son grand écran de 6 × 10 cm permet une visualisation nette et lumineuse des impulsions rapides rencontrées fréquemment dans les circuits modernes. D'autre part, un mode nouveau d'utilisation permet de doubler la luminosité, sur une échelle réduite, pour la représentation de phénomènes ultrarapides jusqu'alors invisibles à l'oscilloscope. Cet instrument possède également quelques autres particularités intéressantes:
Une impédance d'entrée commutable de 50 ohms ou 1 mégohm, une sensibilité de 5 mV par cm sur toute la largeur de bande, des possibilités multiples de déclenchements électroniques, ainsi qu'une double base de temps.
Une démonstration vous convaincra certainement des possibilités étendues de cet oscilloscope portatif. N'hésitez donc pas à nous contacter.



Le voltmètre digital multiforme

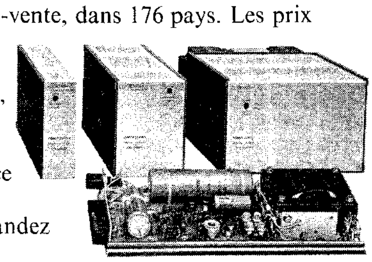
Combien de fois vous est-il arrivé de chercher en vain, un multimètre digital, aux qualités multiples, pour le prix modéré d'un instrument analogue?
Hewlett-Packard offre aujourd'hui une solution à ce problème et vous présente son modèle 3470. Il représente beaucoup plus qu'un voltmètre digital habituel. Il s'agit en fait d'un instrument de mesures pratique, polyvalent, exemplaire quant à son prix et à ses performances.
Combinez vous-même le modèle qui vous convient le mieux, en utilisant l'unité d'affichage d'une part, et les différents modules de mesures d'autre part. Faites-en par exemple un voltmètre à courant continu de 4 gammes, ou encore un multimètre DC/AC possédant en outre 6 échelles de mesures de résistances.
Pour une utilisation indépendante du réseau, il est facile d'intercaler un élément batterie. De plus, en nouveauté, un module BCD interchangeable vous est offert pour coupler votre multimètre à une imprimante numérique. D'autres éléments sont en préparation, qui vous permettront d'étendre ce système à d'autres types de mesures, à tout instant et pour un prix minimum.
Prenez contact avec nous pour une présentation.





La tension qu'il vous faut!

Une heureuse nouvelle pour les constructeurs d'équipements! Une série entièrement nouvelle de sources stabilisées est offerte à votre choix, et quand nous parlons de choix, nous pensons effectivement qu'il s'agit de pouvoir choisir!
Nous mettons à votre disposition des blocs d'alimentations modulaires de la série 62000, qui existent actuellement pour les tensions de 3 à 48 volts. De plus, chacun d'eux est livrable en 4 intensités différentes. Tous ces appareils bénéficient du réseau local de services après-vente, dans 176 pays. Les prix également ont été ajustés pour satisfaire à votre demande, et des rabais OEM sont offerts.
La fiabilité de ces appareils répond aux exigences les plus poussées, chaque élément étant d'ailleurs surdimensionné. Tous les modules possèdent en outre une protection contre les surtensions, une limitation réglable du courant, des sorties indépendantes, en fait tout ce que vous attendez d'une alimentation de qualité Hewlett-Packard.
Les modules de la série 62000 sont livrables à courts termes. Demandez une documentation détaillée.



Hewlett-Packard (Schweiz) AG, 9, ch. Louis-Pictet, 1214 Vernier, tél. 022 41 49 50, télex 27333 *HEWLETT hp PACKARD*

3724

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All enquiries to:
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1211 GENEVA 23 Switzerland
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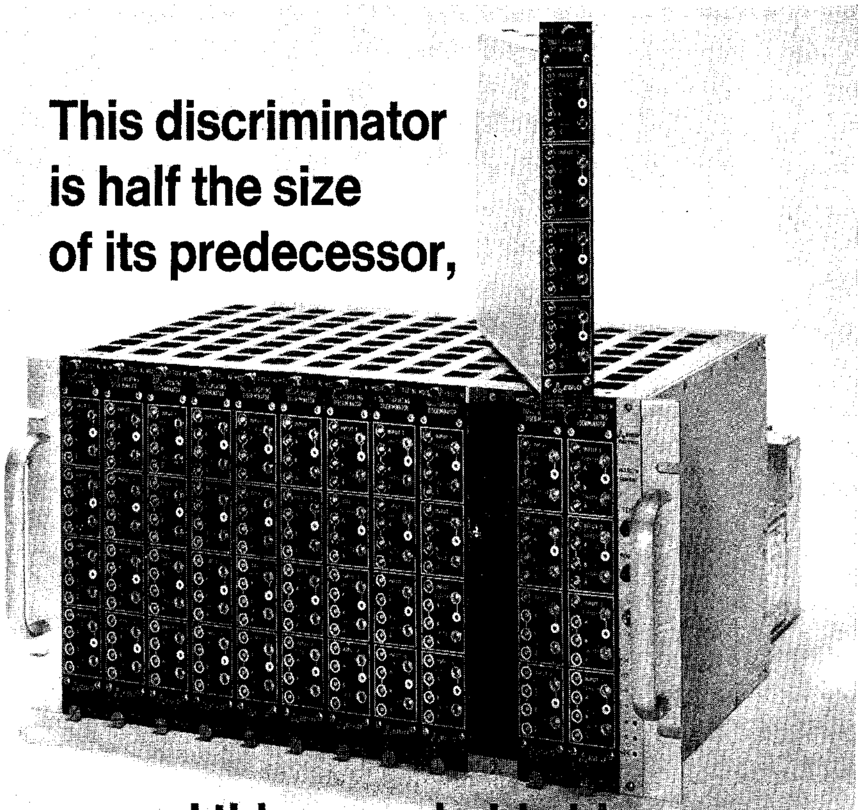
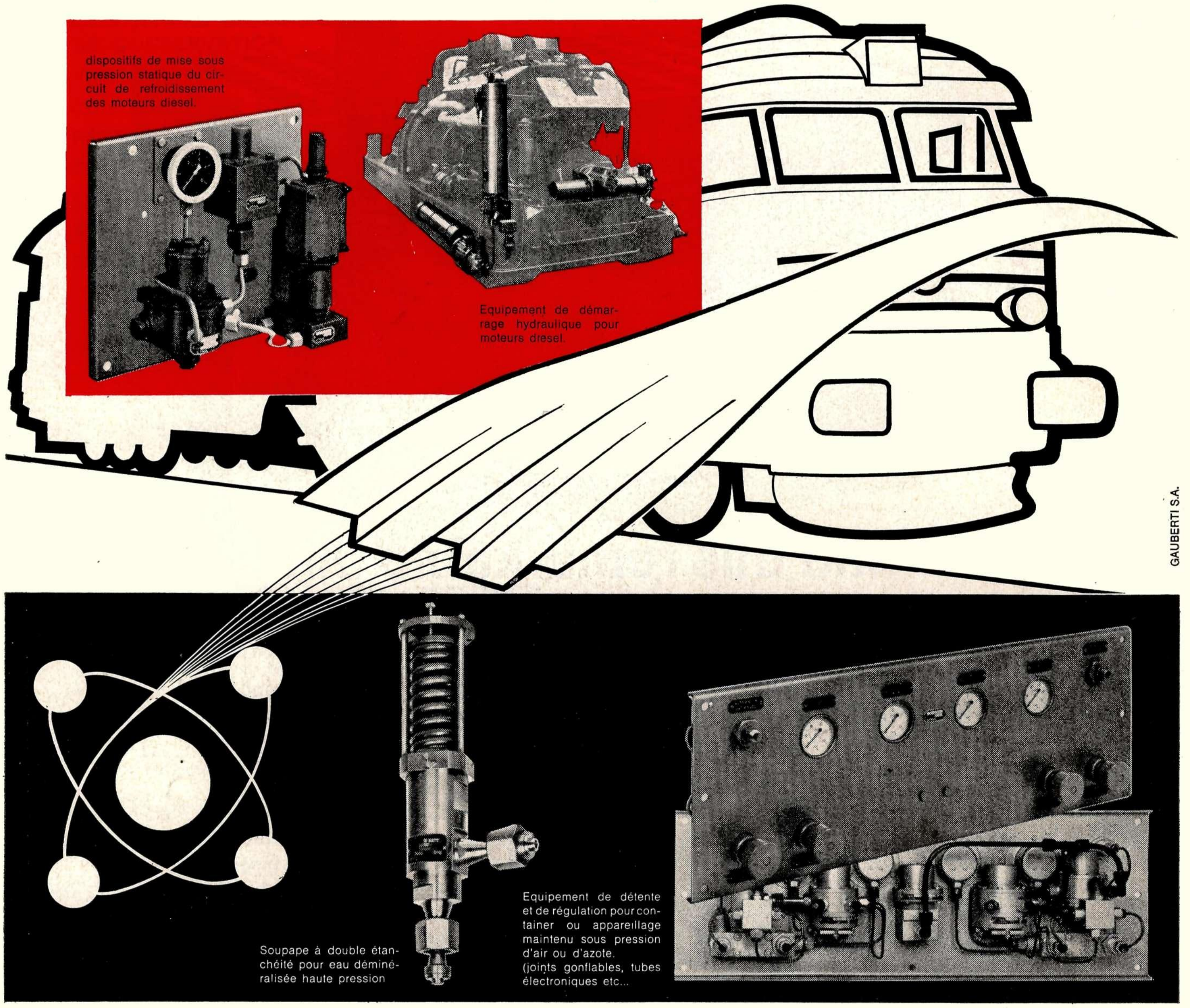


tout problème difficile

dont la solution implique l'emploi de commandes hydrauliques ou pneumatiques est du ressort de la technique ETNA



GAUBERTI S.A.

ETNA étudiera votre problème et vous proposera une solution dont l'expérience et la réputation ETNA en ce domaine garantissent la valeur.
le cas échéant, des appareils adaptés à votre cas seront étudiés et créés spécialement.

QUELQUES REALISATIONS

- Commandes oléo-pneumatiques pour disjoncteurs
- Installations de stockage (250 bars), d'assèchement, de distribution et de régulation d'air comprimé pour disjoncteurs pneumatiques à haute tension
- Commandes hydrauliques à distance
- Suspension hydraulique pour chemin de fer à crémaillère
- Enclencheurs synchrones à commande oléo-pneumatique pour contrôler l'instant de fermeture d'un circuit électrique à très forte intensité
- Commande hydraulique de changement de vitesse mécanique de locomotives diesel électrique
- Commande hydraulique de freinage de matériel de câblerie
- Commande hydraulique de décrasseur automatique de chaudières à charbon

NOTICE 24 TPC

15 A 19, RUE LOUIS BLANC **ETNA** 95 - ARGENTEUIL - FRANCE
PARIS (1) 961-51-06 - CABLE : ISOETNA - ARGENTEUIL - FRANCE